PHILADELPHIA'S WET WEATHER MANAGEMENT PROGRAMS

COMBINED SEWER MANAGEMENT PROGRAM ANNUAL REPORT

National Pollution Discharge Elimination System (NPDES) Permits
Nos. PA0026689, PA0026662, PA0026671

STORMWATER MANAGEMENT PROGRAM ANNUAL REPORT

National Pollution Discharge Elimination System (NPDES) Permit
No. PA 0054712

Reporting Period July 1st 2009 to June 30th 2010

Submitted to:

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION
Bureau of Water Quality Management

And

ENVIRONMENTAL PROTECTION AGENCY – REGION III
Water Protection Division

THIS PAGE LEFT INTENTIONALLY BLANK

Table of Contents

List of Figures

List of Tables

Appendices

Appendix A – 2010 Flow Control Annual Report

Appendix B – Flow Monitoring

Appendix C – Public Education & Materials

Appendix D - BMP Factsheets

Appendix E - Wissahickon Creek Watershed: Sediment Total Maximum Daily Load (TMDL) – Addendum

Appendix F – Suspected PCB Sources & Inspections

Appendix G - PWD Quarterly Dry Weather Water Quality Monitoring Program

Appendix H - PWD/USGS Cooperative Water Quality Monitoring Program Annual Summary

Appendix I – NPDES Permitted Dischargers

Appendix J –Monitoring Locations

Appendix K - WISSAHICKON CREEK STREAM ASSESSMENT STUDY-Lower Wissahickon

Appendix L – Saylor Grove Stormwater treatment wetland.

Appendix M – FY2010 Marshall Road Monitoring report

Appendix N – NLNA Cistern Water Testing

Appendix O – FY2010 Defective Lateral Annual Report

Appendix P – Monoshone Watershed - Quarterly Water Quality Updates

Appendix Q – FY2010 Defective Lateral Quarterly Reports

List of Common Abbreviations

ACSP	Audobon Cooperative Sanctuary Program
ANS	Academy of Natural Science
BEHI	Bank Erosion Hazard Index
BLS	Bureau of Laboratory Services, Philadelphia Water Department
BMP	Best Management Practice
CAC	Citizens Advisory Council
CCIWMP	Cobbs Creek Integrated Watershed Management Plan
CNP	Coastal Non-Point Pollution
CO&A	Consent Order and Agreement
CPCs	Compounds of Potential Concern
CSO	Combined Sewer Overflow
CSOMP	Combined Sewer Overflow Management Program
CWP	Clean Water Partners
DCNR	Department of Conservation and Natural Resources
DMR	Discharge Monitoring Report
DRBC	Delaware River Basin Commission
E&S	Erosion and Sedimentation
EDCs	Endocrine Disrupting Compounds
EWS	Early Warning System
FGM	Fluvial Geomorphology
FOW	Friends of the Wissahickon
FPC	Fairmount Park Commission
FWWIC	Fairmount Water Works Interpretive Center
HHW	Household Hazardous Waste
IPM	Integrated Pest Management
IWMP	Integrated Watershed Management Plan
IWU	Industrial Waste Unit
MS4	Municipal Separate Storm Sewer System
NBS	Near Bank Stress
NCSD	Natural Stream Channel Design
NPDES	National Pollution Discharge Elimination System
O&M	Operation and Maintenance
OOW	Office of Watersheds
PADEP	Pennsylvania Department of Environmental Protection
PCB	Polychlorinated Biphenyl
PCIWMP	Pennypack Creek Integrated Watershed Management Plan
PCSMP	Pre-Construction Stormwater Management Plan
PCWCCR	Pennypack Creek Watershed Comprehensive Characterization Report
PDE	Partnership for the Delaware Estuary
PFBC	Pennsylvania Fish and Boat Commission
PMP	Pollutant Minimization Plan
PWD	Philadelphia Water Department

QAPP	Quality Assurance Project Plan
RBP	Rapid Bioassessment Protocol
RCP	River Conservation Plan
SAN	Schuylkill Action Network
SCEE	Schuylkill Center for Environmental Education
SEC	Senior Environmental Corps
SMP	Stormwater Management Program
SOP	Standard Operating Procedure
SWMM	Stormwater Management Model
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
TTF	Tookany/Tacony-Frankford
TTFIWMP	Tookany/Tacony-Frankford Integrated Watershed Management Plan
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency, Region III
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geologic Survey
WCIWMP	Wissahickon Creek Integrated Watershed Management Plan
WCWCCR	Wissahickon Creek Watershed Comprehensive Characterization Report
WMR	Watershed Mitigation Registry
WRT	Waterways Restoration Team

Compliance Checklist

The Compliance Checklist is attached in a separate document, outside the main report in the front left pocket of report binder in order to provide better convenience.

COMBINED SEWER MANAGEMENT PROGRAM ANNUAL REPORT

I Management and Control of CSOs

This report is submitted pursuant to meeting the requirements of NPDES Permits #'s PA0026662, PA0026671, and PA0026689; PART C, I. OTHER REQUIREMENTS, Combined Sewer Overflows (CSOs), III. IMPLEMENTATION OF THE LONG TERM CSO CONTROL PLAN, C. Watershed-Based Management, IV. Monitoring and Assessment. This section requires that the permittee submit an Annual CSO Status Report. The purpose of this report is to document the status and changes made to programs implemented by the Philadelphia Water Department (PWD), during the time period of July 1st, 2009 through June 30th, 2010, to manage and reduce the combined sewer overflows (CSOs) permitted to discharge to waters of the Commonwealth of Pennsylvania.

II Implementation of the Nine Minimum Controls

In the first phase of the PWD's CSO strategy, and in accordance with its NPDES permits, the PWD submitted to the Pennsylvania Department of Environmental Protection on September 27, 1995, "CSO Documentation: Implementation of Nine Minimum Controls". The nine minimum controls are low-cost actions or measures that can reduce CSO discharges and their effect on receiving waters, do not require significant engineering studies or major construction, and can be implemented in a relatively short time frame. In general, PWD's NMC program includes comprehensive, aggressive measures to maximize water quality improvements through the following measures:

1. Review and improvement of on-going operation and maintenance programs

2. Measures to maximize the use of the collection system for storage

3. Review and modification of PWD's industrial pretreatment program

4. Measures to maximize flow to the wastewater treatment facilities

5. Measures to detect and eliminate dry weather overflows

6. Control of the discharge of solid and floatable materials

7. Implementation of programs to prevent generation and discharge of pollutants at the source

8. Public Notification of CSO impacts

9. Comprehensive inspection and monitoring programs to characterize and report overflows and other conditions in the combined sewer system.

II.A Proper Operation and Regular Maintenance Programs for the Sewer System and the CSOs (NMC 1)

II.A.1 Implement a Comprehensive Geographic Information System (GIS) of the City sewer system

In 2005 the Philadelphia Water Department completed a data conversion project that resulted in the creation of GIS coverages for all of the city's water, sewer, and high pressure fire infrastructure. The conversion project consisted of extracting data from over 250,000 engineering documents that exist in digital format and have been indexed by location.

The project was executed in three phases. The Initiation Phase included a series of workshops designed to ensure that the conversion process properly utilized the 85 different types of source documents maintained by the department. It also included customization of data conversion tools to meet the project's data specifications, the development of a detailed conversion work plan, and conversion of the data for a 2-block area within the city. The Pilot Phase included further definition of the project's data dictionary and conversion tools and applied both to data from 2 of the City's 121 map tiles. The Production Phase included conversion of the remaining tiles and the establishment of links between the GIS data and legacy databases related to valves, hydrants, and storm sewer inlets.

The project was supported through the use of customized conversion tools for data collection, data scrubbing, data entry, graphical placement, and quality control. Conflicts and anomalies in the data were tracked using a web-based tool and database.

PWD expects to utilize the GIS coverages as the foundation for many of their operations including maintenance management, capital improvements, and hydraulic modeling.

To insure PWD's investment in GIS and data conversion does not go to waste, a comprehensive maintenance plan has been put into practice to ensure that the data is as accurate and up to date as possible. Edits and improvements are made on a daily basis to the data. Using a web based application, GIS editors are able to check out work and check it back in when it's complete. The application tracks all changes made out in the field that are recorded on as-built plans. Real-time kinematic (RTK) accurate GPS devices are also employed for high spatial accuracy for new construction projects.

II.A.2 Implement a Comprehensive Sewer Assessment Program (SAP)

PWD has implemented a comprehensive sewer assessment program (SAP) to provide for continued inspection and maintenance of the collection system using closed circuit television. The SAP program was developed by PWD and consultants and was finalized in March 2006. This program development encompassed 2.5 years and cost over $6 million.

The major goals of the SAP development project were to:

- Develop new sewer evaluation protocol and prioritization system that integrates with new and existing computerized databases
- Develop recommendations and schedules for an on-going sewer inspection program
- Create training tools and train PWD personnel

– Apply techniques to pilot areas in the City totaling 7% of the total collection system

A few selected highlights of the SAP project are:

- Development of unique "smart" GIS manhole numbering system
- Implementation of National Association of Sewer Service Companies (NASSCO) standard protocol for uniform evaluation of sewers called Pipeline Assessment & Certification Program (PACP)
- Development of rating and scoring system to prioritize segments for repairs or replacement.
- Development of Intranet-based viewer for digital closed circuit television (CCTV) inspection projects and structural scores with GIS front-end (SINSPECT)
- Development of Intranet-based CCTV Inspection Request and Tracking System with GIS front-end (SAPReq)
- Development of Pre-Inspection (CCTV) Program
- Creation of internal monthly sewer defect review committee (SAP Committee-5)

Any infiltration observed during the on-going CCTV sewer inspection program is coded as part of the NASSCO Pipeline Assessment and Certification Program. The infiltration is categorized based on a range of 5 levels: Weepers, Drippers, Light Runners, Heavy Runners, or Gushers. All occurrences of Heavy Runners or Gushers are reported to PWD's Water Conveyance Leak Detection Unit immediately for investigation.

The SAP is being used to guide the capital improvement program to ensure that the existing sewer systems are adequately maintained, rehabilitated, and reconstructed. For the period of July 2009 – June 2010, the length of TV inspections averaged about 3.89 miles a month for a total of over 46 inspected miles, as can be seen in **TABLE II.A-1 MONTHLY TV INSPECTIONS**.

Table II.A-2 Monthly TV Inspections

Date	Miles Inspected
Jul-09	4.49
Aug-09	3.61
Sep-09	4.92
Oct-09	4.43
Nov-09	4.36
Dec-09	3.75
Jan-10	3.82
Feb-10	2.04
Mar-10	4.26
Apr-10	3.51
May-10	3.36
Jun-10	4.10
Average	**3.89**
Total	**46.65**

II.A.3 Other Initiatives

II.A.3.1 CSO Regulator Inspection & Maintenance Program

Annual summaries of the comprehensive and preventative maintenance activities completed in the combined sewer system over the past year are detailed in and any changes are discussed below.

In response to the CSO compliance inspection performed by DEP in November 2002, PWD has committed to demonstrating an improved follow-up response to sites experiencing a DWO. PWD has instituted a policy of next day follow-up inspection at sites that experience a DWO. PWD will conduct an evaluation of the effectiveness of twice-weekly inspections. During FY 2010, 6591 inspections were completed on 201 regulator units. There were 19 discharges with a total of 231 blocks cleared. Details of the inspections during the past fiscal year can be found on page 3 of **APPENDIX A – FY10 FLOW CONTROLS ANNUAL REPORT.**

II.A.3.2 Tide Gate Inspection and Maintenance Program

For FY 2010, CSO tide gate inspection was done at regulator D-18. Summaries of the tide gate inspection and maintenance completed during the past fiscal year are found on page 12 of **APPENDIX A – FY10 FLOW CONTROLS ANNUAL REPORT**, which documents the locations where preventative maintenance was performed on the tide gates.

