EVALUATION OF THE PERFORMANCE EFFICIENCY OF THE TOWN OF WINDERMERE STORMCEPTOR UNITS

Final Report
April 2010

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SECTION 1

INTRODUCTION

This document provides a summary of work efforts conducted by Environmental Research & Design, Inc. (ERD) for the Town of Windermere to evaluate the pollution reduction efficiencies of two recently installed Stormceptor units. A general location map for the Town of Windermere is given on Figure 1-1. The Town is located in southwest Orange County, west of the City of Orlando, and southeast of Lake Apopka. The Town of Windermere consists of a rural residential community with unpaved dirt roads throughout most of the residential areas. A study conducted by ERD (2004) indicated that the existing dirt roads contribute significant loadings of suspended solids and nutrients during storm events. The Stormceptor units evaluated as part of this project were designed to capture sediment loadings from the residential areas prior to discharge into the adjacent receiving waterbodies. Photographs of the existing dirt roads in the vicinity of the installed Stormceptor systems are given on Figure 1-2.

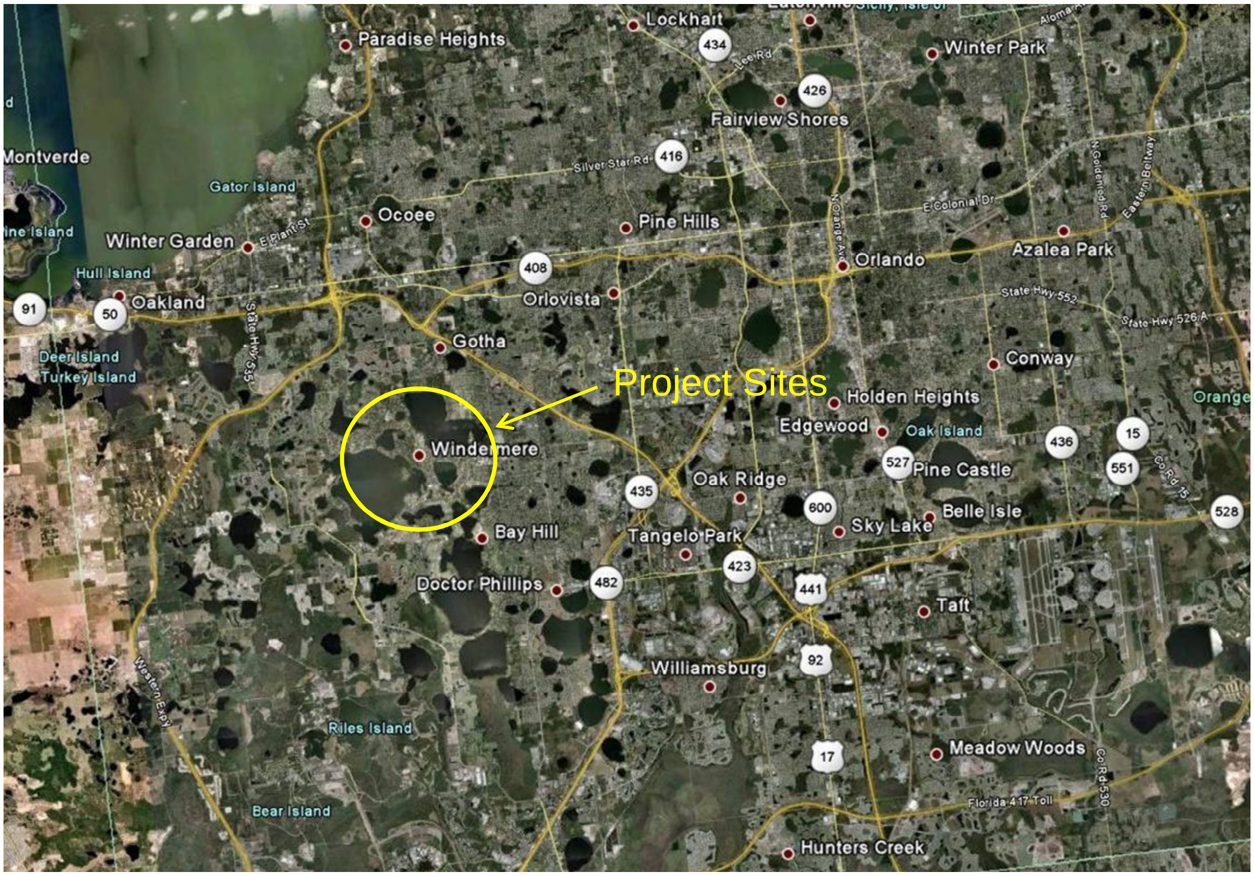


Figure 1-1. General Location Map for the Windermere Stormceptor Sites.

a. Pine Street Site

b. Lake Street Site

Figure 1-2. Dirt Roads in the Vicinity of the Stormceptor Sites.

The Town of Windermere is surrounded by a series of large interconnected waterbodies which are referred to as the Butler Chain-of-Lakes. The Butler Chain-of-Lakes consists of 11 interconnected waterbodies with a total combined surface area of 5040 acres. Historically, the Butler Chain-of-Lakes have been renowned for their excellent water quality and good fishing and are heavily used for recreational activities, such as boating and water sports. The Butler Chain-of-Lakes was designated as an Outstanding Florida Water (OFW) by the Florida legislature in 1987. Outstanding Florida Waters are defined as "waters designated by the Environmental Regulation Commission as worthy of special protection because of their natural attributes".

Locations of the Stormceptor monitoring sites are indicated on Figure 1-3. The Stormceptor systems were constructed to reduce pollutant loadings, consisting primarily of TSS and vegetation debris, discharging from the unpaved roads into the adjacent Chain-of-Lakes. Two separate Stormceptor devices were installed, with one providing pollutant load reductions for discharges from the Town into Lake Down, and the second providing load reductions for discharges from the Town into Lake Butler. The Town of Windermere conducts periodic grading of the dirt streets on an as-needed basis. The streets are drained by a series of shallow swales and driveway culverts along the streets which discharge directly to the adjacent lakes. In some areas, these drainage systems are non-existent, under-sized, or structurally deficient. The Stormceptor systems evaluated in this document comprise two of approximately 20 outfall improvement projects conducted by the Town to reduce pollutant loadings to adjacent waterbodies.

Figure 1-3. Locations of the Stormceptor Monitoring Sites.

1.1 Project Description

An overview of the Pine Street Stormceptor site, also referred to as Outfall No. 8 by the Town of Windermere, is given on Figure 1-3. The Stormceptor unit selected for this site is a Model STC 450i with a 450-gallon storage capacity in the bottom sump. An overview of the contributing drainage basin for the Pine Street site is given on Figure 1-5. The basin area contains approximately 4.42 acres of single-family residential land uses. A plan view of constructed improvements for the Pine Street site is given on Figure 1-6. The Stormceptor unit is located adjacent to the northeast lobe of Lake Butler. The project involved paving portions of the existing dirt roads and construction of a curb and gutter stormsewer system to collect and transport runoff to the Stormceptor unit. A set of selected construction drawings for the Pine Street Stormceptor system is given in Appendix A.1.

Figure 1-4. Overview of the Pine Street Stormceptor Site.

An overview of the Lake Street Stormceptor site is given on Figure 1-7. The Stormceptor unit installed at this site is a Model STC 900 with a 900-gallon storage capacity in the bottom sump. This device provides load reductions for a 9.00-acre drainage basin on the southwest side of Lake Down which consists of single-family residential land uses. This site is also referred to as Outfall No. 4 by the Town of Windermere. An overview of the contributing drainage basin area for the Lake Street site (Outfall No. 4) is given on Figure 1-8.

Figure 1-5. Contributing Drainage Basin for the Pine Street Site.

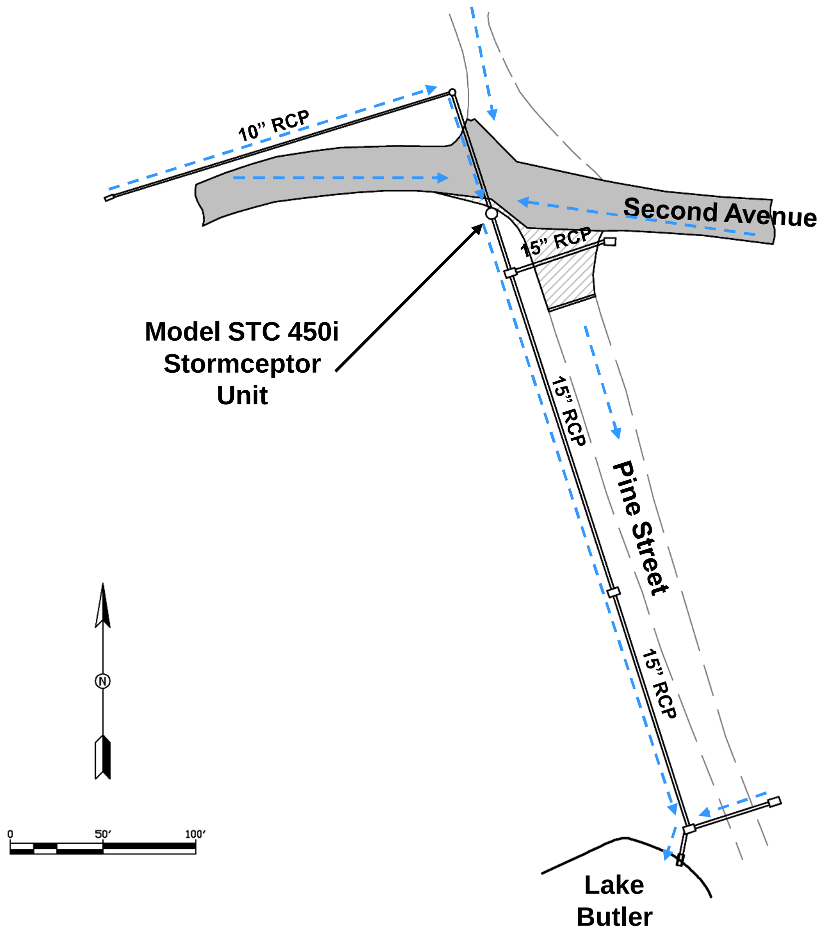


Figure 1-6.

Plan View of Constructed Improvements for the Pine Street Site (Outfall No. 8).

Figure 1-7. Overview of the Lake Street Stormceptor Site.

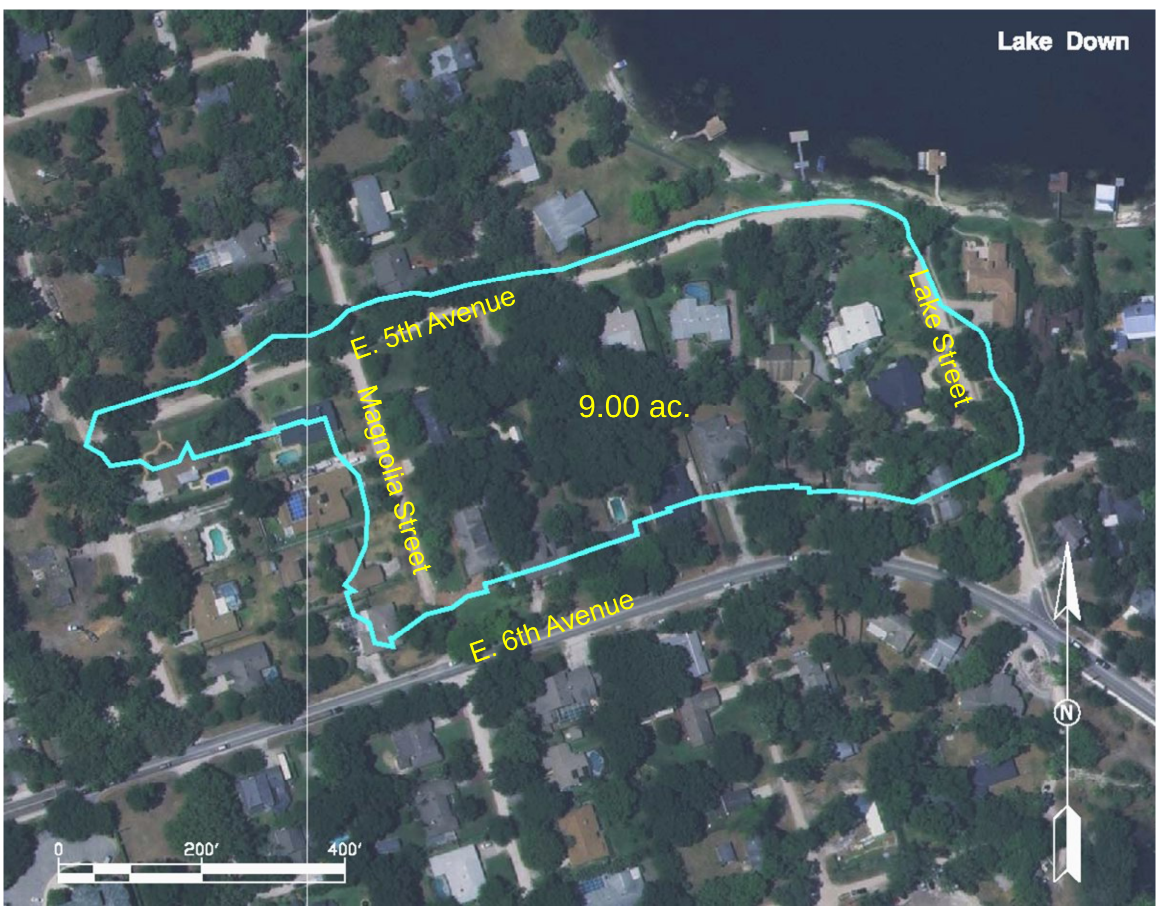


Figure 1-8. Contributing Drainage Basin for the Lake Street Site (Outfall No. 4).

A plan view of the constructed improvements for the Lake Street site is given on Figure 1-9. The project involved paving portions of existing dirt roads and construction of a curb and gutter stormsewer system to collect and transport the runoff to the Stormceptor unit. A set of selected construction plans for the Stormceptor system at the Lake Street site is given in Appendix A.2.

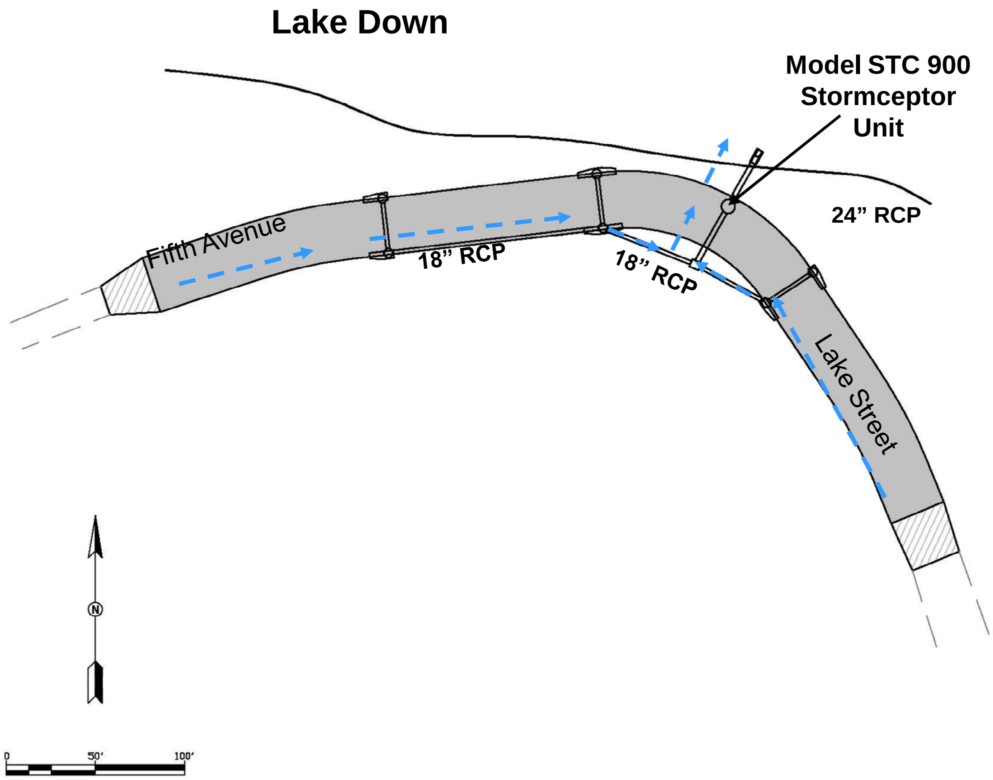


Figure 1-9. Plan View of the Constructed Improvements for the Lake Street Site.

1.2 Characteristics of the Stormceptor Units

Stormceptor is a patented oil/sediment separator unit which is manufactured by the Stormceptor Company, located in Toronto, Canada. A schematic of the Stormceptor unit selected for the Pine Street Site (Outfall No. 8) is given in Figure 1-10. The unit is designated as Model STC 450i with a 450-gallon sump capacity and an oil capacity of 85 gallons.

Water enters the unit through the inlet pipe which consists of a 15-inch RCP for this particular installation. The water initially falls onto a sloped containment area where it enters the sump area of the Stormceptor unit after passing through a semi-conical shaped trash guard with 0.5-inch vertical slots. Larger materials which pass through the slots are trapped and settle onto the bottom of the sump. Water discharges from the sump through an outlet riser pipe which extends below the normal water level to exclude floating oils and greases which have entered the sump from discharging through the outfall. The water discharging through the outlet riser pipe then enters the 15-inch RCP outlet from the structure and ultimately discharges to Lake Butler.

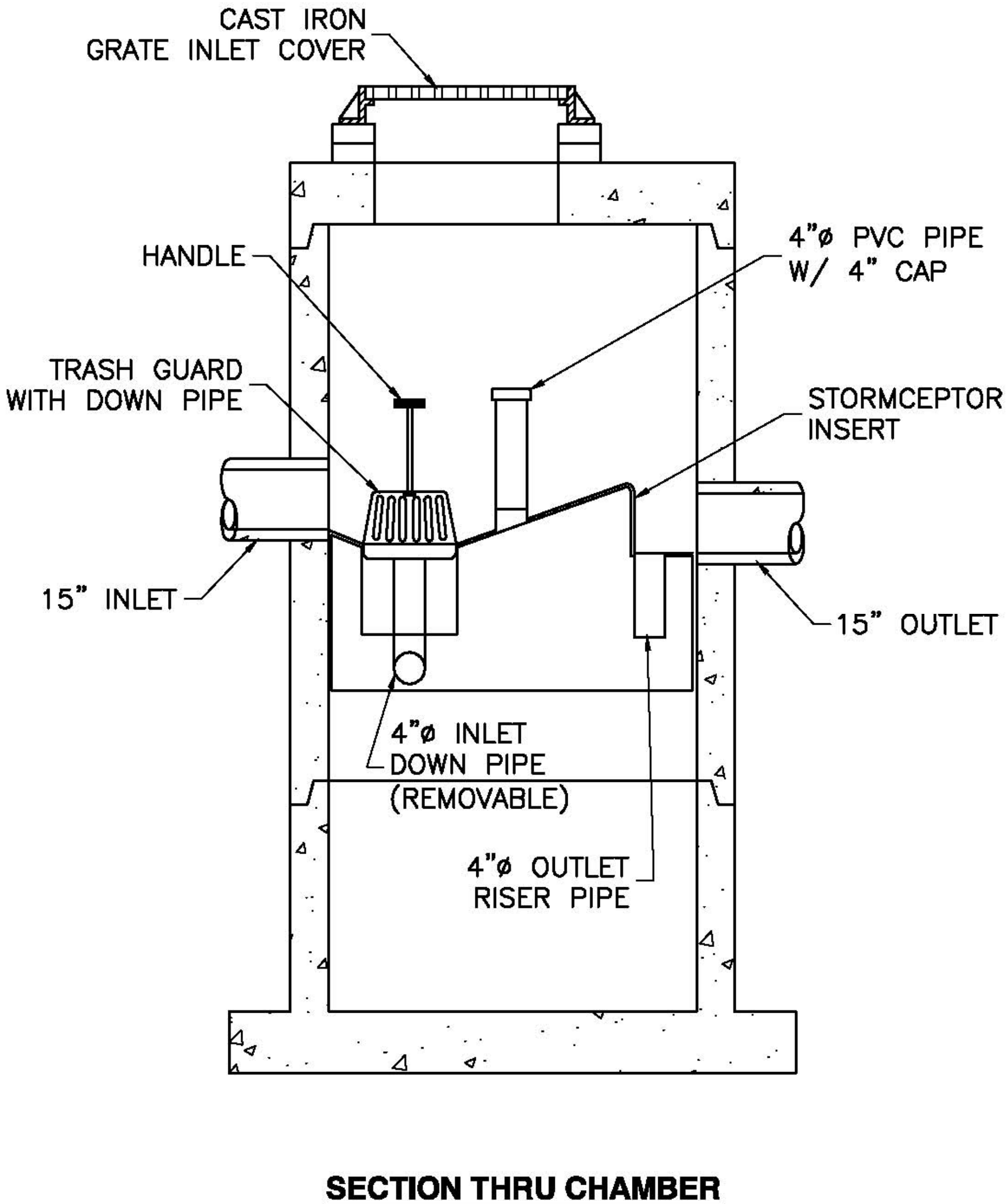


Figure 1-10. Details of the Stormceptor Model STC 450i Unit Installed at the Pine Street Site (Outfall No. 8).

A minimum head difference of 1 inch is required between the inlet and outlet pipe elevations to operate the separator unit. If the design includes multiple pipe inlets, a 3-inch difference between the inlet pipe inverts and outlet pipe invert is required. If the trash guard becomes clogged, the water level can rise and discharge over the sloped containment area directly into the outlet pipe without entering the unit. Maintenance on the unit is conducted by removing the trash guard and down pipe using the T-handle provided with the unit. Solids accumulated within the sump can then be removed using a vacuum-type device.

Access to Stormceptor unit occurs by removing a cast iron grate which provides drainage for a localized area. Runoff which enters through the grate can also be treated by the Stormceptor unit as long as the inflow capacity of the unit is not exceeded. After removal of the grate, the trash guard and down pipe are then removed, allowing access into the lower sump area by a vacuum truck hose connection. The accumulated solids are then removed from the unit, and the trash guard and down pipe are replaced. A photograph of the inlet grate cover for the Pine Street unit is given on Figure 1-11. Additional information and technical details on Stormceptor units is included in Appendix B.

Figure 1-11. Photograph of the Inlet Grate Cover for the Pine Street Stormceptor Unit.

According to information currently on the Stormceptor website, the Stormceptor unit is designed to remove “oil and sediments from stormwater runoff and effectively reduce nonpoint source pollution from reaching receiving waters downstream”. The sample technical specifications provided by Stormceptor indicate that the unit is capable of removing 50-80% of the total suspended sediment load and 60-95% of the floatable free oil. The specifications further state that the separator is capable of trapping silt and clay sized particles in addition to larger particles.

Details of the Stormceptor Model STC 900 installed at the Lake Street Site (Outfall No. 4) are given on Figure 1-12. This model has a bottom sump capacity of 900 gallons and an oil capacity of 242 gallons. Water enters the unit through the inlet pipe which consists of a 24-inch RCP for this particular installation. Runoff inflow is diverted into the Stormceptor unit by a semi-circular weir structure on top of the Stormceptor unit. A photograph of the diversion weir is given on Figure 1-13. The visible pipe in the photograph represents the inflow into the unit which is forced downward into the Stormceptor unit until the water level exceeds the level of the weir. Water discharges from the unit through a 24-inch outlet pipe with a hinged aluminum grate cover. This cover serves primarily as a safety device to prevent maintenance personnel from falling into the sump area of the unit but is also used to conduct periodic maintenance and pump-out activities on the unit.

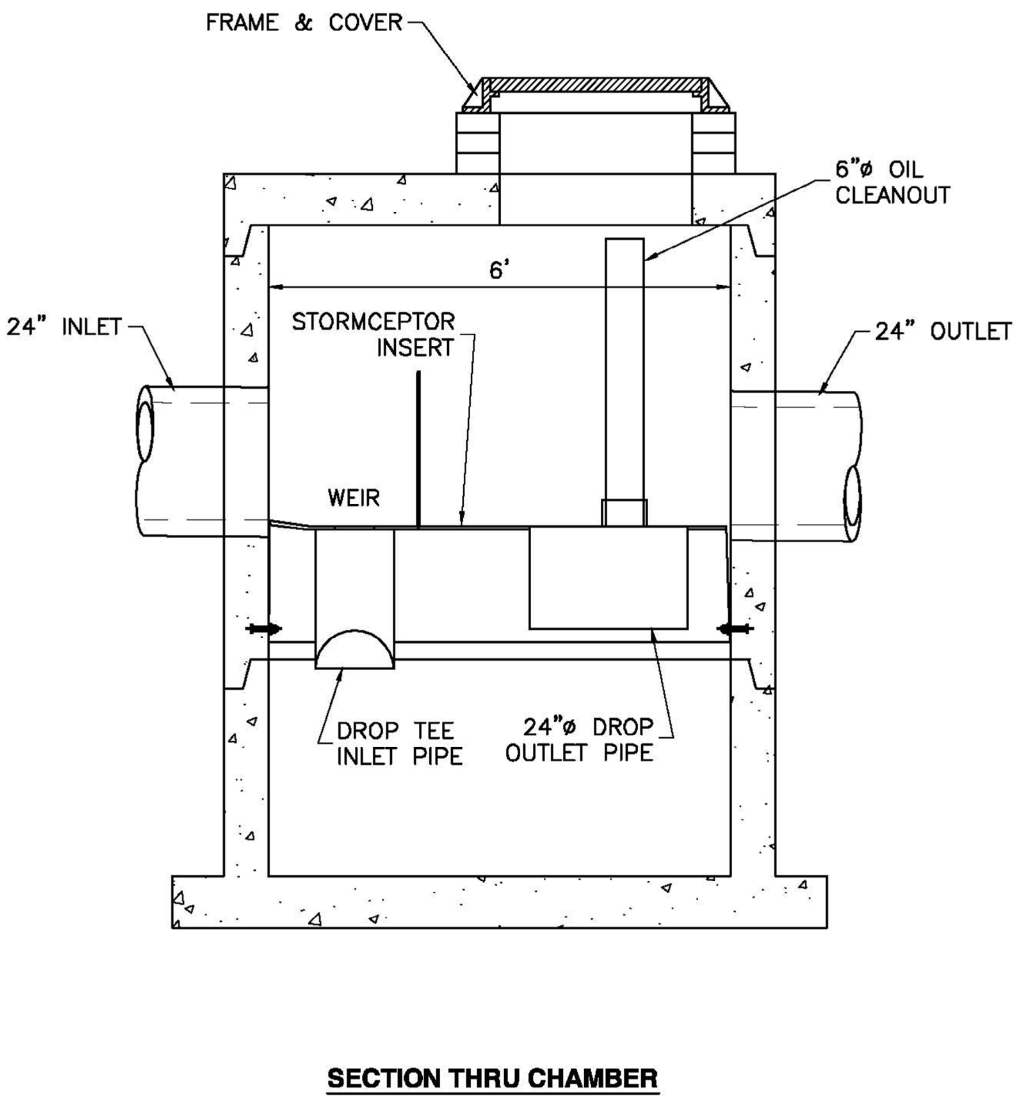


Figure 1-12. Details of the Stormceptor Model STC 900 Installed at the Lake Street Site (Outfall No. 4).

Figure 1-13. Diversion Weir for the Lake Street Stormceptor Unit.

A summary of the characteristics of the Stormceptor units installed by the Town of Windermere is given in Table 1-1. The model STC 900 Stormceptor unit, installed at the Lake Street site, has a treatment chamber diameter of 6 ft, with a total volume of approximately 900 gallons. The maximum operating rate for this unit is 285 gallons per minute (gpm), equivalent to 0.64 cfs. Flows in excess of this amount will begin to discharge over the top of the unit and bypass the system. The calculated unit detention time at the maximum operating rate is 3.2 minutes. An overflow velocity of approximately 0.023 ft/sec is provided within the settling chamber. Maintenance activities are recommended for this unit when the sediment depth reaches approximately 8 inches, equivalent to approximately 19 ft^3 of sediment material. The unit weight of the STC 900 unit is 10.08 tons.

The model STC 450i, utilized at the Pine Street site, has a treatment chamber diameter of 4 ft, with a total chamber volume of 450 gallons. The maximum operating rate for this unit is approximately 0.39 cfs, with flows in excess of this rate bypassing the system. The calculated detention time within this unit is 2.7 minutes, with a mean overflow velocity of approximately 0.03 ft/sec within the unit. Sediment removal and system maintenance is recommended when the sediment depth reaches 8 inches, equivalent to approximately 9 ft^3 within the unit. The weight of the STC 450i unit is approximately 4.01 tons.

TABLE 1-1

CHARACTERISTICS OF THE STORMCEPTOR UNITS INSTALLED BY THE TOWN OF WINDERMERE

PARAMETER	UNITS	MODEL STC 900 (LAKE STREET)	MODEL STC 450i (PINE STREET)
Treatment Chamber Diameter	ft	6	4
Treatment Chamber Volume	gallons	900	450
Sediment Depth Indicating Required Maintenance	inches	8	8
Sediment Volume at Maintenance Depth	ft^3	19	9
Maximum Operating Rate	gpm	285	175
	cfs	0.64	0.39
Calculated Unit Detention Time	minutes	3.2	2.7
Overflow Velocity	ft/sec	0.023	0.031
Oil Storage Capacity	gallons	242	85
Unit Weight	tons	10.08	4.01

1.3 Work Efforts Performed by ERD

A Quality Assurance Project Plan (QAPP) was developed by ERD during April 2009 which provided details concerning the proposed field monitoring and laboratory activities. Monitoring equipment was installed at the two Stormceptor sites by ERD during June 2009. Field monitoring was initiated on June 15, 2009 and was conducted over a 3-month period until September 15, 2009.

This report has been divided into four separate sections which provide a discussion of work efforts conducted by ERD and the results of the field and laboratory monitoring activities. Section 1 contains an introduction to the report, a description of the installed Stormceptor systems, 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. Appendices are attached which contain additional supplemental information referenced within the report.

SECTION 2

FIELD AND LABORATORY ACTIVITIES

Field and laboratory investigations were conducted by ERD from June-September 2009 to evaluate the effectiveness of two Stormceptor systems constructed within the Town of Windermere. These facilities were constructed by the Town to reduce pollutant loadings discharging from adjacent residential watersheds into Lake Down and Lake Butler. Flow monitoring and sample collection equipment was installed at the two sites by ERD, and field monitoring was conducted over a period of 3 months to evaluate system efficiencies. At the end of the 3-month monitoring program, the accumulated sediments within each of the two units were removed and quantified to document mass and nutrient loadings removed by the units.

Specific details of monitoring efforts performed at each of the two Stormceptor monitoring sites are given in the following sections. All field and laboratory work efforts complied with the quality assurance requirements addressed in Chapter 62-160 FAC and the document titled "Requirements for Field and Analytical Work Performed for the Department of Environmental Protection under Contract" (DEP-QA-002/02), February 2002.

2.1 Field Monitoring and Instrumentation

2.1.1 Lake Street Site

Photographs of monitoring equipment installed at the Lake Street Stormceptor site are given on Figure 2-1. Instrumentation was installed to provide a continuous measurement of discharges through the Stormceptor unit under storm event conditions, as well as to collect flow-weighted samples under a wide range of flow conditions. The sampling equipment was installed by ERD during June 2009. Formal monitoring was initiated on June 15, 2009 and continued for a period of 92 days until September 15, 2009.

Monitoring at the Lake Street Stormceptor site was conducted in the 24-inch RCP outfall from the Stormceptor unit, upstream of the point of discharge into Lake Down. An automatic sequential stormwater sampler with integral flow meter, manufactured by Sigma (Model No. 900 MAX-AV) was installed at the outfall location to provide a continuous hydrograph record of discharges from the Stormceptor unit and to collect flow-weighted composite samples of the discharge during storm event conditions. The automatic sampler was housed inside an insulated aluminum shelter which was installed near the point of discharge for the 24-inch RCP. Sensor cables and sample tubing were extended approximately 10 ft from the sampler into the 24-RCP to the point of flow measurement and sample collection. The integral flow meter was programmed to provide a continuous record of discharges from the Stormceptor unit, with measurements stored into internal memory at 10-minute intervals.

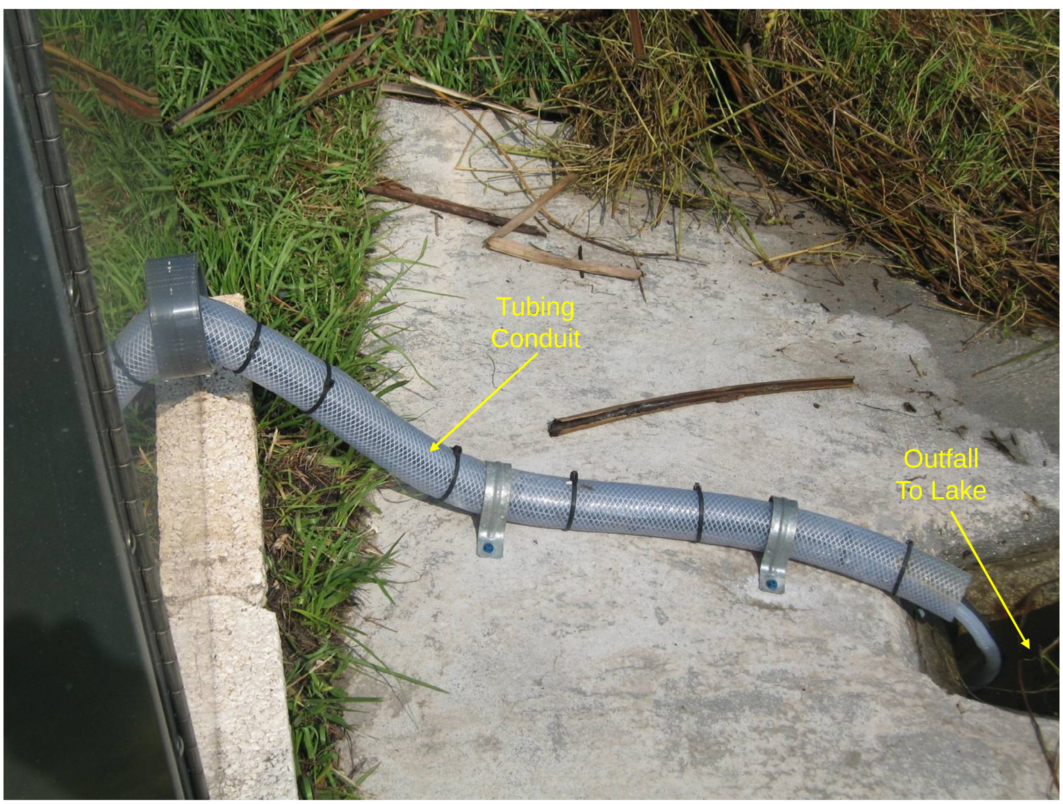


Figure 2-1. Monitoring Equipment at the Lake Street Stormceptor Site.

Flow measurements at the Lake Street monitoring site 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 (A) based upon the geometry of the pipe, and the velocity of flow (V) is measured directly by the velocity probe. Discharge (Q) is then calculated by the flow meter using the continuity equation (Q = A x V) in cubic feet per second (cfs). A built-in pressure transducer within the velocity sensor transforms measurements of water depth into an approximate cross-sectional area for the water flow based upon the water depth and geometric characteristics of the discharge pipe.

The automatic sampler contained a single 5-gallon polyethylene bottle and was programmed to collect samples in a flow-weighted mode. 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.

Rainfall in the vicinity of the Stormceptor sites was monitored using a rain gauge installed at the Lake Street site. The continuous rainfall recorder was attached to a 4-inch x 4-inch wooden post installed adjacent to the equipment shelter, as indicated on Figure 2-1. The rainfall recorder (Texas Electronics Model 1014-C) produced a continuous record of all rainfall which occurred at the site. This record was used to provide information on general rainfall characteristics in the vicinity of the Stormceptor units during the monitoring program and to assist in evaluating hydrologic inputs from the watershed area.

2.1.2 Pine Street Site

The Pine Street Stormceptor unit was constructed with a cast iron grate inlet cover rather than the solid manhole cover used at the Lake Street site. This unit receives inflow from a 15-inch RCP which enters on the north side of the Stormceptor structure, as well as inflow through the cast iron grate inlet over the top of the unit. A photograph of the inlet structure for the Pine Street site is given on Figure 2-2. The grate inlet collects a significant amount of debris during large storm events which reduces the inflow capacity of the grate. During large storm events, excess water overflows the grate inlet and discharges along the right-of-way and onto adjacent property.

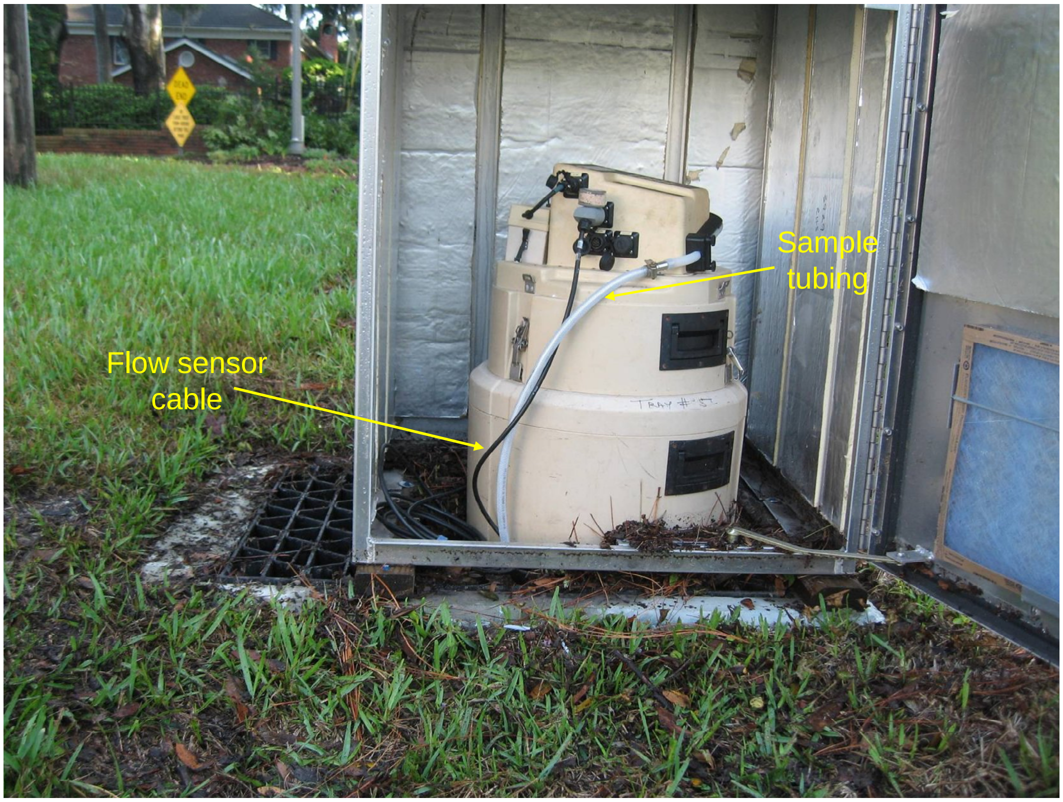
Monitoring at the Pine Street site was conducted at the grate inlet structure located downstream from the Stormceptor unit. Photographs of the equipment shelter and autosampler used at the Pine Street site are given on Figure 2-3. The autosampler used at this location contained an integral flow meter which was installed inside the 15-inch RCP which discharges from the Stormceptor unit. The autosampler installed at this site was manufactured by Sigma (Model No. 900 MAX-AV) and was housed inside the insulated aluminum shelter installed on top of the grate inlet structure. Sample collection tubing and flow monitoring probes were extended from the autosampler into the stormsewer system. Both the sample tubing and flow monitor were extended approximately 10 ft upstream in the stormsewer system toward the Stormceptor unit to avoid impacts from the 15-inch RCP which discharges into the east side of the stormsewer structure at the monitoring site. The integral flow meter inside the autosampler was programmed to provide a continuous record of discharges from the Stormceptor unit, with measurements stored into internal memory at 10-minute intervals.

