FHWA-NJ-2014-10

Stormwater System Monitoring and Evaluation

FINAL REPORT

December 2013

Submitted by

Dr. Qizhong (George) Guo, Principal Investigator
and
Mr. Jung Hoon Kim, Research Assistant

Dept. of Civil & Environmental Engineering &
Center for Advanced Infrastructure and Transportation
Rutgers, The State University of New Jersey

NJDOT Research Project Manager
Edward Stephen Kondrath

In cooperation with

New Jersey
Department of Transportation
Bureau of Research
And
U.S. Department of Transportation
Federal Highway Administration

Disclaimer Statement

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-NJ-2014-010		

4. Title and Subtitle	5. Report Date
Stormwater System Monitoring and Evaluation - Implementation	December 2013
	6. Performing Organization Code CAIT/Rutgers
7. Author(s) Guo, Qizhong (George) and Jung Hoon Kim	8. Performing Organization Report No.
9. Performing Organization Name and Address Rutgers, The State University of New Jersey Department of Civil & Environmental Engineering and Center for Advanced Infrastructure & Transportation (CAIT) 96 Frelinghuysen Road Piscataway, NJ 08854	10. Work Unit No. 11.Contract or Grant No.
12. Sponsoring Agency Name and Address New Jersey Department of Transportation CN 600 Trenton, NJ 08625 Federal Highway Administration U.S. Department of Transportation Washington, D.C. 20590	13. Type of Report and Period Covered 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

To improve the quality of highway runoff and meet the new stormwater management requirements, the New Jersey Department of Transportation (NJDOT) has installed numerous prefabricated stormwater treatment systems throughout the state produced by a range of manufacturers. The use of such systems, known as Manufactured Treatment Devices (MTDs), is expected to continue in the foreseeable future. As the responsible party for the maintenance of these MTDs, NJDOT is interested in determining optimum maintenance intervals and expected maintenance costs for the range of MTDs utilized by the Department.

Twelve stormwater manufactured treatment devices (MTDs) along New Jersey highways were selected for monitoring and analysis. The selected MTDs were cleaned out for subsequent monitoring from a clean state. The water, sediment, oil, and floatable debris pumped out from the MTDs were quantified and analyzed. Analysis of the data shows that sediment, oil, and floatable debris accumulation varies greatly from one site to another. Sediment collected by the devices showed heavy metal below allowable limits in all cases, which indicates the sediment does not need to be treated as hazardous waste and does not need special handling. Combining the sediment depth measurements before and after the cleanout yielded a recommended maintenance interval of about four years, but with a shorter maintenance interval of one and half years where severe land surface erosion problems were observed. Types of information necessary for properly inspecting and maintaining stormwater manufactured treatment devices (MTDs) were also identified through this field monitoring and evaluation project.

17. Key Words	18. Distribution Statement
Stormwater, Maintenance, Stormwater and Roadways	

19. Security Classif (of this report)	20. Security Classif. (of this page)	21. No of Pages	22. Price
Unclassified	Unclassified	205	

Form DOT F 1700.7 (8-69)

ACKNOWLEDGEMENTS

The authors wish to thank various NJDOT staff members who had supported this project, particularly Edward S. Kondrath for project management; David Ahdout, David Rauzino, Ryan Reali, Anthony Gould, and Rafael Gonzalez for technical meetings and inputs; Jay Walsh for field supervision; and Pam Szargowiz for database search. We would also like to thank Joseph Skupien for maintenance consultation; Victoria Fernandez-Martinez, Yunjie Li, Arjun Raju, and Ellen Speace for information gathering and field assistance; Joseph Yamin and Carlos Correa for report assistance; and QC Laboratories for analytical work. Moreover, we would like to thank CAIT staff members for their office and accounting support.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

In the last several years, to improve the quality of highway runoff and meet the new stormwater management requirements, the New Jersey Department of Transportation (NJDOT) has installed numerous prefabricated stormwater treatment systems, known as Manufactured Treatment Devices (MTDs), throughout the state. This project is initiated by the NJDOT with the goal of determining optimum maintenance intervals and expected maintenance costs for these MTDs. The project has resulted in long-term water quality performance evaluation, characterization of trapped contaminants, and the development of maintenance procedures and intervals.

To achieve this purpose, twelve (12) MTDs were selected and studied over a 2-year period. The units were frequently monitored and evaluated focusing on the amount of suspended solids, gross solids, and other contaminants that are trapped continuously across a full spectrum of storms. Thus, this report describes the amount of contaminants actually trapped in the device and a variety of highway drainage area characteristics such as size, slope, soil type, traffic volume, and location. As a result of this monitoring and evaluation, it provides immediate benefits to NJDOT in both maintenance guidance and demonstration of environmental improvements.

From these results, about 4 years are recommended for maintenance interval in a general site. This estimation is based on monitoring depth measurement and the maximum sediment depth of two feet. If the site has severe erosion, one and a half years is recommended for the interval. The results also yield important information about maintenance procedures, maintenance reduction measures, and design/construction for maintenance.

INTRODUCTION

Background

The MTDs most commonly used by NJDOT are the Vortechs^{TM} Stormwater Treatment System and the In-Line Stormceptor Systems (as of 2008). These are hydrodynamic separators designed to enhance gravitational separation of floating and settled materials for stormwater flows. A description follows of these two devices as a general background on how these MTDs work. Stormwater flows enter the Vortechs unit (Figure 1) tangentially to the grit chamber, which promotes a gentle swirling motion. As polluted water circles within the grit chamber, pollutants migrate toward the center of the unit where velocities are the lowest. The majority of settleable solids are left behind as the stormwater exits the grit chamber through two apertures on the perimeter of the chamber. Next, buoyant debris and oil and grease are separated from water flowing under the baffle wall due to their relatively low specific gravity. As stormwater exits the "System" through the flow control wall and ultimately through the outlet pipe, a percentage of both the floating and settleable pollutants in the inflow have been removed.

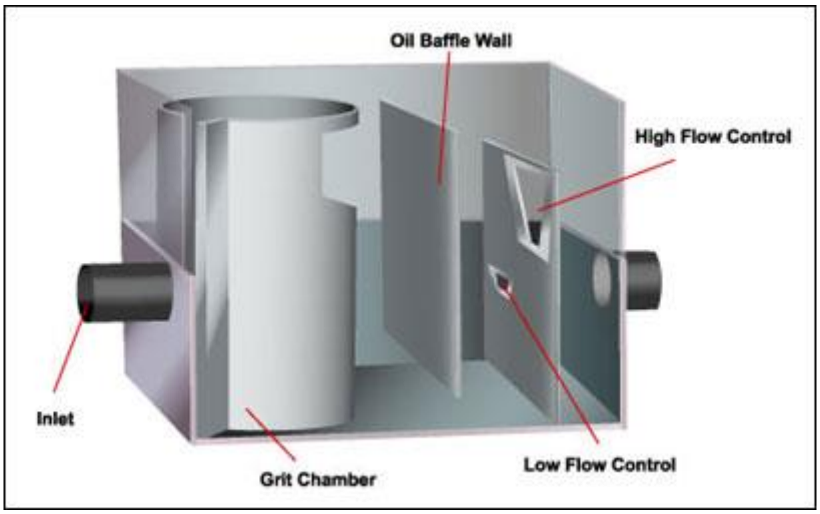


Figure 1. Vortechs stormwater treatment system (Source: http://www.vortechnics.com/**)**

Over time, in the Vortechs units, a conical pile tends to accumulate in the center of the grit chamber containing sediment and associated metals, nutrients, hydrocarbons and other pollutants. Floating debris and oil and grease form a floating layer trapped in front of the baffle wall. Accumulation of these pollutants can be assessed through manholes over each chamber. Maintenance is typically performed through the manhole over the grit chamber.

The units are shown to be able to remove 80% of the annual load of suspended solids, based on laboratory generated performance curves for 50-micron sediments particles. However, the solids removal performances of these manufactured stormwater treatment devices vary widely with operating conditions, evaluation (lab or field) techniques, as well as runoff characteristics such as particle size (Guo 2005). Therefore, removal efficiency for total suspended solids (TSS) was certified by the New Jersey Department of Environmental Protection (NJDEP) to be only 50% for a specific design flow rate. Typical horizontal dimension (length x width) of the unit ranges from 9 ft x 3 ft to 18 ft x 12 ft. A typical height of the unit is about 10 ft. The unit is usually pre-fabricated off site. The acquisition and installation cost of an individual unit is typically less than one hundred thousand dollars.

The In-Line Stormceptor has been proven in laboratory and field tests to remove over 80% of Total Suspended Solids, and 95% of free oils and hydrocarbon spills. As noted above, flow rate will however affect its performance (Guo 2005). Therefore, TSS removal efficiency was certified by NJDEP to be only 50% for a specific design flow rate. The In-Line Stormceptor can be inspected and maintained from the surface, without entry into the unit. Maintenance should be performed once the stored volume reaches 15% of the Stormceptor capacity, or immediately in the event of a spill. Maintenance intervals vary depending on the application. Quarterly inspections during the first year of installation are recommended so the maintenance schedule can be accurately established.

While the manufactured devices mentioned above are two of the more common devices used within the state of New Jersey, there are other manufacturers with similar devices. All of the MTDs that have received the interim certification from the NJDEP for a specific TSS removal efficiency (as of 2008) are listed below:

Type I, Hydrodynamic separation:

Vortechs® (distributed by Contech Stormwater Solutions): 50%
Stormceptor® (by Rinker materials): 50%
CDS (by CDS Technologies, Inc.): 50%
BaySaver® (by BaySaver Technologies, Inc.): 50%
Downstream Defender® (by Hydro International): 50%
Aqua-Swirl™ by AquaShield, Inc.: 50%
VortSentry® (by Contech Stormwater Solutions): 50%

Type II, Filtration:

StormFilter® (by Contech Stormwater Solutions: 80% (standalone)
VortFilter® (by Contech Stormwater Solutions): 80%
AquaFilter™ (by AquaShield, Inc.): 80%

(Source: http://www.state.nj.us/dep/dsr/bscit/CertifiedMain.htm)

This project is not to verify/certify or promote any particular device, and thus the monitoring/testing protocol does not follow the influent/effluent monitoring-oriented Technology Reciprocity Partnership (TARP) protocols used in certification processes, instead this project is entirely maintenance driven.

From the system maintenance/cleaning point of view, it is more important to know what amounts of solids, oil, grease, and buoyant debris are actually trapped in the unit across a full spectrum of storm events continuously over a long period of time, and for a variety of highway drainage area characteristics such as size, slope, soil type, traffic volume, and location. Knowing the amount of contaminants actually trapped in the unit continuously over a long period of time would also provide a more reliable assessment of water quality performance of the unit. However, actual field data of this type is lacking at NJDOT and federal and state highway agencies. For this study, the Bureau of Stormwater and Stream Encroachment is "interested in determining the optional scheduling of maintenance and cleanup of stormwater devices to result in the best performance of the units and the environmental improvements." Thus, a monitoring and evaluation program was proposed to fill the data gap and to provide immediate benefits to NJDOT in both scheduling of maintenance and demonstration of environmental improvements.

Stormwater differs from wastewater by being intermittent in nature and often having high volumes of gross solids. A recent field study indicates that an overwhelming majority of solids trapped in the MTD (90% in mass) was gross solids (larger than 75 microns) rather than fine solids (or suspended solids). An accurate quantification and characterization of gross pollutants is needed in determining maintenance requirements and schedules. Also, most gross pollutants cannot be measured by using autosamplers and standard techniques typically used to evaluate the TSS removal efficiencies. For gross solids we are using the definition used by the American Society of Civil Engineers (ASCE) Gross Solids Technical Committee (Rushton and England 2006); namely, broken into three categories:

- **Litter** includes human derived trash, such as paper, plastic, Styrofoam, metal, and glass.
- **Debris** consists of organic material including leaves, branches, seeds, twigs, and grass clippings.
- **Coarse Sediments** are inorganic breakdown products from soils, pavement, or building material.

A monitoring program can range from basic and relatively inexpensive to extremely complex and expensive. We are proposing utilizing a modified Level 2 program as defined by the ASCE Gross Solids Technical Committee (Rushton; and England 2006). This includes separating gross solids into different categories in order to identify their sources.

Objectives

The objectives of the proposed project are:

- Monitor the amounts of sediment, oil, grease, and buoyant debris that would be actually trapped in the stormwater treatment system units installed by NJDOT.

- Relate the trapped amounts of sediment, oil, grease, and buoyant debris to highway drainage area characteristics.
- Provide NJDOT with quantitative guidance on the maintenance/cleanup schedule and measures to reduce maintenance/cleanup frequency.

LITERATURE REVIEW

An extensive literature search and review covering the sources of library, technical reports, journal articles, and web-based references on stormwater BMPs monitoring and maintenance processes were conducted. This literature search and review mainly concentrated on the following aspects: (1) stormwater BMPs maintenance rules/regulations; (2) highway runoff quality and quantity; (3) maintenance procedures, schedules, and costs; and (4) field monitoring methods and field performance.

To ensure the stormwater management systems are operating effectively, all stormwater BMPs must be maintained regularly and completely. The general maintenance requirements and guidelines for stormwater management measures can be found in the New Jersey Stormwater Best Management Practices Manual or the manuals from other states. For a major watershed development, the design engineer has the responsibility to design a maintenance plan for stormwater management measures. The maintenance plan should specify the specific preventative maintenance tasks; schedules; cost estimates (including the estimated cost of sediment, debris, or trash removal); and the name, address, and telephone number of the person or persons responsible for the required maintenance.

Though the specific maintenance requirements, such as maintenance schedules, procedures, inspection methods, etc., have been recommended by each individual manufacturer for their products to operate effectively, there is little observed or reported field data about the maintenance schedules, procedures, and maintenance costs for manufactured treatment devices. There are no general maintenance guidelines that can be followed for the same family of stormwater treatment devices. This is because the maintenance frequency and requirements depend upon the local pollutant load characteristics and weather conditions of each site. Therefore, the practical maintenance plan and cost estimation must be made in terms of the field data obtained from several selected representative site conditions. Then based on the monitored field data analysis, the reasonable maintenance plans can be recommended for each treatment device in terms of the site conditions.

General Requirements on Stormwater BMPs Maintenance

All stormwater BMPs are required to be maintained periodically. Regular and thorough maintenance is a basic requirement to ensure the stormwater management measures to perform effectively and reliably. Regular inspection and cleaning, sediment and debris removal, and periodic replacement of components for a BMP are necessary so that the effective operation and use life can be maintained. It is the designer's responsibility to design an effective stormwater BMP that can be easily maintained. Experience tells us that failure to do so may lead to diminished or failed performance and cause a series of health and safety problems such as mosquito breeding, vermin, and potential for drowning. As the owner of property or homeowners' association, you may be responsible for the maintenance of these stormwater management measures. But how do we effectively maintain a stormwater BMP? What are the optimal maintenance plans and schedules for the minimum cost requirements? The following sections provide a brief review of maintenance requirements searched from the published references and website.

NJDEP Stormwater Management Rule: N.J.A.C.7.8

Maintenance Requirements:

The general maintenance requirements for stormwater management measures can be found in NJDEP Stormwater management Rule:*N.J.A.C.7:8-5.*8. These requirements are reproduced as follows:

"The design engineer should prepare a maintenance plan for the stormwater management measures incorporated into the design of a major development.
The maintenance plan shall contain specific preventative maintenance tasks and schedules; cost estimates, including estimated cost of sediment, debris, or trash removal; and the name, address, and telephone number of the person or persons responsible for preventative and corrective maintenance (including replacement).
Maintenance guidelines for stormwater management measures are available in the New Jersey Stormwater Best Management Practice Manual (NJDEP Division of Watershed Management). If the maintenance plan identifies a person other than the developer(for example, a public agency or homeowners' association) as having the responsibility for maintenance, the plan shall include documentation of such person's agreement to assume this responsibility, or of the developer's obligation to dedicate a stormwater management facility to such person under an applicable ordinance or regulation.
Responsibility for maintenance shall not be assigned or transferred to the owner or tenant of an individual property in a residential development or project, unless such owner or tenant owns or leases the entire residential development or project.
If the person responsible for maintenance identified under (b) above is not a public agency, the maintenance plan and any future revision based on (h) below shall be recorded upon the deed of record for each property on which the maintenance described in the maintenance plan must be undertaken.
Preventative and corrective maintenance shall be performed to maintain the function of the stormwater management measure, including repairs or replacement to the structure; removal of sediment, debris, or trash; restoration of eroded areas; snow and ice removal; fence repair or replacement; restoration of vegetation; and repair or replacement of nonvegetated linings.
The person responsible for maintenance identified under (b) above shall maintain a detailed log of all preventative and corrective maintenance for the structural stormwater

management measures incorporated into the design of the development, including a record of all inspections and copies of all maintenance-related work orders.
The person responsible for maintenance identified under (b) above shall evaluate the effectiveness of the maintenance plan at least once per year and adjust the plan and the deed as needed.
The person responsible for maintenance identified under (b) above shall retain and make available, upon request by any public entity with administrative, health, environmental or safety authority over the site, the maintenance plan and the documentation required by (f) and (g) above.
Nothing in this section shall preclude the municipality in which the major development is located from requiring the posting of a performance or maintenance guarantee in accordance with N.J.S.A. 40:55D-53."

NJDEP Best Management Practices Manual (BMP)

Maintenance Plan Contents:

The NJDEP BMPs Manual presents some general and specific information and requirements about preparing a maintenance plan for stormwater management facilities in Chapters 8 and 9. According to the NJDEP stormwater management rules, all maintenance plans must include the specific maintenance tasks, schedules, cost estimates, and the name, address, and telephone number of the person or persons responsible for the measures' maintenance.
In *Chapter 8: Maintenance and Retrofit of Stormwater Management Measures,* the general guidelines for the development of maintenance plans are presented. The specific maintenance guidance for structural stormwater BMPs are discussed in *Chapter 9: Structural Stormwater Management Measures*. All maintenance plans for stormwater BMPs must contain:

"The name, address, and telephone number of the person or persons responsible for the preventative and corrective maintenance of stormwater management measure"
"Specific preventative and corrective maintenance tasks such as removal of sediment, trash, and debris; mowing, pruning, and restoration of vegetation; restoration of eroded areas; elimination of mosquito breeding habitats; control of aquatic vegetation; and repair or replacement of damaged or deteriorated components."
"A schedule of regular inspections and tasks."
"Cost estimates of maintenance tasks, including sediment, trash, and debris removal."
"Detailed logs of all preventative and corrective maintenance performed at the stormwater management measure, including all maintenance-related work orders."

Further, the NJDEP Stormwater Management Facility Maintenance Manual requires that the maintenance plan should also include the following items:

"Maintenance equipment, tools, and supplies necessary to perform the various preventative and corrective maintenance tasks specified in the plan."

“Recommended corrective responses to various emergency conditions that may be encountered at the stormwater management measure.”
“Maintenance, repair, and replacement instructions for specialized, propriety, and nonstandard measure components, including manufacturers’ product instructions and user manuals.”
“Procedures and equipment required to protect the safety of inspection and maintenance personnel.”
“Approved disposal and recycling sites and procedures for sediment, trash, debris, and other material removed from the measure during maintenance operations.”
“Origins or copies of manufactures’ warranties on pertinent measure components.”
“As-built construction plans of the stormwater management measure and copies of pertinent construction documents such as laboratory test results, permits, and completion certificates.”

Maintenance Plan Considerations:

The considerations for maintenance plan should include the following aspects:

Access: Trees, shrubs, and underbrush must be trimmed to maintain access to the BMP for inspection and maintenance.

Training of Maintenance Personnel: Maintenance personnel should be trained with the purpose and function of the whole stormwater management measures and its major components as well as the use of all required safety equipment and procedures.

Aesthetics: The effects of the aesthetics of BMPs on the surrounding community should be considered in the design and selection of the BMPs.

Required Maintenance Plan Procedures:

According to the NJDEP Stormwater Management Rules, the following maintenance procedures should be followed:

(a) “Copies of the maintenance plan must be provided to the owner and operator of the stormwater management measure.”
(b) “The title and date of the maintenance plan and the name, address, and telephone number of the person with stormwater management measure maintenance responsibility as specified in the plan must be recorded on the deed of the property on which the measure is located.”
(c) “The person with maintenance responsibility must evaluate the maintenance plan for effectiveness at least annually and revise as necessary.”
(d) “A detailed, written log of all preventative and corrective maintenance performed at the stormwater management measure *must* be kept, including a record of all inspections and copies of maintenance-related work orders.”
(e) “The person with maintenance responsibility must retain and, upon request, make available the maintenance plan and associated logs and other records

for review by a public entity with administrative, *health, environmental, or safety authority over the site."*

Maintenance Requirements for Manufactured Treatment Devices

Furthermore, the NJDEP Stormwater Management Rules specify that all individual structural stormwater management measure must have a specific maintenance plan for those, who are responsible for its operation and maintenance, to follow. Specific maintenance requirements for the manufactured treatment devices are presented in *chapter 9.6: Standard for Manufactured Treatment Devices (MTD).* These requirements must be considered in the MTD's maintenance plan. They are reproduced as follows:

General Maintenance
This section requires that all MTDs should be inspected and maintained in terms of the manufacturer's instructions, and other requirements associated with the device's certification by the NJDEP Office of Innovative Technology.

Vegetation
For devices using vegetation, trimming of vegetation should be carried out with a regular schedule. Vegetated areas should be inspected for erosion and scour as well as unwanted growth at least annually.

Structural Components
"All structural components must be inspected for cracking, subsidence, spalling, erosion, and deterioration at least annually."

Other Maintenance Criteria
Further, the maintenance plan should specify the maximum allowed accumulation level of sediment, and debris, etc. before removal is needed. At the same time, these levels should be monitored during the regular device inspection to help determine the need for removal and other device maintenance.

Ocean County Demonstration Study Stormwater Management Facilities Maintenance Manual (NJDEP)

This manual describes the long term maintenance of stormwater management facilities (SWMFs). There exist insufficient maintenance procedures at SWMFs all over the state, which over the years has resulted in poor water quality, disastrous flood control measures and an increased threat to public health and safety. Keeping this in mind, in 1984, Ocean County was selected by the NJDEP to participate in the demonstration project on the long term maintenance of SWMFs.

The primary purpose of the Demonstration Project was to address the increasing problem of the lack of maintenance procedures undertaken for SWMFs. It was also deemed necessary to develop a stormwater management facility maintenance manual which would respond to maintenance problems by addressing six areas relative to the overall management of SWMFs namely: Ownership and Maintenance Responsibility, Planning and Design Guidelines, Construction Inspection, Maintenance-Equipment and Procedures, Regulatory Aspects, and Cost Data and Financing Techniques.

The manual is intended for use as a reference guide in the design and enforcement of minimum maintenance at SWMFs. It is designed to be applicable to the entire State, which includes a variety of geologic conditions. Therefore, the recommended guidelines in the manual should be evaluated for their applicability to specific site conditions before being utilized. The recommendations regarding the design and construction of SWMFs can be applied to the management needs of both existing and new facilities.

Comprehensive SWMF Maintenance

As part of the maintenance procedures, a comprehensive SWMF inspection program should be initiated. Such a program should not only evaluate the various maintenance needs at SWMFs but also determine the quality and effectiveness of the maintenance being performed. The type and size of facility should be used to determine the extent and frequency of inspections. However, in general, a formal facility inspection should be performed on a regular basis every six months as well as after a major storm event. It is recommended that an informal inspection should be conducted during every visit to a SWMF by maintenance personnel and, if possible, prior to the predicted occurrence of a major storm.

The key requirements of a successful SWMF maintenance program include:

- Adequate funding, staffing, equipment, and materials.
- Performance of routine and emergency maintenance procedures.
- Performance of SWMF inspections.
- Training of maintenance and inspection personnel.
- Periodic program reviews and evaluations.
- Pride of workmanship and a commitment to excellence.

Maintenance Guidelines from Individual Manufacturers and Other Sources

As of 2008, in the State of New Jersey there are 12 manufactured treatment devices that have received the interim certification from NJDEP for a specific TSS removal efficiency. Seven of these technologies that belong to the family of hydrodynamic separators have been certified for a 50% TSS removal. The ones most commonly used by NJDOT are:

Vortechs®
Stormceptor®

The guidelines for maintenance schedules, procedures, and estimated costs from the individual manufacturers are described as follows:

Vortechs Stormwater Treatment System

Maintenance Schedule:
The system recommends seasonal inspections during the first year of operation to establish an appropriate maintenance schedule. After that, it is typically cleaned once per year depending on the site and weather conditions. It is recommended that the maintenance schedule and cleanout for New England installations should be performed just before the winter sanding / salting season.

Inspection and Maintenance Methods / Procedures:
A stadia rod should be used to inspect the sediment level in the grit chamber. Two measurements should be taken: one from the manhole cover to the top of the sediment, and another from the manhole cover to the surface of water. When the depth of sediment has been accumulated to within 6 inches of the dry-weather water level, the cleanout should be performed. A vacuum truck is used to remove the sediments and the floatables by inserting a vacuum hose into the grit chamber

Costs:
The cost of the Vortechs^{TM} system ranges from approximately $8,900 for the model 1000 to $40,000 for the model 16000. The annual maintenance cost is about $2,400. A typical Vortechnics system model 7000 is shown in Figure 2.

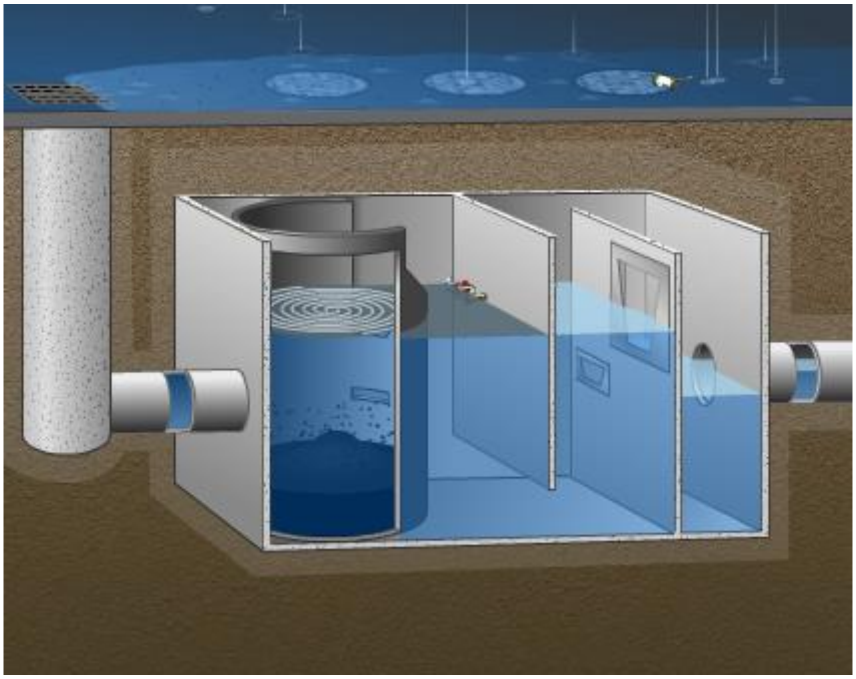


Figure 2. Vortechs system model 7000
(Source: http://www.contech-cpi.com/stormwater/13**)**

Stormceptor®

Maintenance Schedule:
It is recommended that an annual maintenance schedule should be followed. However, the required maintenance frequency will vary with the amount of site pollutant loading and weather conditions (number of hydrocarbon spills, amount of sediments, etc). It proposes that the frequency of maintenance should be increased or reduced depending on the local conditions. If an oil spill occurs or the sediment depth in the Stormceptor reaches the value specified in Table 1, the maintenance should be performed immediately.

Table 1. Sediment Depths Indicating Required Maintenance (Source: Stormceptor®: Owner's Manual, 2000)

Model (Metric)	Model (US)	Sediment Depth Mm (in.)
300	450	200 (8)
750	900	200 (8)
1000	1200	250 (10)
1500	1800	375 (15)
2000	2400	300 (12)
3000	3600	425 (17)

4000	4800	375 (15)
5000	6000	450 (18)
6000	7200	375 (15)

Inspection and Maintenance Methods / Procedures:
A dipstick can be used to measure the levels of the oil and the sediment. The cleanout of Stormceptor is performed using a vacuum tank. No entry into the units is required for maintenance of the spool insert, inlet insert and the disc. The Owner's Manual (2000) emphasizes: "Do not enter the unit unless you have the proper equipment, have been trained and are qualified to enter a confined space, as identified by local Occupational Safety and Health Regulations". To clean out the Stormceptor, the following procedures are recommended by the manufacturer:

Check for oil (using a dipstick tube)
Remove any oil separately using a small portable pump
Decant the water from the unit to the sanitary sewer using a portable pump (prior approval is required from the sewer authority/municipality)
Remove the sludge from the bottom of the unit using a vacuum truck
Re-fill the Stormceptor with water where required by local jurisdiction

Costs:
The range of the Stormceptor® unit cost is between $7600 for STC 900 units and $33,560 for STC 7200 units. Typical estimated cleanout costs are about $250, with disposal costs averaging from $300 to $500. (NHDES & NHEP, 2003).

Broadway Outfall Stormwater Retrofit Project

The retrofit project from the Stormwater/Nonpoint Source Management Section of the Florida Department of Environmental Protection (FDEP) includes a CDS stormwater treatment unit and pond constructed immediately downstream from the unit.

The project consists of two phases:
Phase I – Installation of the CDS unit and construction of the pond.
Phase II - Evaluation

The evaluation included:
1) How much and what kind of gross solids (>75microns) were collected by the CDS unit.
2) The concentration of constituents in the flow stream for the suspended and dissolved particle (<75microns).
3) The accumulation of pollutants in the sediments of the pond.
4) The characterization of the macroinvertebrates in the sediments of the pond.
5) The hydrology of the system including storm flow, base flow and rain fall."

According to the report, the CDS unit has a capacity to remove sediment and large sized particles such as litter, leaves, twigs, sand and paving residue form storm runoff. The report suggested that the unit removes gross solids very well, but it did not remove the dissolved and suspended particles.
Also, it was noticed from the water quality data collected that the flow through the CDS unit did not support the idea that the leaves collected by the unit leached nutrients and increased concentrations in the water downstream. However the reports noted that the result might be influenced because leaching had already occurred while the leaves and water traveled through the storm drain together.

Conclusion
Throughout the report, the purpose of removing gross solids from the monitored CDS unit has been found to be quite effective, but it is undersized and less successful in removing the dissolved and suspended constituents. The CDS unit was also able to eliminate toxic levels of PAHs. The CDS unit effectively removed polluted material that would have caused long-term detrimental effects by re-suspension of bottom sediments, leaching out of sequestered pollutants, smothering of benthic habitat and other problems associated with sediment transport.

Concluding Remarks
Maintenance is a continuing responsibility for local governments and should be highly prioritized. The units need to be visited at least once a month to determine if the screens are clogged, to make certain the unit is working properly and to skim off the collected floatables.

Inspection and Maintenance Guidance for Manufactured BMPs (ASCE)

ASCE/EWRI has assembled a Task Committee on guidelines for certification of manufactured stormwater BMPs. A nine-member subcommittee for maintenance was tasked by the larger committee to develop maintenance guidelines for manufactured stormwater BMPs.
According to the report, the subcommittee has developed recommendations for manufactured BMP maintenance in the following seven areas:

(1) Designing for maintenance.
(2) Defining standard maintenance triggers.
(3) Defining maintenance fundamentals for all manufactured BMPs.
(4) Defining maintenance tasks by BMP design; hydrodynamic or filter design.
(5) Identifying entities best able to maintain manufactured BMPs, and training requirements.
(6) Identifying entities to train maintenance providers
(7) Reviewing recommended disposal techniques for captured pollutants.

Maintenance Trigger
When the BMP is handed over to the property owner/ manager, the BMP must be essentially clean. It is the responsibility of the installer or contractor to leave the BMP in

a clean state. After a clean BMP has been accepted by the maintenance authority, inspections should be made quarterly for one year to determine the appropriate cleanout intervals.

Cleanout operations should be triggered by any one of or combination of the following circumstances:

- A regularly scheduled cleanout interval pre-determined by the manufacturer.
- Sediment accumulations reach the depth recommended by the manufacturer for cleaning. The appropriate depth of sediment determination should be facilitated by a mark or object placed in the BMP. This indication should be readily visible under low light conditions.
- In filter devices, the water drawdown time exceeds the drawdown time recommended by the manufacturer. An easily readable plaque should be placed inside the BMP indicating the recommended drawdown time.

It is possible that providing an upstream pretreatment of gross solids can reduce the time intervals and expense of BMP cleaning. However removal of pollutants by a pre-treatment device only shifts the burden of maintenance to a device further upstream. There is no conclusive evidence that the total expense of maintaining a system of BMPs is reduced if pre-treatment is used.

Disposal of Wastes

Since a drainage basin is privy to pollutant loadings from a wide array of sources, there exists a potential for high concentrations of various pollutants within the BMPs. Therefore the reports recommended that all materials removed from a BMP should be disposed of in a properly permitted landfill in accordance with applicable local or state guidelines. The committee did not come to consensus as to whether the prospective waste material should be tested for pollutant concentrations.

TECHNICAL PANEL

The NJDOT assembled a technical panel composed of representatives from various NJDOT units and other agencies such as the New Jersey Department of Environmental Protection.

The New Jersey Department of Transportation had the responsibility of identifying and inviting these representatives to participate during the project development and review. A presentation was made to the panel to outline the project work plan. Comments from the panel were recorded. NJDOT had the opportunity to modify the work plan based on the outcomes of the presentation. The work plan changed very little and everyone realized the difficulty of this project because no issue was clear cut. In particular, the issue of “hardship waivers” was not taken lightly and every effort was made to eliminate the need to request hardship waivers in the electronic decision making process.

SELECTION OF DEVICES FOR MONITORING

In The State of New Jersey, fifty (50) Vortechs devices were located at twenty three (23) different NJDOT project sites. Other devices found included four Downstream Defender devices at one site and eleven Stormceptor STC models at four different sites (Figure 3).

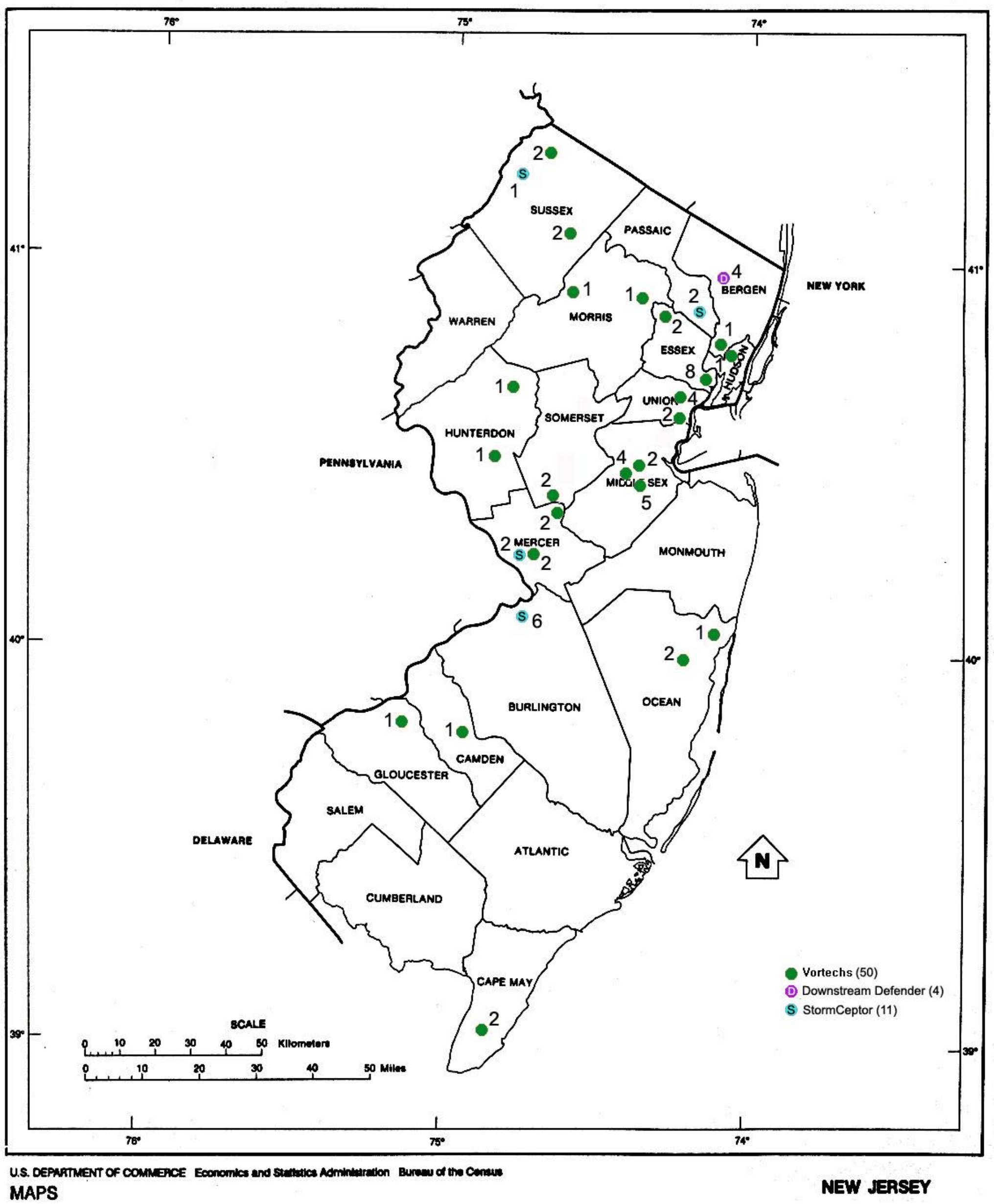


Figure 3. Locations of devices at NJDOT project sites.

For this study, Twelve Vortechs installed at 8 NJDOT project sites were selected to be included in total for the high, medium and low maintenance regions. In general, the same type of devices is selected in each region for consistency in comparison. Based on our understanding of various hydrodynamic separators, the maintenance interval is expected to be primarily related to the site characteristics (a combination of natural and anthropogenic influences) rather than variation among the treatment devices.

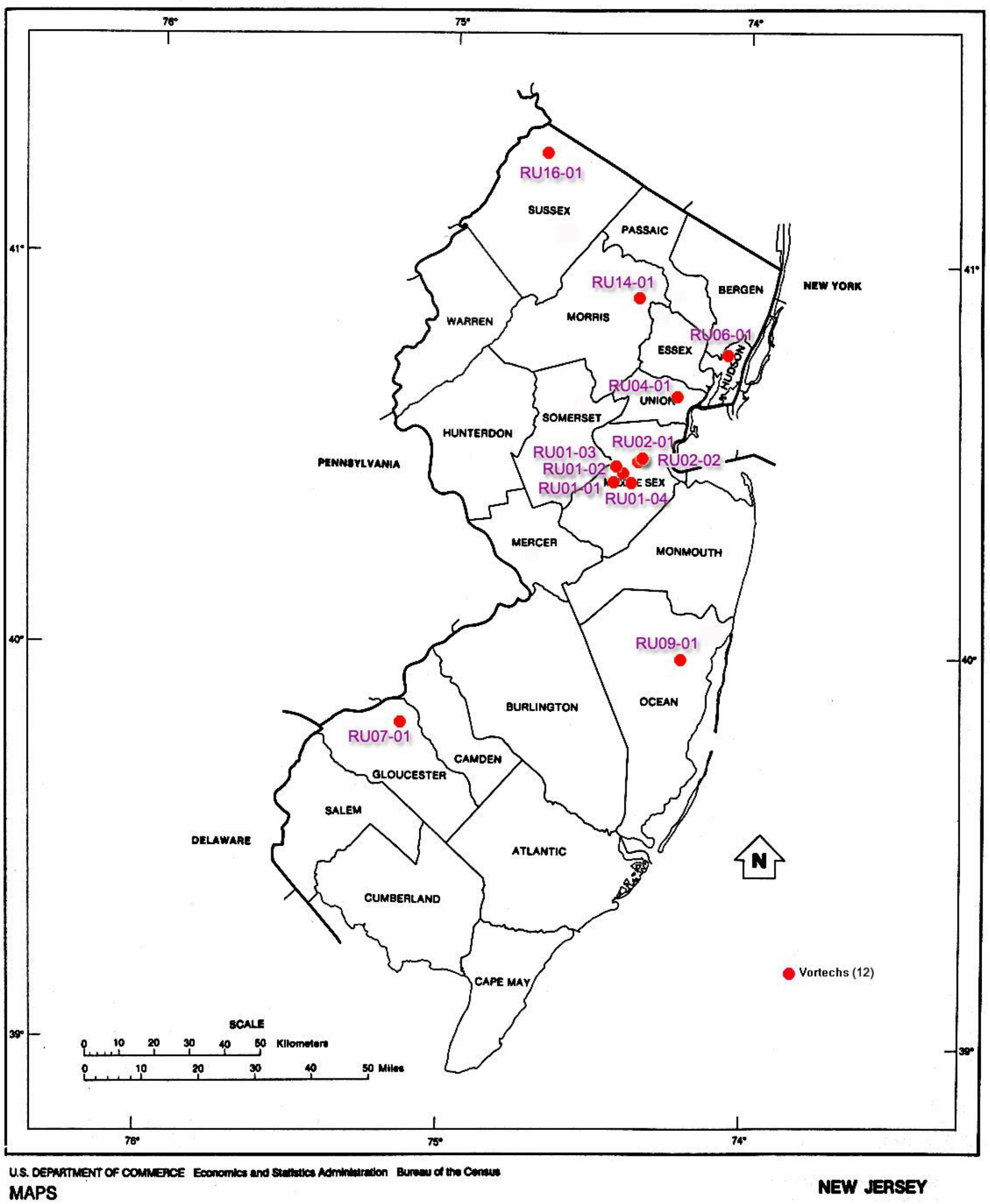


Figure 4. Locations of 12 Vortechs installed at 8 NJDOT project sites that were selected for extensive monitoring

Table 2. Twelve (12) Vortechs Selected for Extensive Monitoring

Site ID	Municipality	County	Location
RU01-01	Piscataway	Middlesex	Rt. 18 Extension along Landing Lane
RU01-02	Piscataway	Middlesex	Rt. 18 Extension along River Road
RU01-03	Piscataway	Middlesex	Rt. 18 Extension along Campus Road
RU01-04	Piscataway	Middlesex	Rt. 18 Extension along River Road
RU02-01	Edison	Middlesex	Evergreen Road and State Highway 27
RU02-02	Edison	Middlesex	Evergreen Road and State Highway 27
RU04-02	Elizabeth	Union	Pearl Street & Grove Street
RU06-01	North Bergen	Hudson	36th Street
RU07-01	Deptford	Gloucester	Rt. 47 near Cattle Road
RU09-01	Lakewood	Ocean	Rt. 9 near Lake Carasaljo
RU14-01	Parsippany	Morris	Rt. 46 & New Road
RU16-01	Frankford	Sussex	Rt.15 & US 206

INSPECTION OF DEVICES

Inspection Forms and Data

Rutgers ID: **RU 01-01** Date 2007-04-06 Time 14:20

Device	Model	Municipality	County	Location
Vortechs	16000	Piscataway	Middlesex	Rte 18 Extension
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
043960223	2003-10-31	40°30.683'	74°27.729'	41ft

Climate Cloudy Wind Sp/Dir 4 mph/NNW Air Temp 75°

Traffic 9 Cars/min one way on Landing lane

☐ Heavy ■ Medium ☐ Low

Gross Solids

Type	■ Litter			■ Debris			■ Coarse Sediments		
Amount	☐ L	☐ M	■ S	■ L	☐ M	☐ S	☐ L	☐ M	■ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ■ Residential ☐ Mixed ☐ Open / Non urban

Design Info

Drainage Area ______ Treatment Flow 10.08 Maximum Flow 25.2

(2007-06-13 visit)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	5.4 ft	1 (center)	2 (in between)	3 (side)	8.15
		8.1	8.1	8.1	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)		
	5.1 ft*	5.1 ft*	5.1 ft*	N/A*	8.1*

* (2007-07-19 visit)

Remarks:
Each manhole cover is fixed with 4 bolts.
The Vortechs is located along the side of Landing lane.
0.05 ft sediment accumulation in the grit chamber.
Water in grit chamber was clear. The bottom was visible.


18
Campus Rd
Fitch Rd
Scarlet Knight Way
Campus Rd
Sutphen Rd
18
Logan Ln
Hillcrest Dr
Wakefield Ln
Ross Hall Blvd N
622
River Rd
Violet Dr
622
River Rd
Johnson Dr
Johnson Dr
Tulip Dr
Johnson Dr
609
George St

RU01-01 (2008-02-01)

<table>
<tr><td rowspan="3">Grit Chamber</td><td colspan="2">Water S. Reading</td><td colspan="4">Sediment Surface Reading</td><td>Bot Reading</td></tr>
<tr><td colspan="2" rowspan="2">5.1</td><td>1 (center)</td><td colspan="2">2 (in between)</td><td>3 (side)</td><td rowspan="2">8.15</td></tr>
<tr><td>8.1</td><td colspan="2">8.15</td><td>8.15</td></tr>
<tr><td rowspan="3">Float. Chamber</td><td colspan="4">Floatables Top Surface Reading</td><td colspan="2">Fl. Bott. Su. R</td><td>Bot Reading</td></tr>
<tr><td>1 (center)</td><td colspan="2">2 (in between)</td><td>3 (side)</td><td colspan="2" rowspan="2">N/A</td><td rowspan="2">8.1</td></tr>
<tr><td>5.0</td><td colspan="2">5.0</td><td>5.0</td></tr>
</table>

Rutgers ID: **RU 01-02** Date 2007-04-06 Time 14:20

Device	Model	Municipality	County	Location
Vortechs	7000	Piscataway	Middlesex	Rte 18 Extension
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
043960223	2003-10-31	40°30.733’	74°27.457’	26ft

Climate Cloudy Wind Sp/Dir 4 mph/NNW Air Temp 75°

Traffic 16 Cars/min one way on River Road

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type	■ Litter			■ Debris			■ Coarse Sediments		
Amount	■ L	☐ M	☐ S	☐ L	■ M	☐ S	☐ L	☐ M	■ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ■ Residential ☐ Mixed ☐ Open / Non urban

Design Info

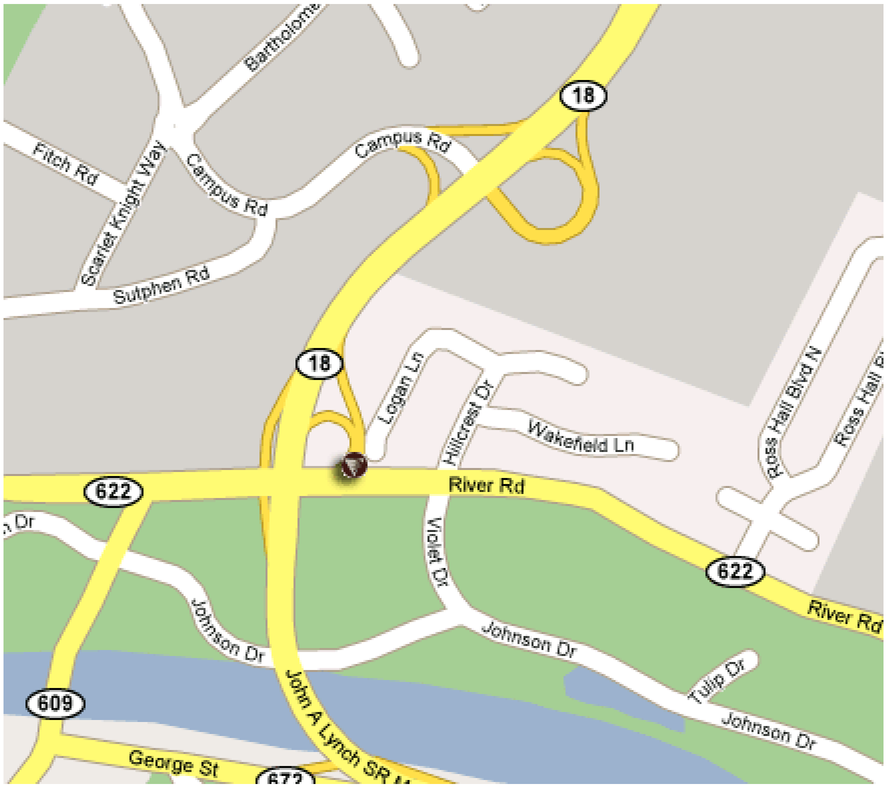
Drainage Area ______ Treatment Flow 4.48 Maximum Flow 11.2

(2007-06-13 visit)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	6.2	1 (center)	2 (in between)	3 (side)	8.9
		8.1	8.1	8.1	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	6.45	9.0 / 9.1
	6.3	6.35	6.35		

Remarks:
The Vortechs is located along the side of River road.
0.7 ft sediment accumulation in the grit chamber (8.9-8.1=0.7)
Water surface of the floatables chamber was mostly covered by floating litter and debris.
One layer of floatables only and thickness difficult to measure.
Sediment was found in the center of the floatables chamber.