II.A.3.3 Somerset Grit Chamber Cleaning

PWD regularly monitors the sediment accumulation in the grit trap at the origin of the Somerset Intercepting Sewer and in locations downstream to determine appropriate cleaning intervals for the grit trap and downstream interceptor. Driven by the monitoring program, the grit basin is cleaned periodically and debris quantities tracked to further refine the frequency of cleaning necessary to maintain adequate capacity in the Somerset Intercepting sewer. During FY 2010, an estimated 150 tons of grit was removed from the Somerset Grit Chamber.

Somerset Grit Chamber cleaning details, specifically tonnage removed and dates of cleaning during the past fiscal year are available on page 12 of **APPENDIX A – FY10 FLOW CONTROLS ANNUAL REPORT.**

II.B Maximum Use of the Collection System for Storage (NMC 2)

II.B.1 Continue to Institutionalize a Comprehensive Monitoring and Modeling Program

II.B.1.1 Monitoring

PWD maintains an extensive monitoring network through the combined sewer system, rain gages, pump stations and connections from all adjacent outlying communities. Information on the monitoring network with the listing of all monitors, rain gages, and pumping stations can be found in **APPENDIX B- FLOW MONITORING**.

II.B.1.2 Modeling

The U.S. EPA's Storm Water Management Model (SWMM) was used to develop the watershed-scale model for the PWD combined sewer system. The components of the SWMM model used in the development of the Philadelphia watershed and wastewater conveyance model were the RUNOFF and EXTRAN modules.

The RUNOFF module was developed to simulate the quantity and quality of runoff in a drainage basin and the routing of flows and contaminants to sewers or receiving water. The program can accept an arbitrary precipitation (rainfall or snowfall) hyetograph and performs a step by step accounting of snowmelt, infiltration losses in pervious areas, surface detention, overland flow, channel flow, and water quality constituents leading to the calculation of one or more hydrographs and/or pollutagraphs at a certain geographic point such as a sewer inlet. The driving force of the RUNOFF module is precipitation, which may be a continuous record, single measured event, or artificial design event. The RUNOFF module also simulates Rainfall Dependant Inflow and Infiltration (RDI/I) in separate sanitary areas using three sets of unit hydrographs defined by R, T, and K values to represent the shape of the RDI/I hydrograph response to the input precipitation hyetograph.

The EXTRAN module was developed to simulate hydraulic flow routing for open channel and/or closed conduit systems. The EXTRAN module receives hydrograph inputs at specific nodal locations by interface file transfer from an upstream module (e.g. the RUNOFF module) and/or by direct user input. The module performs dynamic routing of stormwater and wastewater flows through drainage systems and receiving streams.

II.B.2 Continue to Operate and Maintain a Network of Permanent and Temporary Flow Monitoring Equipment

The Philadelphia Water Department continues to maintain a CSO Monitoring network and temporary monitoring programs to support planning for further CSO control projects and to minimize dry weather overflows and tidal inflows. PWD will continue to review, replace, and update network equipment in order to continue to support the above functions.

II.B.2.1 Permanent Flow Monitoring Program

In fiscal year 2008 the Department purchased and installed a new data acquisition system and RTU's (remote telemetry units) manufactured by Telog Enterprise. This new system replaces a customized solution that was unreliable and difficult to maintain and offers better communications options and system diagnostics which should allow PWD to greatly increase the data capture rate. Thus far 171 RTU's have been switched out to the new system with the balance expected to be completed in fiscal year 2011. As of the end of fiscal year 2010, the 287 remote monitoring sites are 81.0% operational. The listing of permanent flow monitors can be found in **APPENDIX B – FLOW MONITORING TABLE 1- LISTING OF MONITORED OUTLYING COMMUNITY CONNECTIONS.**

II.B.2.2 Temporary Flow Monitoring Program

The PWD temporary flow-monitoring program was initiated in July 1999 with the deployment of portable flow meters throughout targeted Philadelphia sewershed areas to quantify wastewater flow through sanitary sewers and characterize the tributary sewersheds. The identification and quantification of rainfall dependent inflow/infiltration (RDII) into sanitary sewers contributing to the City of Philadelphia's service area is a key component in assessing potential reductions in combined sewer overflow impacts.

The data collected allows for the quantification of wet and dry weather flows in separate sanitary sewers for a specified list of sites over a given period. The flow monitoring data is subjected to rigorous QA/QC procedures resulting in consistently good data quality over the monitoring period. Further analysis of the flow monitoring data is performed using hydrograph separation techniques in order identify the primary flow components.

During FY 2010, PWD, through a contract with CSL Services, Inc. monitored 25 un-metered connections from outlying community service areas, 23 sites in support of CSO model calibration, 14 sites in support of inflow and infiltration investigations, and 1 site in support of design for flood relief at T-14. PWD continues its temporary flow monitoring program through 2 additional sites in support of a Seepage Tank at 47th and Fairmount and 3 sites in support of PC30 model calibration and RDII identification.

The listing of all the temporary flow monitors, their location, and the deployment projects can be found in **APPENDIX B – FLOW MONITORING: TABLE 1- LISTING OF MONITORED OUTLYING COMMUNITY CONNECTIONS** and **TABLE 5 - LISTING OF ALL TEMPORARY FLOW MONITORS DEPLOYED BY PROJECTS**

II.B.3 Continue to Evaluate the Collection System to Ensure Adequate Transport Capacity for Dry and Wet Weather Flow

II.B.3.1 Long Term Control Plan Update

System-wide hydrologic and hydraulic models have been developed in support of the Long Term CSO Control Plan Update (LTCPU). Model evaluations have been performed to evaluate the system performance benefits of various system improvement scenarios.

These scenarios include combinations of traditional large scale infrastructure improvement projects based on increased transmission, storage and treatment of combined sewer flows, as well as, system-wide implementation of low impact development and green infrastructure source control projects utilizing decentralized storage, infiltration, evapotranspiration, and slow release of stormwater before it enters the combined sewer system.

II.B.3.2 PC-30 Extreme Wet Weather Overflow

Modeling work was performed in support of the project to remediate Poquessing Creek Interceptor Extreme Wet Weather Overflows at manhole PC-30. Modeling was used to help design the construction and operation of a relief sewer structure to transmit extreme wet weather flows from the Poquessing Creek Interceptor sanitary sewer system to the Northeast Water Pollution Control Plant (NEWPCP).

II.B.3.3 Storm Flood Relief

The PWD has made a significant investment in detailed hydraulic modeling and analyses that were performed in order to design and evaluate Storm Flood Relief (SFR) projects in several combined sewer areas of Philadelphia, a listing of the current sewer construction projects can be found in **TABLE II.B.3.3-1**. Several system improvement scenarios were proposed based on model simulations in order to effectively relieve basement backups during extreme wet weather events. Additionally, modifications to proposed SFR projects designed to increase capture and treatment of combined sewage flows during small to moderate storm events were also evaluated using system hydraulic modeling.

Table II.B.3.3-1 Storm Flood Relief Sewer Improvement Projects

Project Name	Location	Design Engineer(s)	Construction Estimate	Anticipated Construction Start	Project Status
Northern Liberties Phase 1	Delaware Avenue and Laurel Street	Urban Engineers/ PWD	$3.38 million	April 2010	In Constructioin
Northern Liberties Phase 2	Canal Street Chamber	Hatch Mott MacDonald / PWD	$6 million	Spring 2011	Design 70% complete
Northern Liberties Phase 3	Delaware Ave to River (SugarHouse Site)	Hatch Mott MacDonald / PWD	N/A	N/A	Design Started
Northern Liberties Phase 4	Canal & Laurel Sts. to Germantown Ave. & Wildey St.	Hatch Mott MacDonald / PWD	$13 million	Spring 2013	Design 70% complete
Northern Liberties Phase 5	Germantown Ave. from Wildey St. to Girard Ave.	Hatch Mott MacDonald / PWD	$6.4 million	Spring 2014	Design Started
Northern Liberties Phase 6	Germantown Ave. & Thompson St. to Master & Randolph Sts.	Hatch Mott MacDonald / PWD	$10.3 million	Spring 2015	Design Started
Moore Street	Moore St. ROW, Christopher Columbus Blvd. to Delaware River	Hatch Mott MacDonald / PWD	$5 million	Spring 2011	Design 70% complete
Oregon Ave. Flood Relief Tunnel	Oregon Avenue from Broad to Front	Hatch Mott MacDonald (Feasibility Study)	$100 million	N/A	Issued RFP for Design Engineers

Weccacoe Avenue	Weccacoe Avenue, Wolf Street and Oregon Avenue	Birdsall (former CMX) / PWD	$13 million	Spring 2012	On Queue for Design
Washington West	Washington Ave. from 13th Street to the Delaware River	Birdsall (former CMX) / PWD	$25 million	N/A	Design Started
Porter Street	Porter, 10th to Broad	Birdsall (former CMX) / PWD	$3.5 million	June 2010	In Construction
Snyder Avenue	Snyder, Front to 4th	Pennoni / PWD	$5 million	N/A	In Projects Control

Although the summers of 2007 and 2008 were not characterized by intense rain storms that resulted in basement backups or property damage, the summer of 2009 saw a return to the intense rain storm patterns the City and region experienced between 2004 and 2006. Rain storms on the following dates resulted in a number of calls regarding basement backups in sections of South Philadelphia (CSO neighborhoods) and stormwater flooding of basements due to street flooding or overflow of backyard streams in separate sewered areas:

July 12th, 2004
August 1st, 2004
September 28th, 2004
June 6th, 2005
October 8th, 2005
June 2nd, 2006
August 28th, 2006
July 31, 2009
August 2, 2009
August 9, 2009
August 21, 2009
August 22, 2009
October 2009
July 2010

PWD is continuing to move forward with its Storm Flood Relief (SFR) Sewer Designs for combined sewer neighborhoods in Northern Liberties, Washington Square West and neighborhoods in South Philadelphia. The original SFR project that was slated for Pine Street has been relocated to Washington Avenue. The Washington Ave. SFR will provide additional storm flow capacity to the Lombard system, which serves Washington Square West, and the Reed Street system, which serves portions of South Philadelphia. Community meetings concerning the design and construction of this system have taken place since April 2009 with a number of diverse civic associations whose neighborhoods will be impacted by this construction.

PWD is also in the midst of investigating storm sewer modifications and source control opportunities for the separate sewer neighborhoods that were impacted by this summer's intense rainstorms. Sections of the City including Chestnut Hill, East Falls, Andorra, Roxborough and E. Germantown experienced street and property flooding.

As an interim practice to protect properties in CSO neighborhoods against basement backups while awaiting the construction of the SFR projects, PWD created the Basement Protection Program (info at www.phila.gov/water) which provides interested customers a plumbing inspection and the installation of backwater valves on sewer laterals or plumbing fixtures. Since the program's inception in 2007, 313 properties have participated in the department's program (73 properties in 2010 to date). This program will be discussed futher below in the Individual Property Solutions on page 25.

Update of Comprehensive Flooding & Sewer Overflow Mitigation Program

PWD has initiated a large-scale project to analyze and reduce property damage from flooding and basement backups. Since the interim report on basement flooding (9/1/2005) and the 1st update (3/1/2006), PWD has been working hard on multiple fronts to both understand the causes of flooding as well as to start implementation of items that would be helpful to flood prone properties.

PWD has embarked upon a huge effort to investigate, evaluate, analyze, and look for solutions to these problems. As part of this effort, PWD has begun and will continue to:

1. Inspect sewers in flood prone areas to determine if there are any obstructions and schedule appropriate maintenance where problems are found or schedule capital projects if structural problems are observed.

2. Collect and update data from property owners impacted by flooding.

3. Analyze the sewer system by hydraulically modeling the system to determine how the sewer system responds to storm events.

4. Coordinate with other government entities and enhance the legal framework for managing stormwater.

5. Provide possible remedies/solutions based upon the modeling information, which in turn is based on all of the data collected.

6. Initiate a Basement Back-up Protection Program

Sewer System Inspection and Maintenance

PWD routinely send maintenance crews to inspect sewers in blocks that have experienced and reported flooding, in order to look for blockages, obstructions, or other defects that may have contributed to flooding.