Figure 2-2. Inlet Structure for the Pine Street Site.

The autosampler at the Pine Street site contained a single 5-gallon polyethylene bottle. The autosampler was programmed to collect samples in a flow-weighted mode, with the collected samples placed into the 5-gallon container. 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 Pine Street monitoring site 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. The flow probe provided continuous measurements of water depth which were converted into approximate flow rates.

a. Equipment Shelter



b. Autosampler Inside Equipment Shelter.

Figure 2-3. Monitoring Equipment at the Pine Street Site.

2.1.3 Monitoring Philosophy

As discussed in the previous sections, monitoring was conducted only at the outfalls from each of the two Stormceptor units. This is a departure from previous performance efficiency evaluations conducted by ERD for Stormceptor and CDS units which provided monitoring at both the inflow and outflows to the units. This new monitoring protocol is based upon the assumption that the total mass of solids and nutrients discharging to a Stormceptor unit is equal to the pollutant loadings measured in the discharge from the unit plus the total mass collected by the system. At the completion of the 3-month monitoring program, captured sediments and debris were removed from each of the Stormceptor units, quantified, and analyzed for total nitrogen, total phosphorus, and gross solids. The total input to each of the two Stormceptor units is then calculated by adding the mass of collected solids and nutrients to the mass discharges from the units. Mass removal efficiencies are then calculated based upon the difference between the inflow and outflow mass loadings.

The specific equations used for estimation of input and output loadings, as well as overall removal efficiency, are summarized below:

The total mass of solids entering each Stormceptor unit is calculated as:

$$\textit{Input Mass} = \textit{Discharge Mass} + \textit{Mass of Sump Solids}$$

The performance efficiency of the unit is calculated by:

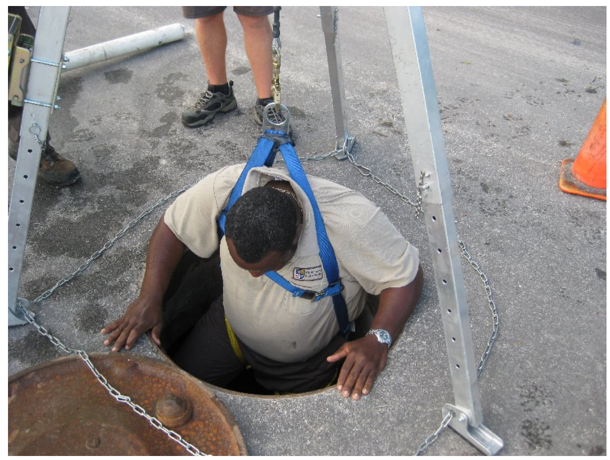
$$\textit{Efficiency} = \frac{\textit{Mass of Sump Solids}}{\textit{Input Mass}} \times 100$$

It is anticipated that the new methodology outlined above will be substantially more accurate in identifying mass inputs and mass losses from the Stormceptor units. It is difficult to quantitatively monitor input concentrations for inflows containing concentrated solid matter since much of this matter is transported as a bed loading along the bottom of the stormsewer pipe where the sample intake strainers are typically located. Since the sample strainers are in an area of concentrated solids flow, TSS measurements at the inflow may exaggerate actual solids inflow concentrations. Monitoring only at the outfall location eliminates much of this concern since the heavier materials which tend to travel along the bottom of the stormsewer pipe will be removed within the Stormceptor units, and the discharge will contain primarily small particle sizes which can be sampled in a more representative manner.

2.1.4 <u>Clean-out Activities</u>

Prior to initiation of the field monitoring program, each of the two Stormceptor systems and connecting stormsewer lines were cleaned by Windermere personnel to remove any existing solids, debris, and leaves to provide clean systems to begin the field monitoring program. Photographs of clean-out activities for the Lake Street Stormceptor unit are given on Figure 2-4. The unit is accessed by removing the traffic-bearing manhole cover over the top of the unit. A maintenance worker is then lowered by harness through the manhole cover onto the top of the unit. The metal grate over the outflow pipe is then raised to provide access to the sump area of the unit. The suction hose is then inserted into the sump, and the accumulated solids are then pumped from the unit. The suction hose is rotated around the bottom of the sump area during the vacuum process to remove as much of the accumulated sediment as possible.

a. Manhole Cover Removed to Access Unit



b. Worker Lowered by Harness into Unit

c. Metal Grate Cover is Raised to Access Sump Area

d. Suction Hose Inserted into Sump

Figure 2-4. Clean-out Activities for the Lake Street Stormceptor Unit.

Photographs of clean-out activities for the Pine Street Stormceptor unit are given in Figure 2-5. To access the Stormceptor unit at this site, the inlet grate cover is removed, and a worker enters the structure using a harness. The trash guard and down pipe are removed using the T-handle (see Figure 1-10) to provide access into the sump area of the unit. The accumulated solids are then pumped from the sump area by rotating the suction line around the bottom of the sump area.

a. Inlet Cover Removed; Worker Enters Using Harness

b. Pipe Removed to Access Sump Area

Figure 2-5. Clean-out Activities for the Pine Street Stormceptor Unit.

A photograph of the portable vacuum unit used by the Town of Windermere is given on Figure 2-6a. The vacuum unit is a Model MC550, manufactured by Vermeer, with a 550-gallon storage capacity. A photograph of solids collected from one of the Stormceptor units is given on Figure 2-6b. The rear door of the vacuum unit is hinged to provide easy access to the accumulated materials. The container can be tilted to allow the accumulated solids to discharge from the unit.

Clean-out operations were also conducted at the completion of the 3-month monitoring program. These operations were conducted jointly by ERD and the Town of Windermere so that the amount of material removed could be quantified and samples collected for laboratory analyses. Clean-out operations were identical to the initial clean-out program prior to monitoring, with the exception that additional measurements were taken to accurately quantify sediment accumulations in each of the two units.

a. Portable Vacuum Unit with 550-Gallon Capacity

b. Solids Collected from Unit

c. Solids Deposited at Town Storage Yard

Figure 2-6. Vacuum Unit Used for Stormceptor Cleaning.

2.2 <u>Laboratory Analyses</u>

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). 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
BOD	SM-21, Sec. 5210B[4]	2 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, 21st Ed., 2005.

A summary of laboratory methods and MDLs for analyses conducted on sediment/solid samples collected during this project is given in Table 2-2. All laboratory analyses on solids materials were conducted in the ERD Laboratory.

TABLE 2-2

ANALYTICAL METHODS AND DETECTION LIMITS FOR SEDIMENT / SOLIDS ANALYSES

PARAMETER	METHOD OF ANALYSIS	METHOD DETECTION LIMITS (MDLs)[1]
Organic Content	EPA/CE-81[2] (pp. 3-54 and 3-59 to 3-60	0.1%
Total Nitrogen	EPA/CE-81 (pp. 3-201 and 3-201 to 3-204	0.01 mg/kg
Total Phosphorus	EPA/CE-81 (pp. 3-323; EPA 365.4	0.005 mg/kg
Particle Size	EPA/CE-81 (pp. 3-29 to 3-32 and 3-33 to 3-47	1%

1. MDLs are calculated based on the EPA method of determining detection limits

2. Procedures for Handling and Chemical Analysis of Sediments and Water Samples, EPA/Corps of Engineers, EPA/CE-81-1, 1981.

In addition to general sediment characterization, a fractionation procedure for inorganic soil phosphorus was conducted on each of the collected sediment samples. The modified Chang and Jackson Procedure, as proposed by Peterson and Corey (1966), was used for phosphorus fractionation. The Chang and Jackson Procedure allows the speciation of sediment phosphorus into saloid-bound phosphorus (defined as the sum of soluble plus easily exchangeable sediment phosphorus), iron-bound phosphorus, and aluminum-bound phosphorus. Although not used in this project, subsequent extractions of the Chang and Jackson procedure also provide calcium-bound and residual fractions.

Saloid-bound phosphorus is considered to be available under all conditions at all times. Iron-bound phosphorus is relatively stable under aerobic environments, generally characterized by redox potentials greater than 200 mv (E_h), while unstable under anoxic conditions, characterized by redox potential less than 200 mv. Aluminum-bound phosphorus is considered to be stable under all conditions of redox potential and natural pH conditions. A schematic of the Chang and Jackson Speciation Procedure for evaluating soil phosphorus bounding is given in Figure 2-7.

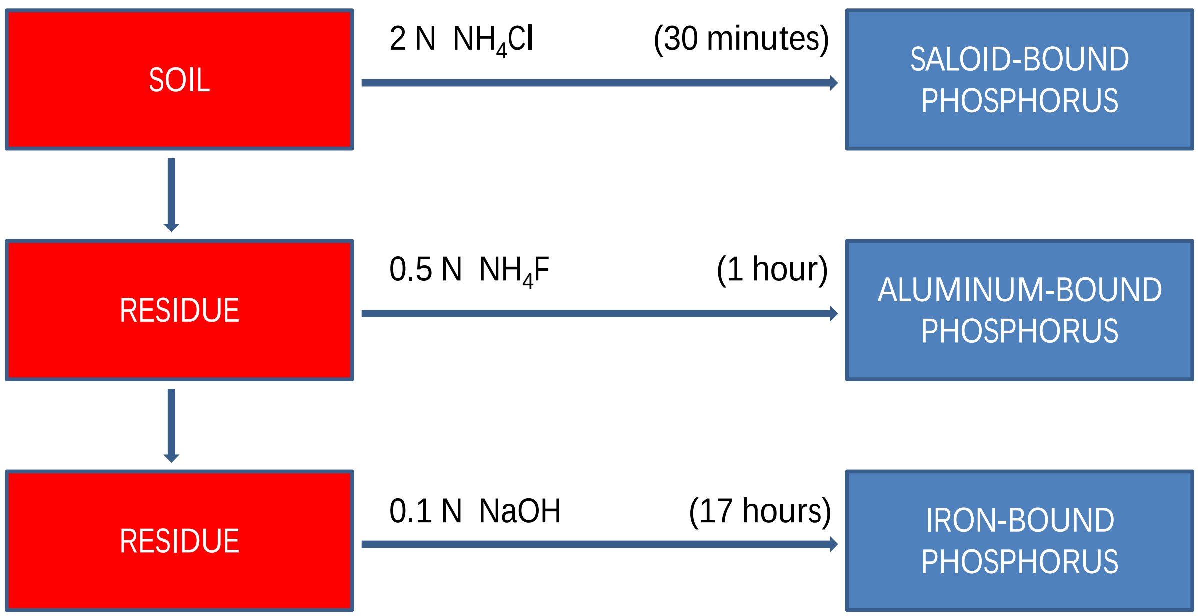


Figure 2-7. Schematic of Chang and Jackson Speciation Procedure for Evaluating Soil Phosphorus Bonding.

For purposes of evaluating release potential, ERD typically assumes that potentially available inorganic phosphorus in soils/sediments, particularly those which exhibit a significant potential to develop reduced conditions below the sediment-water interface, is represented by the sum of the soluble inorganic phosphorus and easily exchangeable phosphorus fractions (collectively termed saloid-bound phosphorus), plus iron-bound phosphorus which can become solubilized under reduced conditions. Aluminum-bound phosphorus is generally considered to be unavailable in the pH range of approximately 5.5-7.5 under a wide range of redox conditions.

SECTION 3

RESULTS

Field monitoring, sample collection, and laboratory analyses were conducted by ERD from June 15-September 15, 2009 to evaluate the pollutant removal efficiencies of two Stormceptor units installed within the Town of Windermere. A discussion of the results of these efforts is given in the following sections.

3.1 Site Hydrology

3.1.1 Rainfall Characteristics

A continuous record of rainfall characteristics was collected at the Lake Street Stormceptor monitoring site from June 15-September 15, 2009 using a tipping bucket rainfall collector with a resolution of 0.01 inch and a digital data logging recorder. Characteristics of individual rain events measured at the Lake Street monitoring site from June 15-September 15, 2009 are given in Table 3-1. Information is provided on the event start time, event end time, rainfall depth, event duration, antecedent dry period, and average intensity 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 20.91 inches of rainfall fell in the vicinity of the Stormceptor monitoring sites over the 92-day monitoring period from a total of 63 separate storm events. A summary of rainfall event characteristics measured at the Stormceptor sites from June 15-September 15, 2009 is given in Table 3-2. Individual rainfall amounts measured at the monitoring site ranged from 0.01-2.32 inches, with an average of 0.33 inches per event. Durations for rain events measured at the monitoring site ranged from 0.01-6.43 hours, with antecedent dry periods ranging from 0.13-5.62 days.

A comparison of measured and typical "average" rainfall in the vicinity of the Windermere Stormceptor units is given in Figure 3-1. Measured rainfall in this figure is based upon the field measured rain events at the monitoring site presented in Table 3-1, summarized on a monthly basis. "Average" rainfall conditions are based upon historical monthly rainfall averages recorded at the Orlando International Airport (OIA) over the 64-year period from 1942-2005. Comparisons between measured and average rainfall are provided for the months of June-September 2009, even though rainfall measurements conducted at the Windermere site during June and September 2009 represent only partial months.

TABLE 3-1

SUMMARY OF RAINFALL MEASURED AT THE TOWN OF WINDERMERE MONITORING SITE FROM JUNE 15 - SEPTEMBER 15, 2009

EVENT START		EVENT END		TOTAL RAINFALL (inches)	DURATION (hours)	ANTECEDENT DRY PERIOD (days)	AVERAGE INTENSITY (in/hr)
Date	Time	Date	Time				
6/17/09	16:39	6/17/09	17:26	0.40	0.77	---	0.52
6/18/09	15:35	6/18/09	18:02	0.08	2.44	0.9	0.03
6/19/09	9:08	6/19/09	9:08	0.15	0.01	0.6	20.00
6/23/09	4:54	6/23/09	8:33	0.47	3.65	3.8	0.13
6/23/09	17:34	6/23/09	20:06	0.51	2.54	0.4	0.20
6/23/09	23:58	6/23/09	23:58	0.01	---	0.2	---
6/25/09	17:52	6/25/09	17:55	0.03	0.06	1.7	0.49
6/25/09	21:18	6/25/09	21:28	0.07	0.18	0.1	0.40
6/26/09	11:14	6/26/09	11:28	0.32	0.23	0.6	1.42
6/27/09	14:44	6/27/09	14:44	0.01	---	1.1	---
6/30/09	10:41	6/30/09	17:07	2.32	6.43	2.8	0.36
7/1/09	8:42	7/1/09	8:42	0.01	---	0.6	---
7/1/09	19:48	7/1/09	19:48	0.01	---	0.5	---
7/2/09	14:03	7/2/09	14:11	0.05	0.13	0.8	0.37
7/4/09	14:32	7/4/09	14:32	0.01	---	2.0	---
7/7/09	13:00	7/7/09	13:16	0.11	0.26	2.9	0.42
7/7/09	16:19	7/7/09	21:37	0.38	5.31	0.1	0.07
7/8/09	9:51	7/8/09	9:51	0.01	---	0.5	---
7/8/09	14:37	7/8/09	19:26	0.16	4.80	0.2	0.03
7/9/09	9:34	7/9/09	11:22	0.17	1.79	0.6	0.10
7/10/09	7:46	7/10/09	8:09	0.03	0.39	0.9	0.08
7/10/09	14:20	7/10/09	16:01	1.92	1.69	0.3	1.14
7/11/09	9:13	7/11/09	9:13	0.01	---	0.7	---
7/11/09	19:12	7/11/09	20:38	0.19	1.44	0.4	0.13
7/12/09	17:12	7/12/09	18:05	0.04	0.89	0.9	0.04
7/13/09	19:08	7/13/09	19:46	0.22	0.63	1.0	0.35
7/18/09	14:10	7/18/09	14:16	0.03	0.10	4.8	0.31
7/19/09	19:10	7/19/09	20:48	0.05	1.64	1.2	0.03
7/20/09	5:41	7/20/09	6:44	0.14	1.06	0.4	0.13
7/22/09	22:37	7/22/09	23:00	0.16	0.38	2.7	0.42
7/26/09	13:17	7/26/09	19:07	1.11	5.84	3.6	0.19
7/27/09	6:51	7/27/09	6:51	0.01	---	0.5	---
7/29/09	18:56	7/29/09	22:14	2.09	3.29	2.5	0.63
7/30/09	14:07	7/30/09	14:07	0.01	---	0.7	---
7/30/09	17:36	7/30/09	19:31	0.28	1.92	0.1	0.15
7/31/09	18:20	7/31/09	19:28	0.07	1.13	1.0	0.06

TABLE 3-1 -- CONTINUED

SUMMARY OF RAINFALL MEASURED AT THE TOWN OF WINDERMERE MONITORING SITE FROM JUNE 15 - SEPTEMBER 15, 2009

EVENT START		EVENT END		TOTAL RAINFALL (inches)	DURATION (hours)	ANTECEDENT DRY PERIOD (days)	AVERAGE INTENSITY (in/hr)
Date	Time	Date	Time				
8/2/09	13:10	8/2/09	13:26	0.11	0.26	1.7	0.43
8/3/09	15:58	8/3/09	20:05	1.84	4.10	1.1	0.45
8/4/09	18:31	8/4/09	18:46	0.02	0.26	0.9	0.08
8/5/09	14:01	8/5/09	14:48	1.24	0.78	0.8	1.59
8/6/09	17:43	8/6/09	17:56	0.07	0.23	1.1	0.31
8/8/09	15:43	8/8/09	17:30	0.97	1.77	1.9	0.55
8/13/09	15:24	8/13/09	19:11	0.70	3.78	4.9	0.19
8/15/09	21:56	8/15/09	23:45	0.03	1.80	2.1	0.02
8/17/09	15:02	8/17/09	15:03	0.02	0.01	1.6	1.95
8/18/09	14:17	8/18/09	18:02	0.10	3.76	1.0	0.03
8/19/09	13:18	8/19/09	13:52	0.06	0.56	0.8	0.11
8/19/09	18:31	8/19/09	18:31	0.01	---	0.2	---
8/20/09	3:15	8/20/09	3:15	0.01	---	0.4	---
8/21/09	15:27	8/21/09	20:30	1.01	5.05	1.5	0.20
8/25/09	19:32	8/25/09	21:46	0.13	2.22	4.0	0.06
8/26/09	18:09	8/26/09	20:56	0.03	2.78	0.8	0.01
8/27/09	22:54	8/27/09	22:54	0.01	---	1.1	---
8/31/09	19:06	8/31/09	20:31	0.32	1.41	3.8	0.23
9/1/09	18:02	9/1/09	20:59	0.85	2.94	0.9	0.29
9/2/09	11:27	9/2/09	15:28	0.11	4.03	0.6	0.03
9/2/09	20:53	9/2/09	22:06	0.07	1.22	0.2	0.06
9/3/09	9:04	9/3/09	9:04	0.01	---	0.5	---
9/3/09	16:54	9/3/09	17:10	0.42	0.27	0.3	1.58
9/6/09	17:12	9/6/09	19:31	0.76	2.31	3.0	0.33
9/12/09	10:24	9/12/09	11:45	0.04	1.36	5.6	0.03
9/12/09	20:36	9/12/09	22:57	0.04	2.35	0.4	0.02
9/13/09	15:46	9/13/09	20:46	0.29	5.01	0.7	0.06
			TOTAL:	**20.91**			

TABLE 3-2

SUMMARY OF RAINFALL CHARACTERISTICS IN THE VICINITY OF THE WINDERMERE STORMCEPTOR UNITS FROM JUNE 15 – SEPTEMBER 15, 2009

PARAMETER	UNITS	MINIMUM VALUE	MAXIMUM VALUE	MEAN EVENT VALUE
Event Rainfall	inches	0.01	2.32	0.33
Event Duration	hours	0.01	6.43	1.94
Average Intensity	inches/hour	0.01	20.0	0.74
Antecedent Dry Period	days	0.13	5.62	1.36

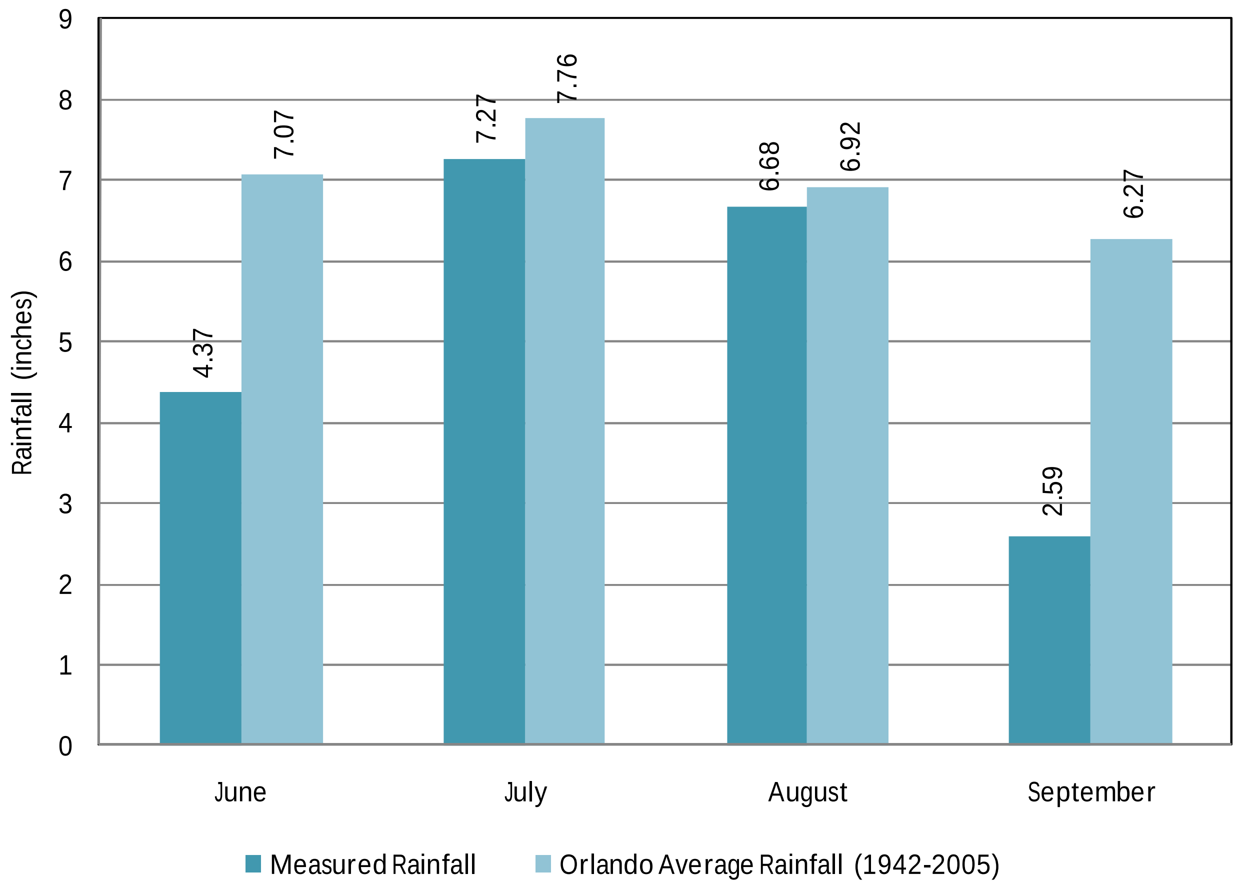


Figure 3-1. Comparison of Average and Measured Rainfall in the Vicinity of the Windermere Stormceptor Units.

As seen in Figure 3-1, measured rainfall in the vicinity of the Stormceptor units was approximately normal during July and August. Rainfall monitoring at the site only included half of the months of June and September. However, if the measured rainfall for June 15-30 was linearly extrapolated to a full 30-day period, the resulting rainfall would be slightly greater than normal. If the measured rainfall for September 1-15 of 2.59 inches was extrapolated to a 30-day period, rainfall during this month would be slightly less than normal. Overall, rainfall measured during the field monitoring program appears to be approximately average or slightly less than average compared with rainfall which occurs normally during the period from June-September in the Central Florida area.

3.1.2 Hydrologic Inputs

The autosamplers installed by ERD at each of the two Stormceptor monitoring sites contained integral flow meters which provided measurements of stormwater discharge with measurements recorded at 15-minute intervals. A graphical summary of measured runoff hydrographs at the Lake Street monitoring site (Outfall No. 4) from June 15-September 15, 2009 is given on Figure 3-2. Rainfall depths for measured rain events at the monitoring sites are also included for evaluation of relationships between rainfall and runoff. Measured discharge rates at the Stormceptor outfall monitoring site ranged from approximately 0-2 cfs, with the majority of peak runoff values less than approximately 1 cfs. Relatively insignificant runoff flow rates were generated from rain events of approximately 0.1 inch or less. The peak flows measured during storm events appear to be closely related to the depth of the rainfall event.

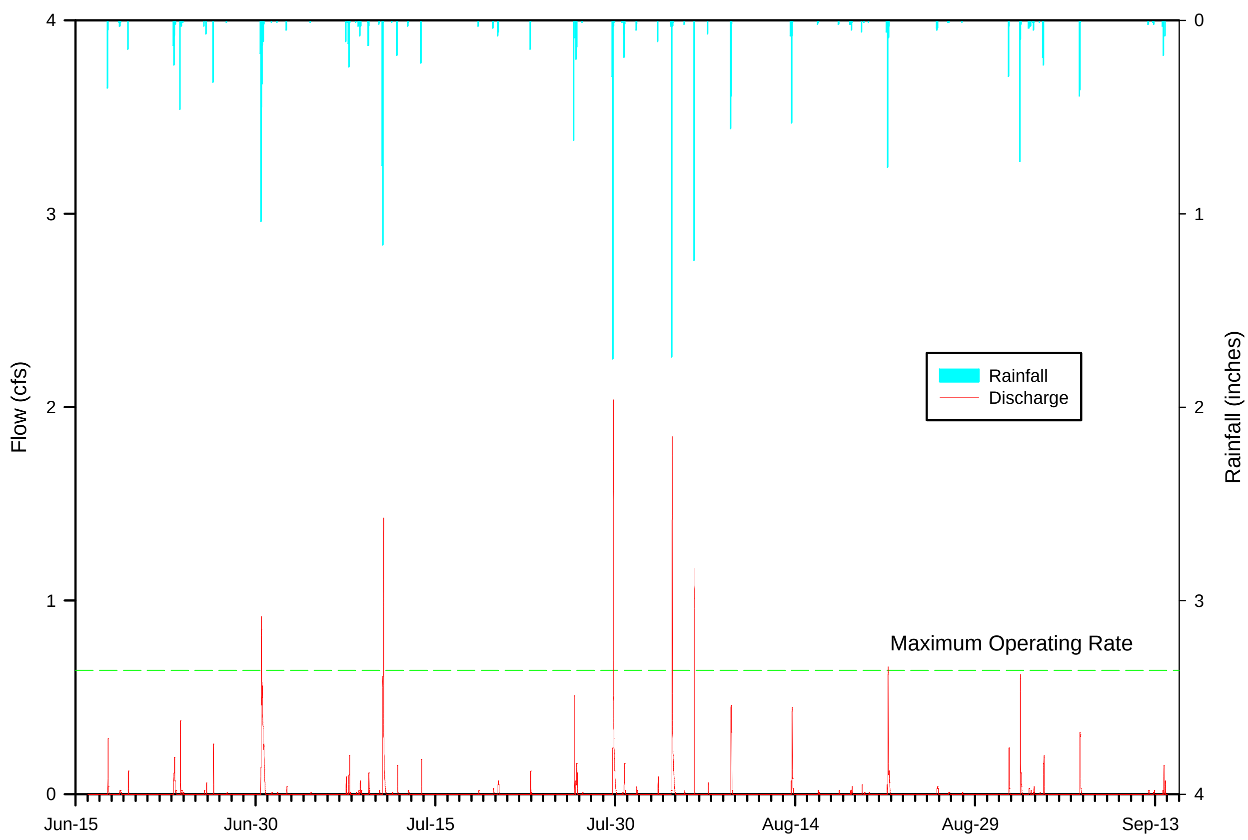


Figure 3-2. Measured Runoff Hydrographs at the Lake Street Site (Outfall No. 4) from June 15-September 15, 2009.

A reference line is also provided on Figure 3-2, representing the maximum operating rate of 0.64 cfs for the STC 900 unit. In general, the majority of events which occurred during the monitoring program generated runoff discharge rates less than the maximum operating rate for the unit. Of the 63 storm events monitored at this site, only 5 generated runoff discharge rates in excess of the design capacity for the unit. The majority of runoff reaching the unit at flows in excess of 0.64 cfs flows over the top of the unit and bypasses the treatment system.

Measured runoff hydrographs at the Pine Street Stormceptor site (Outfall No. 8) from June 15-September 15, 2009 are given on Figure 3-3. Runoff discharge rates as high as 1 cfs were measured during the monitoring program, although the vast majority of observed storm events were characterized by discharge rates of approximately 0.3 cfs or less. The lower runoff discharge rates observed at this site are related to the smaller drainage basin size and lack of significant directly connected impervious areas compared with the Lake Street site. Similar to the trend observed at the Lake Street site, peak hydrograph discharge rates appear to be closely related to the depth of the rainfall event. In general, relatively insignificant discharge rates were observed during storm events with a rainfall depth of 0.1 inch or less.

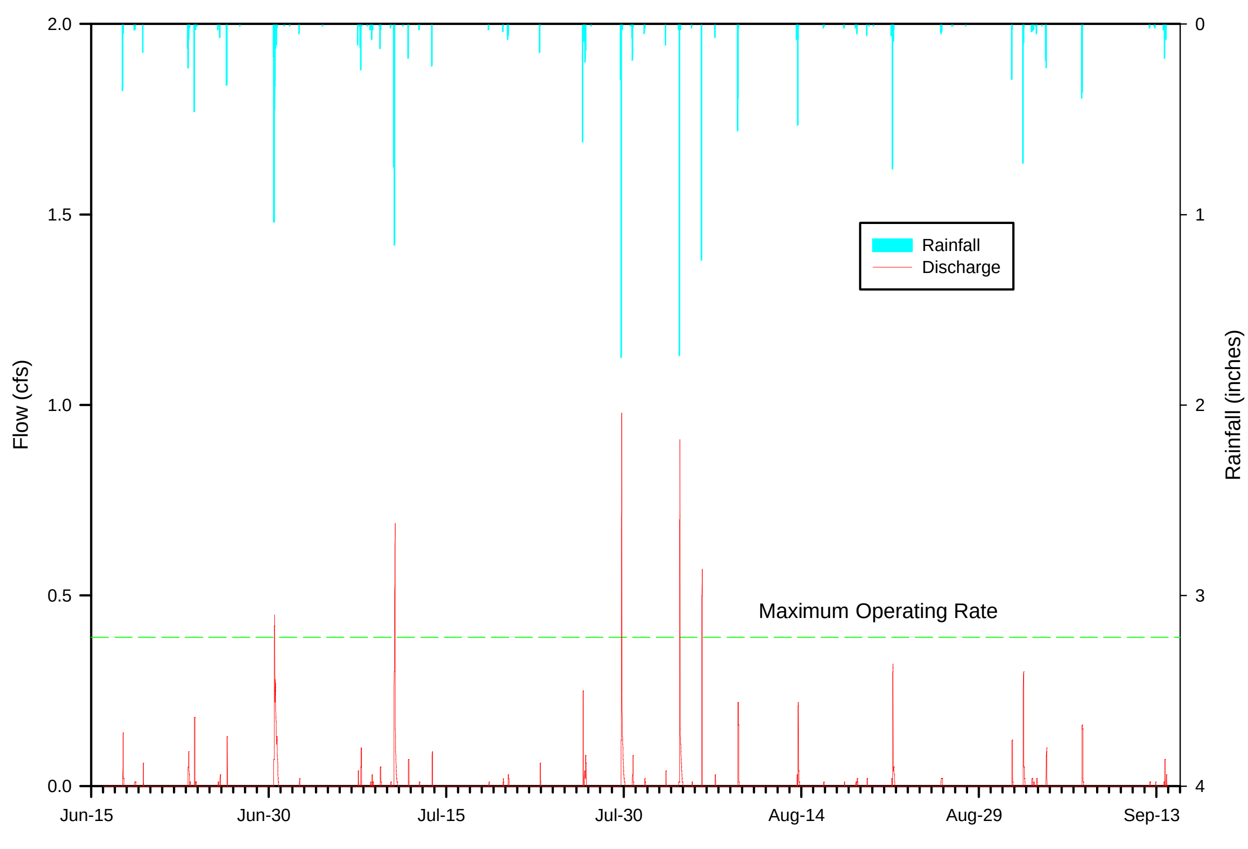


Figure 3-3. Measured Runoff Hydrographs at the Pine Street Site (Outfall No. 8) from June 15-September 15, 2009.

A reference line is also provided on Figure 3-3, representing the maximum operating rate of 0.39 cfs for the STC 450i unit installed at the Pine Street site. In general, the majority of monitored storm events generated runoff discharges less than the maximum operating rate for the unit. Of the 63 monitored storm events at this site, only 5 generated runoff discharge rates in excess of the maximum operating rate.

The runoff hydrographs summarized on Figures 3-2 and 3-3 were graphically integrated to obtain estimates of the volume of stormwater runoff discharging through each of the two Stormceptor units for each monitored storm event. A summary of measured runoff discharges at the Stormceptor monitoring sites, summarized on a monthly basis, is given in Table 3-3. The measured runoff volume discharging through each of the two Stormceptor units are provided for each full or partial month of the monitoring program. During the field monitoring program, approximately 75,866 ft^3 of runoff was discharged through the Lake Street Stormceptor system, with approximately 36,587 ft^3 of runoff discharged through the Pine Street Stormceptor system.

TABLE 3-3

MEASURED RUNOFF DISCHARGES AT THE STORMCEPTOR MONITORING SITES FROM JUNE 15 – SEPTEMBER 15, 2009

MONTH	MEASURED RAINFALL (inches)	MEASURED RUNOFF (ft^3)	
		Lake Street	Pine Street
June (15-30)	4.37	16,067	7,766
July	7.27	28,197	13,581
August	6.68	23,514	11,364
September (1-15)	2.59	8,088	3,876
TOTALS:	**20.91**	**75,866**	**36,587**

A summary of calculated runoff coefficients (C values) for the Stormceptor monitoring sites is given in Table 3-4. The total rainfall volume falling upon each of the two sub-basin areas is calculated by multiplying the basin area times the total measured rainfall depth of 20.91 inches. Measured runoff volumes at each of the two monitoring sites are also provided in Table 3-4, converted into an ac-ft format. The runoff C value is calculated as the measured runoff volume divided by the rainfall volume. The resulting C values are approximately 0.111 for the Lake Street Site and 0.109 for the Pine Street site. These values suggest that on an annual basis, approximately 11% of the rainfall which occurs within each of the two sub-basin areas becomes stormwater runoff. The information summarized in Tables 3-3 and 3-4 is used to estimate mass loadings discharging to and from each of the two Stormceptor units.

TABLE 3-4

CALCULATED RUNOFF COEFFICIENTS (C VALUES) FOR THE STORMCEPTOR MONITORING SITES

PARAMETER	UNITS	LAKE STREET (OUTFALL NO. 4)	PINE STREET (OUTFALL NO. 8)
Basin Area	acres	9.00	4.42
Total Rainfall	inches	20.91	20.91
Rainfall Volume	ac-ft	15.68	7.70
Runoff Volume	ac-ft	1.74	0.84
Runoff C Value	--	0.111	0.109

A comparison of estimated runoff volumes entering and bypassing the Lake Street and Pine Street Stormceptor units during the field monitoring program is given in Table 3-5. Generated runoff volumes during the monitoring program are summarized on a monthly basis, based upon the information provided in Table 3-3. The treated volume represents the runoff volume which actually enters the Stormceptor units for treatment. These volumes are calculated by integrating the runoff hydrographs (summarized on Figures 3-2 and 3-3) for all runoff flows less than the respective maximum operating rates. Runoff volumes represented by hydrograph discharge rates in excess of the maximum operating rates are assumed to bypass the units. Overall, approximately 85.7% of the runoff generated within the Lake Street sub-basin area entered and was treated by the Stormceptor unit, with the remaining volume bypassing the unit without treatment. At the Pine Street site, approximately 89.2% of the runoff generated within the Sub-basin area was treated by the Stormceptor unit, with 10.8% bypassing the unit.

TABLE 3-5

ESTIMATED RUNOFF VOLUMES ENTERING AND BYPASSING THE LAKE STREET AND PINE STREET STORMCEPTOR UNITS

MONTH	RAINFALL (inches)	RUNOFF VOLUME (ft^3)		VOLUME TREATED (ft^3)		PERCENT TREATED (%)	
		Lake Street	Pine Street	Lake Street	Pine Street	Lake Street	Pine Street
June (15-30)	4.37	16,067	7,766	15,325	7,654	95.4	98.6
July	7.27	28,197	13,581	22,791	11,517	80.8	84.8
August	6.68	23,514	11,364	18,789	9,585	79.9	84.3
September (1-15)	2.59	8,088	3,876	8,088	3,876	100.0	100.0
TOTAL:	**20.91**	**75,866**	**36,587**	**64,993**	**32,632**	**Mean = 85.7**	**Mean=89.2**

3.2 Chemical Characteristics of Collected Water Samples

During the field monitoring program from June 15-September 15, 2009, ERD collected a total of 16 flow-weighted composite discharge samples from the Lake Street Stormceptor unit and a total of 9 flow-weighted composite discharge samples from the Pine Street Stormceptor unit. Each of the discharge samples was collected as a flow-weighted composite between the beginning and ending time for each rain event. In addition, vertical profiles and water samples were also collected from inside the Lake Street Stormceptor structure to monitor ambient water quality characteristics within the Stormceptor unit between storm events. The results of these analyses are presented in the following sections.