18
Campus Rd
Fitch Rd
Scarlet Knight Way
Campus Rd
Sutphen Rd
18
Logan Ln
Hillcrest Dr
Wakefield Ln
Ross Hall Blvd N
622
River Rd
Violet Dr
Johnson Dr
Johnson Dr
622
River Rd
Tulip Dr
Johnson Dr
609
George St
John A Lynch SR

RU01-02 (2008-02-01)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	6.3	1 (center)	2 (in between)	3 (side)	8.9
		8.1	8.1	8.1	
Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	9.1
	6.3	6.35	6.35		

Rutgers ID: **RU 01-03** Date 2007-04-11 Time 11:00

Device	Model	Municipality	County	Location
Vortechs	7000	Piscataway	Middlesex	Rte 18 Extension
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
043960223	2003-10-31	40°30.983’	74°27.520’	82ft

Climate Partly Cloudy Wind Sp/Dir 3 mph/NNW Air Temp 77°

Traffic 8 Cars/min one way on Campus Road

☐ Heavy ■ Medium ☐ Low

Gross Solids

Type ■ Litter ■ Debris ■ Coarse Sediments

Amount ☐L ☐M ■ S ☐L ■ M ☐S ☐L ☐M ■ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ■ Residential ☐ Mixed ☐ Open / Non urban

Design Info

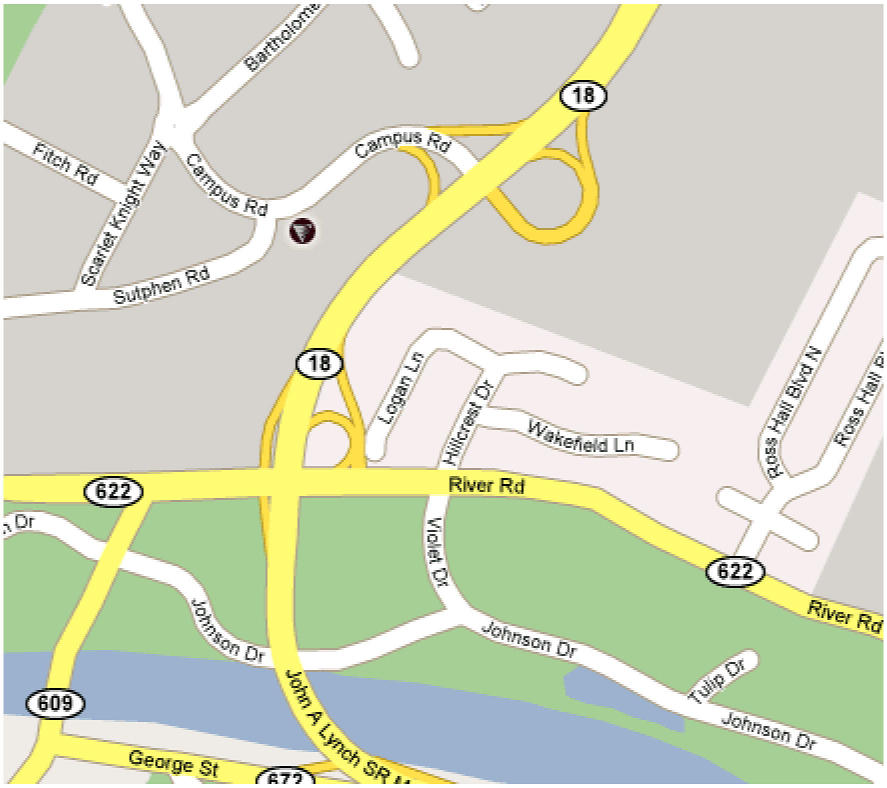
Drainage Area ________ Treatment Flow 4.48 Maximum Flow 11.2

(2007-10-22)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	14.1	1 (center)	2 (in between)	3 (side)	16.9
		14.1	14.3	14.9	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	15.4 / 16.5
	14.1	14.1	14.1		

Remarks:
The Vortechs is located along the side of Campus road.
The Vortechs is installed deep underground.
Sediment above water surface in quarter of the grit chamber area near inlet.
2.5ft sediment accumulation in the grit chamber (16.9-14.4).



18
Campus Rd
Fitch Rd
Scarlet Knight Way
Campus Rd
Sutphen Rd
18
Logan Ln
Hillcrest Dr
Wakefield Ln
Ross Hall Blvd N
622
River Rd
Violet Dr
Johnson Dr
Johnson Dr
622
River Rd
Tulip Dr
Johnson Dr
609
George St

RU01-03 (2008-02-26)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	14.3	1 (center)	2 (in between)	3 (side)	16.9
		14.1	14.1	14.7	
Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	15.4 / 16.5
	14.1	14.1	14.1		

Rutgers ID: **RU 01-04** Date 2007-06-13 Time 14:20

Device	Model	Municipality	County	Location
Vortechs	7000	Piscataway	Middlesex	Rte 18 Extension
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
043960223	2003-10-31	40°30.715’	74°27.415’	19ft

Climate Mostly Sunny Wind Sp/Dir 3 mph/ NW Air Temp 85°

Traffic 12 Cars/min one way on River Road

☐ Heavy ■ Medium ☐ Low

Gross Solids

Type	■ Litter			■ Debris			■ Coarse Sediments		
Amount	☐L	☐M	■ S	☐L	■ M	☐S	☐L	☐M	■ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ■ Residential ☐ Mixed ☐ Open / Non urban

Design Info

Drainage Area ______ Treatment Flow 4.48 Maximum Flow 11.2

(2007-06-13 visit)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
		1 (center)	2 (in between)	3 (side)	
	6.80	7.30	7.10	6.60	9.70

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)		
	6.80	6.80	6.70	N/A	9.0 / 9.6

Remarks:

Manholes are located on shoulder of River road.

Sediment above water surface in quarter of the grit chamber area near inlet.

2.7 ft sediment accumulation in the grit chamber (9.7-7.0=2.7).

In the floatables chamber, only one layer of floatables was present. The thickness of the layer was difficult to measure.

The outlet chamber was not accessible since no cover was above the outlet chamber. However, the outflow water could be observed from an adjacent chamber.

One cover for inflow diversion chamber between River Road and Vortechs.

RU01-04 (2008-01-11)

<table>
<tr><td rowspan="3">Grit Chamber</td><td rowspan="3">Water S. Reading
6.4</td><td colspan="3">Sediment Surface Reading</td><td rowspan="3">Bot Reading
9.7</td></tr>
<tr><td>1 (center)</td><td>2 (in between)</td><td>3 (side)</td></tr>
<tr><td>7.0</td><td>6.6</td><td>6.2</td></tr>
<tr><td rowspan="3">Float. Chamber</td><td colspan="3">Floatables Top Surface Reading</td><td rowspan="3">Fl. Bott. Su. R
N/A</td><td rowspan="3">Bot Reading
9.3
9.6</td></tr>
<tr><td>1 (center)</td><td>2 (in between)</td><td>3 (side)</td></tr>
<tr><td>6.4</td><td>6.4</td><td>6.4</td></tr>
</table>

Rutgers ID: **RU 02-01** Date 2007-04-20 Time 11:00

Device	Model	Municipality	County	Location
Vortechs	16000	Edison	Middlesex	Intersection of Evergreen Road and State Highway 27
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
236960279	2004-09-15	40°33.521'	74°20.364'	53ft

Climate Mostly Sunny Wind Sp/Dir 3 mph/SW Air Temp 76°

Traffic 5 Cars/min one way on Evergreen Rd

☐ Heavy ☐ Medium ■ Low

Gross Solids

Type ■ Litter ■ Debris ■ Coarse Sediments

Amount ☐ L ■ M ☐ S ■ L ☐ M ☐ S ☐ L ☐ M ■ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ☐ Residential ■ Mixed ☐ Open / Non urban

Design Info

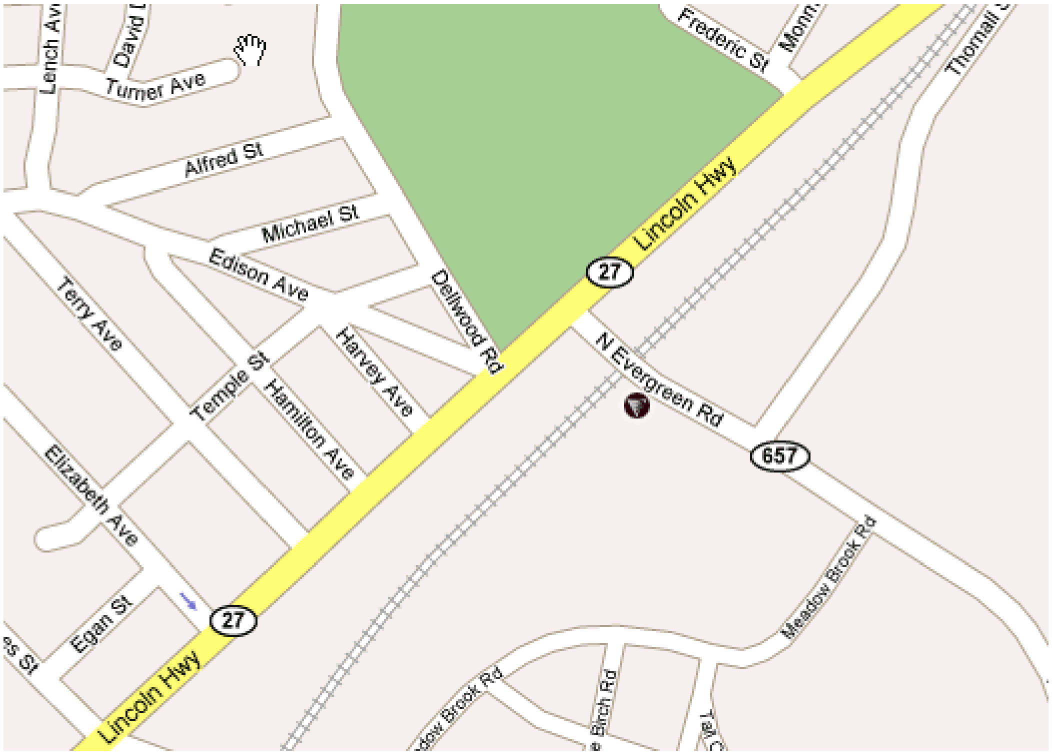
Drainage Area ________ Treatment Flow 10.08 Maximum Flow 25.2

(2007-06-12 visit)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	3.5 ft	1 (center)	2 (in between)	3 (side)	8.3
		7.2	7.3	7.35	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	8.2
	3.1	3.1	3.1		

Remarks:
Erosion problem
1 ft sediment accumulation in grit chamber (8.3-7.3=1.0)
0.3 ft of sediments was found in the outlet chamber (8.3-8.0=0.3).
This road connects Rt. 27 to Rt-1.


Lench Ave
David
Turner Ave
Alfred St
Michael St
Edison Ave
Dellwood Rd
Frederic St
Lincoln Hwy
27
Thornall
Terry Ave
Temple St
Hamilton Ave
Harvey Ave
N Evergreen Rd
657
Elizabeth Ave
Egan St
Meadow Brook Rd
Birch Rd
Lincoln Hwy
27

RU02-01 (2007-12-10)

<table>
<tr><td rowspan="3">Grit Chamber</td><td>Water S. Reading</td><td colspan="3">Sediment Surface Reading</td><td>Bot Reading</td></tr>
<tr><td rowspan="2">3.4</td><td>1 (center)</td><td>2 (in between)</td><td>3 (side)</td><td rowspan="2">8.3</td></tr>
<tr><td>7.4</td><td>7.4</td><td>7.4</td></tr>
<tr><td rowspan="3">Float. Chamber</td><td colspan="3">Floatables Top Surface Reading</td><td>Fl. Bott. Su. R</td><td>Bot Reading</td></tr>
<tr><td>1 (center)</td><td>2 (in between)</td><td>3 (side)</td><td rowspan="2">N/A</td><td rowspan="2">8.2</td></tr>
<tr><td>3.4</td><td>3.4</td><td>3..4</td></tr>
</table>

Rutgers ID: **RU 02-02** Date 2007-04-20 Time 11:20

Device	Model	Municipality	County	Location
Vortechs	9000	Piscataway	Middlesex	Intersection of Evergreen Road and State Highway 27
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
236960279	2004-09-15	40°33.508'	74°20.330'	52ft

Climate Mostly Sunny Wind Sp/Dir 3 mph/SW Air Temp 76°

Traffic 5 Cars/min one way on Evergreen Rd

☐ Heavy ☐ Medium ■ Low

Gross Solids

Type ■ Litter ■ Debris ■ Coarse Sediments

Amount ☐ L ■ M ☐ S ■ L ☐ M ☐ S ☐ L ☐ M ■ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ☐ Residential ■ Mixed ☐ Open / Non urban

Design Info

Drainage Area ________ Treatment Flow 5.67 cfs Maximum Flow 14.175

(2007-06-12 visit)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	5.7	1 (center)	2 (in between)	3 (side)	8.55
		8.0	8.1	8.15	

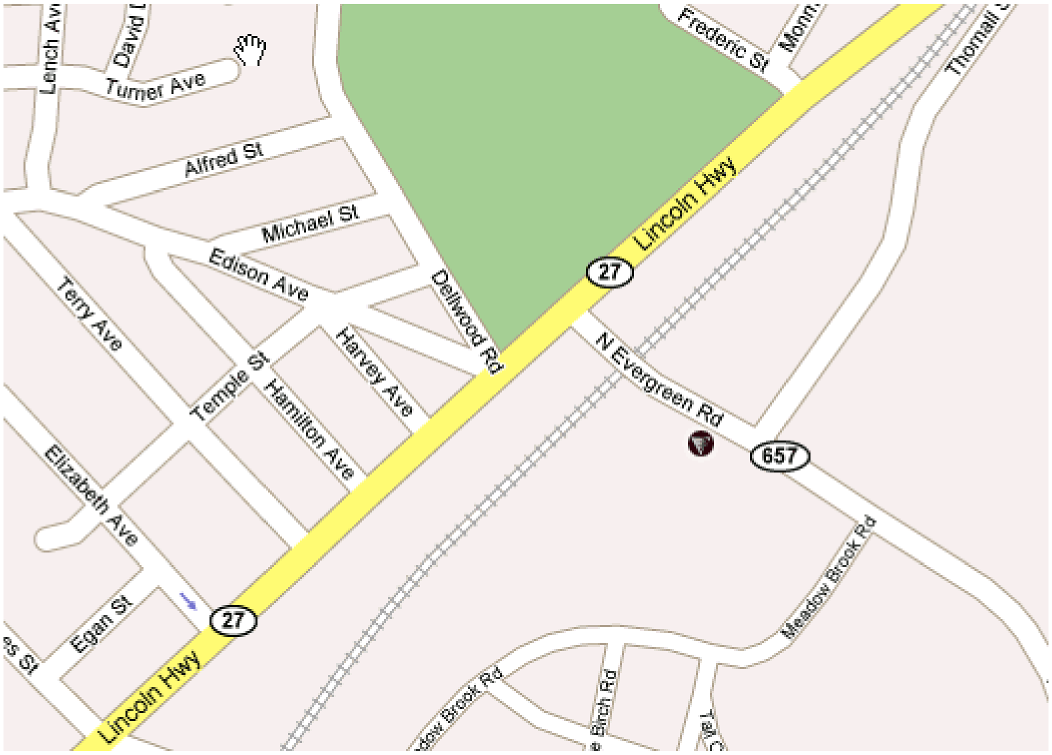
Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	5.41	8.45
	5.4	5.4	5.35		

Remarks:

Erosion problem

0.5 ft sediment accumulation in grit chamber (8.6-8.1=0.5)

This road connects Rt. 27 to Rt-1.


Turner Ave
Alfred St
Michael St
Edison Ave
Terry Ave
Temple St
Hamilton Ave
Harvey Ave
Dellwood Rd
Frederic St
Lincoln Hwy
27
N Evergreen Rd
657
Elizabeth Ave
Egan St
Meadow Brook Rd
27
Lincoln Hwy

RU02-02 (2008-01-09)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	6.2	1 (center)	2 (in between)	3 (side)	8.55
		8.1	8.15	8.15	
Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	5.41	8.45
	6.2	6.2	6.2		

Rutgers ID: **RU 04-02** Date 2007-05-04 Time 14:00

Device	Model	Municipality	County	Location
Vortechs	11000	Elizabeth	Union	Pearl St. and Grove St.
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
043960129	2004-11-30	40°39.342'	74°12.622'	3 ft

Climate Mostly Sunny Wind Sp/Dir N 5 mph Air Temp 67°

Traffic 11 Cars/min one way on Peach St

☐ Heavy ■ Medium ☐ Low

Gross Solids

Type ■ Litter ■ Debris ■ Coarse Sediments

Amount ■ L ☐ M ☐ S ☐ L ☐ M ■ S ☐ L ■ M ☐ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ☐ Residential ■ Mixed ☐ Open / Non urban

Design Info

Drainage Area 7.69 Treatment Flow 7 Maximum Flow 17.5

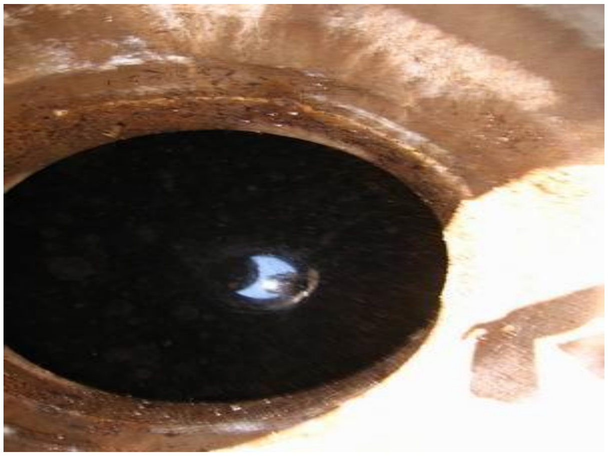
(2007-06-26 visit)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	9.0	1 (center)	2 (in between)	3 (side)	11.5
		10.8	11.1	11.1	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	10.8
	8.1	8.1	8.1		

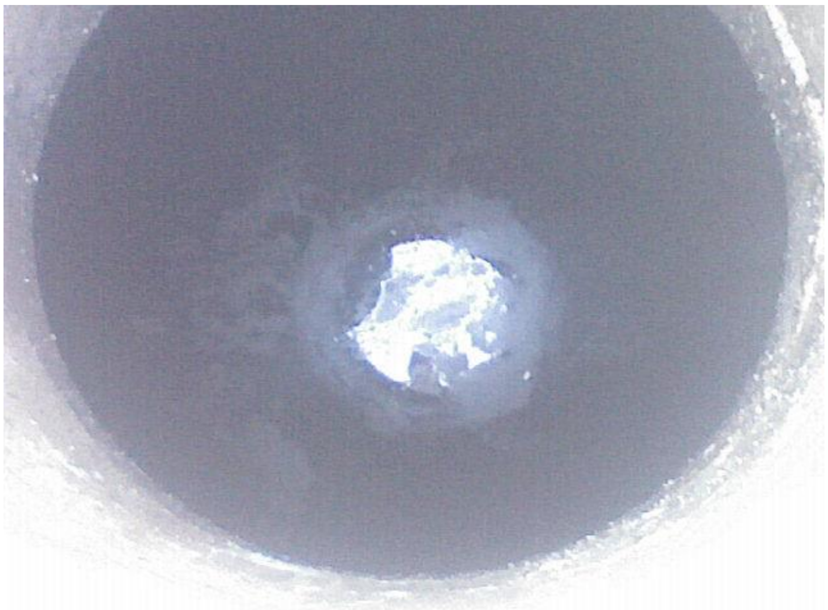
Remarks:
0.5 ft sediment accumulation in the grit chamber (11.5-11.0=0.5)
The cover of the floatables chamber is located on the road shoulder.
The manhole covers are not marked with the Vortechnics logotype


Montgomery St
1
Devine Ave
Nelson Ave
Reuter Ave
Spring St
614
S Pearl St
S 7th St
St
9
Clarkson Ave
US-1 & 9
9
1
Fillmore St
Elizabeth
River Park



RU04-02 (2008-01-16)

<table>
<tr><td rowspan="3">Grit Chamber</td><td>Water S. Reading</td><td colspan="3">Sediment Surface Reading</td><td>Bot Reading</td></tr>
<tr><td rowspan="2">8.7</td><td>1 (center)</td><td>2 (in between)</td><td>3 (side)</td><td rowspan="2">11.5</td></tr>
<tr><td>10.7</td><td>10.7</td><td>10.8</td></tr>
<tr><td rowspan="3">Float. Chamber</td><td colspan="3">Floatables Top Surface Reading</td><td>Fl. Bott. Su. R</td><td>Bot Reading</td></tr>
<tr><td>1 (center)</td><td>2 (in between)</td><td>3 (side)</td><td rowspan="2">N/A</td><td rowspan="2">10.9</td></tr>
<tr><td>8.0</td><td>8.0</td><td>8.0</td></tr>
</table>



Rutgers ID: **RU 06-01** Date 2007-05-17 Time 15:40

Device	Model	Municipality	County	Location
Vortechs	3000	North Bergen	Hudson	Paterson Plank Road - SecaucusDU
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
	2001-11-06	40°46.784’	74°02.364’	20 ft

Climate Mostly Cloudy Wind Sp/Dir WN 10 mps Air Temp 70°

Traffic 26 Cars/min one way on Rt. 1

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type ■ Litter ■ Debris ■ Coarse Sediments

Amount ■ L ☐ M ☐ S ☐ L ☐ M ■ S ☐ L ■ M ☐ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

■ Commercial ☐ Residential ☐ Mixed ☐ Open / Non urban

Design Info

Drainage Area 1.18 Treatment Flow 1.75 Maximum Flow 4.375

(2007-06-26)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	4.0	1 (center)	2 (in between)	3 (side)	7.3
		5.3	5.5	5.9	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	4.2	6.9 / 7.6
	4.0	4.0	3.9		

Remarks:
Low traffic
The device was installed in 2001
The trapped material looked orange and rotten and needs to be cleaned out
1.7 ft sediment accumulation in the grit chamber (7.3-5.6=1.7)
A 0.7 ft layer of sediments was found in the floatables chamber (7.6-6.9=0.7)
A 0.8 ft layer of sediments was found in the outlet chamber (7.8-7.0=0.8)

Paterson Plank Rd W
Tonnelle Ave
40th St
39th St
38th St
36th St
34th St
Liberty Ave
Westside Ave
Union Turnpike
Paterson Plank Rd
US-1 & 9
Grand Ave
Charles Ct
Meadow L
1
495

RU06-01 (2008-02-28)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
		1 (center)	2 (in between)	3 (side)	
	4.3	5.0	4.7	4.7	7.3

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)		
	4.3	4.3	4.3	4.5	6.9 / 7.6

Rutgers ID: **RU 07-01** Date 2007-05-20 Time 12:40

Device	Model	Municipality	County	Location
Vortechs	9000	Deptford Twp.	Gloucester	Rt. 47 EB near Cattell Rd
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
070970204	N/A	39°48.893'	75°07.483'	34 ft

Climate Cloudy Wind Sp/Dir W 5 mps Air Temp 68°

Traffic 18 Cars/min one way on S Delsea Dr

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type	■ Litter	■ Debris	■ Coarse Sediments
Amount	☐ L ☐ M ■ S	■ L ☐ M ☐ S	■ L ☐ M ☐ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ■ Residential ☐ Mixed ☐ Open / Non urban

Design Info

Drainage Area 1.28 Treatment Flow 5.67 Maximum Flow 14.175

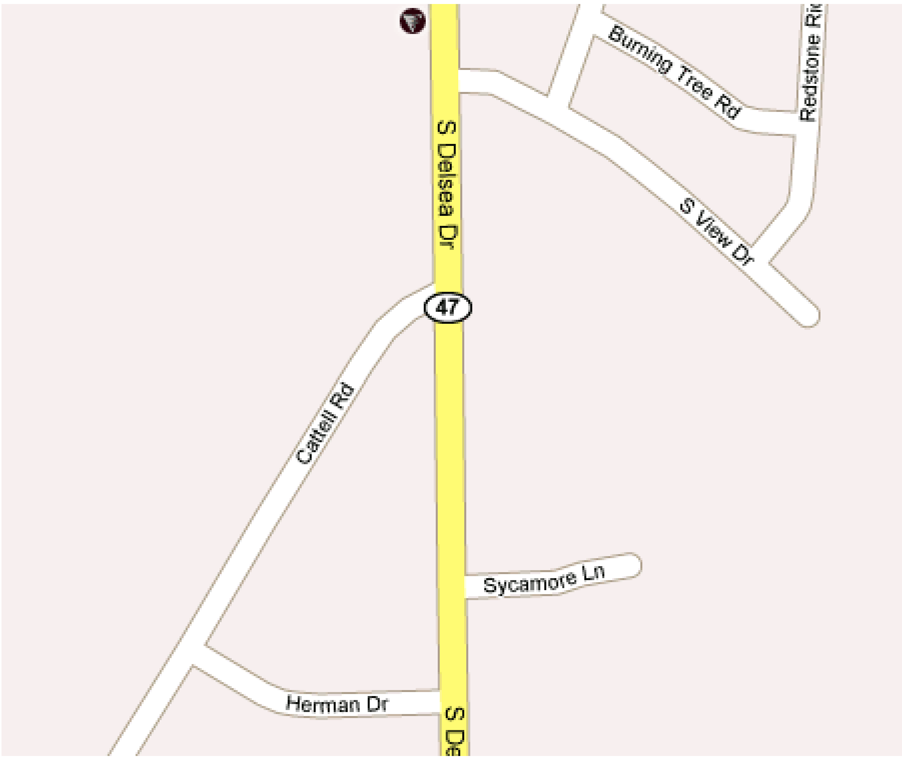
(2007-06-22 visit)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
		1 (center)	2 (in between)	3 (side)	
	6.9*	6.9*	6.9*	6.9*	9.5 est.*

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)		
	6.0*	6.0*	6.0*	N/A	9.5*

Below lower end of the ladder.

Remarks:
Bottom of the Vortechs System could not be reached with the measurement rod since the device is installed deep underground and sediment accumulation was hard to penetrate.
The accumulated sediment was above water surface in half of the grit chamber area.
2.6 ft (est.) of sediment accumulation in the grit chamber (9.5-6.9=2.6).
Erosion Problem
The device collects flow from Alkera Living House Town.


Burning Tree Rd
S Delsea Dr
47
S View Dr
Catteil Rd
Sycamore Ln
Herman Dr

RU07-01 (2008-03-13)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	10.8	1 (center)	2 (in between)	3 (side)	14.5
		11.5	11.3.	11.5	
Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	14 / 14.5
	10.8	10.8	10.8		

Rutgers ID: **RU 09-01** Date 2007-05-13 Time 13:30

Device	Model	Municipality	County	Location
Vortechs	3000	Lakewood	Ocean	U.S. Rt. 9
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
101960174	N/A	40°05.092’	74°12.935’	83 ft

Climate Cloudy Wind Sp/Dir 9 mps Air Temp 73°

Traffic 17 Cars/min one way on Rt. 9

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type	■ Litter			■ Debris			■ Coarse Sediments		
Amount	■ L	☐ M	☐ S	☐ L	☐ M	■ S	☐ L	■ M	☐ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ☐ Residential ■ Mixed ☐ Open / Non urban

Design Info

Drainage Area 0.49 Treatment Flow 1.75 Maximum Flow 4.375

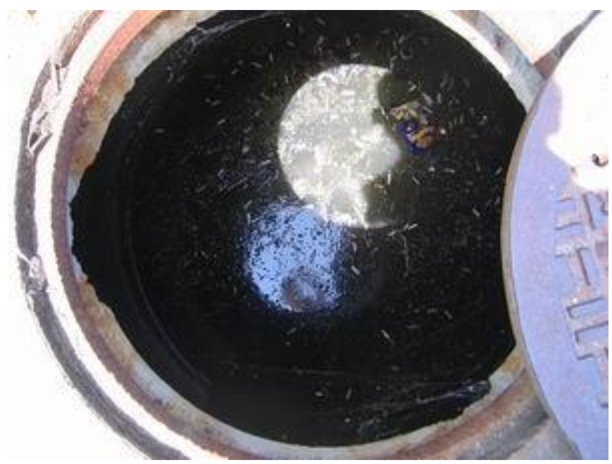
(2007-06-21 visit)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	4.0	1 (center)	2 (in between)	3 (side)	7.4
		5.9	5.8	5.7	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	4.3	7.3 / 7.5
	4.0	4.0	3.9		

Remarks:
1.6 ft sediment accumulation in the grit chamber (7.4-5.8=1.6).
The grit chamber and the floatables chamber were mostly covered by floating litter (such as cigarette butts).
Outlet level was almost the same as Lake Carasaljo level.

Lake Carasaljo
2nd St
1st St
1st St
Clifton Ave
S Lake Dr
N Lake Dr
Main St
88
River Ave
S Clifton Ave
Myrtle Pl
Lapsley Ln
Kimball Rd
Davis Rd
Central Ave
547
9
Hurley Ave
Bradshaw Rd
Freeman Rd
Caranetta Dr
Caranetta Dr
528
Roberto Clemente Park
Sunset Rd
Ashley Ave
River Ave
John St
9
Sunset Rd
Edgewood Ct
Lois Ln



RU09-01 (2007-12-19)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	4.2	1 (center)	2 (in between)	3 (side)	7.5
		6.2	6.5	6.5	
Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	7.3
	4.2	4.2	4.1		7.5

Rutgers ID: **RU 14-01** Date 2007-06-15 Time 16:40

Device	Model	Municipality	County	Location
Vortechs	16000	Parsippany	Morris	Route 46 Section 11M
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
049960394	2003-10-29	40°51.505'	74°20.926'	173ft

Climate Mostly Sunny Wind Sp/Dir 4 mph/NE Air Temp 73°

Traffic 66 Cars/min one way on Rt18

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type ■ Litter ■ Debris ■ Coarse Sediments

Amount ■ L ☐M ☐S ☐ L ☐M ■ S ☐ L ☐M ■ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

■ Commercial ☐ Residential ☐ Mixed ☐ Open / Non urban

Design Info

Drainage Area ______ Treatment Flow 10.08 Maximum Flow 25.2

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	5.5 ft	1 (center)	2 (in between)	3 (side)	9.1
		7.7	7.7	7.8	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	5.7	8.9 / 9.2
	5.5	5.5	5.6		

Remarks:

The Vortechs is located on an island surrounded by roads.

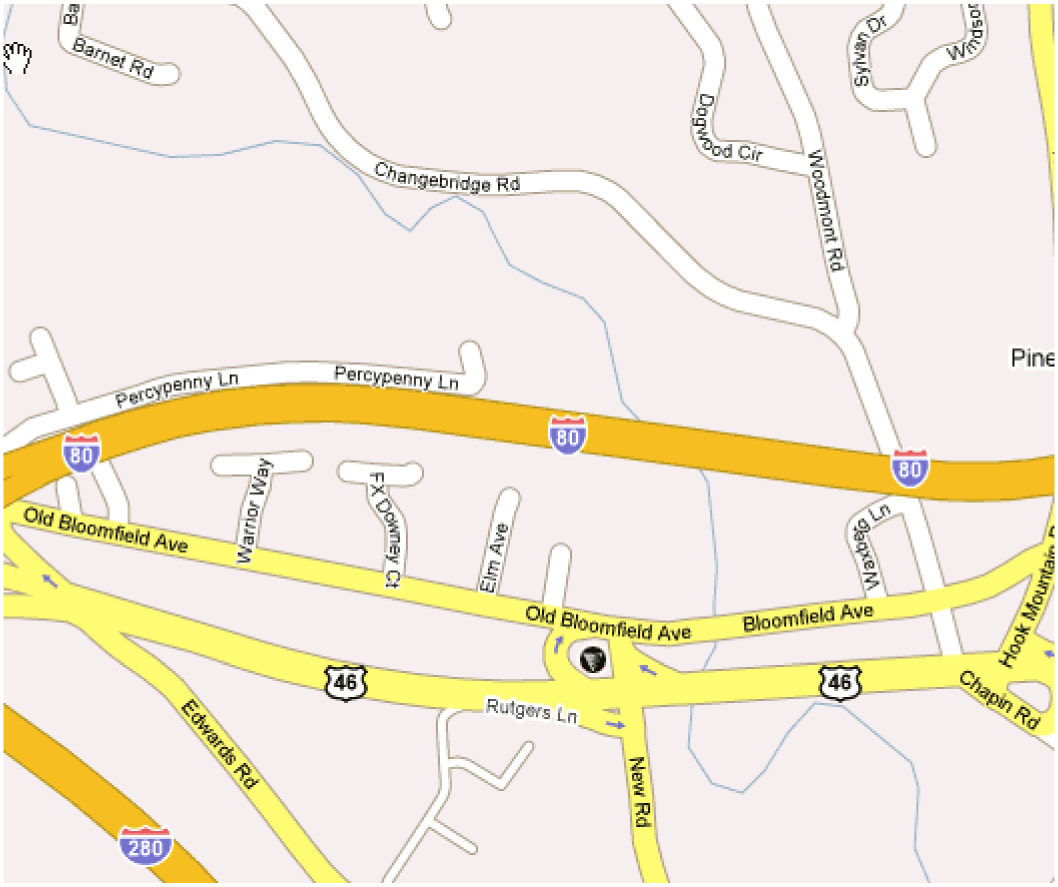
Heavy traffic.

1.4 ft sediment accumulation in the grit chamber (9.1-7.7=1.4).

Water surface of grit chamber was half covered by floating litter.

Water surface of floatables chamber was mostly covered by floating litter.

0.3 ft sediment accumulation in the floatables chamber (9.2-8.9=0.3)


Barnet Rd
Changebridge Rd
Dogwood Cir
Woodmont Rd
Sylvan Dr
Pine
Percypenny Ln
Percypenny Ln
80
80
80
Warrior Way
FX Downey Ct
Elm Ave
Waxbeg Ln
Old Bloomfield Ave
Old Bloomfield Ave
Bloomfield Ave
46
46
Rutgers Ln
Edwards Rd
New Rd
Chapin Rd
280

RU14-01 (2008-05-08)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	1.2	1 (center)	2 (in between)	3 (side)	9.1
		7.5	7.5	7.6	
Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	9.2 / 8.9
	1.2	1.2	1.2		

Rutgers ID: **RU 16-01** Date 2007-06-19 Time 12:00

Device	Model	Municipality	County	Location
Vortechs	5000	Frankford	Sussex	NB side of Rt. 206 between Paulins Kill and Rt.15
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
	N/A	41°07.180’	74°42.819’	495ft

Climate Mostly Sunny Wind Sp/Dir 2 mph/NE Air Temp 79°

Traffic 7 Cars/min one way on Rt206

☐ Heavy ☐ Medium ■ Low

Gross Solids

Type	■ Litter			■ Debris			■ Coarse Sediments		
Amount	☐ L	■ M	☐ S	☐ L	☐ M	■ S	☐ L	☐ M	■ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ☐ Residential ☐ Mixed ■ Open / Non urban

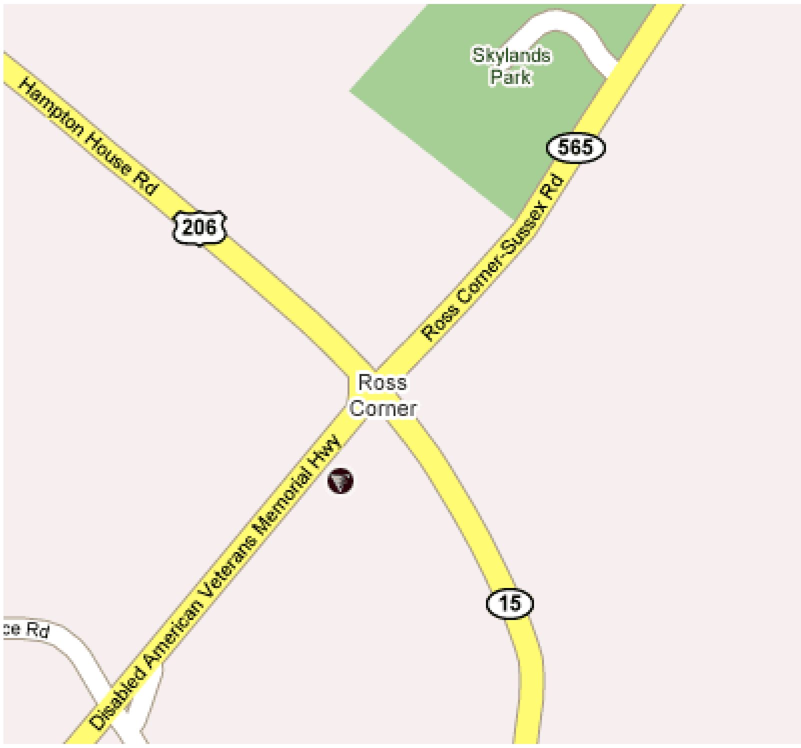
Design Info

Drainage Area ____ Treatment Flow 3.43 Maximum Flow 8.575

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
		1 (center)	2 (in between)	3 (side)	
	6.0	7.5	7.5	8	9.8

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)		
	5.9	6.0	6.0	6.1	9.5 / 9.8

Remarks:
The Vortechs is installed in parking lot.
2.1 ft sediment accumulation in the grit chamber (9.8-7.7=2.1)
Water surface of the floatables chamber was mostly covered by floating litter.
A 0.3 ft layer of sediments was found in the floatables chamber (9.8-9.5=0.3).


Skylands Park
565
Hampton House Rd
206
Ross Corner-Sussex Rd
Ross Corner
Disabled American Veterans Memorial Hwy
15
ce Rd

RU16-01 (2008-02-07)

<table>
<tr><td rowspan="3">Grit Chamber</td><td>Water S. Reading</td><td colspan="3">Sediment Surface Reading</td><td>Bot Reading</td></tr>
<tr><td rowspan="2">5.6</td><td>1 (center)</td><td>2 (in between)</td><td>3 (side)</td><td rowspan="2">9.8</td></tr>
<tr><td>7.8</td><td>7.8</td><td>7.8</td></tr>
<tr><td rowspan="3">Float. Chamber</td><td colspan="3">Floatables Top Surface Reading</td><td>Fl. Bott. Su. R</td><td>Bot Reading</td></tr>
<tr><td>1 (center)</td><td>2 (in between)</td><td>3 (side)</td><td rowspan="2">5.7</td><td rowspan="2">9.6 / 9.8</td></tr>
<tr><td>5.5</td><td>5.8</td><td>5.8</td></tr>
</table>

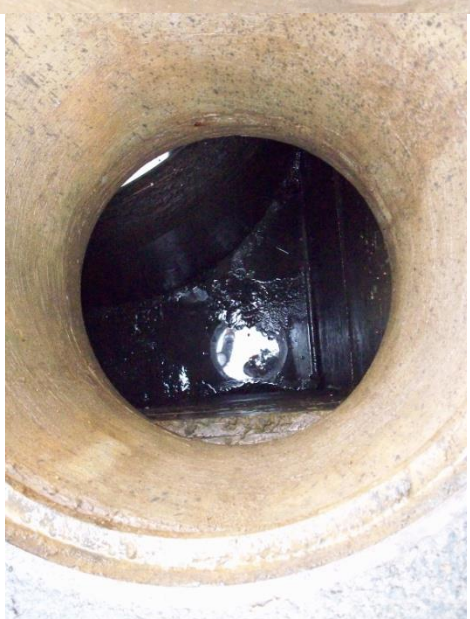


Table 3. Depth of Sediment Trapped and Removed

Site ID	Model Number	Construction Date	Inspection Date	Sediment Depth in Grit Chamber
RU01-01	16000	2003-10-31	2007-06-13	0.05 ft
RU01-02	7000	2003-10-31	2007-10-22	0.7 ft
RU01-03	7000	2003-10-31	2007-06-13	2.5 ft
RU01-04	7000	2003-10-31	2007-06-12	2.7 ft
RU02-01	16000	2004-09-15	2007-06-12	1.0 ft
RU02-02	9000	2004-09-15	2007-06-26	0.5 ft
RU04-02	11000	2004-11-30	2007-06-26	0.6 ft
RU06-01	3000	2001-11-06	2007-06-22	1.7 ft
RU07-01	9000	2000-11-03*	2007-06-21	2.6 ft
RU09-01	3000	2000-05-10*	2007-06-15	1.6 ft
RU14-01	16000	2003-10-29	2007-06-19	1.4 ft
RU16-01	5000	2000-09-13*	2007-06-13	2.1 ft

* Construction plans approval date, not actual construction date.

CLEANOUT

General Standard Procedures

<u>Preparation before Site Visit</u>

1. Check weather forecast looking for dry day before making arrangement for sampling day. Also, check forecast the day before working day to again confirm adequate weather.
2. Make arrangements for crash truck and vacuum truck
3. Make arrangements for sending samples.
4. Obtain supplies:
    - Pens
    - Labels
    - Papers
    - Camera
    - Permission letter
    - Custody
    - Shipping labels
5. Obtain safety equipment:
    - Traffic cones
    - Outfits (i.e. reflector vests)
    - Noxious gas detector
6. Obtain sampling and measurement equipment:
    - Gloves
    - Boots
    - Manhole hook
    - Claws

Telescoping measurement rod
Paper towels
Bleach
Ethanol or DI water
Scoops and shovels
Pool skimmer
Oil absorbent booms
Plastic sheets
Weighing scale
Mesh bags
Coolers (Ice + Container + Shipping label)
Flashlights
Bottles

7. Clean sampling equipment by washing with DI water and ethanol

Pre-Procedure before Using Vacuum Truck

1. Arrange sampling and measurement equipment
2. Grit chamber:
   - Open manhole cover with equipment (i.e. hook and claw) and measure depth of floatables, water and sediment.
   - Remove floatables with pool skimmer and place in the mesh bag.
   - Collect oil with oil absorbent booms.
   - Measure oil weight with scale.

3. Floatables chamber
   - Open manhole cover with equipment (i.e hook and claw) and measure depth of floatables and water
   - Remove floatables with pool skimmer and place in mesh bag.
   - Collect oil with oil absorbent booms.
   - Measure oil with scale.

4. Outlet chamber:
   - Open manhole cover with equipment (i.e hook and claw) and measure depth of water.

The depths for floatables, water and sediment were measured by using the prescribed telescoping measurement rod. The measurement of sediment depth was taken at three locations within the grit chamber: (1)center, (2)side and (3)midway between the center & side (the average of the three measurements was taken as the depth of sediment).

Floatable debris was skimmed off both the grit and floatables chambers. Mesh and/or plastic bags were used for storing floatables until they were sorted at a later stage.

Oil absorbents were used to remove oil in the chamber.

Procedure during Vacuum Out

1. Grit chamber
   - Make an estimate of how much material was collected and what kind of material collected.
   - Pump out water.
   - Dewater to the drainage system.
   - Take two water quality samples and store in the cooler.
   - Vacuum up sediment.
   - Dispose all sediment at maintainable, or other available yard
   - Take two sediment samples.
   - Mail samples to the lab for analysis.

2. Floatables chamber
   - Vacuum water.

3. Outlet chamber
   - Vacuum water.

Vacuum out procedure was divided into two separate operations. First, water was pumped and decanted to the drainage system, minimizing disturbance was required during pumping procedure.

Water samples were collected at the beginning and end of decanting. Each set consisted of two bottles taken at each sample time. One polyethylene bottle was treated with sulfuric acid (H_2SO_4) and refrigerated, where the other bottle was only refrigerated.

Second, sediment was vacuumed out and disposed of at a maintenance yard. NJDOT provided a contractor's yard located in Burlington, NJ; however, a maintenance yard on Rutgers University's Livingston Campus was chosen for convenience.

Figure 5. The cleanout of the Vortechs system: (a) Cleaning out the Vortechs unit with vacuum truck, (b) Pumping out water first and then pumping out solids (Typically)

Procedure for Processing Vacuumed Materials

1. Litter and debris
   - Wash floatables and place on plastic sheets to air dry.
   - Categorize litter.
   - Measure volume and weight of collected debris.

2. Sediment
   - Mix to sediment pile
   - Package samples (two 8 oz. jars) and place in the cooler
   - Send to the lab for analysis
   - Take samples and perform Particle Size Distribution (PSD) using soil sieves.
   - Determine organic contents
   - Measure volume and weight of total sediment removed.

Two sediment samples were taken on opposite sides of pile.

Specific Cleanout Procedure

RU01-01 and RU01-02: Two devices are within close proximity to each other and near maintenance yard. Both operations were completed with standard procedure in one day. (Date: 02/01/2008)

RU01-03: The device is installed deep underground. The depth of structure is 17' below grade. It was necessary to confirm the depth that the vacuum truck could reach for cleaning. Operation was completed with standard procedure. (Date: 02/26/2008)

RU01-04: Cleanout operation was completed with standard procedure. (Date: 01/11/2008)

RU02-01: Cleanout operation was completed with standard procedure. (Date: 12/10/2007)

RU02-02: Cleanout operation was completed with standard procedure. (Date: 01/09/2008)

RU04-02: Cleanout operation was completed with standard procedure. (Date: 01/09/2008)

RU06-01: Due to mush sediment, pumped water was disturbed. Water was decanted into the downstream drainage network, via manhole. Operation was completed. (Date: 02/28/2008)

RU07-01: Cleanout operation failed because of flow from outlet chamber during suction (01/30/2008). Operation was completed after putting the plug-in in the outlet pipe. (Date: 03/13/2008)

RU09-01: Cleanout operation was completed with standard procedure. (Date: 12/19/2008)

RU14-01: Cleanout operation failed twice. First, the ground was too soft to support the vacuum truck (02/09/2008). Second, water was flowing from inlet due to small size plug-in (04/17/2008). Operation was completed with proper plug-in size (42''). (Date: 05/08/2008)

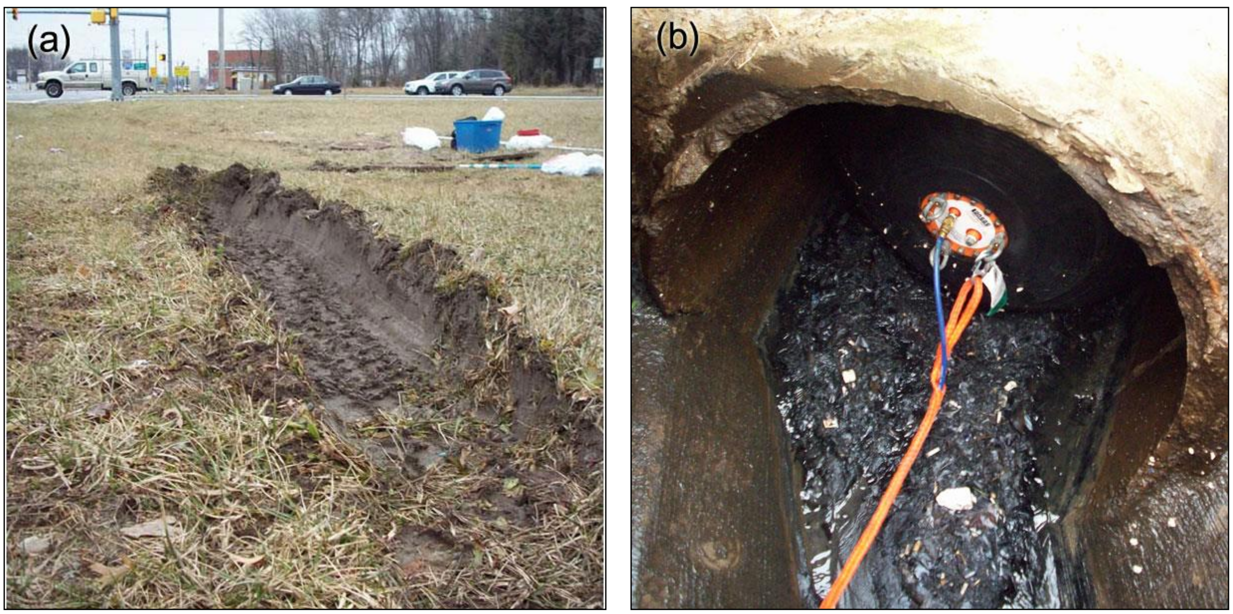


Figure 6. Encountered problems while cleanout at RU14-01 site: (a) Soft ground might not support the vacuum truck after a rainy day. Operation was completed on a dry day, (b) Water was flowing from inlet pipe which size is 42-inch. Operation was completed with a pneumatic pipe plug

RU16-01: Cleanout operation was completed with standard procedure. (Date: 02/07/2008)

Table 4. Cleanout Date and Description

Date	Id	Model	City	Status	Description
12/10/07	RU02-01	16000	Edison	Completed	Completed with standard procedure
12/19/07	RU09-01	3000	Lakewood	Completed	Completed with standard procedure
01/09/08	RU02-02	9000	Edison	Completed	Completed with standard procedure
01/11/08	RU01-04	7000	Piscataway	Completed	Completed with standard procedure
01/16/08	RU04-02	11000	Elizabeth	Completed	Completed with standard procedure
01/30/08	RU07-01	9000	Deptford	Failed to clean out	Back flow from outlet chamber
02/01/08	RU01-01	16000	Piscataway	Completed	Completed with standard procedure
02/01/08	RU01-02	7000	Piscataway	Completed	Completed with standard procedure
02/07/08	RU16-01	5000	Frankford	Completed	Completed with standard procedure
02/09/08	RU14-01	16000	Parsippany	Failed to clean out	Too soft ground to support truck
02/26/08	RU01-03	7000	Piscataway	Completed	Completed with standard procedure
02/28/08	RU06-01	3000	North Bergen	Completed	Completed with standard procedure
03/13/08	RU07-01	9000	Deptford	Completed	Completed with plug-in
04/17/08	RU14-01	16000	Parsippany	Failed to clean out	Inflow from inlet / small size plug-in
05/08/08	RU14-01	16000	Parsippany	Completed	Completed with plug-in

Problems Encountered and Solutions

<u>Inflow / Backflow</u>

Although a dry day was chosen for clean up, previous rain events caused inflow from inlet or backflow from outlet. An air compressor, pipe plugs and sand bags were used to prevent inflow or backflow during vacuum procedures.