To date, PWD has inspected multiple sewers and identified no obstructions or accumulation of debris that would result in basement flooding. The small amounts of debris that were observed in a few isolated blocks have been cleaned. As part of this investigation, PWD identified two blocks that have structurally failing sewers. These locations have been added to the PWD sewer reconstruction capital program and given a high priority.

Property Data Collection

Input from neighborhoods and individual customers are essential in defining the extent and cause of the problem. In order to better understand the extent and severity of backups, PWD has modified its customer complaint system to allow for basement backup data to be collected in a more useful way. As it is impossible for PWD to observe conditions in every home, it is critically important that residents work with their civic leaders to accurately record, and communicate information about the date, time, depth, and duration of basement backups. It is also important to characterize the type and elevation (height from basement floor) of each basement plumbing fixture from which the backup has been observed. This information is needed to hydraulically model the storm event, evaluate the sewer system response to the rainfall, and identify measure to resolve backups.

PWD met with several community groups to discuss the flooding issue and has attempted to obtain more information from affected property owners. To facilitate information gathering, PWD generated a flooding questionnaire to help standardize data collection. The information gathered has been vital in helping PWD understand the limits of the affected areas as well as calibrating and verifying the hydraulic modeling of the sewer system. The questionnaire has been distributed at all community meetings on the subject as well as given to community group leaders for distribution to individuals who may have been unable to attend the public meetings.

Sewer System Analysis

PWD has made a significant investment in the latest technology in order to understand and analyze this city's infrastructure. PWD also has made a large investment in the ability to hydraulically model and analyze the sewer system and how it reacts and functions during wet weather events. In order for the hydraulic modeling results to be valid the model must be calibrated to ensure that the results reflect how the system is truly functioning. Building the computerized model of the sewer system and calibrating it is time consuming. Calibration quite often requires flow monitors to be installed in the sewers at key locations. The monitors will provide actual data of sewer flows and depths during wet weather events. This data will in turn be utilized in the hydraulic model to ensure that the model reflects the actual response of the sewer system to rainfall and that flood relief alternatives can indeed be effective.

PWD has installed temporary flow monitors in the sewer system at many key locations in order to obtain flow data during rain events. The monitors were installed in specific locations that would provide the most beneficial information to the modelers. In order for the information to be relevant, the monitors must be in place for several rain events, typically for several months. The information gathered is then used in conjunction with the hydraulic model to calibrate and/or verify that the model reflects what is actually taking place in the sewer system.

The modeling has been completed for the following trunk sewer systems:

- Snyder/McKean St. sewershed east of Broad St. (South Philadelphia)

- Lombard St. sewershed east of Broad St. (Washington Square West)
- Laurel St. sewershed (Northern Liberties/Old Kensington)
- Tasker and Reed St. sewersheds (South Philadelphia)
- Shunk St., Porter St., Wolf St. sewersheds east of Broad St. (South Philadelphia)
- Passyunk Ave. and Shunk St. sewersheds west of Broad St. (South Philadelphia)

Many individual projects (**TABLE II.B.3.3-3**) have subsequently been identified that are required to increase the capacity of these trunk sewer systems in order to handle intense rain events. These projects are being incorporated into the PWD Capital Program. As PWD designs and ultimately constructs the sewer improvement projects, modifications to the size and location of new sewers may arise from the design process. PWD engineering staff continues to re-evaluate these projects to determine if there are better, less disruptive, or more efficient ways of achieving the required results. This list will be periodically modified to reflect any changes.

The projects are large and complicated and will take several years to design and construct. Based upon conservative assumptions, the hydraulic model indicates that the sewer systems improvements will eliminate or greatly reduce the potential for flooding based upon historical storm events. The hydraulic model indicates that these sewer system improvements greatly reduce the number of events that caused flooding and the severity, but may not be able to handle all possible rain events. PWD is sensitive to the fact that the improvement projects are disruptive to the community, and will do everything it can to minimize residential discomfort.

Government and Regulatory Initiatives

PWD is sensitive to the impact stormwater, particularly urban runoff, has on the combined sewer system. Regulations requiring modern stormwater management practices in Philadelphia became effective January 1, 2006, and are described in detail in **SECTION F.5 – MONITOR AND CONTROL STORMWATER FROM CONSTRUCTION ACTIVITIES** on page 278**.** The stormwater regulations aim to prevent worsening of basement flooding, and ultimately reduce stormwater runoff even as Philadelphia re-develops.

Individual Property Solutions

Beginning November ’06, PWD conducted a pilot Basement Protection Program, working with volunteer residents in the affected neighborhoods to install backwater valves on individual plumbing fixtures and main drains if warranted, and also to identify opportunities to disconnect the property’s downspouts. The pilot program allows for the development of an anticipated and proposed scope of work for the department’s contracted plumbers, and to determine related costs for this work, which involves restoring the portions of the basement or sidewalk affected by the installation of backwater valves. To date, PWD has retrofitted 313 properties while also developing a program protocol that will allows for a larger pool of customers to participate in the program which is free to eligible property owners.

PWD has budgeted $1 million in FY 2010 for the implementation of this program. On July 1 2007 PWD initiated its soft launch, working through City Council offices and neighborhood organizations. The goal of soft launch is to allow the program staff and plumbers to begin protecting additional qualifying properties with backwater valve protection while not working under the duress of a rain storm which results in basement backups.

Application forms may be obtained by calling the PWD hotline (215-685-6300). To qualify for the program, the applicant must be the property owner of record; the property should be located within the identified flooding neighborhoods; and the property's water/sewer bill should be paid to date. The property owner will be required to sign a Basement Backflow Prevention Agreement. Once a scope of work has been defined for the property work may proceed. Backwater valves require regular maintenance in order to keep them clean and functioning properly. In properties experiencing basement backups, basement fixtures can be elevated, plugged, individually retrofitted with a backwater valve, or eliminated. Homeowners can also have a licensed engineer or registered plumber evaluates the feasibility of installing a backwater valve and or ejector pump.

Flood Relief Project Summary

PWD understands the hardships caused by basement flooding, and therefore the solution to this issue is one of the highest priorities for PWD. This complex problem will require time and resources to implement targeted solution. PWD has budgeted $1 million in FY 2010 for the installation of back water valves on individual property laterals and other solutions that prevent back ups. PWD has worked diligently to analyze and identify sewer system improvements, and is now beginning to implement solutions. PWD identified approximately $200 million in sewer system projects to improve the conveyance of stormwater from intense rain events more efficiently, and ultimately reduce the potential for basement flooding. PWD's capital budget has also been increased to fund the sewer improvement projects. PWD will continue to modify the size and location of projects based upon knowledge gained through the design process in order to optimize the results of each project while minimizing disruption to the community during construction.

II.B.3.4 Real Time Control Evaluation

The PWD has completed the installation of an inflatable dam in the Rock Run Relief Sewer and is constructing a crest gate in the trunk sewer of regulating structure T14 ("I" St. and Ramona Avenue) to reduce CSO discharges to the Tacony Creek as part of the Long-Term CSO Control Plan. These capital projects achieve reductions in CSO volumes through utilization of in-system storage in the Rock Run Relief and T14 trunk sewer in a cost-effective manner.

Modeling analyses were performed to evaluate control logics for the inflatable dam and gate that optimize storage utilization and minimize flooding impacts of the projects. Analyses were also performed to develop control logics for the projects' drain-down control gates and to size Dry Weather Outlet (DWO) pipes for the Rock Run Relief project.

System hydraulic modeling was performed to evaluate the performance benefit of Real Time Control (RTC) projects in the Southwest Drainage District (SWDD). These projects included the completed phase of raising the overflow dam height and DWO pipes size at Cobbs Creek High Level Interceptor CSO regulating chamber C17. Ongoing phases also evaluated using system hydraulic models include reconstruction of the triple barrel gravity sewer dispersion chamber control gates and increasing the DWO pipe size at the Lower Schuylkill West Side Interceptor regulating chamber S45 in order to deliver more wet weather flow to the Southwest Water Pollution Control Plant (NEWPCP) for treatment.

System hydraulic modeling was performed to evaluate the performance improvements realized through implementation of the Main Relief Inflatable Dam project.

II.B.3.5 Other Capital Project Support

Hydraulic modeling was performed to evaluate conveyance improvements to the Northeast Drainage District (NEDD) Frankford High Level (FHL) Interceptor system including removing transmission bottlenecks and sealing an existing out of service gravity sewer for pressurization in order to bring more wet weather flow to the NEWPCP.

II.B.4 Fully Integrate the Real-Time Control Facility into the Operations of PWD

The construction of the Collector System Real Time Control Center (RTC) building was completed in the summer of 2003. The Real Time Control Center became operational in September 2006. The center, located at the Collector System Headquarters at Fox St. and Abbottsford Rd., is currently attended to during the day shift and for major storm events. The 24 ft. by 46 ft. room incorporates a two high by three wide matrix of video projection cubes for a total video screen wall of 89.4 square feet. The ergonomically designed room and furniture layout enables large groups of people to simultaneously view the display screens.

The display screens make use of the Decision Support System that has been under development since 2002. This web-based application consolidates many of PWD's information sources into one application making real-time and static information easier for the decision maker to use. Some of the information sources currently in use are: pump station and CSO control site SCADA and alarm systems, Collector System monitoring network data, the Department's wide variety of GIS data, sewer system and equipment scanned drawings, CCTV inspections video and reports, Collector Systems work order management systems, and weather and tide predictions.

II.B.5 Operate and Maintain In-Line Collection Storage System Projects Contained within the LTCP

II.B.5.1 Main Relief

The Main Relief Inflatable Dam storage project was completed in fiscal year 2007 and is currently in operation. The Department continues to maintain and monitor this in-line collection system storage site.

This project reduces the discharge of CSO into the Schuylkill River through utilization of the available in-system storage volume. The Main Relief Sewer provides flood relief to combined sewer areas in all three of PWD's drainage districts (Northeast, Southeast and Southwest). It discharges to the Schuylkill River at Fairmount Park, a highly visible recreational area.

In November of 2003, the project was advertised and bid. The bid was awarded in mid-December to Ross Araco for an amount of $1,029,919. The project construction was initiated on 9/16/2004 with the issuance of the Notice to Proceed. Field work began on 12/15/2004 and was substantially completed on 11/3/2005. Following a lengthy system start up/ tune-up period, the project was closed out at a final total cost of $1,068,031 on 5/10/2007. The dam did not become fully automated until the Dauphin Street job, which used a portion of the Main Relief Sewer as a bypass during construction, was completed in the fall of 2006.

The current operational set-points for the inflatable dam are; >7 ft the bag fully inflates; at 16 ft +- 0.25" the dam modulates to maintain 16 ft; at 24 ft the dam fully deflates in failsafe mode. All levels are measured from the invert of the trunk sewer approximately 20 feet upstream of the centerline of the dam. The designed level of 20 feet dam modulation was never achieved without failure so the level was reduced to 16 feet, which is a more realistic capture level. This 16 feet is still much higher than any other Bridgestone installation. The failures at the 20 foot dam height included surges to well over the 24 ft failsafe before the bag would react, constant stretching of the rubber resulting in bolt loosening and allowing water into the bag, and dislodging of level sensors due to the violent turbulence.

In a typical year, the operation of the dam prevents about 31 to 22 million gallons (high and low estimates) of combined from overflowing to the Schuylkill River and facilitates capture of about 47 to 34 million gallons in the Southwest drainage district.

II.C Review and Modification of Pretreatment Requirements to Assure CSO Impacts are Minimized (NMC 3)

II.C.1 Expand the Pretreatment Program to Include Significant Industrial Users (SIUs) Whose Facilities Contribute Runoff to the Combined Sewer System

The City of Philadelphia's Pretreatment Program permits all significant industrial users (SIUs) in its service area, which includes SIUs in both separate and combined sewer systems. These permits are site-specific and are intended to control the introduction of pollutants from the industrial users which may pass through or interfere with wastewater treatment processes.