3.2.1 Stormceptor Discharge Samples

Characteristics of Stormceptor discharge samples collected at the Lake Street site are summarized in Table 3-6 for each of the 16 discharge samples collected at this site. Summary statistics are provided at the bottom of Table 3-6 which include the mean value, minimum value, maximum value, and log-normal mean concentration. In general, environmental data typically exhibit a log-normal distribution rather than a normal distribution, indicating that the log-normal mean value is a more accurate indicator of central tendency for these data sets than the mean value. All subsequent calculations involving mean characteristics for collected samples are conducted using the calculated log-normal mean values.

In general, discharge samples from the Lake Street Stormceptor were slightly alkaline in pH, with measured pH values ranging from 7.35-8.04. The discharge samples were moderately well buffered, with measured alkalinity values ranging from 41-334 mg/l. Measured specific conductivity values, which ranged from 98-434 μmho/cm, are similar to values commonly observed in urban runoff.

Measured concentrations of total nitrogen in the Lake Street Stormceptor discharge were generally lower in value than total nitrogen concentrations commonly observed in runoff from residential areas. The log-normal mean value of 1052 μg/l is approximately half of the typical total nitrogen concentration for residential areas. Measured concentrations of ammonia and NO_x were generally low in value, although elevated levels for both parameters were observed on multiple occasions. Approximately 60% of the total nitrogen measured at this site was present as particulate nitrogen, with approximately 30% as dissolved organic nitrogen and the remainder comprised of ammonia and NO_x.

Measured total phosphorus concentrations in the Lake Street Stormceptor discharge were similar to concentrations commonly observed in residential areas. The dominant phosphorus species measured at this site is particulate phosphorus which comprises approximately 81% of the total nitrogen measured. Approximately 14% of the total phosphorus is comprised of SRP, with the remainder contributed by dissolved organic phosphorus.

Measured concentrations of turbidity and TSS in the Stormceptor discharge were substantially elevated in value compared with concentrations commonly observed in residential runoff. Measured values for each of these parameters were approximately twice as high as observed in other residential areas. These differences are likely related to the presence of the dirt roads which contribute additional turbidity and TSS loadings. This finding is consistent with the 2004 ERD report for the Butler Chain-of-Lakes which also documented elevated concentrations of turbidity and TSS in areas with dirt roads. Measured color concentrations in the Stormceptor discharge were moderate in value and similar to values observed in other residential areas.

TABLE 3-6

CHARACTERISTICS OF STORMCEPTOR DISCHARGE SAMPLES COLLECTED AT THE LAKE STREET SITE

DATE COLLECTED	pH (s.u.)	COND. (μmho/cm)	ALK. (mg/l)	NH_3 (μg/l)	NO_x (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)	TURB (NTU)	TSS (mg/l)	COLOR (PCU)
6/23/09	7.65	199	334	96	140	876	1287	2399	97	8	823	928	643	627	49
6/30/09	7.85	98	201	35	16	204	1054	1309	92	19	842	953	604	575	38
6/30/09	7.61	137	100	15	7	252	395	669	23	35	300	358	185	128	47
7/7/09	8.04	434	157	524	6	477	316	1323	70	25	32	127	7.8	17.8	49
7/8/09	7.72	297	120	216	6	465	249	936	84	1	66	151	25.7	26.5	46
7/9/09	7.35	283	68	11	3	338	106	458	10	4	40	54	4.0	7.0	25
7/14/09	7.95	162	215	12	59	170	408	649	125	18	583	726	616	444	53
7/26/09	7.82	227	119	31	168	601	779	1579	85	2	239	326	142	148	33
7/29/09	7.58	211	59.2	35	168	62	177	442	85	80	34	199	53.3	182	29
8/3/09	7.46	226	75.0	52	83	138	1252	1525	61	20	381	462	172	293	24
8/7/09	7.60	160	120	47	246	106	1185	1584	119	80	795	994	588	550	65
8/8/09	7.38	243	41.4	17	3	324	805	1149	2	2	321	325	200	278	19
8/20-23/09	7.70	269	80.4	60	3	279	797	1139	5	1	253	259	62	132	29
8/25-9/1/09	7.65	269	48.6	42	19	241	442	744	6	9	28	43	1.7	7.4	21
9/1/09	7.37	346	123	27	7	297	1156	1487	26	30	313	369	36	106	48
9/3-8/09	7.59	278	93.8	28	3	333	829	1193	31	28	292	351	60	161	38
Mean	**7.65**	**240**	**122**	**78**	**59**	**323**	**702**	**1162**	**58**	**23**	**334**	**414**	**213**	**230**	**38**
Minimum	**7.35**	**98**	**41**	**11**	**3**	**62**	**106**	**442**	**2**	**1**	**28**	**43**	**1.7**	**7.0**	**19**
Maximum	**8.04**	**434**	**334**	**524**	**246**	**876**	**1287**	**2399**	**125**	**80**	**842**	**994**	**643**	**627**	**65**
Log-Normal	**7.64**	**226**	**105**	**41**	**19**	**267**	**563**	**1052**	**34**	**11**	**197**	**295**	**76.0**	**118**	**36**

Characteristics of Stormceptor discharge samples collected at the Pine Street site are summarized in Table 3-7. Discharge samples at this site were found to be slightly alkaline in pH, with measured values ranging from 7.29-7.98. The discharge samples were also found to be moderately to well buffered, with conductivity values similar to those commonly observed in residential runoff.

Elevated levels of total nitrogen were observed in discharges at the Pine Street site, with total nitrogen concentrations approximately 2.5 times greater than concentrations measured at the Lake Street site. The dominant nitrogen species at the Pine Street site was particulate nitrogen which comprised approximately 75% of the total nitrogen measured. Measured concentrations of dissolved organic nitrogen at the Pine Street site are similar to values measured at the Lake Street site. However, the Pine Street site is characterized by substantially higher concentrations for NO_x than measured at the Lake Street site.

Extremely elevated concentrations of total phosphorus were measured in the Stormceptor discharges at the Pine Street site. Measured total phosphorus concentrations ranged from 753-1502 μg/l, with a log-normal mean value of 1066 μg/l. This value is more than 3 times higher than the concentrations measured at the Lake Street site and concentrations commonly observed in residential runoff. More than 80% of the total phosphorus is contributed by particulate phosphorus which appears to be 3-5 times higher at the Pine Street site than observed at the Lake Street site. Relatively elevated levels of SRP were also observed at the Pine Street site, with values approximately 5 times higher than measured at the Lake Street Site.

Extremely elevated levels of both turbidity and TSS were measured at the Pine Street site, with concentrations many times greater than observed at the Lake Street site and commonly observed in residential runoff. Measured color concentrations at the Pine Street site are similar to those measured at the Lake Street site.

A statistical comparison of pH, alkalinity, conductivity, and TSS measured in the Lake Street and Pine Street Stormceptor discharges is given on Figure 3-4. In general, the characteristics of discharge samples appear to be relatively similar between the two sites for pH, alkalinity, and conductivity. However, measured TSS concentrations at the Pine Street site appear to be higher in value and more variable than concentrations measured at the Lake Street site.

A statistical comparison of nitrogen species measured in the Lake Street and Pine Street Stormceptor discharges is given on Figure 3-5. The collected discharge samples appear to be relatively similar in both concentration and degree of variability for ammonia. However, the Pine Street site is characterized by higher concentrations and more variability within the data for NO_x, particulate nitrogen, and total nitrogen compared with the Lake Street site.

A statistical comparison of phosphorus species measured in the Lake Street and Pine Street Stormceptor discharges is given on Figure 3-6. In general, discharge samples collected at the Pine Street site appear to have higher concentrations as well as a higher degree of variability for all measured phosphorus species than observed at the Lake Street site. Differences between the two sites are particularly apparent for SRP, particulate phosphorus, and total phosphorus.

TABLE 3-7

CHARACTERISTICS OF STORMCEPTOR DISCHARGE SAMPLES COLLECTED AT THE PINE STREET SITE

DATE COLLECTED	pH (s.u.)	COND. (µmho/cm)	ALK. (mg/l)	NH_3 (µg/l)	NO_x (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)	TURB (NTU)	TSS (mg/l)	COLOR (PCU)
6/23/09	7.51	211	353	43	171	281	4025	4520	128	5	1283	1416	765	2129	44
6/30/09	7.30	170	222	29	401	248	3148	3826	58	50	1394	1502	686	1604	38
7/26/09	7.57	677	118	43	1074	1001	2726	4844	335	36	614	985	165	496	21
7/29/09	7.98	125	167	74	1074	176	1291	2615	335	221	581	1137	322	498	36
7/30-8/3/09	7.74	127	128	30	165	176	1877	2248	146	6	854	1006	480	640	33
8/7/09	7.73	164	111	52	274	176	2017	2519	179	5	1215	1399	1176	659	40
8/8/09	7.76	109	88.0	40	93	135	1571	1839	111	7	697	815	336	473	28
9/1/09	7.56	249	98.6	85	75	289	929	1378	349	32	372	753	45	190	59
9/6/09	7.29	210	110	46	18	245	1725	2034	124	23	719	866	187	447	48
Mean	**7.60**	**227**	**155**	**49**	**372**	**303**	**2145**	**2869**	**196**	**43**	**859**	**1098**	**463**	**793**	**39**
Minimum	**7.29**	**109**	**88.0**	**29**	**18**	**135**	**929**	**1378**	**58**	**5**	**372**	**753**	**45.4**	**190**	**21**
Maximum	**7.98**	**677**	**353**	**85**	**1074**	**1001**	**4025**	**4844**	**349**	**221**	**1394**	**1502**	**1176**	**2129**	**59**
Log-Normal	**7.60**	**192**	**140**	**46**	**197**	**249**	**1959**	**2648**	**168**	**19**	**793**	**1066**	**329**	**624**	**37**

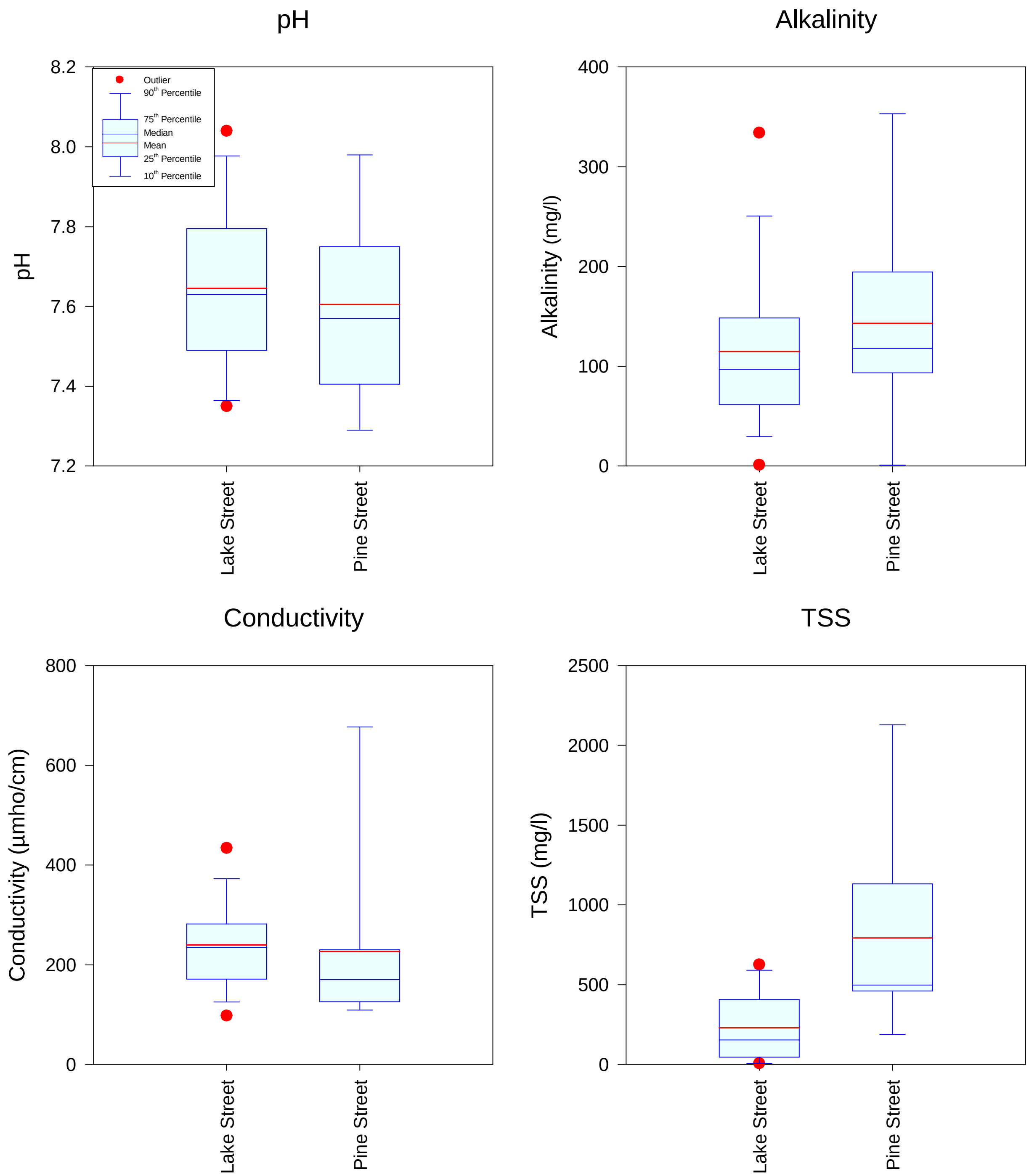


Figure 3-4. Statistical Comparison of pH, Alkalinity, Conductivity, and TSS Measured in the Lake Street and Pine Street Stormceptor Discharges.

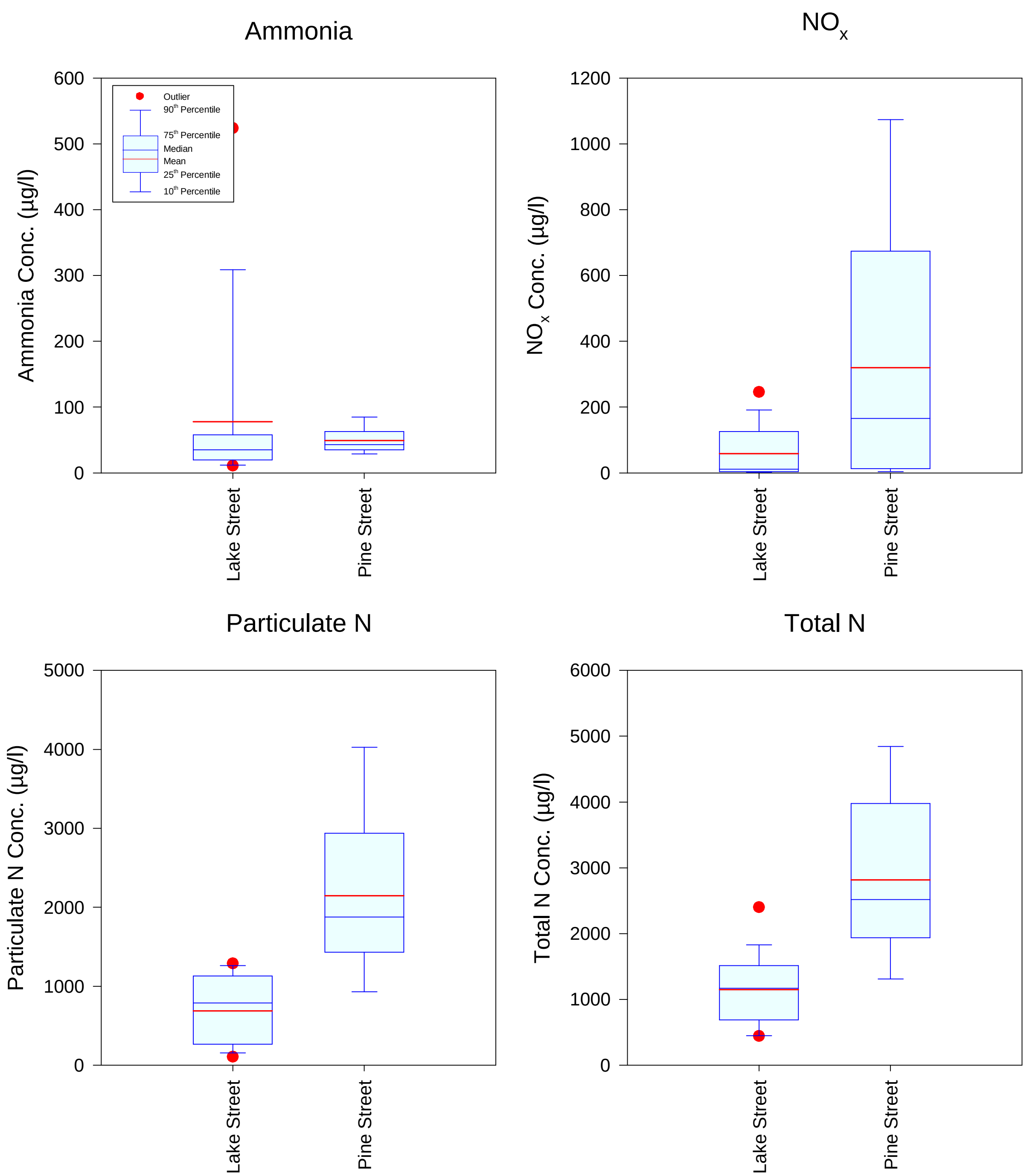


Figure 3-5. Statistical Comparison of Nitrogen Species Measured in the Lake Street and Pine Street Stormceptor Discharges.

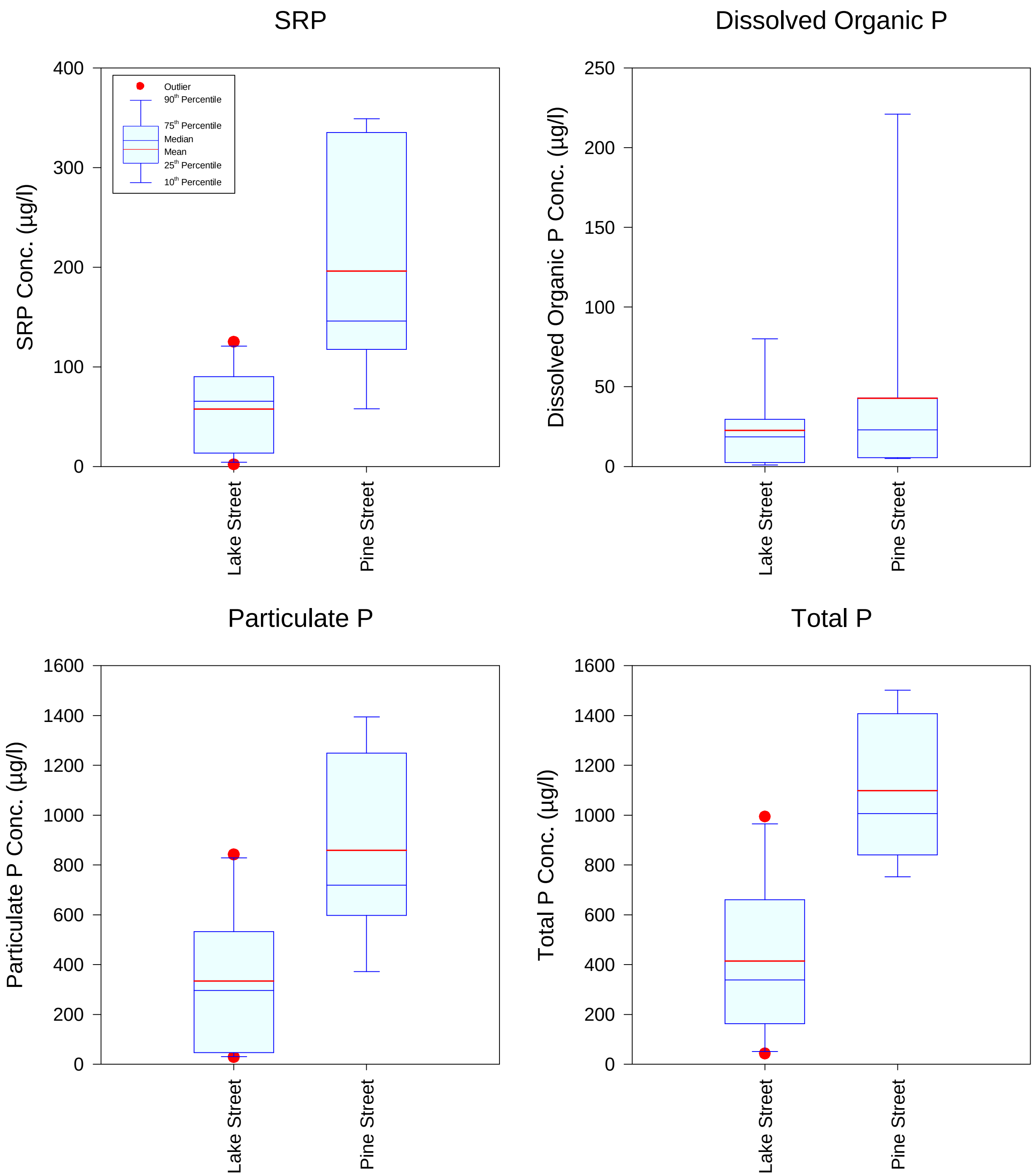


Figure 3-6. Statistical Comparison of Phosphorus Species Measured in the Lake Street and Pine Street Stormceptor Discharges.

A statistical comparison of turbidity and color measurements in the Lake Street and Pine Street Stormceptor discharges is given on Figure 3-7. In general, turbidity measurements were relatively elevated in the discharges for each of the two units, with a slightly higher turbidity level observed at the Pine Street site. Measured turbidity concentrations were highly variable over the monitoring program at each of the two sites. Measured color concentrations appear to be relatively similar at both sites.

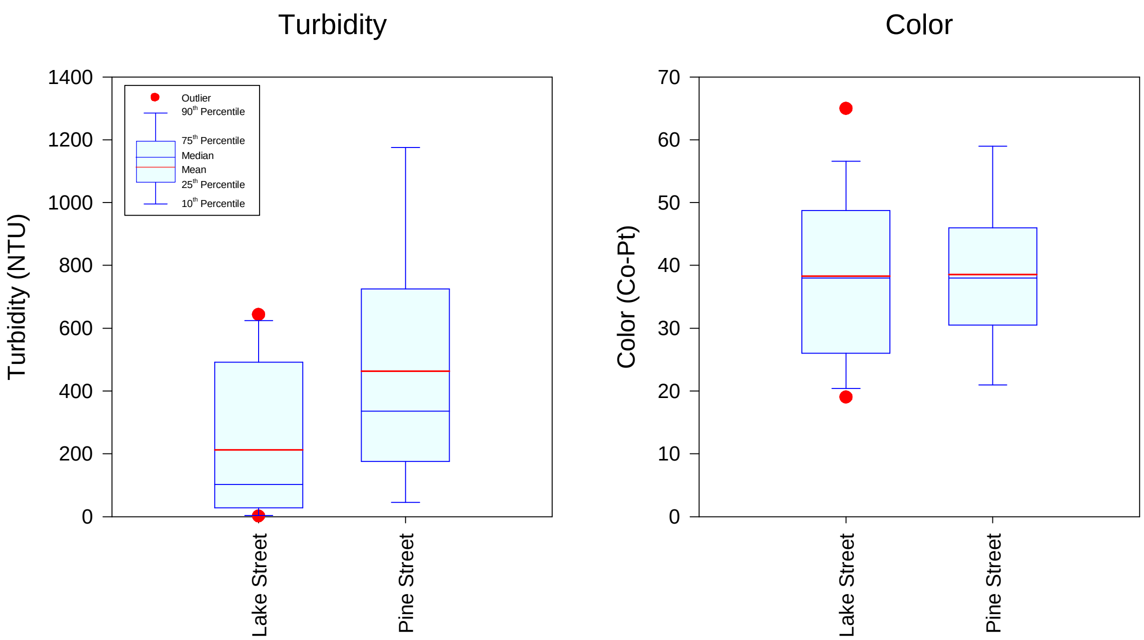


Figure 3-7. Statistical Comparison of Turbidity and TSS Measured in the Lake Street and Pine Street Stormceptor Discharges.

3.2.2 <u>Internal Stormceptor Samples</u>

As discussed previously, vertical profiles of pH, conductivity, temperature, dissolved oxygen, and oxidation-reduction potential (ORP) were conducted inside the Lake Street Stormceptor unit on approximately a weekly basis during the field monitoring program. The vertical profiles were collected inside the sump area which was accessed by lifting the grated aluminum cover over the outlet pipe for the unit. This is the same access location used for removing solids from the sump area, as indicated on Figure 2-4d. Vertical profiles were collected at initial depths of 0.25 and 0.5 m and continued at 0.5-m intervals to the sump bottom which ranged from approximately 1.5-1.8 m, depending upon solids accumulation at the time of the monitoring event. A complete listing of vertical profiles collected inside the Lake Street Stormceptor unit is given in Appendix C. Vertical profiles were not collected inside the Pine Street Stormceptor unit since access into the internal sump area was substantially more complicated for this unit type.

A compilation of vertical field profiles of temperature, pH, conductivity, and dissolved oxygen collected inside the Lake Street Stormceptor unit is given on Figure 3-8. Individual profiles are provided for each of the 14 separate measurements conducted during the monitoring program. Decreases in temperature with increasing depth were observed within the Stormceptor unit during each of the monitoring events. In some cases, differences in temperature between top and bottom measurements exceeded 5-6^{o}C, while on other dates, these differences were limited to 1^{o}C or less.

Measured pH values within the Stormceptor unit were approximately neutral in value, although pH measurements in excess of 8.0 were measured during 2 of the 14 monitoring events. A trend of slightly decreasing pH with increasing water depth was observed during some events, while the opposite trend was observed during other events. In general, no distinct pattern of increasing or decreasing pH is apparent within the Stormceptor unit.

Measured conductivity values within the Stormceptor unit exhibit a number of different patterns, with increases in conductivity with increasing depth observed during some events, decreases in conductivity with increasing depth observed during other events, and relatively isograde conductivity values observed during the remaining events.

Measured dissolved oxygen concentrations within the Stormceptor unit decreased rapidly with increasing water depth. The most rapid reduction occurred between the 0.25-0.5 m measurements, with anoxic conditions (defined as dissolved oxygen concentrations less than 1 mg/l) were observed at a depth of 0.5 m during a majority of the monitoring events. Anoxic conditions were observed in the bottom portions of the Stormceptor unit during all but 2 of the 14 monitoring events.

A summary of vertical profiles of oxidation-reduction potential (ORP) collected inside the Lake Street Stormceptor unit is given on Figure 3-9. In general, ORP values less than 200 mv indicate reduced conditions, while ORP values in excess of 200 mv reflect oxidized conditions. Based upon these criteria, reduced conditions were observed inside the Stormceptor unit, extending from a depth of 0.5 m to the sump bottom, during 10 of the 14 monitoring events. Reduced conditions at the bottom of the sump, near the sediment/water interface, were observed during 12 of the 14 monitoring events. These data suggest that reduced conditions are maintained within the sump of the Stormceptor unit during a majority of the time, with dissolved oxygen concentrations typically equal to 1 mg/l or less. These conditions are favorable for release of phosphorus and other molecules from the accumulated material in the Stormceptor unit.

Although outside of the proposed Scope of Services for this project, water samples were also collected from within the Lake Street Stormceptor sump on six separate occasions during the final month of the monitoring program. These samples were collected at approximately mid-depth within the available water column in the unit at the time of sample collection. A summary of the characteristics of the water samples collected inside the Lake Street Stormceptor unit is given in Table 3-8. In general, the characteristics of water samples collected inside the Stormceptor unit are similar to the characteristics of the discharge samples measured at this site for many parameters. Water samples collected inside the Stormceptor unit are approximately neutral in pH and similar to values measured in the outflow. A similar pattern is apparent for measured concentrations of alkalinity. However, somewhat higher concentrations of specific conductivity were observed inside the Stormceptor chamber compared with samples collected in the outflow, suggesting an increase in conductivity within the unit, presumably a result of release of ions into the water column under the constant anoxic conditions which exist within the unit.

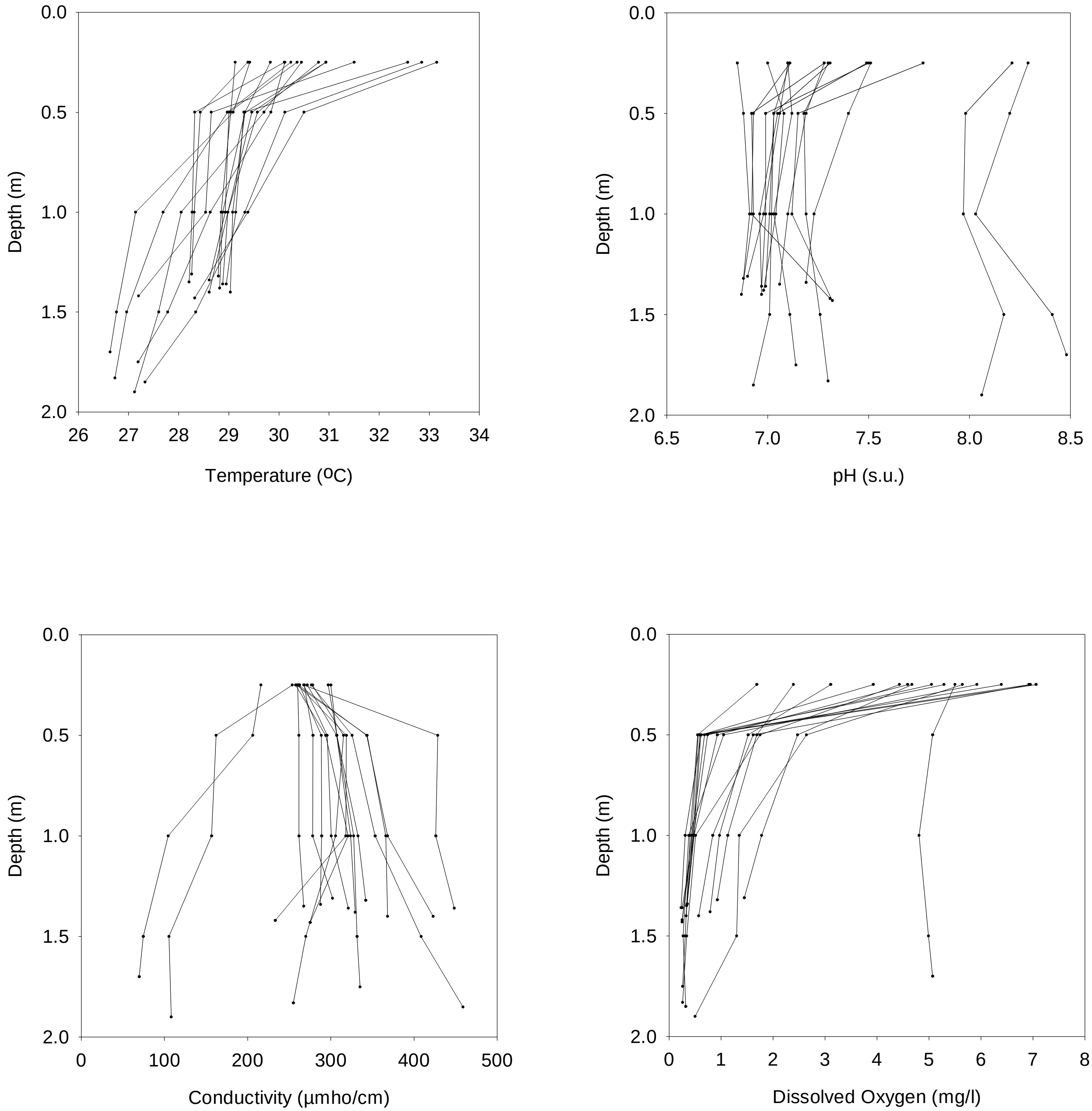


Figure 3-8. Vertical Profiles of Temperature, pH, Conductivity, and Dissolved Oxygen Conducted Inside the Lake Street Stormceptor Unit.

TABLE 3-8

CHARACTERISTICS OF WATER SAMPLES COLLECTED INSIDE THE LAKE STREET STORMCEPTOR UNIT

DATE COLLECTED	pH (s.u.)	COND. (μmho/cm)	ALK. (mg/l)	NH_3 (μg/l)	NO_x (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)	TURB (NTU)	TSS (mg/l)	COLOR (PCU)
8/25/09	7.20	295	75	106	10	419	159	694	5	4	49	58	3.1	7.4	39
9/1/09	7.22	325	136	692	19	456	473	1640	6	78	130	214	7.8	5.8	63
9/3/09	7.18	308	111	19	5	663	476	1163	77	30	88	195	10.2	65.1	44
9/8/09	7.29	313	118	550	7	447	330	1334	22	84	200	306	14.4	28.4	75
9/11/09	7.36	328	99	474	5	224	287	990	48	77	14	139	7.9	26.2	32
9/14/09	7.18	295	96	673	18	281	451	1423	102	24	136	262	17.2	20.8	46
Mean	**7.24**	**311**	**106**	**419**	**11**	**415**	**363**	**1207**	**43**	**50**	**103**	**196**	**10.1**	**25.6**	**50**
Minimum	**7.18**	**295**	**75.4**	**19**	**5**	**224**	**159**	**694**	**5**	**4**	**14**	**58**	**3.1**	**5.8**	**32**
Maximum	**7.36**	**328**	**136**	**692**	**19**	**663**	**476**	**1640**	**102**	**84**	**200**	**306**	**17.2**	**65.1**	**75**
Log-Normal	**7.24**	**310**	**104**	**250**	**9**	**391**	**339**	**1164**	**25**	**34**	**77**	**173**	**8.9**	**18.7**	**48**

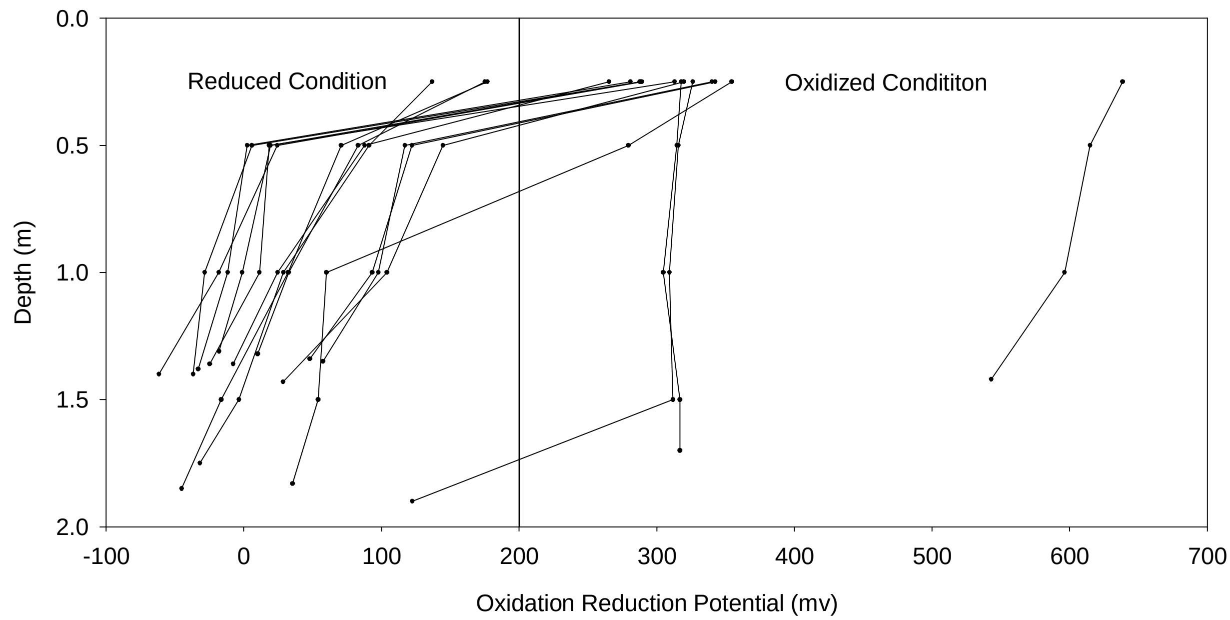


Figure 3-9. Vertical Profiles of Oxidation-Reduction Potential (ORP) Conducted Inside the Lake Street Stormceptor Unit.

Measured total nitrogen concentrations within the Stormceptor sump are similar to values measured in the discharge samples. However, the distribution of nitrogen species appears to have shifted somewhat, with substantially lower levels of particulate nitrogen measured within the sump area and much higher concentrations of ammonia. A reduction in measured concentrations of NO_x is also apparent. The increases in ammonia and decreases in NO_x are also likely related to the anoxic conditions which occur within the unit.

Measured phosphorus concentrations in the Stormceptor sump appear to be lower in value than measured in discharge samples from the unit. A similar pattern is apparent for measured concentrations of turbidity and TSS, with a slight increase in color.

3.3 <u>Quantification of Sediment Accumulations</u>

At the completion of the field monitoring program, each of the two Stormceptor systems was cleaned by Town of Windermere personnel using the same techniques which were used for the initial clean-out prior to beginning the field monitoring program. These clean-out activities required approximately two days for the Lake Street site and a half day for the Pine Street site. The Lake Street site required additional effort for maintenance since the outfall pipe and Stormceptor unit are submerged at the normal water levels in Lake Down. Before the clean-out could be conducted, a pneumatic bladder plug was inserted into the 24-inch RCP discharge from the unit. The plug was installed immediately upstream of the point of discharge into Lake Down which allowed both the Stormceptor unit and downstream stormsewer line to be dewatered. The Stormceptor unit located at the Pine Street site was not submerged under ordinary operating conditions, and no special procedures were required to maintain this unit.

Immediately prior to initiating the clean-out activities, ERD personnel observed, measured, and photographed sediment accumulations, if any, present in the inflow and discharge stormsewer lines for each of the two units. In addition, sediment was also observed covering the top of the Lake Street Stormceptor unit, and this material was also quantified. Samples were collected from each area with accumulated solids and returned to the ERD Laboratory for physical characterization and nutrient analyses. Sufficient field measurements were collected to allow quantification of the solids accumulated within various parts of the stormsewer systems.

During the maintenance procedures, sediments collected within the sumps of the two Stormceptor units were segregated from solids located in portions of the stormsewer system. The clean-out activities generally required multiple loadings of the vacuum truck and disposal at the Windermere maintenance yard. After each load was emptied from the vacuum truck, a sub-sample of the solids was collected by ERD and placed in a 4-liter wide-mouth polyethylene container. At the conclusion of the clean-out process, each of the 4-liter solids samples were combined together to form a composite sample reflecting the characteristics of the solids removed from each of the two units. These samples were returned to the ERD Laboratory for physical and chemical analysis.

Photographs of the accumulated solids removed from the Lake Street and Pine Street Stormceptor units are given on Figure 3-10, including solids removed from the top of the Lake Street Stormceptor unit. The large mound of soil in the background of the two photographs contains sand and small gravel which is used to regrade the residential dirt streets as needed. The materials removed from the Stormceptor units, which originated primarily from the dirt streets, will be combined with the larger pile and used for maintenance and repair activities on the dirt roads.