Deep Underground Devices

Some devices, for design reasons, were placed deep underground. The truck used assembled pipe sections to reach the bottom for vacuuming, however, could not reach the edge of the device. The pipes had a limited sweep angle due to the relatively small hole diameter and depth of device. The combination of high pressure water jetting attached to a vacuum truck is recommended to allow for a more thorough cleaning of the device. If the jetting apparatus is not available, it is possible to send a laborer down into the device with a portable power washer or tool to clean the edges of the chamber. However, it is imperative that precautions are taken to ensure the safety of personnel. This includes, but is not limited to: (1) harness system to allow for emergency egress from device, (2) protective clothing, (3) noxious gas detector, etc.

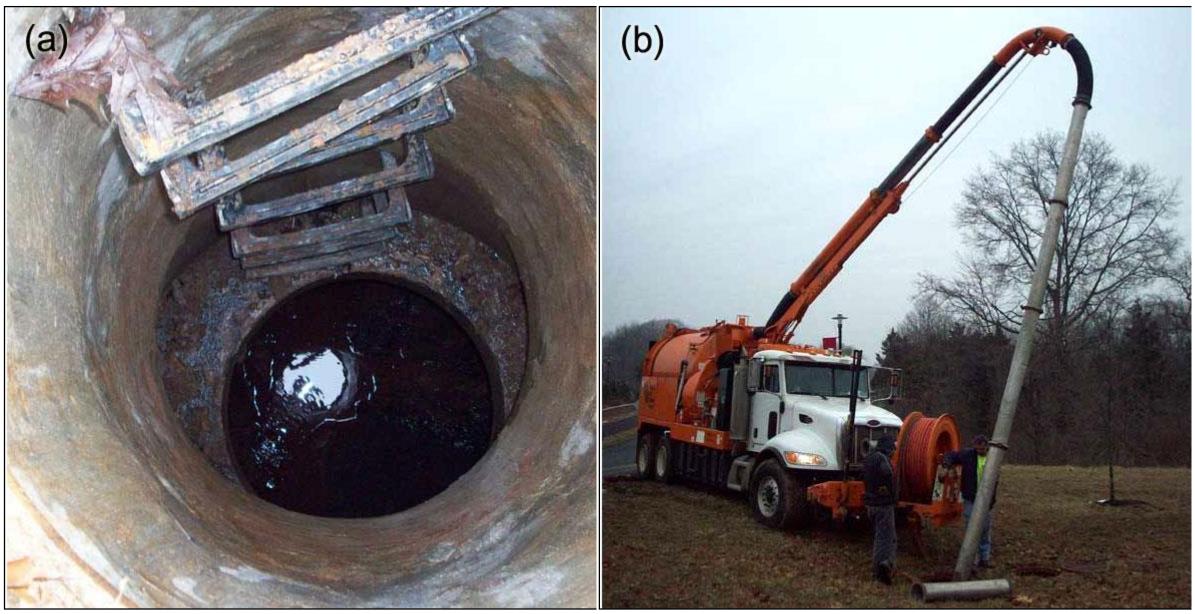


Figure 7. The cleanout of the Vortechs unit buried deep underground: (a) The depth of the Vortechs unit in Piscataway, NJ. is 17-feet below grade, (b) Cleaning out the deep underground device with assembled vacuum tubes

Turbid Water

Laborers performed the vacuum operation, minimizing disturbance, so water could be decanted in the outlet drainage. In the case of RU06-01, turbidity was caused by mush sediment in the device. Therefore, water should be decanted into the downstream drainage network, via manhole. Although water was decanted at a slow rate, some turbid water flowed back into the device and mush sediment settled down in the outlet chamber of the device. The depth of sediment in the outlet chamber was approximately 0.3 ft.

Manhole Location

Sites where manhole covers were located in the center of the road are excluded from cleanout and monitoring. For this study, traffic could not be shut down or detoured to enable proper monitoring of the devices. In most cases, manhole covers were located outside the road such as in shoulders, sidewalks and some case parking lots. Traffic safety for a shoulder closing was required, and was accomplished using cones and a crash truck.

Costs

Every cleanout activity took approximately half a day (4 hours). We have a fixed rate of $3,500/day which includes the following:

- 1 crash truck and proper signage to provide necessary lane closure and safety support to the traveling public.
- 1 Vacuum truck
- 3 Laborers
- 1 Driver

If it is necessary, pump both water and solids out and dispose them together at a pre-treatment facility (similar to what Montgomery County, Maryland is doing, at $59/ton).

PHYSICAL & CHEMICAL CHARACTERIZATION OF REMOVED MATERIALS

Water Samples

Table 5. Water Sample Guidelines and Analysis Methods.

Constituents	Method Reference	Minimum Sample Volume	Lab. Reporting Limits (RLs)	Preservation	Maximum Storage Time
Total Suspended Solids (TSS)	SM 20th Ed. 2540	1000 ml	2.0 mg/l	Refrigerate	7 days
Biochemical Oxygen Demand (BOD)	SM 20th Ed. 5210B	1000 ml	5.9 mg/l	Refrigerate to 4°C	48 hours
Chemical Oxygen Demand (COD)	HACH Method 8000	500 ml	10.0 mg/l	H_2SO_4 to pH<2, and refrigerate	28 days

Total Phosphorus (TP)	SM 20th Ed. 4500-p B.5 E	500 ml	0.07 mg/l	H_2SO_4 to pH<2, and refrigerate	28 days
Total Kjeldahl Nitrogen (TKN)	EPA 600 Method 351.2	500 ml	1.0 mg/l	H_2SO_4 to pH<2, and refrigerate	28 days

Due to the nature of the operation there was concern about polluted and turbid water being decanted during cleanout. In order to monitor pollutant levels and water quality, samples were collected. Based on sampling and handling requirements, each set of samples consisted of two bottles. One of the sample bottles was refrigerated as well as treated with sulfuric acid; the second bottle was only refrigerated. These samples, using two bottles each, were taken at the beginning and end of decanting.

The QC Laboratories was contracted to perform water quality and sediment analysis. Arrangements were made with the laboratory a week before cleanout as well as the day before, to ensure timely pick-up of the water samples. The samples were analyzed within the holding times specified by standard industry methods.

Water quality results were compared to concentrations of typical untreated domestic wastewater (Metcalf and Eddy, 2003) and are shown in the following figures.

Total Suspended Solids (TSS)

The TSS concentrations from the twelve devices ranged from 306 to 388,000 mg/L. Although laborers manually performed the vacuuming procedures, which minimized disturbance, the TSS levels were nonetheless higher than medium concentrations of municipal wastewater (210 mg/L). The highest TSS concentration was observed at the RU06-01 site. In this case, turbidity was caused by the presence of mush sediments as well as the relatively small size of the device.

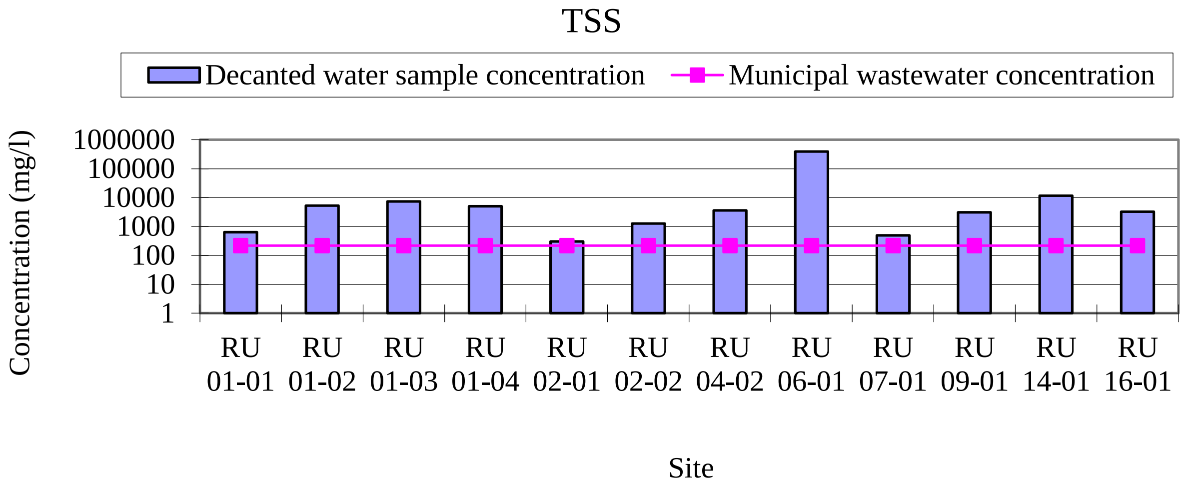


Figure 8. Comparison of total suspended solids (TSS) concentration in decanted water samples and typical untreated municipal wastewater at medium strength

Biochemical Oxygen Demand (BOD)

The BOD concentrations from the twelve devices ranged from 11 to 1,720 mg/L. Most of the BOD concentrations were lower than medium concentrations of municipal wastewater (190 mg/L). The highest BOD concentration was 1,720 mg/L from the RU01-03 site and the second highest was 1,177 mg/L from RU06-01. During the cleanout activity, water from RU01-03 and RU06-01 was turbid due to the presence of mush sediments. Site RU01-03, located on the Busch Campus of Rutgers University, had long drainage ditches located beside the turf field. It was observed that sediment in the device contained a large amount of organic matter.

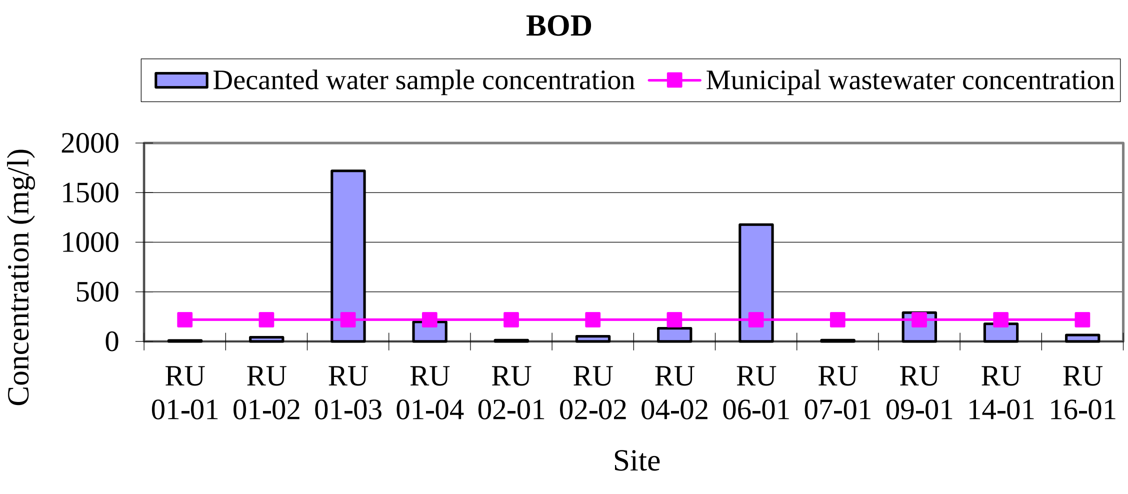


Figure 9. Comparison of biochemical oxygen demand (BOD) concentration in decanted water samples and typical untreated municipal wastewater at medium strength

Chemical Oxygen Demand (COD)

The COD concentrations from the twelve devices ranged from 204 to 51,700 mg/L. Most of the COD concentrations were higher than medium concentrations of municipal wastewater (430 mg/L). The highest COD concentration was observed at the RU06-01 site, which had the largest TSS levels. Sites that included commercial areas such as RU04-02 (Elizabeth, NJ), RU09-01 (Lakewood, NJ) and RU14-01 (Parsippany, NJ) showed higher levels of COD.

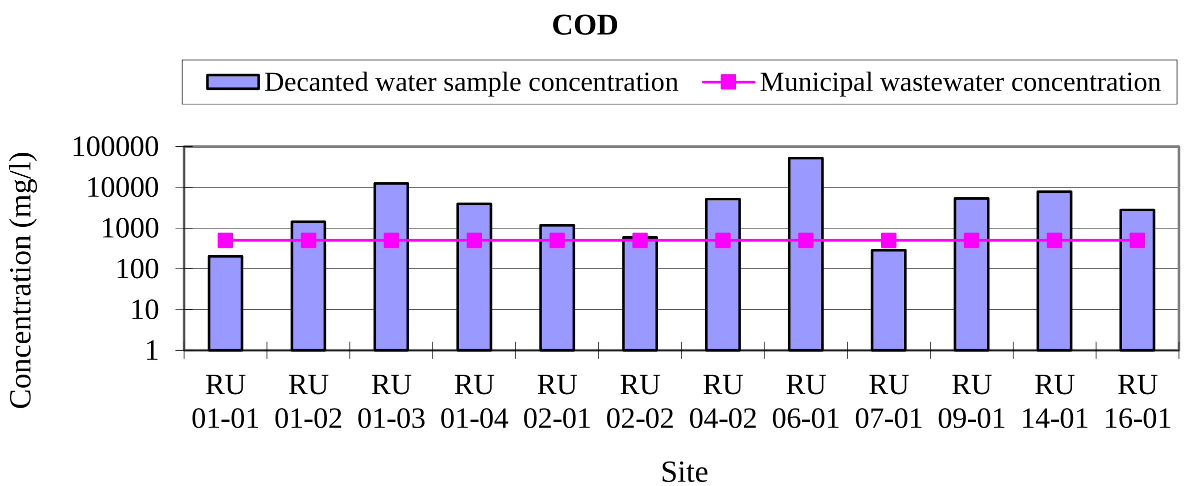


Figure 10. Comparison of chemical oxygen demand (COD) concentration in decanted water samples and typical untreated municipal wastewater at medium strength

Total Phosphorus (TP)

The TP concentrations from the twelve devices ranged from 0.6 to 58.6 mg/L. The highest COD concentration was observed at the RU14-01 site. Most of TP levels were lower than medium concentrations of municipal wastewater (7 mg/L).

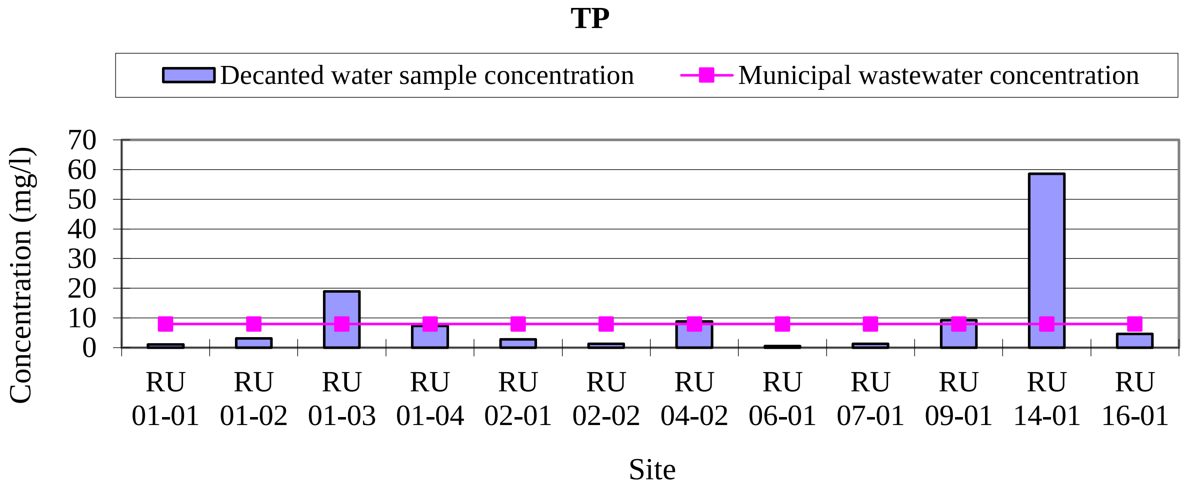


Figure 11. Comparison of total phosphorus (TP) concentration in decanted water samples and typical untreated municipal wastewater at medium strength

Total Kjeldahl Nitrogen (TKN)

The TKN concentrations from the twelve devices ranged from 3.3 to 154.5 mg/L. The highest TKN concentration was observed at the RU06-01 site. Most of the TKN levels were lower than medium concentrations of municipal wastewater (40 mg/L). In the case of RU01-03, there was a period of time where TKN equipment failed at the contract laboratory. The laboratory subcontracted the TKN analysis to another lab. The reported TKN concentrations from the second lab showed detectable levels within the sediment; however, the water samples had no detectable levels of TKN. The fact that there was TKN in the sediment, but not in the water, does raise questions about the validity of the results from the lab – but no clarifications were presented.

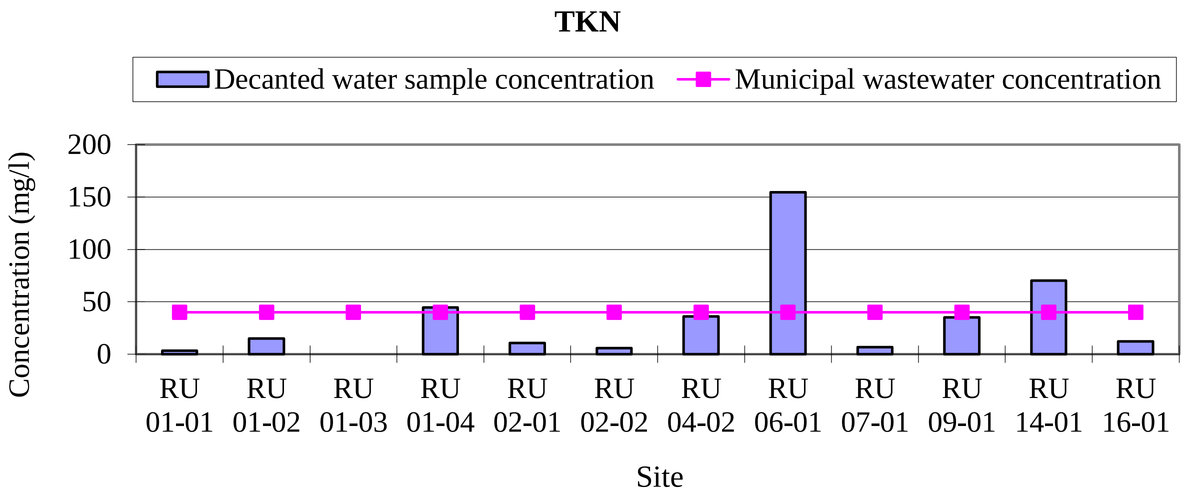


Figure 12. Comparison of total kjeldahl nitrogen (TKN) concentration in decanted water samples and typical untreated municipal wastewater at medium strength

Oil and Grease

The amount of oil in the devices was measured using oil-only absorbents. For this study, the PIG®Sump skimmer, an absorbent polypropylene fiber material was chosen. This material absorbs and retains oil and oil-based liquids including lubricants, fuels and cleaning agents. Each skimmer is designed to absorb 1.8 gallons of oil without absorbing water.

The weight of oil in each device, which was measured in both the grit and floatables chambers, is shown in Figure 13. The weight of oil ranged from 0.9 to 6.1 lbs; and large amounts of oil were observed at sites that are more commercialized (i.e. RU04-02: Elizabeth, RU06-01: North Bergen, and RU14-01: Parsippany).

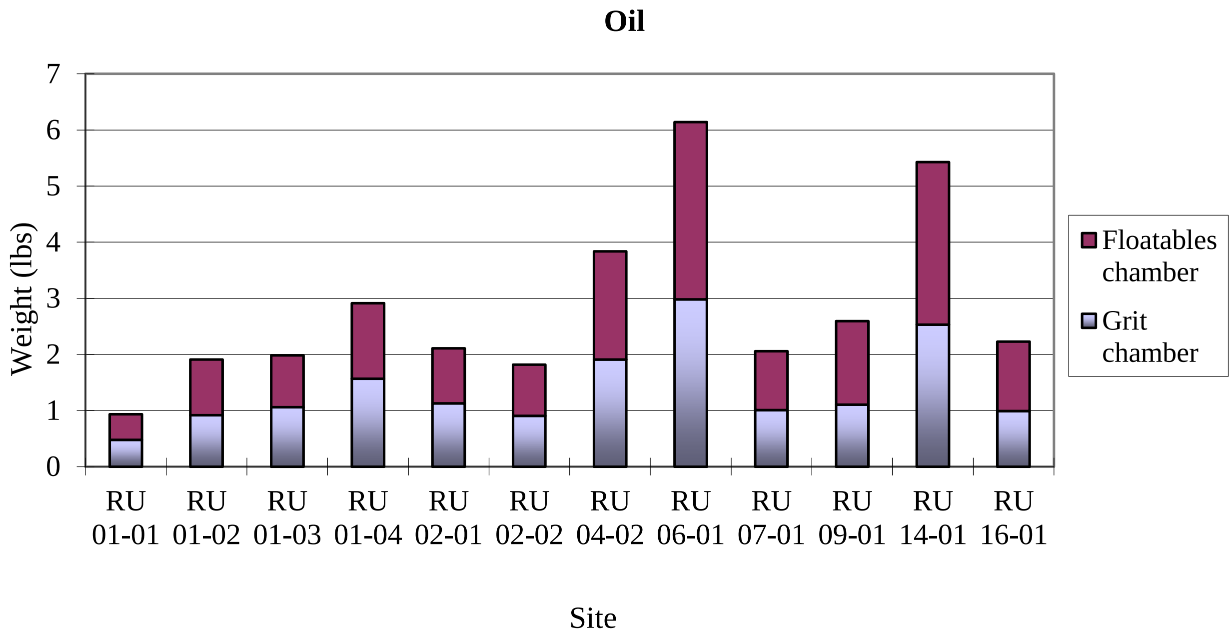


Figure 13. Weight of oil trapped in grit and floatables chambers

Floatables

Prior to the removal of sediment and water (via vacuum truck), floatable litter and organic debris were skimmed off both the grit and floatables chambers. Collected floatables from each site were placed in the laboratory to be air dried, sorted and weighed (Appendix B). Total volume of floatables was 8.56 ft^3 and total weight was 16.45 lbs. The result does not include litter in the sediment. The measurement was conducted based on litter investigations by New York City in response to what has been described as “one of the major issues of wet-weather pollution, the control of floatable pollution”.

Types and volume proportions of floatables are shown in Appendix C. The most common types of floatables were plastic, Styrofoam, and organic debris. The characteristics of the floatable litter found in the study show Styrofoam contributed over 50 percent of total volume and plastics contributed over 40 percent of total weight. Most of the Styrofoam found in the devices was a part of coffee/beverage cups. However, as shown in Figure 14, a large amount of Styrofoam was found at the RU14-01 device, most of which consisted of packing Styrofoam and Styrofoam boards. In the case of these Styrofoam, the debris might have come from unusual activities, not necessarily from roadway runoff.

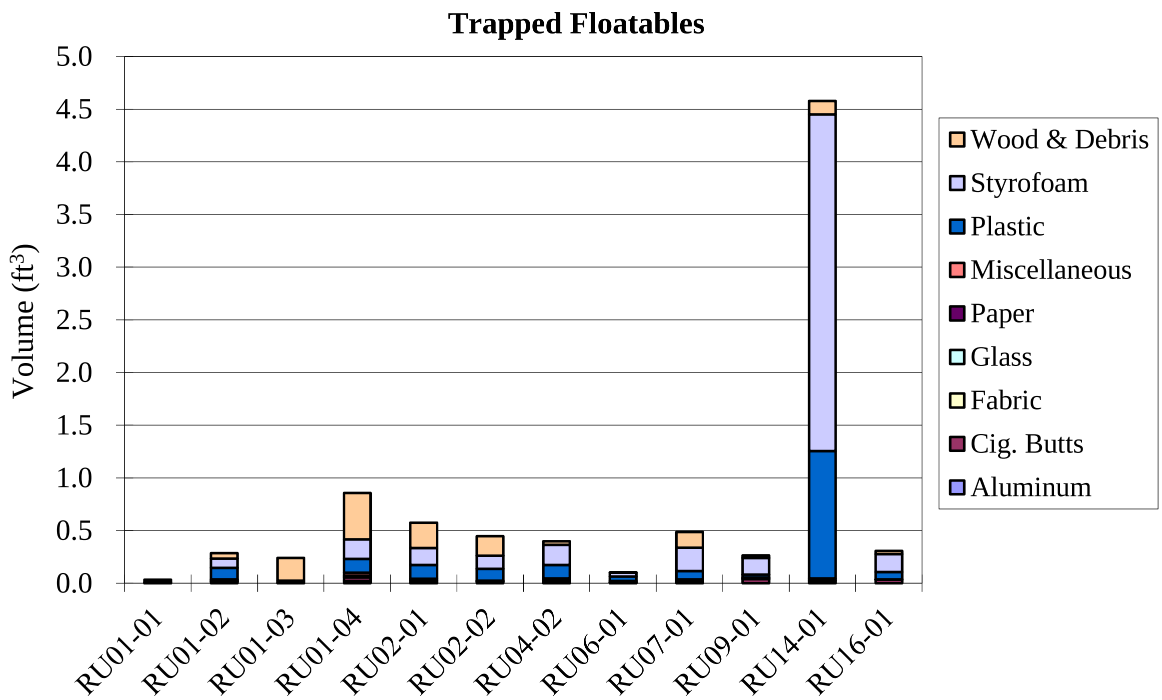


Figure 14. Volume and type of floatables trapped

Pumped-Out Bottom Sediment

Weight and Volume of Sediment

Sediment was collected, air dried, and measured at a maintenance yard. During clean out activity, some sediment in the device(s) was vacuumed out and decanted into the outlet drainage along with the effluent water. However, most sediment was collected after decanting the water, and was disposed of at a maintenance yard. The weight and volume of sediments are shown in Figure 15 and Figure 16.

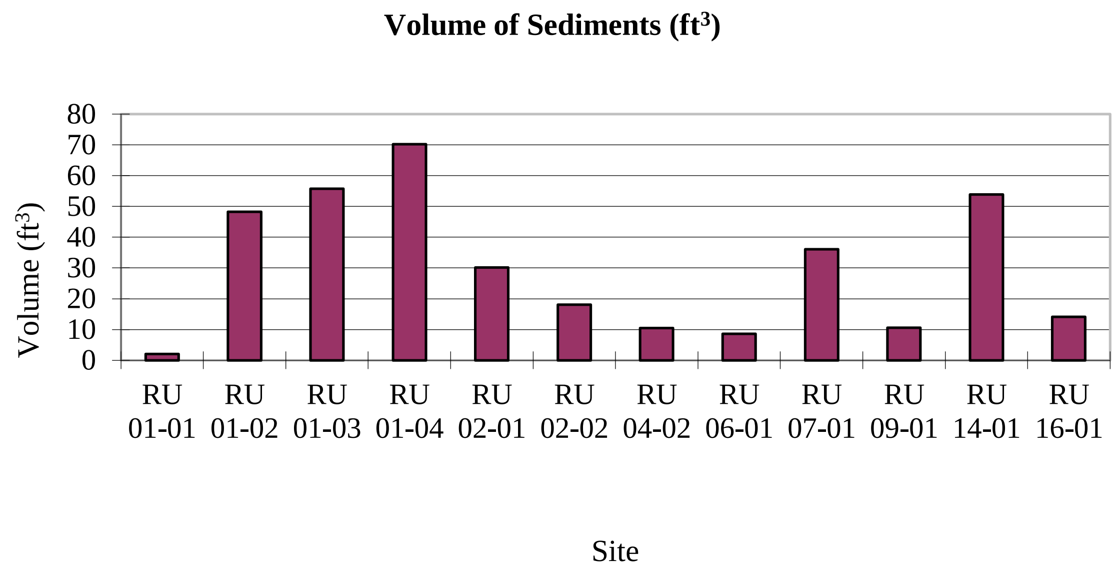


Figure 15. Volume of trapped bottom sediments

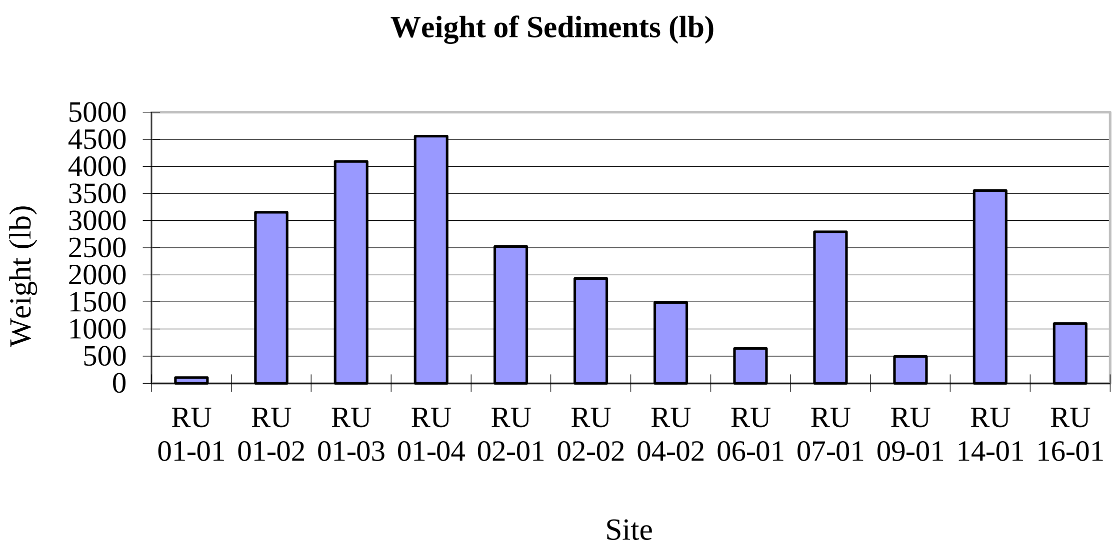


Figure 16. Weight of trapped bottom sediments

Sediment Particle Size Using Sieve Analysis

The device is designed to remove litter and large sized particle in a drainage basin. For sediment particle size testing, two sediment samples were taken, on opposite sides of the discarded pile of sediment, and placed in sealed coolers (due to possible presence of phosphorous and ammonia compounds which are potentially volatile). A sieve analysis was performed using standard procedures with five varying sieve sizes between, and including, #4 and #200 (Appendix E). Samples used a #4 sieve (4.75 mm) to separate other material such as leaves, litter and debris from the sediment. The particle size analysis was conducted after the larger debris was shifted out. Percentage of sediment samples with a particle size greater than 4.75 mm is shown in Figure 17.

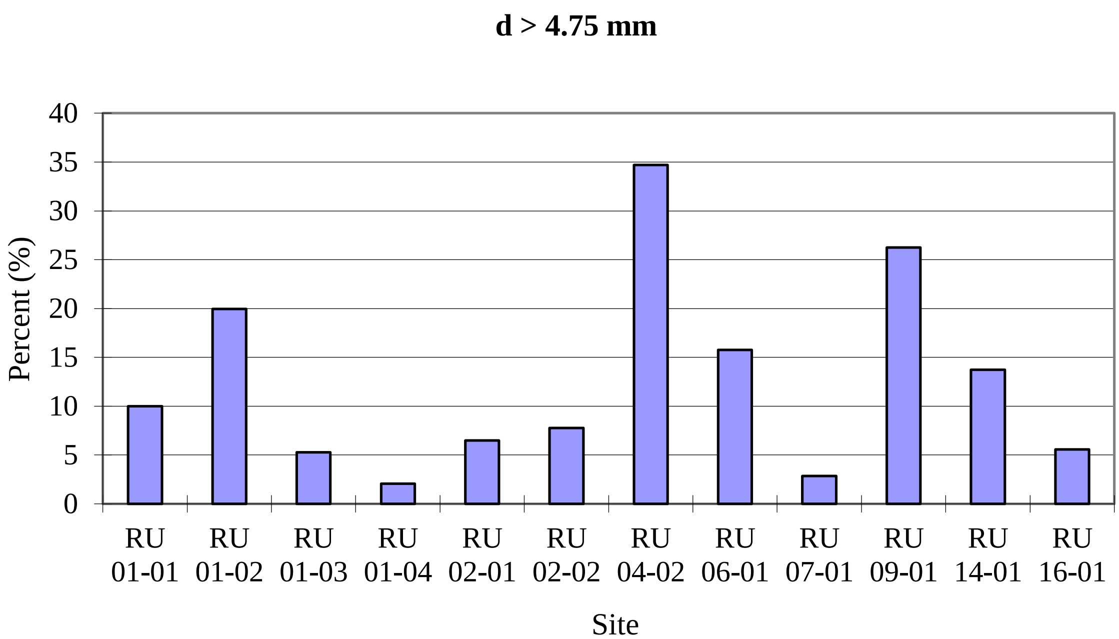


Figure 17. Percentage of particles larger than 4.75 mm

This monitoring guideline is designed for devices that primarily collect particles greater than 75 microns. In this study, on average, 8 percent of the sediment, by weight, of the total sediment in each one of the 12 samples analyzed passed the #200 (75 μm) sieve.

Chemical Analysis for Sediment Samples

Chemical analysis was performed on two samples before sieving. The QC Laboratories was contracted to perform chemical analysis of the sediment samples; the analytical methodology is shown in Table 6.

The results of the analysis concluded that concentrations of Arsenic, Cadmium, Copper, Lead and Zinc were well below levels that are considered hazardous. The Total Kjeldahl Nitrogen and the Total Phosphorus concentrations were compared to non-residential soil quality from Rutgers pinelands field station data (Tuininga et al. 2002); on average the concentrations measured were higher than non-residential soil quality.

Table 6. Analytical methodology for organic debris and coarse solids

Constituents	Method Reference	Laboratory Reporting Limits (RLs)
Arsenic	SW846 Method 6010B	1.34 mg/kg
Copper	SW846 Method 6010B	1.34 mg/kg
Lead	SW846 Method 6010B	2.67 mg/kg
Zinc	SW846 Method 6010B	0.07 mg/kg
Kjeldahl Nitrogen	EPA 600 Method 351.2	119. mg/kg
Phosphorus Total	SM 20th Ed. 4500-P B.5 E	8.78 mg/kg

Arsenic: The Arsenic concentrations from the twelve devices ranged from 0 to 3.88 mg/kg. Most of the Arsenic concentrations were lower than median concentrations for residential and non-residential soil quality (20 mg/kg).

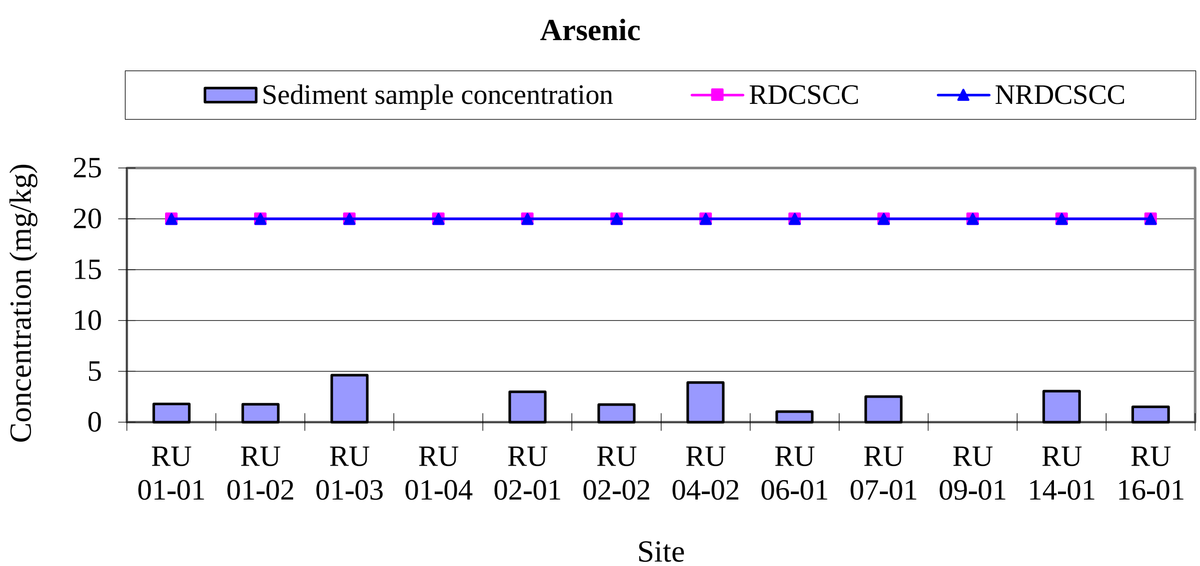


Figure 18. Concentration of arsenic in sediment compared to residential direct contact soil cleanup criteria (RDCSCC) and non-residential direct contact soil cleanup criteria (NRDCSCC)

Copper: The Copper concentrations from the twelve devices ranged from 30.9 to 136.5 mg/kg. Most of the Copper concentrations were lower than median concentrations for residential and non-residential soil quality (600 mg/kg).

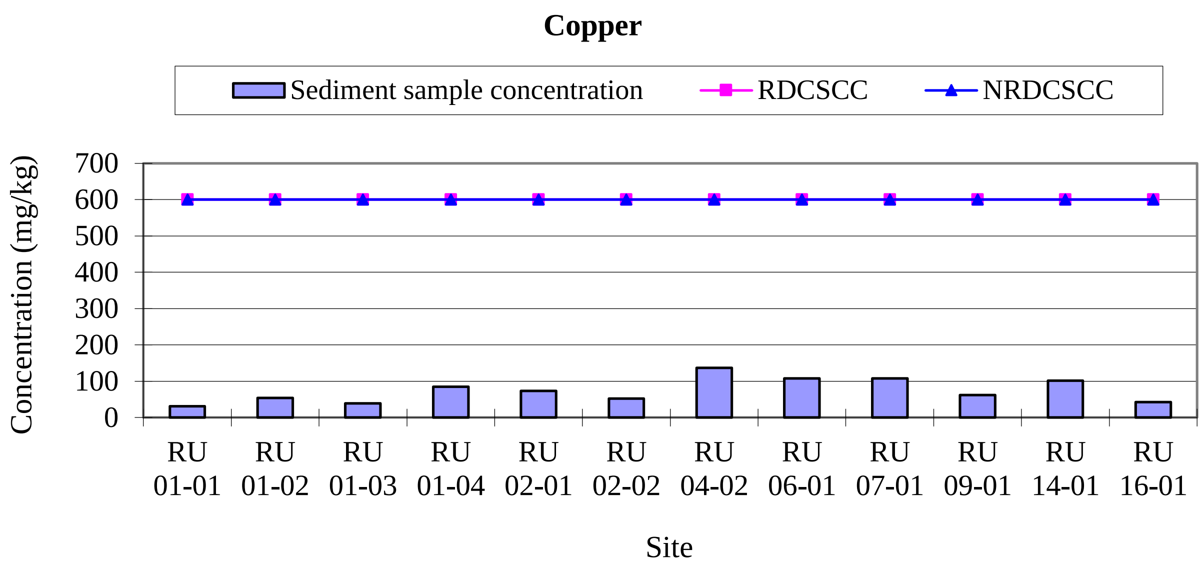


Figure 19. Concentration of copper in sediment compared to residential direct contact soil cleanup criteria (RDCSCC) and non-residential direct contact soil cleanup criteria (NRDCSCC)

Lead: The Lead concentrations from the twelve devices ranged from 17.9 to 163.6 mg/kg. Most of the Lead concentrations were lower than median concentrations for residential soil quality (400 mg/kg) and non-residential soil quality (600 mg/kg).

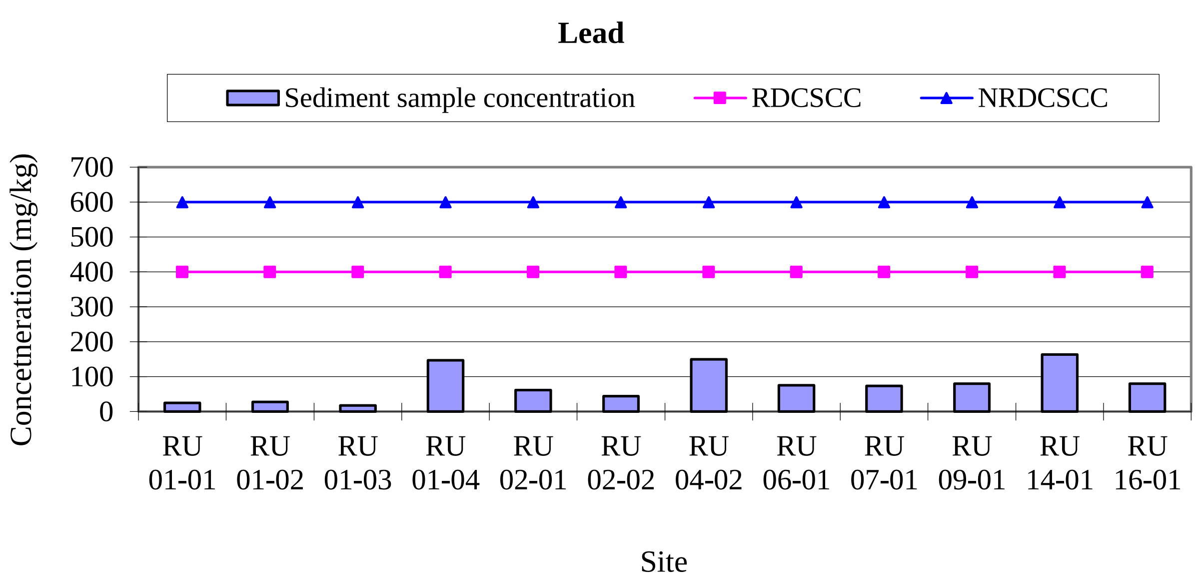


Figure 20. Concentration of lead in sediment compared to residential direct contact soil cleanup criteria (RDCSCC) and non-residential direct contact soil cleanup criteria (NRDCSCC)

Zinc: The Zinc concentrations from the twelve devices ranged from 59.6 to 587 mg/kg. Most of the Zinc concentrations were lower than median concentrations for residential and non-residential soil quality (1500 mg/kg).

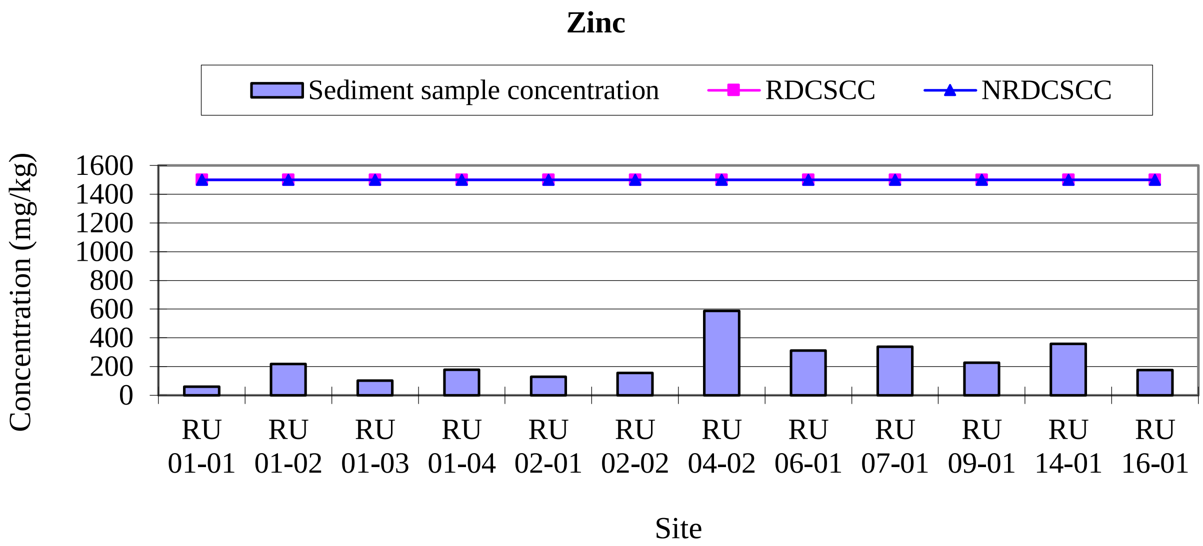


Figure 21. Concentration of zinc in sediment compared to residential direct contact soil cleanup criteria (RDCSCC) and non-residential direct contact soil cleanup criteria (NRDCSCC)

TKN: The Total Kjeldahl Nitrogen concentrations from the twelve devices ranged from 195 to 2885 mg/kg. Most TKN concentrations were higher than concentrations for forest soil quality (219 mg/kg) from Rutgers pinelands field station data.

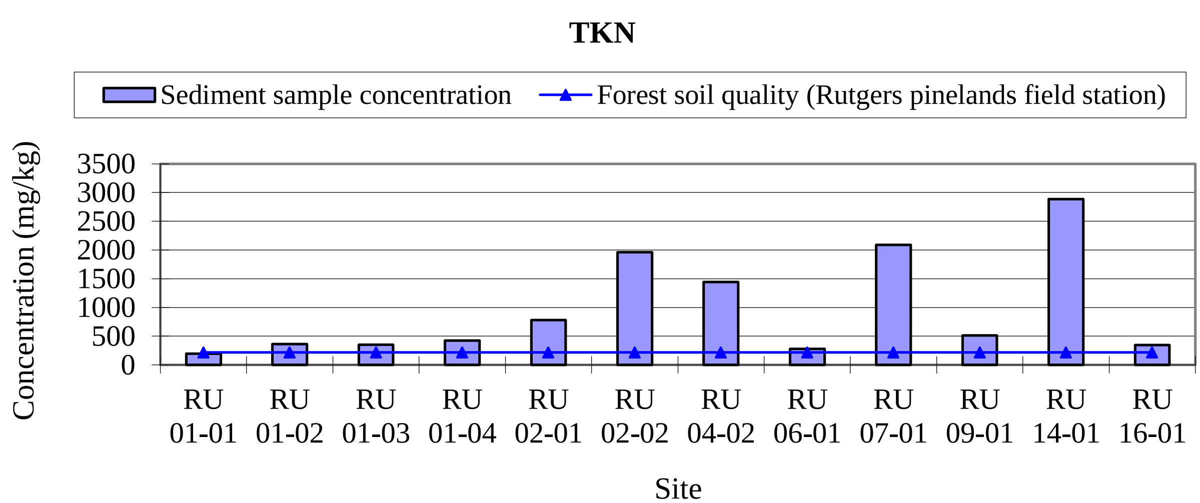


Figure 22. Concentration of total kjeldahl nitrogen (TKN) in sediment compared to forest soil quality (Rutgers pinelands field station)

TP: The Phosphorus Total concentrations from the twelve devices ranged from 83.8 to 705 mg/kg. Most TP concentrations were higher than concentrations for forest soil quality (94 mg/kg) from Rutgers pinelands field station data.

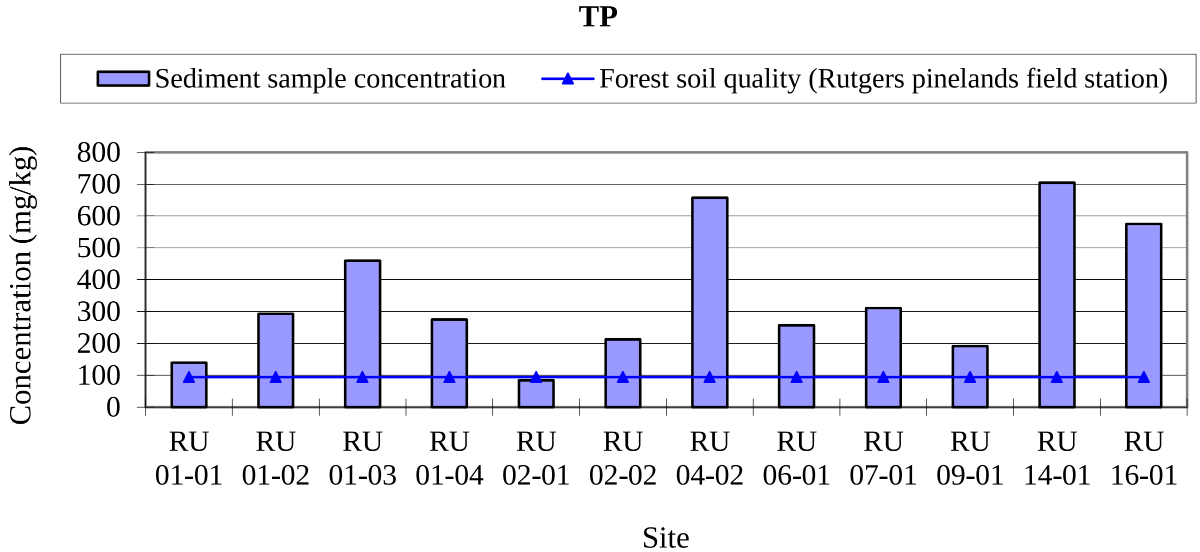


Figure 23. Concentration of total phosphorus (TP) in sediment compared to forest soil quality (Rutgers pinelands field station)

Percent Organic Matter of Sediment

A common organic content analysis is the loss-on-ignition (LOI) method that is carried out at high temperatures. For this study, ASTM D2974 Method C, which consists of an ash burning at 440 degrees Celsius, was used. One concern with the LOI method is the possibility that inorganic constituents of the soil may lose structural water and carbonate minerals; and in some cases hydrated slats are decomposed upon heating (Nelson and Sommers, 1996).