The City has done an analysis on the issuance of general permits for industrial dischargers and concluded that there would be no additional benefit over the site-specific permits that are currently issued. These site-specific permits regulate all wastewater discharged from the facility, which includes contaminated storm water (i.e. rainfall contaminated by products, by-products, waste products, or other materials). Additionally all SIUs are required to monitor their flow to the sewer system. Due to the large amount of regulatory changes that would be necessary to enact the use of general permits, namely it would require a change to the City's Wastewater Control Regulations, the EPA's approval, and promulgation into City Law, the City would like to continue to use the site-specific permits and will continue to demonstrate that there is no detriment in using the site-specific permits over the general permits.

The City has updated its Industrial Waste Inspection Forms used during inspections which take place during enforcement activities as part of its Pretreatment program. The updated form was faxed to Jennifer Fields, Regional Manager, PADEP on March 29th, 2006. A copy of the Industrial Waste Inspection Forms was submitted in FY2009 CSO/SW Annual Report but can also be found in **ADDITIONAL DOCUMENTS FOLDER IN THE SUPPLEMENTAL CD**.

Through the Pretreatment Program, the City inspects each of its SIUs at least once per year. These inspections provide an opportunity to give guidance on possible pollution prevention activities. Pollution prevention is reducing or eliminating waste at the source by modifying production processes, promoting the use of non-toxic or less-toxic substances, implementing conservation techniques, and re-using materials rather than putting them into the waste stream. Pollution prevention is viewed as a win-win situation for both the City and its SIUs. As such, the City intends to provide industrial stormwater BMP guidance to its SIUs and evaluate those efforts during inspections.

II.C.2 Incorporate guidance on BMPs for industrial stormwater discharges into Stormwater Management Regulations guidance

The Stormwater Management Guidance Manual incorporates guidance on BMPs for industrial stormwater dischargers. The Stormwater Management Guidance Manual is intended to guide the developer in meeting the requirements of the Stormwater Regulations. The Manual is laid out to guide the developer through the entire site design process, beginning with initial site design considerations, through the Post-Construction Stormwater Management Plan (PCSMP) submittal elements, and ultimately PWD prerequisite approval on Building Permit approval. Tools are provided to assist in completion and submittal of a PCSMP consistent with the requirements of PWD. These tools work together to address stormwater management on the development site from concept to completion.

One of the tools in the Guidance is the Stormwater Management Practice Design Guidelines (SMPs), which presents technical design guidance for managing stormwater and specifications for structural SMPs. These SMPs include technologies such as green roofs, rain barrels and cisterns, filters, bioinfiltration / bioretention, detention basins, porous pavement, etc. Each of the technologies is described and illustrated to show which applications it would be appropriate for. This assists industrial stormwater dischargers decide which BMPs are most appropriate for industrial applications. More information along with the full version of the Stormwater Management Guidance Manual can be found at:

http://www.phillyriverinfo.org/Programs/SubprogramMain.aspx?Id=StormwaterManual

II.C.3 Continue to Serve as a Member of the Philadelphia Inter-governmental Scrap and Tire Yard Task Force

To address numerous complaints about the operation of scrap metal and auto salvage businesses, which may cause polluted runoff to enter the City's sewers, as well as create blight in City neighborhoods, and contribute to short dumping and other environmental harms to area waterways, the City will: (1) continue to participate with the USEPA and PADEP in a multi-governmental task force to conduct random inspections of these facilities; (2) provide compliance assistance to scrap yard operators on the various relevant laws and regulations; (3) provide educational assistance on measures that can be undertaken by the industry to control runoff from storage or transport areas; and (4) where necessary, support comprehensive enforcement actions in cases where facilities are unwilling to cooperate.

The Scrap Yard Task Force (SYTF) is in its second year of operation since it was reorganized on September 5, 2008. Vince Dougherty from the city Commerce Department has taken over as the new head chairman of the SYTF. The PWD, through Jim D'Agostino, has assumed the role of coordinator for the SYTF. Inspections and meetings have been taking place once a month in an effort to reach more scrap yards and get them into compliance. A geodatabase has been created that displays in GIS the location and outline of all scrap yard parcels in the city. The geodatabase contains information about the scrap yards that will be important in the future operation of the task force, such as: the address, owner, surface area, last inspection, and previous violations. Currently, there are 209 licensed scrap yards, 174 are auto salvage yards and 35 are junk yards. It is the intent of the SYTF to be more efficient by operating frequently, knowing the scrap yards better, and following up on the results of the inspections.

During the period from July 2009 to July 2010, the SYTF conducted inspections 11 times and inspected 36 scrap yards. Violation notices of varying types from different agencies were issued to the majority of the sites. No sites were shut down and the incidence of stolen vehicles and parts was low. In two cases, stolen vehicles were found and arrests were made. There was one instance where several very large Marijuana plants were discovered and the PPD Vice Squad was notified and took the necessary actions. One scrap yard had several serious violations. The SYTF was prepared to cease operations on the facility, but the facility owner did the necessary work to return to compliance. The enhanced inspection schedule has resulted in greater awareness throughout the business community with noticeable benefits. Violations are in large part not as egregious as in previous inspections, and corrective measures have been implemented by many of the facilities.

II.D Maximization of Flow to the Publicly Owned Treatment Works for Treatment (NMC 4)

II.D.1 Continue to Analyze and Implement Non-Capital Intensive Steps to Maximize the Wet Weather Flow to the POTW

II.D.1.1 Modified Regulator Plan

The basic strategy of flow maximization, or Modified Regulator Plan (MRP) was to deliver more flow to the WPCPs more frequently and enable greater pollutant removals. The results of the hydraulic modeling of the interceptor sewers under the flow maximization scenarios indicate that significantly higher rates of flow can be delivered to the WPCPs more frequently than under current conditions. To date, 100% of the projected flow increase associated with the Modified Regulator Plan has been implemented. Some additional modifications may be made in the future to prioritize certain overflows or to reflect an improved understanding of the collection system dynamics as identified throughout the ongoing modeling work, but no additional capture is expected to result on a system wide basis.

II.D.1.2 Maximization of Wet Weather Treatment in the LTCPU

Increasing the treatment capacity of the WPCPs and increasing the transmission of flows to the WPCPs is being analyzed as past of the LTCPU. Please refer to **SECTION III.B.1.3.1"EVALUATE STRESS TEST REPORT OPTIONS IN THE LTCPU"** on page 89 for more information on this analysis.

II.D.2 Continue the Program which Requires Flow Reduction Plans in Agreements to Treat Wastewater Flows from Satellite Collection Systems where Violations of Contractual Limits are Observed

PWD has executed substantially revised agreements with Cheltenham and Lower Southampton townships to reduce peak wet weather flows to the wastewater treatment plants.

Bucks County Water & Sewer Authority

Bensalem Township's wastewater is delivered to PWD's system under a contract assumed several years ago by the Bucks County Water & Sewer Authority (BCWSA). Under the terms of a recently negotiated agreement with PWD, BCWSA is undertaking the installation of meters at all connection points not currently monitored.

In addition, BCWSA has agreed to construct a 1.8 million gallon surge tank and pump station. This effort has been proposed by BCWSA as an effective manner in which to address high peak flows to PWD's system. BCWSA is continuing to work on the surge tank and pump station in compliance with the terms of its agreement with PWD. PWD is satisfied that reasonable progress is being made on the aforementioned project. The project was supposed to be completed by September of 2010, but has been delayed due to issues with aquiring property rights.

Cheltenham Township

Cheltenham Township entered a five year contract with PWD on June 30, 2010. The agreement requires the Township to immediately begin Act 537 planning and establishes strict oversight of Cheltenham's efforts to reduce its Sanitary System Overloads (SSO's). The Township is required to meet with PWD at established intervals to report on progress in developing its Act 537 Official Plan. Within the five year term of the new agreement Cheltenham is required to be in full compliance with its contractual flow rates. The Agreement provides for significant financial penalties in the event of noncompliance by the Township.

Lower Southampton

Lower Southampton Township has also executed a new wastewater agreement with PWD, effective June 23, 2010. This new contract imposes financial penalties in the event the Township exceeds its contractual flow limits. As a result of this new agreement Lower Southampton is aggressively undertaking an Infiltration/Inflow mitigation program to reduce it wet weather related peak flows to PWD's system.

Future Plans

PWD has notified three additional satellite municipalities that it will be seeking to enter new wastewater agreements in FY 2011. Springfield Township (Montco), Lower Moreland Township and DELCORA have been advised that their peak flows will have to be reduced and new contracts will include language to enforce and encourage action by the satellite municipalities to make significant reductions in their wet weather peak flows to the PWD system. The list of outlying community contracts can be found in **APPENDIX B – Flow Monitoring: Table 6.**

II.D.3 Use Comprehensive Monitoring and Modeling Program to Identify Suburban Communities where Excessive Rainfall-dependant I/I Appear to be Occurring

II.D.3.1 Monitoring and Modeling

PWD is currently aware of 63 connections from outlying communities. Presently, permanent flow monitors are installed at 38 connections and temporary monitors at 22 connections. There are 3 unmonitored coonnections. Through temporary deployments, average flow statistics were determined. **APPENDIX B - TABLE 1** contains the list of all known connections, their location and weather or not the connection is permanently monitored.

The U.S. EPA's Storm Water Management Model (SWMM) was used to develop the watershed-scale model for the PWD combined sewer system. The components of the SWMM model used in the development of the Philadelphia watershed and wastewater conveyance model were the RUNOFF and EXTRAN modules. Outlying communities are modeled as separate runoff sheds that load directly to the PWD sewer network. The sheds are calibrated to flow monitoring data collected at each respective connection.

II.D.3.2 Outlying Community Contracts

Please refer to **SECTION II.D.2 "CONTINUE THE PROGRAM WHICH REQUIRES FLOW REDUCTION PLANS IN AGREEMENTS TO TREAT WASTEWATER FLOWS FROM SATELLITE COLLECTION SYSTEMS WHERE VIOLATIONS OF CONTRACTUAL LIMITS ARE OBSERVED"** on page 32 for information pertaining to outlying communitiy contracts.

II.E Prohibition of CSOs during Dry Weather (NMC 5)

II.E.1 Optimize the Real-Time Control Facility to Identify and Respond to Blockages and (non-chronic) Dry Weather Discharges

Dry weather discharges at CSO outfalls can occur in any combined sewer system on either a chronic (i.e., regular or even frequent) basis or on a random basis (i.e., as a result of unusual conditions, or equipment malfunction). Random dry weather discharges can occur at virtually any CSO outfall following sudden clogging by unusual debris in the sewer, structural failure of the regulator, or hydraulic overloading by an unusual discharge of flow by a combined sewer system user. Chronic dry weather discharges can and should be prevented from occurring at all CSO outfalls. Random discharges cannot be prevented, but they can and must be promptly eliminated by cleaning repair, and/or identification and elimination of any excessive flow and/or debris sources.

Regular and reactive inspections and maintenance of the CSO regulators are performed throughout the City. These programs ensure that sediment accumulations and/or blockages are identified and corrected immediately to avoid dry weather overflows. The CSO maintenance group utilizes the remote monitoring network system daily as a tool to help identify the locations that are showing abnormal flow patterns. By using the system in this manner the crews are able to correct many partial blockages before they become a dry weather discharge. For FY 2010, there were a total of 231blockages cleared from CSO regulators. The detailed inspection report summaries are included on pages 6 and 9 of **APPENDIX A – FY10 FLOW CONTROLS ANNUAL REPORT**.

II.F Control of Solid and Floatable Materials in CSOs (NMC 6)

The control of floatables and solids in CSO discharges addresses aesthetic quality concerns of the receiving waters. The ultimate goal of NMC 6 is to reduce if not eliminate, by relatively simple means, the discharge of floatables and coarse solids from combined sewer overflows to the receiving waters where feasible. The initial phase of the NMC process has and will continue to focus on the implementation of, at a minimum, technology-based, non-capital intensive control measures.