Figure 3-10. Accumulated Solids Removed from the Stormceptor Units.

3.3.1 Lake Street Site

Photographs of accumulated solids at the Lake Street Stormceptor site are given on Figure 3-11. When the water was drained from the stormsewer system, accumulated solids were observed in both the inflow and outfall stormsewer lines as well as on the top of the Stormceptor unit. Sediment accumulations as deep as 3-4 inches were observed in each of these locations. Physical measurements of the depth and extent of these accumulations were conducted by ERD personnel to quantify these additional solids. The volume of accumulated solids within the Stormceptor unit was obtained by measuring the depth of solids within the unit through the available access ports into the sump area. The volume of accumulated solids was then calculated based upon the depth of solids and geometry of the sump area.

a. Inflow Pipe to Stormceptor Unit

b. Accumulated Solids on Top of Stormceptor Unit

c. Accumulated Solids in Outfall Pipe

Figure 3-11. Accumulated Solids at the Lake Street Site.

A graphical summary of the locations and quantities of accumulated solids at the Lake Street site at the completion of the field monitoring program is given on Figure 3-12. The shaded areas representing solids are drawn to an approximate vertical scale. At the completion of the monitoring program, approximately 57 ft^3 of solids had been collected inside the sump area. An additional 31.4 ft^3 of solids had settled inside the inflow pipe prior to reaching the Stormceptor unit. Solids accumulated on the top of the Stormceptor unit represented approximately 0.89 ft^3, with 9.48 ft^3 of solids inside the outflow pipe. The accumulation of solidus in the inflow and outflow pipes is likely related to the surcharged nature of the stormsewer system. When runoff events enter the surcharged stormsewer system, the cross-sectional area increases substantially, resulting in a decrease in velocity and a settling of solid materials.

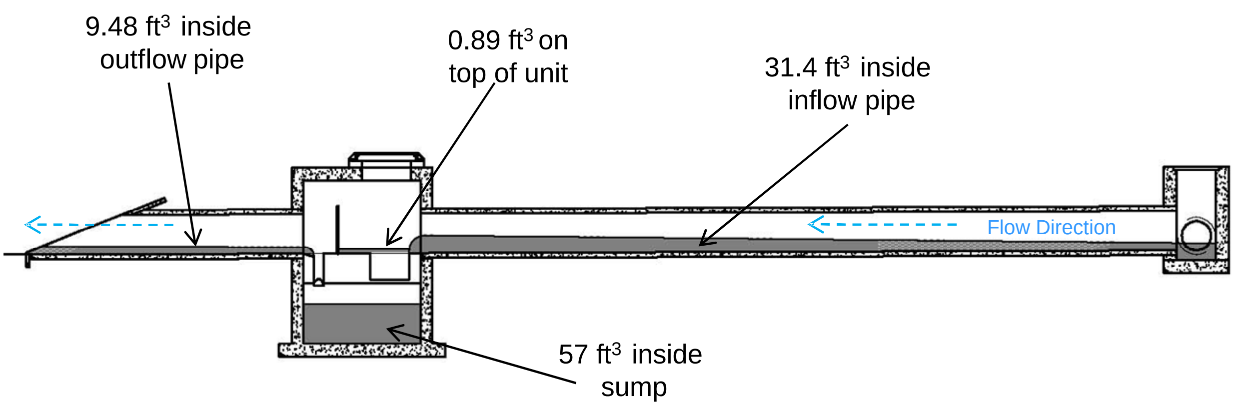


Figure 3-12. Locations and Quantities of Accumulated Solids at the Lake Street Site at the Completion of the Monitoring Program.

The collected samples of accumulated solids were returned to the ERD Laboratory and evaluated for particle size, physical characteristics, and nutrient concentrations. These analyses were conducted on the composite sample as well as each of the individual sieve size fractions used for the sieve analysis. A complete listing of the physical and chemical characteristics of accumulated solids at the Lake Street Stormceptor site by particle size is given in Appendix D.1.

Characteristics of accumulated solids at the Lake Street site are summarized on Table 3-9 for solids samples collected from the Stormceptor site, on top of the Stormceptor unit, and upstream and downstream of the Stormceptor system. Solids which accumulated within the Stormceptor sump were characterized by a mean density of 2.27 g/cm^3. This value is used along with the measured sediment volume to estimate the mass of dry solids contained within the sump, approximately 3662 kg. Solids collected from the sump are characterized by a low organic content, low total nitrogen, and moderate total phosphorus. Solids collected from the upstream stormsewer pipe are characterized by a higher mean density, lower organic content, and lower nutrient content, all of which are consistent with the relatively large diameter inorganic particles which are likely to settle in this area. Solids accumulated in the downstream stormsewer pipe are characterized by a lower mean density of 1.98 g/cm^3, with higher concentrations for organic content and nutrients than observed at the other locations. These characteristics are also consistent with the type of solids which would be expected to settle in this area after the larger particles have been removed in the upstream stormsewer or within the Stormceptor sump.

TABLE 3-9

CHARACTERISTICS OF ACCUMULATED SOLIDS AT THE LAKE STREET SITE

LOCATION	VOLUME (ft^3)	MEAN DENSITY (g/cm^3)	MASS (kg dry wt.)	ORGANIC CONTENT (%)	TOTAL NITROGEN (μg/g)	TOTAL PHOSPHORUS (μg/g)
Stormceptor Sump	57.0	2.27	3662	1.1	90	184
On Top of Stormceptor Unit	0.89	2.17	54.7	1.0	114	210
Upstream Pipe	31.4	2.40	2133	0.7	18	108
Downstream Pipe	9.48	1.98	531	2.8	188	238

Particle size distributions of accumulated solids at the Lake Street Stormceptor site are given on Figure 3-13 for each of the solids accumulation areas. Solids collected within the upstream stormsewer pipe are primarily large diameter particles with higher densities which settle rapidly from the runoff flow upon entering the stormsewer system. Solids collected within the Stormceptor sump appear to be primarily fine gravel (represented by particle sizes greater than 2000 μm), coarse sand, and fine sand. Particle retention appears to be relatively minimal for particle sizes less than 75 μm. Solids collected from the top of the Stormceptor unit appear to consist primarily of medium to fine sand, with relatively few larger and smaller particles. Solids collected from the downstream stormsewer pipe appear to be similar in distribution to particles collected on the top of the Stormceptor unit.

Nutrient concentrations as a function of sieve size for solids collected from each of the accumulation areas are summarized on Figure 3-14. Phosphorus and nitrogen in the solids which accumulated in the upstream stormsewer pipe are primarily associated with particles greater than 2000 μm. The particles are likely to contain organic detritus which would indicate elevated nutrient levels. Relatively minimal contributions of both total nitrogen and total phosphorus are present in the remaining particle sizes.

Nutrients contained within the Stormceptor sump are also associated primarily with larger particle sizes, presumably reflecting organic materials. Measured nitrogen concentrations in the remaining sieve sizes appear to be relatively similar with a slight trend of decreasing nitrogen concentration with decreasing sieve size. However, elevated concentrations of phosphorus were observed in particles ranging from 75-180 μm, although the phosphorus concentrations are less than observed in the >2000 μm fraction.

Nutrient concentrations from solids collected on top of the Stormceptor unit and in the downstream stormsewer pipe appear to be relatively similar. Nutrient distributions are also similar to solids collected from the Stormceptor sump with the exception that the >2000 μm particles are apparently removed within the Stormceptor sump.

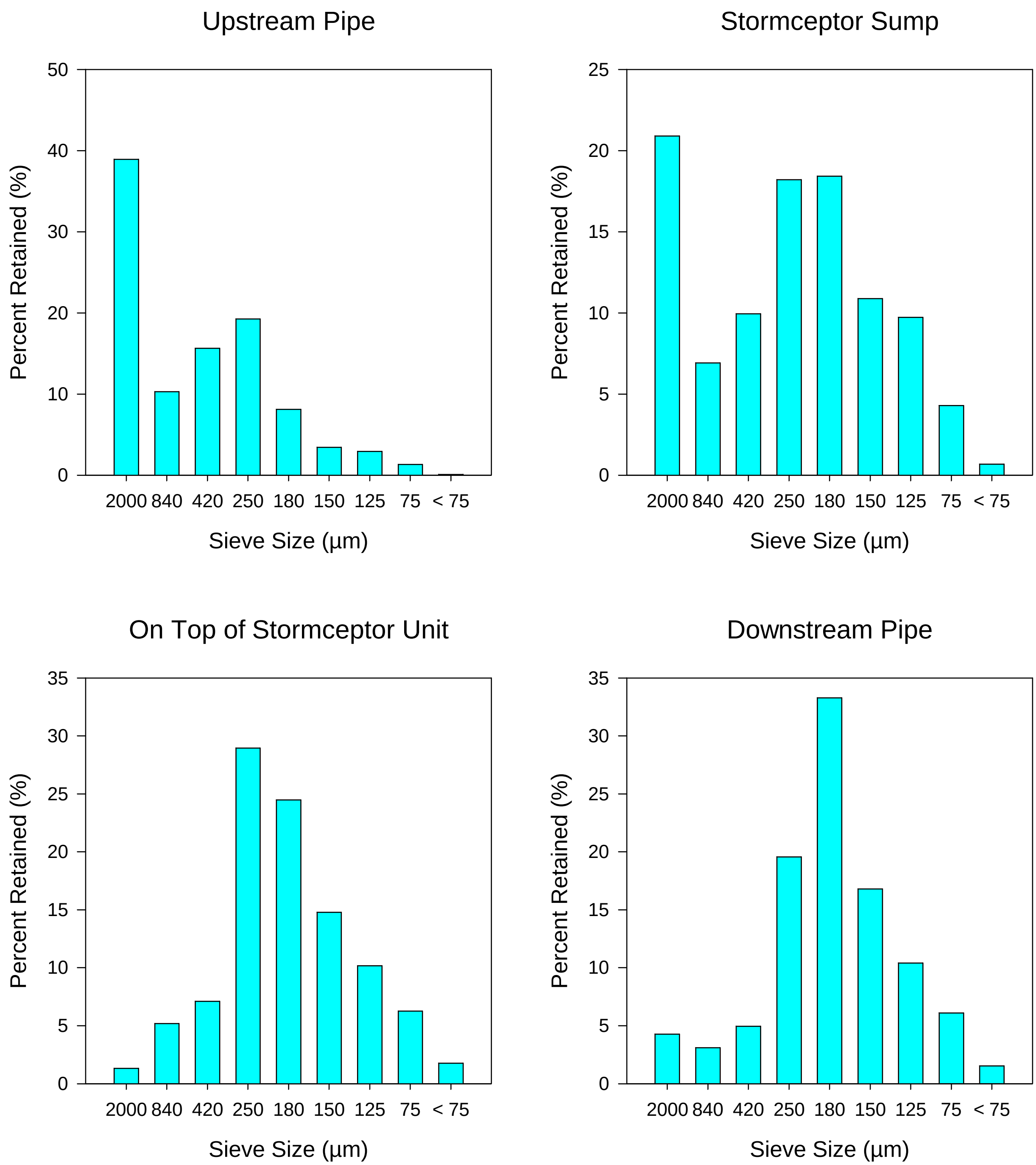


Figure 3-13. Particle Size Distributions of Accumulated Solids at the Lake Street Site.

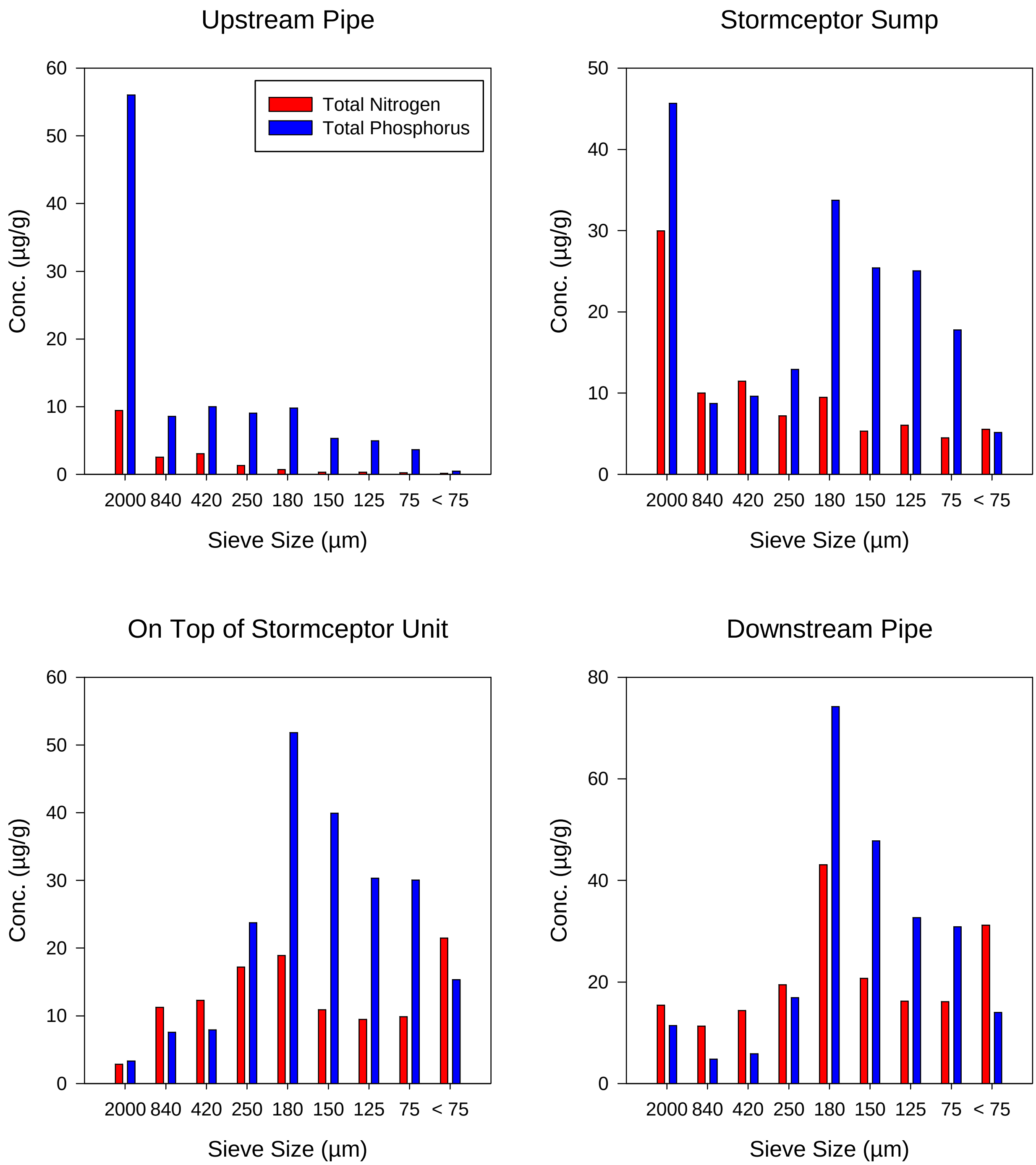


Figure 3-14. Nitrogen and Phosphorus Concentrations in Solids Collected at the Lake Street Site.

Phosphorus speciation in accumulated solids collected at the Lake Street site is summarized in Table 3-10. As discussed in Section 2.3, this procedure is valuable in evaluating the release potential for phosphorus in solids which accumulate within the Stormceptor units. In general, phosphorus bound as a saloid or with iron is considered to be readily available for release into the overlying water column during reduced conditions, while aluminum-bound phosphorus is typically unavailable. However, measured values for both saloid and iron-bound phosphorus in the accumulated solids samples collected at each of the four locations are low in value and reflect a low release potential for phosphorus under anoxic conditions with these particular solids. Phosphorus which is potentially available for release during anoxic conditions represents approximately 3.9-14% of the phosphorus measured at each of the four sites. This low release potential explains the lack of significant phosphorus release observed in samples collected within the sump area of the Lake Street unit.

TABLE 3-10

PHOSPHORUS SPECIATION OF ACCUMULATED SOLIDS AT THE LAKE STREET SITE

LOCATION	TOTAL PHOSPHORUS (µg/g dry wt.)	PHOSPHORUS CONCENTRATION PER FRACTION (µg/g dry wt.)				PERCENT AVAILABLE PHOSPHORUS (%)
		Saloid-Bound	Fe-Bound	Al-Bound	Total Available	
Stormceptor Sump	184	4.2	4.0	8.0	8.2	4.5
On Top of Stormceptor Unit	210	4.1	4.1	9.8	8.2	3.9
Upstream Pipe	108	12.0	3.1	3.7	15.1	14.0
Downstream Pipe	238	5.7	3.9	11.2	9.6	4.0

3.3.2 Pine Street Site

At the completion of the field monitoring program, the cast-iron grate cover for the Stormceptor system at the Pine Street system was removed, and visual observations of the Stormceptor unit and incoming and outgoing stormsewer lines were evaluated. No significant accumulation of solids was observed in the 15-inch inflow stormsewer line since this portion of the stormsewer system does not experience surcharged conditions. No significant accumulation of solids was visible on the top of the Stormceptor unit as was observed at the Lake Street site. However, a significant accumulation of suspended solids was observed downstream from the Stormceptor unit, with a measured depth of approximately 3-5 inches inside the 15-inch RCP. This accumulation continued to the next manhole structure located approximately 133 ft downstream from the Stormceptor structure. According to the construction drawings provided in Appendix A.2, the discharge pipe has a relatively steep slope of approximately 1.3%. Solids were also observed to have accumulated in the sump area for the downstream manhole structure.

Significant accumulations of solids and debris were observed around the inlet structure for the Pine Street Stormceptor system throughout the majority of the monitoring program. Photographs of these accumulations are given on Figure 3-15. The grate inlet structure allows runoff to discharge directly onto the top of the Stormceptor unit. Depending upon which portion of the grate the runoff water enters, some of the runoff may enter the Stormceptor system, while a portion of the runoff can bypass the system and immediately discharge downstream. This material was not quantified or further evaluated since it did not enter the stormsewer system.

Figure 3-15. Accumulated Solids and Debris Around the Pine Street Stormceptor Grate Inlet.

Locations and quantities of accumulated solids at the Pine Street site at the completion of the monitoring program are illustrated on Figure 3-16. During the 92-day monitoring period, approximately 10.9 ft^3 of solids had accumulated in the sump area of the Stormceptor unit. An additional 2.65 ft^3 had accumulated inside the outflow pipe between the Stormceptor structure and the downstream manhole structure. An additional 3.4 ft^3 of solids had accumulated inside the downstream manhole sump. A complete listing of the physical and chemical characteristics of accumulated solids at the Lake Street Stormceptor site by particle size is given in Appendix D.2.

Characteristics of accumulated solids at the Pine Street site are summarized on Table 3-11. Solids collected from the sump area at this site were characterized by a higher organic content and higher nutrient concentrations than observed in the sump area of the Lake Street Stormceptor unit. These values suggest a higher percentage of organic debris in the solids at this site compared with the Lake Street site. Nutrient concentrations in solids collected in the downstream stormsewer pipe were also higher than observed at the Lake Street site.

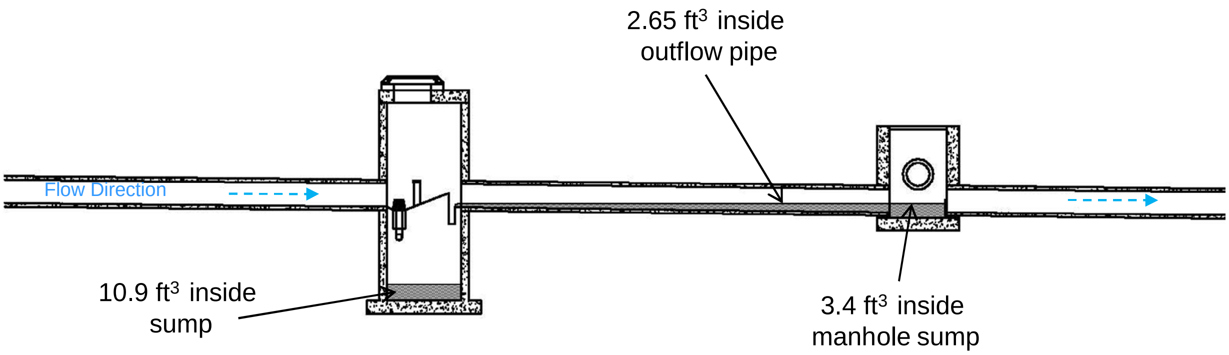


Figure 3-16. Locations and Quantities of Accumulated Solids at the Pine Street Site at the Completion of the Monitoring Program.

TABLE 3-11

CHARACTERISTICS OF ACCUMULATED SOLIDS AT THE PINE STREET SITE

LOCATION	VOLUME (ft^3)	MEAN DENSITY (g/cm^3)	MASS (kg dry wt.)	ORGANIC CONTENT (%)	TOTAL NITROGEN (µg/g)	TOTAL PHOSPHORUS (µg/g)
Stormceptor Sump	10.9	1.98	611	6.3	441	236
Downstream Pipe	2.65	2.27	170	1.6	281	246

Particle size distributions of accumulated solids in the Stormceptor sump and downstream stormsewer system at the Pine Street site are illustrated on Figure 3-17. In general, solids collected from both areas are primarily 150 µm or larger in size. As observed at the Lake Street site, the Pine Street Stormceptor sump appears to provide a low collection efficiency for particles less than 75 µm.

Measured nutrient concentrations of various particle sizes in solids collected at the Pine Street site are given in Figure 3-18. Nitrogen concentrations in solids collected from the sump area are associated primarily with particles of approximately 180 µm or more, with relatively low nitrogen concentrations for particle sizes less than 180 µm. A similar pattern is apparent for total phosphorus, with the majority of measured phosphorus associated with particles in excess of 150 µm and relatively low phosphorus concentrations for smaller particles. Nutrient concentrations in solids collected in the downstream stormsewer pipe are also primarily associated with particles of approximately 180 µm or more. Substantially lower concentrations of both total nitrogen and total phosphorus were measured in particle sizes less than 180 µm.

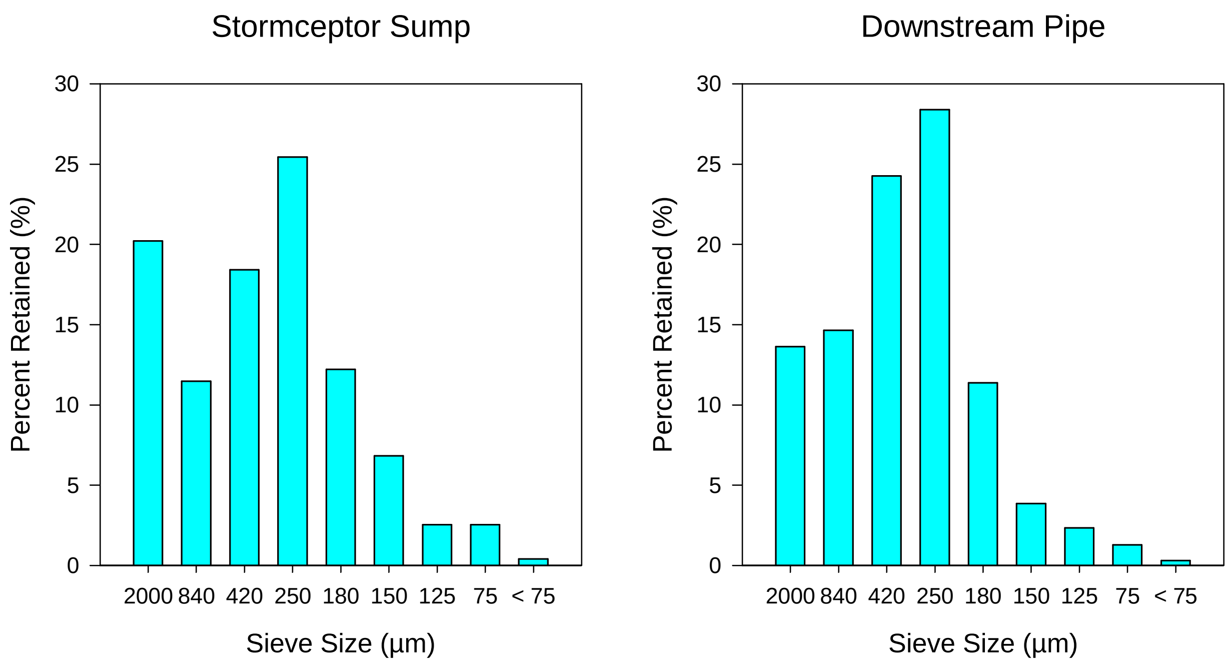


Figure 3-17. Particle Size Distributions of Accumulated Solids at the Pine Street Site.

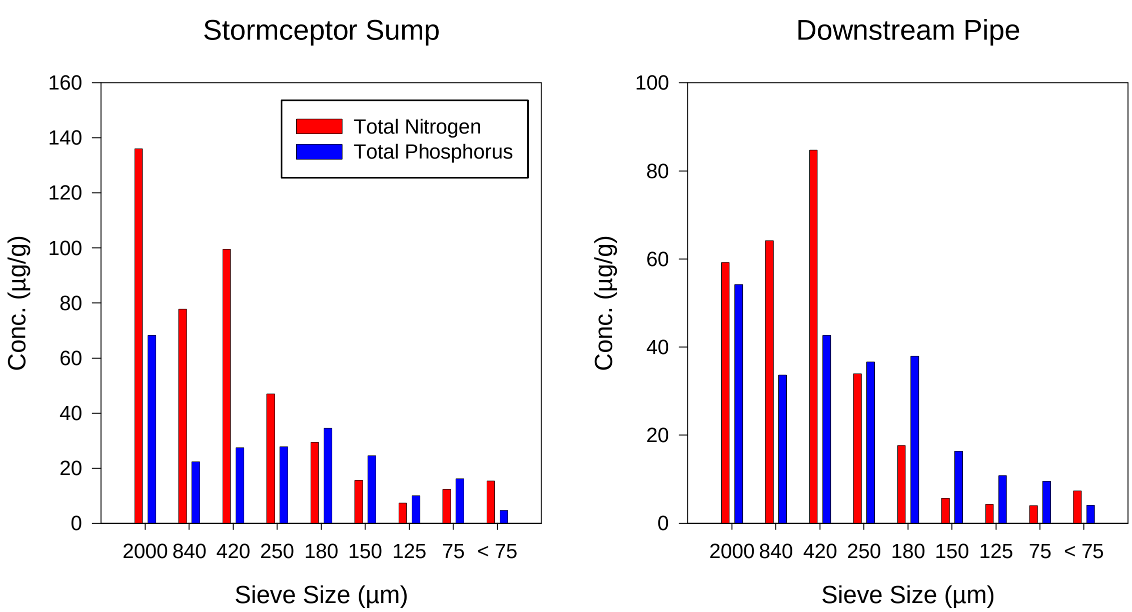


Figure 3-18. Nitrogen and Phosphorus Concentrations in Solids Collected at the Pine Street Site.

Phosphorus speciation in accumulated solids at the Pine Street is given in Table 3-12. Relatively low levels of both saloid and iron-bound phosphorus associations were observed in solids collected from the Stormceptor sump as well as the downstream stormsewer pipe. Overall, available phosphorus in the solids collected at this site range from 3.7-5.0%, indicating a relatively potential for release of phosphorus from these sediments under anoxic conditions.

TABLE 3-12

PHOSPHORUS SPECIATION OF ACCUMULATED SOLIDS AT THE PINE STREET SITE

LOCATION	TOTAL PHOSPHORUS (μg/g dry wt.)	PHOSPHORUS CONCENTRATION PER FRACTION (μg/g dry wt.)				PERCENT AVAILABLE PHOSPHORUS (%)
		Saloid-Bound	Fe-Bound	Al-Bound	Total Available	
Stormceptor Sump	236	7.5	4.4	6.9	11.9	5.0
Downstream Pipe	246	5.5	3.5	6.4	9.0	3.7

3.4 Performance Efficiency

Performance efficiencies of the Stormceptor units for removal of TSS, total nitrogen, and total phosphorus were evaluated using the general methodology outlined in Section 2.1.3. Slight modifications to this methodology were made to adjust for site-specific conditions where applicable. Details of the performance efficiency evaluations are provided in the following sections.

3.4.1 Lake Street Site

At the Lake Street site, the total mass of solids presented to the Stormceptor unit for removal is assumed to be the sum of the mass of solids removed within the sump, the mass of solids in the runoff discharge from the Stormceptor unit, the mass of solids within the downstream stormsewer system, and the mass of solids which settle on the top of the unit. Each of these groups of solids has an opportunity to enter the unit for removal. This relationship is expressed in equation form as follows:

Input Mass Reaching Unit =

Mass in Discharge + Mass of Sump Solids + Mass in Downstream Stormsewer + Mass on Top of Unit

A summary of removal efficiency calculations for TSS at the Lake Street Stormceptor site is given on Table 3-13. During the 92-day monitoring program, approximately 75,866 ft^3 of runoff discharged through the Stormceptor site. Based on a log-normal mean TSS discharge concentration of 118 mg/l, the total mass of suspended solids contained in discharges from the Stormceptor unit is approximately 253 kg. As indicated on Table 3-9, an additional 531 kg of suspended solids was present in the downstream stormsewer pipe, with approximately 54.7 kg of suspended solids from the top of the unit. The sum of these loadings is 838.7 kg which reflects suspended solids not removed by the Stormceptor unit. The mass of solids contained within the sump of the Stormceptor unit was approximately 3662 kg, for a total of 4501 kg of TSS which reached the Stormceptor site. The removal efficiency is calculated by dividing the mass of solids contained within the sump by the total mass of TSS reaching the unit. For TSS, the estimated removal efficiency at the Lake Street site is approximately 81.4% during the monitoring program.

TABLE 3-13

REMOVAL EFFICIENCY CALCULATIONS FOR TSS AT THE LAKE STREET STORMCEPTOR SITE

PARAMETER	UNITS	VALUE
TSS Loading in Stormceptor Discharges a. Discharge Volume b. Discharge TSS Concentration c. Discharge TSS Mass	 ft^3 mg/l kg	 75,866 118 253
TSS in Downstream Pipe	kg	531
TSS on Unit Top	kg	54.7
Total TSS Not Collected by Unit	kg	838.7
TSS Collected by Unit	kg	3662
Total TSS to Unit	kg	4501
Mean Runoff TSS Concentration	mg/l	2096
Removal Efficiency	%	81.4

The estimated mean runoff TSS concentration at the Lake Street site was calculated by dividing the total TSS mass reaching the Stormceptor site (4501 kg) by the volume of runoff generated in the Lake Street sub-basin during the field monitoring program (75,866 ft^3). The resulting mean TSS concentration is 2096 mg/l which is approximately 10-50 times higher than TSS concentrations commonly observed in urban runoff. This extremely elevated concentration is a result of transport of solids from the adjacent dirt roads during storm events.

Removal efficiencies for total nitrogen at the Lake Street Stormceptor site are given on Table 3-14. The log-normal mean discharge concentration for total nitrogen at the Lake Street site was approximately 1052 μg/l. The resulting discharge of total nitrogen from the unit was approximately 2.26 kg over the 92-day monitoring period. The total nitrogen concentration in solids collected in the downstream stormsewer pipe were calculated by multiplying the total nitrogen concentration for solids in the downstream stormsewer line times the mass of solids collected in this area (as summarized on Table 3-9). This calculation was also performed to estimate total nitrogen content in the solids collected on top of the unit by multiplying the total nitrogen concentration of 114 μg/g times the mass of dry solids, equivalent to 54.7 kg. The resulting nitrogen content in the downstream stormsewer pipe is equivalent to approximately 0.100 kg, with 0.006 kg on the top of the Stormceptor unit. Overall, approximately 2.366 kg of total nitrogen bypassed the Stormceptor unit during the monitoring program. The mass of total nitrogen collected by the unit within the sump is approximately 0.33 kg. The sum of total nitrogen reaching the Stormceptor site during the monitoring program is approximately 2.696 kg, resulting in a calculated removal efficiency for total nitrogen of approximately 12.2%.

TABLE 3-14

REMOVAL EFFICIENCY CALCULATIONS FOR TOTAL NITROGEN AT THE LAKE STREET STORMCEPTOR SITE

PARAMETER	UNITS	VALUE
Total Nitrogen Loading in Stormceptor Discharges a. Discharge Volume b. Discharge Total Nitrogen Concentration c. Discharge Total Nitrogen Mass	 ft^3 μg/l kg	 75,866 1,052 2.260
Total Nitrogen in Downstream Pipe	kg	0.100
Total Nitrogen on Unit Top	kg	0.006
Total Nitrogen Not Collected by Unit	kg	2.366
Total Nitrogen Collected by Unit	kg	0.330
Total Nitrogen to Unit	kg	2.696
Mean Runoff Total Nitrogen Concentration	μg/l	1255
Removal Efficiency	%	12.2

The calculated mean runoff concentration for total nitrogen in runoff generated within the Lake Street sub-basin is also listed on Table 3-14. The mean runoff total nitrogen concentration of 1255 μg/l is approximately 40% lower than total nitrogen concentrations commonly observed in runoff from residential areas.

Removal efficiency calculations for total phosphorus at the Lake Street Stormceptor site are illustrated on Table 3-15. The mass of phosphorus contained in runoff discharges from the Stormceptor unit was approximately 0.634 kg. An additional 0.126 kg of phosphorus was present in solids collected in the downstream stormsewer pipe, with 0.011 kg of total phosphorus on the top of the unit. Overall, approximately 0.771 kg of total phosphorus reaching the Stormceptor site was not collected by the unit. The total phosphorus collected in the sump of the unit was approximately 0.674 kg, for a total phosphorus loading of approximately 1.445 kg to the Stormceptor unit. The removal efficiency for total phosphorus during the 92-day monitoring period was approximately 46.6%.

TABLE 3-15

REMOVAL EFFICIENCY CALCULATIONS FOR TOTAL PHOSPHORUS AT THE LAKE STREET STORMCEPTOR SITE

PARAMETER	UNITS	VALUE
Total Phosphorus Loading in Stormceptor Discharges		
a. Discharge Volume	ft^3	75,866
b. Discharge Total Phosphorus Concentration	μg/l	295
c. Discharge Total Phosphorus Mass	kg	0.634
Total Phosphorus in Downstream Pipe	kg	0.126
Total Phosphorus on Unit Top	kg	0.011
Total Phosphorus Not Collected by Unit	kg	0.771
Total Phosphorus Collected by Unit	kg	0.674
Total Phosphorus to Unit	kg	1.445
Mean Runoff Total Phosphorus Concentration	μg/l	673
Removal Efficiency	%	46.6

The calculated mean runoff total phosphorus concentration for the Lake Street watershed is also summarized in Table 3-15. During the 92-day monitoring program, the mean total phosphorus concentration in runoff reaching the Stormceptor unit was 673 μg/l. This value is approximately twice phosphorus concentrations commonly observed in runoff generated in residential areas, and reflects the added phosphorus loadings resulting from wash-off and erosion of existing dirt roads.

3.4.2 Pine Street Site

Mass inputs into the Pine Street Stormceptor unit are reflected by the mass of solids within the sump, the mass of solids present in the discharges from the Stormceptor unit, and the mass of solids which accumulate in the downstream stormsewer system. This relationship is summarized mathematically as follows:

Input Mass Reaching Unit =

Mass in Discharge + Mass of Sump Solids + Mass in Downstream Stormsewer

Removal efficiency calculations for TSS at the Pine Street Stormceptor site are summarized on Table 3-16. During the monitoring program, approximately 36,587 ft^3 of runoff discharged from the Stormceptor unit. The log-normal mean TSS concentration in these discharges is 624 mg/l which is equivalent to a discharge mass of approximately 646 kg of TSS. As indicated on Table 3-11, approximately 170 kg of TSS was present in accumulated solids in the downstream stormsewer pipe, for a total of 816 kg of TSS which appears to have bypassed the Stormceptor unit. The total mass collected by the unit is approximately 611 kg, for a total of 1427 kg of TSS which reached the Stormceptor unit. The removal efficiency for TSS at the Pine Street site is approximately 42.8%.

TABLE 3-16

REMOVAL EFFICIENCY CALCULATIONS FOR TSS AT THE PINE STREET STORMCEPTOR SITE

PARAMETER	UNITS	VALUE
TSS Loading in Stormceptor Discharges		
a. Discharge Volume	ft^3	36,587
b. Discharge TSS Concentration	mg/l	624
c. Discharge TSS Mass	kg	646
TSS in Downstream Pipe	kg	170
Total TSS Not Collected by Unit	kg	816
TSS Collected by Unit	kg	611
Total TSS to Unit	kg	1427
Mean Runoff TSS Concentration	mg/l	1378
Removal Efficiency	%	42.8

Mean runoff concentrations of TSS are also summarized in Table 3-16 for the Pine Street sub-basin. During the monitoring program, approximately 1427 kg of TSS reached the Stormceptor monitoring site. The total runoff volume during this period was approximately 36,587 ft^3. This results in a mean TSS concentration of approximately 1378 mg/l. This value is also extremely elevated, and approximately 10-20 times higher than TSS concentrations commonly observed in runoff from residential areas. This additional TSS loading is directly related to the erodible nature of existing dirt roads.

Removal efficiency calculations for total nitrogen at the Pine Street Stormceptor site are given on Table 3-17. During the 92-day monitoring program, approximately 2.743 kg of total nitrogen discharged past the Stormceptor unit with the runoff flow. An additional 0.048 kg of total nitrogen was present in the downstream stormsewer pipe, resulting in a total of 2.791 kg of total nitrogen which bypassed the Stormceptor unit. Approximately 0.269 kg of total nitrogen was collected by the unit, with a total of 3.06 kg of total nitrogen actually reaching the Stormceptor site. The resulting removal efficiency for total nitrogen was approximately 8.8%.

TABLE 3-17

REMOVAL EFFICIENCY CALCULATIONS FOR TOTAL NITROGEN AT THE PINE STREET STORMCEPTOR SITE

PARAMETER	UNITS	VALUE
Total Nitrogen Loading in Stormceptor Discharges a. Discharge Volume b. Discharge Total Nitrogen Concentration c. Discharge Total Nitrogen Mass	 ft^3 μg/l kg	 36,587 2,648 2.743
Total Nitrogen in Downstream Pipe	kg	0.048
Total Nitrogen Not Collected by Unit	kg	2.791
Total Nitrogen Collected by Unit	kg	0.269
Total Nitrogen to Unit	kg	3.060
Mean Runoff Total Nitrogen Concentration	μg/l	2954
Removal Efficiency	%	8.8

The calculated mean runoff total nitrogen concentration measured at the Pine Street watershed is also summarized in Table 3-17. Based upon the total nitrogen reaching the Stormceptor unit and the measured runoff volume, the calculated mean total nitrogen concentration for runoff was 2954 μg/l. This value is approximately 50% higher than total nitrogen concentrations in runoff commonly observed in residential areas, and reflects the additional nitrogen loadings contributed by erosion of the dirt roads.