The organic content of the sediments ranged from 2.7 % to 33.8 %. The highest value was 33.8 % from the site RU01-03, which had long drainage ditches located beside the University's turf field. The second highest was 24.3% from the site RU07-01, located in an open/non-urban area and the lowest value was 2.7 % from RU06-01, located in an urban area.

Table 7. Measurement of Organic Content in Bottom Sediments

ID	Weight of aluminum pan (mg)	Weight of residue + pan before ignition (mg)	Weight of residue + pan after ignition (mg)	Organic content(%)
RU01-01	14.01	140.50	109.25	22.2
RU01-02	14.28	160.60	140.15	12.7
RU01-03	14.32	213.93	141.71	33.8
RU01-04	15.22	157.53	143.52	8.9
RU02-01	13.53	188.80	151.30	19.9
RU02-02	13.74	196.58	155.42	20.9
RU04-02	13.75	213.44	193.50	9.3
RU06-01	13.80	175.90	171.21	2.7
RU07-01	15.71	185.16	140.19	24.3
RU09-01	13.97	203.71	188.23	7.6
RU14-01	14.20	113.33	91.51	19.3
RU16-01	14.90	190.78	146.80	23.1

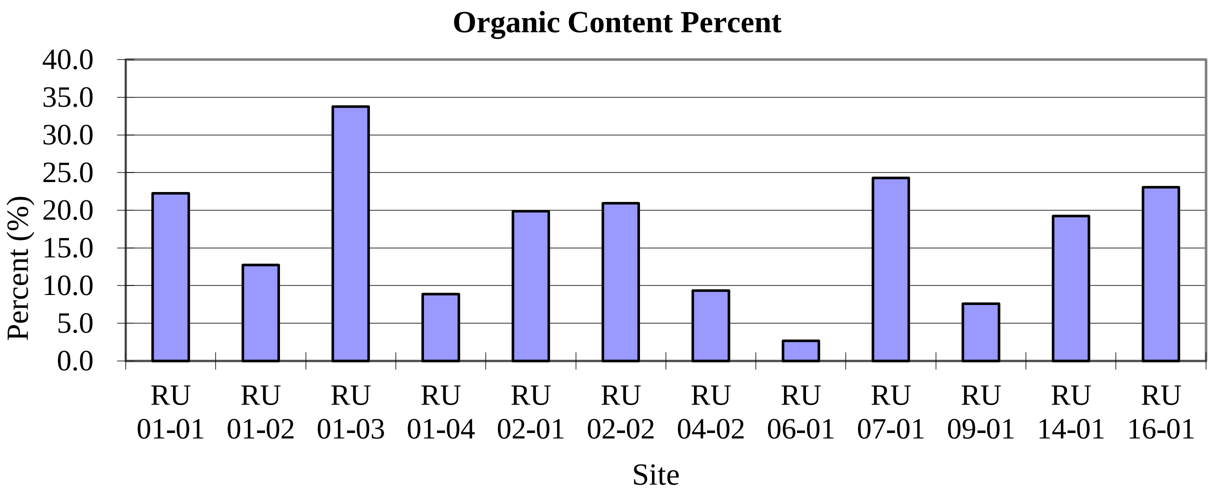


Figure 24. Percentage of organic content from bottom sediments

POST-CLEANOUT MONITORING

The monitoring program began once the device was in a clean state and performed every two months thereafter. The earliest monitoring day was January of 2007 and the latest day was July of 2008. The monitoring period is scheduled to last three years, in which valuable data will be gathered to predict future cleanout periods. In general, there can be large variations in pollutants accumulated in the device between rainfall events due to variables such as rainfall intensity and duration, antecedent dry periods, land use, soil type, seasonality, deicing practices, etc. These variations are even more significant for Gross and Suspended Solids than dissolved solids (Rushton and England

2007). In order to normalize these variations, yearly data accumulation measurements of solids will provide more useful results than shorter time frequency comparisons. The main purpose of monitoring is to check that the sediment, amount of floatables, and oil levels in the grit chamber. The monitoring date and the depth of sediment accumulated in the device are shown in Table 8 and Table 9.

Table 8. Monitoring of Devices Starting from the Clean State (every two months)

ID	Clean-out	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
RU 01-01	02/01/2008	04/15/2008	06/04/2008	08/13/2008	10/16/2008	12/19/2008	02/16/2009	04/17/2009	06/26/2009	08/15/2009	
RU 01-02	02/01/2008	04/15/2008	06/04/2008	08/13/2008	10/17/2008	12/19/2008	02/16/2009	04/17/2009	06/26/2009	08/15/2009	
RU 01-03	02/26/2008	04/27/2008	06/30/2008	09/04/2008	11/03/2008	01/12/2009	03/02/2009	05/08/2009	07/10/2009	09/17/2009	
RU 01-04	01/11/2008	03/19/2008	05/23/2008	07/22/2008	09/19/2008	11/21/2008	01/20/2009	03/14/2009	05/14/2009	07/16/2009	09/17/2009
RU 02-01	12/10/2007	02/18/2008	04/21/2008	06/30/2008	08/25/2008	10/26/2008	12/28/2008	02/25/2009	04/28/2009	06/29/2009	09/21/2009
RU 02-02	01/09/2008	03/19/2008	05/23/2008	07/22/2008	09/22/2008	11/21/2008	01/21/2009	03/18/2009	05/10/2009	06/29/2009	09/21/2009
RU 04-02	01/16/2008	03/10/2008	05/16/2008	07/14/2008	09/15/2008	11/15/2008	01/19/2009	03/27/2009	05/12/2009	07/28/2009	
RU 06-01	02/28/2008	04/27/2008	06/30/2008	08/25/2008	10/25/2008	12/29/2008	02/27/2008	04/30/2009	06/28/2009		
RU 07-01	03/13/2008	05/10/2008	07/07/2008	09/04/2008	11/05/2008	01/12/2009	03/14/2009	05/15/2009	07/20/2009	09/20/2009	
RU 09-01	12/19/2007	02/19/2008	05/31/2008	07/29/2008	09/27/2008	11/24/2008	01/27/2009	03/22/2009	05/25/2009	07/16/2009	
RU 14-01	05/08/2008	07/08/2008	09/10/2008	11/11/2008	01/13/2009	03/09/2009	05/08/2009	07/10/2009			
RU 16-01	02/07/2008	04/10/2008	06/06/2008	08/04/2008	10/07/2008	12/07/2008	02/10/2009	04/10/2009	06/22/2009	08/10/2009	

Table 9. Depth of Sediment Accumulated in Grit Chamber (ft)

Month / ID	2	4	6	8	10	12	14	16	18	20
RU01-01	0.00	0.00	0.10	0.00	0.10	0.03	0.03	0.10	0.10	
RU01-02	0.00	0.10*	0.10	0.10	0.15	0.13	0.15	0.17	0.23	
RU01-03	0.00	0.10	0.10	0.23	0.30	0.22	0.24	0.27	0.37	
RU01-04	0.00	0.10*	0.20*	0.20	0.23	0.23	0.25	0.30	0.47	0.77
RU02-01	0.00	0.10*	0.10	0.10	0.10	0.20*	0.10	0.10	0.17	0.37
RU02-02	0.00	0.00	0.10*	0.10	0.00	0.10	0.07	0.10	0.13	0.23
RU04-02	0.00	0.00	0.10	0.20	0.10	0.20	0.25	0.27	0.40	
RU06-01	0.30*	0.30	0.30	0.30	0.58	0.55	0.58	0.70		
RU07-01	0.00	0.00	0.10	0.33	0.46	0.40	0.50	1.53	2.30	
RU09-01	0.00	0.10*	0.20*	0.20	0.20	0.28	0.23	0.27	0.33	
RU14-01	0.00	0.10	0.10	0.13	0.15	0.15	0.23			
RU16-01	0.00	0.20*	0.20	0.20	0.23	0.28	0.30	0.35	0.43	

* Only a quarter of the bottom area (adjacent to the grit chamber inlet) was covered with sediment.

Table 10. Covered Area of Floatables in the Chamber (ft)

Month / ID	2	4	6	8	10	12	14	16	18	20
RU01-01	**Very Little**	Very Little	Very Little	Very Little	Very Little	Very Little	Very Little	Very Little	Very Little	
RU01-02	Very Little	5-10%	5-10%	5-10%	10-15%	10-15%	10-15%	10-15%	15-20%	
RU01-03	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
RU01-04	5-10%	5-10%	5-10%	5-10%	10-15%	10-15%	15-20%	15-20%	20-25%	20-25%
RU02-01	Very Little	Very Little	5-10%	5-10%	10-15%	10-15%	5-10%	10-15%	10-15%	15-20%
RU02-02	Very Little	Very Little	Very Little	5-10%	5-10%	5-10%	5-10%	5-10%	10-15%	10-15%
RU04-02	5-10%	5-10%	5-10%	5-10%	10-15%	10-15%	10-15%	15-20%	15-20%	
RU06-01	5-10%	10-15%	10-15%	5-10%	5-10%	10-15%	10-15%	5-10%		
RU07-01	Very Little	Very Little	5-10%	10-15%	10-15%	10-15%	10-15%	20-25%		
RU09-01	5-10%	Very Little	5-10%	5-10%	10-15%	10-15%	10-15%	10-15%	15-20%	
RU14-01	Very Little	5-10%	10-15%	10-15%	15-20%	15-20%	10-15%			
RU16-01	Very Little	5-10%	5-10%	10-15%	10-15%	10-15%	10-15%	10-15%	10-15%	

Specific Monitoring and Investigation of Unusual Sites

<u>RU01-01</u>
Six months after cleanout, a very thin layer of sediment was measured at only a quarter of the bottom area adjacent to the grit chamber inlet. Also, very little floatables were observed. Until eighteen months from cleanout day, the depth range of accumulated sediment was 0 to 0.1 feet and floatables covered very little area. Oil sheen was not observed. During the monitoring period it was noticed that the depth of sediment accumulated in the grit chamber was very little.

The difference between expected and observed results is due to an incorrectly constructed diversion chamber. The stormwater runoff is not being diverted to the installed Vortechs stormwater treatment device, thus is not receiving treatment. The runoff produced by small frequent rainfalls or early part of large infrequent rainfalls should have been diverted to the treatment device, since this part of the runoff contains the most pollutants. However, no weir was installed inside the main storm sewer line to divert the low flow to the treatment device. Moreover, invert of the diverting/inlet pipe to the device was positioned higher than that of the main storm sewer line, preventing any low flow from entering the treatment device.

The device was installed as an offline system. For a correctly designed and installed offline system, low flow would be diverted entirely to the treatment device, and after treatment, it would be directed back to the main storm sewer line (Figure 25). During a high flow, only a small portion of the flow would be diverted to the treatment device, and the remaining large portion would bypass the treatment device and continue along the main storm sewer line.

A field observation was conducted on June 5, 2009 shortly after a small rainfall. The runoff was observed to enter the main storm sewer line (Figure 26), but the flow continued along the main storm sewer (Figure 27), without entering the treatment device (Figure 28).

Water level in the diversion chamber was observed to be below invert of the diverting/inlet pipe (Figure 28). Water depth in the diversion chamber was approximately eight inches. In a correct installation, inflow to the treatment device would occur before outflow from the diversion chamber. But in this incorrect installation, inflow to the treatment device did not occur (Figure 28) even after outflow from the diversion chamber occurred (Figure 27).

Since little or no solids-laden stormwater has been diverted to the treatment device due to faulty installation, there is practically no sediment trapped in the treatment device even after more than five years of installation.

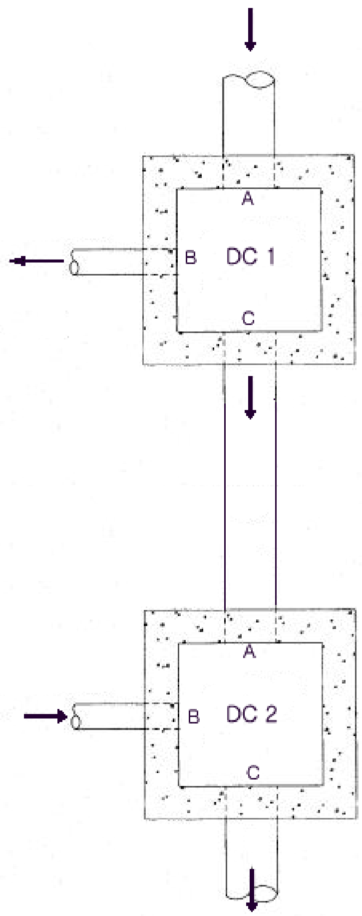


Figure 25. Schematic of flow diversion from main storm sewer to an offline treatment device

Figure 26. Inflow to diversion chamber (Point A in DC 1 in Figure 25)

Figure 27. Outflow from diversion chamber (Point C in DC 1 in Figure 25)

Figure 28. No flow from diversion chamber to treatment device (Point B in DC 1 in Figure 25).

RU01-02

Four months after cleanout, a very thin layer of sediment and little floatables could be measured. Until eighteen months from cleanout day, the depth range of accumulated sediment was 0.2 to 0.3 feet and floatables covered 15-20% of the surface. Some oil sheen was also observed four months after cleanout.

RU01-03

Four months after cleanout, a very thin layer of sediment could be measured. Sediment sampled from the telescoping measurement rod was very soft and organic. This likely resulted from the device having been connected to an open drainage channel which drains to a grassy area. Since the device is deep underground, floatables and oil sheen were difficult to observe. Until eighteen months from cleanout day, the average sediment depth was about 0.37 feet.

RU01-04

Two months after cleanout, little floatable litter was observed. At four months, a very thin layer of sediment was measured at only a quarter of the bottom area adjacent to the grit chamber inlet. At eight months, sediment covered the entire bottom of the grit chamber. Until eighteen months from cleanout day, the depth range of accumulated sediment was 0.4 to 0.5 feet: average depth was 0.47 feet. Due to heavy rain events between July and September 2009, a relatively large amount of sediment accumulation was noticed in the grit chamber. At twenty months, the averaged sediment depth was 0.77 feet and floatables covered about 20-25% of the surface. At every inspection interval, some oil sheen was observed.

RU02-01

Four months after cleanout, a very thin layer of sediment was measured at only a quarter of the bottom area adjacent to the grit chamber inlet. Also, little floatables were observed. Until twenty months from cleanout day, the average depth of accumulated sediment was 0.37 feet and floatables covered about 15-20% of the surface. A couple of oil strips were observed four months after cleanout day.

RU02-02

Six months after cleanout, a very thin layer of sediment was measured at only a quarter of the bottom area adjacent to the grit chamber inlet. Little floatables were observed at the second inspection. Until twenty months from cleanout day, the average depth of accumulated sediment was 0.23 feet and floatables covered about 10-15% of the surface. A couple of oil strips were observed four months after cleanout day.

RU04-02

Four months after cleanout, a very thin layer of sediment could be measured. Little floatable litter was observed at the first inspection. Until eighteen months from cleanout day, the average depth of accumulated sediment was 0.4 feet and floatables covered about 15-20% of the surface. Some oil sheen was observed at every inspection interval.

RU06-01

During cleanout activity, some turbid water flowed back into the device and mush sediment settled down in the outlet chamber of device. The depth of sediment in the outlet chamber was approximately 0.3 ft. Backflow from outfall was not observed during the monitoring period. However, there was sediment in both the floatables chamber, and outlet chamber. Mush sediment from the grit chamber flowed into the floatables chamber and the outlet chamber. Until sixteen months after cleanout, the average depth of sediment of the grit, floatables and outlet chamber were 0.77, 0.7 and 1.3 feet respectively.

At the first inspection, which occurred two months after cleanout, 0.3 feet of sediment was measured at a quarter of bottom area adjacent to the grit chamber inlet and floatables covered about 5% of the surface. Water in the chamber was cloudy and sediment was very soft, not much sand or silt was observed. The presence of mush sediments was also confirmed when the measuring rod was extracted from the device and a film of mush was deposited on the rod.

At four months, sediment covered the entire bottom of the grit chamber. Floatables covered about 5-10% of the surface until sixteen months after cleanout. Some oil sheen was observed at every inspection interval.

Construction activities (beneath the overpass) observed near Tonnelle Ave has contributed to sand washing into the storm sewers. One catch basin in the network is completely backed-up, due to a considerable amount of sand deposits. On 36th street, beneath Paterson Plank Rd., there is a significant amount of mush sediment on the roadway directly in front of the scupper. Although the exact source of the mush sediment is not fully known at this time, it is assumed, based on its location (near the scupper outlet), that it is washing off of the bridge deck. This mush sediment is washing directly into the nearest catch basin to the device and is settling in the grit chamber.

RU07-01

Six months after cleanout, a very thin layer of sediment and little floatables could be measured. Until fourteen months from cleanout day, the average depth of accumulated sediment was 0.58 feet and floatables, which were mostly organic debris. Oil sheen was hardly observed.

Between May and September 2009, there was a significant increase of accumulated sediment. Eighteen months from cleanout day, the average depth of accumulated sediment was 2.30 feet. Sand sediment was above the water surface in a quarter of the grit chamber area near inlet and the rest of the area was covered with organic and mush sediment.

It was noticed that a driveway comprised mostly of sand was eroded from a nearby farm and the sand was washing into the network. Not only eroded sand, but also a large amount of deposited sand was at the driveway of the construction area. Sand was seen deposited outside of the effluent culvert and inside the drainage manholes (Figure 29). Also, the RU07-01 site has steep roads and the slope of pipe connected to the device is 0.04, which is the highest in our research. Eroded sand from the farm, deposited sand from construction activity, heavy rain events (51.16 inches between September 25th 2008 and September 24th 2009), and steep roads were responsible for unusually high increases of accumulated sediment.

Figure 29. Eroded sand into network: (a) Sand was eroded from the driveway to the farm, (b) Sand was eroded from the driveway to the construction area

<u>RU09-02</u>
Four months after cleanout, a very thin layer of sediment was measured at only a quarter of the bottom area adjacent to the grit chamber inlet. Meanwhile, little floatables were observed at the first inspection. Until sixteen months from cleanout day, the depth range of accumulated sediment was 0.2 to 0.3 feet, and floatables, which were mostly cigarette butts and beverage cups, covered about 15-20% of the surface. Some oil sheen was observed at every inspection interval.

<u>RU14-01</u>
Four months after cleanout, a very thin layer of sediment and little floatables could be measured. Until fourteen months from cleanout day, the average depth of accumulated sediment was 0.3 feet and floatables covered about 10-15% of the surface. Some oil sheen was observed at every inspection interval.

<u>RU16-01</u>
Four months after cleanout, 0.2 feet of sediment and little floatables could be measured at only a quarter of the bottom area adjacent to the grit chamber inlet. Also, little floatables were observed. Until sixteen months from cleanout day, the average depth of accumulated sediment was 0.4 feet and floatables covered about 10-15% of the surface. Some oil sheen was observed four months after cleanout.
Normally, a very thin layer of sediment could be measured four months after cleanout day and significant increase in summer 2009 was observed.

DRAINAGE AREA ASSESSMENT

The drainage area data was gathered from the corresponding design companies and information for the devices was obtained from the manufacturing company's verification report. Pipe information such as slope, length and diameter of the connected device was obtained from NJDOT Drainage plans. Manning's n value of storm sewer is 0.011-0.012 from the Concrete Pipe Design Manual (American Concrete Pipe Association, 2000).

Table 11. Drainage Area Information

ID	Model	SS[a] (yd^3)	MPV[b] (gall.)	MTC[c] (cfs)	DA[d] (acres)	DA/CA[e] ($acre/ft^2$)	Pipe Slope	Pipe L. (m)	Pipe Diameter & Material
RU01-01	16000	7.1	2774	25.2	4.97*	0.044	0.00357	43.4	855 mm*1345 mm H.E.R.C.C.P.
RU01-02	7000	4.0	1244	11.2	1.13*	0.023	0.00758	24	450 mm (c)
RU01-03	7000	4.0	1244	11.2	0.98*	0.020	0.01471	31	600 mm (c)
RU01-04	7000	4.0	1244	11.2	1.45*	0.029	0.01562	6.4	750 mm (c)
RU02-01	16000	7.1	2774	25.2	0.61*	0.005	0.00909	11	490*770 mm R.C.E.C.P. Class HE-III
RU02-02	9000	4.8	1582	14.2	0.61*	0.010	0.00556	9	450 mm R.C.C.P
RU04-02	11000	5.6	1947	17.5	7.70	0.097	0.00556	9	750 mm R.C.C.P
RU06-01	3000	1.8	506	4.4	1.18	0.059	0.00571	3.5	525 mm Pipe (C&SM)
RU07-01	9000	4.8	1582	14.2	1.28	0.020	0.04101	3.95	450 mm R.C.C.P
RU09-01	3000	1.8	506	4.4	0.49	0.025	0.01000	3	450 mm R.C.C.P
RU14-01	16000	7.1	2774	25.2	2.45*	0.022	0.00152	6.6	1050 mm R.C.C.P
RU16-01	5000	3.2	952	8.6	1.13*	0.030	0.00730	13.7	600 mm R.C.C.P

* Calculated approximate areas from drainage construction plans.
a. Sediment Storage (yd^3)
b. Maintenance "Pump Out" Volume (gallons)
c. Maximum Treatment Capacity (cfs)
d. Drainage Area (acres)
e. Drainage Area / Grit Chamber Area ($acres/ft^2$)

Traffic Counts

The traffic volume was counted for 15 minutes from 8:15 a.m. to 8:30 a.m. Traffic count in number of vehicles per hour is shown in Table 12.

Table 12. Traffic Count in Number of Vehicles Per Hour (Based on 15-minute count from 8:15 a.m. to 8:30 a.m.)

RU01-01	1688	96	1784
RU01-02	712	28	740
RU01-03	644	44	688
RU01-04	728	32	760
RU02-01	1140	28	1168
RU02-02	972	24	996
RU04-02	2624	464	3088
RU06-01	1292	100	1392
RU07-01	1116	32	1148
RU09-01	1488	80	1568
RU14-01	4984	360	5344
RU16-01	1092	40	1132

New Jersey Precipitation

Average annual precipitation ranges from about 40 inches along the southeast coast to 51 inches in north-central parts of the state. Many areas average between 43 and 47 inches (ONJSC, 2009).

The daily precipitation at each site during monitoring period is shown in Figure 30. Precipitation data were gained from NJWxnet (New Jersey Weather and Climate Network) and NCDC (National Climatic Data Center).

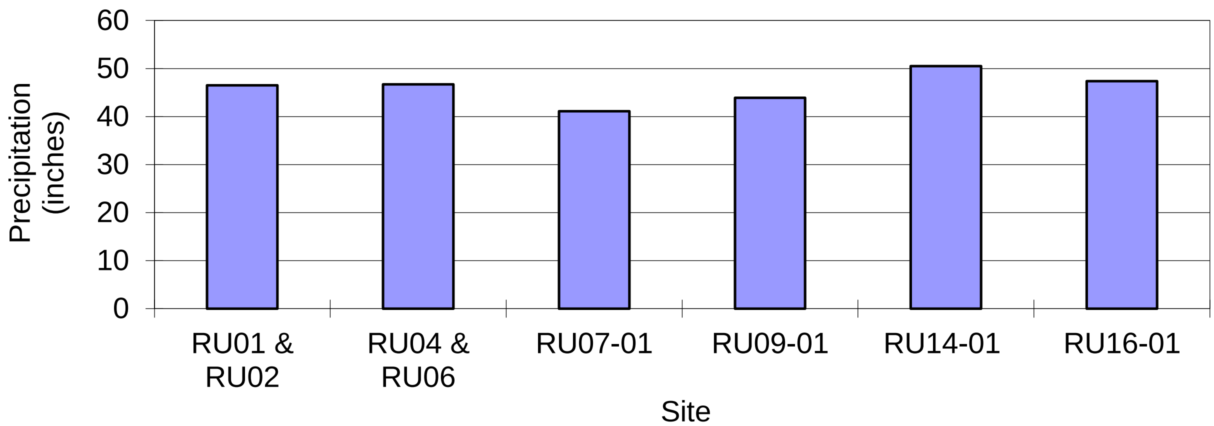


Figure 30. Precipitation in one year (07.01.2008 ~ 06.30.2009)

Specific Information

RU01-01

The device is located in Piscataway, NJ. Site RU01-01 has heavy traffic and a large drainage area. The approximate drainage area from the drainage construction plans is 4.97 acres and the ratio of the device chamber area to drainage area is 0.044 (acres/ ft^2). The traffic volume is 1784 vehicles per hour at rush hours. The largest device, which is model number 16000, is installed on Landing Lane and belongs to the Route 18 extension project. The area covered by this device is River Road, which connects to Route 18, Rutgers University and I-287. Storm drainage area and network are shown in Appendix: H.

RU01-02

The approximate drainage area is 1.13 acres and the ratio of the device chamber area to drainage area is 0.023 (acres/ ft^2). The traffic volume is 740 vehicles per hour at rush hours. The area covered by this device is Route 18 exit ramp connects to River road. This site contained long drainage swale, located beside Route 18 ramp.

RU01-03

The approximate drainage area is 0.98 acres and the ratio of the device chamber area to drainage area is 0.020 (acres/ ft^2). The traffic volume is 688 vehicles per hour at rush hours. This site contained long drainage ditches, located beside an athletic turf field, which channeled additional water into the network. The area has a steep slope. The slope of pipe connected to device is 0.147.

RU01-04

The approximate drainage area is 1.45 acres and the ratio of the device chamber area to drainage area is 0.029 (acres/ ft^2). The traffic volume is 760 vehicles per hour at rush hours. The area covered by the device is River road, and the residential area has a steep slope. The slope of pipe connected to device is 0.1562.

RU02-01 and RU02-02

Devices are located in Edison, NJ. The approximate drainage area is 0.61 acres and the ratio of RU02-01's chamber area to drainage area is 0.005 (acres/ ft^2). This ratio is the smallest number in our study. In this case, the largest device (model #16000) covers a relatively small drainage area (0.61 acres). The ratio for RU02-02 is 0.010. The traffic counts are 1168 (RU02-01) and 996 (RU02-02) vehicles per hour at rush hours. The area covered by the device is Route 27 and Evergreen road. The storm drainage area and network are shown in Appendix H.

RU04-02

Site RU04-02 has the largest drainage area. The device is located in Elizabeth, NJ and the drainage area of site RU01-04 is 7.69 acres. The area was obtained from Summary of proposed stormwater treatment system design data (TAMS Consultants, Inc., 2003). The drainage covered not only main roads such as Route 1&9, but also four very large parking lots in commercial area. The ratio of the device chamber area to drainage area is 0.097 (acres/ ft^2) and is the largest number in our research. The traffic volume is 3088 vehicles per hour at rush hours.

<u>RU06-01</u>
The device is located in North Bergen, NJ and the drainage area of site RU01-04 is 1.18 acres. The value was obtained from Drainage report: Route U.S.1&9 - Section 7E Paterson Plank Road (URS Greiner Woodward Clyde, 2000). The ratio of the device chamber area to drainage area is 0.059 (acres/ ft^2) and the traffic volume is 1392 vehicles per hour at rush hours.
According to the construction documents provided, which detail the drainage network of the bridge deck, there should be a drain on the median near the light where vehicles turn to merge onto Tonnelle Ave. During the monitoring it was noticed that no catch basin was present at that location, and no scupper was observed in the area where that drain would have its outflow. However, it is important to note that the location in question is the abutment for the bridge and is enclosed in concrete - so any substructure drainage would not be easily seen.

<u>RU07-01</u>
The device is located in Deptford, NJ and the drainage area of site RU07-01 is 1.28 acres. The value was obtained from Stormwater system analysis report for Route 47 and Cattell Road (CMX (Schoor DePalma), 1999). The ratio of the device chamber area to drainage area is 0.020 (acres/ ft^2) and the traffic volume is 1148 vehicles per hour at rush hours. During inspection, it was noticed that a driveway comprised mostly of sand was eroded from a nearby farm and a large amount of deposited sand was on the driveways of the construction area.
According to the design plan, a Stormceptor model 1800 device was supposed to be installed, but Vortechs device model 11000 was installed instead. The area has a steep slope. The slope of pipe connected to device is 0.04, which is the largest slope in our research.

<u>RU09-01</u>
The device is located in Lakewood, NJ and the RU09-01 site has a small drainage area (0.49 acres) and device (model #3000). The value was obtained from Drainage report: Route 9 - Lake Carasaljo. (Edwards & Kelcey Inc., 2000). The ratio of the device chamber area to drainage area is 0.025 (acres/ ft^2) and the traffic volume is 1568 vehicles per hour at rush hours.

RU14-01
The device is located in Parsippany, NJ. Site RU14-01 has the largest traffic volume (5344 vehicles per hour) in the study. The approximate drainage area is 2.45 acres and the device chamber area over the drainage area is 0.022 (acres/ ft^2). The area covered by the device is US-46 and New road area. Storm drainage area and network are shown in Appendix H.

RU16-01
The device is located in Frankford, NJ and the traffic volume is 1132 vehicles per hour at rush hours. The approximate drainage area is 1.13 acres and the ratio of the device chamber area to drainage area is 0.030 (acres/ ft^2). The area covered by the device is US-206 and NJ-15 area. Storm drainage area and network are shown in Appendix H.

DEVELOPMENT OF MAINTENANCE GUIDANCE

Estimated Maintenance Interval

For a general site, 4 years is the recommended cleanout interval. This estimation is based on the monitored time variation of sediment depth and the maximum allowable sediment depth of two feet. If the site has severe erosion, one and a half years are recommended for the cleanout interval.
This cleanout interval is for the device sized according to the uniform intensity design storm in New Jersey. With the new stormwater management rule that specifies a non-uniform storm (NJDEP 2004), the new devices would be larger in size than the ones currently used in this study and the cleanout interval could be longer than that recommended from the study.

There are many combined variables related to the increase in the amount of trapped materials. If unusual activities such as severe erosion, construction activity, and blocking pipes, are noticed, the inspection is recommended on a regular basis every six months as well as after a major storm event.

Maintenance Procedures

Preparation

- Estimated total volume of water and sediment by depth measurement. It is required to confirm the vacuum truck can handle both water and sediment quantities
- Check weather forecast looking for dry day. Also, check forecast the day before working day to reconfirm adequate weather.
- Make arrangements for crash truck and vacuum truck
- Obtain supplies: (Pens, Papers, Camera, Permission letter)
- Obtain safety equipment: (Traffic cones, Outfits (i.e. reflector vests))

- Obtain measurement equipment: (Gloves, Boots, Manhole hook, Telescoping measurement rod, Paper towels, Bleach, Scoops and shovels, Pool skimmer, Oil absorbent booms, Mesh bags, Flashlights)

Pre-Procedure before Using Vacuum Truck

- Open manhole covers with equipment and measure depth of floatables, water and sediment.
- If heavy oil is visible, collect oil with oil absorbent booms.

Cleanout Activity

- Pump water, oil, floatables and solids out together
- Dispose trapped material at an acceptable facility such as the hazardous waste landfill.

Maintenance Reduction Measures

While developing the Maintenance Guidance, the Stormwater Best Management Practices manual by the NJDEP offered useful insights on several aspects of Stormwater Management. Chapter 2 of the BMP, Low Impact Development (LID) Techniques refers to the importance of source control in preventing and reducing the amount of pollutants, floatables, and other contaminants entering the stormwater network. It also lists several structural and non-structural methods to limit the pollutants as well as assist in LID, which prevent undesirable stormwater runoff impacts from occurring and provide necessary treatment alternatives closer to the point of origin of these impacts. Several preventative source control methods are suggested, as following, which can work in tandem with manufactured treatment devices to improve their performance and that of stormwater management practices in general.

- Litter fences, regular sweeping, manual collection and providing trash receptacles throughout the site are methods to reduce the trash and litter accumulated at a site.
- Pet Waste stations installed in residential areas provide bags for waste collection and containers for waste disposal. Stricter rules and high penalties for violators will go a long way in reducing pet litter and waste.
- Reducing the size of drain inlets, grate and curb openings will sieve out floatables and installing alternate devices at storm drain inlets will help reduce trash and debris entering the network.
- Constructing or installing overhangs, knee walls, berms, secondary containment, stormwater diversion devices, oil/grit separators, indoor storage can all help contain or limit spills, leaks and other unwanted accumulation of pollutants which go on to contaminate the runoff. Immediate and proper cleanup after such accidents is also recommended.
- Diversion of stormwater runoff, away from sites of possible contamination or even to vegetated or pervious regions will reduce the runoff.

- It is recommended to standardize indoor storage of all raw materials, finished and byproducts at commercial and industrial sites to prevent exposure to runoff.
- Providing and preserving the existing vegetative cover on as much area as possible will reduce runoff quantities through infiltration, surface storage and evapotranspiration. They also provide surface area for groundwater recharge.
- Pervious paving materials, unconnected impervious areas, vegetated roofs, and increasing the time of concentration of the runoff are all methods that can be employed to enact source control and reduce stormwater runoff quantity.

Design and Construction for Maintenance

There should be easy access to all chambers of a device for cleaning, inspections, and repairs. It had been noted that many floatables chambers of Vortechs were either not accessible or very difficult to access since the device has no cover above the floatables chamber.

The location of the device should provide easy access and safety for cleaning, inspections, and repairs. Also, the location should not block traffic. However, locating the device in the roadway is sometimes the only alternative. In this case, the device should be located on one lane so that the other lanes of traffic can remain open during cleaning and maintenance operations. In the case of RU03 on Doremus Avenue, Newark (Appendix: A), the devices were located in the roadway and some of them installed underneath both lanes. Because Doremus Avenue is a major truck route, it was difficult to shut down or detour traffic.

The device must be essentially clean after installation. It is the responsibility of the installer or contractor to leave the device in a clean state.

Recommended forms for Maintenance

In order to implement a maintenance system properly, it is imperative to have complete information on the characteristics and location of each MTD. Also, keeping track of the dates of each inspection, cleanout procedure and conditions at each site along time will facilitate maintenance forecasting and will allow adjusting the preventive maintenance plan as conditions and seasons change. To facilitate this task, it is recommended that at least three forms are used to keep track of pertinent information: 1) MTD information form, 2) Inspection form, 3) Maintenance form.

The MTD information form contains detailed information on the type of device, the mode of installation (online or offline), the site where it is installed, etc. This form will generally be filled only once, but it might need to be updated as conditions around the site change. The inspection form will contain information relative to the observations made during the regularly scheduled inspections to the MTD and will allow to schedule timely cleanout and maintenance activities. Finally, the maintenance form will be used to describe the tasks performed when the MTD is cleaned out or serviced. Recommended sample forms follow:

Vortechs® MTD Information Data Form

MTD Location Info

MTD ID	Device Name	Model	Serial No.

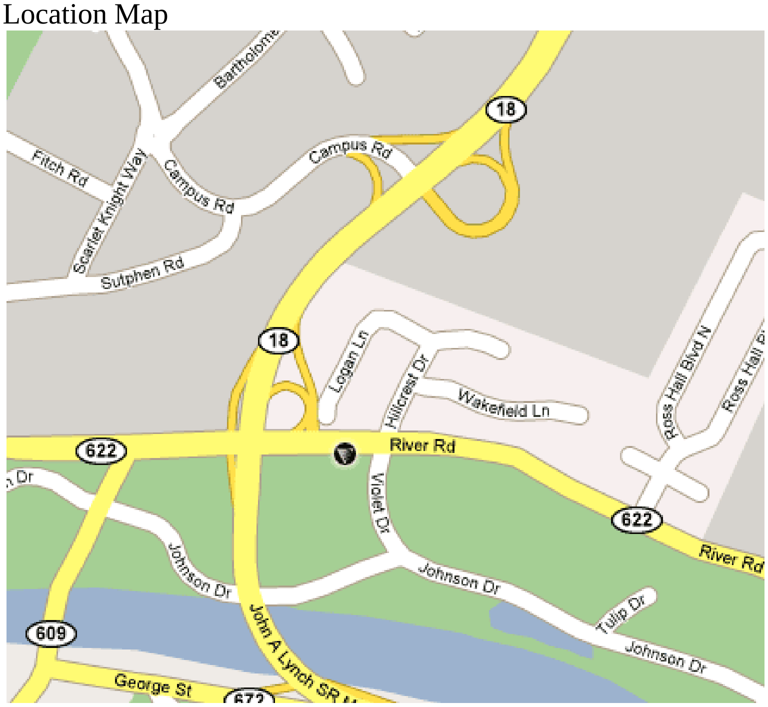
Nearest Road	Road Direction	Municipality	County	Region
	(NB, SB, EB, WB)			

GPS Latitude	GPS Longitude	Elevation (ft)	State Plane Coordinate X	State Plane Coordinate Y

Nearest Cross Road	Nearest Landmark	Nearest Milepost	Distance from Milepost (ft)

Depth from Ground Surface to Device Bottom (ft)	Distance from Roadway Centerline (ft)	Physical Location*	Is Device in Vehicle Traffic?
			(Yes / No)

Location Map



*Physical Location: On the Median, On Road, On Shoulder, On Sidewalk, On Mild-Slope Bank, On Steep-Slope Bank, On Large Traffic Island, On Small Traffic Island, On Parking Lot, on Flat Large Area Open Space, Other

NJDOT Project Info

Project Name	Project No.	Plan Approval Date	Project Completion Date

Project Description	

NJDOT Project Manager	Designer Company/Organization	Designer Name

NJDOT Environment Person	Contractor Company/Organization	Contractor Name	NJDOT Construction Field Manager

Env. Permit Issuer	Permit No.	Permit Date	Design Traffic Data (A.D.T)		
			Road	Present (vpd)	Future (vpd)

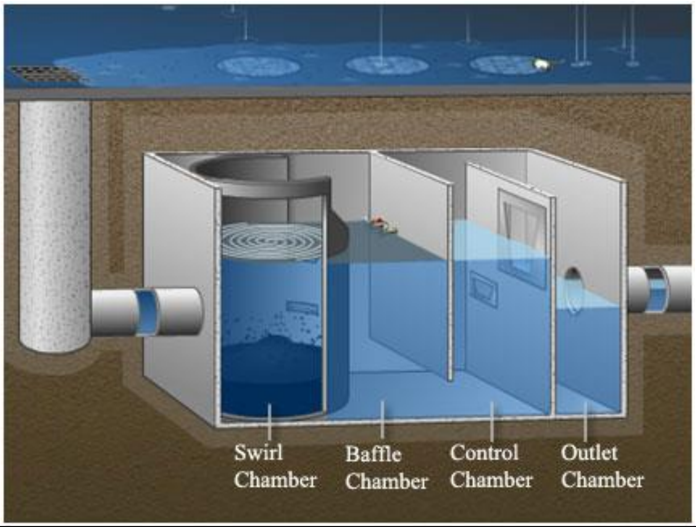
Water Quality Design Storm	Flood Control Design Storm (Maximum)	Groundwater Recharge Design Storm
NJDEP Uniform WQ Design Storm ( ) Non-uniform WQ Design Storm ( )	100-Year Storm ( ) 50-Year Storm ( ) 25-Year Storm ( ) 10-Year Storm ( ) 5-Year Storm ( ) 2-Year Storm ( )	Average Annual Storm ( ) 2-Year Storm ( )

NJDOT UPC	NJDOT Job Number	Route No.	Milepost	Federal Project No.
Municipality 1	Municipality 2	Municipality 3	County 1	County 2

Bid Date	BD Number

Device Characteristics Info

Schematic of Device: Vortechs®



Device Height (ft)	Device Width (ft)	Device Length (ft)	Device Footprint Area (sq. ft)	Materials Used for Manufacturing the Device

No. of Manhole Covers	All Components Visible from Ground?	If Not, Name Component(s) Invisible from Ground	All Compartments Accessible by Vacuum Hose?	If Not, Name Compartment(s) Inaccessible by Vacuum Hose
	(Yes / No)		(Yes / No)	

Swirl Chamber Diameter (ft)	Swirl Chamber Area (sq. ft)	Sediment Storage Capacity (ft^3)	Sediment Storage Depth (ft)	Sediment Cleanout Depth Threshold (ft)

Baffle Chamber Dimensions (approx.)		Baffle Chamber Area (sq. ft)	Trash/ Debris/ Oil Storage Capacity (ft^3)	Trash/ Debris/ Oil Storage Depth (ft)	Trash/ Debris Cleanout Thickness Threshold (ft)	Trash/ Debris Cleanout Area Threshold (%)	Oil Cleanout Thickness Threshold (ft)	Oil Cleanout Area Threshold (%)
Length (ft)	Width (ft)							

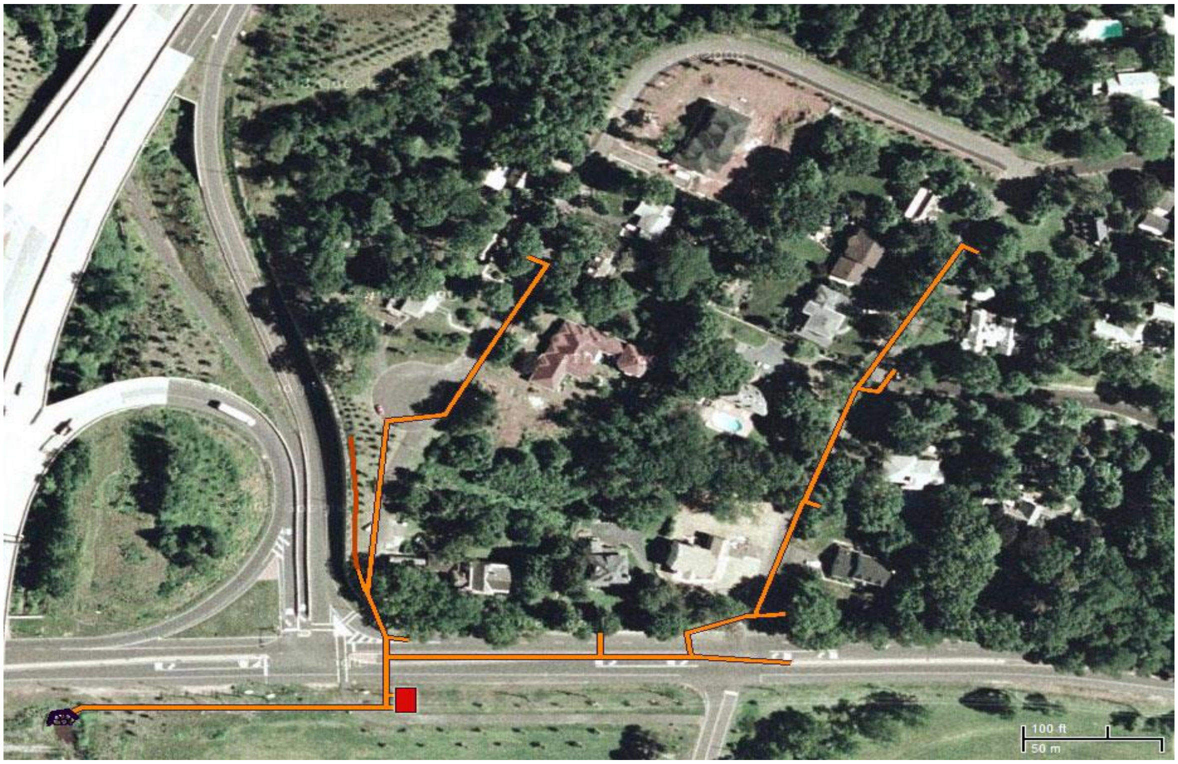
TSS Removal Rate Certified by NJDEP (%)	Maximum Treatment Flow Rate (cfs)	Maximum Hydraulic Flow Rate (cfs)	Head Loss at Maximum Treatment Flow (ft)	Head Loss at Maximum Hydraulic Flow (ft)

Device Vendor	Invoice Date	Delivery Date	Installation Date	Device Cost (includes S&H)	Installation Cost

Item Sequence No. on Plan	Item No. on Plan	Item Name on Plan	Plan Sheet No.	Special Provisions Page No.

Device Watershed Info

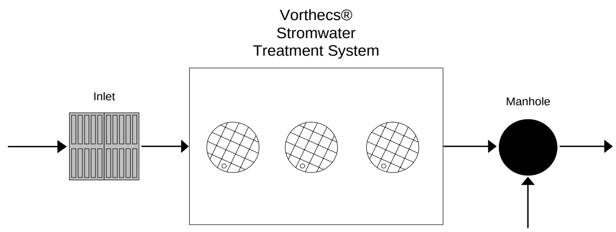
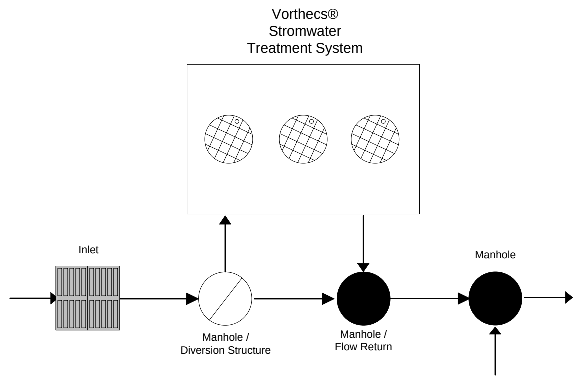
Aerial Satellite Image and Drainage Network



Drainage Area (acre)	Watershed Land Use*	Watershed Soil Type	Percentage of Impervious Area (%)
		(Sand , Silt , Clay)	
Longest Flow Path Length (ft)	Slope along Flow Path	Manning's Roughness Coefficient along Flow Path	Time of Concentration (minutes)
Runoff Coefficient		NRCS Curve Number	

*Watershed Land Use: Commercial, Residential, Mixed(Commercial & Residential), Industrial, Rural, Open Space (Park, Woodland, Golf course, etc.)