II.F.1 Control the Discharge of Solids and Floatables by Cleaning Inlets and Catch Basins

The Inlet Cleaning Unit's primary responsibility is the inspection and cleaning of approximately 76,043 active stormwater inlets within the City, this number is lower than previous years due to consolidation of older inlets. This unit is also charged with the responsibility for the following areas: retrieving and installing inlet covers, installing original replacement covers that are missing, installing locking covers, unclogging choked inlet traps and outlet pipes so that inlets can take water; alleviating flooded streets and intersections when hydrants are opened, broken water mains, rain storms and other weather related problems. Inlet Cleaning is also charged with answering flood complaints at the Philadelphia Business Center. Finally, Inlet Cleaning has five highway crews, whose duties are to clean high volume traffic areas during the night hours, 11 PM - 7 AM.

To insure the efficient and effective operation of the City's inlets and connecting stormwater sewers, it has been found necessary to use specialized inlet cleaning equipment to work along with the various units of the PWD as well as other government agencies and the private sector. The unit also cleans inlets on PWD properties.

About 80% of inlet cleaning work orders are scheduled jobs, while the remaining 20% are in response to customer calls or requests from other departments. Scheduled cleaning routes for an area are created by the crew chief and assigned to the crews.

For the period of July 2009– June 2010, 88,604 inlets were inspected, 73,764 inlets were cleaned. Average amount of debris removed from each cleaned inlet was 271.4 lbs. 4,165 inlets had other work performed. This is an average of every inlet being examined or cleaned and examined 1.16 times during this period. Additional statistics and information pertaining to Inlet Cleaning from FY10 can be found in **TABLE II.F.1-1 AND FIGURE II.F.1-1.**

Table II.F.1-1: FY10 Inlet Cleaning Statistics

Total Inlets Inspected	88,604
Total Inlets Cleaned	73,764
Total Grates Cleared	5,827
Total Covers Replaced	1,662
Tons of Debris Removed	10,010
Avg. Lbs./ Inlet	271.4

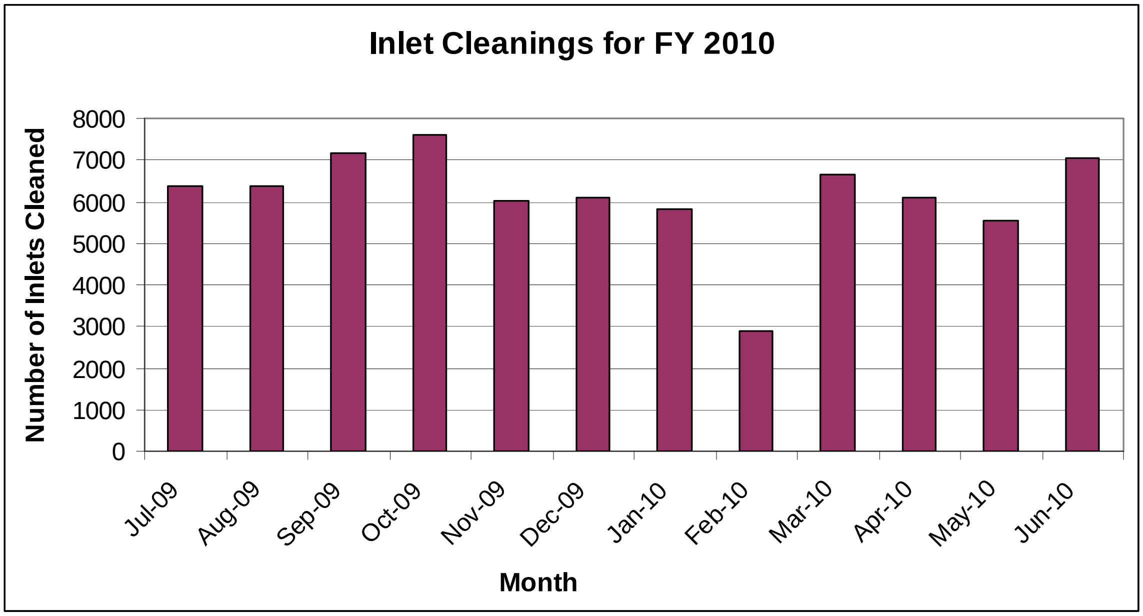


Figure II.F- 1 Monthly Inlet Cleaning Statistics

II.F.2 Continue to Fund and Operate the Waterways Restoration Team (WRT)

PWD's Waterways Restoration Team (WRT) is a multi-crew force dedicated to removing large trash – cars, shopping carts, and other short dumped debris - from the 100 miles of stream systems that define our City neighborhoods. This crew also restores eroded streambanks and streambeds around outfall pipes and in tributaries as a part of PWD’s goal to naturally restore our streams while meeting Clean Water Act permit requirements. The team is focused on the completion of in-stream restoration work that protects the department's sewer infrastructure in the banks and beds of our streams, while also using Natural Stream Channel Design to restore these streams to a habitat supporting waterway and a community amenity. The Waterways Restoration Team works in partnership with the FPC staff and the various Friends of the Parks groups to maximize resources and the positive impacts to our communities.

The WRT performs stream clean up work throughout the city, in the city's streams – Cobbs, Wissahickon, Tacony, Pennypack, and Poquessing creeks, and their tributaries, along the banks of the non-tidal Schuylkill River, in addition to the Manayunk Canal.

Typical tasks for the WRT include:

- Debris and trash removal - This is one of the most basic tasks of the WRT – the removal of trash and large debris from our waterways. In addition to satisfying one of the primary goals of the Clean Water Act, ensuring that our streams and rivers are clean and beautiful enhances public stewardship as people will only seek and value waterways and parks that look and smell good. Public willingness to pay for the protection of our waterways is intricately linked to the recognition that these waterways are being maintained and valued by the City. Residents care little about the quality of the water emptying into our streams if the streams are smelly eyesores. If the public does not have a desire to go to these waterways, they will not care about them.

- Watershed assessments - WRT watershed assessments include visual inspections of the banks of Cobbs, Wissahickon, Pennypack, Poquessing and Tacony Creeks and are completed once per year. This field survey work essentially involves the inspection of stream segments (upstream to downstream) to check for evidence of exposed or damaged infrastructure, chronic pollution sources, dry weather sewer overflows along Cobbs and Tacony Creek. These assessments also support the implementation of the completed watershed management plans for these stream systems.

- Sanitary discharge clean-ups - The WRT is recruited to clean up sanitary discharges to our streams or parks.

- Property restoration repair - The WRT is recruited to restore natural areas on public and private land impacted by water main breaks.

- Operation of PWD Floatables Pontoon Boat in spring/summer/fall

- Restoration projects such as plunge pool removals and stream restorations

- Inspection of intake walls

- Woody debris removal

- General maintenance - General Maintenance responsibilities include the fish ladder, PWD plunge pool and streambank restoration projects, and other PWD land-based stormwater management facilities. Currently, the WRT performs ongoing maintenance at the following habitat improvement or best management practice sites:

    - Saylor Grove stormwater treatment wetland

- Fairmount fish ladder
- Marshall Road streambank restoration project in Cobbs Creek
- Wises Mill streambank restoration project in Wissahickon Creek
- West Mill Creek tree trenches
- Mill Creek urban farm street runoff diversion
- Manayunk Canal boom maintenance and algae removal

In FY 2010, WRT removed the greatest volume of trash than what was removed in the previous fiscal years (i.e., FY 2006-FY 2009). A total of 1,438 tons of debris, including 152vehicles, 1,062 tires and 268 shopping carts, were removed from the City's waterways (**TABLE II.F.2-1**).

Table II.F.2- 1 Summary of Waterways Restoration Team - Performance Measurements FY 2006-2010

Waste Removed	**FY 2006**	**FY 2007**	**FY 2008**	**FY 2009**	**FY 2010**
Debris Removed (tons)	425	441	326	657	1,438
Cars Removed	21	41	80	15	12
Tires Removed	396	1,201	861	924	1,062
Shopping Carts Removed	161	84	72	268	102
Number of Clean-up Sites	124	142	178	375	335

In addition to PWD's Waterways Restoration Team's main task of removing large debris from the city's streams, this crew works to restore eroded stream banks and streambeds around outfall pipes and in tributaries that protect the department's sewer infrastructure in the banks and beds of our streams. Types of projects that the team works on are plunge pool removals, fish passage projects, emergency stream bank restorations and interim stabilization projects. **TABLE II.F.2.-2 & 3** show a listing of projects that WRT has either completed or have planned to date.

Table II.F.2-2 Completed WRT restoration projects

Project	Watershed	Description
CC Creek 61st Street Repair	COBB	Emergency streambank restoration after a sewer line rupture
Indian Creek	COBB	Interim stabilization completed by WRU; future restoration project to be completed by a contractor
Marshall Road Restoration Work	COBB	Stream restoration where erosion had exposed a sanitary sewer lateral
Indian Creek Daylighting Project	COBB	Reopened west branch to a lake, protected sewer line, Interim stabilization implemented; future large-scale restoration project to be completed by a contractor
63rd and Market Interceptor Sewer	COBB	DRW, installed road to allow access to infras. sewer
Cobb's Creek and City Line	COBB	Outfall Cleanup
Indian Creek and Landsowne	COBB	Stream Restoration and Clean Up
Cobbs Creek and Locust	COBB	Debris Removal
Cobb's Creek and Ludlow	COBB	Debris Removal
Cobb's Creek and Catharine	COBB	Debris Removal
Naylors Run and Cobb's Creek Confluence	COBB	Debris Removal
Baltimore and Cobb's Creek	COBB	Debris Removal
Whitby Ave and Cobb's Creek	COBB	Debris Removal
Cobb's Creek and 70th St	COBB	Debris Removal
Cobb's Creek and Woodland Ave.	COBB	Debris Removal, Stream and bank Restoration
Maxwell Place Outfall	PPK	Plunge pool removal
PP Rock Ramp	PPK	Fish passage project;
Winchester Outfall	PPK	Plunge pool removal and tributary restoration.
Pennypack Creek and Frankford	PPK	Debris Removal
Wooden Bridge Run at Angus	PPK	Debris Removal
Byberry Creek - Waldermire	POQ	Monitoring of Byberry at Waldermere Dr
ByBerry Creek - Nottingham	POQ	Stream Bank Restoration
Byberry Creek @ Chesterfield & Berea	POQ	Stream clean-up
Walten's Run	POQ	Debris Removal
Poquessing Creek - Ernie Davis Circle	POQ	Debris Removal
Poquessing Creek - Century Lane	POQ	Debris Removal
NEC Ditman & Eden	POQ	Outfall Restoration and Stabilization
Adams Ave Fish Ramp	TTF	Fish passage project
Awbury Stream Daylighting	TTF	Phase I included development of a bioswale and daylighting of a spring/stream
Crescentville Outfall	TTF	Plunge pool removal and culvert restoration with boulders
Bingham Street Sewer Crossing	TTF	Plunge pool removal
Bingham and Garland	TTF	Stream Bed Habitat Modification
Tookany-Tacony park view apartments	TTF	Debris Removal
Tookany - Tacony F Street	TTF	Debris Removal

Project	Watershed	Description
Tookany- Tacon - Penway	TTF	Debris Removal
86th and Luther	SCH	DRW, installed road to allow access to infras. sewer
Strawberry Mansion Bridge	SCH	Repair Headwall and Stream Restoration
Spring Garden	SCH	DRW, installed road to allow access to infras. sewer
Concourse Lake	SCH	Stream restoration
Mount Pleasant and Greene	WISS	Outfall Restoration
Wises Mill Run	WISS	Lower segment; interim stabilization
Gorgas Run	WISS	Interim stabilization; infrastructure protection with boulders
Carpenters Woods	WISS	Stormwater outfall restoration; 3 outfalls discharge to one location creating severe erosion
Rex Ave	WISS	WRU has built a rock wall along the stream to stabilize and protect it; future restoration project to be completed by a contractor
Wissahickon Creek and Cherokee	WISS	Storm Cleanup
Wissahickon Creek and Monastary	WISS	Outfall Cleanup
Wissahickon Creek and Lincoln	WISS	Storm Cleanup
Hartwell Lane	WISS	Stream restoration