Removal efficiency calculations for total phosphorus at the Pine Street Stormceptor site are given on Table 3-18. The log-normal mean concentration of total phosphorus in discharges from the unit was approximately 1066 μg/l. This equates to a discharged phosphorus mass of approximately 1.104 kg. An additional 0.042 kg of total phosphorus was present in the downstream stormsewer pipe, for a total of 1.146 kg of total phosphorus not collected by the Stormceptor unit. Solids removed from the sump of the unit contained approximately 0.144 kg of total phosphorus, for a total phosphorus loading to the unit of approximately 1.29 kg. The calculated removal efficiency for total phosphorus at the Pine Street site is approximately 11.2%.

TABLE 3-18

REMOVAL EFFICIENCY CALCULATIONS FOR TOTAL PHOSPHORUS AT THE PINE STREET STORMCEPTOR SITE

PARAMETER	UNITS	VALUE
Total Phosphorus Loading in Stormceptor Discharges a. Discharge Volume b. Discharge Total Phosphorus Concentration c. Discharge Total Phosphorus Mass	 ft^3 μg/l kg	 36,587 1,066 1.104
Total Phosphorus in Downstream Pipe	kg	0.042
Total Phosphorus Not Collected by Unit	kg	1.146
Total Phosphorus Collected by Unit	kg	0.144
Total Phosphorus to Unit	kg	1.290
Mean Runoff Total Phosphorus Concentration	μg/l	1245
Removal Efficiency	%	11.2

The calculated mean total phosphorus runoff concentration generated within the Pine Street sub-basin area is also provided in Table 3-18. During the monitoring program, the mean runoff total phosphorus concentration was 1245 μg/l. This value is approximately 3-5 times greater than total phosphorus concentrations commonly measured in residential runoff, and reflects additional contributions of total phosphorus into runoff as a result of the adjacent dirt roads.

3.5 Mass Removal Costs

A summary of estimated project costs and funding sources for the Lake Street and Pine Street Stormceptor units is given in Table 4-1 in Section 4. Based on information provided by Mike Galura, P.E. (the Engineer of Record for the Stormceptor projects), the total construction cost for the Pine Street Stormceptor unit (Outfall No. 8) was $57,685, with a somewhat higher construction cost of $172,541.50 for the Lake Street Site (Outfall No. 4) since this site involved additional stormsewer and roadway activities. However, costs for design, permitting, and bidding for the two Stormceptor units are difficult to estimate since the Lake Street and Pine Street Stormceptor units are part of multiple stormwater improvement projects constructed as part of the 319 Grant awarded to the Town of Windermere. The total construction cost for all of the stormwater improvement projects was $579,375, with the construction costs for the Pine Street and Lake Street Stormceptor units representing approximately 40% of this value. Therefore, it is assumed that approximately 40% of the overall design, permitting, and bidding fees for the stormwater projects are associated with the Lake Street and Pine Street units, resulting in an estimated design, permitting, and bidding cost of $97,200. The total cost for the two units (including construction, design, permitting, and bidding) is approximately $327,399.50.

An evaluation of present worth costs for the Pine Street and Lake Street Stormceptor units is given in Table 3-19. As discussed previously, construction costs for the two Stormceptor units are approximately $327,399.50. Annual maintenance costs are estimated to be approximately $10,000 for the two units. The 20-year present worth cost is calculated by adding 20 years of the estimated annual maintenance costs to the BMP construction costs, resulting in an estimated 20-year present worth cost of $527,399.50 for the two units.

TABLE 3-19

EVALUATION OF PRESENT WORTH COST FOR THE PINE STREET AND LAKE STREET STORMCEPTOR UNITS

PARAMETER	VALUE
Total Basin Area (acres)	13.42
BMP Construction Costs ($)[1]	327,399.50
Annual Maintenance Cost ($)	10,000
Present Worth Cost (20-year) ($)	527,399.50

1. Includes design, construction, permitting, and bidding

A summary of estimated annual mass load reductions for total nitrogen, total phosphorus, and TSS at the Pine Street and Lake Street Stormceptor sites is given in Table 3-20. Estimates of the annual runoff volume generated within each of the two drainage basin areas were obtained by multiplying the respective basin areas times the field measured runoff coefficient C value (summarized in Table 3-4) and an assumed annual rainfall of 50.03 inches. This analysis results in an estimated generated runoff volume of 4.16 ac-ft/yr for the Lake Street outfall and 2.01 ac-ft/yr for the Pine Street outfall.

Estimated annual loadings of total nitrogen, total phosphorus, and TSS from the two watershed areas were calculated by multiplying the annual runoff volume for each basin times the mean runoff concentrations for TSS, total nitrogen, and total phosphorus for each of the two sites (summarized in Tables 3-13 through 3-15 for the Lake Street site and in Tables 3-16 through 3-18 for the Pine Street site). This calculation produced an estimate of the generated mass of these parameters within each watershed on an average annual basis. The field measured removal efficiencies are applied to the annual mass loading, assuming that this portion of the loading is removed by the Stormceptor unit. Information on assumptions used to estimate annual mass load reductions for the evaluated parameters are given at the bottom of Table 3-20.

TABLE 3-20

ESTIMATED ANNUAL MASS LOAD REDUCTIONS FOR TOTAL NITROGEN, TOTAL PHOSPHORUS, AND TSS AT THE PINE STREET AND LAKE STREET STORMCEPTOR SITES

UNIT/ SITE	PARAMETER	UNITS	GENERATED VOLUME/ MASS	REMOVED BY STORMCEPTOR UNITS		DISCHARGE TO RECEIVING WATER
				%	Mass	
Lake Street (Outfall No. 4)	Runoff Volume[1]	ac-ft/yr	4.16	0	0	4.16
	Total N Load[2]	kg/yr	6.45	12.2	0.79	5.66
	Total P Load[3]	kg/yr	3.46	46.6	1.61	1.85
	TSS Load[4]	kg/yr	10,766	81.4	8764	2002
Pine Street (Outfall No. 8)	Runoff Volume[5]	ac-ft/yr	2.01	0	0	2.01
	Total N Load[6]	kg/yr	7.32	8.8	0.64	6.68
	Total P Load[7]	kg/yr	3.08	11.2	0.34	2.74
	TSS Load[8]	kg/yr	3414	42.8	1461	1953

1. Based on a basin area of 9.00 acres, a C-value of 0.111, and an annual rainfall of 50.03 inches (Table 3-4)
2. Based on a mean total nitrogen concentration of 1255 μg/l (Table 3-14)
3. Based on a mean total phosphorus concentration of 673 μg/l (Table 3-15)
4. Based on a mean TSS concentration of 2096 mg/l (Table 3-13)
5. Based on a basin area of 4.42 acres, a C-value of 0.109, and an annual rainfall of 50.03 inches (Table 3-4)
6. Based on a mean total nitrogen concentration of 2954 μg/l (Table 3-17)
7. Based on a mean total phosphorus concentration of 1245 μg/l (Table 3-18)
8. Based on a mean TSS concentration of 1378 mg/l (Table 3-16)

An evaluation of mass load reduction costs for the Pine Street and Lake Street Stormceptor units is given in Table 3-21. The estimated annual mass removal costs for total nitrogen, total phosphorus, and TSS are obtained by dividing the 20-year present worth cost of $527,399.50 by 20 years of annual mass removal for each of the evaluated parameters. The resulting present worth costs per kg of pollutant removed over a 20-year life cycle cost are summarized in the last row of Table 3-21. The estimated present worth cost per kg of total nitrogen removed is approximately $18,440, with a mass removal cost of $13,523 for total phosphorus. These mass removal costs are extremely elevated compared with removal costs for nitrogen and phosphorus commonly observed in wet ponds and with alum treatment systems.

A comparison of life cycle costs per mass pollutant removal for typical stormwater retrofit projects is given in Table 3-22. Pollutant mass removal costs are provided for five alum treatment projects and two wet detention projects designed by ERD over the previous 10 years. In general, pollutant removal costs for total phosphorus ranged from approximately $100-600 per kg removed, with total nitrogen removal costs ranging from approximately $10-200 per kg removed and TSS removal costs ranging from $1-4 per kg removed. Mass removal costs for total nitrogen and total phosphorus in the Pine Street and Lake Street Stormceptor units are many times greater than pollutant removal costs associated with other retrofit techniques, indicating that the Stormceptor units do not provide an economical method of removal for either total phosphorus or total nitrogen. However, mass removal costs for TSS in the Stormceptor units are more in line with TSS removal costs observed on other projects, suggesting that Stormceptor units may be an economically viable method of removing suspended solids.

TABLE 3-21

MASS LOAD REDUCTION COSTS FOR THE PINE STREET AND LAKE STREET STORMCEPTOR UNITS

PARAMETER	TOTAL NITROGEN	TOTAL PHOSPHORUS	TSS
Annual Mass Removed (kg/yr)	1.43	1.95	3,955
Present Worth Cost per kg Removed ($)	18,440	13,523	6.67

TABLE 3-22

COMPARISON OF LIFE CYCLE COSTS PER MASS POLLUTANT REMOVED FOR TYPICAL STORMWATER RETROFIT PROJECTS*

PROJECT		20-YEAR LIFE CYCLE COST ($)	COST PER MASS POLLUTANT REMOVED ($/kg)		
			Total Phosphorus	Total Nitrogen	TSS
Alum Treatment	Largo Regional STF	2,044,780	253	65	4
	Lake Maggiore STF	4,086,060	200	71	2
	Gore Street Outfall STF	1,825,280	87	12	1
	East Lake Outfall TF	1,223,600	135	17	1
	LCWA NuRF Facility	34,254,861	198	30	2
Wet Detention	Melburne Blvd. STF	1,069,000	371	125	2
	Clear Lake Ponds STF	1,091,600	658	237	2

*Does not consider cost of land purchase, if any

3.6 <u>Quality Assurance</u>

Supplemental samples were collected during the field and laboratory monitoring program for quality assurance purposes. Supplemental samples included 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 E. All quality assurance samples met the applicable criteria established in the Quality Assurance Manual for ERD.

SECTION 4

SUMMARY

A field monitoring program was conducted by ERD from June-September 2009 to evaluate the performance efficiency of two Stormceptor units installed within the Town of Windermere. The units are designed to provide removal of suspended solids and soils from residential watershed areas with dirt roads. Automatic samplers with integral flow meters were used to provide a continuous record of hydrologic discharges through each of the two Stormceptor units as well as collect discharge samples from the units on a flow-weighted basis. A recording rain gauge was installed adjacent to the monitoring sites to provide information on rainfall characteristics.

A total of 20.91 inches of rainfall fell at the Stormceptor monitoring sites over the 92-day monitoring period from a total of 63 separate storm events. Composite runoff samples were collected during a total of 16 storm events at the Lake Street Stormceptor site, with 9 storm events monitored at the Pine Street Stormceptor site. The collected runoff samples were found to be highly variable with respect to chemical characteristics, with elevated concentrations for phosphorus and suspended solids. At the completion of the monitoring program, all collected suspended solids were removed from each of the two units and analyzed for total nitrogen, total phosphorus, and TSS. Grain size and sieve analyses were conducted to evaluate the characteristics of solids collected by the two units.

The Stormceptor units provided removal efficiencies ranging from 43-81% for TSS, 9-12% for total nitrogen, and 11-47% for total phosphorus. The two units combined will remove approximately 1.4 kg/yr of total nitrogen, 1.95 kg/yr of total phosphorus, and 10,225 kg/yr of TSS. An economic analysis of mass removal costs was conducted for total nitrogen, total phosphorus, and TSS. Mass removal costs for total nitrogen and total phosphorus are extremely high for the two Stormceptor units, suggesting that the Stormceptor systems are not cost-effective methods for nutrient load reductions. A much lower mass removal cost was observed for TSS, although the calculated removal costs are still higher than observed for wet ponds and alum treatment systems.

A summary of project costs and funding sources for the Lake Street and Pine Street Stormceptor units is given in Table 4-1. The FDEP contributed approximately $151,168.80 (43%) of the total costs for the two Stormceptor units, with $201,230.70 (57%) contributed by the Town of Windermere.

TABLE 4-1

SUMMARY OF PROJECT COSTS AND FUNDING SOURCES FOR THE LAKE STREET (OUTFALL NO. 4) AND PINE STREET (OUTFALL NO. 8) SITES

PROJECT FUNDING ACTIVITY	319(h) AMOUNT ($)	MATCHING CONTRIBUTION ($)	MATCH SOURCE ($)
Design, Permitting, and Bidding	0	97,200.00	Town of Windermere
Construction	140,168.80	90,030.70	Town of Windermere
Project Administration and Reporting (including Project Close-out)	0	4,000.00	Town of Windermere
Monitoring	10,000.00	10,000.00	Town of Windermere
Public Education	1,000.00	1,000.00	Town of Windermere
Total:	**$ 151,168.80**	**$ 201,230.70**	
Total Project Cost:	**--**	**$ 352,399.50**	
Percentage Match:	**43%**	**57%**	

APPENDICES

APPENDIX A

SELECTED CONSTRUCTION PLANS FOR THE STORMCEPTOR SYSTEMS

1. **Lake Street Site (Outfall No. 8)**
2. **Pine Street Site (Outfall No. 4)**

A.1 Lake Street Site (Outfall No. 8)

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.

TOWN OF WINDERMERE
WINDERMERE, FLORIDA

CONSTRUCTION PLANS

STORMWATER OUTFALL IMPROVEMENTS
OUTFALL NO. 8

BID NO. 2008-01

FEBRUARY 2008

RECORD DRAWING

This "RECORD DRAWING" is intended for the exclusive use by the Owner to identify deviations from the Conformed Bidding Documents based soley on information received from the Contractor as to the location and details of the facilities actually constructed. PEC has not provided detailed or continuous inspections of the construction work nor has PEC performed any "as-built" measurements of the facilities shown on this sheet. Intermittent visual inspections have been made by others and the facilities appear to have been reasonably installed in accordance with this drawing. This Record Drawing has been prepared for the sole use of the Owner, others are cautioned not to rely on it for design purposes.

Michael B. Galura 12/04/2008 P.E.

Michael B. Galura
Engineer of Record @ PEC
FBPE Registration No. 41728

INDEX OF SHEETS

CONFORMED DRAWING

PLANS DATED: APRIL 8, 2008

CERTIFICATION TO PLANS

THIS IS TO CERTIFY THAT THE DRAINAGE IMPROVEMENT CONSTRUCTION PLANS AND SPECIFICATIONS AS CONTAINED HEREIN WERE DESIGNED TO APPLICABLE STANDARDS AS SET FORTH IN THE "MANUAL OF UNIFORM MINIMUM STANDARDS FOR DESIGN, CONSTRUCTION AND MAINTENANCE FOR STREETS AND HIGHWAYS", STATE OF FLORIDA, AS PREPARED BY THE FLORIDA DEPARTMENT OF TRANSPORTATION TALLAHASSEE, FLORIDA, DATED MAY 2002.

DATE: ____________ ENGINEER: MICHAEL B. GALURA, P.E. REG. NO. 41728

PEC/Professional Engineering Consultants, Inc.

200 E. Robinson Street, Suite 1560, Orlando, FL 32801

TOW-009\AUTOCAD FILES\COVER SHEET.DWG

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Michael B. Galura 12/04/2008 P.E.

Michael B. Galura
Engineer of Record @ PEC
FBPE Registration No. 41728

CONFORMED DRAWING

REV.	DATE	DESCRIPTION	APP'D BY
1	4/8/2008	CONFORMED DRAWING	

SIGN OFF		DATE
CLIENT		
PM/CM BC		
PM/CM DM		
PM		
CM		
OTHERS		

FIELD: PEC SURVEY
DRAWN BY: CADD
DESIGNED BY: MBG
CHECKED BY: DWH
DATE: FEBRUARY 2008

PEC PROFESSIONAL ENGINEERING CONSULTANTS, INC
200 East Robinson Street, Suite 1560 Eola Park Centre
Orlando, Florida 32801 407/422-8062
ENGINEERING BUSINESS NUMBER 3556

TOWN OF WINDERMERE
PUBLIC WORKS DEPARTMENT
P.O DRAWER 669, WINDERMERE, FLORIDA 34786

JOB No. TOW-009.01.000
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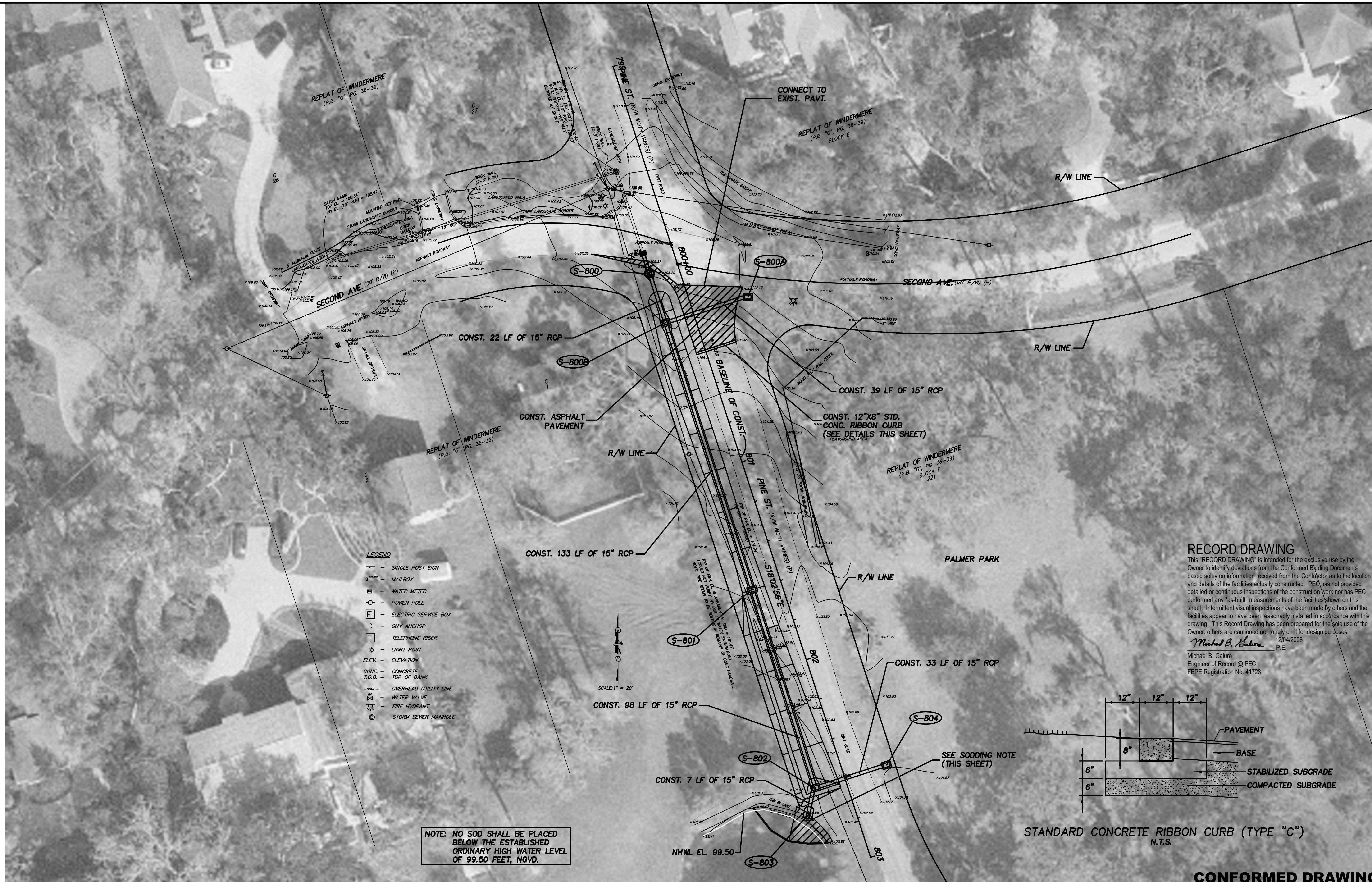
ARCHIVE DISC:
SCALE: 1"=40'

OUTFALL NO. 8 DRAINAGE BASIN MAP

DRWG. G-3 OF G-3 SHEET 4 OF 11



NOTE: NO SOD SHALL BE PLACED BELOW THE ESTABLISHED ORDINARY HIGH WATER LEVEL OF 99.50 FEET, NGVD.

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Michael B. Galura 12/04/2008 P.E.

Michael B. Galura
Engineer of Record @ PEC
FBPE Registration No. 41728

CONFORMED DRAWING

L:\TOW-009 Outfall Improvements\AutoCAD Files\DESIGN Files\Outfall No. 8\OUTFALL 8 DESIGN.dwg 7/26/2007 8:29:42 AM EDT

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PM/CM BC		
PM/CM DM		
PM		
CM		
OTHERS		

FIELD: PEC SURVEY
DRAWN BY: CADD
DESIGNED BY: MBG
CHECKED BY: DWH
DATE: FEBRUARY 2008

PEC PROFESSIONAL ENGINEERING CONSULTANTS, INC
200 East Robinson Street, Suite 1560 Eola Park Centre
Orlando, Florida 32801 407/422-8062
ENGINEERING BUSINESS NUMBER 3556

TOWN OF WINDERMERE
PUBLIC WORKS DEPARTMENT
P.O. DRAWER 669, WINDERMERE, FLORIDA 34786

JOB No. TOW-009
FILE NAME: SEE LEFT MARGIN
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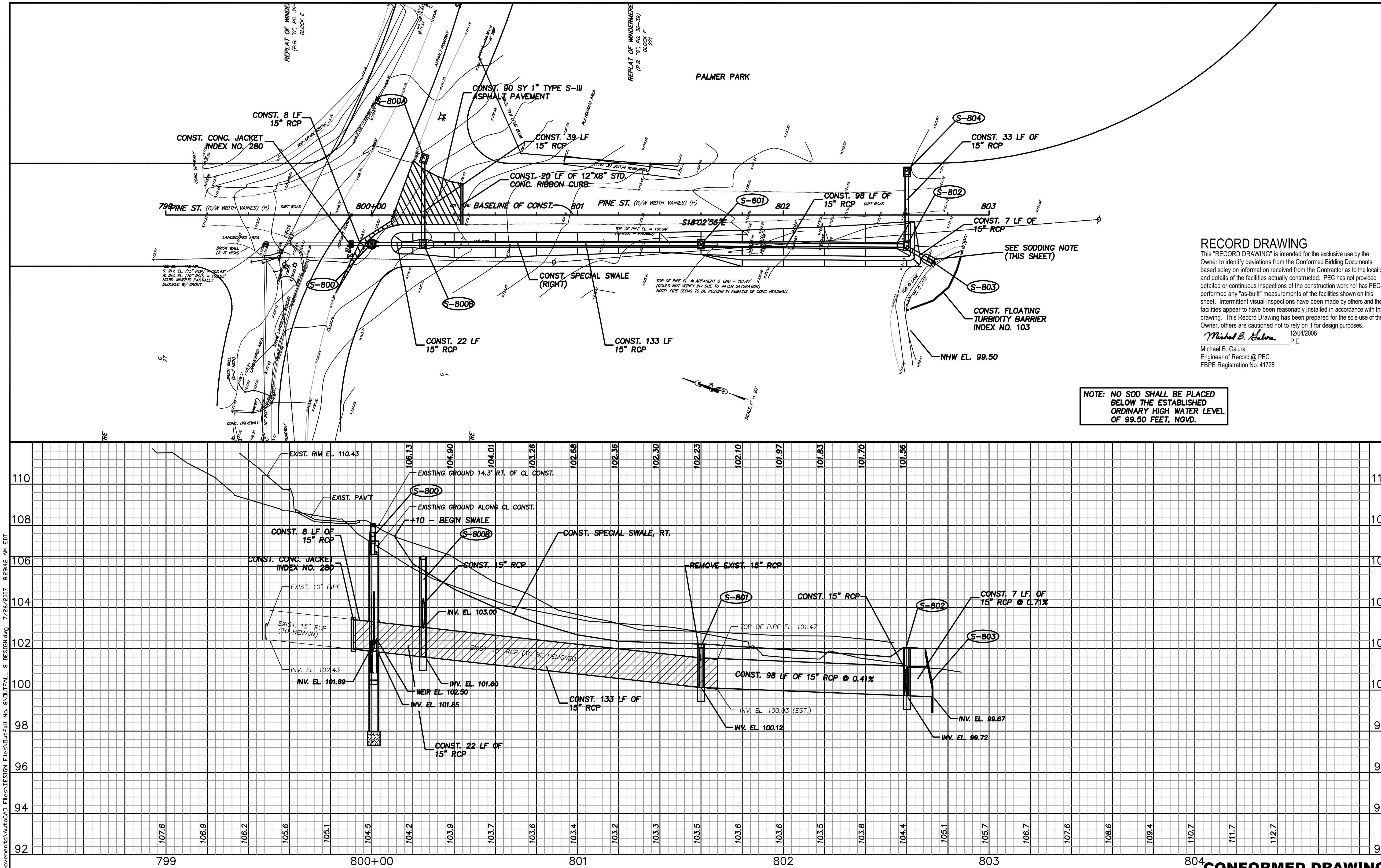
OUTFALL NO. 8
PLAN VIEW
2ND AVENUE AND PINE STREET

DRWG. C-1 OF C-5 SHEET 5 OF 11



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Engineer of Record @ PEC
FBPE Registration No. 41728

CONFORMED DRAWING

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OTHERS		

FIELD: PEC SURVEY
DRAWN BY: CADD
DESIGNED BY: MBG
CHECKED BY: DWH
DATE: FEBRUARY 2008

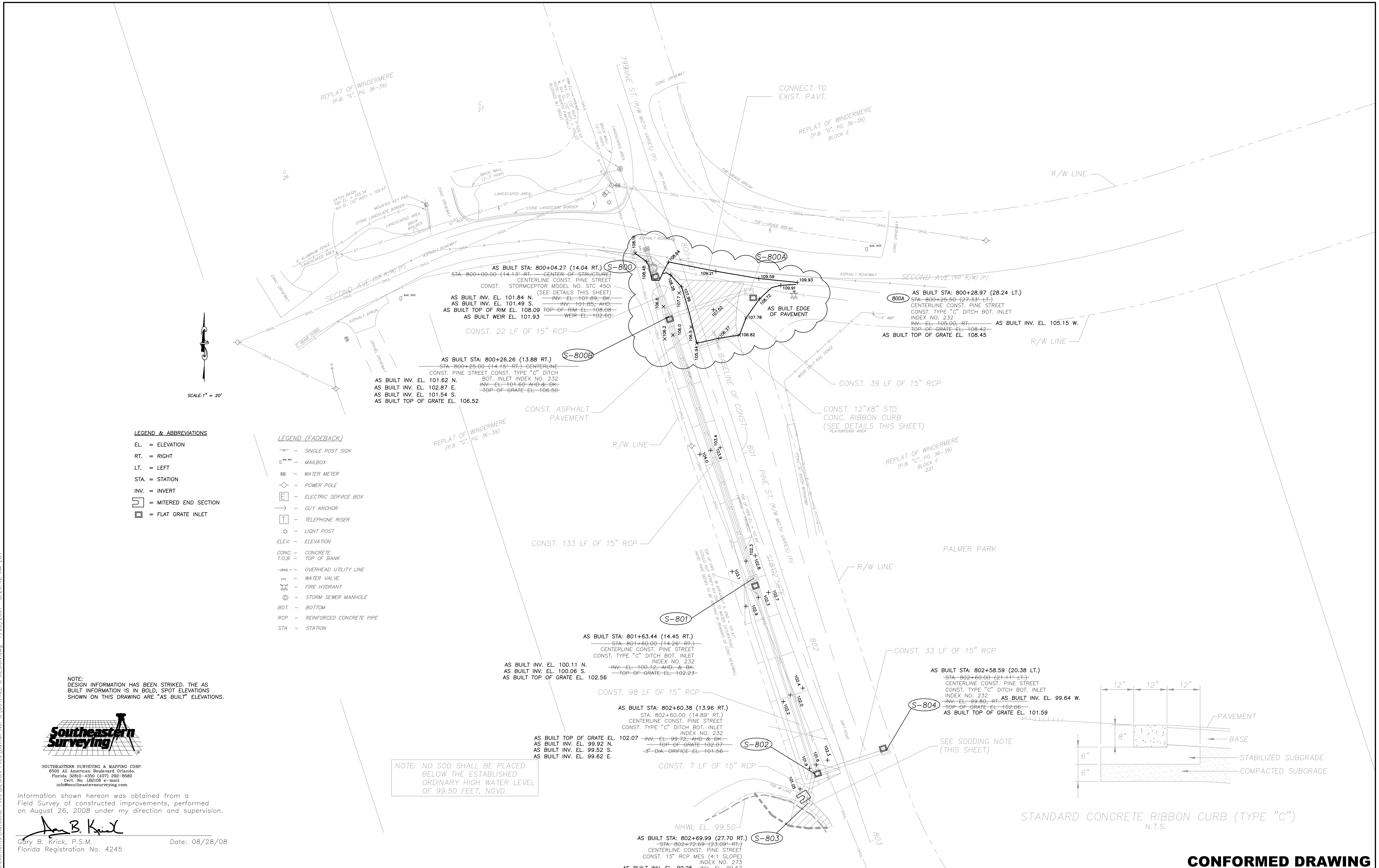
PEC PROFESSIONAL ENGINEERING CONSULTANTS, INC
200 East Robinson Street, Suite 1560 Eola Park Centre
Orlando, Florida 32801 407/422-8062
ENGINEERING BUSINESS NUMBER 3556

TOWN OF WINDERMERE
PUBLIC WORKS DEPARTMENT
P.O. DRAWER 669, WINDERMERE, FLORIDA 34786

JOB No. TOW-009.01.000
FILE NAME: SEE LEFT MARGIN
ARCHIVE DISC:
SCALE: HORIZ.= 1"=20' VERT.= 1"=2'

SECOND AVENUE/PINE STREET
PLAN AND PROFILE
STA. 800+00 TO STA. 802+80

DRWG. C-2 OF C-5 SHEET 6 OF 11



SOUTHEASTERN SURVEYING & MAPPING CORP.
6500 All American Boulevard Orlando, Florida 32810-4350 (407) 292-8580
Cert. No. LB2108 e-mail: info@southeasternsurveying.com

Information shown hereon was obtained from a Field Survey of constructed improvements, performed on August 26, 2008 under my direction and supervision.

Gary B. Krick, P.S.M.
Florida Registration No. 4245
Date: 08/28/08

CONFORMED DRAWING

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1	4/8/2008	CONFORMED DRAWING	

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PM/CM DM	
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JOB No. TOW-009
FILE NAME: SEE LEFT MARGIN
ARCHIVE DISC:
SCALE: 1"=20'

OUTFALL NO. 8
PLAN VIEW
2ND AVENUE AND PINE STREET

DRWG. C-1 OF C-5 SHEET 5 OF 11

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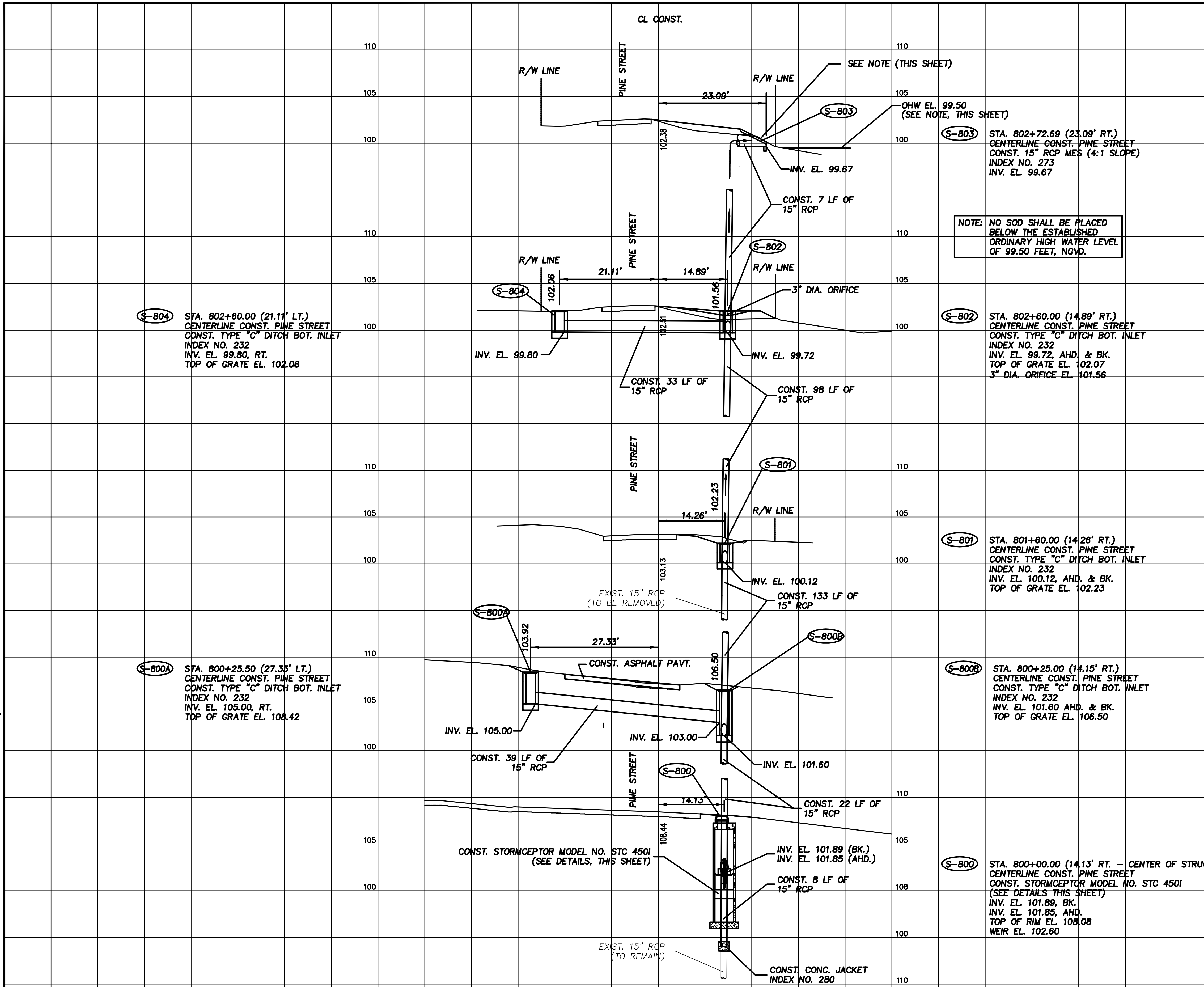


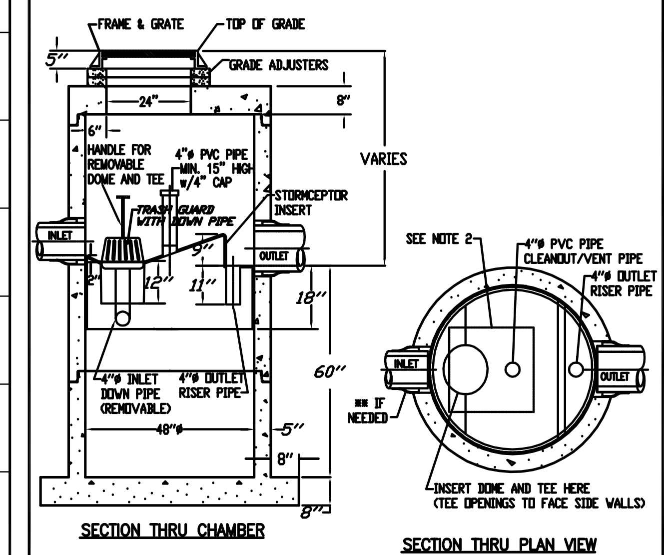
CSR

Hydro Conduit

STC 450i Precast Concrete Stormceptor
(450 US Gallon Capacity)

PROJECT:
LOCATION:

DR. BY: N. BALDWIN
CK. BY:
DATE: MARCH 20, 2001
SCALE: N.T.S.
DWG.#



SECTION THRU CHAMBER

SECTION THRU PLAN VIEW

NOTE :

1. THE USE OF FLEXIBLE CONNECTIONS IS RECOMMENDED AT THE OUTLET WHERE APPLICABLE.
2. THE COVER SHOULD BE POSITIONED OVER THE 4"ø CLEANOUT/VENT PIPE AND THE 4"ø INLET DOWN PIPE.
3. THE STORMCEPTOR SYSTEM IS PROTECTED BY ONE OR MORE OFF THE FOLLOWING U.S. PATENTS: #4985148, #5498331, #5725760, #5753115, #5849181.
4. CONTRACTOR TO PROVIDE CRANE TO SET UNIT (HEAVIEST SECTION WEIGHS 5000 LB)

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Michael B. Galura 12/04/2008
P.E.
Michael B. Galura
Engineer of Record @ PEC
FBPE Registration No. 41728

CONFORMED DRAWING

SCALE: 1"= 10' HORIZ.
1"= 5' VERT.

REV.	DATE	DESCRIPTION	APP'D BY
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OTHERS		

FIELD: PEC SURVEY
DRAWN BY: CADD
DESIGNED BY: MBG
CHECKED BY: DWH
DATE: FEBRUARY 2008

PEC PROFESSIONAL ENGINEERING CONSULTANTS, INC
200 East Robinson Street, Suite 1560 Eola Park Centre
Orlando, Florida 32801 407/422-8062
ENGINEERING BUSINESS NUMBER 3556

TOWN OF WINDERMERE
PUBLIC WORKS DEPARTMENT
P.O DRAWER 669, WINDERMERE, FLORIDA 34786

JOB No. VO-007.001
FILE NAME: SEE LEFT MARGIN
ARCHIVE DISC:
SCALE: HORIZ.= 1"=10'
VERT.= 1"=5'

SECOND AVENUE/PINE STREET
DRAINAGE STRUCTURES
STA. 800+00.00 TO STA. 802+72.69

DRWG. C-3 OF C-5 SHEET 7 OF 11

A.2 Pine Street Site (Outfall No. 4)

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.

TOWN OF WINDERMERE
WINDERMERE, FLORIDA

MAYOR GARY BRUHN	
JOHN BRIGGS	COUNCIL MEMBER
BURNS HOVEY	COUNCIL MEMBER
RONALD D. MARTIN	COUNCIL MEMBER
JENNIFER ROPER	COUNCIL MEMBER
ROBERT SPRICK	COUNCIL MEMBER
CECILIA BERNIER	TOWN MANAGER

CONSTRUCTION PLANS

STORMWATER OUTFALL IMPROVEMENTS
OUTFALL NO. 4

BID NO. 2008-01

FEBRUARY 2008

RECORD DRAWING

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Michael B. Galura 12/31/2008 P.E.