Device Spatial Relation Info

<table>
<tr><td colspan="3">Online System

</td><td colspan="3">Offline System

</td></tr>
<tr><td colspan="3">Is Device Offline?</td><td colspan="3">(Yes / No)</td></tr>
<tr><td rowspan="12">For both Offline and Online Device</td><td>Dimensions (Length x Width) of Upstream Inlet or Catch Basin, or Diameter of Upstream Manhole</td><td>Invert Elevation of Upstream Inlet, Catch Basin, or Manhole</td><td>Ground Elevation of Upstream Inlet, Catch Basin, or Manhole</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Diameter of Downstream Manhole or Dimensions (Length x Width) of Catch Basin</td><td>Invert Elevation of Downstream Manhole or Catch Basin</td><td>Ground Elevation of Downstream Manhole or Catch Basin</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Diameter of Upstream Storm Sewer Pipe (ft)</td><td>Invert Elevation of Upstream Storm Sewer Pipe (ft)</td><td>Slope of Upstream Storm Sewer Pipe (ft)</td><td>Material of Upstream Storm Sewer Pipe (ft)</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>Diameter of Downstream Storm Sewer Pipe (ft)</td><td>Invert Elevation of Downstream Storm Sewer Pipe (ft)</td><td>Slope of Downstream Storm Sewer Pipe (ft)</td><td>Material of Downstream Storm Sewer Pipe (ft)</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="8">For Offline Device Only</td><td>Diameter of Upstream Diversion Manhole</td><td>Invert Elevation of Upstream Diversion Manhole</td><td>Ground Elevation of Upstream Diversion Manhole</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Diameter of Downstream Return Manhole</td><td>Invert Elevation of Downstream Return Manhole</td><td>Ground Elevation of Downstream Return Manhole</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Diameter of Upstream Diversion Pipe (ft)</td><td>Invert Elevation of Upstream Diversion Pipe (ft)</td><td>Slope of Upstream Diversion Pipe (ft)</td><td>Material of Upstream Diversion Pipe (ft)</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>Diameter of Downstream Return Pipe (ft)</td><td>Invert Elevation of Downstream Return Pipe (ft)</td><td>Slope of Downstream Return Pipe (ft)</td><td>Material of Downstream Return Pipe (ft)</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Device Outlet Drains to</td><td colspan="4">Other Types of Stormwater BMPs ( )
Outfall ( )</td></tr>
</table>

Additional Comments

Vortechs®MTD Inspection Form

MTD ID	MTD_Inspection_Rec_ID	Weather*	Air Temp. (ºF)

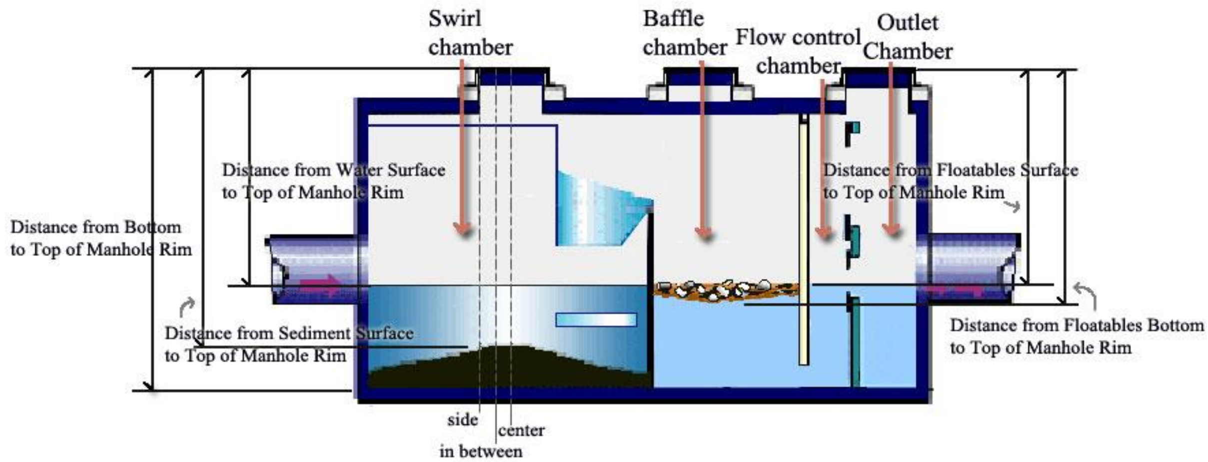
Inspection Date	Inspection Time		Purpose of Inspection	Inspector
MM-DD-YYYY	Start	End	Routine Inspection ( ) Inspection Immediately before Cleanout ( ) Inspection Immediately after Cleanout ( ) Other ( )	
	HH:MM	HH:MM		

Inspection Cost	Last Inspection Date	Inspection Interval (months)	Projected Next Inspection Date	Recent Precipitation Event	
				Date	Depth (in)
	(Function)		(Function)	MM-DD-YYYY	

* Weather: Sunny, Windy, Cloudy, Rainy, Stormy, Blizzard

Measurements from Ground above the Device (Routine Inspection or Inspection Immediately before Cleanout)

Schematic for Measurements: Vortechs®



Swirl Chamber						
Distance from Water Surface to Top of Manhole Rim **(ft)**	Distance from Sediment Surface to Top of Manhole Rim **(ft)**			Distance from Bottom to Top of Manhole Rim **(ft)**	Water Depth **(ft)**	Sediment Depth **(ft)**
	1 [Center]	2 [In Between]	3 [Side]		(Function)	(Function)

Device Cleanout Trigger: Sediment Depth **(ft)**		Cleanout Necessary Based on the Measured Sediment Depth?	Yes or No (Function)

Trash/Debris Areal Coverage **(%)**	Distance from Trash/Debris Surface to Top of Manhole Rim **(ft)**	Distance from Bottom of Trash/Debris to Top of Manhole Rim **(ft)**	Trash/Debris Thickness **(ft)**
			(Function)
Oil Areal Coverage **(%)**	Distance from Oil Surface to Top of Manhole Rim **(ft)**	Distance from Bottom of Oil to Top of Manhole Rim **(ft)**	Oil Thickness **(ft)**
			(Function)

Baffle Chamber						
Distance from Water Surface to Top of Manhole Rim **(ft)**	Distance from Sediment Surface to Top of Manhole Rim **(ft)**			Distance from Bottom to Top of Manhole Rim **(ft)**	Water Depth **(ft)**	Sediment Depth **(ft)**
	1 [Center]	2 [In Between]	3 [Side]		(Function)	(Function)

Trash/Debris Areal Coverage **(%)**	Distance from Trash/Debris Surface to Top of Manhole Rim **(ft)**	Distance from Bottom of Trash/Debris to Top of Manhole Rim **(ft)**	Trash/Debris Thickness **(ft)**
			(Auto)
Device Cleanout Trigger: Trash/Debris Thickness **(ft)**		Cleanout Necessary Based on the Measured Trash/Debris Thickness?	Yes or No (Function)
Device Cleanout Trigger: Trash/Debris Areal Coverage **(%)**		Cleanout Necessary Based on the Measured Trash/Debris Areal Coverage?	Yes or No (Function)
Oil Areal Coverage **(%)**	Distance from Oil Surface to Top of Manhole Rim **(ft)**	Distance from Bottom of Oil to Top of Manhole Rim **(ft)**	Oil Thickness **(ft)**
			(Function)
Device Cleanout Trigger: Oil Thickness **(ft)**		Cleanout Necessary Based on the Measured Oil Thickness?	Yes or No (Function)
Device Cleanout Trigger: Oil Areal Coverage **(%)**		Cleanout Necessary Based on the Measured Oil Areal Coverage?	Yes or No (Function)

Outlet Chamber						
Distance from Water Surface to Top of Manhole Rim **(ft)**	Distance from Sediment Surface to Top of Manhole Rim **(ft)**			Distance from Bottom to Top of Manhole Rim **(ft)**	Water Depth **(ft)**	Sediment Depth **(ft)**
	1 [Center]	2 [In Between]	3 [Side]		(Function)	(Function)

Trash/Debris Areal Coverage **(%)**	Distance from Trash/Debris Surface to Top of Manhole Rim **(ft)**	Distance from Bottom of Trash/Debris to Top of Manhole Rim **(ft)**	Trash/Debris Thickness **(ft)**
			(Function)
Oil Areal Coverage **(%)**	Distance from Oil Surface to Top of Manhole Rim **(ft)**	Distance from Bottom of Oil to Top of Manhole Rim **(ft)**	Oil Thickness (ft)
			(Function)

Observations of Device and Surrounding Drainage Area Characteristics (Routine Inspection or Inspection Immediately before Cleanout)

Traffic Density	Gross Solids - Litter	Gross Solids – Debris	Gross Solids – Coarse Sediment
(Low, Medium, Heavy)	(Small, Medium, Large)	(Small, Medium, Large)	(Small, Medium, Large)

Any Soil Erosion and Sediment Deposition in Watershed?	If Severe, Location(s) of Erosion and Deposition in Watershed
(Low, Moderate, Severe)	

Construction Activities in Watershed?	If Yes, Condition of Source Control Management Practices	If Poor, Location of Source Control Management Practices	If Poor, Describe Condition of Source Control Management Practices
(Yes / No)	(Good, Moderate, Poor)		

Winter Sanding Operation?	Space Available for Cleanout Activities without Traffic Blockage?
(Yes / No)	(Yes / No)

Insects (Mosquitoes, Larvae, etc…) in MTD?	Vegetation Growth in MTD?	Any Blockage to Flow Path in MTD?	If Yes, Name Location of the Blockage
(Yes / No)	(Yes / No)	(Yes / No)	

Any Blockage in Inlet, Manhole, Catch Basin, or Pipe Upstream and Downstream of the Device?	Location of Blockage	Type of Solids in Inlet, Manhole, Catch Basin or Pipe
(Yes / No)		(Gravel, Sand, Silt, Clay, Mud, Debris, Litter)
Dry Weather Flow in inlet pipe and outlet Pipe?	Backwater to outlet pipe from downstream?	Blockage at Outfall?
(Yes / No)	(Yes / No)	(Yes / No)

Outfall Structure					
Sediment discharged from MTD?	(Yes / No)	Trash/Debris discharged from MTD?	(Yes / No)	Oil Spill Out from MTD?	(Yes / No)

Device Structural Inspection - Visual Observation from Ground above the Device (Routine Inspection or Inspection Immediately before Cleanout)

Damage to Manhole Cover(s)	(No, Minor, Serious)	Description of Damage	
Damage to Side Walls	(No, Minor, Serious)	Description of Damage	
Damage to Swirl Chamber Aluminum Wall, Baffle Wall, Flow Control Wall or Orifice Plates	(No, Minor, Serious)	Description of Damage	
Damage to Inlet Pipe	(No, Minor, Serious)	Description of Damage	
Damage to Outlet Pipe	(No, Minor, Serious)	Description of Damage	

Photos Taken during Routine Inspection or Inspection Immediately before Cleanout

Photo 1	Photo 2	Photo 3
		

Additional Comments from Routine Inspection or Inspection Immediately before Cleanout

Device Structural Inspection – Visual Observation and Physical Testing from Inside of the Device (Inspection Immediately after Cleanout)

Damage to Side Walls, Ceiling or Bottom	(No, Minor, Serious)	Description of Damage	
Damage to Swirl Chamber Aluminum Wall, Baffle Wall, Flow Control Wall or Orifice Plates	(No, Minor, Serious)	Description of Damage	
Damage to Inlet Pipe	(No, Minor, Serious)	Description of Damage	
Damage to Outlet Pipe	(No, Minor, Serious)	Description of Damage	

Photo Taken During Structural Inspection Immediately after Cleanout

Photo 1	Photo 2	Photo 3
		

Additional Comments from Structural Inspection Immediately after Cleanout

AUTO Functions:

1. [Last Inspection Date]: From the Previous Inspection Record

2. [Projected Next Inspection Date] = [Last Inspection Date] + [Inspection Interval]

3. [Water Depth] and [Sediment Depth] are calculated automatically from measured [Distance from Water Surface to Top of Manhole Rim], [Distance from Sediment Surface to Top of Manhole Rim] and [Distance from Bottom to Top of Manhole Rim].

   [Water Depth] = (The Average [Distance from Sediment Surface to Top of Manhole Rim] of [Center], [In Between], and [Side]) – [Distance from Water Surface to Top of Manhole Rim]
   [Sediment Depth] = [Distance from Bottom to Top of Manhole Rim] – (The Average [Distance from Sediment Surface to Top of Manhole Rim] of [Center], [In Between], and [Side])

4. Cleanout Necessary Based on Sediment Depth?
   Yes, if [Sediment Depth] is equal or larger than [Device Cleanout Trigger: Sediment Depth], No otherwise.

5. [Trash/Debris Thickness] = [Distance from Bottom of Trash/Debris to Top of Manhole Rim] - [Distance from Trash/Debris Surface to Top of Manhole Rim]

6. Cleanout Necessary Based on Trash/Debris Thickness?
   Yes, if [Trash/Debris Thickness] is equal or larger than [Device Cleanout Trigger: Trash/Debris Thickness], No otherwise.

7. Cleanout Necessary Based on Trash/Debris Areal Coverage?
   Yes, if [Trash/Debris Areal Coverage] is equal or larger than [Device Cleanout Trigger: Trash/Debris Areal Coverage], No otherwise.

8. [Oil Thickness] = [Distance from Bottom of Oil to Top of Manhole Rim] - [Distance from Oil Surface to Top of Manhole Rim]

9. Cleanout Necessary Based on Oil Thickness?
   Yes, if [Oil Thickness] is equal or larger than [Device Cleanout Trigger: Oil Thickness], No otherwise.

10. Cleanout Necessary Based on Oil Areal Coverage?
    Yes, if [Oil Areal Coverage] is equal or larger than [Device Cleanout Trigger: Oil Areal Coverage], No otherwise.

Vortechs® MTD Maintenance Form

General Information

MTD ID	MTD_Inspection_Rec_ ID	MTD_ Maintenance _Rec_ID	Weather*	Air Temp. (°F)

* Weather: Sunny, Windy, Cloudy, Rainy, Stormy, Blizzard

Maintenance Date	Maintenance Time		Purpose of Maintenance	Maintenance Company	Number of MTD Maintenance Persons	Inspector
MM-DD-YYYY	Start HH:MM	End HH:MM	Cleanout ( ) Repair ( ) Replacement ( )			

Maintenance Cost	Last Maintenance Date	Maintenance Interval (months)	Projected Maintenance Date
	(Function)		(Function)

Info for Cleanout Planning

Need Blockage to Traffic?	Check Weather Forecast for Dry Day?
(Yes / No)	(Yes / No)

Estimated Volume of Sediment (cubic feet)	Estimated Volume of Water (cubic feet)	Estimated Volume of Trash/Debris (cubic feet)	Estimated Volume of Oil (cubic feet)	Vacuum Truck Storage Capacity (cubic feet)
(Function)	(Function)	(Function)	(Function)	

Any Other Device to be Cleaned out during the Same Trip?						(Yes / No)
(If Yes) Number of MTDs for Cleanout	(If Two MTDs total)		(If Three MTDs total)		(If Four MTDs total)	
	The 2nd MTD_ Maintenance _Rec_ID	Distance (miles)	The 3rd MTD_ Maintenance _Rec_ID	Distance (miles)	The 4th MTD_ Maintenance _Rec_ID	Distance (miles)

Sediment Disposal

Name of Sediment Disposal Facility	Distance from MTD Location to Facility (miles)	Estimated Disposal Cost

Water Disposal

Possible to Dispose Water into the Downstream Drainage Network?	(If No) Name of Water Disposal Facility	Distance from MTD Location to Facility (miles)	Estimated Disposal Cost
(Yes / No)			

Trash/Debris Disposal

Need to Remove Trash/Debris before Cleanout?	(If Yes) Name of Trash/Debris Disposal Facility	Distance from MTD Location to Facility (miles)	Estimated Disposal Cost
(Yes / No)			

Oil Disposal

Need to Remove Oil before Cleanout?	(If Yes) Name of Oil Disposal Facility	Distance from MTD Location to Facility (miles)	Estimated Disposal Cost
(Yes / No)			

Need to Clean out Sediment/Trash/Debris/Oil Adjacent to MTD?					(Yes / No)
Inlet Pipe?	Outlet Pipe?	Inlet?	Manhole?	Catch Basin?	Outfall Structure?
(Yes / No)	(Yes / No)	(Yes / No)	(Yes / No)	(Yes / No)	(Yes / No)

Need to Block Inlet or Outlet Pipe by Pipe Plugs during Operation?	(Yes / No)

Records of Cleanout

Sediment Disposal

Name of Sediment Disposal Facility	Distance from MTD Location to Facility (miles)	Disposal Cost

Water Disposal

Was Water Disposed into the downstream Drainage Network?	(If No) Name of Water Disposal Facility	Distance from MTD Location to Facility (miles)	Disposal Cost
(Yes / No)			

Trash/Debris Disposal

Were Trash/Debris Removed before Cleanout?	(If Yes) Name of Trash/Debris Disposal Facility	Distance from MTD Location to Facility (miles)	Disposal Cost
(Yes / No)			

Oil Disposal

Was Oil Removed before Cleanout?	(If Yes) Name of Oil Disposal Facility	Distance from MTD Location to Facility (miles)	Disposal Cost
(Yes / No)			

Was Traffic Blocked?	(Yes / No)	Was Inlet or Outlet Pipe Blocked by Pipe Plugs during Operation?	(Yes / No)
Is Further Cleaning of MTD by Water Jet Necessary?	(Yes / No)	(If Yes) Was MTD Further Cleaned Using Water Jet?	(Yes / No)

Was Sediment/Trash/Debris/Oil Adjacent to MTD Cleaned out?					(Yes / No)
Inlet Pipe?	Outlet Pipe?	Inlet?	Manhole?	Catch Basin?	Outfall Structure?
(Yes / No)	(Yes / No)	(Yes / No)	(Yes / No)	(Yes / No)	(Yes / No)

Photos Taken Immediately after Cleanout

Photo 1	Photo 2	Photo 3
		

Additional Comments on Cleanout

Records of Repair

Were Any Components Repaired?					(Yes / No)
Manhole Cover(s)?	Side Walls?	Ceiling?	Bottom?		
(Yes / No)	(Yes / No)	(Yes / No)	(Yes / No)		
Swirl Chamber Aluminum Wall?	Baffle Wall?	Flow Control Wall?	Orifice Plates?	Inlet Pipe?	Outlet Pipe?
(Yes / No)	(Yes / No)	(Yes / No)	(Yes / No)	(Yes / No)	(Yes / No)

Photos Taken Immediately after Repair

Photo 1	Photo 2	Photo 3
		

Additional Comments on Repair

Records of Replacement

Were Any Components Replaced?					(Yes / No)
Manhole Cover(s)?	Side Walls?	Ceiling?	Bottom?		
(Yes / No)	(Yes / No)	(Yes / No)	(Yes / No)		
Swirl Chamber Aluminum Wall?	Baffle Wall?	Flow Control Wall?	Orifice Plates?	Inlet Pipe?	Outlet Pipe?
▼(Yes / No)	(Yes / No)	(Yes / No)	(Yes / No)	(Yes / No)	(Yes / No)
Was Entire Device Replaced?					(Yes / No)

Photos Taken Immediately after Replacement

Photo 1	Photo 2	Photo 3
		

Additional Comments on Replacement

Functions

Last Maintenance Date: Import [Maintenance Date] data from previous record.
Projected Maintenance Date: [Maintenance Date] + [Maintenance Interval]

'Water Volume', 'Sediment Volume', 'Trash/Debris Volume', and 'Oil Volume' are estimated/calculated automatically based on the measured quantities from the "Inspection Form."

[Estimated Water Volume] = [Water Depth] (from Inspection Form) X [Device Footprint Area (from Information Data Form)]

> The water volume above may be overestimated since water in the baffle chamber, the flow control chamber, and the outlet chamber, if judged to be clean, does not need to be pumped out.

[Estimated Sediment Volume] = [Sediment Depth (in Swirl Chamber) (from Inspection Form)] X [Swirl Chamber Area (from Information Data Form)]

> If there is sediment in Baffle Chamber, add [Sediment Volume in Baffle Chamber], where [Sediment Volume in Baffle Chamber] = [Sediment Depth in Baffle Chamber (from Inspection Form)] X [Device Width (from Information Data Form)] X [2.58 (use 3.00 if 'Model' is 16000 or larger (from Information Data Form)]
>
> If there is sediment in Outlet Chamber, add [Sediment Volume of Outlet Chamber], where [Sediment Volume in Outlet Chamber] = [Sediment Depth in Outlet Chamber] X [Device Width (from Information Data Form)] X [2.00]

[Estimated Trash/Debris Volume] = [Average Trash/Debris Thickness in Swirl Chamber and Baffle Chamber (from Inspection Form)] X [Device Width (from Information Data Form)] X [Device Length (from Information Data Form) – 3.50]

> If there are Trash/Debris in Outlet Chamber, add [Trash/Debris Volume in Outlet Chamber], where
> [Trash/Debris Volume in Outlet Chamber] = [Trash/Debris Thickness in Outlet Chamber] X [Device Width (from Information Data Form)] X [2.00]

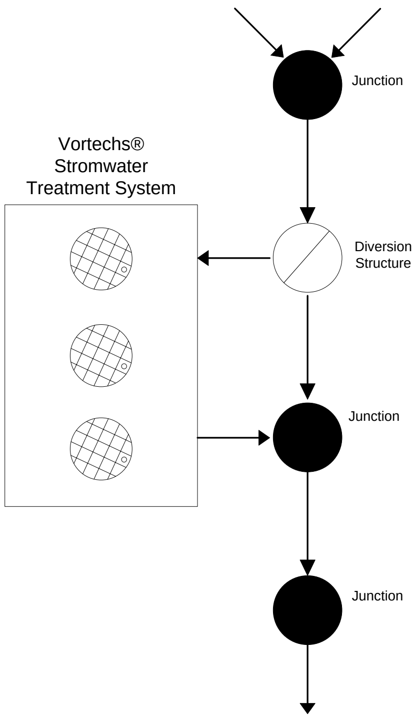
[Estimated Oil Volume] = [Average Oil Thickness in Swirl Chamber and Baffle Chamber (from Inspection Form)] X [Device Width (ft) (from Information Data Form)] X [Device Length (from Information Data Form) – 3.50]

> If there is Oil in Outlet chamber, add [Oil Volume in Outlet Chamber], where
> [Oil Volume in Outlet Chamber] = [Oil Thickness in Outlet Chamber (from Inspection Form)] X [Device Width (from Information Data Form)] X [2.00]

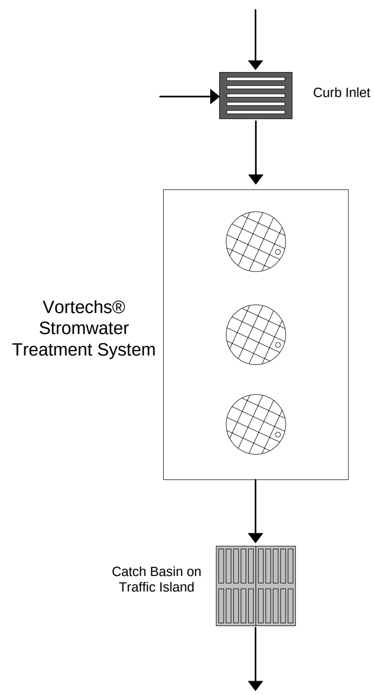
Spatial Relation Samples

The configuration of online and offline devices can vary greatly depending on the conditions of the installation. For the MTD Information form, it is recommended to detail the installation as much as possible in order to aid maintenance personnel in the inspection, maintenance and cleanout. Some samples of spatial relation layouts gathered in the present study follow:

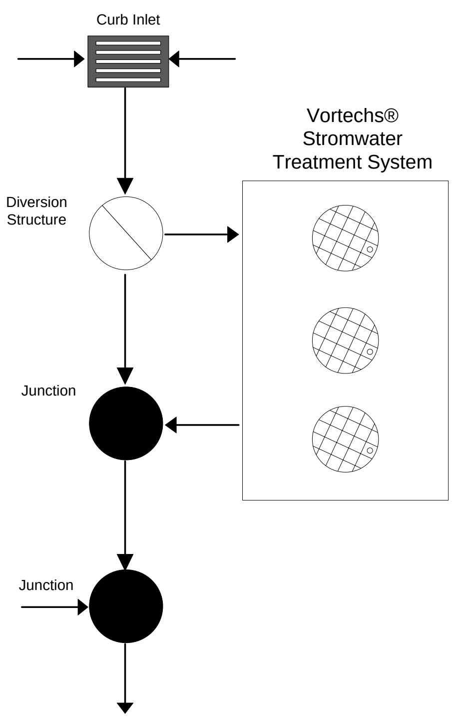
RU01-01: Piscataway



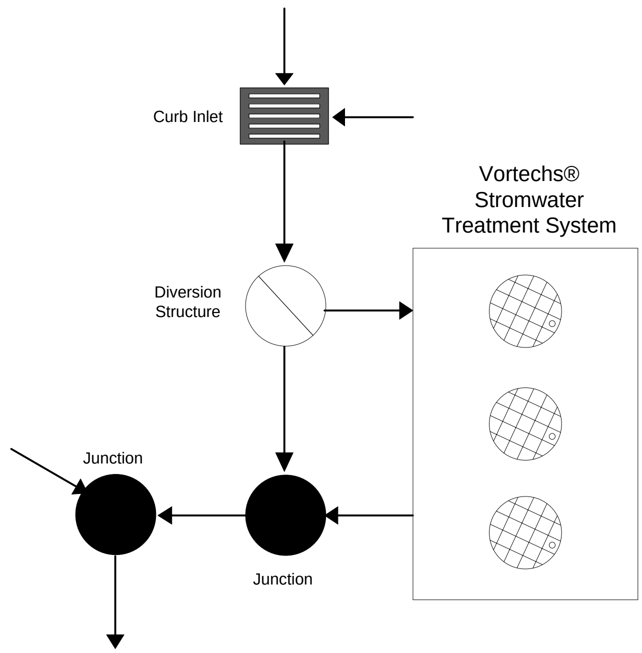
RU01-02: Piscataway



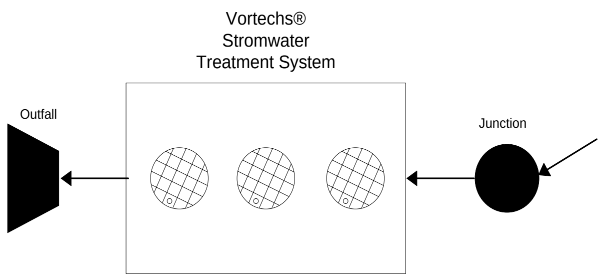
RU01-03: Piscataway



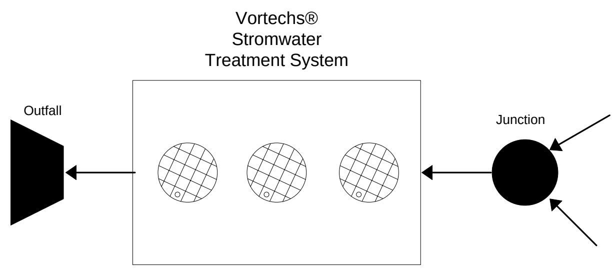
RU01-04: Piscataway



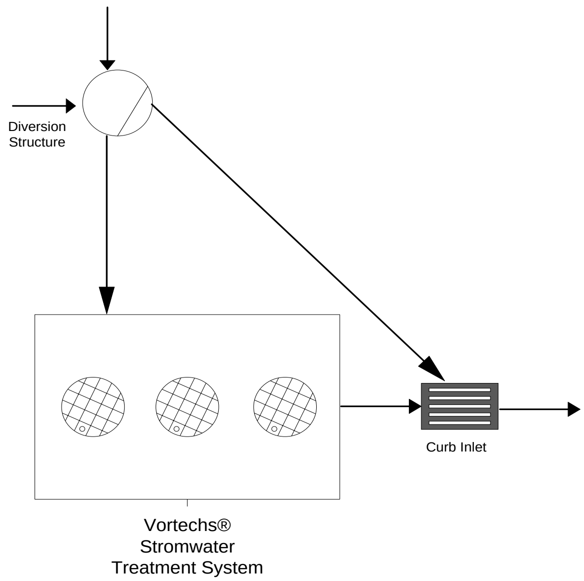
RU02-01: Edison



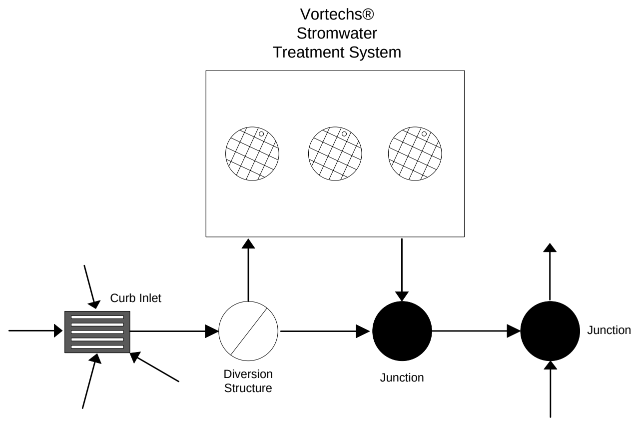
RU02-02: Edison



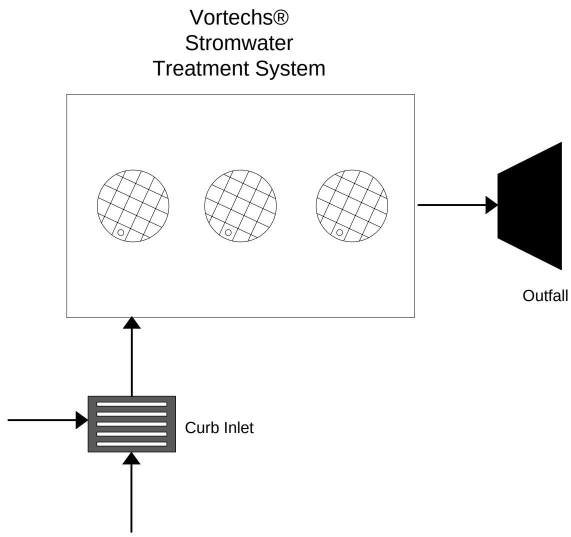
RU04-02: Elizabeth



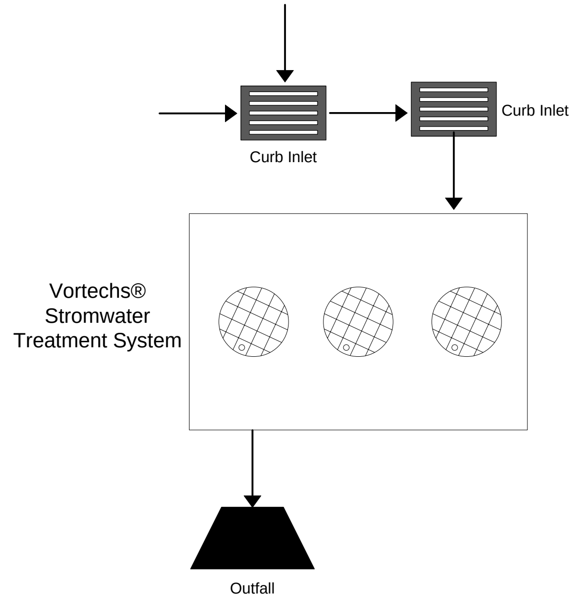
RU06-01: North Bergen



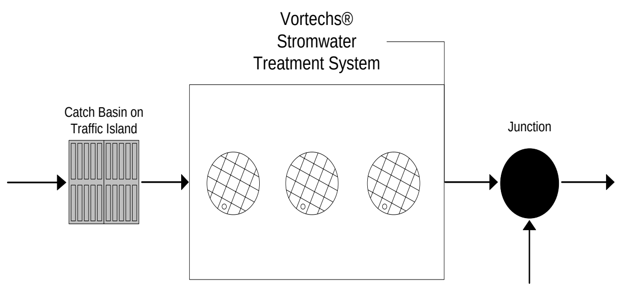
RU07-01: Deptford



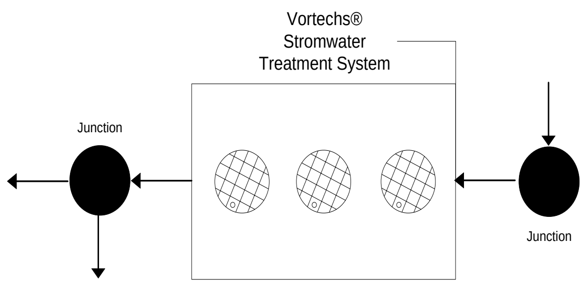
RU09-01: Lakewood



RU14-01: Parsippany



RU16-01: Frankford



IMPLEMENTATION & TRAINING

- The NJDOT maintenance personnel were involved in the actual cleanout of the devices. NJDOT and its contractors gained first-hand and valuable field maintenance experience.
- Early observations and suggestions on maintenance accessibility and intervals were provided to NJDOT. It was suggested to the NJDOT to add manufactured treatment devices into the highway database, such as the "Straight Line Diagrams," in order to consider device accessibility during design and construction despite other constraints, and to minimize the amount of gross solids that would enter the devices.
- A device inspection form was made and provided to the NJDOT Maintenance Division for their use.
- A field trip was organized for the NJDOT personnel to Montgomery County, Maryland on June 5, 2008 to observe their maintenance program on stormwater manufactured treatment devices.
- Progress of the project and early observations and suggestions were presented at the NJDOT Research Showcase on November 28, 2007 and October 16, 2008.

CONCLUSIONS & RECOMMENDATIONS

Pre- and Post-Cleanout Monitoring

To develop the maintenance procedure and schedule, a detailed and thorough investigation was conducted on the characteristics and quantities of stormwater, floatables and sediment accumulated in the manufactured treatment devices (MTDs). The water quality test yielded high levels of Total Suspended Solids in the pumped-out stormwater as compared to median municipal wastewater levels. Even the Chemical Oxygen Demand of the pumped-out stormwater was found to be generally higher than the median municipal wastewater levels. This suggests that the pumped-out stormwater should ideally be routed to a wastewater treatment facility for proper disposal. Several sites yielded high levels of oils and grease. Large amounts of floatables were also collected from the sites consisting mostly of plastic, Styrofoam and organic debris. Testing of the pumped-out sediments indicated safe levels of heavy metals in comparison to the soil cleanup criteria but high levels of Total Kjeldahl Nitrogen and Total Phosphorus in comparison to the forest soil quality. The particle size distribution test showed that, in twelve samples analyzed, only eight percent of sediment by weight passed the #200 (75 μm) sieve. That is, devices primarily collected particles greater than 75 microns.

Observation of the accumulated sediment depth started from the clean state. The sediment depth was the main indicator for determining the time interval between MTDs cleanouts. At a general site, the sediment was observed to accumulate slowly during the first four months after cleanout. However, a relatively large amount of trapped sediment was observed after the summer of 2009 due to heavy rain events. Twenty months after cleanout, the highest sediment depth was observed to be 2.3 feet and the lowest was 0.23 feet, excluding an incorrectly installed device.

Maintenance Interval

For a general highway site, four years is the recommended cleanout interval. This estimation is based on the measured time variation of sediment depth and the maximum allowable sediment depth of two feet. If the site has severe erosion, one and a half years are recommended for the cleanout interval.

Environmental and Cost Benefits from the Research Project

For the 12 sites that were included in the study, the time between the device installation and cleanout was around 4.8 years. During this period, a combined total of around 33.95 lbs of oil, 26431.5 lbs of sediment and 16.45 lbs of floatables had collected in the MTDs. These harmful substances were trapped by the devices and thus removed from the environment. At the beginning of this study, the devices were cleaned out of the trapped materials yielding the environmental benefits. After the device cleanout, the averaged number of monitoring months was 18 months and the total volume of trapped solids in devices was 378.06 ft^3, estimated from the measured sediment depth and the grit chamber area. Again, these materials were removed from the receiving waters leading to environmental benefits. The cleanout at each site cost $3,500 with an additional charge of approximately $59 /ton for disposal. If the oil was to be separately disposed, 12 oil booms with a capacity of 1.8 gallons each and costing $150 each would have been used. If a disposal facility can receive both water and solids, transportation between the site and the facility can be reduced. Considering that the number of installed MTDs would increase in the near future to thousands, the total cost for cleanout would reach millions. With the measured and recommended cleanout interval of four years from this study, the total cleanout cost would be much smaller than the initially anticipated based on the projected one-year cleanout interval. A proper planning and scheduling of the cleanout activities would further reduce the cleanout cost.

Project Continuation Suggestion to NJDOT

1. Continue to monitor the existing devices until sediment accumulates in the devices to the full capacity that requires maintenance cleanout. After one year or more, only one of the twelve (12) monitored devices had sediment accumulated to the maximum storage capacity that required maintenance.
   The objective is to confirm the maintenance interval extrapolated from the current monitoring project, thus NJDOT can implement the current research results with a high level of confidence.

2. Clean out the twelve (12) existing devices when they reach the full capacity and characterize the cleanout materials.
   The objective is to quantify the amount of pollutants that can actually be removed by the devices in between the maintenance activities, and thus to unambiguously and accurately demonstrate the environmental benefits.

3. Select and monitor two other types of manufactured treatment devices.
   The objective is to expand beyond the single type of treatment devices that has been monitored in the current project. The current project focuses on the effect of more sensitive land/road condition variation rather than the effect of less sensitive device type variation.

4. Development and integration of information and decision-making system for inspection and maintenance

REFERENCES

CMX (1999) Stormwater system analysis report for Route 47 and Cattell Road.

Division of Watershed Management (2004). New Jersey Stormwater Best Management Practices Manual. New Jersey Department of Environmental Protection.

Edwards & Kelcey Inc. (2000) Drainage Report: Route 9 - Lake Carasaljo.

Guo, Q. (2005). “Development of Adjustment and Scaling Factors for Measured Suspended Solids Removal Performance of Stormwater Hydrodynamic Treatment Devices.” Proceedings of the World Water & Environmental Resources Congress, May 15-19, 2005, Anchorage, Alaska, ASCE-EWRI.

Hunt, W., England, G., DeBruijn, H,. Gee, R., Guo, Q., Lord, W., Miller, M., Mosheni, O., and Perry, S. (2008) “Inspection and Maintenance Guidance for Manufactured BMPs.” Proceedings of World Environmental and Water Resources Congress 2008, pp. 1-7

Metcalf & Eddy, Inc. (2003). Wastewater Engineering Treatment and Reuse, Fourth Edition. p.186.

National Climatic Data Center (NCDC), Record of Climatological Observations. http://cdo.ncdc.noaa.gov/dly/DLY

New Hampshire Department of Environmental Services (NHDES) and New Hampshire Estuaries Project (NHEP) (2003). Innovative Stormwater Treatment Technologies Best Management Practices Manual.
http://www.des.state.nh.us/wmb/was/manual

New Jersey Department of Environmental Protection (2005). *The Stormceptor® System Model STC 900*, Bureau of Sustainable Communities and Innovative Technologies, Division of Science, Research and Technology, NJDEP, Trenton, New Jersey.
http://www.state.nj.us/dep/dsr/bscit/Int_Cert_Findings.pdf

New Jersey Department of Environmental Protection (2005). *Vortechs® Stormwater Treatment System, Inc.,* Bureau of Sustainable Communities and Innovative Technologies, Division of Science, Research and Technology, NJDEP, Trenton, New Jersey.
http://www.state.nj.us/dep/dsr/bscit/Conditional%20Interim%20Findings(Vort).pdf

New Jersey Weather and Climate Network (NJWxnet)
http://climate.rutgers.edu/njwxnet/

NJDEP Division of Watershed Management Rules & Guidance (2004). Stormwater Management Rule: N.J.A.C. 7:8. New Jersey Department of Environmental Protection.

www.state.nj.us/dep/watershedmgt/rules.htm

Ocean County Planning and Engineering Department and Killam Associate (1989). Stormwater Management Facilities Maintenance Manual. New Jersey Department of Environmental Protection. Trenton, NJ.

Office of the New Jersey State Climatologist (ONJSC)
http://climate.rutgers.edu/

Rushton, B. and England, G. (2007). ASCE Guideline for Monitoring Stormwater Gross Pollutants. Environmental & Water Resources Institute, Urban Water Resources Research Council, Gross Solids Technical Committee.

Stormceptor® (2000). Owner's Manual.
http://www.stormceptor.com/downloads/pdf/OwnerAPR00.PDF

TAMS Consultants, Inc. (2003). Summary of Proposed Stormwater Treatment System Design Data.

Tuininga, A., Dighton, J., and Gray, D. (2002). "Burning, watering, litter quality and time effects on N, P and K uptake by pitch pine seedlings (pinus rigida) in a greenhouse study." Soil Biology and Biochemistry 34 (2002)

URS Greiner Woodward Clyde (2000). Drainage report: Route U.S.1&9 - Section 7E Paterson Plank Road.

APPENDICES

Appendix A: Other sites inspection reports

There are 37 inspected stormwater treatment devices (36 Vortechs and 1 Downstream Defender). Inspection reports for selected sites are in the main report (Chapter: Inspection of devices) and for others are shown in Appendix A. The list of other site reports is shown in the following table**.**

ID	Municipality	County	Location
RU 03-01	Newark	Essex	Doremus Ave. Roadway
RU 03-02	Newark	Essex	Doremus Ave. Roadway
RU 03-03	Newark	Essex	Doremus Ave. Roadway
RU 03-04	Newark	Essex	Doremus Ave. Roadway
RU 03-05	Newark	Essex	Doremus Ave. Roadway
RU 03-06	Newark	Essex	Doremus Ave. Roadway
RU 03-07	Newark	Essex	Doremus Ave. Roadway
RU 03-08	Newark	Essex	Doremus Ave. Roadway
RU 04-01	Elizabeth	Union	Pearl St. & Grove St
RU 04-03	Elizabeth	Union	E Mravlag Pl
RU 04-04	Elizabeth	Union	E Mravlag Pl
RU 05-01	Princeton Twp.	Mercer	NJ-27
RU 05-02	Princeton Twp.	Mercer	NJ-27
RU 08-01	Berlin	Camden	Jackson Rd. and Rte-73
RU 09-01	Lakewood	Ocean	Rte-9
RU 10-01	Middle Twp.	Cape May	Rte-9 and Crest Haven Rd.
RU 10-02	Middle Twp.	Cape May	Rte-9 and Crest Haven Rd.
RU 11-01	Rahway	Union	Rte-1&9
RU 11-02	Rahway	Union	Rte-1&9
RU 12-01	Clinton Twp.	Hunterdon	Rte-78 and Rte-173
RU 13-01	New Brunswick	Middlesex	Rte-18
RU 13-02*	Paramus & Fair Lawn	Bergen	Rte-208 and Saddle River Rd.
RU 16-02	Frankford	Sussex	Rte-206 and NJ-15
RU 17-01	Montgomery	Somerset	Great Rd (601) & Cherry Valley Rd
RU 17-01	Montgomery	Somerset	Great Rd (601) & Cherry Valley Rd

* The device is Downstream Defender

Rutgers ID: **RU 03-01** Date 2007-06-26 Time 14:00

Device	Model	Municipality	County	Location
Vortechs	N/A	Newark	Essex	Doremus Ave Roadway
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
N/A	2004-05-12	40°43.157'	74°07.590'	5ft

Climate Sunny Wind Sp/Dir 3 mph/SW Air Temp 92°

Traffic 24 Cars/min one way on Evergreen Rd

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type ■ Litter ■ Debris ■ Coarse Sediments

Amount ■ L ☐ M ☐ S ☐ L ☐ M ■ S ☐ L ☐ M ■ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

■ Commercial ☐ Residential ☐ Mixed ☐ Open / Non urban

Design Info

Drainage Area ________ Treatment Flow ________ Maximum Flow ________

(2007-12-02)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	10.3	1 (center)	2 (in between)	3 (side)	15.1
		14.6	14.6	14.6	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	15.2
	10.9	10.9	10.9		

Remarks:

0.5 ft sediment accumulation in grit chamber (15.1-14.6=0.5)

Heavy truck traffic

Industrial area

Large amount of litters around Doremus Ave.

The Vortechs manholes are located on the center of the road

Vortechs was installed deep underground

Overflow and backflow problems


Ferry St
US-1 And 9
New Jersey
95
New Jersey Tpke
9

Rutgers ID: **RU 03-02** Date 2007-06-26 Time 14:00

Device	Model	Municipality	County	Location
Vortechs	N/A	Newark	Essex	Doremus Ave Roadway
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
N/A	2004-05-12	40°43.171'	74°07.582'	8ft

Climate Sunny Wind Sp/Dir 3 mph/SW Air Temp 92°

Traffic 24 Cars/min one way on Evergreen Rd

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type ■ Litter ■ Debris ■ Coarse Sediments

Amount ■ L ☐ M ☐ S ☐ L ☐ M ■ S ☐ L ☐ M ■ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

■ Commercial ☐ Residential ☐ Mixed ☐ Open / Non urban

Design Info

Drainage Area ______ Treatment Flow ______ Maximum Flow ______

(2007-12-02)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	8.6	1 (center)	2 (in between)	3 (side)	11.0
		9.2	10.0	10.3	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	11.0
	8.0	8.0	8.0		

Remarks:
1.2 ft sediment accumulation in grit chamber (11.0-9.8=1.2)
Heavy truck traffic
Industrial area
Large amount of litters around Doremus Ave.
The Vortechs manholes are located in the center of the road
Overflow and backflow problems


Ferry St
US-1 And 9
New Jersey
New Jersey Tpke
95
1
9

Rutgers ID: **RU 03-03** Date 2007-06-26 Time 14:00

Device	Model	Municipality	County	Location
Vortechs	N/A	Newark	Essex	Doremus Ave Roadway
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
N/A	2004-05-12	40°43.407’	74°07.449’	8ft

Climate Sunny Wind Sp/Dir 3 mph/SW Air Temp 92°

Traffic 24 Cars/min one way on Evergreen Rd

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type ■ Litter ■ Debris ■ Coarse Sediments

Amount ■ L ☐M ☐S ☐ L ☐ M ■ S ☐ L ☐M ■ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

■ Commercial ☐ Residential ☐ Mixed ☐ Open / Non urban

Design Info

Drainage Area ________ Treatment Flow ________ Maximum Flow ________

(2007-12-02)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	6.2	1 (center)	2 (in between)	3 (side)	10.6
		9.3	9.3	9.3	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	9.6
	6.1	6.1	6.1		

Remarks:
1.3 ft sediment accumulation in grit chamber (10.6-9.3=1.3)
Heavy truck traffic
Industrial area
Large amount of litters around Doremus Ave.
The Vortechs manholes are located in the center of the road
Overflow and backflow problems
Water surface of floatables chamber are mostly covered by floating litter.
Oil in outlet chamber


Ferry St
US-1 And 9
New Jersey
95
1
9
New Jersey Tpke

Rutgers ID: **RU 03-04** Date 2007-06-26 Time 14:00

Device	Model	Municipality	County	Location
Vortechs	N/A	Newark	Essex	Doremus Ave Roadway
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
N/A	2004-05-12	40°43.413’	74°07.443’	6ft

Climate Sunny Wind Sp/Dir 3 mph/SW Air Temp 92°

Traffic 24 Cars/min one way on Evergreen Rd

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type ■ Litter ■ Debris ■ Coarse Sediments

Amount ■ L ☐M ☐S ☐ L ☐ M ■ S ☐ L ☐M ■ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

■ Commercial ☐ Residential ☐ Mixed ☐ Open / Non urban

Design Info

Drainage Area ______ Treatment Flow ______ Maximum Flow ______

(2007-12-02)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
		1 (center)	2 (in between)	3 (side)	
	6.2	8.8	8.8	8.8	11.0

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	10.4 / 10.8
	6.2	6.2	6.2		

Remarks:
2.2 ft sediment accumulation in grit chamber (11.0-8.8=2.2)
0.4 ft of sediments was found in floatables chamber (10.8-10.4=0.4)
Heavy truck traffic
Industrial area
Large amount of litters around Doremus Ave.
The Vortechs manholes are located in the center of the road
Overflow and backflow problems

Water surfaces of both grit chamber and floatables chamber are mostly covered by floating litter (such as Styrofoam).
Oil in outlet chamber

Rutgers ID: **RU 03-05** Date 2007-06-26 Time 14:00

Device	Model	Municipality	County	Location
Vortechs	N/A	Newark	Essex	Doremus Ave Roadway
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
N/A	2004-05-12	40°43.600'	74°07.361'	5ft

Climate Sunny Wind Sp/Dir 3 mph/SW Air Temp 92°

Traffic 24 Cars/min one way on Evergreen Rd

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type	■ Litter			■ Debris			■ Coarse Sediments		
Amount	■ L	☐ M	☐ S	☐ L	☐ M	■ S	☐ L	☐ M	■ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

■ Commercial ☐ Residential ☐ Mixed ☐ Open / Non urban

Design Info

Drainage Area ________ Treatment Flow ________ Maximum Flow ________

(2007-12-02)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	N/A	1 (center)	2 (in between)	3 (side)	8.2
		3.9	3.6	3.5	
Float. Chamber	**Floatables Top Surface Reading**			**Fl. Bott. Su. R**	**Bot Reading**
	1 (center)	2 (in between)	3 (side)	N/A	6.9 / 8.2
	4.3	4.3	4.3		

Remarks:

4.5 ft sediment accumulation in grit chamber (8.2-3.7=4.5)

1.3 ft of sediments was found in floatables chamber (8.2-6.9=1.3)

Heavy truck traffic

Industrial area

Large amount of litters around Doremus Ave.