Table II.F.2-3 Planned or On-going WRT restoration projects

Project	Watershed	Status	Description
Springfield Ave	Cobbs	In progress	Trail restoration
Naylors Run Wetland	Cobbs	On-going	Repair Swale
Marshall Road Sewer Project	Cobbs	On-going	Stream Bank Restoration
Cobb's creek and Daggot	Cobbs	On-going	Cleanup Restoration
Cobb's Creek Stream Restoration Baltimore	Cobbs	On-going	Stream Restoration and Infrastructure
Pleasanthill Park	DD	In Progress	Basin Modifications
Bustleton & Scotchbrook	PPK	In Design	Stream/Outfall restoration project.
Tustin Street Outfall Restoration	PPK	In Design	Outfall restoration project. WRU performed interim stabilization work on exposed interceptor but further creak stabilization is to come.
Hower Creek (Formerly called Martin's Creek)	PPK	In Design	Outfall Restoration and additional restoration of ~300 feet of stream where there has been chronic erosion.
Pennypack & the Blvd	PPK	On-going	Stream restoration/Fish passage
Paul's Run	PPK	On-going	Stream restoration
Holmes Ave & Crispen Field	PPK	In progress	Debris removal
Bennet Rd Daylighting Project	POQ	In Design	Stream Daylighting
Kelly Drive at Strawberry Mansion "Canoe House"	SCH	In Design	East Park Canoe House – installation of a deflector for the dock that will also provide fish habitat
Whittaker & F St	TTF	In progress	Debris removal/fence repair
St Martin's Lane Bridge	WISS	In Design	A bridge is in disrepair, needs stabilization.
George's Lane	WISS	In Design	Culvert restoration
FPC Tree House	WISS	In Design	A number of SW BMPs will be implemented at the Andorra Education Center where a good deal of erosion is taking place on the property
Oriole Street	WISS	On-going	Repair Swale
Mt.Plesant Place	WISS	On-going	Plunge-Pool Modification
Manayunk Canal	WISS	In progress	Alge removal/debris removal
Wissahickon and Cathedral	WISS	In Design	Stream Bank Restoration and Vegetation
Fountain Street Stairs	WISS	In Design	Infrastructure Restoration
Forbidden Drive & the Covered Bridge	WISS	In Design	Stream restoration
Valley Green Road	WISS	On-going	Stream Restoration
Saint Georges	WISS	On-going	Trib. Cleanup

II.F.3 Continue to Operate and Maintain a Floatables Skimming Vessel

Reduction in floatables improves both water quality and aesthetics of receiving streams. The use of a skimmer vessel also allows for a mobile control program capable of managing debris at various locations, increasing the effectiveness of this control measure. In addition, the boat will be a visible control and will increase the public awareness and education of floatables impacts.

II.F.3.1 Floatables Skimming Vessel – R.E. Roy

The Philadelphia Water Department's large skimming vessel is a 39-ft, front loading, single hull, shallow draft, debris skimming vessel with a hydraulically controlled grated bucket and a 5.6 cubic yard on-board hold equipped with a main diesel engine, Caterpillar Model 3056 205-hp.

Construction of the floatables skimming vessel was initiated in June 2004 and the completed vessel was delivered to PWD in July 2005. The total cost of the vessel was $526,690. The vessel, now known as the R. E. Roy, was operated in-house by PWD personnel from delivery until April 2006. During this time, PWD was in the process of securing a contractor for the permanent operation of the skimming vessel. River Associates was the contractor selected for the operations of the vessel and they have been operating it since April 2006.

The vessel is operated approximately five days per week, 8 months of the year. The vessel's main purpose is to perform general debris collection and removal on both the Delaware and Schuylkill Rivers. The vessel is also used to clean up for and serve as a highlight for public relations events such as the Schuylkill Regatta.

During the 2010 fiscal year, the skimmer vessel was in operation from April 2009 through November 2009 before shutting down for winter maintenance. It resumed operation again in June 2010. There was a period where the vessel was out of service due to serious mechanical problems. In all, 3 months worth of Skimming was lost. The total amount of debris collected in FY 2010 from July 1, 2009 to June 30, 2010 was 18 tons. The weights of debris collected during each month are displayed in **TABLE II.F.3-1.**

Table II.F.3-1 Debris Collected by R.E. Roy Skimming Vessel

Month	Tons of Debris Collected
July 2009	4.36
August 2009	5.42
September 2009	1.28
October 2009	2.16
November 2009	4.96
December 2009	No winter service
January 2010	No winter service
February 2010	No winter service
March 2010	No winter service
April 2010	Mechanical failure
May 2010	Mechanical failure
June 2010	Collected but not disposed, no data available. Total added to July 2010 total disposal.
FY 2010 Total	**18.18**

II.F.3.2 Floatables Pontoon Vessel

The Philadelphia Water Department has purchased a pontoon vessel that is being used as a workboat on the Upper Schuylkill, Lower Schuylkill, and Delaware Rivers within Philadelphia. The vessel is used to retrieve floating trash and debris from the waterways within the service area. The debris is hand netted from the water surface by employees standing on the vessel deck. The hand nets are emptied into ten 44-gallon debris containers on the deck and the containers are offloaded by hand. The pontoon vessel can be utilized in the tight spaces found in marinas, among piers, and in near shore areas.

The pontoon vessel was acquired by PWD in June 2006. PWD manages a skimming operation for floatable debris on the non-tidal Schuylkill through use of the pontoon vessel. This program is an extension of the large debris removal already occurring on the tidal portions of the Delaware and Schuylkill rivers. The public outreach component of the pontoon skimming vessel program is one of the greatest benefits.

The operational area of the Pontoon Vessel includes:

1. The Lower Schuylkill above Fairmount Dam up to Flatrock Dam (7.2 miles)

2. The Lower Tidal Schuylkill down to the confluence with the Delaware River (8.1 miles)

3. The Delaware River from the confluence up to the Philadelphia City Boundary (18.8 miles)

During fiscal year 2010, the pontoon vessel was operated 17 times. 10 trips during the summer/fall 2009 removed a total of 15.18 cubic yards of mixed trash from the non-tidal Schuylkill River. The spring /summer 2010 season saw 7 trips with a total removal of 4.6 cubic yards of bottles and containers and 4.4 cubic yards of mixed trash. A better separation scheme was introduced for the spring/summer 2010 season resulting in a more accurate count of the types of materials collected. In addition to containers and mixed trash, the following has also been removed from the river: 11 tires and various types and sizes of lumber.

There has been a marked reduction in material removal when one compares this year to last. This is likely attributable to 2 major factors. First, the user groups on the river have joined forces with PWD and have made great strides to ensure that participants are more aware of their effects on the river. Secondly, the extremely low rainfall during the 2010 summer season has not allowed for the migration of material from the city sewers nor from areas upstream. A result of this lighter than anticipated loading on the river has been a reduction in the number of trips the Pontoon vessel made this season. In an effort to avoid wasting man hours searching the river banks for very limited floatables loading, the schedule has been cut back to ensure the vessel is used in an efficient manner.

PWD has partnered with Streets Department for the recycling of appropriate material that has been removed from the river.

II.F.4 Other Initiatives

II.F.4.1 Pilot Netting Facility

A pilot, in-line, floatables netting chamber was constructed as part of a sewer reconstruction project at CSO T4 Rising Sun Ave. East of Tacony Creek. The construction of the chamber was completed in March of 1997 and the netting system continues to operate. The quantity of material collected is weighed with each net change. The City has compared the floatables removed from the net with other floatables control technologies employed. More specifically, on an area weighted basis the inlet cleaning program data suggests that street surface litter dominates the volume of material that can enter the sewer system. The pilot in-line netting system installed at T4 has also been shown to capture debris on the same order as the WPCP influent screens indicating that effective floatables control needs to target street surface litter in order to effectively reduce the quantity of debris likely to cause aesthetic concerns in receiving streams. In FY 2010, 3 net removals were done and a total of 447 lbs of debris was collected. The dates and amount of debris captured from this facility during the reporting period are available on page 12 of **APPENDIX A-FY10 FLOW CONTROLS ANNUAL REPORT.**

II.F.4.2 Repair, Rehabilitation, and Expansion of Outfall Debris Grills

Debris grills are maintained regularly at sites where the tide introduces large floating debris into the outfall conduit. This debris can then become lodged in a tide gate thus causing inflow to occur. Additionally, these debris grills provide entry restriction and some degree of floatables control. During FY 2010, 36 debris grill inspections were done. The list of the debris grills receiving preventative maintenance is available on page 12 of **APPENDIX A - FY10 FLOW CONTROLS ANNUAL REPORT.**

II.G Pollution Prevention (NMC 7)

Most of the city ordinances related to NMC7 are housekeeping practices that help to prohibit litter and debris from actually being deposited on the streets and within the watershed area. These include litter ordinances, hazardous waste collection, illegal dumping policies and enforcement, bulk refuse disposal practices, and recycling programs. As pollutant parameters accumulate within the watershed, practices such as street sweeping and regular maintenance of catch basins can help to reduce the amount of pollutants entering the combined system and ultimately, the receiving water. Examples of these programs are ongoing and are presented in the NMC document. The City will continue to provide public information about the litter and stormwater inlets as part of the implementation this minimum control as well as continue to develop the following new programs.

II.G.1 Continue to Develop and Share a Variety of Public Information Materials Concerning the CSO LTCP

The Philadelphia Water Department began the development of an extensive CSO LTCPU Public Participation Program in Spring, 2007, and has continued to distribute materials and host community meetings and events to date. The following components of the Public Participation Program have been completed thus far.

1. Backgrounders (**TABLE II.G.1-1**)– The eight page backgrounders are designed for a general audience (the public) and serve to provide an introduction to the CSO LTCP, along with the history, background, and approach taken by PWD to address CSOs. The backgrounders are distributed to our partners, the CSO LTCPU advisory committee, and to the public at advisory committee meetings, community meetings, public meetings, additional public events, and on the PWD website.

Table II.G.1-1 CSO LTCPU Backgrounders

Backgrounder I	The CSO Long Term Control Plan – History & Background
Backgrounder II	The CSO Long Term Control Plan Update – Clean Water Benefits & The Balanced Approach
Backgrounder III	Current Status of Our Waterways

2. Bill Stuffers, WaterWheels, Annual Drinking Water Quality Report, Press Releases & Ads – The Bill Stuffers and WaterWheels are newsletters mailed out with the water bill to the estimated one-half million customers of the Philadelphia Water Department. Every year PWD also publishes an annual drinking water quality report. This report is mailed to every resident in the City and contains a wealth of information regarding the source, safety, and contents of the City's drinking water. This report is also available year-round on the City's website www.phila.gov.

These documents have been developed and have been distributed throughout the City at advisory committee meetings, public meetings, and other public events, in addition to being distributed through the water bill to PWD customers. A listing of these documents can be found in **APPENDIX C- PUBLIC EDUCATION AND INFORMATION MATERIALS – TABLE 1.**

3. Fact Sheets – The fact sheets highlight projects designed and/or implemented by PWD to address combined sewer overflows and other stormwater and sourcewater related information. The fact sheets also provide information on other PWD programs. The fact sheets are distributed to our partners, the CSO LTCPU advisory committee and to the public at steering committee meetings, public meetings, additional public events, and on the website.

Green Cities, Clean Waters Information Fair

Components of the Green Cities, Clean Waters Information Fair are displayed during community meetings and public events throughout the year.

APPENDIX C- PUBLIC EDUCATION AND INFORMATION MATERIALS – TABLE 2 lists samples of the materials from the Green Cities, Clean Waters Information Fair, in addition to materials distributed at other events and meetings.