Michael B. Galura
Engineer of Record @ PEC
FBPE Registration No. 41728

INDEX OF SHEETS

GENERAL		SHEET NO.
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C-5	OUTFALL NO. 4 CROSS SECTIONS STA. 400+20 TO STA. 402+00	9
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CD-2	DRAINAGE DETAILS – SIDE DRAIN MITERED END SECTION (ROUND CONCRETE PIPE) (INDEX NO. 273)	13

CONFORMED DRAWING

PLANS DATED: APRIL 8, 2008

CERTIFICATION TO PLANS

THIS IS TO CERTIFY THAT THE DRAINAGE IMPROVEMENT CONSTRUCTION PLANS AND SPECIFICATIONS AS CONTAINED HEREIN WERE DESIGNED TO APPLICABLE STANDARDS AS SET FORTH IN THE "MANUAL OF UNIFORM MINIMUM STANDARDS FOR DESIGN, CONSTRUCTION AND MAINTENANCE FOR STREETS AND HIGHWAYS", STATE OF FLORIDA, AS PREPARED BY THE FLORIDA DEPARTMENT OF TRANSPORTATION TALLAHASSEE, FLORIDA, DATED MAY 2002.

DATE: ____________ ENGINEER: MICHAEL B. GALURA, P.E. REG. NO. 41728

PEC/Professional Engineering Consultants, Inc.

200 E. Robinson Street, Suite 1560, Orlando, FL 32801

TOW-009\AUTOCAD FILES\COVER SHEET.DWG

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12/31/2008
P.E.

Michael B. Galura
Engineer of Record @ PEC
FBPE Registration No. 41728

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1	4/8/2008	CONFORMED DRAWING	

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OTHERS		

FIELD: PEC SURVEY
DRAWN BY: CADD
DESIGNED BY: MBG
CHECKED BY: DWH
DATE: FEBRUARY 2008

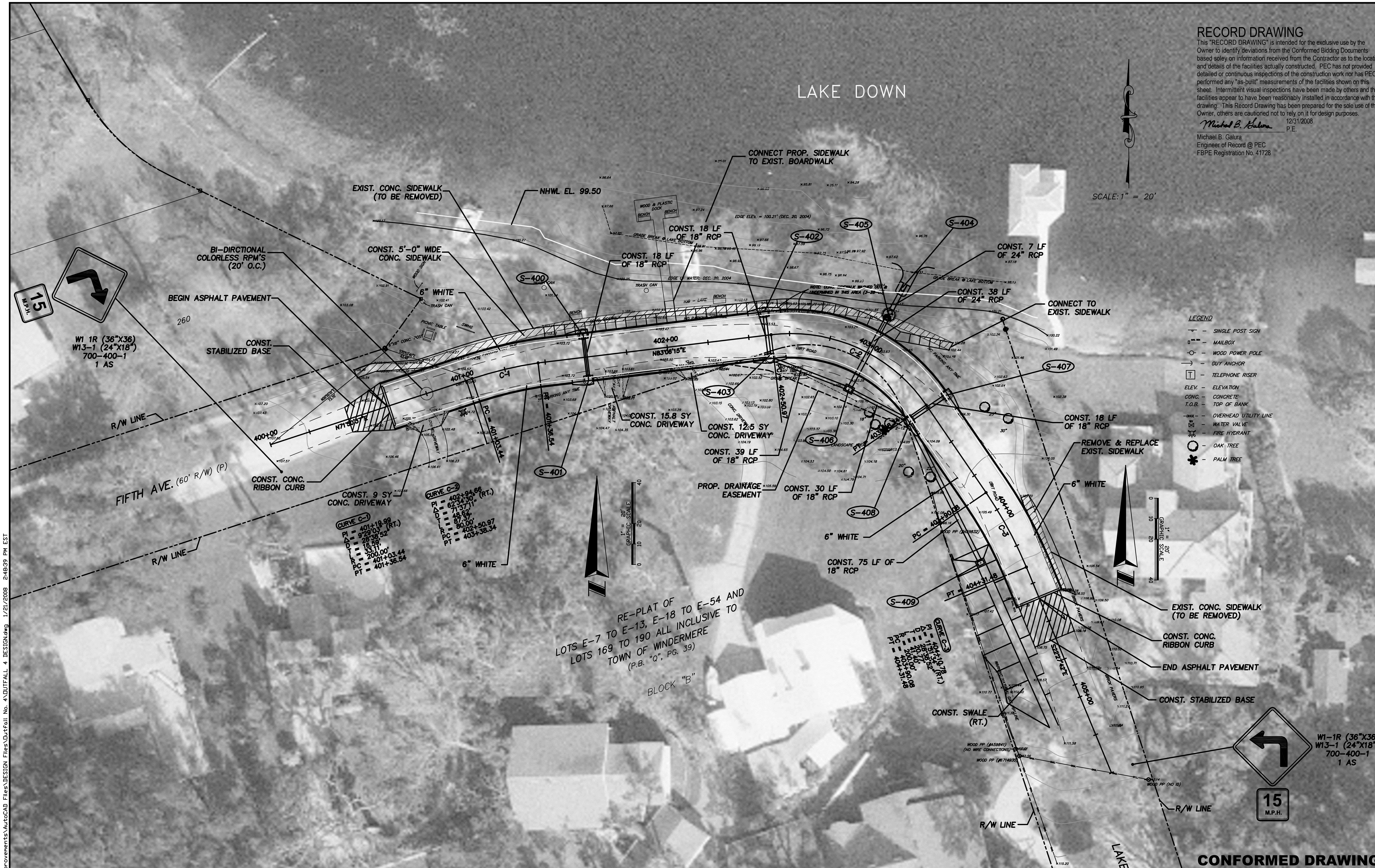
PEC PROFESSIONAL ENGINEERING CONSULTANTS, INC
200 East Robinson Street, Suite 1560 Eola Park Centre
Orlando, Florida 32801 407/422-8062
ENGINEERING BUSINESS NUMBER 3556

TOWN OF WINDERMERE
PUBLIC WORKS DEPARTMENT
P.O DRAWER 669, WINDERMERE, FLORIDA 34786

JOB No. TOW-009.01.000
FILE NAME: SEE LEFT MARGIN
ARCHIVE DISC:
SCALE: 1"=40'

OUTFALL NO. 4
DRAINAGE BASIN MAP

DRWG. G-3 OF G-3 SHEET 4 OF 13



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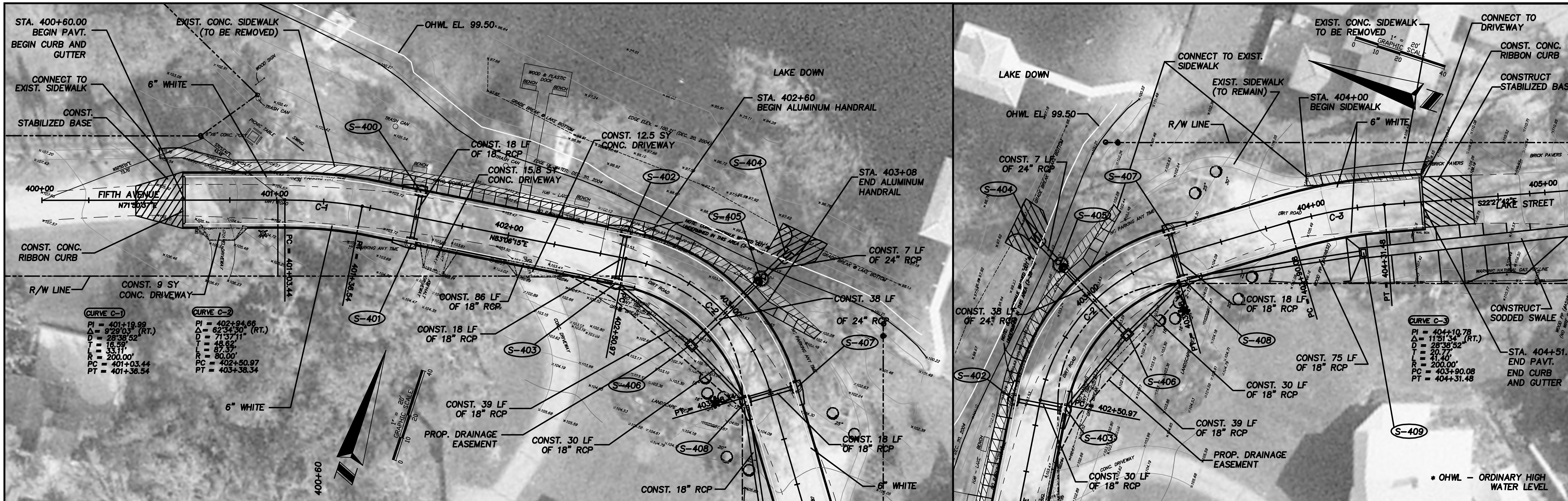
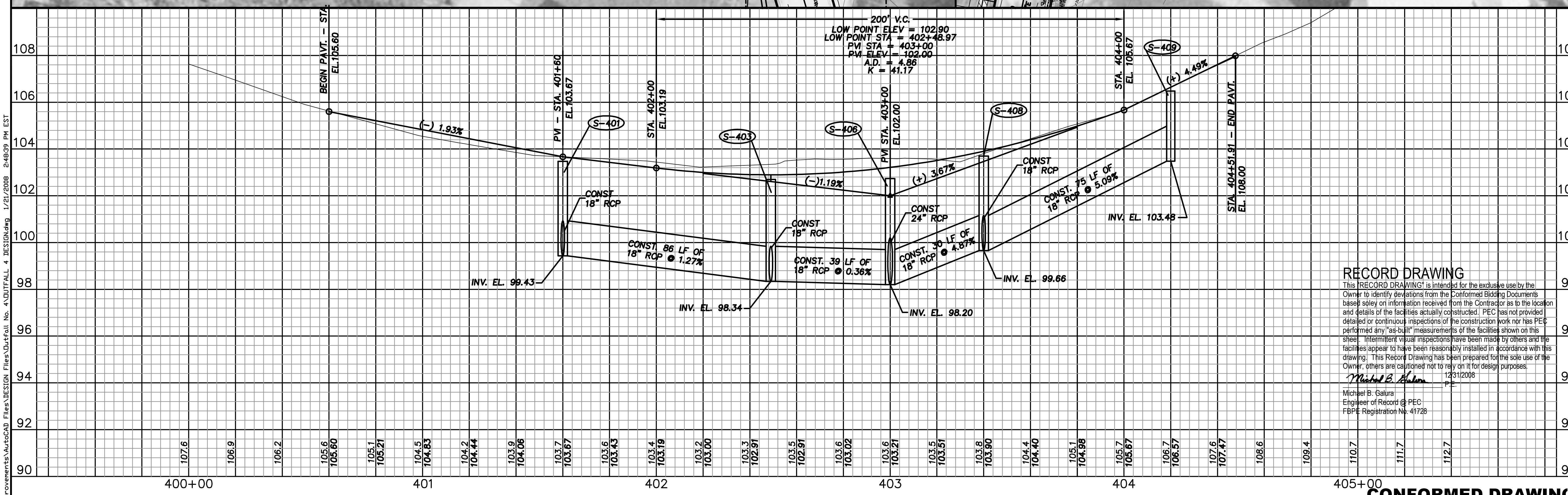
JOB No. TOW-009.01.000
FILE NAME: SEE LEFT MARGIN
ARCHIVE DISC:
SCALE: 1"=20'

OUTFALL NO. 4
PLAN VIEW
5TH AVENUE AND LAKE STREET

DRWG. C-2 OF C-7 SHEET 6 OF 13





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FILE NAME: SEE LEFT MARGIN
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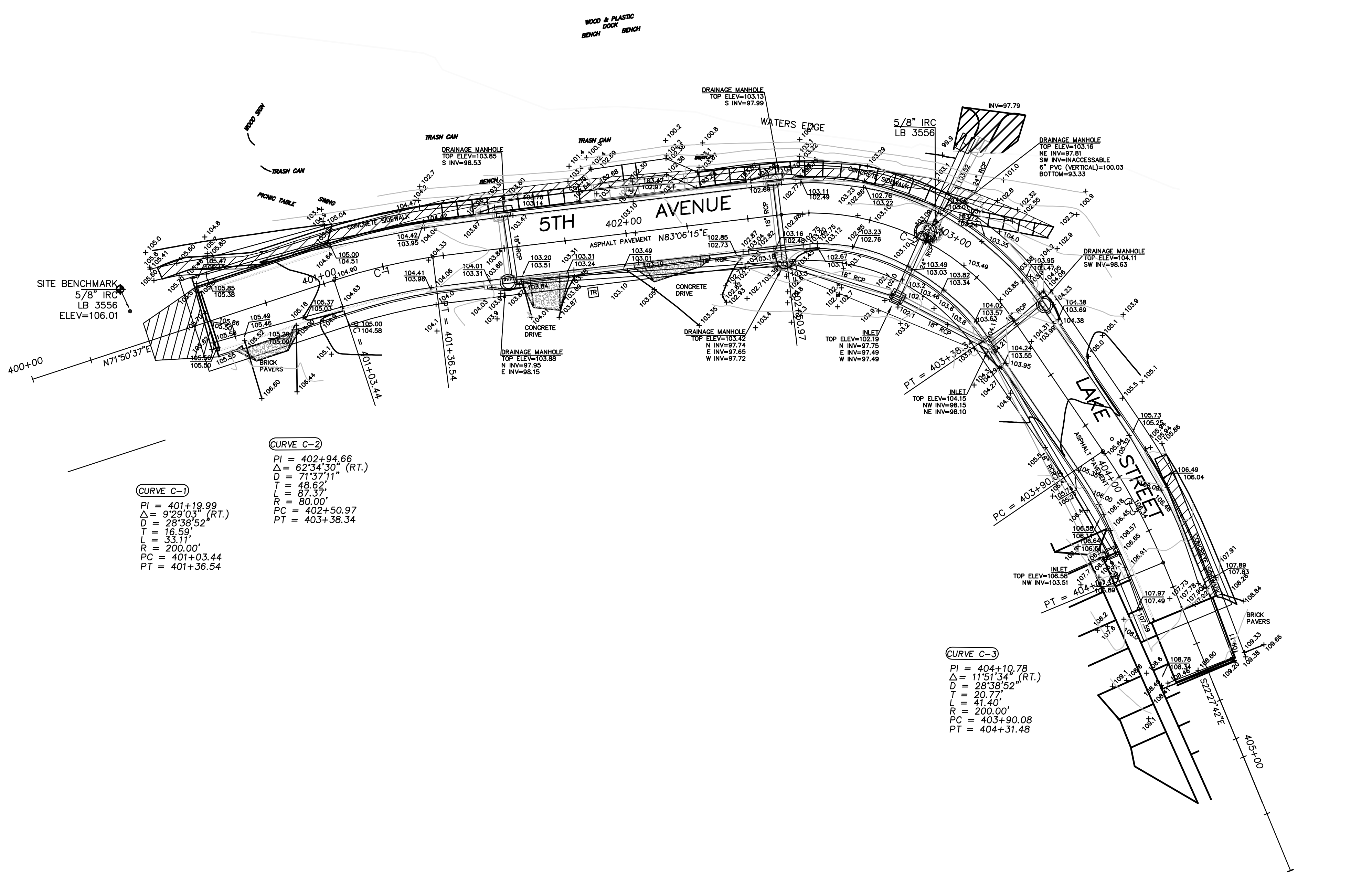
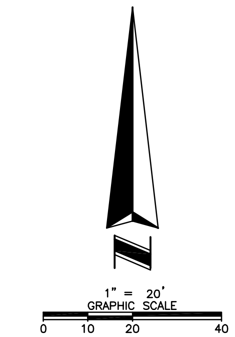
SCALE: HORIZ.= 1"=20' VERT.= 1"=2'

FIFTH AVENUE/LAKE STREET
PLAN AND PROFILE
STA. 400+00 TO STA. 405+00

DRWG. C-3 OF C-7 SHEET 7 OF 13





LEGEND & ABBREVIATIONS

- = MANHOLE
- = IRON ROD
- = FLAT GRATE INLET
- = MITERED END SECTION
- TR = TRANSFORMER ON SLAB
- RCP = REINFORCED CONCRETE PIPE
- INV = INVERSE
- ELEV = ELEVATION
- = INLET
- PVC = POLYVINYL CHLORIDE

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P.E.

Michael B. Galura
Engineer of Record @ PEC
FBPE Registration No. 41728

DESCRIPTION:

A portion of Section 7, Township 23 South, Range 28 East, Orange County, Florida

SURVEYOR'S REPORT:

1. Utility locations if shown hereon are based on field location of markings by Utility Company representatives, surface features and construction plans furnished to the surveyor. Additional sub-surface utilities may exist that have not been field located.
2. Easements or rights of way that appear on recorded plans or that have been furnished to the surveyor or by others have been incorporated into this drawing with appropriate notation. Other easements may be discovered by a search of the Public Records.
3. Measurement methods used for this survey meet MINIMUM TECHNICAL STANDARDS FOR LAND SURVEYING CH. 61G17-6 requirements.
4. Not valid without the signature and raised seal of a Florida Licensed Surveyor and Mapper.
5. Features shown by symbol as indicated in the legend are not to scale.
6. This Survey was performed without benefit of an abstract, title search, title opinion or title commitment. A title search may reveal additional information affecting the Parcel as shown.
7. Unless shown, only those visible features in the immediate vicinity of the above described parcel boundary have been located.
8. Dimensions are shown in feet and decimals thereof.

NOTICE OF LIABILITY:

This survey is certified to those individuals shown on the face thereof. Any other use, benefit or reliance by any other party is strictly prohibited and restricted. Surveyor is responsible only to those certified and hereby disclaims any other liability and hereby restricts the rights of any other individual or firm to use this survey, without express written consent of the surveyor.

Southeastern Surveying	As-Built Survey, Outfall #4		SOUTHEASTERN SURVEYING & MAPPING CORP. 6500 All American Boulevard Orlando, Florida 32810-4350 (407) 292-8580 Cert. No. LB2108 e-mail: info@southeasternsurveying.com
	Survey Date: 12/18/2005	Drawing Number 53493005	Scale: 1"=20' Drawn By: SB
	For: All Florida Guardrail Corp.		
	Fifth Ave @ Lake Street, Windermere 53493005		GARY B. KRICK Registered Land Surveyor No. 4245

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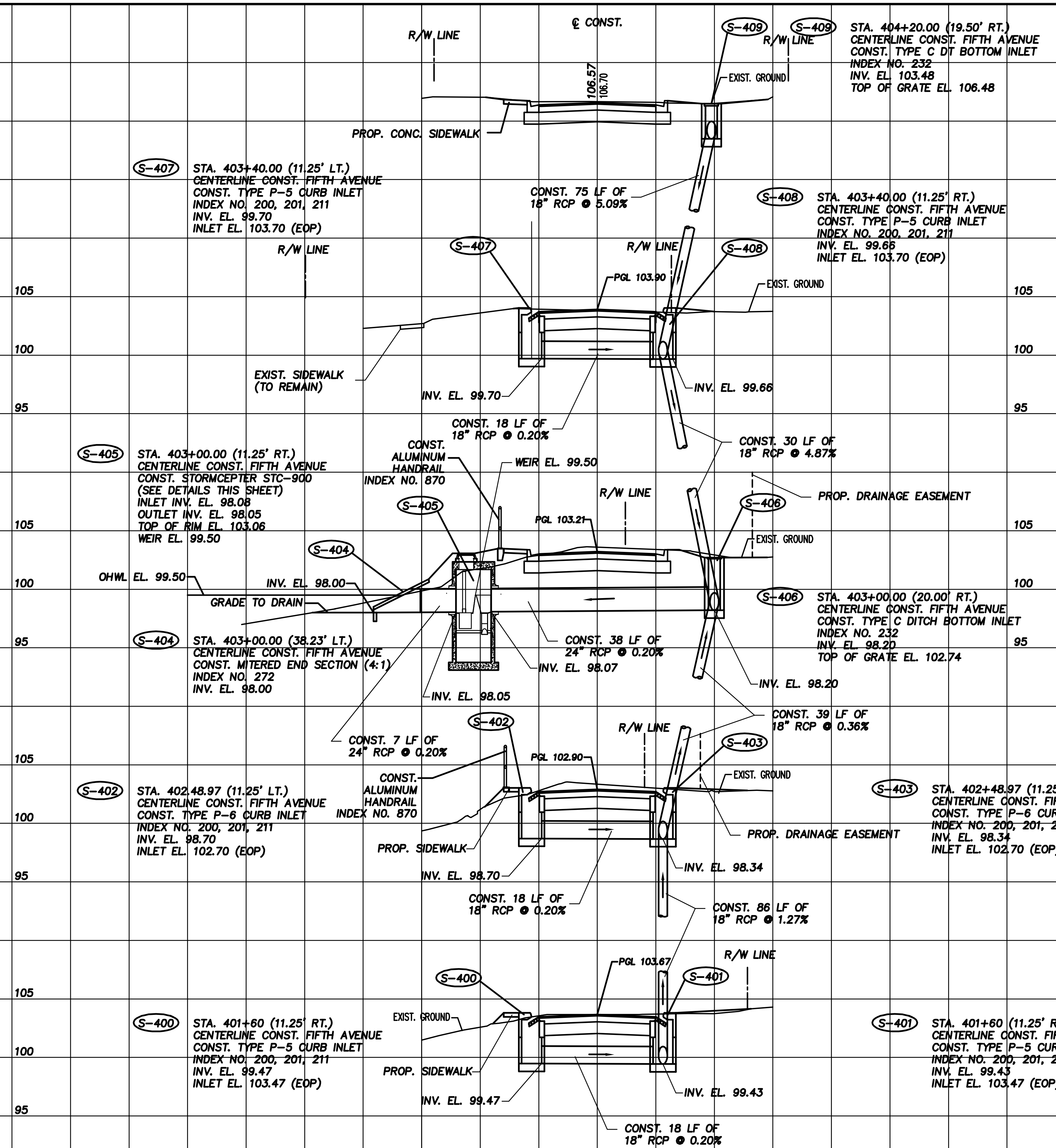
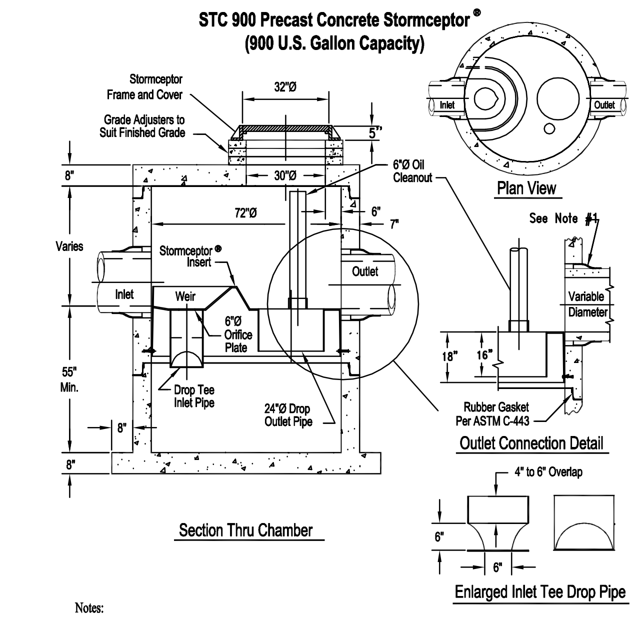


Rinker MATERIALS™ Hydro Conduit Division

STC 900 Precast Concrete Stormceptor®
(900 U.S. Gallon Capacity)



Notes:
1. The use of a Flexible Connection is recommended at The Inlet and Outlet Pipe.
2. The Cover should be positioned over The Outlet Drop Pipe and The Vent Pipe.
3. The Stormceptor System is protected by one or more of the following U.S. Patents: #4985148, #5498331, #5725760, #5753115, #5849181, #6068765, #6371690.
4. Contact a Hydro Conduit representative for further details not listed on this sheet.

Rinker 028

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Michael B. Galura 12/31/2008
P.E.
Michael B. Galura
Engineer of Record @ PEC
FBPE Registration No. 41728

SCALE: 1"= 10' HORIZ.
1"= 5' VERT.

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OTHERS		

FIELD: PEC SURVEY
DRAWN BY: CADD
DESIGNED BY: MBG
CHECKED BY: DWH
DATE: FEBRUARY 2008

PEC PROFESSIONAL ENGINEERING CONSULTANTS, INC
200 East Robinson Street, Suite 1560 Eola Park Centre
Orlando, Florida 32801 407/422-8062
ENGINEERING BUSINESS NUMBER 3556

TOWN OF WINDERMERE
PUBLIC WORKS DEPARTMENT
2560 WEST STATE ROAD 44, DeLAND, FLORIDA 32720-2803

JOB No. TOW-009.01.000
FILE NAME: SEE LEFT MARGIN
ARCHIVE DISC:
SCALE: HORIZ.= 1"=10' VERT.= 1"=5'

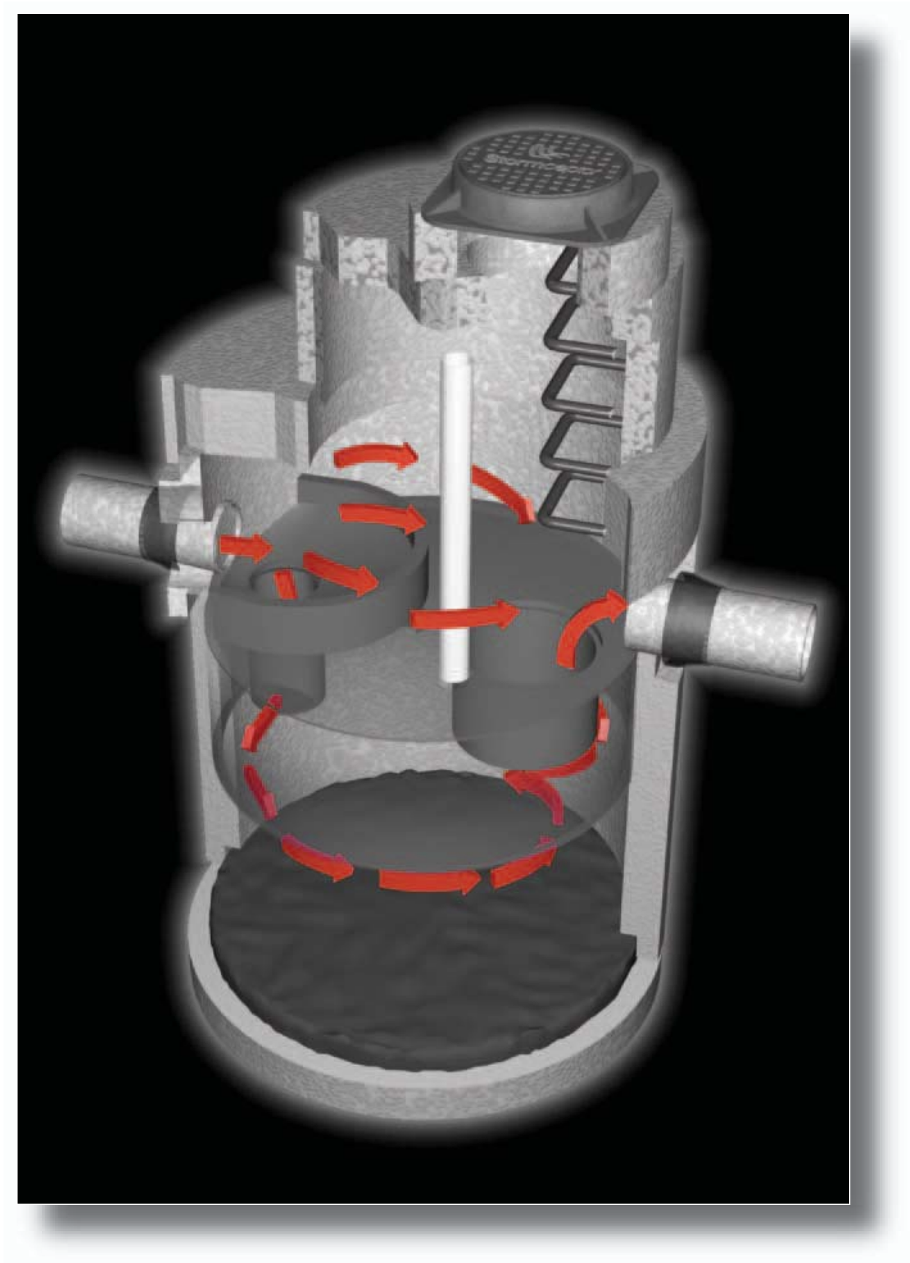
FIFTH AVENUE/LAKE STREET
DRAINAGE STRUCTURES
STA. 401+60.00 TO STA. 403+40.00

DRWG. C-4 OF C-7 SHEET 8 OF 13

APPENDIX B

TECHNICAL DETAILS
FOR STORMCEPTOR UNITS

Rinker MATERIALS™



THE STORMCEPTOR® SYSTEM

Technical Manual

Stormceptor® Summary

Stormceptor is a patented water quality treatment structure for storm drain systems. Stormceptor removes free oil and suspended solids from storm water preventing spills and non-point source pollution from entering downstream lakes and rivers. The key benefits of implementing Stormceptor include:

- Capable of removing more than 80% of the annual sediment load when properly applied as a source control for small areas
- Captures free oil from storm water during normal flow conditions
- Prevents scouring or re-suspension of trapped pollutants
- Can be implemented as part of a treatment train (ex. prevents groundwater contamination in recharge measures, extends the maintenance period for other storm water quality measures)
- Excellent hydrocarbon spills control device for commercial and industrial developments
- Simple to design and specify
- Easy to install in new or retrofit situations
- Easy to maintain (vacuum truck)
- Can be used as a bend structure
- Pre-engineered for traffic loading
- Does not require a large drop in storm drain elevation for implementation (1" for single inlet, 3" for multiple inlet)
- STORMCEPTOR clearly marked on the cover (excluding inlet designs)

Although Stormceptor is extremely versatile, users of this document should keep in mind several key constraints:

- Only the STC 450*i* Stormceptor is specifically designed as a storm drain inlet
- The difference between the inlet pipe invert elevation and the outlet pipe elevation must be 1" for a one inlet/one outlet configuration and 3" for a multiple inlet, STC 450*i* and STCs (series) configuration
- The largest standard inlet/outlet size that can be accommodated without customization is 42" I.D. RCP (excluding the STC 450*i*)
- There is a minimum requirement for 24" of cover above the crown of the pipe (inside top of pipe) to grade for the concrete Stormceptor

Rev. 3/2006

Stormceptor Technical Manual Contents

1.0 Stormceptor Overview

The Stormceptor System is a water quality treatment device used to remove total suspended solids (TSS) and free oil (TPH) from storm water run-off. Stormceptor takes the place of a conventional junction or inlet structure within a storm drain system. Rinker Materials manufactures the Stormceptor System with precast concrete components and a fiberglass disc insert. A fiberglass Stormceptor can also be provided for special applications. Thousands of Stormceptor Systems have been installed in various locations throughout North America, Australia and the Carribbean since 1990.

Stormceptor follows the philosophy of treating pollution at its source. Treating pollution at the source is the preferred methodology for water quality control since the dilution of pollutants in storm water becomes problematic in terms of effective treatment as the drainage area increases.

The Stormceptor System product line consists of four patented designs:

- The In-Line (Conventional) Stormceptor, available in eight model sizes ranging from 900 to 7200 gallon storage capacity.
- An In-Line (Series) Stormceptor is available in three model sizes ranging from 11,000 to 16,000 gallon storage capacity.
- The Submerged Stormceptor, an in-line system designed for oil and sediment removal in partially submerged pipes, available in all models sizes ranging from 450 to 16,000 gallon storage capacity.
- The Inlet Stormceptor is a 450 gallon inlet (or in-line) structure designed for small drainage areas.

The key advantage of Stormceptor compared to other water quality controls in a storm drain is the patented internal by-pass (no external by-pass required) which prevents the resuspension and scouring of settled material during subsequent storm events.

1.1 Stormceptor Applications

Stormceptor is applicable in a variety of development situations including:

- storm water quality retrofits for existing developments
- industrial and commercial parking lots
- automobile service stations
- airports and military installations
- vehicle loading and unloading areas
- areas susceptible to spills of material lighter than water (bus depots, transfer stations, etc.)
- new residential developments, re-development in the urban core
- pre-treatment (as part of a treatment train)

Existing Development Retrofits

Existing developed areas generally provide numerous constraints to the implementation of water quality enhancement. Surrounding properties define the grading of the development (or else berms and expensive retaining walls are required) and existing sewer inverts and locations define the minor system drainage route. These constraints generally limit the number and type of options available to the storm water management professional with respect to water quality enhancement.

In retrofit applications, Stormceptor is an attractive solution due to its vertical orientation, low life cycle costs, ease of installation and maintenance and compatibility with the existing drainage system.

Potential Spill Areas

Parking lots, streets, and industrial areas that are subject to high volumes of traffic and/or transfer of hydrocarbon materials are potential spill areas. Generally, the area of land draining to the storm drains in these instances is small.

Stormceptor is recommended for these types of land use regardless of whether other water quality control techniques are proposed. The spills protection provided by Stormceptor prevents water resources from damaging spills which have toxic effects on the instream aquatic resources.

Re-development/Intensification

Re-development/intensification can be classified as new construction or re-development on an existing developed parcel of land. This can be an addition to an existing development, or the replacement of the entire development with a similar or new type of land use.

In these situations, surface treatment techniques are generally not feasible, meaning that any treatment system must conform to the existing storm drain. The implementation of large underground systems (such as tanks, underground sand filters, etc.) can be problematic in ultra-urban areas due to the proximity of other underground utilities, the configuration of the existing storm drain, and long term maintenance.

Most redevelopment situations are small in size. Surface storm water quality techniques for these areas would result in a loss of developable land that could jeopardize the economic feasibility of small urban areas.

Pre-Treatment

Stormceptor is not intended to replace natural storm water management system solutions (wet ponds, wetlands) for large residential subdivisions. However, Stormceptor is effective as part of the treatment train approach in these developments. The use of Stormceptor for street drainage can help to offset long-term maintenance costs if catch-basin sumps are eliminated.

In these situations, maintenance is centralized at Stormceptor locations reducing the time and cost of storm drain maintenance.

1.2 Stormceptor System Operation

The Stormceptor consists of a lower treatment chamber, which is always full of water, and a by-pass chamber. Storm water flows into the by-pass chamber via the storm drain or grated inlet (Inlet Stormceptor). Normal flows are diverted by a weir and drop pipe arrangement into a treatment chamber. Water flows up through the submerged outlet pipe based on the head at the inlet weir and is discharged back into the by-pass chamber downstream of the weir. The downstream section of the pipe is connected to the outlet storm drain pipe.

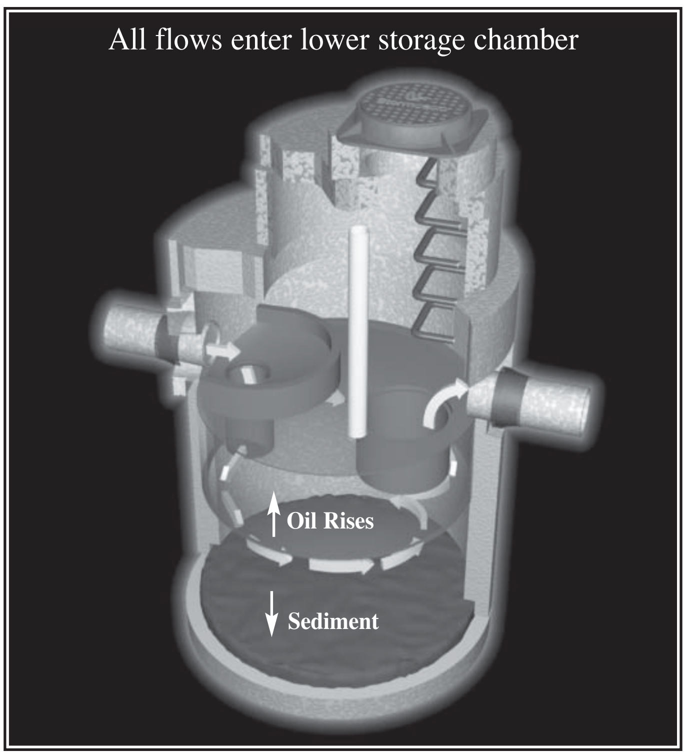


Figure 1. Stormceptor Operation During Normal Flow Conditions

Oil and other liquids with a specific gravity less than water will rise in the treatment chamber and become trapped under the fiberglass weir, since the outlet pipe is submerged. Sediment will settle to the bottom of the chamber by gravity. The circular design of the treatment chamber helps to prevent turbulent eddy currents and to promote settling.

During infrequent high flow conditions, storm water will by-pass the weir and be conveyed to the outlet storm drain directly (Figure 2). Water, which overflows the weir, creates a backwater effect on the outlet pipe (head stabilization between the inlet drop pipe and outlet riser pipe) ensuring that excessive flow will not be forced into the treatment chamber which could scour or resuspend the settled material. The by-pass is an integral part of the Stormceptor since other oil/grit separators have been noted to scour during high flow conditions (Schueler and Shepp, 1993).

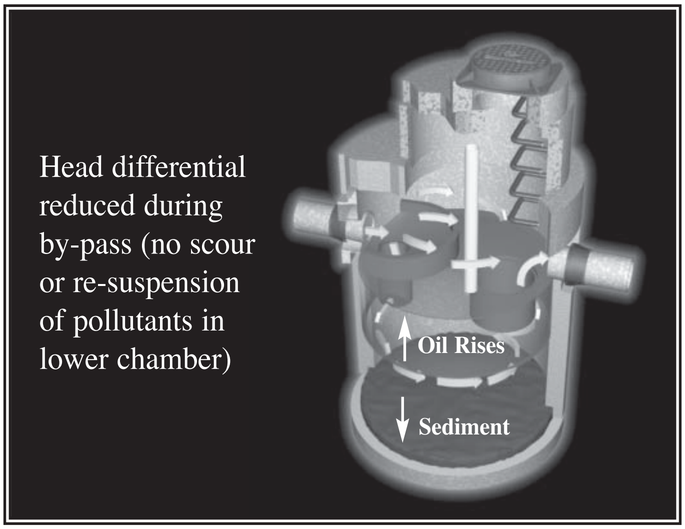


Figure 2. Stormceptor Operation During High Flow Conditions

Stormceptor comes complete to the job site with its own frame and cover. The cover (excluding the inlet design) has the name STORMCEPTOR clearly embossed on it to allow easy identification of the unit in the field for maintenance.

1.3 Stormceptor Testing

At Rinker Materials and Stormceptor Corporation testing the effectiveness of the Stormceptor System goes far beyond the controlled laboratory environment. Since its introduction in 1990, numerous independent field test and studies detailing the effectiveness of Stormceptor have been completed.

Detailed reports from these studies are available from the Rinker Materials Stormceptor office at (800) 909-7763. The major findings of many of these studies are summarized as follows:

- Laboratory testing at the University of Coventry indicated that over 97% of oil, 83% of sand, and 73% of peat are removed at a flow rate of 0.32 cfs (9 L/s) in a 6 foot diameter Stormceptor
- The NWRI laboratory testing (with 150μm synthetic sand) indicated that 90% removal would be achieved at a flowrate of $\leq$ 0.21 cfs (6 L/s)
- Negligible scouring of settled material occurred in the NWRI laboratory testing under high flow conditions
- The TSS removal rate for the unit in Westwood, Massachusetts (1997) was consistent with state requirements (>80%).
- Captured sediment particle size distribution indicate that 85% of the sediment collected by Stormceptor is smaller than 100 μm in size

- Numerous spills have been captured by units in operation (US Peace Bridge Authority, City of Edmonton, City of Toronto, Canadian Forces Base, City of Madison)
- The Stormceptor can remove approximately 20-30% of the Total Phosphorus from influent storm water (Madison, Wisconsin study; Como Park, Minnesota study).
- The headloss through the Stormceptor unit is approximately equal to a 60˚ bend at a manhole (loss coefficient K ≅ 1.3) (single inlet design)

2.0 Design Information

The Stormceptor System is designed based on the total annual rainfall (using historical rainfall data), total drainage area and the percent of impervious area. Small frequent storms account for a majority of annual rainfall and for a majority of the sediment loading.