The Vortechs manholes are located in the center of the road

Overflow and backflow problems

Both grit chamber and floatables chamber are mostly filled with litter (such as Styrofoam) and oil. Oil in outlet chamber

Rutgers ID: **RU 03-06** Date 2007-06-26 Time 14:00

Device	Model	Municipality	County	Location
Vortechs	N/A	Newark	Essex	Doremus Ave Roadway
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
N/A	2004-05-12	40°43.631'	74°07.351'	5ft

Climate Sunny Wind Sp/Dir 3 mph/SW Air Temp 92°

Traffic 24 Cars/min one way on Evergreen Rd

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type	■ Litter			■ Debris			■ Coarse Sediments		
Amount	■ L	☐ M	☐ S	☐ L	☐ M	■ S	☐ L	☐ M	■ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

■ Commercial ☐ Residential ☐ Mixed ☐ Open / Non urban

Design Info

Drainage Area ______ Treatment Flow ______ Maximum Flow ______

(2007-12-02)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	10.2	1 (center)	2 (in between)	3 (side)	17.8
		13.2	13.2	13.2	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	17.8
	10.2	10.2	10.2		

Remarks:
4.6 ft sediment accumulation in grit chamber (17.8-13.2=4.6)
Heavy truck traffic
Industrial area
Large amount of litters around Doremus Ave.
The Vortechs manholes are located in the center of the road
Vortechs was installed deep underground
Overflow and backflow problems
Oil in outlet chamber


Ferry St
US-1 And 9
New Jersey
95
9
New Jersey Tpke

Rutgers ID: **RU 03-07** Date 2007-06-26 Time 14:00

Device	Model	Municipality	County	Location
Vortechs	N/A	Newark	Essex	Doremus Ave Roadway
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
N/A	2004-05-12	40°43.845’	74°07.261’	8ft

Climate Sunny Wind Sp/Dir 3 mph/SW Air Temp 92°

Traffic 24 Cars/min one way on Evergreen Rd

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type ■ Litter ■ Debris ■ Coarse Sediments

Amount ■ L ☐M ☐S ☐ L ☐ M ■ S ☐ L ☐M ■ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

■ Commercial ☐ Residential ☐ Mixed ☐ Open / Non urban

Design Info

Drainage Area ______ Treatment Flow ______ Maximum Flow ______

(2007-12-02)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
		1 (center)	2 (in between)	3 (side)	
	7.4	12.2	12.2	12.2	12.3
Float. Chamber	**Floatables Top Surface Reading**			**Fl. Bott. Su. R**	**Bot Reading**
	1 (center)	2 (in between)	3 (side)		
	7.5	7.4	7.4	N/A	12.2

Remarks:
Heavy truck traffic
Industrial area
Large amount of litters around Doremus Ave.
The Vortechs manholes are located in the center of the road
Overflow and backflow problems
Oil in outlet chamber


Ferry St
US-1 And 9
New Jersey
95
1
9
New Jersey Tpke

Date 2007-06-26 Time 14:00

Rutgers ID: **RU 03-08**

Device	Model	Municipality	County	Location
Vortechs	N/A	Newark	Essex	Doremus Ave Roadway
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
N/A	2004-05-12	40°43.860'	74°07.248'	8ft

Climate Sunny Wind Sp/Dir 3 mph/SW Air Temp 92°

Traffic 24 Cars/min one way on Evergreen Rd

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type ■ Litter ■ Debris ■ Coarse Sediments

Amount ■ L ☐M ☐S ☐ L ☐ M ■ S ☐ L ☐M ■ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

■ Commercial ☐ Residential ☐ Mixed ☐ Open / Non urban

Design Info

Drainage Area ______ Treatment Flow ______ Maximum Flow ______

(2007-12-02)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	5.9	1 (center)	2 (in between)	3 (side)	9.6
		8.5	8.5	8.5	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	9.6
	6.3	6.2	6.2		

Remarks:

1.1 ft sediment accumulation in grit chamber (9.6-8.5=1.1)

Heavy truck traffic

Industrial area

Large amount of litters around Doremus Ave.

The Vortechs manholes are located in the center of the road

Overflow and backflow problems

Water surface of floatables chamber is mostly covered by floating litter.

Oil in outlet chamber

Rutgers ID: **RU 04-01** Date 2007-05-04 Time 14:00

Device	Model	Municipality	County	Location
Vortechs	11000	Elizabeth	Union	Pearl St. & Grove St
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
043960129	2004-11-30	40°39.348’	74°12.632’	7 ft

Climate Mostly Sunny Wind Sp/Dir 3 mph/N Air Temp 67°

Traffic 11 Cars/min one way on Peach St

☐ Heavy ■ Medium ☐ Low

Gross Solids

Type ■ Litter ■ Debris ■ Coarse Sediments

Amount ■ L ☐M ☐S ☐ L ☐ M ■ S ☐ L ■ M ☐S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ☐ Residential ■ Mixed ☐ Open / Non urban

Design Info

Drainage Area 7.65 Treatment Flow 7 Maximum Flow 17.5

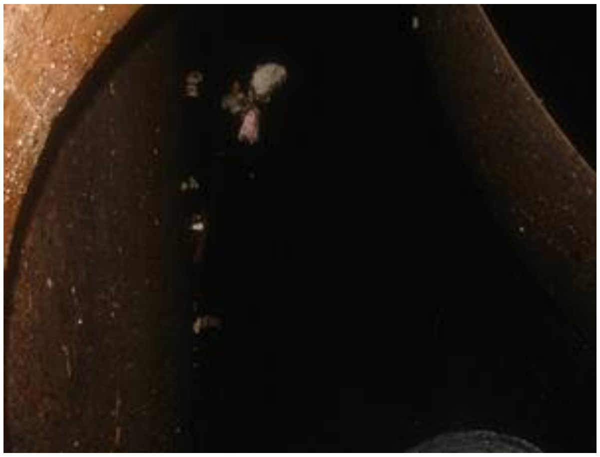
(2007-06-26)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
		1 (center)	2 (in between)	3 (side)	
	8.1 ft	10.2	10.3	10.3	10.9

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)		
	8.21	8.21	8.21	N/A	10.7 / 11.1

Remarks:
The device collects flow from Rout 1 & 9
0.4 ft of sediments were found in the floatables chamber (10.7-11.1ft).
The manhole covers are not identified with the Vortechnics logotype.


Montgomery St
Devine Ave
Nelson Ave
Reuter Ave
Spring St
614
S Pearl St
S 7th St
St
US-1 & 9
Clarkson Ave
Fillmore St
Elizabeth
River Park



Rutgers ID: **RU 04-03** Date 2009-03-30 Time 11:00

Device	Model	Municipality	County	Location
Vortechs	11000	Elizabeth	Union	E Mravlag Pl
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
043960129	2004-11-30	40°38.140’	74°12.919’	3 ft

Climate Mostly Sunny Wind Sp/Dir WS 13 mph Air Temp 71°

Traffic 23 Cars/min one way on Rt.1&9

■ Heavy □ Medium □ Low

Gross Solids

Type ■ Litter ■ Debris ■ Coarse Sediments

Amount ■ L □ M □ S □ L □ M ■ S □ L ■ M □ S

Soil Type

□ Sand ■ Silt □ Clay

Land Use

■ Commercial □ Residential □ Mixed □ Open / Non urban

Design Info

Drainage Area 5.8 Treatment Flow 7 Maximum Flow 17.5

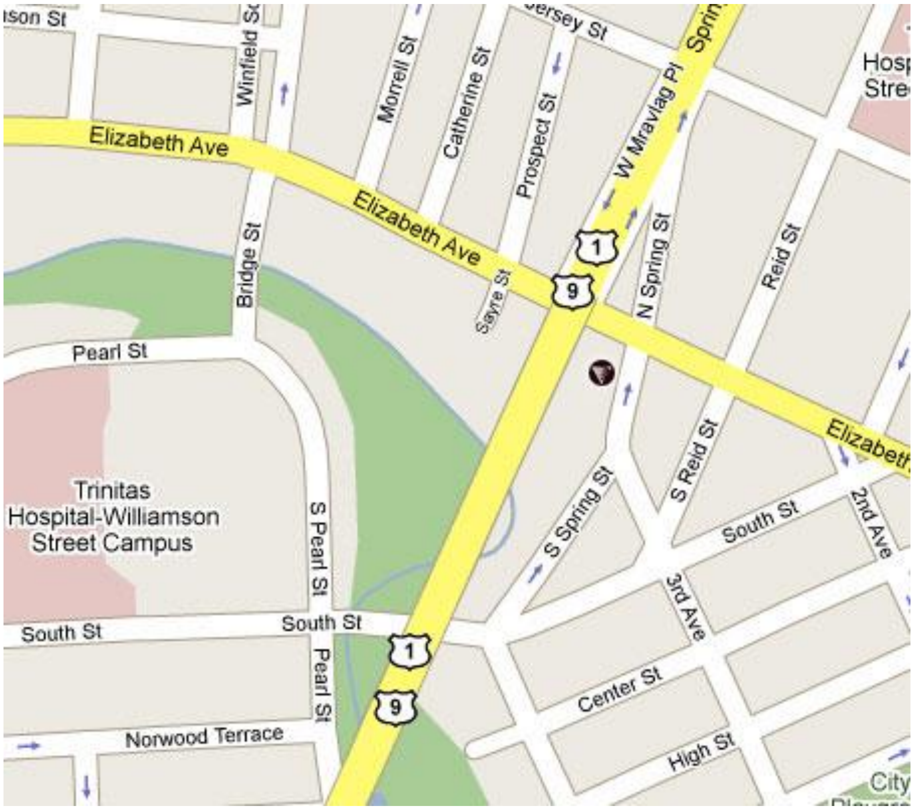
(2009-03-30 visit)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	10.5	1 (center)	2 (in between)	3 (side)	11.6
		10.6	10.6	10.6	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	8.7	10.8
	8.5	8.5	8.4		

Remarks:

The Vortechs is located between Rt.1&9 and Spring St.
1.0 ft sediment accumulation in the grit chamber (11.6-10.6=1.0)



Elizabeth Ave
Elizabeth Ave
Winfield St
Morrell St
Catherine St
Prospect St
W Mravlag Pl
N Spring St
Reid St
Sayre St
Bridge St
Pearl St
Trinitas
Hospital-Williamson
Street Campus
S Pearl St
S Spring St
S Reid St
South St
2nd Ave
3rd Ave
South St
South St
Pearl St
Center St
Norwood Terrace
High St
City
1
9
1
9

Rutgers ID: **RU 04-04** Date 2009-03-30 Time 11:00

Device	Model	Municipality	County	Location
Vortechs	16000	Elizabeth	Union	E Mravlag Pl
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
043960129	2004-11-30	40°38.140’	74°12.919’	3 ft

Climate Mostly Sunny Wind Sp/Dir WS 13 mph Air Temp 71°

Traffic 23 Cars/min one way on Rt.1&9

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type ■ Litter ■ Debris ■ Coarse Sediments

Amount ■ L ☐M ☐S ☐ L ☐ M ■ S ☐ L ■ M ☐S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

■ Commercial ☐ Residential ☐ Mixed ☐ Open / Non urban

Design Info

Drainage Area 8.18 Treatment Flow 10.08 Maximum Flow 25.2

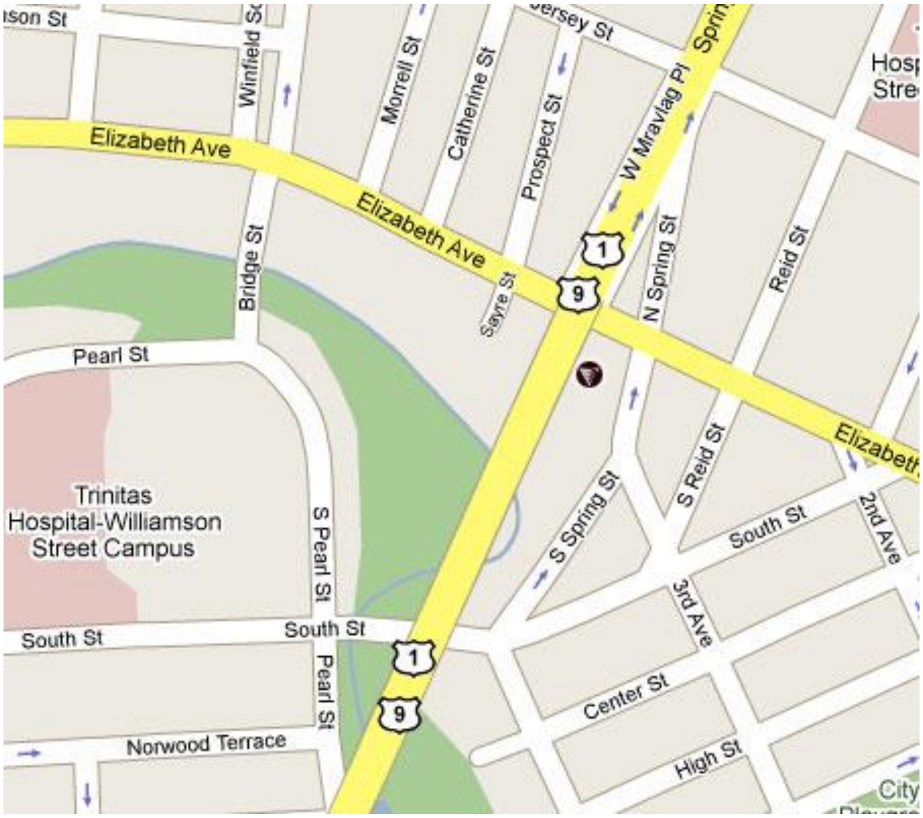
(2009-03-30 visit)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	11.4	1 (center)	2 (in between)	3 (side)	12.6
		11.5	11.5	11.5	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	10.7	11.8
	10.5	10.5	10.5		

Remarks:

The Vortechs is located between Rt.1&9 and Spring St.
1.1 ft sediment accumulation in the grit chamber (12.6-11.5=1.1)


Elizabeth Ave
Elizabeth Ave
Winfield St
Morrell St
Catherine St
Prospect St
W Mravlag Pl
Bridge St
Sayre St
N Spring St
Reid St
Pearl St
Trinitas
Hospital-Williamson
Street Campus
S Pearl St
S Spring St
S Reid St
South St
2nd Ave
3rd Ave
South St
South St
Pearl St
Center St
Norwood Terrace
High St

Rutgers ID: **RU 05-01** Date 2007-05-10 Time 11:40

Device	Model	Municipality	County	Location
Vortechs	3000	Princeton Twp	Mercer	NJ-27
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
N/A	2004-03-31	40°21.935’	74°37.639’	48 ft

Climate Mostly Cloudy Wind Sp/Dir W 4 mph Air Temp 61°

Traffic 9 Cars/min one way on 27

☐ Heavy ■ Medium ☐ Low

Gross Solids

Type ■ Litter ■ Debris ■ Coarse Sediments

Amount ☐ L ■ M ☐ S ☐ L ☐ M ■ S ☐ L ■ M ☐ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ■ Residential ☐ Mixed ☐ Open / Non urban

Design Info

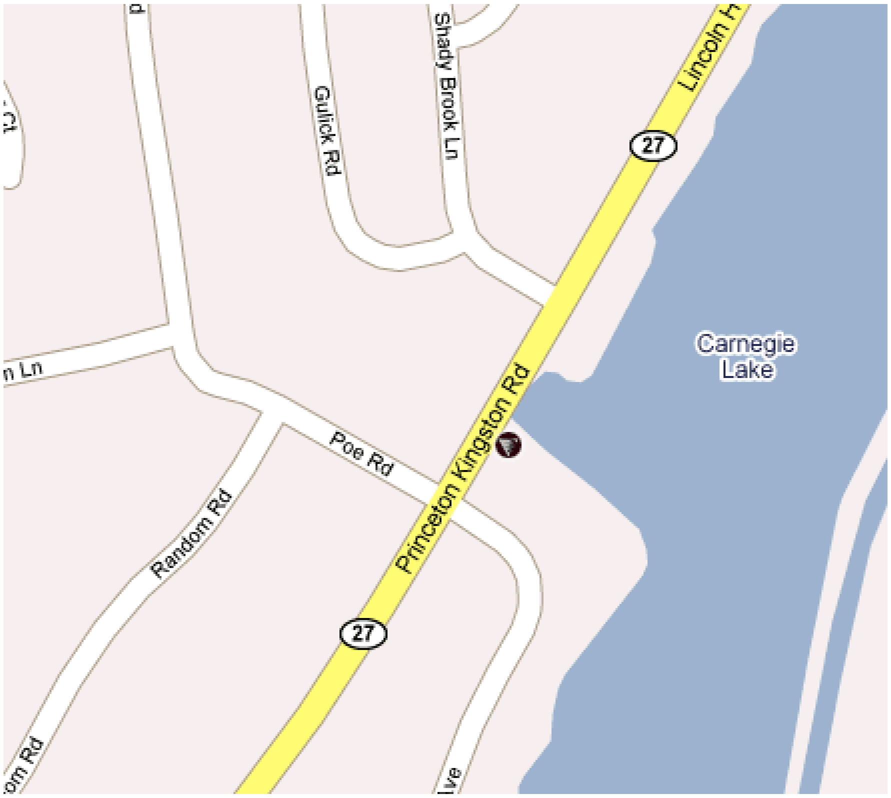
Drainage Area ______ Treatment Flow 1.75 Maximum Flow 4.375

(2007-06-10)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	4.45	1 (center)	2 (in between)	3 (side)	8.75
		6.3	6.3	6.8	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	N/A
	N/A	N/A	N/A		

Remarks:
Located at Harry’s Brook bridge
It had rained the day before the site visit. (05-10-07)
The floatables chamber was not accessible since there were only two covers and none above the floatables chamber.
In the outlet chamber, The depth of water was 4.32ft (4.5-8.82ft)


Shady Brook Ln
Gulick Rd
Lincoln H
27
Carnegie Lake
Princeton Kingston Rd
Poe Rd
Random Rd
27

Rutgers ID: **RU 05-02** Date 2007-05-10 Time 11:40

Device	Model	Municipality	County	Location
Vortechs	1000	Princeton Twp	Mercer	NJ-27
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
N/A	2004-03-31	40°21.961’	74°37.620’	51 ft

Climate Mostly Cloudy Wind Sp/Dir W 4 mph Air Temp 61°

Traffic 9 Cars/min one way on 27

☐ Heavy ■ Medium ☐ Low

Gross Solids

Type	■ Litter			■ Debris			■ Coarse Sediments		
Amount	☐ L	■ M	☐ S	☐ L	☐ M	■ S	☐ L	■ M	☐ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ■ Residential ☐ Mixed ☐ Open / Non urban

Design Info

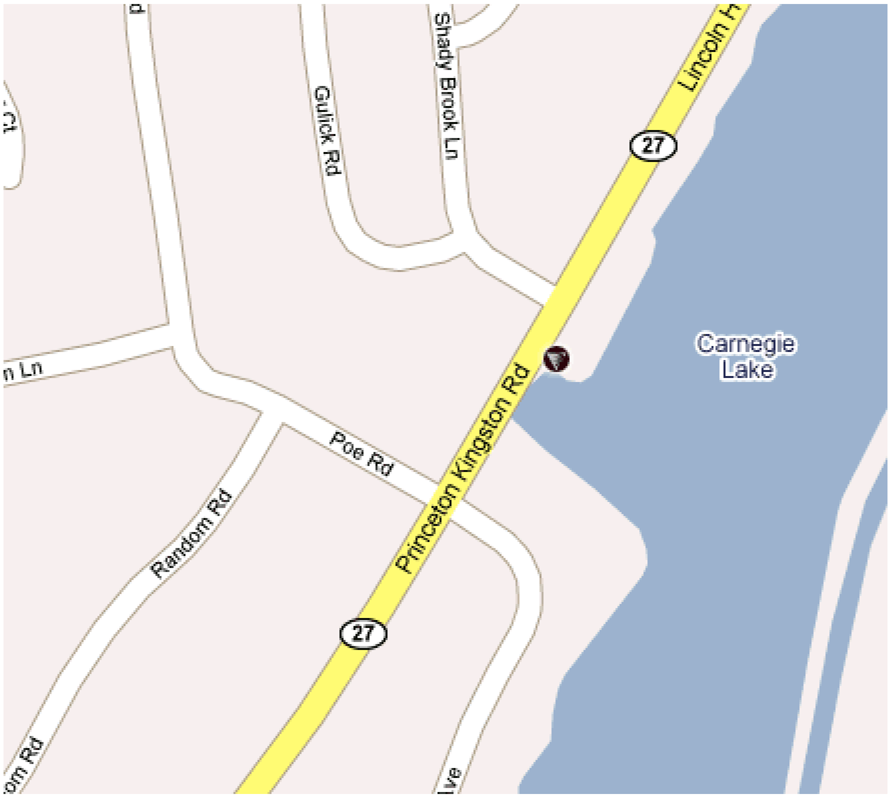
Drainage Area ________ Treatment Flow 0.63 Maximum Flow 1.575

(2007-06-10)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	3.05	1 (center)	2 (in between)	3 (side)	8.1
		4.2	4.2	4.45	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	N/A
	N/A	N/A	N/A		

Remarks:
Located at Harry’s Brook bridge
It had rained the day before the site visit:
The floatables chamber was not accessible since there were only two covers and none above the floatables chamber.
In the outlet chamber, the depth of water is 4.0ft (3.4-7.4ft) and the depth of sediment is 0.7ft (7.4-8.1ft).


Shady Brook Ln
Gulick Rd
Lincoln H
27
Carnegie
Lake
Princeton Kingston Rd
Poe Rd
Random Rd
27

Rutgers ID: **RU 08-01** Date 2007-05-20 Time 14:40

Device	Model	Municipality	County	Location
Vortechs	11000	Berlin	Camden	Jackson Rd and Route 73
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
N/A	2006-04-11	39°47.130’	74°54.469’	157ft

Climate Cloudy Wind Sp/Dir NW 5 mps Air Temp 68°

Traffic 16 Cars/min one way on Rt73

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type	■ Litter	■ Debris	■ Coarse Sediments
Amount	☐ L ■ M ☐ S	☐ L ☐ M ■ S	☐ L ■ M ☐ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ☐ Residential ■ Mixed ☐ Open / Non urban

Design Info

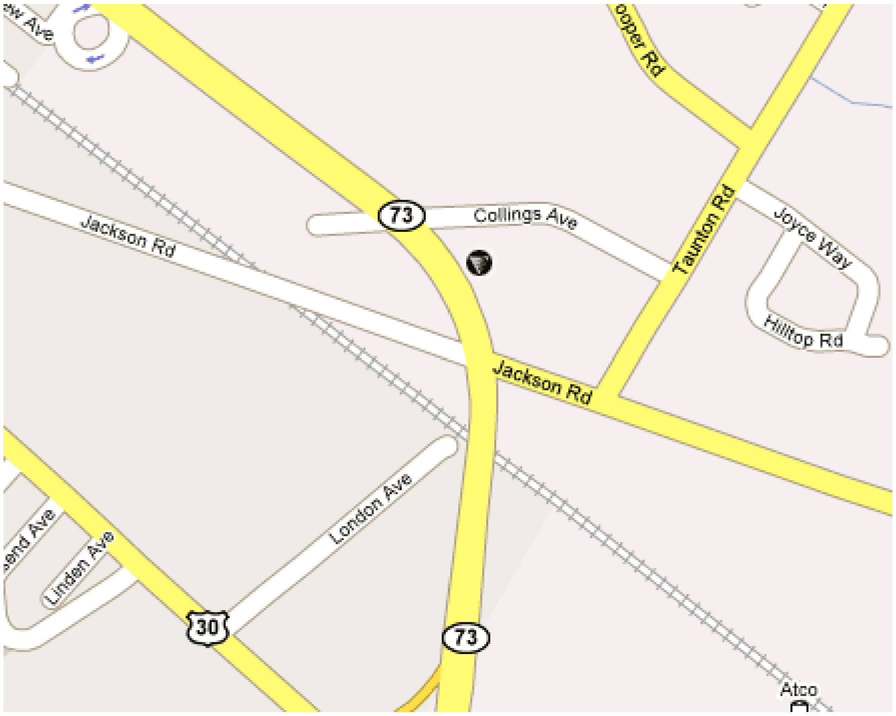
Drainage Area ______ Treatment Flow 7 Maximum Flow 17.5

(2007-06-22)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	N/A	1 (center)	2 (in between)	3 (side)	N/A
		N/A	N/A	N/A	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	N/A
	N/A	N/A	N/A		

Remarks:
The bottom of the Vortechs System could not be reached with the measurement tool since the device is installed deep underground.
Manhole cover above floatables chamber is located on the Rt73. It is difficult to open without blocking traffic.


Jackson Rd
73
Collings Ave
Taunton Rd
Joyce Way
Hilltop Rd
Jackson Rd
London Ave
Linden Ave
30
73
Atco

Rutgers ID: **RU 09-02** Date 2007-05-13 Time 13:30

Device	Model	Municipality	County	Location
Vortechs	1000	Lakewood	Ocean	U.S. Rt. 9
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
101960174	N/A	40°05.287'	74°12.945'	48 ft

Climate Cloudy Wind Sp/Dir 9 mps Air Temp 73°

Traffic 20 Cars/min one way on Rt. 9

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type ■ Litter ■ Debris ■ Coarse Sediments

Amount ■ L ☐ M ☐ S ☐ L ☐ M ■ S ☐ L ■ M ☐ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ☐ Residential ■ Mixed ☐ Open / Non urban

Design Info

Drainage Area 0.2 Treatment Flow 0.63 Maximum Flow 1.575

(2007-06-21)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
		1 (center)	2 (in between)	3 (side)	
	6.3	7.7	7.7	7.7	9.6

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)		
	5.4	5.4	5.4	5.6	8.8

Remarks:
The device is on the slope.
A lot of small gravels around covers
The grit chamber and the floatables chamber were mostly covered by floating litter (Such as cigarette butts).


Lake Carasaljo
2nd St
1st St
1st St
Clifton Ave
N Lake Dr
S Lake Dr
Myrtle Pl
Lapsley Ln
Kimball Rd
Davis Rd
Bradshaw Rd
Freeman Rd
Central Ave
Caranetta Dr
Caranetta Dr
Sunset Rd
Sunset Rd
River Ave
River Ave
88
Main St
S Clifton Ave
547
9
Hurley Ave
528
Roberto Clemente Park
Ashley Ave
John St
9
Edgewood Ct
Lois Ln

Rutgers ID: **RU 10-01** Date 2007-05-28 Time 11:30

Device	Model	Municipality	County	Location
Vortechs	1000	Middle Twp.	Cape May	Route 9 & Crest Haven Rd
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
014970244	2004-11-04	39°06.115'	74°48.553'	17 ft

Climate Sunny Wind Sp/Dir 5 mps Air Temp 85°

Traffic 19 Cars/min one way on Rt. 9

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type	■ Litter	■ Debris	■ Coarse Sediments
Amount	☐ L ☐ M ■ S	☐ L ☐ M ☐ S	☐ L ☐ M ☐ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ☐ Residential ■ Mixed ☐ Open / Non urban

Design Info

Drainage Area 0.213 Treatment Flow 0.63 Maximum Flow 1.575

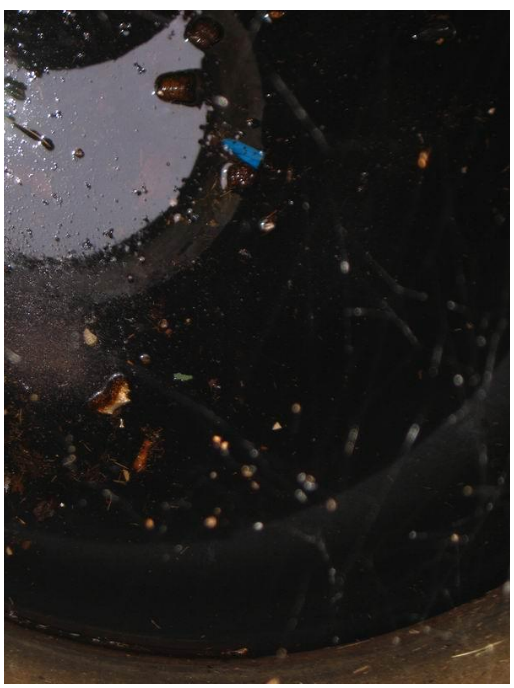
(2007-08-05)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	6.3	1 (center)	2 (in between)	3 (side)	9.15
		8.1	8.2	8.4	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	N/A
	N/A	N/A	N/A		

Remarks:
The first visiting day (05/28/07) was a holiday (Memorial day)
The floatables chamber was not accessible since there were only two covers and none above the floatables chamber.

Stone Harbor Golf Course
Aspen Dr
Cedar Dr
Birch Dr
Cedar Dr
Avocado Dr
9
Justice
Toft Dr
Pkwy Dr
County Park Rd
9
N Shore Rd
Cape May County Park
County Park Rd
Crest Haven Rd
Fox Run Rd
11
Moore Rd
Vortec Rd
Crest Haven Rd
Crest Haven Rd



Rutgers ID: **RU 10-02** Date 2007-05-28 Time 11:30

Device	Model	Municipality	County	Location
Vortechs	1000	Cape May	Cape May	Route 9 & Crest Haven Rd
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
014970244	2004-11-04	39°06.133’	74°48.511’	17 ft

Climate Sunny Wind Sp/Dir 5 mps Air Temp 85°

Traffic 19 Cars/min one way on Rt. 9

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type	■ Litter	☐ Debris	☐ Coarse Sediments
Amount	☐ L ■ M ☐ S	☐ L ☐ M ■ S	☐ L ☐ M ■ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ☐ Residential ■ Mixed ☐ Open / Non urban

Design Info

Drainage Area 0.13 Treatment Flow 0.63 Maximum Flow 1.575

(2007-08-05)

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	5.4	1 (center)	2 (in between)	3 (side)	8.25
		8.1	7.6	7.4	
Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	N/A
	N/A	N/A	N/A		

Remarks:

The first visiting day (05/28/07) was a holiday (Memorial day)
The floatables chamber was not accessible since there were only two covers and none above the floatables chamber.
The contaminated outlet flow is accumulated in front of the outlet mouth. Surrounded lake vegetables impede flow through lake

Stone Harbor
Golf Course
Aspen Dr
Cedar Dr
Birch Dr
Cedar Dr
Avocado Dr
9
Justice
Toft Dr
Pkwy Dr
County Park Rd
9
Cape May
County Park
N Shore Rd
11
Crest Haven Rd
Fox Run Rd
Vortec Rd
Moore Rd
Crest Haven Rd
Crest Haven Rd


Date of photo : 05-28-2007


Date of photo : 05-28-2007


Date of photo : 08-05-2007


Date of photo : 08-05-2007


Date of photo : 05-28-2007

Google Map @2007

Rutgers ID: **RU 11-01** Date 2007-06-08 Time 14:00

Device	Model	Municipality	County	Location
Vortechs	16000	Rahway	Union	Rt. 1 & 9 Section 1K and 3M
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
037960126	2006-08-28	40°35.716’	74°16.338’	52ft

Climate Mostly Sunny Wind Sp/Dir 6 mph/NNW Air Temp 81°

Traffic 16 Cars/min one way on Randolph Ave

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type	■ Litter			■ Debris			■ Coarse Sediments		
Amount	☐ L	■ M	☐ S	☐ L	☐ M	■ S	■ L	☐ M	☐ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

■ Commercial ☐ Residential ☐ Mixed ☐ Open / Non urban

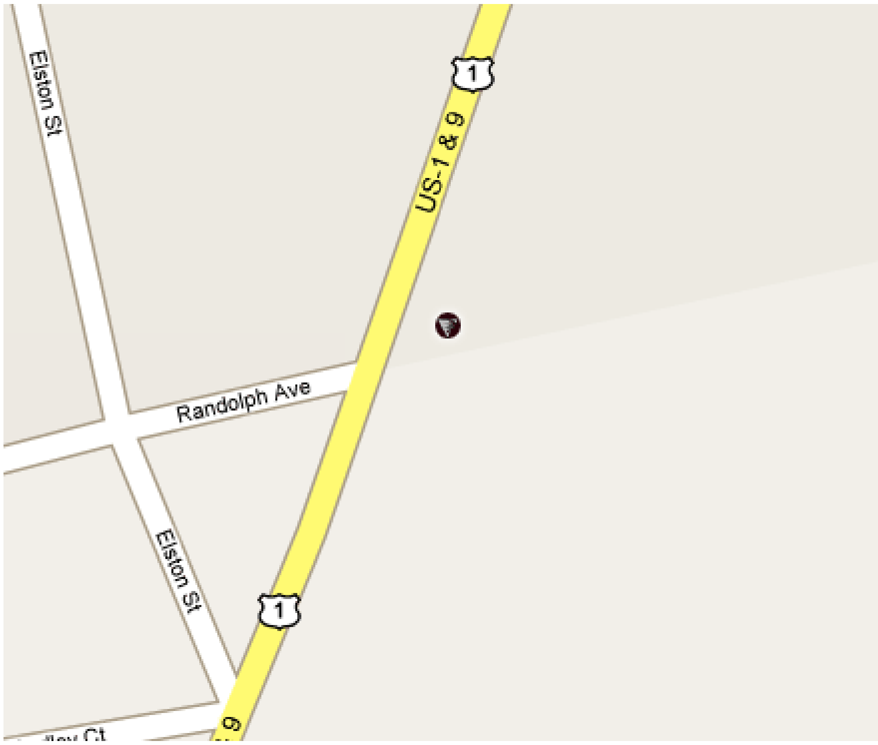
Design Info

Drainage Area ________ Treatment Flow 10.08 Maximum Flow 25.2

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
		1 (center)	2 (in between)	3 (side)	
	4.2 ft	7.45	7.45	7.45	8.2

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	8.1
	4.2	4.3	4.3		

Remarks:
Vortechs manholes are located on a construction site.
The Vortechs is located along the side of Randolph Ave and is about 30ft away from Rt.1&9.
There are two other manhole covers between the Vortechs device and the road.
Water surfaces of both grit (swirl) chamber and floatables chamber were mostly covered by floating litter (such as Styrofoam). One layer of floatables only and thickness difficult to measure.


Elston St
US-1 & 9
Randolph Ave
Elston St

Rutgers ID: **RU 11-02** Date 2007-06-08 Time 14:00

Device	Model	Municipality	County	Location
Vortechs	9000	Rahway	Union	RTE US 1 & 9 Section 1K and 3M
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
037960126	2006-08-28	40°35.711’	74°16.256’	52ft

Climate Mostly Sunny Wind Sp/Dir 6 mph/NNW Air Temp 81°

Traffic 16 Cars/min one way on Randolph Ave

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type	■ Litter			■ Debris			■ Coarse Sediments		
Amount	☐L	☐M	■S	☐L	☐M	■S	■L	☐M	☐S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

■ Commercial ☐ Residential ☐ Mixed ☐ Open / Non urban

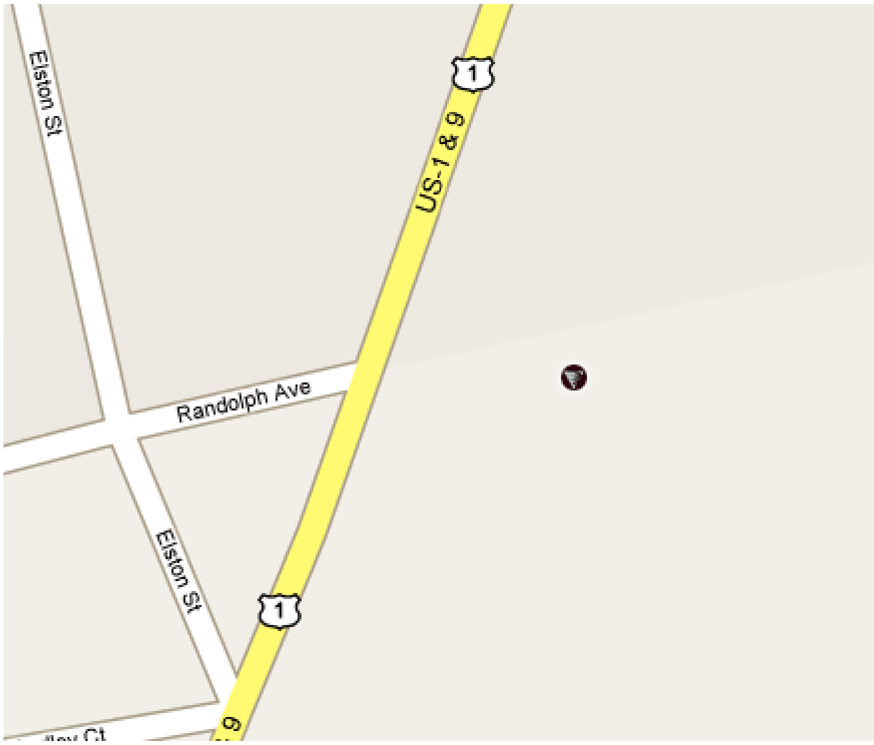
Design Info

Drainage Area ______ Treatment Flow 5.67 Maximum Flow 14.175

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	7.6	1 (center)	2 (in between)	3 (side)	10.5
		10.1	10.1	10.1	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	10.6
	7.6	7.6	7.6		

Remarks:
Vortechs manholes are located on a construction site.
The Vortechs is located along the side of Randolph Ave and is about 70ft away from Rt 1&9.
There are two other manhole covers between the Vortechs device and the road.
Water surface of both grit (swirl) chamber and floatables chamber was about half covered by floating litter. One layer of floatables only and thickness difficult to measure.


Elston St
US-1 & 9
1
Randolph Ave
Elston St
1

Rutgers ID: **RU 12-01** Date 2007-06-08 Time 15:30

Device	Model	Municipality	County	Location
Vortechs	11000	Clinton Twp	Hunterdon	Rt. 78 & Rt. 173
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
000950475	2006-04-27	40°37.911’	74°55.067’	15ft

Climate Mostly Sunny Wind Sp/Dir 3 mph/SW Air Temp 71°

Traffic 19 Cars/min one way on Rte 173

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type ■ Litter ■ Debris ■ Coarse Sediments

Amount ☐ L ■ M ☐ S ☐ L ☐ M ■ S ☐ L ■ M ☐ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ☐ Residential ■ Mixed ☐ Open / Non urban

Design Info

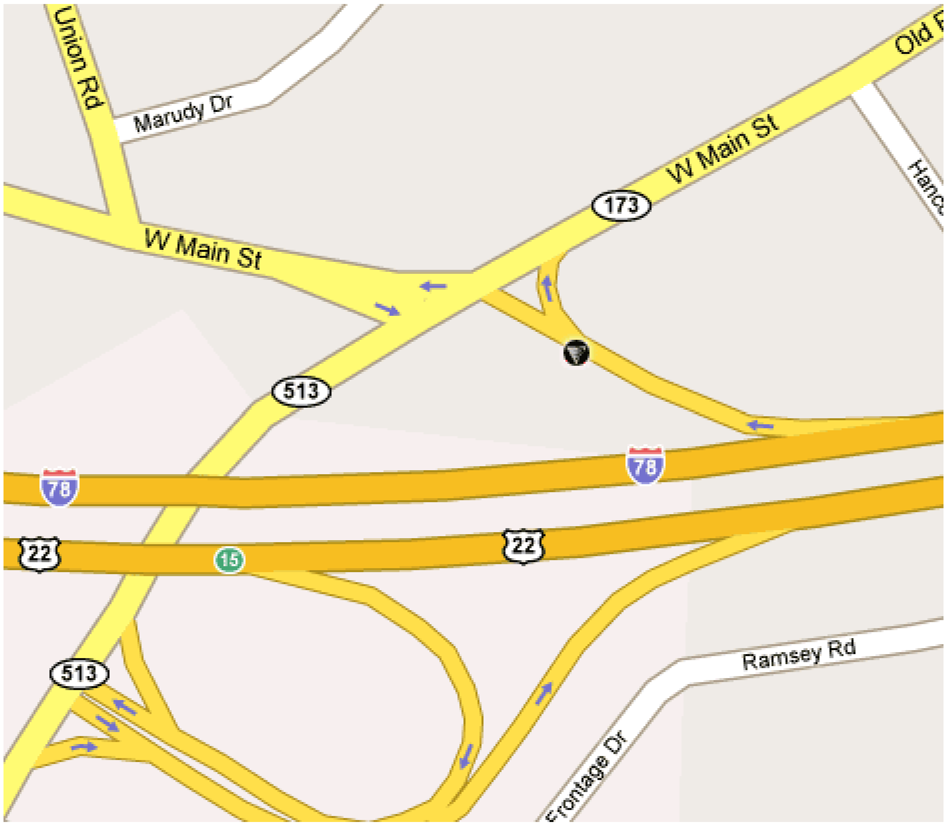
Drainage Area ______ Treatment Flow 7.0 Maximum Flow 17.5

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
		1 (center)	2 (in between)	3 (side)	
	N/A	N/A	N/A	N/A	N/A

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)		
	N/A	N/A	N/A	N/A	N/A

Remarks:

- Vortechs system manholes are located on the road and shoulder.


Union Rd
Marudy Dr
W Main St
173
W Main St
513
78
78
22
15
22
513
Ramsey Rd
Frontage Dr

Rutgers ID: **RU 13-01** Date 2007-06-12 Time 13:00

Device	Model	Municipality	County	Location
Vortechs	4000	New Brunswick	Middlesex	Rt.18 Section 2F, 7E & 11H
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
040960224	2006-12-08	40°29.297'	74°26.089'	7ft

Climate Mostly Sunny Wind Sp/Dir 3 mph/N Air Temp 70°

Traffic 18 Cars/min one way on Rt18

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type	■ Litter	■ Debris	■ Coarse Sediments
Amount	☐ L ■ M ☐ S	☐ L ☐ M ■ S	■ L ☐ M ☐ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ☐ Residential ■ Mixed ☐ Open / Non urban

Design Info

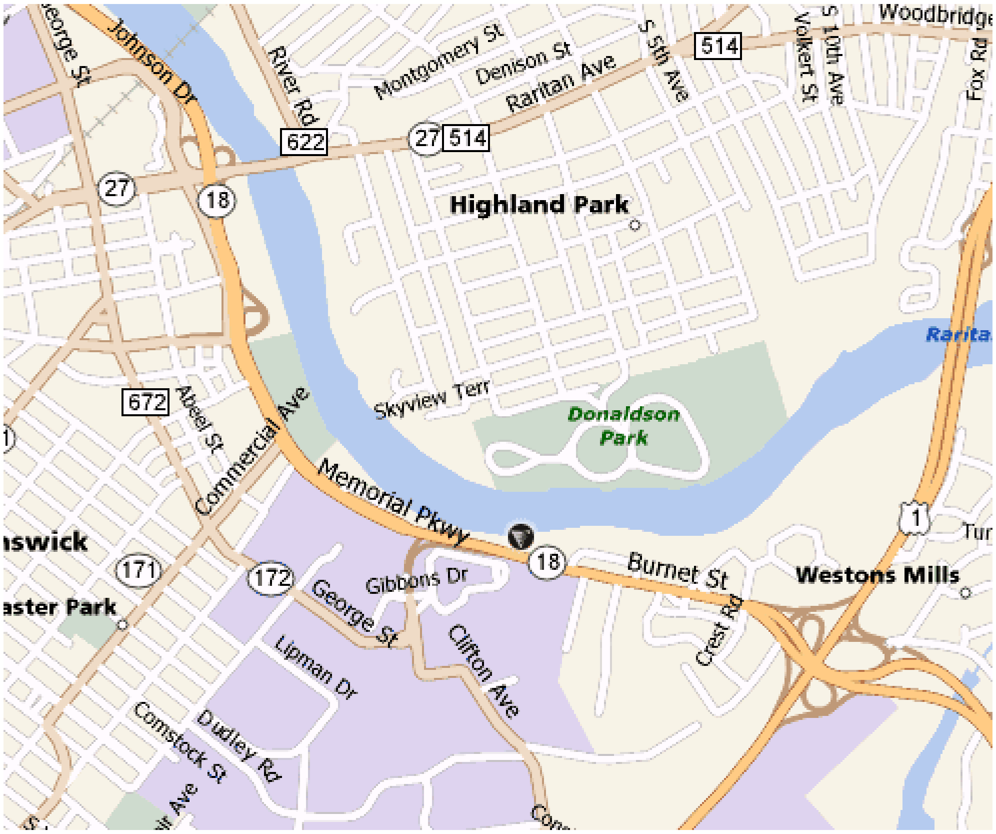
Drainage Area ______ Treatment Flow 2.52 Maximum Flow 6.3

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	7.6 ft	1 (center)	2 (in between)	3 (side)	9.85
		9.85	9.85	9.70	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	9.2
	6.9	6.9	6.9		

Remarks:

- Vortechs manholes are located on a construction site.
- This Vortechs is installed recently. : 2006-12-08.


Johnson Dr
River Rd
Montgomery St
Denison St
Raritan Ave
S 5th Ave
514
Volkert St
S 10th Ave
Woodbridge
Fox Rd
622
27
18
Highland Park
Skyview Terr
Donaldson Park
672
Abeel St
Commercial Ave
Memorial Pkwy
Burnet St
Westons Mills
171
172
Gibbons Dr
George St
Lipman Dr
Clifton Ave
Crest Rd
Comstock St
Dudley Rd
1

Rutgers ID: **RU 13-02** Date 2007-06-12 Time 13:00

Device	Model	Municipality	County	Location
Vortechs	9000	New Brunswick	Middlesex	Rt 18 Section 2F, 7E & 11H
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
040960224	2006-12-08	40°29.514’	74°26.298’	8ft

Climate Mostly Sunny Wind Sp/Dir 3 mph/N Air Temp 70°

Traffic 22 Cars/min one way on Rt18

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type	■ Litter	■ Debris	■ Coarse Sediments
Amount	☐L ■M ☐S	☐L ☐M ■S	■L ☐M ☐S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ☐ Residential ■ Mixed ☐ Open / Non urban

Design Info

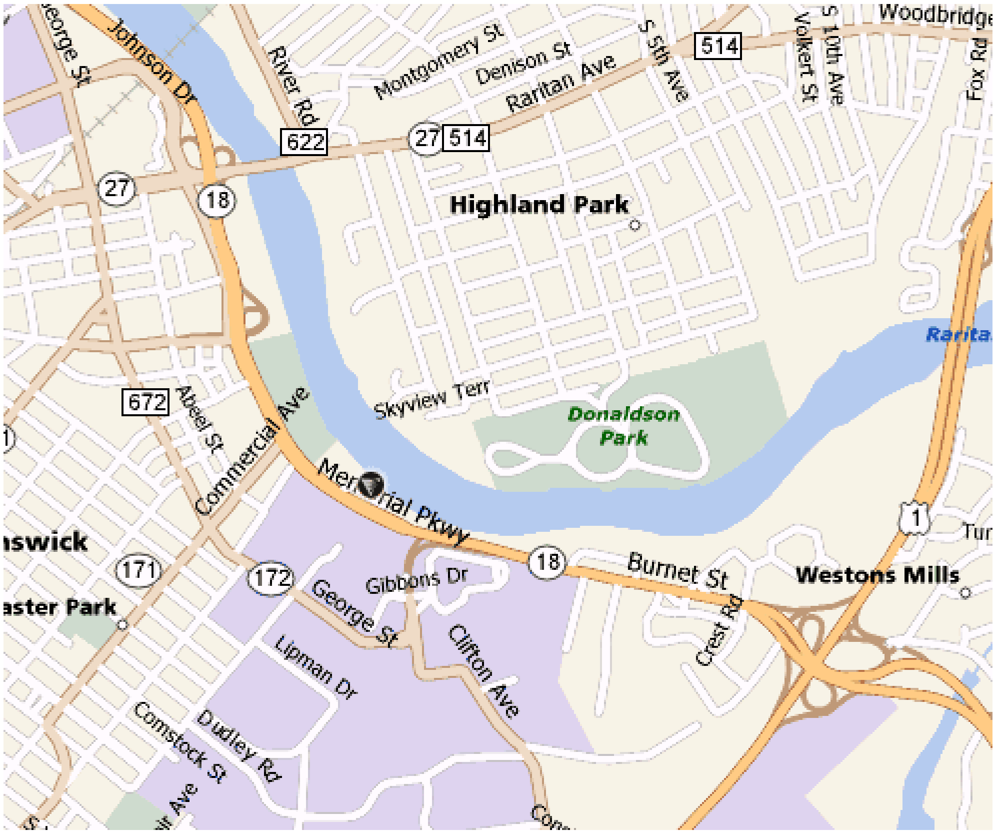
Drainage Area ______ Treatment Flow 2.52 Maximum Flow 6.3

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
		1 (center)	2 (in between)	3 (side)	
	11.5	12.51	12.51	12.51	12.6

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	11.0
	9.0	9.0	9.0		

Remarks:

- Vortechs manholes are located on a construction site.
- This Vortechs is installed recently. : 2006-12-08.