In addition to the above materials, PWD recently produced a Green City, Clean Waters Community Orientation Packet which can be found at:

http://www.phillywatersheds.org/sites/default/files/GreenCitiesCleanWatersOrientationPacketFINALsmall.pdf

4. Website – The following websites were designed to educate the public and to inform the public on the Philadelphia Water Department's CSO, stormwater and watershed related programs, resources, and events.

PhillyRiverInfo - http://www.phillyriverinfo.org

This website is OOW's original site. Once can find information for developers. One can also find details on the nature of CSOs, the LTCPU, the history of CSOs, and public events, among other CSO-related information. The CSO LTCPU page, in particular, was created to provide the public with all updated CSO LTCPU–related information and materials, such as reports, maps, photographs, fact sheets, event dates and details, meeting minutes and background information.

The webpage with this detailed information can be found on the following page: http://www.phillyriverinfo.org/csoltcpu/. FIGURE II.G.1-1 shows an example of public information found on the PhillyRiverInfo website**.** For more information on the PhillyRiverInfo website please refer to **SECTION II.G.2.1 – PHILLYRIVERINFO/ PHILLYWATERSHEDS** on page 62.

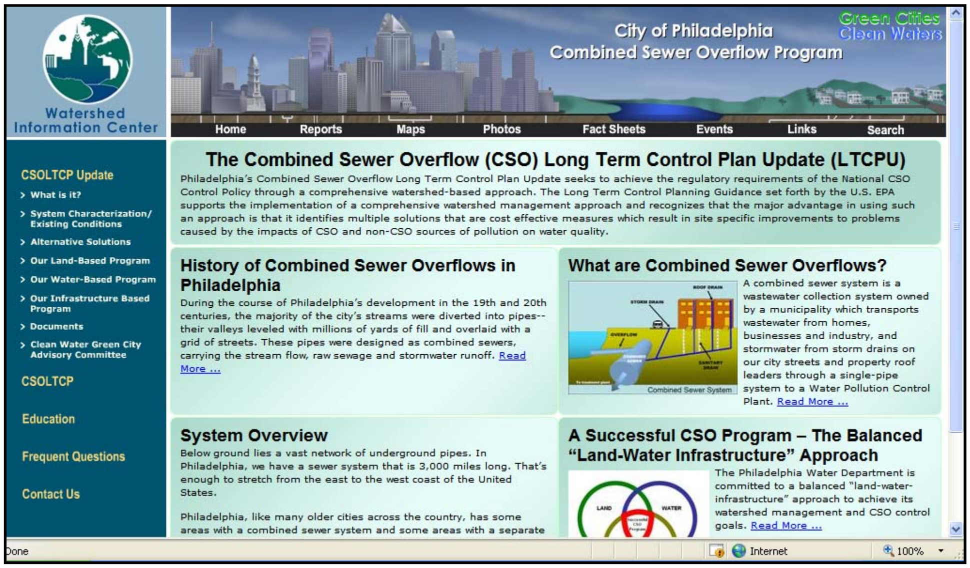


Figure II.G.1-1 Example of public information on PhillyRiverInfo

RiverCast - http://www.phillyrivercast.org/

The Philly RiverCast is a forecast of water quality that predicts potential levels of pathogens in the Schuylkill River between Flat Rock Dam and Fairmount Dam (*i.e.*, between Manayunk and Boathouse Row). One would visit this site to find out the daily RiverCast prediction and to learn more about water quality **(FIGURE II.G.1-2).** For more information on the stormwater billing program please refer to **SECTION II.G.2.2 - RIVERCAST** on page 62.

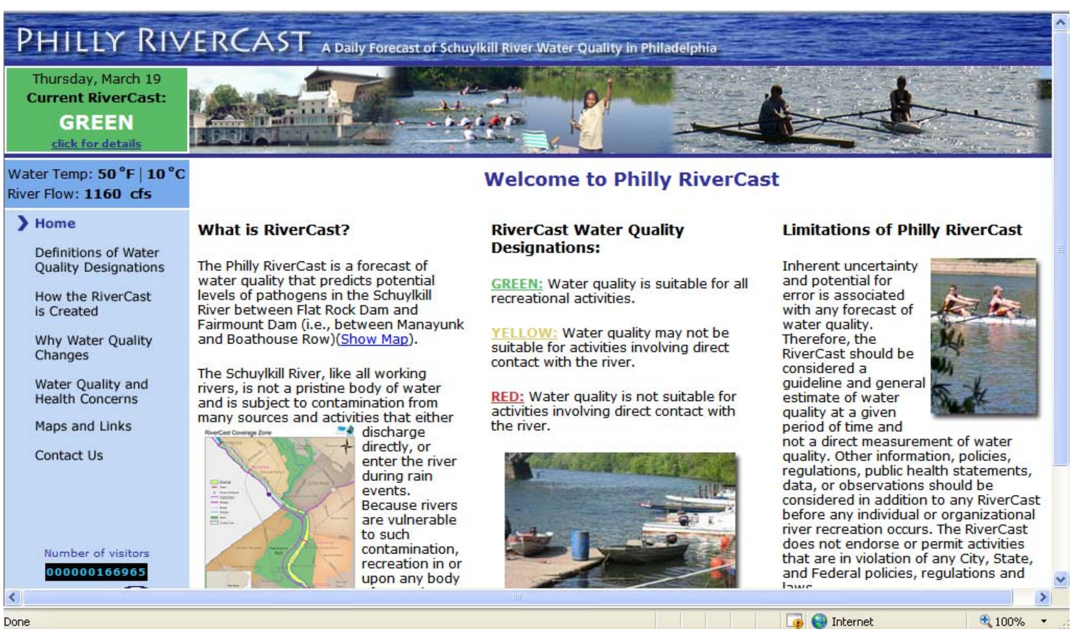


Figure II.G.1-2 RiverCast

CSOcast http://www.phillywatersheds.org/csocast
The CSOcast is PWD's latest effort in demonstrating the overflow status of the City's 164 combined sewer outfalls. CSOcast informs the public whether CSOs are occurring or are suspected to have occurred within the last 24 hours **(SEE FIGURE II.G.1-4)**. It is updated twice daily with information from PWD's extensive sewer monitoring network. **The CSOCast page can be found on the website in the following location:** http://www.phillywatersheds.org/what_were_doing/documents_and_data/live_data/csocast/**.** For more information on the CSOcast please refer to **SECTION II.H.2 – INTERNET-BASED NOTIFICATION SYSTEM** on page 82.

Figure II.G.1-3 CSOcast

Rain Barrel Program - http://www.phillywatersheds.org/rainbarrel/
The Philadelphia Water Department had been providing rain barrels to residents of Philadelphia's watersheds free of charge in order to promote the reduction of stormwater flows to the local sewer system and creeks **(SEE FIGURE II.G.1-5)**. This project consists of the implementation of rain barrels as a method of reduction of stormwater runoff on residential private property. The primary goal of this project is to implement a property-level best management practice to aid in reducing the volume of stormwater reaching the receiving stream or to increase the length of time it takes the stormwater to reach the receiving stream.

At the workshop, residents are instructed on how to install and properly use and maintain their rain barrel. They also learn about the environmental benefits of operating a rain barrel and how stormwater affects the sewer system and local waterways. After successfully completing the workshop, they receive their rain barrel. This program has been a success and there is great demand to continue and expand this program. Work is currently underway to expand this program in order to meet the demand of City residents. To date, over 30 workshops have been held and more than 1,500 rain barrels have been given out. PWD is determining a better approach to meet the demand –

potentially through a contractor. This new system should enable the program to resume in the spring, 2011.

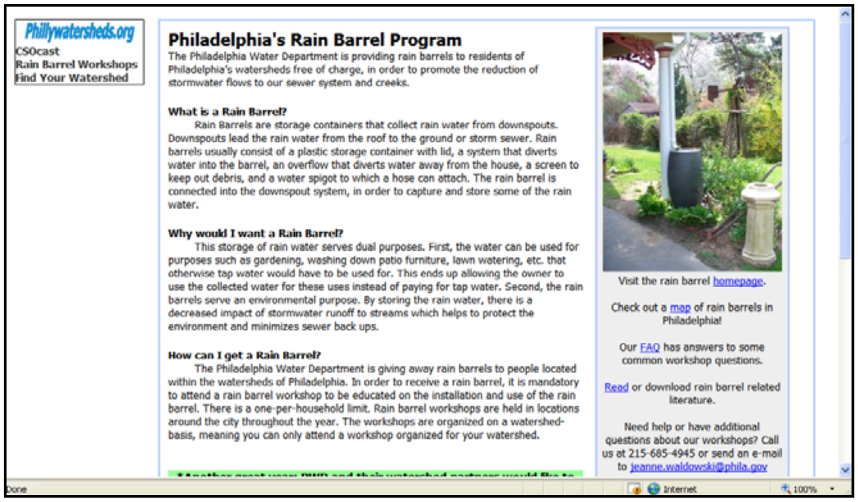


Figure II.G.1-4 Rain Barrel Program

Facebook <u>http://www.facebook.com/green.cities.clean.waters</u>.

The Philadelphia Water Department has a Facebook page and Facebook wall dedicated to the Green Cities, Clean Waters program **(FIGURE II.G.1-5)**. Facebook, a free-access social networking website, enables PWD to reach out to an audience that may otherwise not choose to become familiarized with its programs. Friends abound on PWD's Green Cities, Clean Waters Facebook wall, where approximately 375 members can find public meeting announcements, view images of Green Streets and where visitors can leave comments on the City's green stormwater infrastructure approach. The Facebook page also hosts the Green Neighborhoods through Green Streets survey. To access PWD's Facebook page, visit <u>http://www.facebook.com/green.cities.clean.waters</u>.

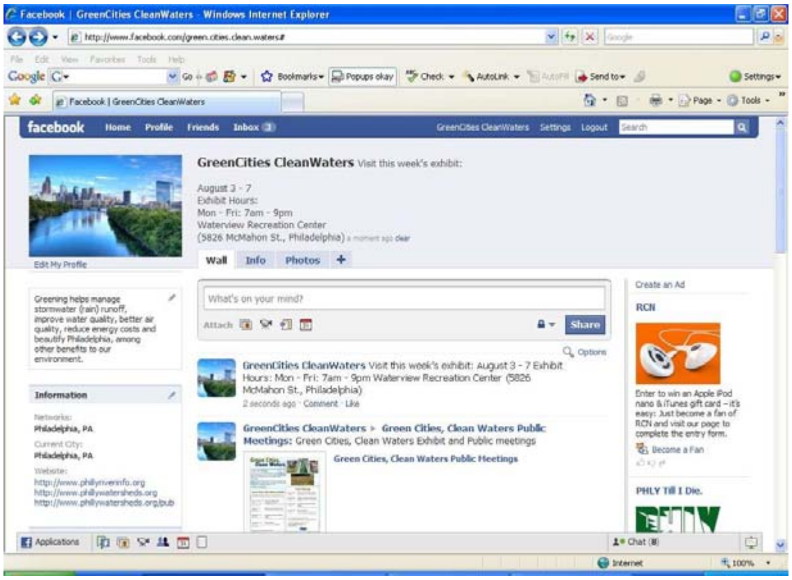


Figure II.G.1-5 Facebook Screenshot

Development Review Program Website

PWD's Development Review Program has a website where developers can go to for guidance in the review process: http://www.phillyriverinfo.org/PWDDevelopmentReview/home.aspx.

Stormwater Billing

PWD also has a stormwater billing program website to help non-residential properties determine the cost of their bill based on the new stormwater billing charges which is guided by the amount of impervious surface on a property. The website and tool can be found in the following location: http://www.phila.gov/water/stormwater_billing.html. For more information on the stormwater billing program please refer **SECTION III.C.1.3 – PARCEL-BASED STORMWATER BILLING** on page 130.

WaterQuality Website

PWD's general water quality website can be found in the following location: http://www.phila.gov/water/Water_Quality.html.