Storm sewers are designed to convey a specific flow generated by the design storm. The design storm is typically the highest flow event that may be encountered for a specific period of time, measured in years. Typical design storms are the 2 year, 5 year and 10 year storms.

These design principles are impractical when they are applied for stormwater quality. By definition, design storms occur infrequently and typically account for a very small fraction of the annual rainfall volume. Designing for stormwater quality using principles for sizing sewers becomes impracticable and uneconomical in that BMP's would have to be designed to contain a large volume of runoff created by a design storm which would in turn be needed on a very infrequent basis.

2.1 Sizing Guidelines

Stormceptor sizing is based on computer simulation of suspended solids removal within the Stormceptor. A computer model was developed based on the USEPA SWMM Version 4.3. Solids build-up, wash-off and settling calculations were added to the hydrology code to estimate suspended solids capture by the Stormceptor. For the complete Stormceptor Sizing Program, please contact your local area representative or the Rinker Materials Stormceptor office at (800) 909-7763.

Stations across the United States were selected based on location, period of record, data resolution and completeness within the period of record. Fifteen minute data were utilized recognizing the small time of concentration that would typically be encountered in most Stormceptor applications. The model uses an internal 5 minute timestep at all times regardless of the rainfall timestep.

SWMM models catchments and conveyance systems are based on input rain, temperature, wind speed and evaporation data. Only rain data is used in the model. The default SWMM daily evaporation value (0.1"/day) was used. The Horton equation was chosen for infiltration. The method of infiltration chosen is unimportant due to the level of imperviousness of Stormceptor applications (mainly parking lots, etc.). Values of SWMM parameters used in the model are shown in Table 1.

Table 1. SWMM Area Parameters	
Area - acre	variable
Imperviousness	99%
Width - feet	variable*
Slope	2%
Impervious Depression Storage - inches	0.19
Pervious Depression Storage - inches	0.02
Impervious Manning's n	0.015
Pervious Manning's n	0.25
Maximum Infiltration Rate - inches/hour	2.46
Minimum Infiltration Rate - inches/hour	0.39
Decay Rate of Infiltration (s^{-1})	0.00055

* The width of catchment is assumed equal to twice the square root of the area.

The distribution of pollutant load is important for measures that incorporate a high-flow by-pass (commonly known as "first flush" measures). Accordingly, build-up/wash-off calculations are employed to correctly distribute the pollutant load with flow recognizing the need to optimize the sizing of small-site storm water quality measures.

In the model, solids build-up and wash-off are both approximated using an exponential distribution. The distribution of solids build-up is a function of antecedent dry days according to equation 1 (Sartor and Boyd, 1972).

The choice of particle size distribution and settling velocities are a key part of the modeling exercise. Different settling velocities can be applied to the same particle size distribution based on the specific gravity of the particles, or to account for the effect of non-ideal settling or the effect of flocculation on settling. Two particle size distributions can be selected in the model. A fine particle size distribution can be selected that reflects the fines in storm water (USEPA, 1983; Minton, 1999). This particle size distribution is given in Table 2. The distribution given in Table 2 is commonly accepted by most regulatory agencies in North America. A coarse particle size distribution can also be selected which reflects material larger than or equal to 150 μm. This distribution is given in Table 3. The coarse distribution is provided to allow comparisons with competitors that size their devices based on only the larger particles.

Settling velocities were then assessed for each of the particle sizes provided in Tables 2 and 3. The calculation of settling velocities is based on Stokes' law.

A specific gravity of 2.65 is commonly associated with sand-size particles whereas the fines in storm water are commonly associated with a lower specific gravity due to the organic content.

Research indicates that there is a high potential for coagulation amongst the smaller particles (Ball and Abustan, 1995) which will increase settling velocities and TSS removal rates. Furthermore, historical settling velocity calculations have been based on discrete particle methodologies (vertical settling column tests) that do not account for potential coagulation or flocculation. Numerous field tests on the Stormceptor (Labatiuk, 1996; Ontario MOE, 1999; Bryant, 1995) have shown that a significant percentage of the solids collected in the Stormceptor are fine. In recognition of this, a flocculation equation was used to determine the settling velocity for particles equal to or smaller than 20 μm.

Table 2. Typical Storm Water Particle Size Distribution

Particle Size (μm)	Percent by mass (%)	Specific Gravity	Settling Velocity (m/s)
20	20	*	0.00035
60	20	1.8	0.00158
150	20	2.2	0.01070
400	20	2.65	0.06500
2000	20	2.65	0.28700

* Flocculated settling velocity based on $V_s = 0.35 + 1.77\ P_s$

Where: V_s = Settling Velocity (mm/s)

P_s = Particle Size (μm)

Table 3. Coarse Storm Water Particle Size Distribution

Particle Size (μm)	Percent by mass (%)	Specific Gravity	Settling Velocity (m/s)
150	60	2.65	0.01440
400	20	2.65	0.06500
2000	20	2.65	0.28700

The influent pollution is distributed uniformly in the flow such that during by-pass conditions the amount of pollution in the by-pass is proportional to the flow being by-passed. The total load to the Stormceptor, load removed by the Stormceptor, and load by-passing the Stormceptor are calculated at the end of the simulation to provide an estimate of overall TSS removal. The total volume of water coming to the Stormceptor and by-passing the Stormceptor for the period of record are used to calculate the percentage of annual runoff treated by the Stormceptor.

Figure 3 indicates that the model provides reasonable estimates of TSS removal when compared with actual monitoring performance.

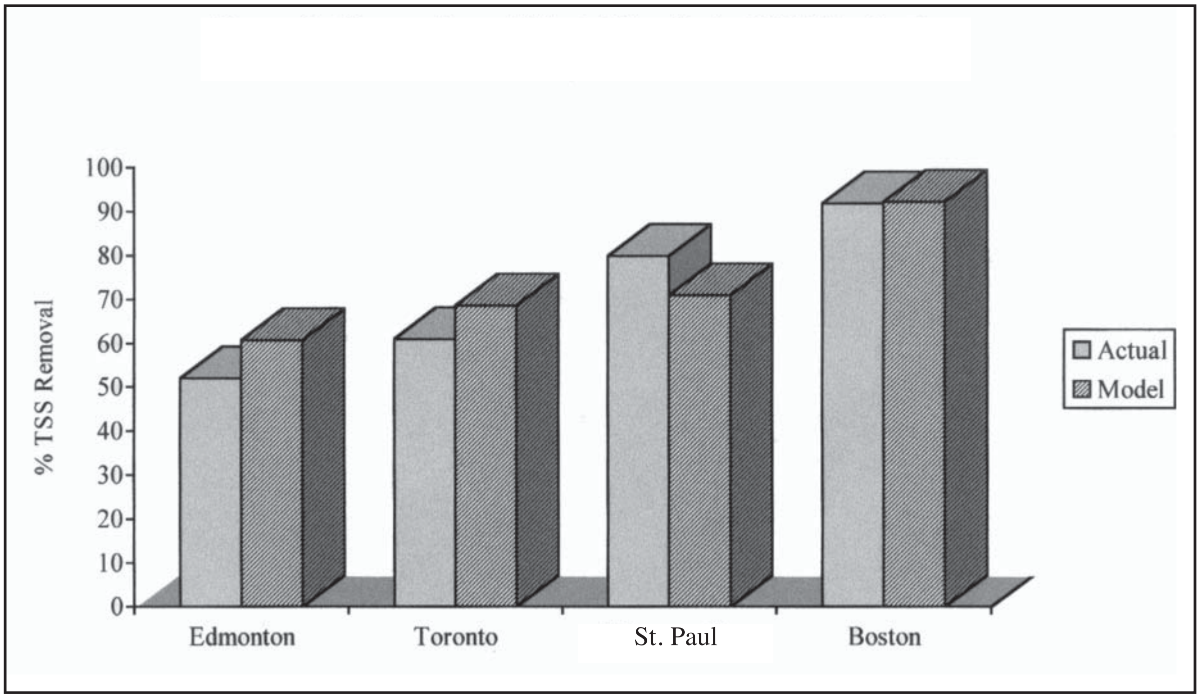


Figure 3. Comparison of Model Results to Field Monitoring

Free Oil (Spills) Capture

The results from the National Water Research Institute in Burlington indicate that free oil is retained in the Stormceptor for both dry weather spills and during minor storms (Marsalek, 1994). In a dry weather spill the latter portion of the spill will remain in the drop pipe. This oil will be purged into the Stormceptor during subsequent inflow to the separation chamber.

Based on API style calculations with a 150 μm oil globule (rise velocity of 0.005 ft/s) the oil will rise anywhere from 5" to 12" during peak flow conditions in the separation chamber depending on the size of unit implemented. These distances are based on the assumption that only half of the storage volume in the separator is used in the flow through zone. As such, the calculations and laboratory tests indicate that oil will be readily trapped since the outlet riser is the same elevation as the inlet riser.

2.2 Configuration of the Storm Drain System

The configuration of the storm sewer system is important since Stormceptor works most efficiently for small drainage areas and one influent pipe.

Inlet Configuration

The STC 450*i* is the smallest Stormceptor and is designed to replace a catch-basin (Figure 4). It has an open grate at the surface to allow water to enter the unit from above.

All of the other Stormceptor units are designed to replace a junction structure in a storm drain system (require a horizontal inlet pipe).

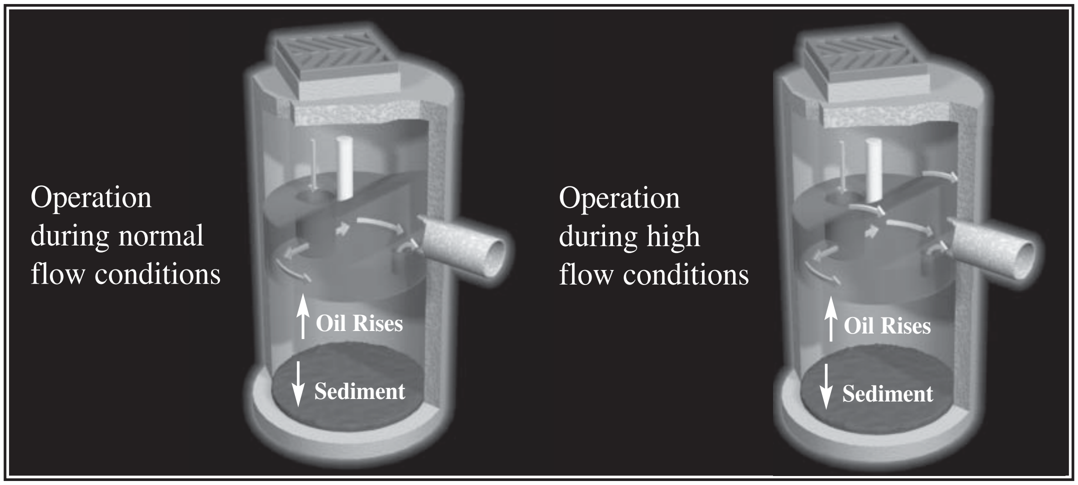


Figure 4 450*i* Inlet Stormceptor

In-Line Configuration

Stormceptor recommends that a one influent pipe - one outlet pipe arrangement be used in new development applications of the separator (Figure 5). This may require junction manholes upstream of the separator to provide this arrangement. The Stormceptor can be used as a bend structure as shown in Figure 6 without compromising oil and sediment removal effectiveness. Although additional hydraulic losses will occur as result of the bend, the hydraulics in the lower chamber will not be affected.

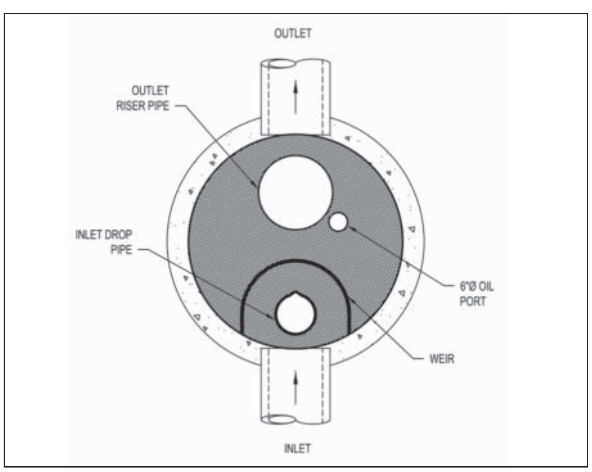


Figure 5 Typical Stormceptor Configuration

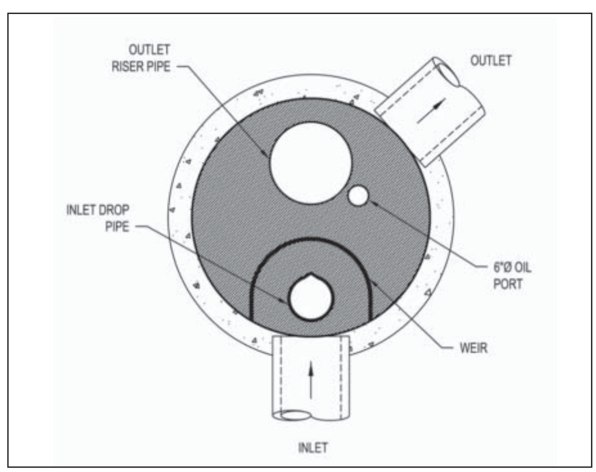


Figure 6 Stormceptor as a Bend Structure

In situations where it is not feasible to have one inlet pipe to the Stormceptor (i.e. existing storm drain applications, location of other infrastructure/utilities, etc.), it is possible to accommodate several influent pipes with a modified diversion/by-pass configuration (Figure 7). The elevation difference between the inlet and outlet pipes for the multiple inlet design is 3". It is recommended that a maximum of two inlet pipes be implemented into a Stormceptor in a new development application.

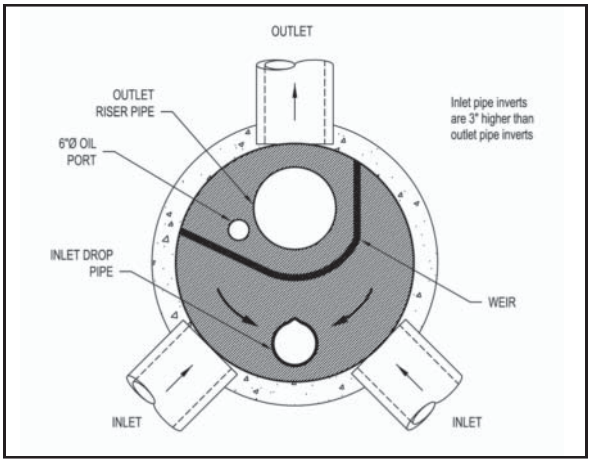


Figure 7. Multiple Inlets to Stormceptor

Series Configuration

The series Stormceptor configuration requires a one inlet - one outlet pipe arrangement. The series Stormceptor is able to treat larger drainage areas by splitting the flow into two circular structures. If the series Stormceptor is to be used as a bend structure then only the outlet pipe in the second unit can be deflected to accomplish the change in direction.

Submerged Configuration

Stormceptor also has a design that can accommodate a partially or fully submerged pipe application. Submergence is common in areas close to lakes, coastal areas and areas with high groundwater tables. The insert in these applications has a custom weir height and second drop pipe as shown in Figure 8. Both the weir height and height of the second drop pipe are site specific depending on the level of submergence. The second drop pipe elevation corresponds to the actual submergence elevation while the weir is built to be 9" higher than the submergence elevation.

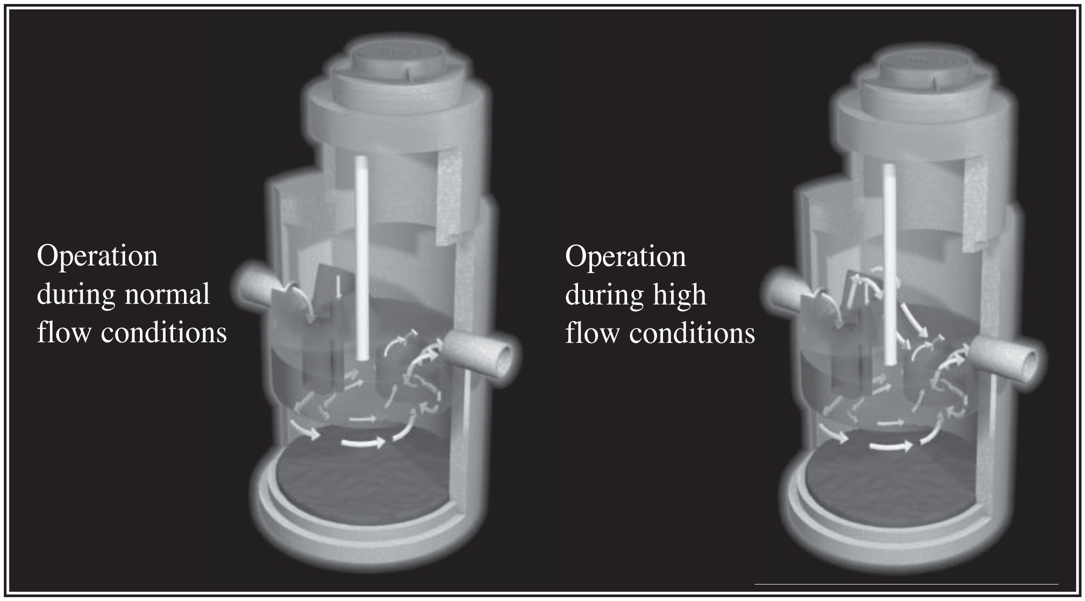


Figure 8. Submerged Stormceptor Design

By-Pass Chamber

The by-pass chamber is available in two diameters 6’ diameter and 8’ diameter. Table 4 indicates the maximum pipe diameters that can be implemented with the two by-pass chamber sizes currently being manufactured. The largest pipe that can currently be accommodated in the 8’ diameter by-pass chamber is a 60" I.D. concrete pipe. These pipes represent what can physically fit into the Stormceptor and are considerably larger than the pipe sizes that would be used if properly sized for new development applications (i.e. retrofit). Pipes with an inside diameter greater than 42" require customization of the 6’ diameter insert.

Table 4. Influent and Effluent Pipe Diameters (Concrete)

Insert Size	**One influent and one effluent pipe 180˚ apart**	**Two influent pipes 90˚ apart and one effluent pipe**	
Insert Diameter	Pipe Diameter	Influent Diameter	Effluent Diameter
4'	24"	18"	24"
6'	42"	33"	42"
8'	60"	42"	60"

2.3 Location in the Storm Drain System

Stormceptor is designed to accommodate everyday flows. These frequent flows are the most important since all storm water events contribute pollution. The frequency of the magnitude of a flow rate is dependent on the upstream drainage area and the level of imperviousness of that drainage area. If the drainage area is too large, the Stormceptor will by-pass more frequently. Accordingly, it is better that the Stormceptor unit is implemented on local or lateral storm drains rather than trunk storm sewers for new development applications (Figure 9).

This may not be possible for many retrofit or redevelopment designs, and in these cases a reduction in water quality performance must be accepted. The implementation of a Stormceptor in retrofit and redevelopment applications is important, since they can provide significant enhancement (i.e. to remove storm water bedload sediments) at a small cost in situations where there are few economical options for treatment.

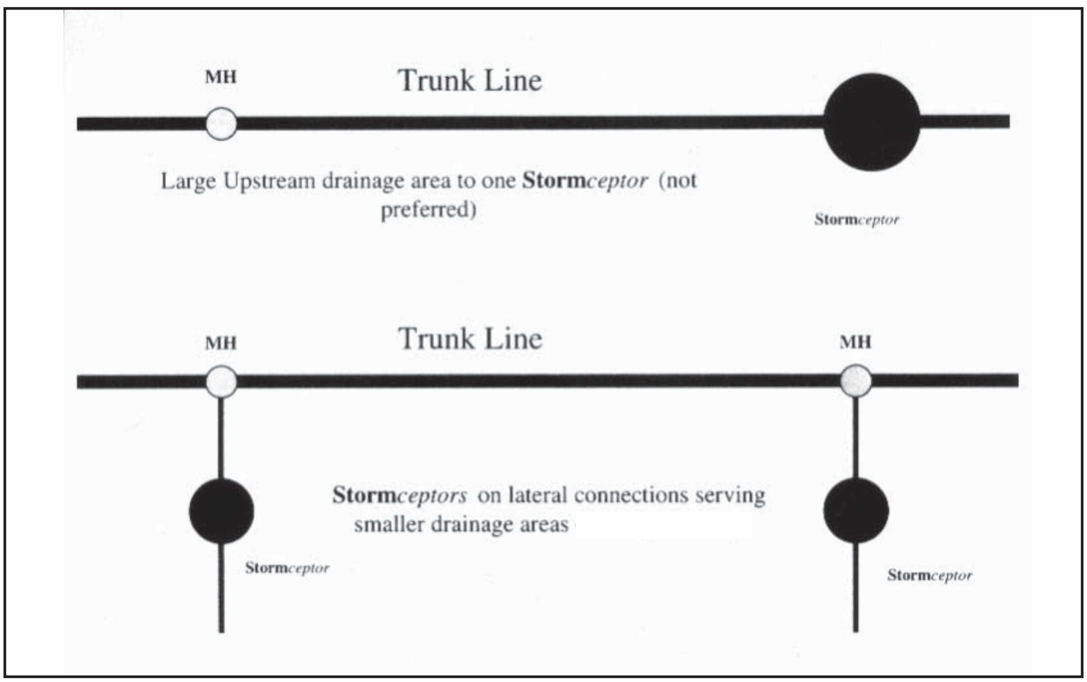


Figure 9. Stormceptor Location

2.4 Technical Specifications

The Stormceptor dimensions vary with the size of unit that is specified. Dimensions of the concrete Stormceptor units are provided in Table 5.

Table 5. Stormceptor Dimensions *

Model	Treatment Chamber Diameter	Pipe Invert to Bottom of Base Slab
450*i*	4'	68"
900	6'	63"
1200	6'	79"
1800	6'	113"
2400	8'	104"
3600	8'	144"
4800	10'	140"
6000	10'	162"
7200	12'	148"
11000*s***	10'	140"
13000*s***	10'	162"
16000*s***	12'	148"

* Depths are approximate
** Two vertical structures

Storage capacities for Stormceptor are provided in Table 6. The STCs series consists of two vertical structures, storage capacities represent the total storage for both chambers.

Table 6. Stormceptor Capacities

Model	Down Pipe Orifice	*Sediment Capacity (ft^3)	Oil Capacity (US Gal.)	Total (US Gal.)
450*i*	6	9	86	470
900	6	19	251	952
1200	6	25	251	1234
1800	6	37	251	1833
2400	8	49	840	2462
3600	8	75	840	3715
4800	10	101	909	5059
6000	10	123	909	6136
7200	12	149	1059	7420
11000*s*	10	224**	2797**	11194**
13000*s*	10	268**	2797**	13348**
16000*s*	12	319**	3055**	15918**

* Capacity prior to recommended maintenance
** Total both structures combined

The different flow rates are achieved by manipulating the down pipe orifice diameter. The weir directing the flow through the lower treatment chamber is manufactured at a constant height of 8" for all of the units. Since the outlet is 1" lower than the inlet, a total potential head of 9" is available to convey flow through the lower treatment chamber before overflow conditions occur. The orifice diameter for each size of Stormceptor is shown in Table 6.

The by-pass flow rate is simply a function of head over the overflow weir.

Table 7. By-Pass Flow Rate

Head (in)	STC 450*i* (cfs)	STC 900-7200 (cfs)	STC 11000*s*-16000*s* (cfs)
1	0.20	0.36	0.56
2	0.55	1.01	1.56
4	1.54	2.87	4.45
6	2.85	5.35	8.31
8	4.44	8.37	13.05
10	6.27	11.90	18.60
12	8.33	15.91	24.94
15	11.82	22.79	35.87
18	15.74	30.67	48.47
21	20.06	39.53	62.73

Digital AutoCad drawings for all of the Stormceptor models are available from the Rinker Materials Stormceptor office at (800) 909-7763 or at www.rinkerstormceptor.com.

2.5 Design Parameters

There are some standard design parameters that must be provided in any storm drain design with a Stormceptor installation.

Inlet / Outlet Elevation Difference

Inlet Stormceptor
There is a three inch difference in elevation between the inlet invert and outlet invert in the Inlet Stormceptor (450i).

In-Line Stormceptor:
There is a one inch difference in elevation between the inlet invert and the outlet invert in an In-Line Stormceptor designed for one inlet. There is a three inch difference in elevation between the inlet invert and the outlet invert in an In-Line Stormceptor designed for multiple inlets. Storm drain designs must accommodate this elevation difference.

Series Stormceptor
The STCs Series Stormceptor consists of two treatment chambers connected by piping. Each circular chamber has a one inch difference in elevation between the inlet invert and the outlet invert. Additionally, there is a one inch drop between each structure, for a total drop of three inches.

Influent and Effluent Pipe Diameter

In most cases, flexible rubber boots are used to facilitate the installation of the influent/effluent pipes to the Stormceptor. These boots are installed in the by-pass chamber section at the Rinker Materials manufacturing facility. Boots are available for pipe sizes with an O.D. (outside diameter) up to 44" (36" concrete I.D.).

The influent/effluent pipes can be grouted/mortared in the concrete Stormceptor if desired. Pipes up to 24" in diameter can be grouted without any special preparation. Larger pipe diameters will need to be modified to fit the curvature of the Stormceptor.

Head Loss Through the Stormceptor

The measured head loss through the Stormceptor is approximately equal to a 60˚ bend at a manhole. An appropriate K value to use in calculating minor losses through the storm drain system for a Stormceptor unit would be 1.3 (Minor Loss = 1.3 v^2 /2g).

Installation Depth

There is a minimum inlet crown (inside top of pipe) to grade elevation required to physically implement the In-Line Stormceptor due to the modular construction of the structure. The minimum crown to grade elevation is 24", depending on pipe size and material. Flexible couplings cannot be supplied for shallow concrete Stormceptor applications. The maximum installation depth (from finish grade to influent pipe invert) for the precast concrete Stormceptor is 33 feet.

Stormceptor installations at depths greater than those noted above will require custom manufacturing. Rinker Materials should be consulted for recommendations in these instances.

3.0 Installation Procedures

The installation of the concrete Stormceptor should conform in general to state highway, provincial or local specifications for the construction of manholes. Selected sections of a general specification that are applicable are summarized in the following sections.

Excavation

Excavation for the installation of the Stormceptor should conform to state highway, provincial or local specifications. Topsoil that is removed during the excavation for the Stormceptor should be stockpiled in designated areas and should not be mixed with subsoil or other materials. Topsoil stockpiles and the general site preparation for the installation of the Stormceptor should conform to state highway, provincial or local specifications.

The Stormceptor should not be installed on frozen ground. Excavation should extend a minimum of 12" from the precast concrete surfaces plus an allowance for shoring and bracing where required. If the bottom of the excavation provides an unsuitable foundation additional excavation may be required. In areas with a high water table, continuous dewatering should be provided to ensure that the excavation is stable and free of water.

Backfilling

Backfill material should conform to state highway, provincial or local specifications. Backfill material should be placed in uniform layers not exceeding 12" in depth and compacted to state highway, provincial or local specifications.

Stormceptor Installation Sequence

The concrete Stormceptor is installed in sections in the following sequence:

1. aggregate base
2. base slab
3. treatment chamber section(s)
4. transition slab (if required)
5. by-pass section
6. connect inlet and outlet pipes
7. riser section and/or transition slab (if required)
8. maintenance riser section(s) (if required)
9. frame and access cover

The precast base should be placed level at the specified grade. The entire base should be in contact with the underlying compacted granular material. Subsequent sections, complete with joint seals, should be installed in accordance with the licensed precast concrete manufacturer’s recommendations.

Adjustment of the Stormceptor can be performed by lifting the upper sections free of the excavated area, re-leveling the base, and re-installing the sections. Damaged sections and gaskets should be repaired or replaced as necessary.

Down Pipe and Riser Pipe

Once the by-pass section has been attached to the lower treatment chamber, the inlet down pipe, and outlet riser pipe must be attached. Pipe installation instructions and required materials are provided with the insert.

Inlet and Outlet Pipes

Inlet and outlet pipes should be securely set into the by-pass chamber using grout, boots, or approved pipe seals so that the structure is watertight. Boots are normally used and installed at the precast concrete plant prior to shipping. Boots are applicable for pipes with an outside diameter up to 44". Installation of the boots should follow the manufacturer's recommendations. The following procedure should be followed to attach the inlet and outlet pipes at the Stormceptor:

1. Center the pipe in the boot opening
2. Lubricate the outside of the pipe and/or inside of the boot if the pipe outside diameter is the same as the inside diameter of the boot
3. Position the pipe clamp in the groove of the boot with the screw at the top
4. Tighten the pipe clamp screw per manufacturers requirement
5. On minimum outside diameter installations lift the boot such that it contacts the bottom of the pipe while tightening the pipe clamp to ensure even contraction of the rubber.
6. Move the pipe horizontally and/or vertically to bring it to grade

Frame and Cover Installation

Precast concrete adjustment units should be installed to set the frame and cover at the required elevation. The adjustment units should be laid in a full bed of mortar with successive units being joined using sealant recommended by the manufacturer. Frames for the cover should be set in a full bed of mortar at the elevation specified. Orientation of the frame and cover must allow access to the 24" oulet riser pipe as well as the oil inspection port.

4.0 Stormceptor Maintenance Guidelines

The performance of all storm water quality measures decrease as they fill with sediment. Although the maintenance frequency will be site specific, Rinker Materials generally recommends annual maintenance be performed or when the sediment volume in the unit reaches 15% of the total storage. This recommendation is based on several factors:

- Minimal performance degradation due to sediment build-up.
- Sediment removal is easier when removed on a regular basis (as sediment builds up it compacts and solidifies making maintenance more difficult).
- Development of a routine maintenance interval helps ensure a regular maintenance schedule is followed. Although the frequency of maintenance will depend on site conditions, it is estimated that annual maintenance will be required for most applications; annual maintenance is a routine occurrence which is easy to plan for and remember.

Hydrocarbon Spills

In the event of any hazardous material spill, Rinker Materials recommends maintenance be performed immediately. Maintenance should be performed by a licensed liquid waste hauler. You should also notify the appropriate regulatory agencies as required.

4.1 Recommended Maintenance Procedure

Oil is removed through the 6" inspection/oil port and sediment is removed through the 24" diameter outlet riser pipe. Alternatively, oil could be removed from the 24" opening if water is removed from the treatment chamber, lowering the oil level below the drop pipes.

The depth of sediment can be measured from the surface of the Stormceptor with a dipstick tube equipped with a ball valve (Sludge Judge®). Rinker Materials recommends maintenance be performed once the sediment depth exceeds the guideline values provided in Table 8.

Table 8. Sediment Depths Indicating Required Maintenance*

Model	Sediment Depth
450*i*	8" (200 mm)
900	8" (200 mm)
1200	10" (250 mm)
1800	15" (375 mm)
2400	12" (300 mm)
3600	17" (425 mm)
4800	15" (375 mm)
6000	18" (450 mm)
7200	15" (375 mm)
11000*s*	17" (425 mm)**
13000*s*	20" (500 mm)**
16000*s*	17" (425 mm)**

* *Depths are approximate*

** *Depths in each structure*

No entry into the unit is required for routine maintenance of the Inlet Stormceptor or the smaller disc insert models of the In-Line Stormceptor. Entry to the level of the by-pass may be required for servicing the larger in-line models. Any potential obstructions at the inlet can be observed from the surface. The by-pass chamber has been designed as a platform for authorized maintenance personnel, in the event that an obstruction needs to be removed, drain flushing needs to be performed, or camera surveys are required.

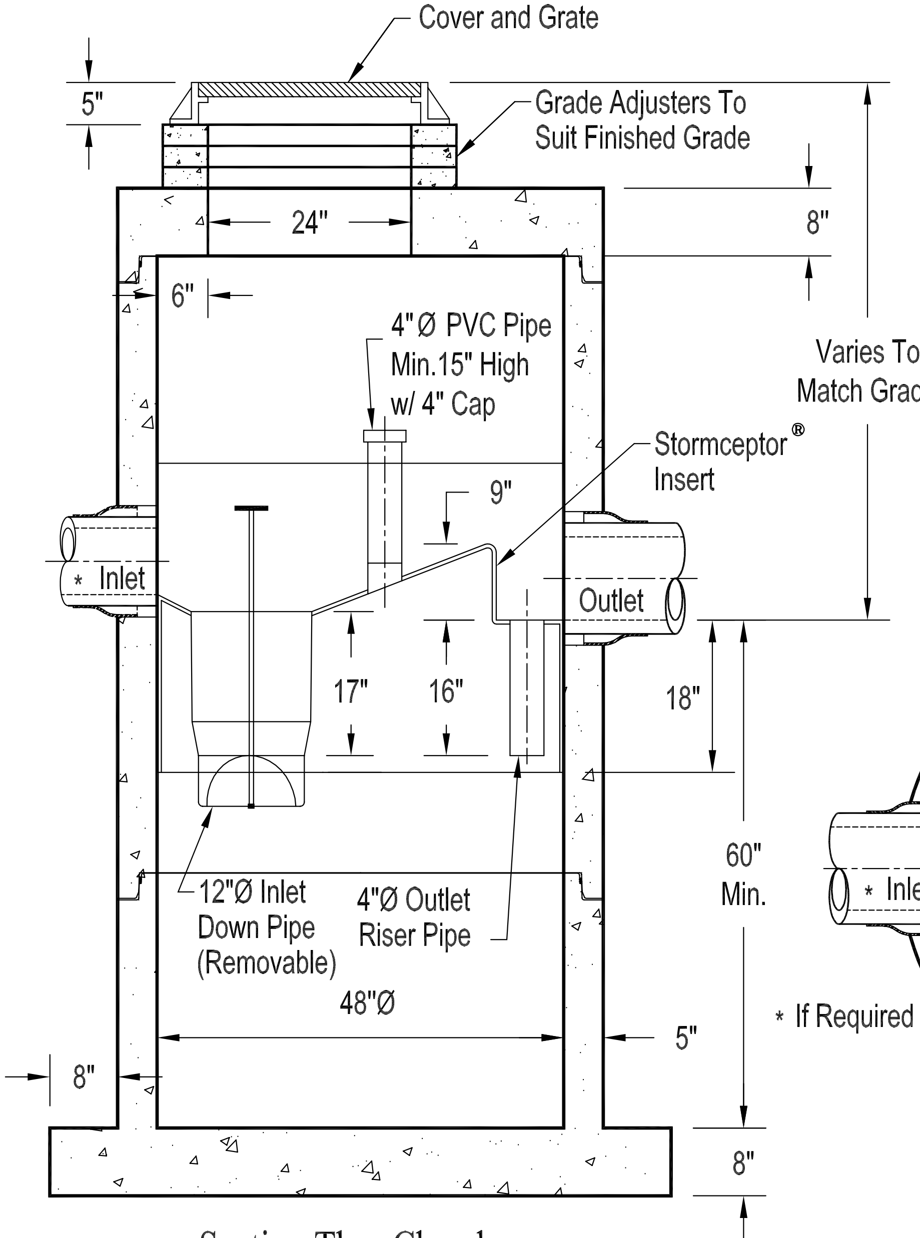
Typically, maintenance is performed by the Vacuum Service Industry, a well established sector of the service industry that cleans underground tanks, sewers, and catch-basins. Costs to clean a Stormceptor will vary based on the size of the unit and transportation distances. If you need assistance for cleaning a Stormceptor unit, contact your local Rinker Materials representative, or the Rinker Materials Stormceptor Information Line at (800) 909-7763.

Disposal

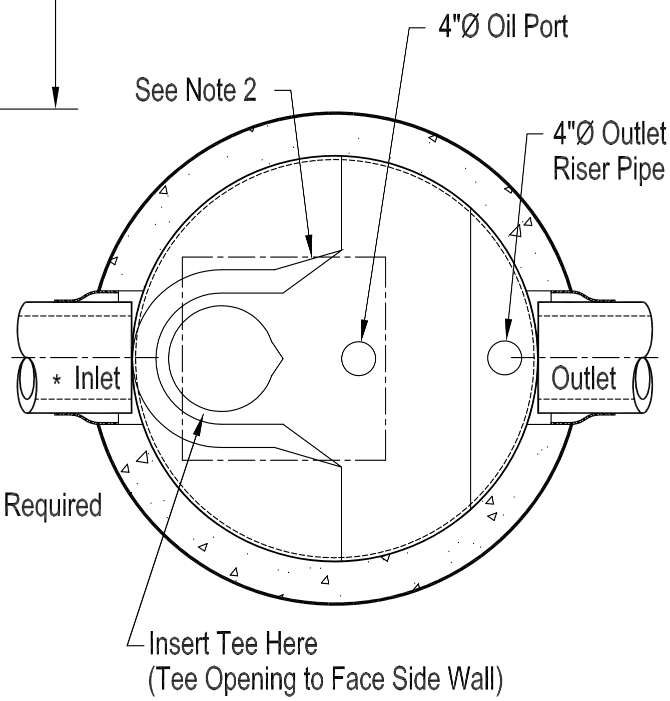
The requirements for the disposal of material from a Stormceptor are similar to that of any other Best Management Practices (BMPs). Local guidelines should be consulted prior to disposal of the separator contents.

In most areas the sediment, once dewatered, can be disposed of in a sanitary landfill. It is not anticipated that the sediment would be classified as hazardous waste. In some areas, mixing the water with the sediment will create a slurry that can be discharged into a trunk sanitary sewer. In all disposal options, approval from the disposal facility operator/agency is required. Petroleum waste products collected in Stormceptor (oil/chemical/fuel spills) should be removed by a licensed waste management company.