Johnson Dr
River Rd
Montgomery St
Denison St
Raritan Ave
S 5th Ave
514
Volkert St
S 10th Ave
Fox Rd
622
27
514
27
18
Highland Park
Skyview Terr
Donaldson Park
672
Abeel St
Commercial Ave
1
18
Burnet St
Westons Mills
Crest Rd
171
172
Gibbons Dr
George St
Lipman Dr
Clifton Ave
Comstock St
Dudley Rd

Rutgers ID: **RU 15-01** Date 2007-06-17 Time 15:30

Device	Model	Municipality	County	Location
Stormceptor	N/A	Paramus & Fair Lawn	Bergen	SB Rt. 208 and Saddle River Rd.
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
N/A	N/A	40°55.624'	74°05.735'	49ft

Climate Mostly Sunny Wind Sp/Dir 4 mph/NE Air Temp 73°

Traffic 16 Cars/min one way on Saddle River Rd

■ Heavy ☐ Medium ☐ Low

Gross Solids

Type	■ Litter			■ Debris			■ Coarse Sediments		
Amount	■ L	☐ M	☐ S	☐ L	■ M	☐ S	☐ L	☐ M	■ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ☐ Residential ■ Mixed ☐ Open / Non urban

Design Info

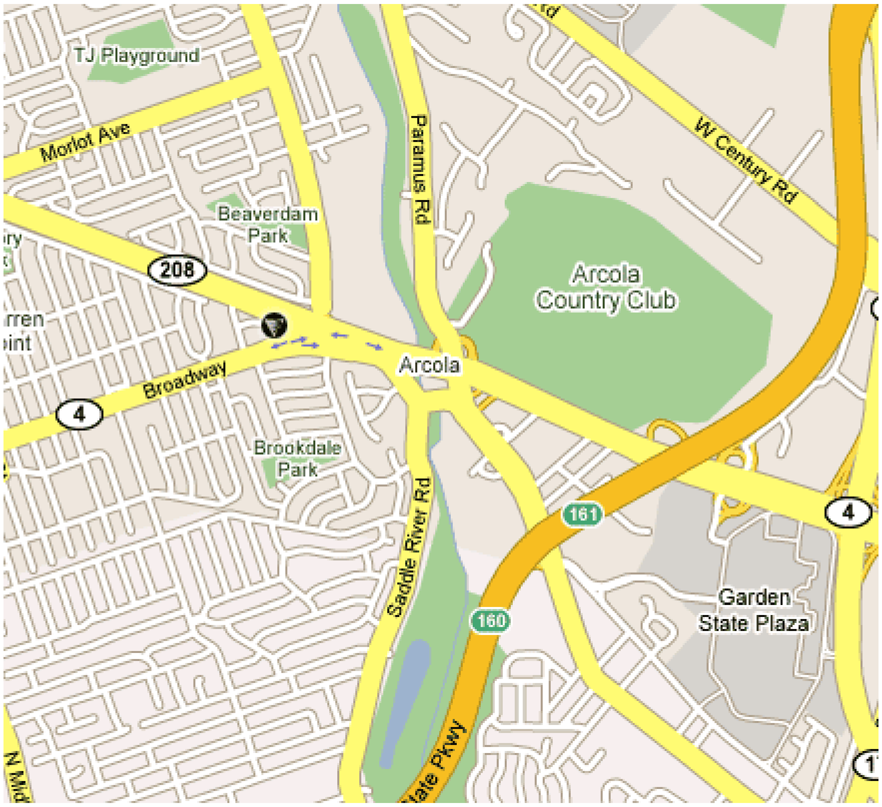
Drainage Area ________ Treatment Flow ________ Maximum Flow ________

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
		1 (center)	2 (in between)	3 (side)	More than 13
		(8.4) 12.4	12.4	(8.4) 12.4	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)		~~12.3~~ 12.9
	8.4	8.4	8.4		

Remarks:

The device is Stormceptor®


TJ Playground
Morlot Ave
Beaverdam Park
208
Broadway
4
Brookdale Park
Paramus Rd
Arcola
Arcola Country Club
W Century Rd
161
160
Saddle River Rd
Garden State Plaza
4

Rutgers ID: **RU 16-02** Date 2008-12-07 Time 14:00

Device	Model	Municipality	County	Location
Vortechs	9000	Frankford	Sussex	SB side of Rt. 206 between Paulins Kill and Rt.15
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
N/A	N/A	41°07.179’	74°42.818’	490ft

Climate Mostly Cloudy Wind Sp/Dir 3 mph/SE Air Temp 40°

Traffic 6 Cars/min one way on Rt206

☐ Heavy ☐ Medium ■ Low

Gross Solids

Type	■ Litter			■ Debris			■ Coarse Sediments		
Amount	☐ L	■ M	☐ S	■ L	☐ M	☐ S	☐ L	☐ M	■ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ☐ Residential ☐ Mixed ■ Open / Non urban

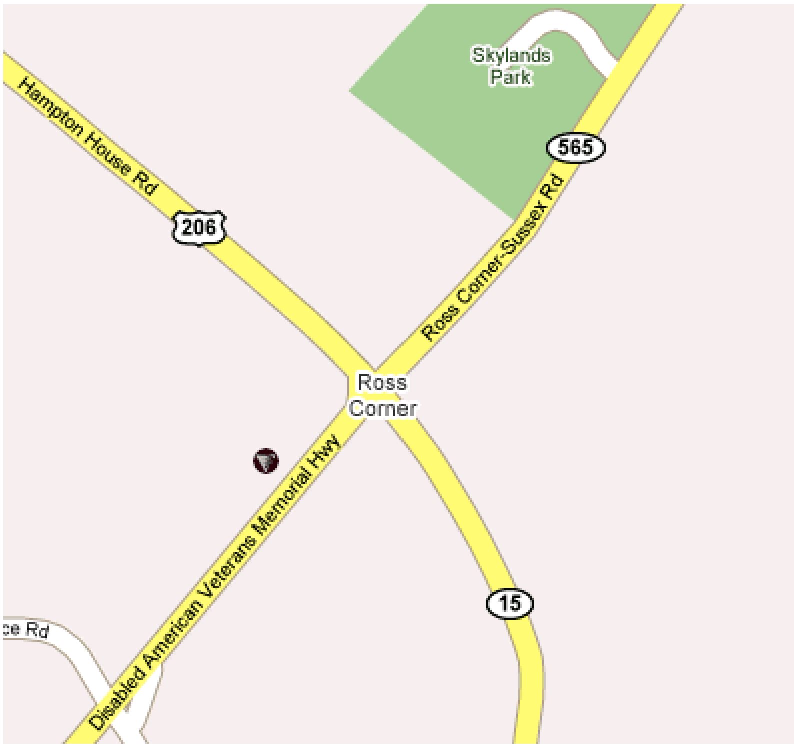
Design Info

Drainage Area ________ Treatment Flow 5.67 Maximum Flow 14.175

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
		1 (center)	2 (in between)	3 (side)	
	4.9	6.3	6.3	6.3	8.4

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)		
	N/A	N/A	N/A	N/A	N/A

Remarks:
A 2.1 ft layer of sediments was found in the floatables chamber (6.3-8.4ft).
The floatables chamber was not accessible since there was no cover above it.


Skylands
Park
Hampton House Rd
206
565
Ross Corner-Sussex Rd
Ross
Corner
Disabled American Veterans Memorial Hwy
15
ce Rd


SPEED
LIMIT
50

Rutgers ID: **RU 17-01** Date 2007-08-08 Time 10:30

Device	Model	Municipality	County	Location
Vortechs	3000	Montgomery	Somerset	Great Rd (601) & Cherry Valley Rd
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
05020	2006-06-07	40°22.991'	74°41.893'	257ft

Climate Partly Cloudy Wind Sp/Dir 7 mph/SW Air Temp 84°

Traffic 7 Cars/min one way on Rt601 SB

☐ Heavy ☐ Medium ■ Low

Gross Solids

Type ■ Litter ■ Debris ■ Coarse Sediments

Amount ☐ L ☐ M ■ S ☐ L ■ M ☐ S ☐ L ☐ M ■ S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ■ Residential ☐ Mixed ☐ Open / Non urban

Design Info

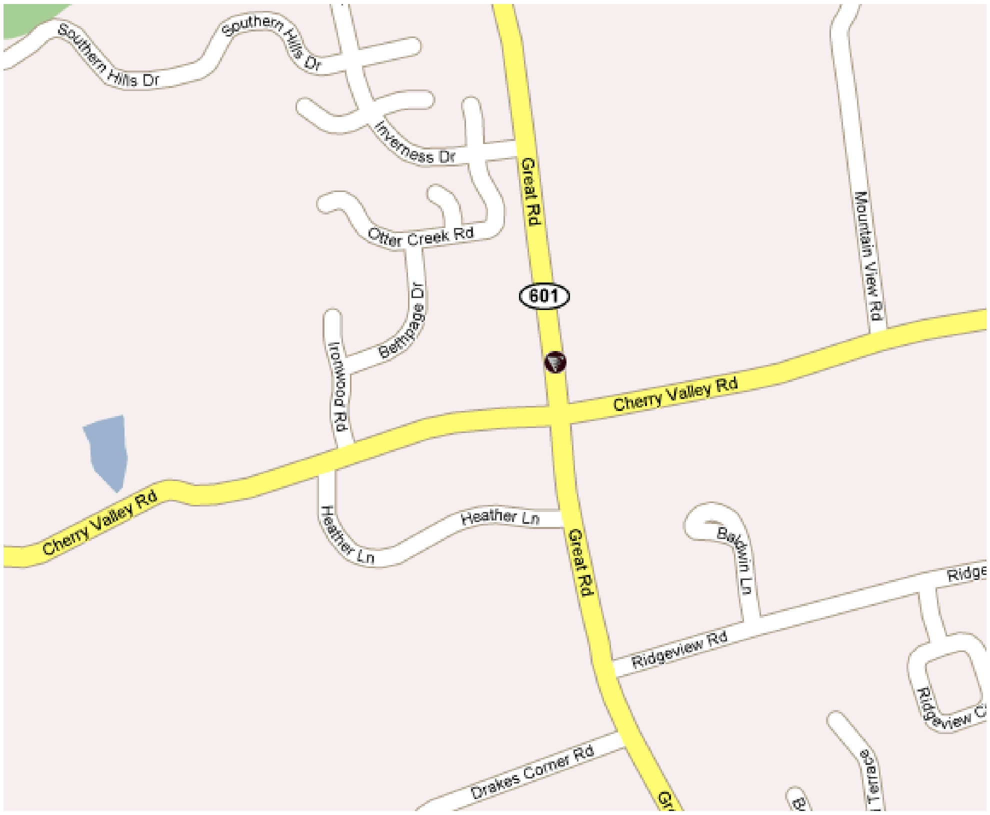
Drainage Area ______ Treatment Flow 1.75 Maximum Flow 4.375

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	N/A	1 (center)	2 (in between)	3 (side)	N/A
		N/A	N/A	N/A	

Float. Chamber	Floatables Top Surface Reading			Fl. Bott. Su. R	Bot Reading
	1 (center)	2 (in between)	3 (side)	N/A	
	N/A	N/A	N/A		N/A

Remarks:

- The Vortechs manholes are located in the center of the road
- Agriculture residential



Southern Hills Dr
Southern Hills Dr
Inverness Dr
Otter Creek Rd
Great Rd
601
Bethpage Dr
Ironwood Rd
Mountain View Rd
Cherry Valley Rd
Cherry Valley Rd
Heather Ln
Heather Ln
Great Rd
Baldwin Ln
Ridgeview Rd
Drakes Corner Rd

SCHOOL BUS

Rutgers ID: **RU 17-02** Date 2007-08-09 Time 7:30

Device	Model	Municipality	County	Location
Vortechs	3000	Montgomery	Somerset	Great Rd (601) & Cherry Valley Rd
NJDOT Project Number	Installation Date	Latitude	Longitude	Elevation
05020	2006-06-07	40°22.750’	74°41.859’	288ft

Climate Partly Cloudy Wind Sp/Dir 6 mph/SE Air Temp 71°

Traffic 5 Cars/min one way on Rt601 SB

☐ Heavy ☐ Medium ■ Low

Gross Solids

Type ■ Litter ■ Debris ■ Coarse Sediments

Amount ☐ L ☐M ■ S ☐ L ■ M ☐S ☐ L ■ M ☐S

Soil Type

☐ Sand ■ Silt ☐ Clay

Land Use

☐ Commercial ■ Residential ☐ Mixed ☐ Open / Non urban

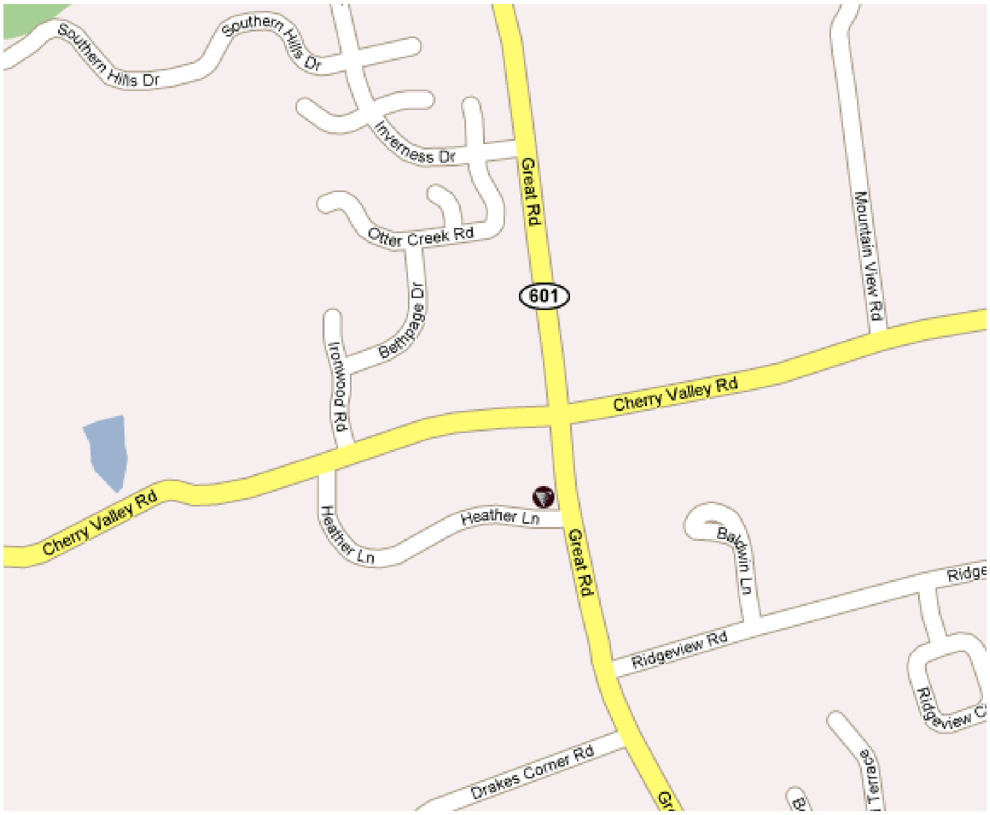
Design Info

Drainage Area ______ Treatment Flow 1.75 Maximum Flow 4.375

Grit Chamber	Water S. Reading	Sediment Surface Reading			Bot Reading
	4.4	1 (center)	2 (in between)	3 (side)	9.4
		8.5	8.5	8.6	
Float. Chamber	**Floatables Top Surface Reading**			**Fl. Bott. Su. R**	**Bot Reading**
	1 (center)	2 (in between)	3 (side)	N/A	N/A
	N/A	N/A	N/A		

Remarks:

- The floatables chamber was not accessible since there were only two covers and none above the floatables chamber.
- Agriculture residential
- Two diversion chambers for inlet and outlet have each cover


Southern Hills Dr
Southern Hills Dr
Inverness Dr
Great Rd
Otter Creek Rd
601
Bethpage Dr
Ironwood Rd
Mountain View Rd
Cherry Valley Rd
Cherry Valley Rd
Heather Ln
Heather Ln
Great Rd
Baldwin Ln
Ridgeview Rd
Drakes Corner Rd

Appendix B: The volume and weight of floatables collected in the device

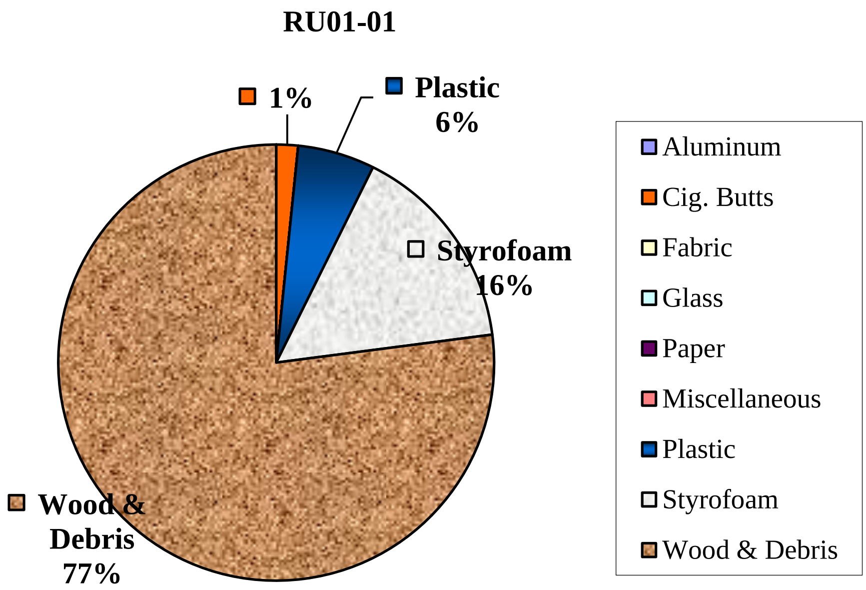
The Volume (ft^3)

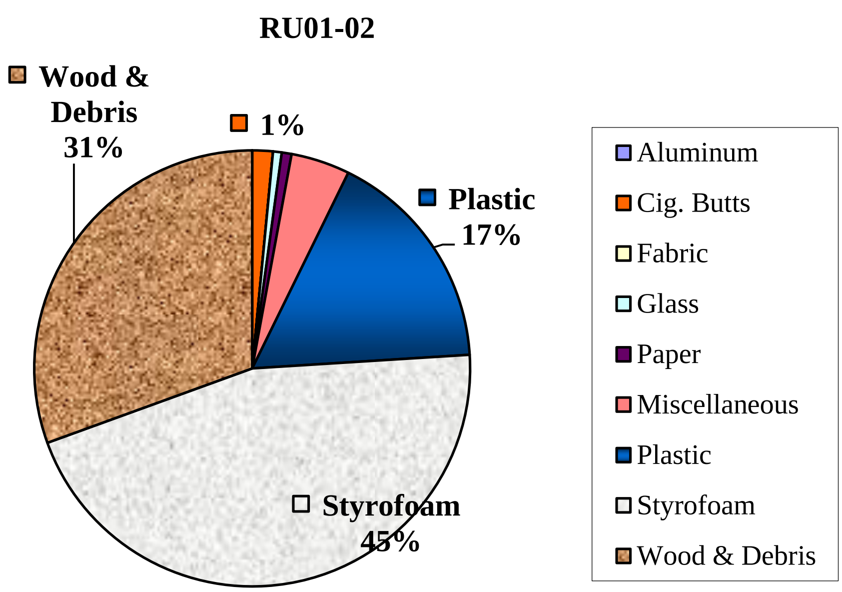
ID	Aluminum	Cig. Butts	Fabric	Glass	Paper	MISC	Plastic	Styrofoam	Wood & Debris	Total
RU01-01	0.000	0.001	0.000	0.000	0.000	0.000	0.002	0.005	0.026	0.034
RU01-02	0.018	0.005	0.000	0.000	0.000	0.014	0.110	0.086	0.051	0.284
RU01-03	0.004	0.000	0.000	0.000	0.000	0.000	0.002	0.018	0.215	0.239
RU01-04	0.021	0.032	0.000	0.008	0.011	0.028	0.131	0.184	0.441	0.857
RU02-01	0.007	0.020	0.000	0.000	0.000	0.011	0.112	0.161	0.240	0.574
RU02-02	0.000	0.015	0.000	0.000	0.000	0.011	0.112	0.125	0.184	0.445
RU04-02	0.004	0.017	0.000	0.003	0.004	0.018	0.127	0.194	0.032	0.397
RU06-01	0.004	0.001	0.000	0.003	0.000	0.014	0.040	0.039	0.000	0.101
RU07-01	0.000	0.007	0.000	0.003	0.004	0.021	0.081	0.221	0.148	0.486
RU09-01	0.000	0.040	0.000	0.002	0.000	0.014	0.025	0.159	0.025	0.265
RU14-01	0.000	0.025	0.000	0.004	0.000	0.018	1.207	3.196	0.127	4.676
RU16-01	0.000	0.032	0.000	0.002	0.000	0.004	0.068	0.170	0.030	0.305

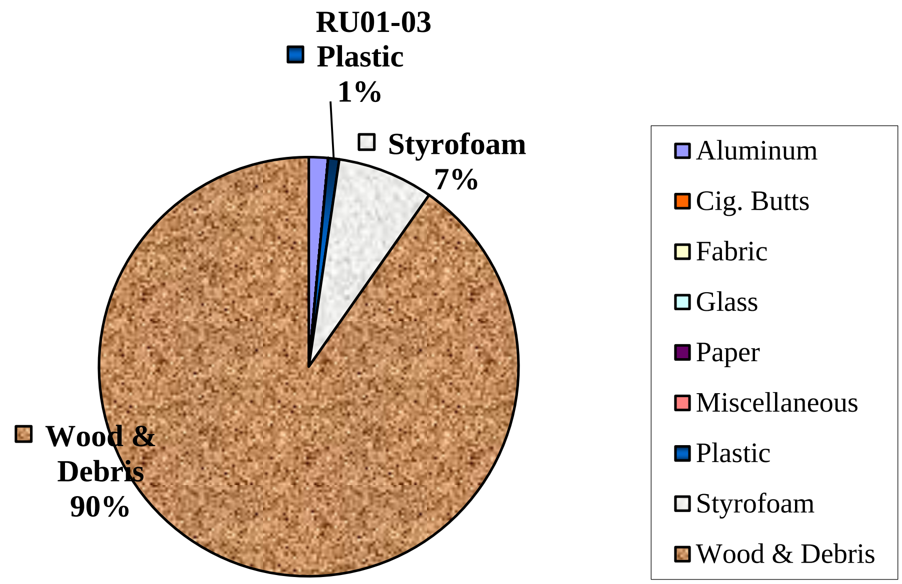
The Weight (lbs)

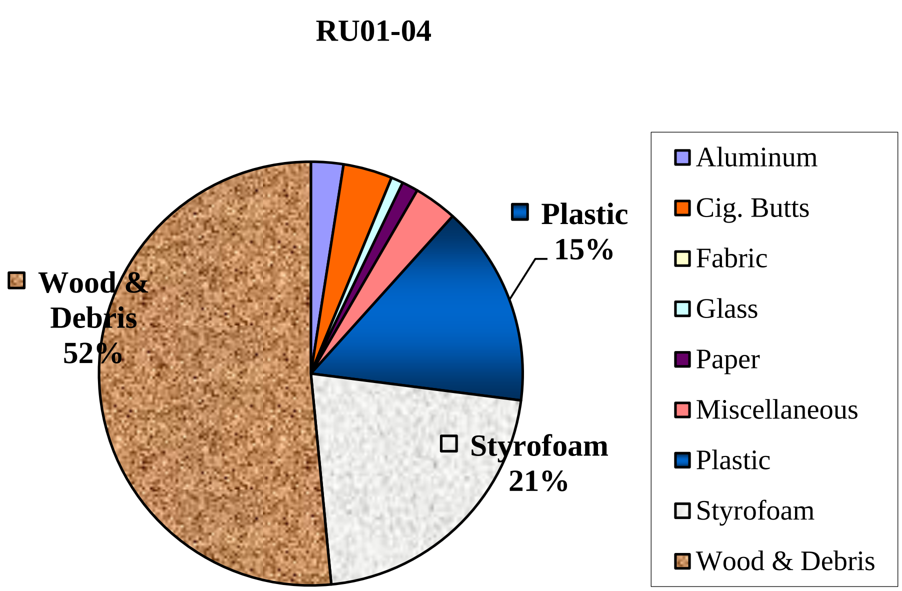
ID	Aluminum	Cig. Butts	Fabric	Glass	Paper	MISC	Plastic	Styrofoam	Wood & Debris	Total
RU01-01	0.000	0.001	0.000	0.000	0.000	0.000	0.006	0.004	0.071	0.082
RU01-02	0.052	0.008	0.000	0.000	0.000	0.300	0.310	0.031	0.101	0.802
RU01-03	0.012	0.000	0.000	0.000	0.000	0.000	0.050	0.006	0.690	0.758
RU01-04	0.074	0.039	0.000	0.108	0.013	0.510	0.310	0.081	1.321	2.456
RU02-01	0.052	0.024	0.000	0.000	0.000	0.122	0.412	0.131	0.628	1.369
RU02-02	0.000	0.022	0.000	0.000	0.000	0.214	0.575	0.192	0.521	1.524
RU04-02	0.011	0.029	0.000	0.042	0.010	0.280	0.167	0.021	0.085	0.645
RU06-01	0.010	0.001	0.000	0.048	0.000	0.121	0.100	0.019	0.001	0.300
RU07-01	0.000	0.009	0.000	0.042	0.018	0.340	0.123	0.056	0.400	0.988
RU09-01	0.000	0.056	0.000	0.028	0.000	0.272	0.777	0.090	0.051	1.274
RU14-01	0.000	0.037	0.000	0.110	0.000	0.411	3.801	1.151	0.387	5.897
RU16-01	0.000	0.042	0.000	0.028	0.000	0.080	0.213	0.041	0.056	0.460

Appendix C: Types and volume proportions of floatables that were trapped and removed

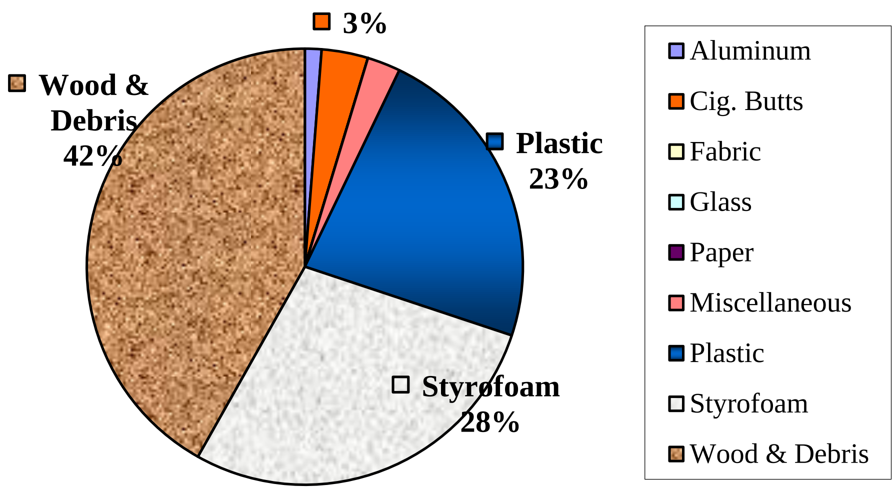




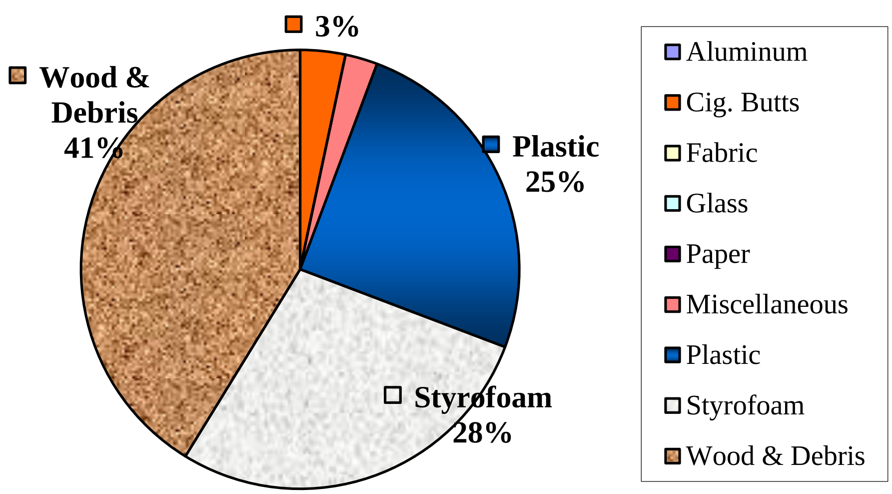

RU01-03
Plastic 1%
Styrofoam 7%
Wood & Debris 90%
Aluminum
Cig. Butts
Fabric
Glass
Paper
Miscellaneous
Plastic
Styrofoam
Wood & Debris

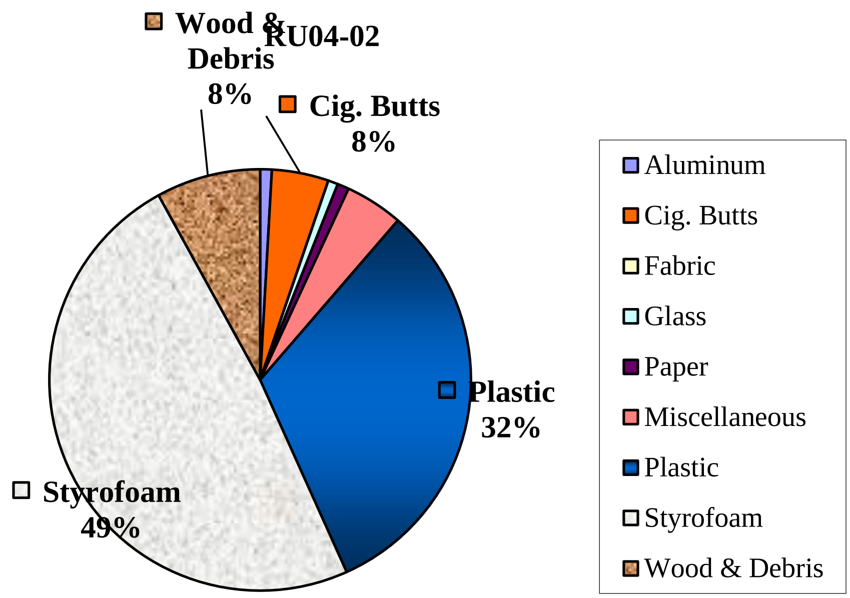

RU01-04
Plastic 15%
Wood & Debris 52%
Styrofoam 21%
Aluminum
Cig. Butts
Fabric
Glass
Paper
Miscellaneous
Plastic
Styrofoam
Wood & Debris

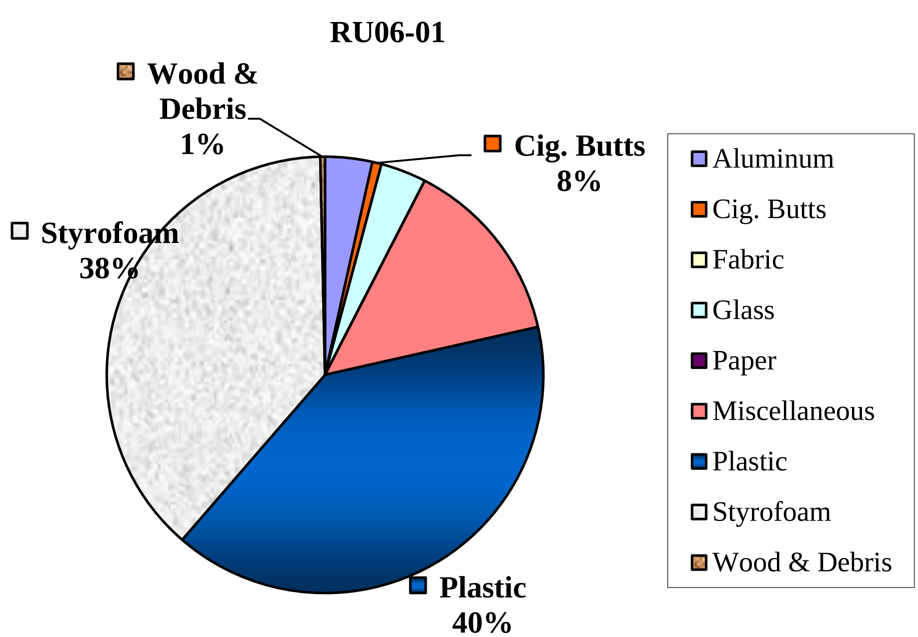
RU02-01

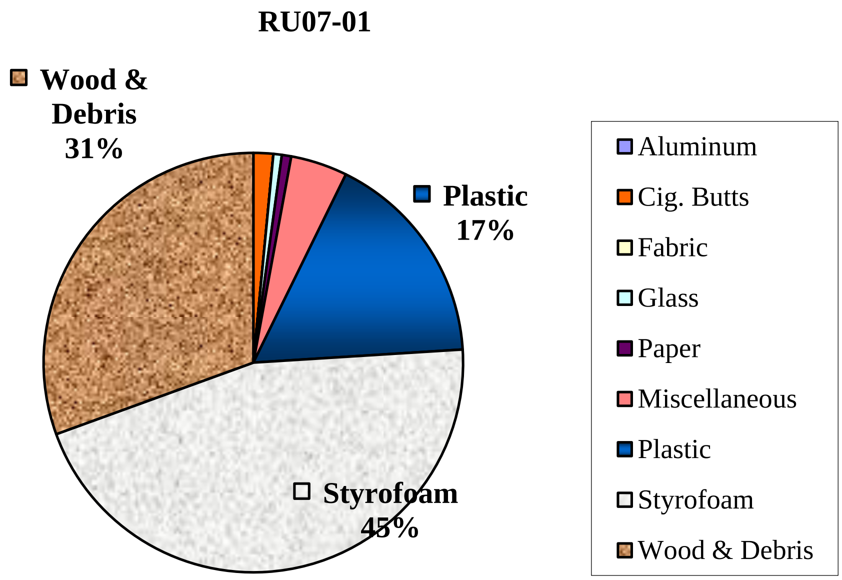


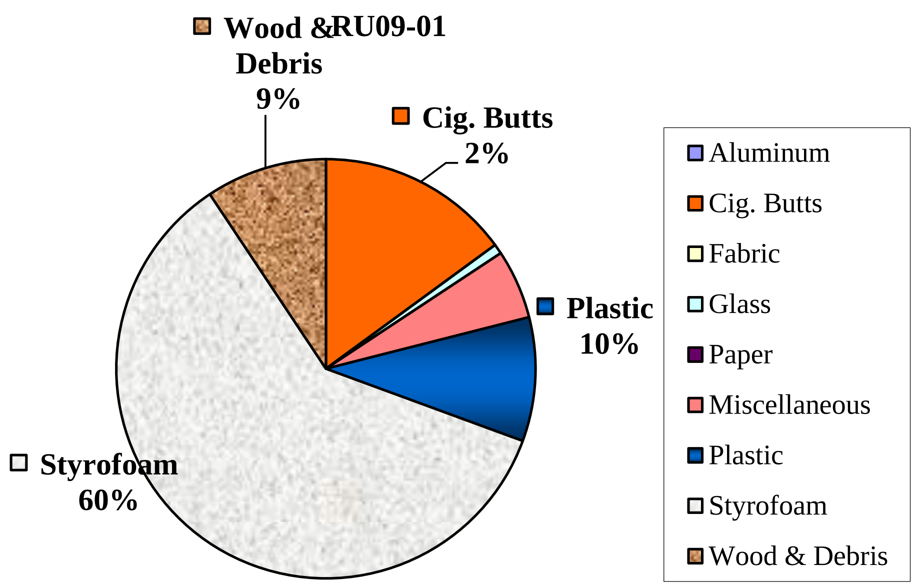
RU02-02

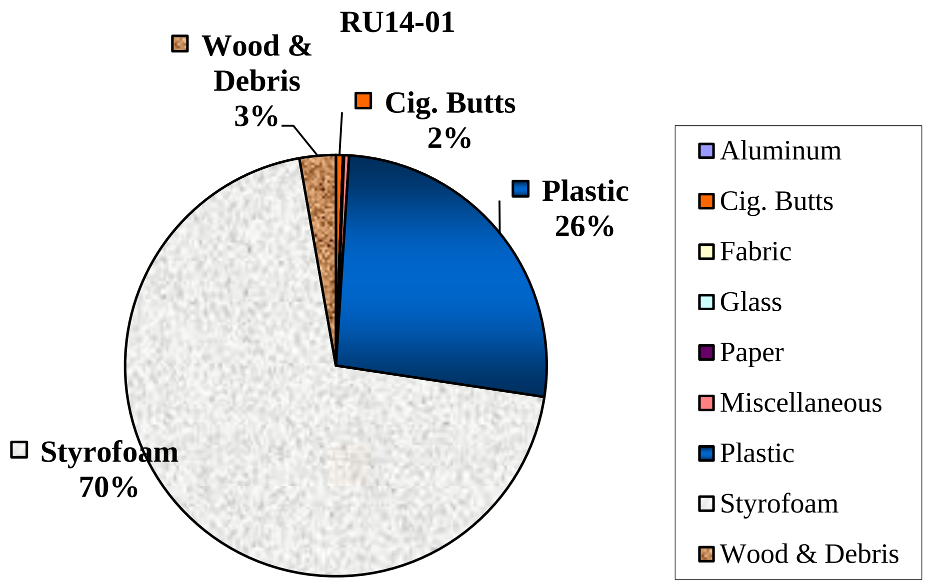


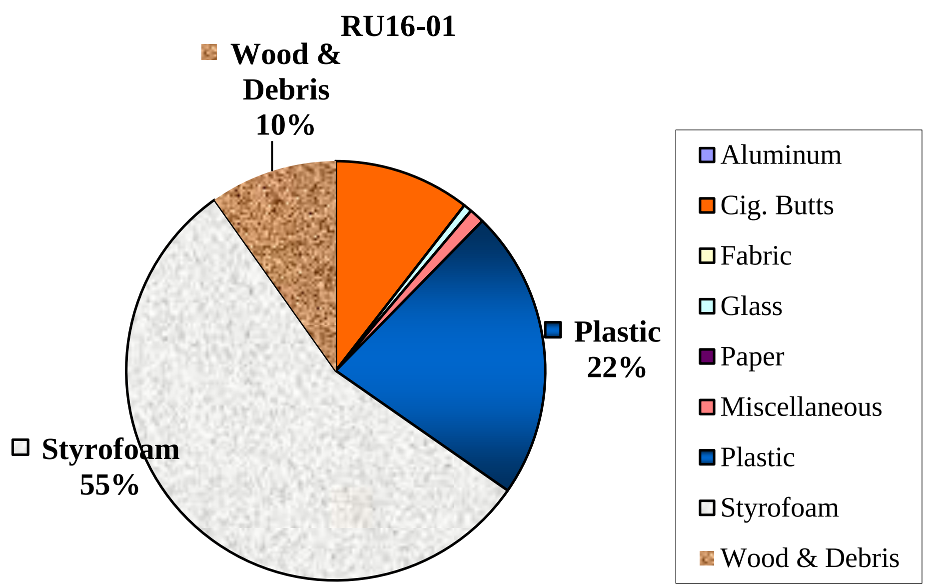

RU04-02
Wood & Debris 8%
Cig. Butts 8%
Plastic 32%
Styrofoam 49%
Aluminum
Cig. Butts
Fabric
Glass
Paper
Miscellaneous
Plastic
Styrofoam
Wood & Debris


RU06-01
Wood & Debris 1%
Cig. Butts 8%
Styrofoam 38%
Plastic 40%
Aluminum
Cig. Butts
Fabric
Glass
Paper
Miscellaneous
Plastic
Styrofoam
Wood & Debris

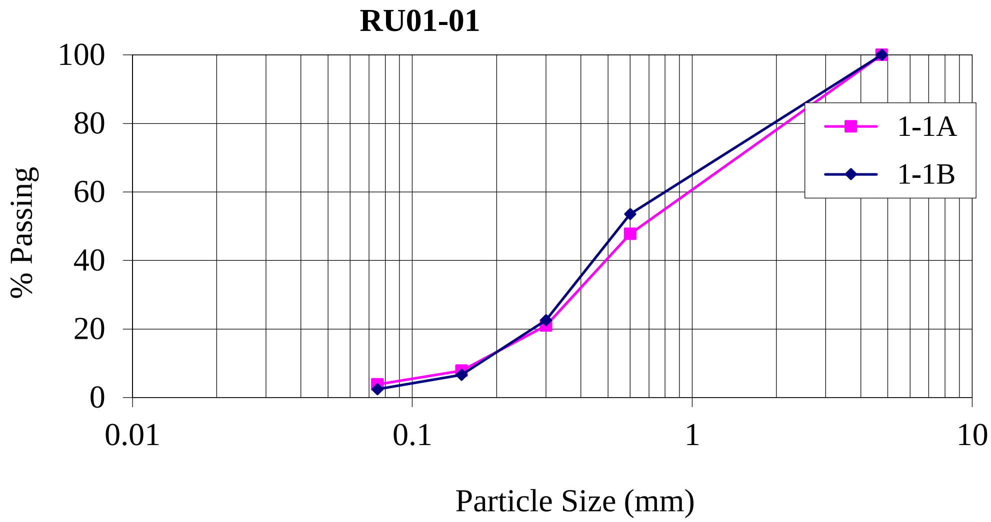

RU07-01
Wood & Debris 31%
Plastic 17%
Styrofoam 45%
Aluminum
Cig. Butts
Fabric
Glass
Paper
Miscellaneous
Plastic
Styrofoam
Wood & Debris

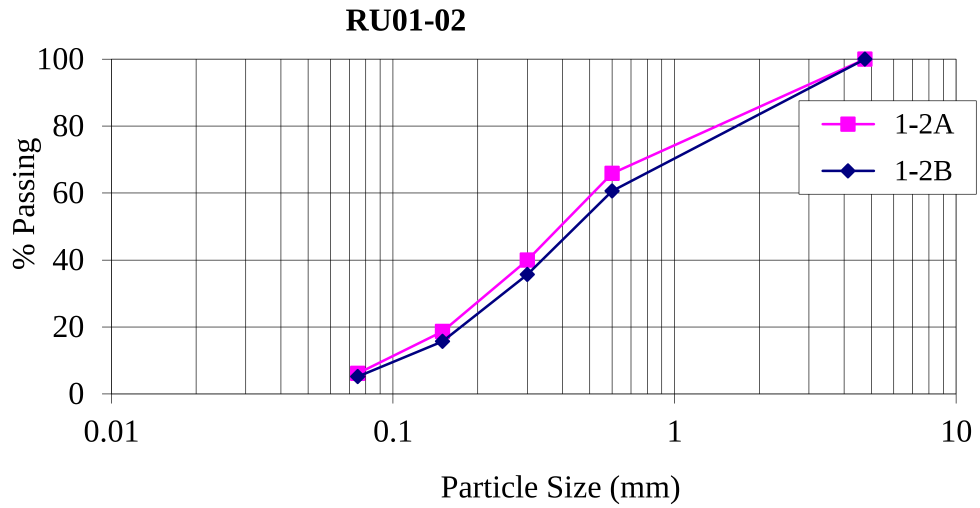

RU09-01
Wood & Debris 9%
Cig. Butts 2%
Plastic 10%
Styrofoam 60%
Aluminum
Cig. Butts
Fabric
Glass
Paper
Miscellaneous
Plastic
Styrofoam
Wood & Debris

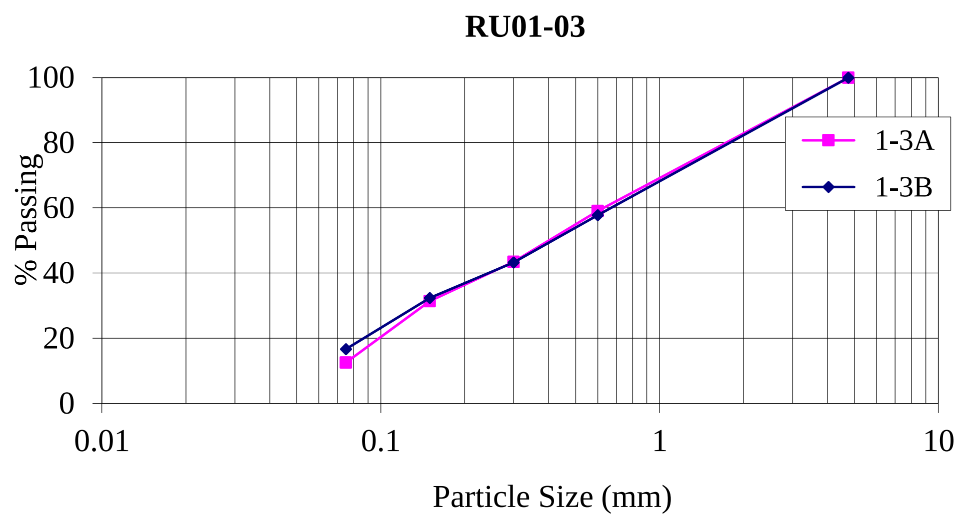

RU14-01
Wood & Debris 3%
Cig. Butts 2%
Plastic 26%
Styrofoam 70%
Aluminum
Cig. Butts
Fabric
Glass
Paper
Miscellaneous
Plastic
Styrofoam
Wood & Debris

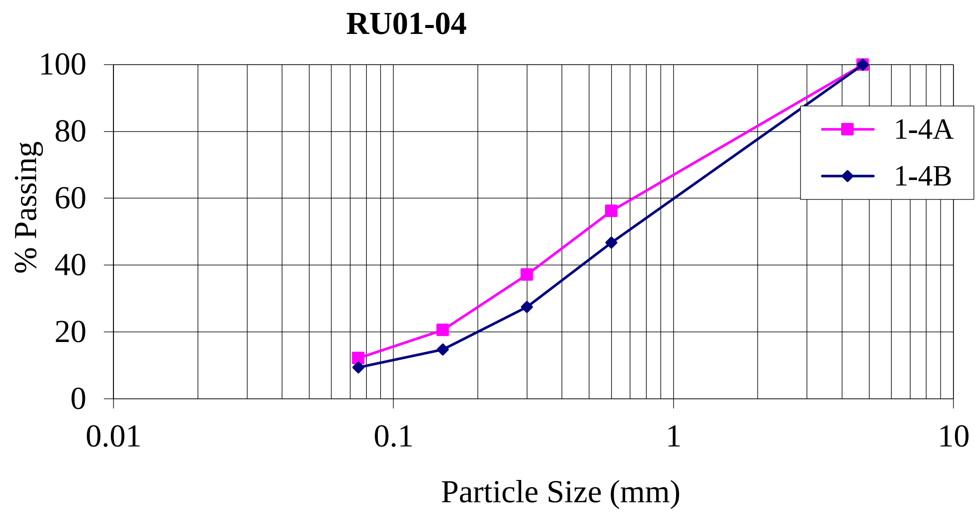

RU16-01
Wood & Debris 10%
Plastic 22%
Styrofoam 55%
Aluminum
Cig. Butts
Fabric
Glass
Paper
Miscellaneous
Plastic
Styrofoam
Wood & Debris

Appendix E: Particle size analysis for sediment samples

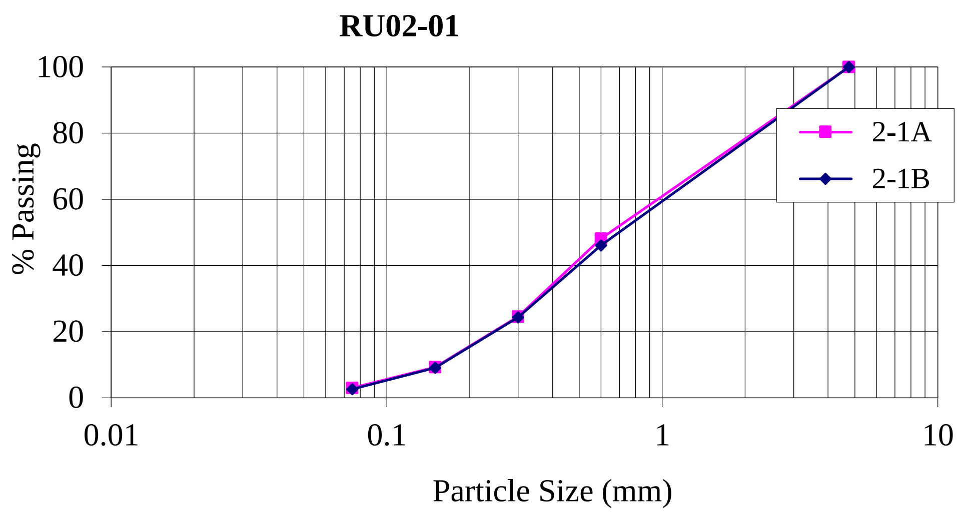




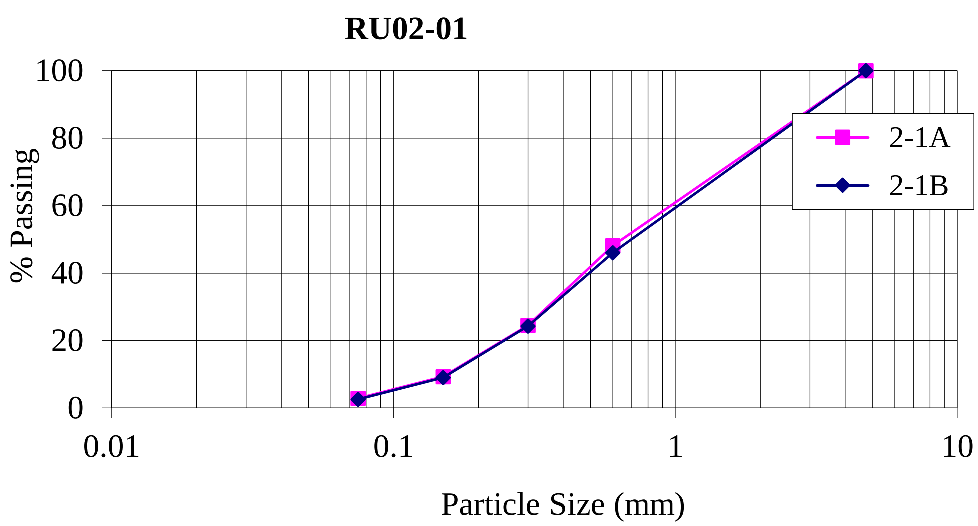




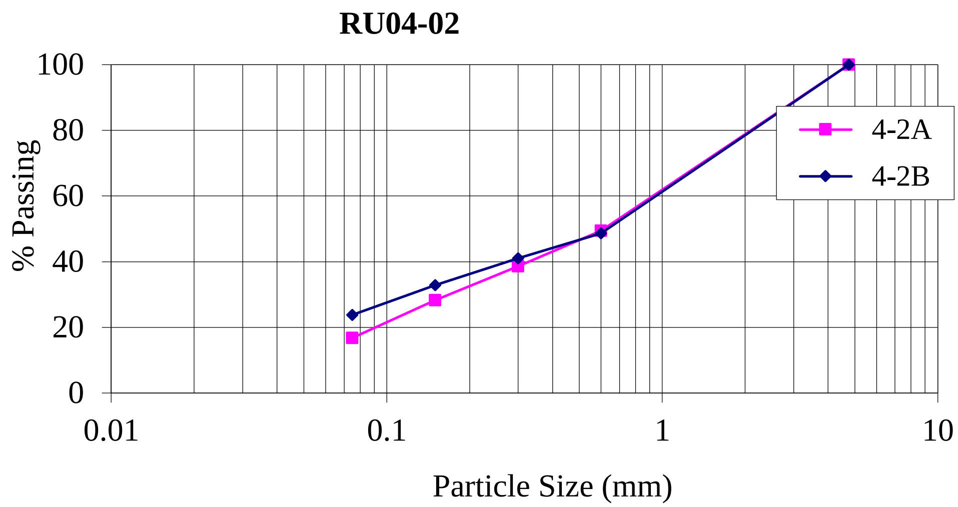
RU01-04
100
80
60
40
20
0
% Passing
0.01
0.1
1
10
Particle Size (mm)
1-4A
1-4B