STC 450i Precast Concrete Stormceptor®
(450 U.S. Gallon Capacity)



Section Thru Chamber

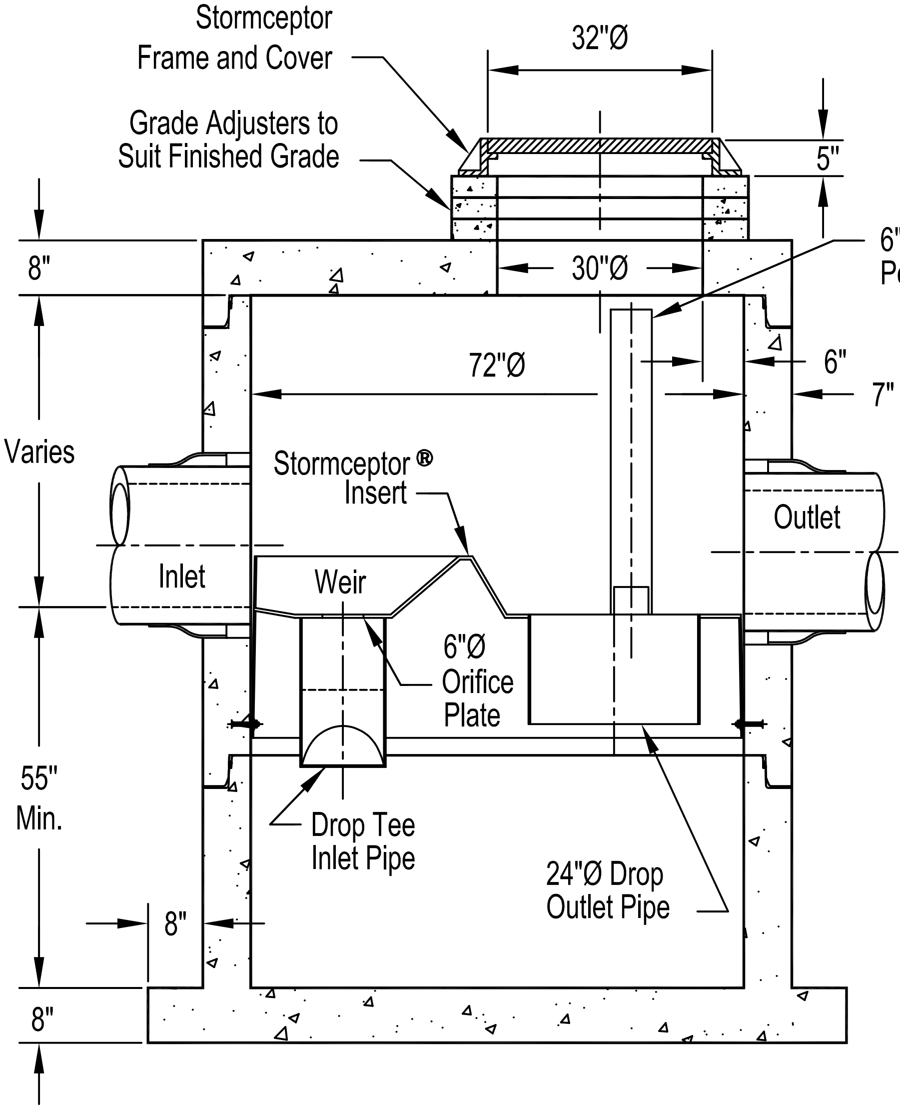


Plan View

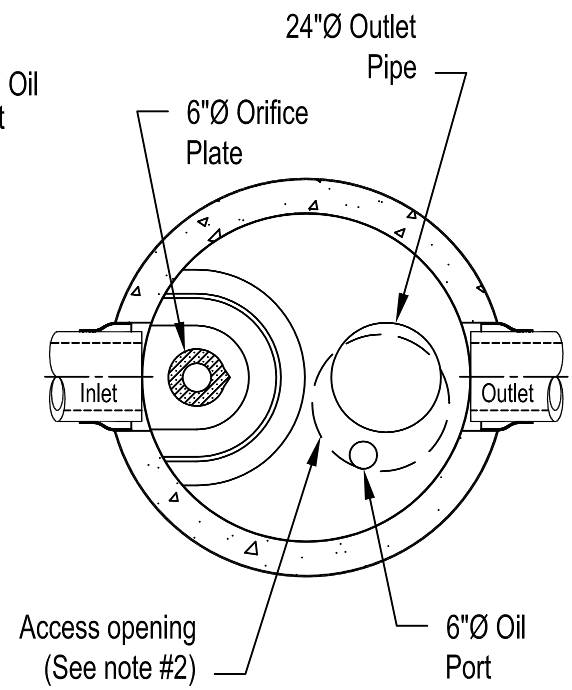
Notes:

1. The Use Of Flexible Connection is Recommended at The Inlet and Outlet Where Applicable.
2. The Cover Should be Positioned Over The Inlet Drop Pipe and The Oil Port.
3. The Stormceptor System is protected by one or more of the following U.S. Patents: #4985148, #5498331, #5725760, #5753115, #5849181, #6068765, #6371690.
4. Contact a Concrete Pipe Division representative for further details not listed on this drawing.

STC 900 Precast Concrete Stormceptor®
(900 U.S. Gallon Capacity)



Section Thru Chamber



Plan View

Notes:

1. The Use Of Flexible Connection is Recommended at The Inlet and Outlet Where Applicable.
2. The Cover Should be Positioned Over The Outlet Drop Pipe and The Oil Port.
3. The Stormceptor System is protected by one or more of the following U.S. Patents: #4985148, #5498331, #5725760, #5753115, #5849181, #6068765, #6371690.
4. Contact a Concrete Pipe Division representative for further details not listed on this drawing.

APPENDIX C

VERTICAL FIELD PROFILES COLLECTED IN THE LAKE STREET STORMCEPTOR UNIT

Town of Windermere
Lake Street Stormceptor Field Profiles

Date	Time	Dep25 (m)	Temp (^{o}C)	pH (s.u.)	SpCond (µmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (sat)	ORP (mv)
7/13/09	14:01	0.25	30.24	7.30	278	178	4.4	59	354
7/13/09	14:03	0.50	28.97	7.18	315	202	1.8	23	279
7/13/09	14:06	1.00	27.69	7.19	306	196	0.5	7	60
7/13/09	14:07	1.50	26.96	7.26	270	173	0.3	4	54
7/13/09	14:08	1.83	26.73	7.30	255	163	0.3	3	35
7/16/09	8:51	0.25	30.12	7.10	300	192	1.7	22	137
7/16/09	8:52	0.50	29.84	7.12	307	197	0.6	7	91
7/16/09	8:53	1.00	28.63	7.03	328	210	0.4	5	29
7/16/09	8:53	1.50	27.78	7.11	332	212	0.3	4	-4
7/16/09	8:55	1.75	27.19	7.14	335	215	0.3	3	-32
7/22/09	16:02	0.25	32.85	7.31	277	177	5.9	82	177
7/22/09	16:02	0.50	30.12	7.03	326	208	1.1	14	71
7/22/09	16:03	1.00	29.32	7.02	353	226	0.4	5	32
7/22/09	16:04	1.50	28.34	7.01	409	261	0.3	4	-16
7/22/09	16:04	1.85	27.33	6.93	459	294	0.3	4	-45
7/27/09	14:54	0.25	30.45	8.21	254	162	5.6	75	326
7/27/09	14:55	0.50	29.70	7.98	162	104	2.6	35	316
7/27/09	14:56	1.00	28.05	7.97	157	100	1.4	17	309
7/27/09	14:57	1.50	27.60	8.17	105	67	1.3	33	312
7/27/09	14:59	1.90	27.12	8.06	108	69	0.5	6	122
7/30/09	9:14	0.25	29.42	8.29	216	138	5.5	72	318
7/30/09	9:16	0.50	29.09	8.20	206	132	5.1	66	315
7/30/09	9:17	1.00	27.14	8.03	104	67	4.8	61	305
7/30/09	9:18	1.50	26.76	8.41	75	48	5.0	62	317
7/30/09	9:18	1.70	26.63	8.48	70	45	5.1	63	317
8/5/09	13:33	0.25	31.50	7.11	261	167	5.3	72	638
8/5/09	13:34	0.50	28.65	6.93	319	204	0.6	8	615
8/5/09	13:35	1.00	28.54	6.92	318	204	0.5	6	596
8/5/09	13:36	1.42	27.20	7.31	233	149	0.3	3	543
8/10/09	15:50	0.25	33.15	7.77	258	165	6.9	97	320
8/10/09	15:51	0.50	30.50	7.15	294	188	0.6	8	145
8/10/09	15:52	1.00	29.38	7.12	321	205	0.4	6	104
8/10/09	15:53	1.43	28.32	7.32	275	176	0.3	3	29
8/13/09	15:46	0.25	32.57	7.50	268	172	7.1	98	313
8/13/09	15:47	0.50	29.30	6.99	429	274	0.6	8	18
8/13/09	15:48	1.00	29.14	6.99	426	273	0.5	6	11
8/13/09	15:50	1.36	28.95	6.97	449	287	0.3	3	-25
8/17/09	15:26	0.25	30.94	7.49	259	166	6.4	86	288
8/17/09	15:27	0.50	29.32	7.05	344	220	0.7	9	6
8/17/09	15:28	1.00	29.08	6.96	366	234	0.4	6	-28
8/17/09	15:29	1.40	29.03	6.97	368	236	0.3	4	-37

Town of Windermere
Lake Street Stormceptor Field Profiles

Date	Time	Dep25 (m)	Temp (°C)	pH (s.u.)	SpCond (μmho/cm)	TDS (mg/l)	DO (mg/l)	DO% (sat)	ORP (mv)
8/20/09	14:59	0.25	30.79	7.28	262	168	7.0	93	289
8/20/09	15:00	0.50	29.57	6.92	343	220	1.6	21	24
8/20/09	15:01	1.00	28.98	6.93	368	236	0.8	11	-18
8/20/09	15:02	1.40	28.61	6.87	423	271	0.6	7	-62
8/25/09	9:00	0.25	29.83	7.00	272	174	3.1	41	281
8/25/09	9:01	0.50	29.32	7.08	307	196	1.5	20	3
8/25/09	9:02	1.00	28.88	7.04	324	207	1.0	13	-12
8/25/09	9:03	1.38	28.82	6.98	329	211	0.8	10	-33
9/1/2009	14:02:09	0.25	30.94	7.11	267.6	0.1712	3.93	53	265
9/1/2009	14:03:10	0.5	29.46	7.03	295.5	0.1891	0.62	8.1	88
9/1/2009	14:04:22	1	28.98	7.01	300.5	0.1923	0.31	4	25
9/1/2009	14:05:38	1.36	28.88	6.99	321	0.2055	0.23	2.9	-8
9/3/2009	14:08:59	0.25	30.11	7.28	260	0.1664	5.05	67	340
9/3/2009	14:10:11	0.5	28.32	7.19	261.5	0.1673	0.74	9.6	117
9/3/2009	14:11:07	1	28.27	7.1	261.7	0.1675	0.47	6.1	98
9/3/2009	14:12:39	1.35	28.21	7.06	267.4	0.1712	0.34	4.3	57
9/8/2009	14:15:58	0.25	30.36	7.51	262.4	0.1679	4.59	61.2	343
9/8/2009	14:16:56	0.5	29	7.4	288.6	0.1845	0.93	12.1	122
9/8/2009	14:17:41	1	28.93	7.23	289.1	0.185	0.48	6.2	93
9/8/2009	14:18:41	1.34	28.61	7.19	287.5	0.184	0.35	4.6	48
9/11/2009	12:48:13	0.25	29.13	6.85	296.9	0.19	2.39	31.2	175
9/11/2009	12:48:54	0.5	29.04	6.88	307.3	0.1967	1.69	22	83
9/11/2009	12:50:06	1	28.85	6.91	332.7	0.2129	1.13	14.7	33
9/11/2009	12:51:07	1.32	28.79	6.88	342.1	0.2189	0.93	12.1	10
9/14/2009	13:41:49	0.25	29.38	7.1	268.1	0.1716	4.67	61.1	288
9/14/2009	13:43:02	0.5	28.43	7.06	278.5	0.1783	2.47	31.8	19
9/14/2009	13:44:14	1	28.31	6.98	278.2	0.1781	1.78	22.9	-1
9/14/2009	13:45:15	1.31	28.26	6.9	302.1	0.1934	1.45	18.6	-18

APPENDIX D

PHYSICAL AND CHEMICAL CHARACTERISTICS OF ACCUMULATED SOLIDS AT THE STORMCEPTOR SITES BY PARTICLE SIZE

1. **Lake Street Site**
2. **Pine Street Site**

1. Lake Street Site

Lake Street – Upstream Pipe

Sieve Size (µm)	Sample & Sieve wt. (grams)	Sieve wt. (grams)	Sample Retained (grams)	Percent Retained	Cumulative Percent Retained	TN (µg/g)	TP (µg/g)	TN (µg/g)	TP (µg/g)
2000	1330.90	474.84	856.06	38.9	38.9	24	144	9.4	56.1
840	671.44	445.33	226.11	10.3	10.3	24	83	2.5	8.5
420	767.72	423.74	343.98	15.6	64.8	19	64	3.0	10.0
250	818.12	394.42	423.70	19.3	84.1	7	47	1.3	9.0
180	569.43	391.28	178.15	8.1	92.2	9	121	0.7	9.8
150	456.82	381.00	75.82	3.4	95.7	8	154	0.3	5.3
125	428.70	364.48	64.22	2.9	98.6	10	170	0.3	5.0
75	405.06	375.84	29.22	1.3	99.9	18	273	0.2	3.6
< 75	371.04	369.05	1.99	0.1	100.0	137	497	0.1	0.4
			2199.25					**17.9**	**107.7**

Lake Street – Stormceptor Sump

Sieve Size (µm)	Sample & Sieve wt. (grams)	Sieve wt. (grams)	Sample Retained (grams)	Percent Retained	Cumulative Percent Retained	TN (µg/g)	TP (µg/g)	TN (µg/g)	TP (µg/g)
2000	870.10	474.63	395.47	20.9	20.9	143	218	30.0	45.7
840	576.12	445.19	130.93	6.9	6.9	144	126	10.0	8.7
420	611.04	422.73	188.31	10.0	37.8	115	97	11.5	9.6
250	738.00	393.39	344.61	18.2	56.0	39	71	7.2	12.9
180	739.46	390.75	348.71	18.4	74.4	51	183	9.5	33.7
150	586.72	380.76	205.96	10.9	85.3	49	233	5.3	25.4
125	548.24	364.16	184.08	9.7	95.0	62	257	6.0	25.1
75	456.85	375.75	81.10	4.3	99.3	105	415	4.5	17.8
< 75	381.94	369.03	12.91	0.7	100.0	813	753	5.5	5.1
			1892.08					**89.5**	**184.0**

Lake Street – On Top of Stormceptor Unit

Sieve Size (µm)	Sample & Sieve wt. (grams)	Sieve wt. (grams)	Sample Retained (grams)	Percent Retained	Cumulative Percent Retained	TN (µg/g)	TP (µg/g)	TN (µg/g)	TP (µg/g)
2000	500.94	474.89	26.05	1.3	1.3	216	253	2.8	3.3
840	548.33	445.37	102.96	5.2	5.2	217	146	11.2	7.5
420	565.26	423.97	141.29	7.1	13.6	173	112	12.3	7.9
250	974.34	397.87	576.47	29.0	42.5	59	82	17.2	23.8
180	878.56	391.51	487.05	24.5	67.0	77	212	18.9	51.8
150	675.42	381.15	294.27	14.8	81.8	73	270	10.9	39.9
125	567.09	364.46	202.63	10.2	92.0	93	298	9.5	30.3
75	500.51	375.92	124.59	6.3	98.2	157	480	9.9	30.0
< 75	404.00	369.02	34.98	1.8	100.0	1223	872	21.5	15.3
			1990.29					**114.1**	**210.0**

Lake Street – Downstream Pipe

Sieve Size (µm)	Sample & Sieve wt. (grams)	Sieve wt. (grams)	Sample Retained (grams)	Percent Retained	Cumulative Percent Retained	TN (µg/g)	TP (µg/g)	TN (µg/g)	TP (µg/g)
2000	548.85	474.68	74.17	4.3	4.3	361	266	15.4	11.4
840	499.61	445.66	53.95	3.1	3.1	364	154	11.3	4.8
420	509.05	423.25	85.80	4.9	12.3	290	118	14.3	5.8
250	733.44	393.71	339.73	19.6	31.9	99	86	19.4	16.9
180	968.80	390.82	577.98	33.3	65.1	129	223	43.1	74.2
150	672.68	380.81	291.87	16.8	82.0	123	284	20.7	47.8
125	545.43	364.47	180.96	10.4	92.4	156	314	16.2	32.7
75	481.90	375.78	106.12	6.1	98.5	264	505	16.1	30.9
< 75	395.49	369.04	26.45	1.5	100.0	2048	918	31.2	14.0
			1737.03					**187.7**	**238.4**

Lake Street – Roadway Dirt

Sieve Size (µm)	Sample & Sieve wt. (grams)	Sieve wt. (grams)	Sample Retained (grams)	Percent Retained	Cumulative Percent Retained	TN (µg/g)	TP (µg/g)	TN (µg/g)	TP (µg/g)
2000	828.38	475.28	353.10	19.2	19.2	99	312	19.1	60.0
840	546.98	445.43	101.55	5.5	5.5	100	180	5.5	10.0
420	749.34	426.27	323.07	17.6	42.4	80	138	14.0	24.3
250	1094.66	396.66	698.00	38.0	80.4	27	101	10.4	38.5
180	473.40	391.99	81.41	4.4	84.8	36	261	1.6	11.6
150	524.91	381.94	142.97	7.8	92.6	34	333	2.6	25.9
125	425.43	364.80	60.63	3.3	95.9	43	367	1.4	12.1
75	440.71	376.04	64.67	3.5	99.5	72	592	2.6	20.9
< 75	378.98	369.10	9.88	0.5	100.0	563	1075	3.0	5.8
			1835.28					**60.3**	**209.0**

2. **Pine Street Site**

Pine Street – Stormceptor Sump

Sieve Size (µm)	Sample & Sieve wt. (grams)	Sieve wt. (grams)	Sample Retained (grams)	Percent Retained	Cumulative Percent Retained	TN (µg/g)	TP (µg/g)	TN (µg/g)	TP (µg/g)
2000	786.54	475.08	311.46	20.2	20.2	673	338	136.0	68.3
840	622.28	445.48	176.80	11.5	11.5	678	195	77.8	22.4
420	707.88	424.15	283.73	18.4	50.1	541	149	99.5	27.5
250	786.98	395.14	391.84	25.4	75.5	185	110	47.1	27.9
180	579.77	391.71	188.06	12.2	87.7	241	283	29.4	34.6
150	487.18	382.11	105.07	6.8	94.5	229	361	15.6	24.6
125	404.21	365.19	39.02	2.5	97.1	290	398	7.4	10.1
75	415.05	376.09	38.96	2.5	99.6	491	642	12.4	16.2
< 75	375.35	369.12	6.23	0.4	100.0	3817	1165	15.4	4.7
			1541.17					**440.7**	**236.2**

Pine Street – Downstream Stormsewer

Sieve Size (µm)	Sample & Sieve wt. (grams)	Sieve wt. (grams)	Sample Retained (grams)	Percent Retained	Cumulative Percent Retained	TN (µg/g)	TP (µg/g)	TN (µg/g)	TP (µg/g)
2000	665.82	475.40	190.42	13.6	13.6	435	398	59.3	54.3
840	650.12	445.45	204.67	14.6	14.6	438	230	64.2	33.7
420	765.10	426.13	338.97	24.3	52.5	349	176	84.7	42.7
250	792.82	396.21	396.61	28.4	80.9	120	129	34.0	36.7
180	551.88	393.01	158.87	11.4	92.3	156	334	17.7	37.9
150	436.45	382.50	53.95	3.9	96.1	148	425	5.7	16.4
125	398.18	365.73	32.45	2.3	98.4	188	469	4.4	10.9
75	394.31	376.62	17.69	1.3	99.7	318	756	4.0	9.6
< 75	373.38	369.21	4.17	0.3	100.0	2467	1373	7.4	4.1
			1397.80					**281.3**	**246.2**

Pine Street – Roadway Dirt

Sieve Size (µm)	Sample & Sieve wt. (grams)	Sieve wt. (grams)	Sample Retained (grams)	Percent Retained	Cumulative Percent Retained	TN (µg/g)	TP (µg/g)	TN (µg/g)	TP (µg/g)
2000	556.55	474.92	81.63	4.4	4.4	163	381	7.1	16.7
840	528.29	445.36	82.93	4.4	4.4	164	220	7.3	9.8
420	612.32	424.22	188.10	10.1	18.9	131	168	13.2	17.0
250	1220.45	397.21	823.24	44.2	63.1	45	124	19.8	54.6
180	734.40	394.24	340.16	18.2	81.3	58	319	10.6	58.2
150	495.56	383.15	112.41	6.0	87.4	55	407	3.3	24.5
125	428.82	366.02	62.80	3.4	90.7	70	449	2.4	15.1
75	428.93	376.78	52.15	2.8	93.5	119	723	3.3	20.2
< 75	489.89	369.01	120.88	6.5	100.0	923	1313	59.9	85.1
			1864.30					**127.0**	**301.3**

APPENDIX E

QA DATA

MATRIX SPIKE RECOVERY STUDY

PARAMETERS	UNITS	SAMPLE ID	SAMPLE DESCRIPTION	DATE COLLECTED	DATE ANALYZED	INITIAL CONC.	INITIAL VOLUME (ml)	SPIKE CONC.	SPIKE VOLUME ADDED (ml)	THEORETICAL CONC.	MEASURED CONC.	PERCENT RECOVERY	ACCEPTANCE RANGE
Alkalinity	mg/l	09-2334	Outfall #8	07/29/09	07/30/09	167	50	1000	0.5	177.0	178	101%	95-105
Alkalinity	mg/l	09-2479	Blank	08/06/09	08/10/09	0.8	50	1000	0.5	10.8	10.8	100%	95-105
Alkalinity	mg/l	09-2496	Outfall #8	08/08/09	08/11/09	88.0	50	1000	0.5	98.0	98.8	101%	95-105
Alkalinity	mg/l	09-2968	Outfall #8	09/01/09	09/04/09	98.6	50	1000	0.5	109	109	100%	95-105
Turbidity	NTU	09-2479	Outfall #8 Blank	08/06/09	08/07/09	0.2	50	4000	0.25	20.2	20.2	100%	87-104
Turbidity	NTU	09-2968	Outfall #8	09/01/09	09/04/09	45.4	50	4000	0.25	66.4	68.2	103%	87-104
Turbidity	NTU	09-3113	Site #4 SC	09/11/09	09/11/09	7.9	50	4000	0.25	27.9	27.9	100%	87-104
Color	PCU	09-2479	Blank	08/07/09	08/07/09	1	25	500	1.00	21	21	100%	87-104
Color	PCU	09- 2049	Outfall #4	06/30/09	07/01/09	47	25	500	1.00	67	66	98.5%	87-104
Color	PCU	09-2867	Outfall #4	08/25/09-09/01/09	09/03/09	21	25	500	0.75	51	51	100%	87-104
Color	PCU	09-3113	Outfall #4	09/11/09	09/11/09	32	25	500	0.75	107	110	103%	87-104
Color	PCU	09-3210	Outfall #4	09/16/09	09/17/09	36	25	500	0.75	111	110	99.1%	87-104
Color	PCU	09- 2032	Outfall #8	06/23/09	06/24/09	44	25	500	1.00	64	61	95.3%	87-104
Color	PCU	09-2496	Outfall #8	08/08/09	08/10/09	28	25	500	1.00	68	68	100%	87-104
Color	PCU	09- 2170	Outfall #8 Sampler Blank	07/09/09	07/10/09	2	25	500	1.00	22	21	93.2%	87-104
SRP	µg/l	09-1981f	Outfall #8 Sampler Blank	6/18/2009	06/19/09	0	10	10000	0.225	225	221	98.2%	92-112
SRP	µg/l	09-2300f	Outfall #8	7/26/2009	07/29/09	335	10	10000	0.100	435	442	102%	92-112
SRP	µg/l	09-2478f	Outfall #8	8/7/2009	08/07/09	179	10	10000	0.350	529	502	94.9%	92-112
SRP	µg/l	09-2867f	Outfall #4	08/25/09-09/01/09	09/03/09	6	10	10000	0.225	231	229	99.1%	92-112
SRP	µg/l	09-2966f	Outfall #4	9/1/2009	09/04/09	26	10	10000	0.225	251	253	101%	92-112
SRP	µg/l	09-3113f	Outfall #4 Stormceptor	9/11/2009	09/11/09	48	10	100000	0.100	1048	1050	100%	92-112
NOx-N	µg/l	09-1981f	Outfall #8 Sampler Blank	6/18/2009	06/19/09	0	10	100000	0.100	1000	984	98.4%	85-115
NOx-N	µg/l	09-2300f	Outfall #8	7/26/2009	07/29/09	1074	10	100000	0.100	2074	2198	106%	85-115
NOx-N	µg/l	09-2478f	Outfall #8	8/7/2009	08/07/09	274	10	100000	0.450	4774	4800	101%	85-115
NOx-N	µg/l	09-2867f	Outfall #4	08/25/09-09/01/09	09/03/09	19	10	10000	0.150	169	163	96.4%	85-115
NOx-N	µg/l	09-2966f	Outfall #4	9/1/2009	09/04/09	7	10	10000	0.150	157	162	103%	85-115
NOx-N	µg/l	09-3113f	Outfall #4 Stormceptor	9/11/2009	09/11/09	5	10	100000	0.200	2005	1937	96.6%	85-115
Ammonia	µg/l	09-2183p	Outfall #4	07/14/09	07/22/09	12	10	8222	1.000	834	792	94.9%	80-120
Ammonia	µg/l	09-2868p	Outfall #4 Stormceptor	9/1/2009	09/23/09	692	10	8222	1.000	1514	1377	90.9%	80-120
Ammonia	µg/l	09-3129p	Outfall #4 Load 10	9/15/2009	09/28/09	366	10	8222	1.000	1188	1069	90.0%	80-120
Total N	µg/l	09-2168p	Outfall #4	07/09/09	08/12/09	457	10	226000	0.020	909	845	93.0%	92-112
Total N	µg/l	09-2966fp	Outfall #4	09/01/09	09/10/09	331	10	226000	0.010	557	530	95.2%	92-112
Total N	µg/l	09-3115fp	Outfall #8 Stormceptor	09/15/09	11/04/09	1926	10	226000	0.100	4186	3906	93.3%	92-112
Total P	µg/l	09-2168p	Outfall #4	07/09/09	08/12/09	54	10	50000	0.090	504	498	98.8%	92-112
Total P	µg/l	09-2966fp	Outfall #4	09/01/09	09/10/09	56	10	50000	0.030	206	206	100%	92-112
Total P	µg/l	09-3115fp	Outfall #8 Stormceptor	09/15/09	11/04/09	734	10	50000	0.100	1234	1165	94.4%	92-112

SAMPLE DUPLICATE RECOVERY

PARAMETERS	UNITS	SAMPLE ID	SAMPLE DESCRIPTION	DATE COLLECTED	DATE ANALYZED	REPEAT 1	REPEAT 2	MEAN	STD. DEV.	% RELATIVE STD. DEVIATION (% RSD)	ACCEPTANCE RANGE (% RSD)	FLAG
pH	s.u.	09-1981	Outfall #8 Sampler Blank	06/18/09	06/22/09	5.81	5.82	5.82	0.01	0.12	0-2	A
pH	s.u.	09-2048	Outfall #8	06/30/09	07/07/09	7.30	7.32	7.31	0.01	0.19	0-2	A
pH	s.u.	09-2168	Site #4	07/09/09	07/13/09	7.35	7.37	7.36	0.01	0.19	0-2	A
pH	s.u.	09-2170	Outfall #8 Sampler Blank	07/09/09	07/13/09	5.51	5.51	5.51	0.00	0.00	0-2	A
pH	s.u.	09-2334	Outfall #8	07/29/09	07/30/09	7.98	7.96	7.97	0.01	0.18	0-2	A
pH	s.u.	09-2479	Outfall #8 Sampler Blank	08/07/09	08/10/09	5.80	5.82	5.81	0.01	0.24	0-2	A
pH	s.u.	09-2496	Outfall #8	08/08/09	08/10/09	6.67	6.69	6.68	0.01	0.21	0-2	A
pH	s.u.	09-2968	Outfall #8	09/01/09	09/04/09	7.56	7.53	7.55	0.02	0.28	0-2	A
pH	s.u.	09-3113	Outfall #4 Stormceptor	09/11/09	09/11/09	7.36	7.34	7.35	0.01	0.19	0-2	A
pH	s.u.	09-3123	Outfall #4 Load 5 Field Dup	09/15/09	09/16/09	7.18	7.18	7.18	0.00	0.00	0-2	A
pH	s.u.	09-3210	Outfall #4 SC	09/16/09	09/18/09	7.37	7.39	7.38	0.01	0.19	0-2	A
Alkalinity	mg/l	09-1981	Outfall #8 Sampler Blank	06/18/09	06/22/09	1.0	1.0	1.00	0.00	0.00	0-4	A
Alkalinity	mg/l	09-2048	Outfall #8	06/30/09	07/07/09	222	221	221.50	0.71	0.32	0-4	A
Alkalinity	mg/l	09-2168	Site #4	07/09/09	07/13/09	68.0	67.4	67.70	0.42	0.63	0-4	A
Alkalinity	mg/l	09-2170	Outfall #8 Sampler Blank	07/09/09	07/13/09	0.6	0.6	0.60	0.00	0.00	0-4	A
Alkalinity	mg/l	09-2334	Outfall #8	07/29/09	07/30/09	167	168	167.50	0.71	0.42	0-4	A
Alkalinity	mg/l	09-2479	Outfall #8 Sampler Blank	08/07/09	08/10/09	0.8	0.9	0.83	0.03	3.41	0-4	A
Alkalinity	mg/l	09-2496	Outfall #8	08/08/09	08/11/09	88.6	88.0	88.30	0.42	0.48	0-4	A
Alkalinity	mg/l	09-2968	Outfall #8	09/01/09	09/04/09	98.6	98.2	98.40	0.28	0.29	0-4	A
Alkalinity	mg/l	09-3113	Outfall #4 Stormceptor	09/11/09	09/11/09	99.2	99.0	99.10	0.14	0.14	0-4	A
Alkalinity	mg/l	09-3123	Outfall #4 Load 5 Field Dup	09/15/09	09/16/09	82.4	82.6	82.50	0.14	0.17	0-4	A
Alkalinity	mg/l	09-3210	Outfall #4 SC	09/16/09	09/18/09	125	125	125.00	0.00	0.00	0-4	A
Specific Conductivity	µmho/com	09-1981	Outfall #8 Sampler Blank	06/18/09	06/23/09	2.0	2.0	2.00	0.00	0.00	0-2	A
Specific Conductivity	µmho/com	09-2032	Outfall #8	06/23/09	07/06/09	211	211	211.00	0.00	0.00	0-2	A
Specific Conductivity	µmho/com	09-2300	Outfall #8	07/26/09	08/10/09	677	677	677.00	0.00	0.00	0-2	A
Specific Conductivity	µmho/com	09-2048	Outfall #8	06/30/09	07/06/09	170	170	7.09	0.00	0.00	0-2	A
Specific Conductivity	µmho/com	09-2170	Outfall #8 Sampler Blank	07/09/09	07/27/09	1.8	1.8	6.92	0.00	0.00	0-2	A
Specific Conductivity	µmho/com	09-2183	Outfall #4	07/14/09	07/27/09	162	162	5.22	0.00	0.00	0-2	A
Turbidity	NTU	09-1981	Outfall #8 Sampler Blank	06/18/09	06/18/09	0.2	0.2	0.20	0.00	0.00	0-2	A
Turbidity	NTU	09-2032	Outfall #8	06/23/09	06/25/09	765	769	767.00	2.83	0.37	0-2	A
Turbidity	NTU	09-2047	Outfall #4	06/30/09	07/01/09	604	597	600.50	4.95	0.82	0-2	A
Turbidity	NTU	09-2049	Outfall #4	06/30/09	07/01/09	185	187	186.00	1.41	0.76	0-2	A
Turbidity	NTU	09-2170	Site #8 Blank	07/09/09	07/10/09	0.2	0.2	0.20	0.00	0.00	0-2	A
Turbidity	NTU	09-2300	Outfall #8	07/26/09	07/29/09	165	166	165.50	0.71	0.43	0-2	A
TSS	mg/l	09-2032	Outfall #8	06/23/09	06/24/09	2129	2051	2090.00	55.15	2.64	0-2	A
TSS	mg/l	09-2047	Outfall #4	06/30/09	07/01/09	575.0	572.0	573.50	2.12	0.37	0-2	A
TSS	mg/l	09-2049	Outfall #4	06/30/09	07/01/09	128.0	127.0	127.50	0.71	0.55	0-2	A
TSS	mg/l	09-2170	Outfall #8 Sampler Blank	07/09/09	07/10/09	0.3	0.3	0.30	0.00	0.00	0-2	A
TSS	mg/l	09-2300	Outfall #8	07/26/09	08/07/09	496.0	521.0	508.50	17.68	3.48	0-2	A
TSS	mg/l	09-3121	Outfall #4 L4	09/15/09	09/16/09	37.2	40.0	38.60	1.98	5.13	0-2	A
TSS	mg/l	09-3210	Outfall #8	09/16/09	09/18/09	196.0	210.0	203.00	9.90	4.88	0-2	A
Color	PCU	09-2479	Outfall #8 Sampler Blank	08/07/09	08/07/09	1	1	1.0	0.00	0.00	0-2	A
Color	PCU	09-2867	Outfall #4	08/25/09-09/01/09	09/03/09	21	20	20.5	0.71	3.45	0-2	A
Color	PCU	09-3123	Outfall #4 Load 5 Field Dup	09/15/09	09/17/09	24	24	24.0	0.00	0.00	0-2	A
Color	PCU	09-3113	Outfall #4 Stormceptor	09/11/09	09/11/09	32	31	31.5	0.71	2.24	0-2	A

SAMPLE DUPLICATE RECOVERY

PARAMETERS	UNITS	SAMPLE ID	SAMPLE DESCRIPTION	DATE COLLECTED	DATE ANALYZED	REPEAT 1	REPEAT 2	MEAN	STD. DEV.	% RELATIVE STD. DEVIATION (% RSD)	ACCEPTANCE RANGE (% RSD)	FLAG
Color	PCU	09-3210	Outfall #4 Stormceptor Pump Out	09/16/09	09/17/09	36	37	36.5	0.71	1.94	0-2	A
SRP	µg/l	09-1981f	Outfall #8 Sampler Blank	06/18/09	06/19/09	<1	<1	<1	0.00	0.00	0-2	A
SRP	µg/l	09-2047f	Outfall #4	06/30/09	07/02/09	92	93	92.5	0.71	0.76	0-2	A
SRP	µg/l	09-2300f	Outfall #8	07/26/09	07/29/09	335	345	340.0	7.07	2.08	0-2	A
SRP	µg/l	09-2460f	Outfall #4	08/03/09	08/06/09	61	61	61.0	0.00	0.00	0-2	A
SRP	µg/l	09-2478f	Outfall #8	08/07/09	08/07/09	179	174	176.5	3.54	2.00	0-2	A
SRP	µg/l	09-2867f	Outfall #4	08/25/09-09/01/09	09/03/09	6	5	5.4	0.21	3.97	0-2	A
SRP	µg/l	09-3113f	Outfall #4 Stormceptor	09/11/09	09/11/09	48	49	48.5	0.71	1.46	0-2	A
SRP	µg/l	09-3123f	Outfall #4 Load 5 Field Dup	09/15/09	09/16/09	30	30	30.0	0.00	0.00	0-2	A
NOx-N	µg/l	09-1981f	Outfall #8 Sampler Blank	06/18/09	06/19/09	<5	<5	<5	0.00	0.00	0-2	A
NOx-N	µg/l	09-2047f	Outfall #4	06/30/09	07/02/09	16	16	16.0	0.00	0.00	0-2	A
NOx-N	µg/l	09-2300f	Outfall #8	07/26/09	07/29/09	1074	1117	1095.5	30.41	2.78	0-2	A
NOx-N	µg/l	09-2460f	Outfall #4	08/03/09	08/06/09	83	84	83.5	0.71	0.85	0-2	A
NOx-N	µg/l	09-2478f	Outfall #8	08/07/09	08/07/09	274	289	281.5	10.61	3.77	0-2	A
NOx-N	µg/l	09-2867f	Outfall #4	08/25/09-09/01/09	09/03/09	19	21	20.0	1.41	7.07	0-2	A
NOx-N	µg/l	09-3113f	Outfall #4 Stormceptor	09/11/09	09/11/09	5	5	5.0	0.00	0.00	0-2	A
NOx-N	µg/l	09-3123f	Outfall #4 Load 5 Field Dup	09/15/09	09/16/09	3	3	3.0	0.00	0.00	0-2	A
Ammonia	µg/l	09-2168p	Outfall #4	07/09/09	07/22/09	11	12	11.5	0.71	6.15	0-2	A
Ammonia	µg/l	09-2183p	Outfall #4	07/14/09	07/22/09	12	13	12.5	0.71	5.66	0-2	A
Ammonia	µg/l	09-2476p	Outfall #4	08/07/09	08/18/09	47	49	48.0	1.41	2.95	0-2	A
Ammonia	µg/l	09-2868	Outfall #4 Stormceptor	9/1/2009	09/23/09	692	693	692.5	0.71	0.10	0-2	A
Ammonia	µg/l	09-3119	Outfall #4 Load 2	09/15/09	09/28/09	575	524	549.5	36.06	6.56	0-2	A
Ammonia	µg/l	09-3129	Outfall #4 Load 10	09/15/09	09/28/09	366	367	366.5	0.71	0.19	0-2	A
Total N	µg/l	09-2168p	Outfall #4	07/09/09	08/12/09	457	483	470.0	18.38	3.91	0-2	A
Total N	µg/l	09-2868p	Outfall #4 Stormceptor	09/01/09	09/01/09	1640	1681	1660.5	28.99	1.75	0-2	A
Total N	µg/l	09-2966fp	Outfall #4	09/01/09	09/10/09	331	346	338.5	10.61	3.13	0-2	A
Total N	µg/l	09-3122p	Outfall #4 Load 5	09/15/09	11/04/09	1212	1200	1206.0	8.49	0.70	0-2	A
Total N	µg/l	09-3115fp	Outfall #8 Stormceptor	09/15/09	11/04/09	1926	1838	1882.0	62.23	3.31	0-2	A
Total N	µg/l	09-3125fp	Outfall #4 Load 7	09/15/09	11/04/09	517	531	524.0	9.90	1.89	0-2	A
Total P	µg/l	09-2168p	Outfall #4	07/09/09	08/12/09	54	57	55.5	2.12	3.82	0-4	A
Total P	µg/l	09-2868p	Outfall #4 Stormceptor	09/01/09	09/01/09	214	222	218.0	5.66	2.59	0-4	A
Total P	µg/l	09-2966fp	Outfall #4	09/01/09	09/10/09	56	54	55.0	1.41	2.57	0-4	A
Total P	µg/l	09-3122p	Outfall #4 Load 5	09/15/09	11/04/09	254	248	251.0	4.24	1.69	0-4	A
Total P	µg/l	09-3115fp	Outfall #8 Stormceptor	09/15/09	11/04/09	734	727	730.5	4.95	0.68	0-4	A
Total P	µg/l	09-3125fp	Outfall #4 Load 7	09/15/09	11/04/09	34	32	33.0	1.41	4.29	0-4	A