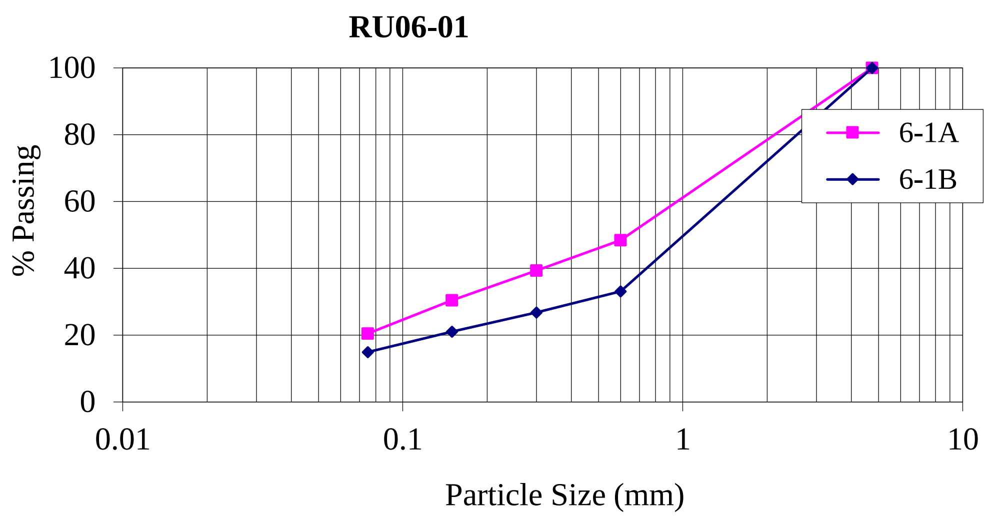


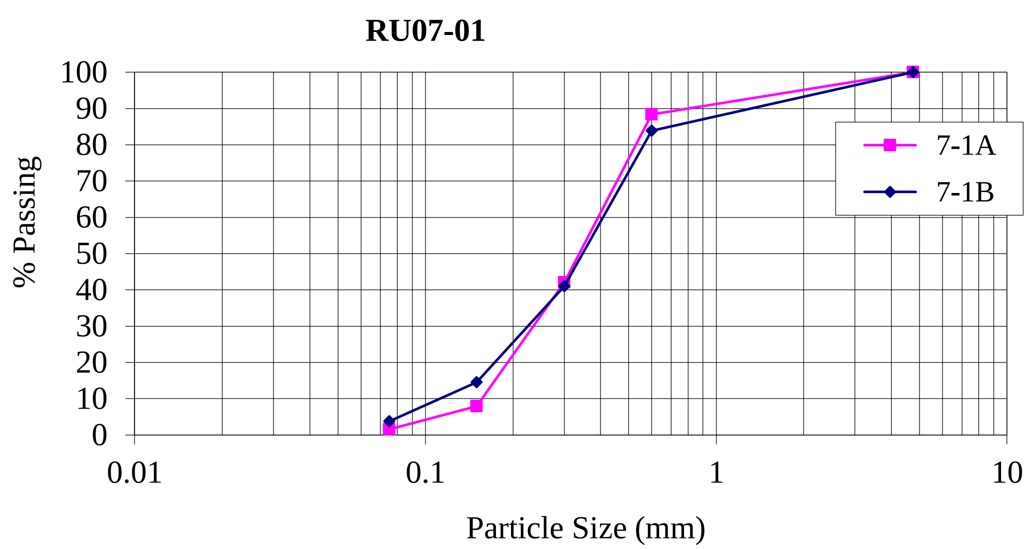
RU02-01
100
80
60
40
20
0
% Passing
0.01
0.1
1
10
Particle Size (mm)
2-1A
2-1B

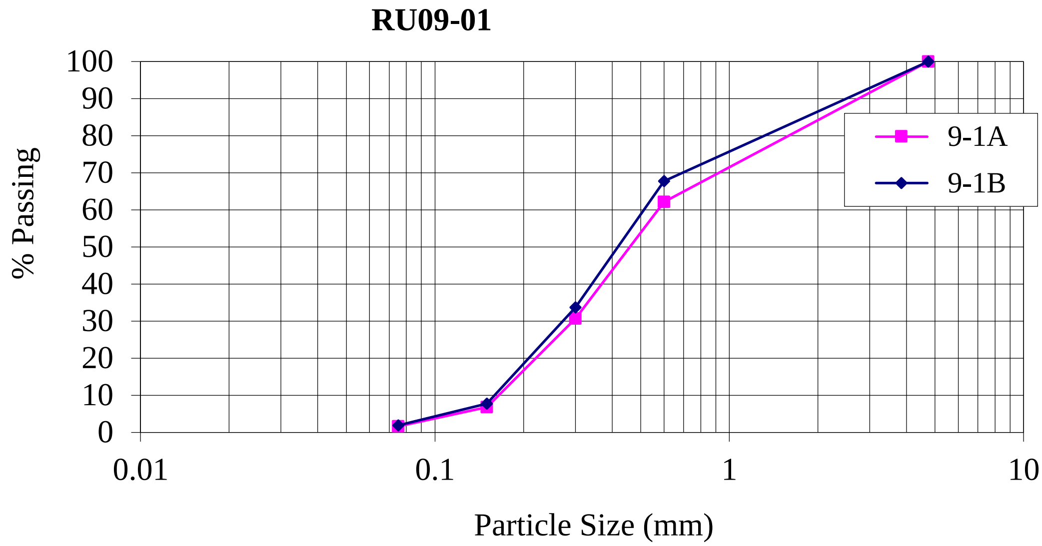


RU02-01
100
80
60
40
20
0
% Passing
0.01
0.1
1
10
Particle Size (mm)
2-1A
2-1B

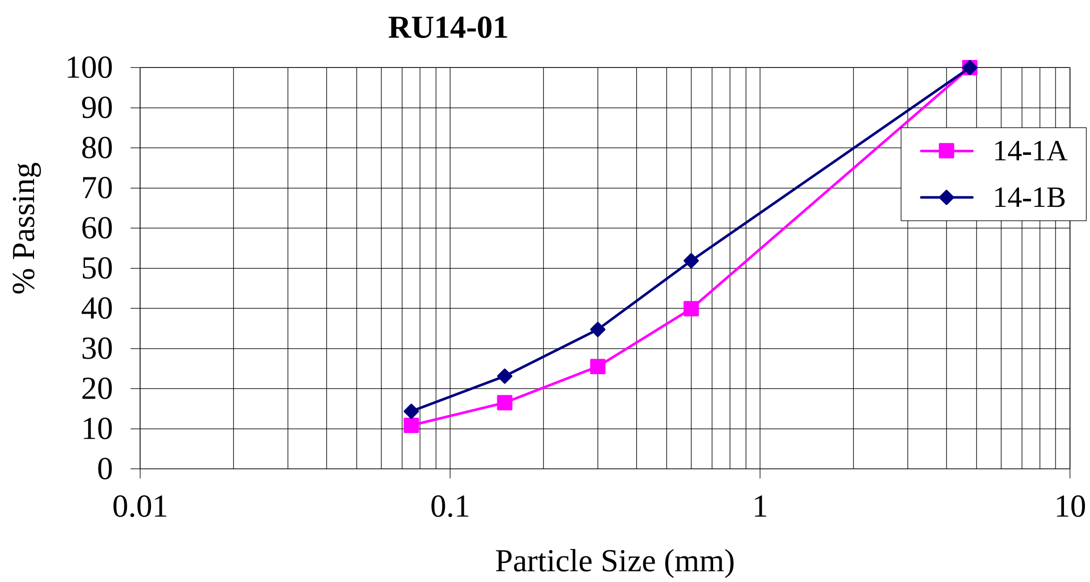

RU04-02
100
80
60
40
20
0
% Passing
0.01
0.1
1
10
Particle Size (mm)
4-2A
4-2B


RU06-01
100
80
60
40
20
0
% Passing
0.01
0.1
1
10
Particle Size (mm)
6-1A
6-1B

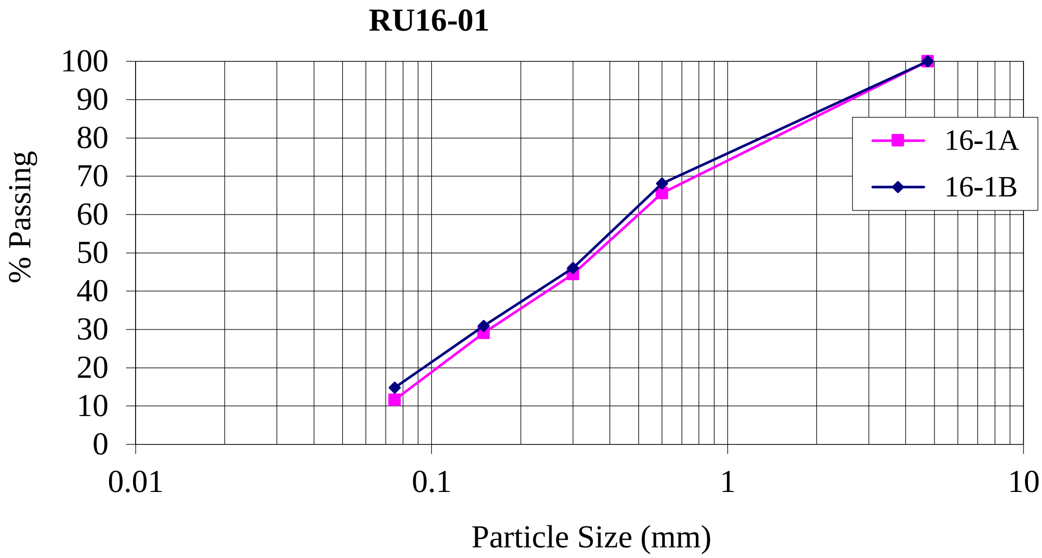

RU07-01
100
90
80
70
60
50
40
30
20
10
0
% Passing
0.01
0.1
1
10
Particle Size (mm)
7-1A
7-1B



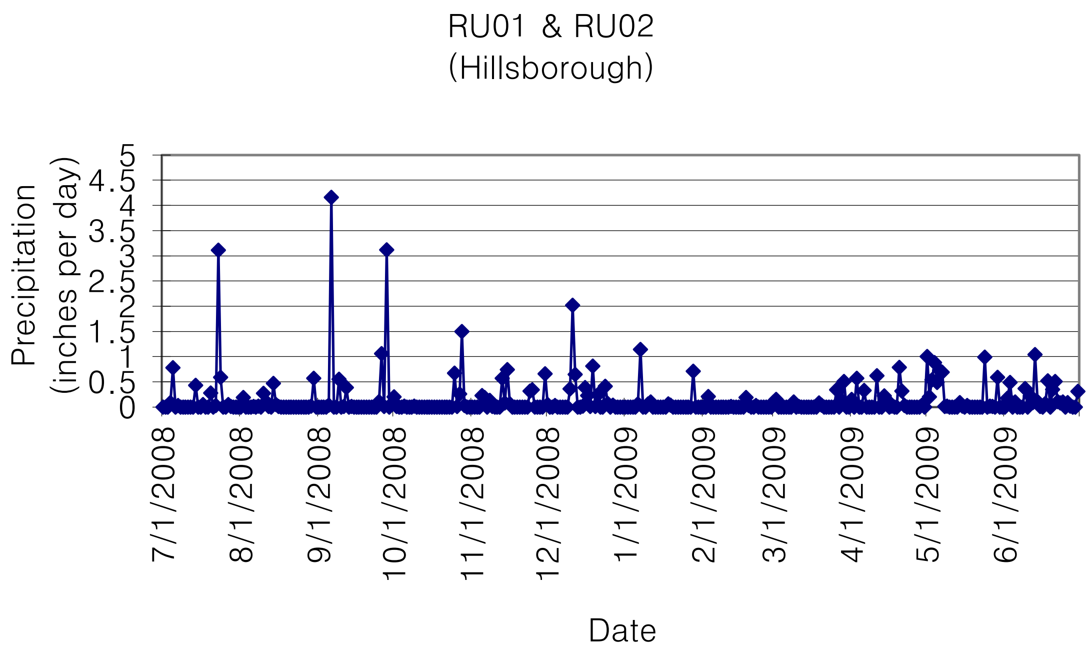
RU09-01
% Passing
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
Particle Size (mm)
9-1A
9-1B

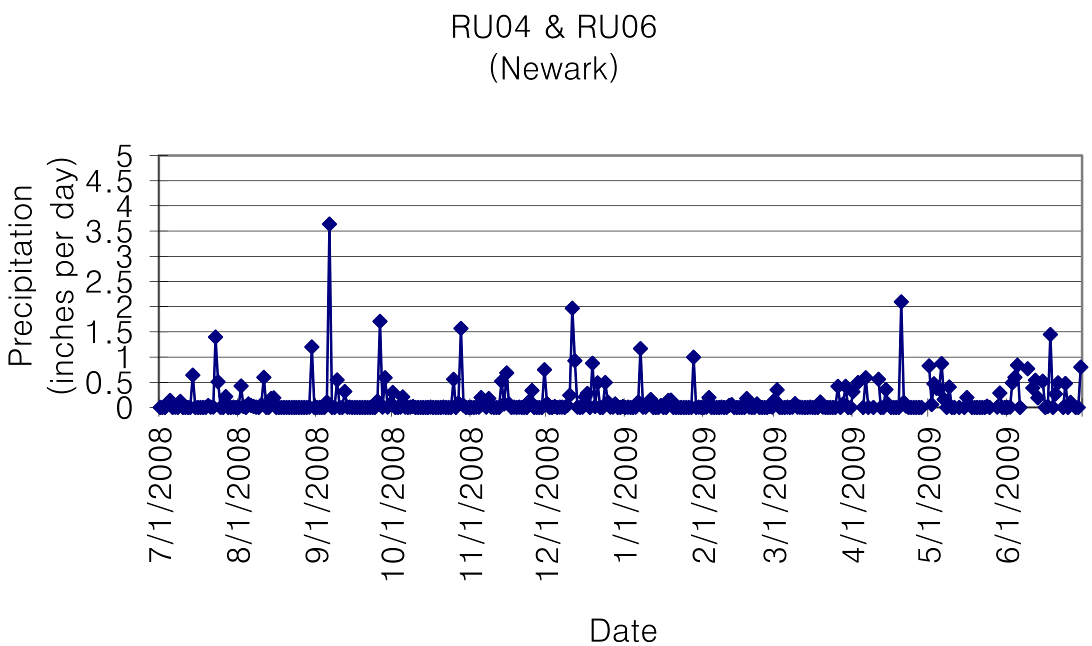


RU14-01
% Passing
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
Particle Size (mm)
14-1A
14-1B

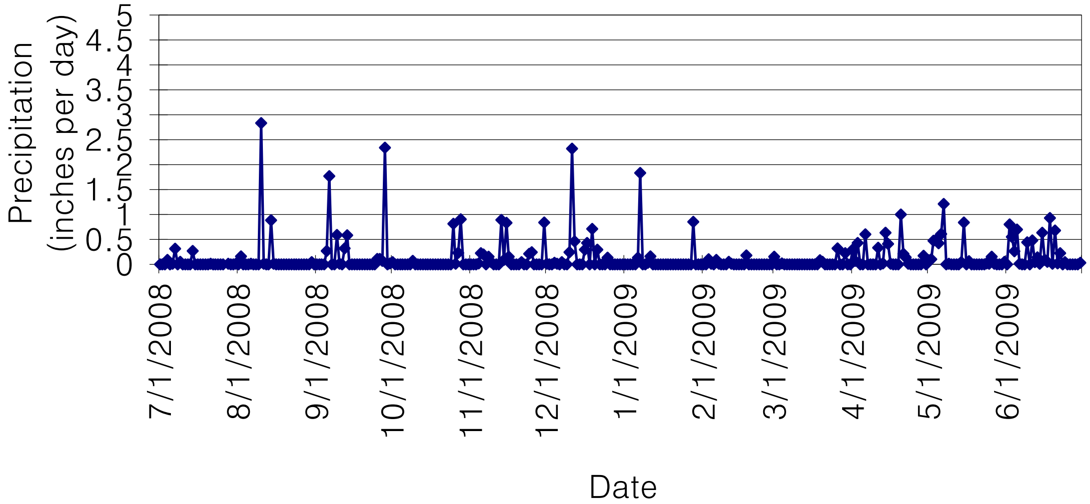

RU16-01
100
90
80
70
60
50
40
30
20
10
0
% Passing
0.01
0.1
1
10
Particle Size (mm)
16-1A
16-1B

Appendix G: Precipitation history

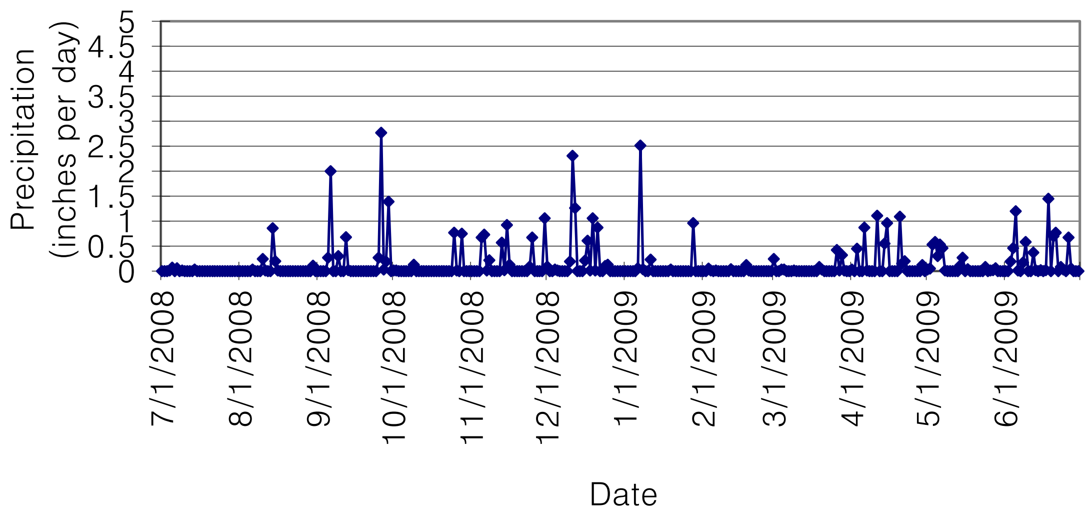


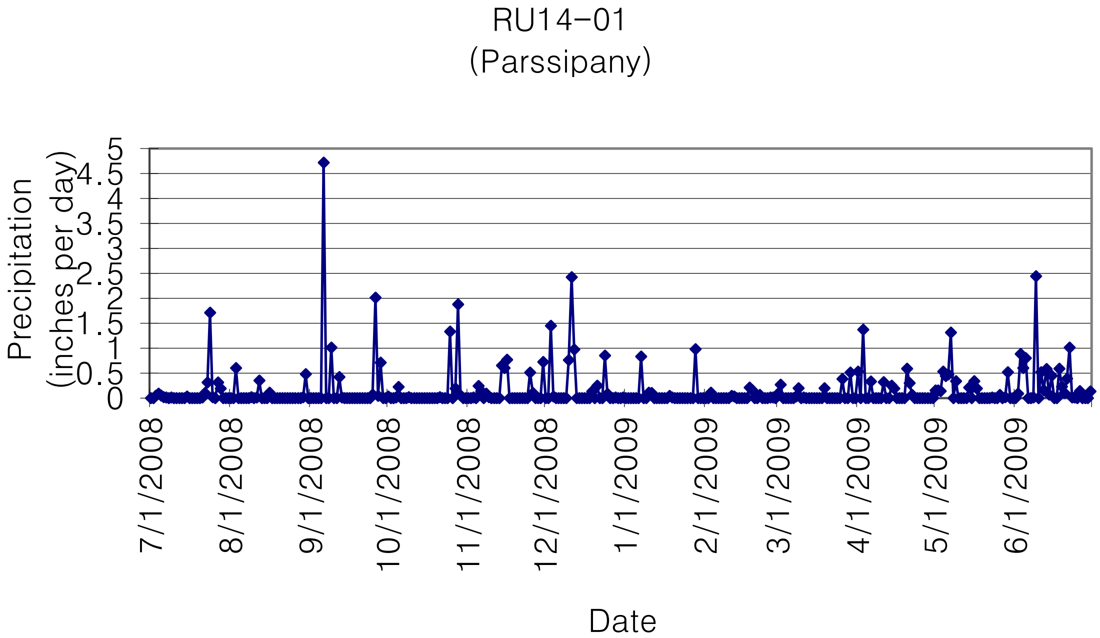


RU07-01
(Bethel Mill Park)

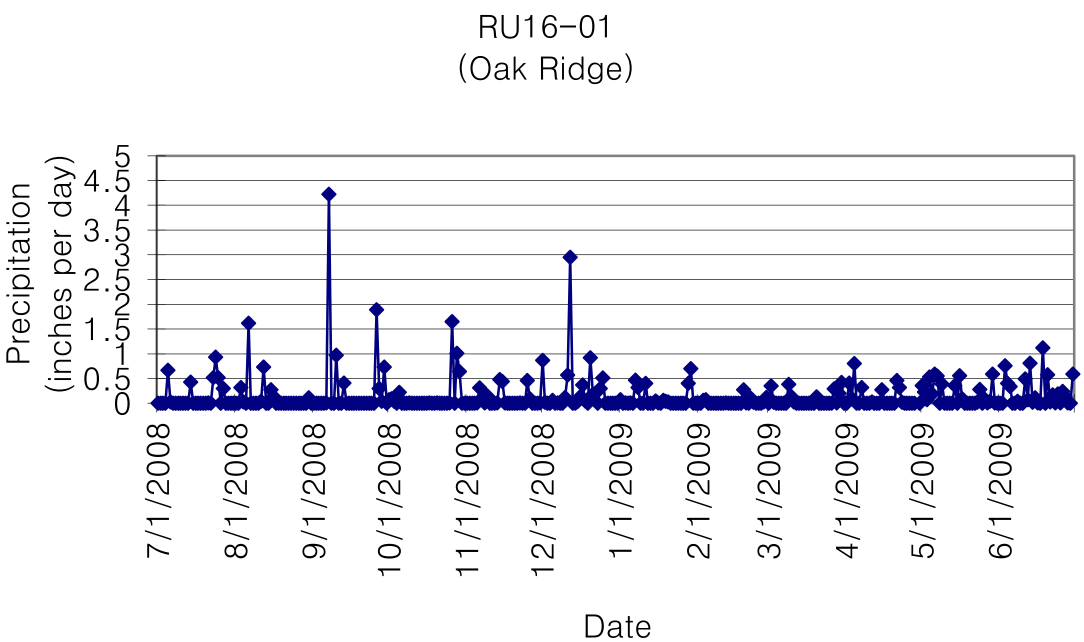


RU09-01
(Wall Twp.)





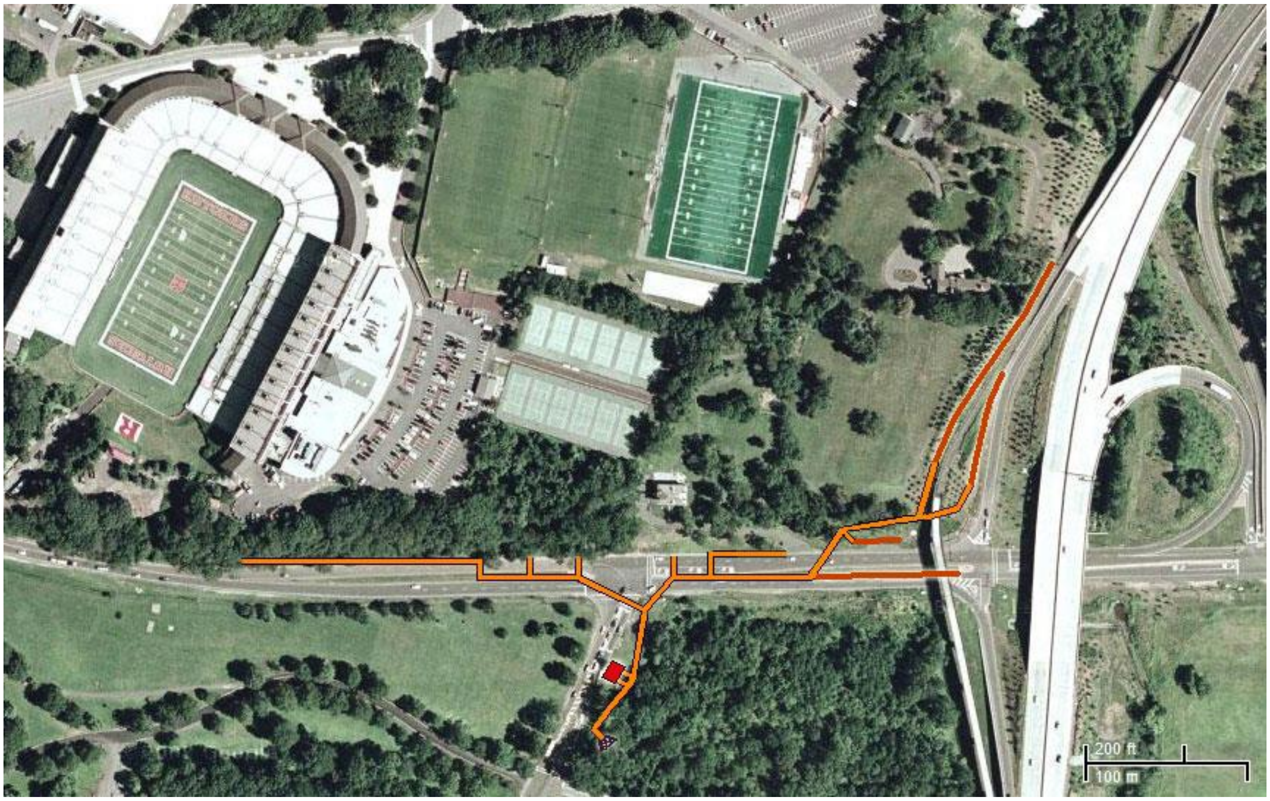
RU14-01
(Parssipany)
Precipitation
(inches per day)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
7/1/2008
8/1/2008
9/1/2008
10/1/2008
11/1/2008
12/1/2008
1/1/2009
2/1/2009
3/1/2009
4/1/2009
5/1/2009
6/1/2009
Date



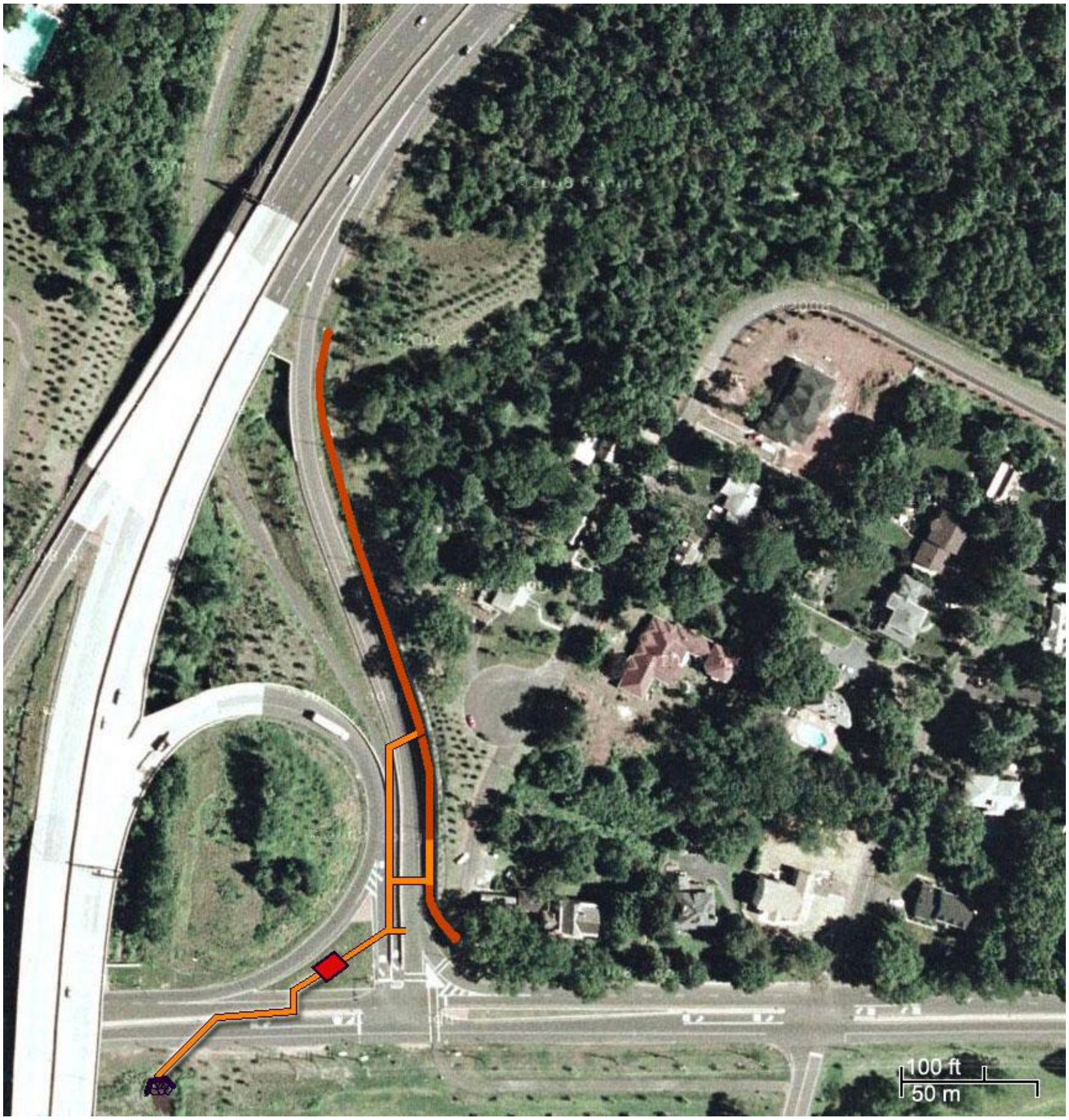
RU16-01
(Oak Ridge)
Precipitation
(inches per day)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
7/1/2008
8/1/2008
9/1/2008
10/1/2008
11/1/2008
12/1/2008
1/1/2009
2/1/2009
3/1/2009
4/1/2009
5/1/2009
6/1/2009
Date

Appendix H: Storm Drainage Area and Network

RU01-01: Piscataway

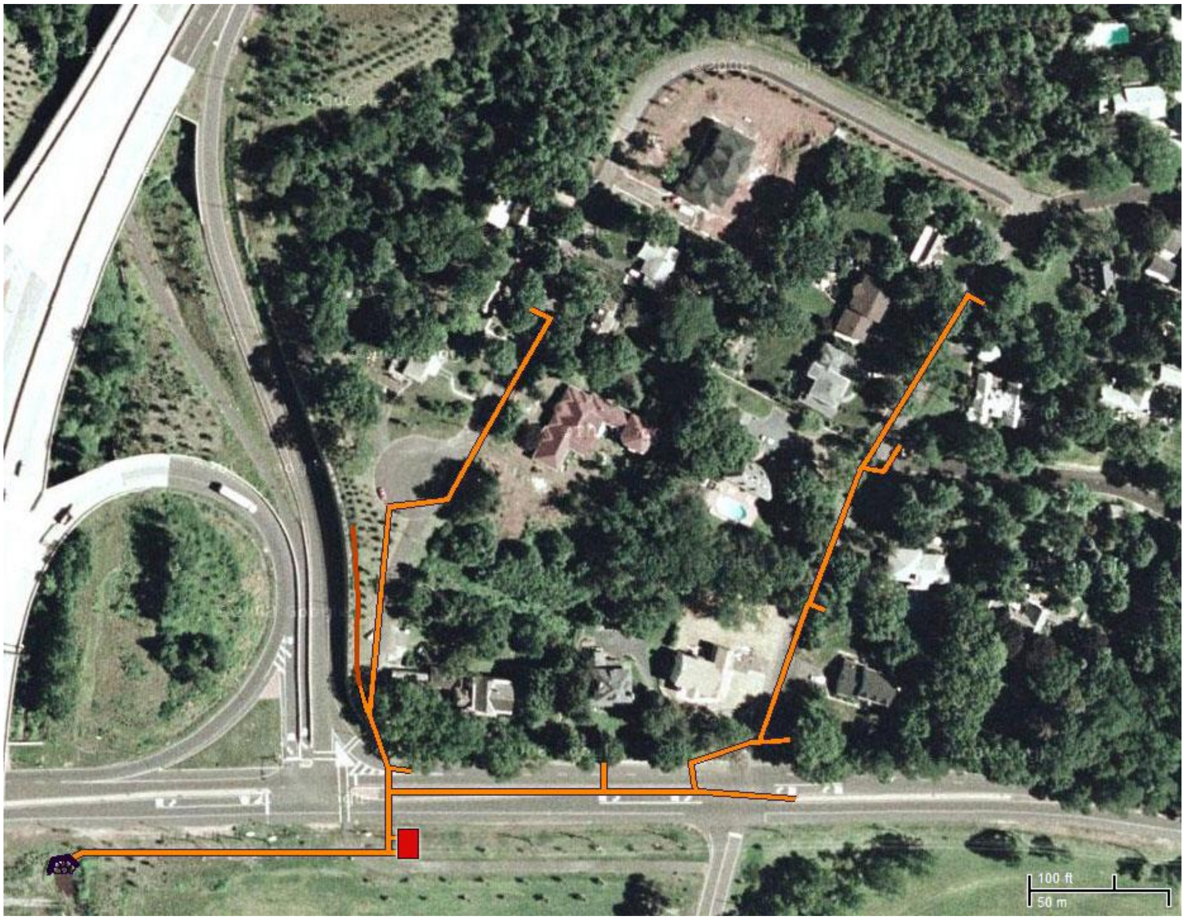


RU01-02: Piscataway

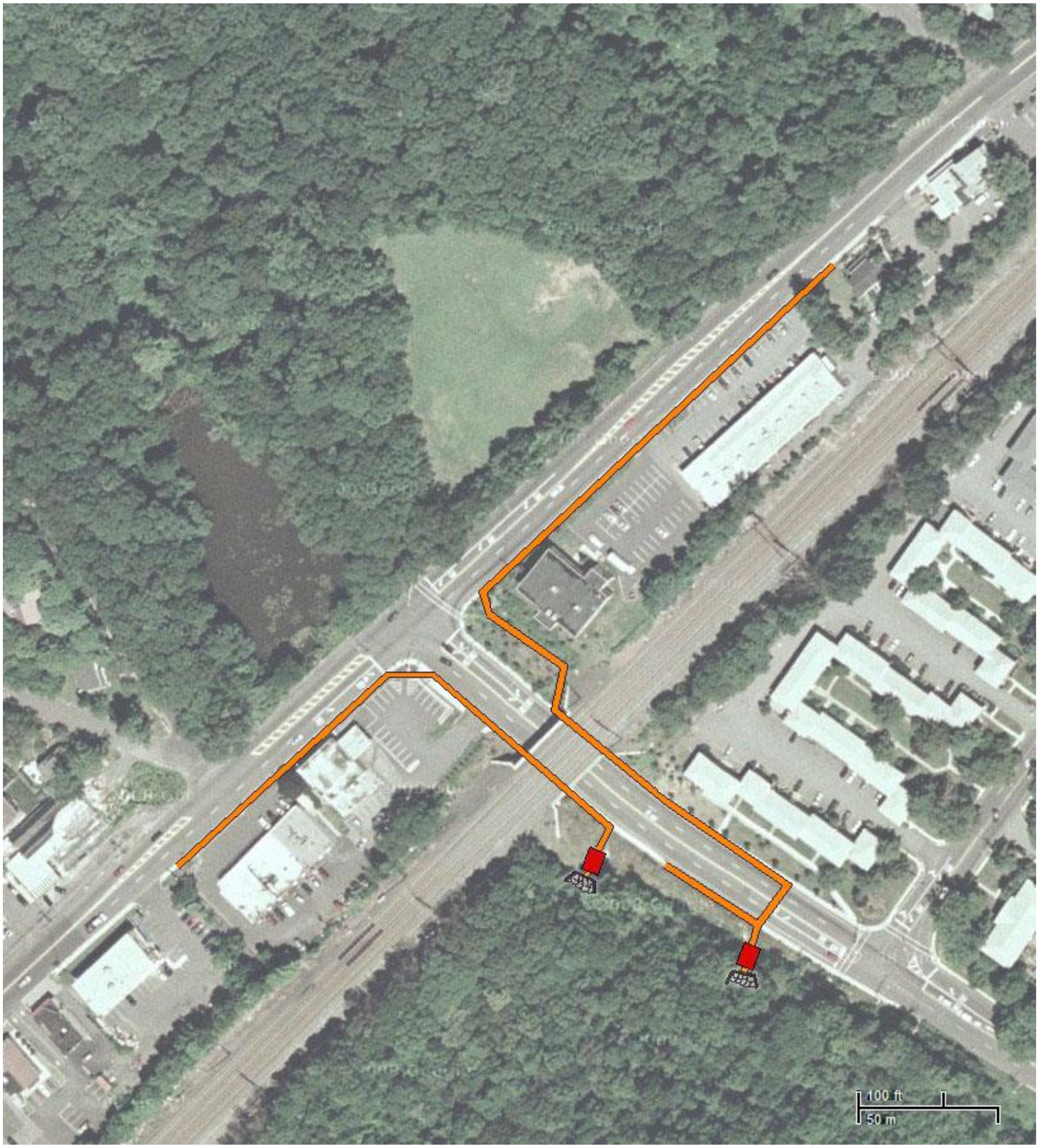


RU01-03: Piscataway

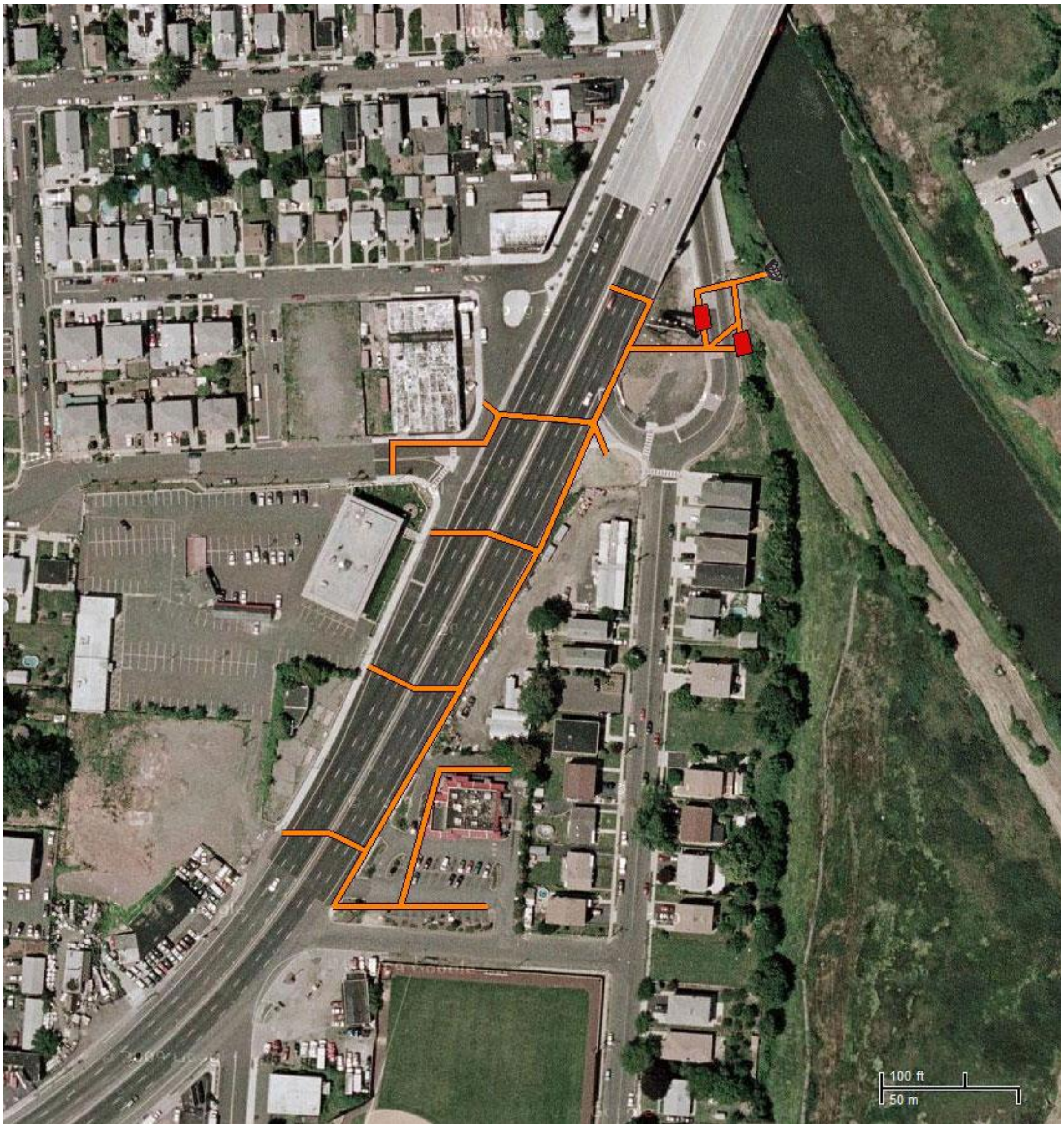
RU01-04: Piscataway



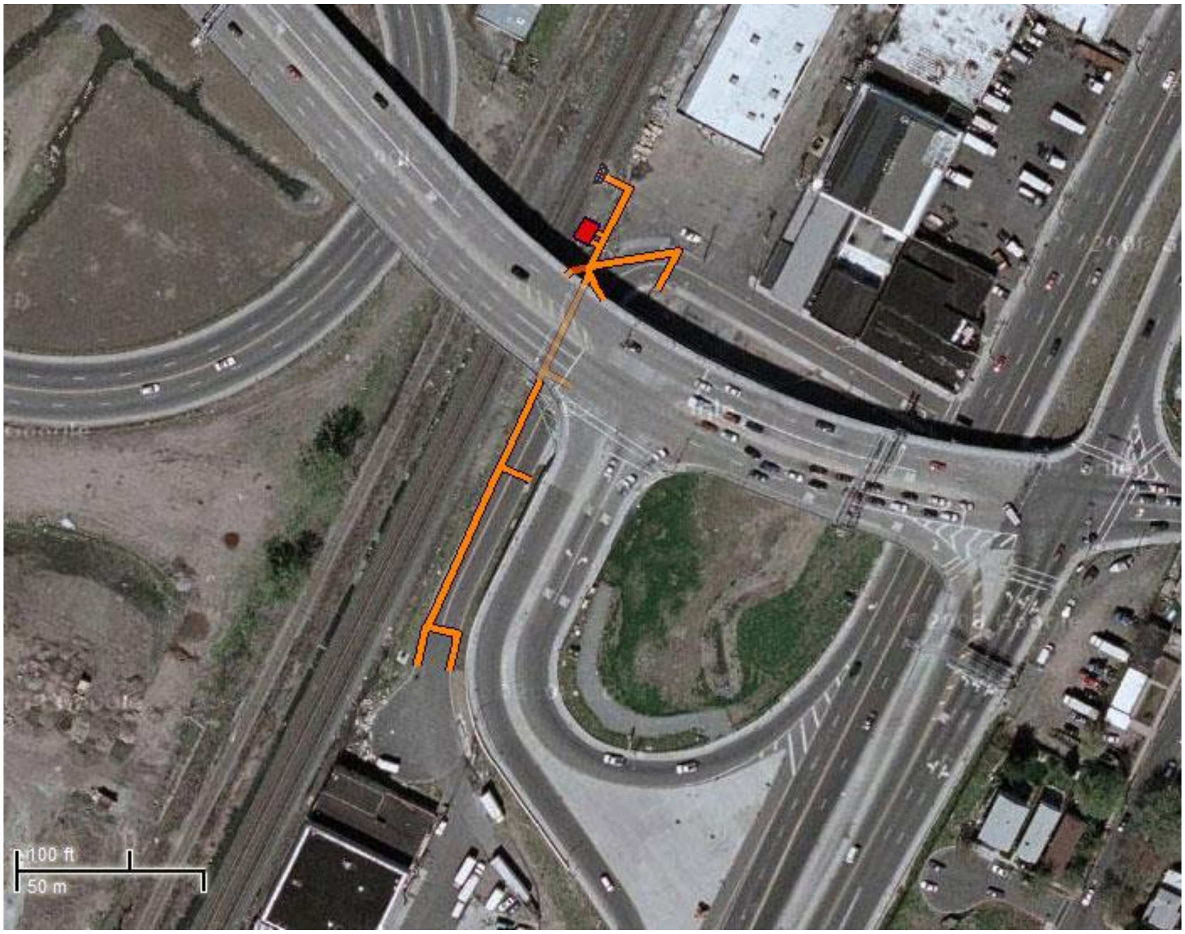
RU02-01 & RU02-02: Edison



RU04-02: Elizabeth



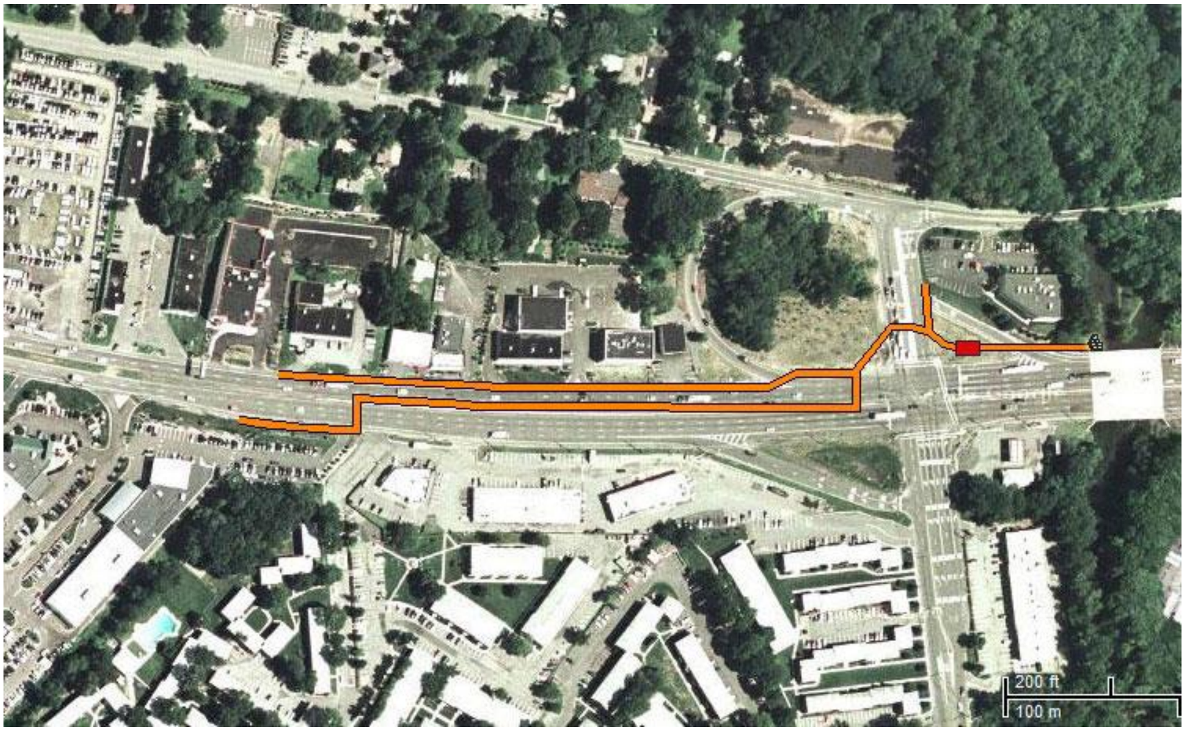
RU06-01: North Bergen



RU07-01: Deptford

RU09-01: Lakewood

RU14-01: Parsippany



RU16-01: Frankford