Schuylkill Action Network Website

The Schuylkill Action Network (SAN) website includes an internal component that allows for improved communication among SAN workgroup members and facilitates on-the-ground work. It also includes a public component that conveys SAN's message about protecting and improving the Schuylkill River to outside audiences. The website also allows the public to share their unique stories and experiences relating to the Schuylkill River: www.schuylkillwaters.org. For more information on the Schuylkill Action Network please refer to **SECTION II.G.2.3** on page 63.

5. Green Cities, Clean Waters Exhibit: The CSO Long Term Control Plan (LTCP) Update Public Participation Team developed a one-of-a-kind informational exhibit and art

exhibit in 2008. Since then, various other exhibits and programs have been hosted at the FWWIC. Please refer to **SECTION II.G.4 "CONTINUE TO SUPPORT THE FAIRMOUNT WATER WORKS INTERPRETIVE CENTER"** on page 78 for information on the programs at the FWWIC pertinent to the 2009-2010 reporting period.

For the Green City, Clean Waters 2008 exhibit, the two elements comprising the exhibit were displayed at the Fairmount Water Works Interpretive Center (in Philadelphia) for approximately one month (October 10, 2008 – November 7, 2008). The purpose of the combined exhibit was to unite art with educational information on CSO controls in order to raise awareness on the CSO LTCP Update. The goal of this approach was to target a new audience and to capture the attention of the general public through art, providing a gateway to the informational displays.

While the Green Cities, Clean Waters Exhibit was on display at the Fairmount Water Works Interpretive Center, over a month-long period, roughly 992 visitors had a direct experience with the artwork and the messages portrayed through the informational displays. The exhibit also received media coverage on the local television CBS News affiliate and in local newspapers, such as the Philadelphia Inquirer and the City Paper, in addition to other media.

The artistic component of the exhibit was comprised of artwork (photography and jars) from artist and educator, Bill Kelly. Mr. Kelly specializes in depicting nature in an urban context. He was commissioned to interpret the Green Cities, Clean Waters program through an artistic eye. Bill Kelly used recycled mason jars, filled with water, plants and photography to interpret the CSO LTCPU. The unique exhibit also included photographs of the jars. His work was funded through a Coastal Non-Point Pollution Program grant through the Pennsylvania Department of Environmental Protection's Coastal Zone Management Program and the National Oceanic and Atmospheric Administration (NOAA). **(SEE FIGURE II.G.1-6 AND FIGURE II.G.1-7 FOR EXAMPLES OF BILL KELLY'S ARTWORK)**.

The informational component of the exhibit was made up of a variety of posters that relayed CSO-related and watershed-related information, in addition to displaying a rain barrel. The informational posters also circulated throughout the City, before the final round of public meetings held in August, 2009**.** Thumbnails of the informational posters that were presented the Green Cities, Clean Waters Exhibit can be found in **APPENDIX C: PUBLIC EDUCATION & INFORMATION MATERIALS - TABLE 3.**

An artist reception was held on October 16, 2008, at the Fairmount Water Works Interpretive Center, to celebrate the opening of the Green Cities, Clean Waters Exhibit. The reception also gave the Public Participation Program Team an opportunity to discuss the material behind the informational posters, the CSO LTCPU, with the attendees. Approximately 77 individuals attended the artist reception.

Recently, the Office of Watersheds has been working with the Fairmount Water Works Interpretive Center on a faith-based exhibit that will focus on stormwater management-related work embraced by the various faith-based organizations in the City. This exhibit will be displayed in the spring 2011.

Figure II.G.1-6 Sample of Bill Kelly Art

Figure II.G.1-7 Sample of Bill Kelly Art

The Green Cities, Clean Waters informational posters were also on display throughout Philadelphia, in CSO-watersheds. **TABLE II.G.1-5** lists the locations the Green Cities, Clean Waters exhibit visited.

Table II.G.1-2 Green Cities, Clean Waters Traveling Exhibit

Green Cities, Clean Waters Exhibit			
Exhibit	**Date**	**Time**	**Location**
1	July 21- August 21, 2009	Tuesday – Saturday 10:00pm - 5:00pm Sunday 1:00pm – 5:pm	Fairmount Water Works Interpretive Center, Philadelphia
2	July 20 -24, 2009	Monday – Friday 10:00am - 1:00pm	Northern Liberties Community Center, Philadelphia
3	July 27-31, 2009	Monday and Wednesday 12:00pm - 8:00pm Tuesday, Thursday and Friday 10:00am – 5:00pm	Walnut Street West Library, Philadelphia
4	August 3-7, 2009	Monday – Friday 7:00am - 9:00pm	Waterview Recreation Center, Philadelphia
5	August 10-14, 2009	Monday – Friday: 9:00am - 9:00pm	Columbus Square Recreation Center, Philadelphia
6	August 17-21, 2009	Monday – Thursday: 9:00am - 9:00pm Friday: 9:00am – 6:00pm	Parkway Central Library, Philadelphia

6. Green City, Clean Waters Advisory Committee: The Advisory Committee is comprised of City and state environmental experts, as well as leaders of local, regional, and national environmental organizations. The committee guides the Public

Participation Program, by providing input to the Public Participation Program Team on the communication strategies, public information, and products and materials developed to ensure successful public participation. After the initial kick-off meeting, held in the fall of 2007, the committee met twice per year. The committee has not met again since August 2009, as the CSO LTCPU was submitted to the PA DEP and US EPA in September 2009. For a list and description of topics discussed during Green City, Clean Waters Advisory Committee meetings please refer to **APPENDIX C –PUBLIC EDUCATION & INFORMATION MATERIALS– TABLE 4.**

The representative organizations that serve on the Green Cities, Clean Waters Advisory Committee are listed in **TABLE II.G.1-6.**

Table II.G.1-3 Advisory Committee Organizations

Type of Group	Organization
Business	• Building Industry Association
Citizen Groups	• Northern Liberties Neighborhood Association • Passyunk Square Neighbors Association • Washington West Civic Association
Interest Groups	• Community Legal Services, Inc. • Delaware River City Corporation • Impact Services Corporation • PennFuture (Next Great City) • Pennsylvania Environmental Council • Tookany/Tacony-Frankford Watershed Partnership • Schuylkill River Development Corporation • Sierra Club
Regulatory Agencies	• Pennsylvania Department of Environmental Protection (DEP)
Local Government Agencies	• Fairmount Park Commission • Mayor's Office of Sustainability • Philadelphia Water Department

7. Public Meetings: Public meetings are held throughout the development of the LTCPU in order to keep the public apprised of the progress of the plan and to garner feedback on the plan. For the first series of public meetings, the event was held in three separate locations in Philadelphia in order to maximize the likelihood of attendance for the residents of the City. An information fair was also integrated into each meeting. The information fair included posters on CSO LTCPU-related projects, fact sheets and a rain barrel.

In order to drum up attention for the final round of public meetings, the Green Cities, Clean Waters Exhibit traveled throughout the City, educating the public and promoting the final round of public meetings. Along with the exhibit, Green Stormwater Infrastructure Program Fact Sheets were available.

The meetings and venue sites where the exhibit was hosted are listed in **APPENDIX C – PUBLIC EDUCATION & INFORMATION MATERIALS– TABLE 5.** Since the last LTCPU public meeting in August, 2009, one month prior to the final LTLCPU report was submitted to the PA DEP and US EPA, the meetings with the public have mainly been community meetings in the neighborhoods targeted for the Green Street projects.

8. Model Neighborhoods - In recent months, the Philadelphia Water Department has seen the desire for green stormwater infrastructure rapidly increase in demand by residents of CSO-impacted areas. Through PWD's Model Neighborhoods initiative, PWD has received approximately 750 signatures to date (from March – July 2009), from residents petitioning for Green Streets for their blocks. These residents want PWD to install green stormwater infrastructure on their block in order to help them serve as a model green neighborhood for the City. Currently, the demand for Green Streets is so high that it has exceeded PWD's implementation capacity. This initiative is a true testament to the overwhelmingly positive response the City is receiving from its citizens, regarding green stormwater infrastructure.

The Model Neighborhoods initiative began in January, 2009. It is the result of PWD's partnership with Citizens for Pennsylvania's Future and the Next Great City coalition, Fairmount Park, Pennsylvania Horticultural Society and a diverse number of civic representatives, among other City department staff and environmentally-minded partners. The goal of the initiative is to transform the neighborhoods of Philadelphia into model green communities that manage stormwater in innovative ways. These neighborhoods will showcase green stormwater infrastructure elements, such as street tree trenches, sidewalk planters, and vegetated bump outs/curb extensions through the Green Streets Program, and, flow-through planters, rain barrels and rain gardens through the Green Homes Program. These communities are going to become models for green stormwater infrastructure projects. The ultimate goal is to design projects that will manage stormwater runoff on one greened acre of each participating neighborhood. Design of the green stormwater infrastructure tools are currently in place.

The construction of the first Green Street took place over the past year, with an unveiling in June, 2010, in Passyunk at Columbus Square. The project is a series of sidewalk planters that manage street runoff. A partnership with the Christopher Columbus Charter School Green Club was formed through the process. The teachers and students of the club have agreed to adopt the planters.

The Model Neighborhoods program requires a great deal of public outreach in order to generate public awareness and enthusiasm for green stormwater infrastructure components. The civic partners representing each neighborhood are pivotal to the success of each community, as they initiate the grass-roots civic engagement process that leads a neighborhood to become considered for this program. **TABLE II.G.1- 9** lists the current neighborhoods that are being targeted for Green Streets and Green Homes projects.

Table II.G.1-4 Model Neighborhoods and Civic Partners

Location	Civic Partner
Passyunk Square	Passyunk Square Civic Association
Awbury/Cliveden	Tookany/Tacony-Frankford (TTF) Watershed Partnership
Northern Liberties	Northern Liberties Neighbors Association
New Kensington/ Fishtown	New Kensington CDC
North Philadelphia	Associación Puertorriqueños en Marcha (APM)
Lower Moyamensing	Lower Moyamensing Civic Association
Cobbs	Cobbs Creek CDC
Haddington	Haddington CDC

PWD has developed a Model Neighborhoods overview brochure and informational handouts on trees and laterals, along with other outreach materials **(APPENDIX C: TABLE 6)**. Photo simulations of green stormwater infrastructure elements have been created for each of the first three neighborhoods. The photo simulations depict a street before and after the implementation of green stormwater infrastructure projects, providing strong visuals to help residents better visualize a Green Street in their neighborhood. PWD also produced the Green Streets Community Orientation Packet. The document serves as a guide for Model Neighborhoods civic partners and included information to best prepare civic leaders reaching out to residents for Model Neighborhoods support. **FIGURE II.G.1-8** illustrates an example Green Street photo simulation set.

Before

After

Figure II.G.1-8 Example of Model Neighborhoods Photo Simulation Set (3rd and Brown Streets, Northern Liberties)

A number of Model Neighborhoods educational materials and programs have been developed with additional outreach tools currently in production. Fairmount Park has led a series of free walks in the Model Neighborhoods, titled "Tree Walk on Your Blocks" in Northern Liberties, Passyunk Square and Awbury/Cliveden. They have also offered a free environmental education program in schools and in recreation centers for children in the Model Neighborhoods. Fairmount Park has also produced a number of informational fact sheets and handouts, regarding tree care and maintenance. **APPENDIX C: TABLE 6** lists examples of the Model Neighborhoods education materials.

Below is a description of the Model Neighborhoods Fairmount Park Outreach Program.

Public Programs & Walks
2009 thru 2010
A variety of innovative programs and walks focusing on the importance of neighborhood trees to capture storm water runoff and beautify streets and neighborhoods were offered to community members in both model neighborhoods and Pennypack and Wissahickon watersheds.
Programs: *Street Tree Walk; Tree Walk on Your Block; Living Streamside-Backyard Buffer; After the Rain Tour; Green Street Stroll; Wissahickon/Schuylkill River Watershed Walk; Tree Crafts & Walk; Back to our Roots-Poquessing Watershed Day; Clearview Street Block Party/Energy Fair; Clean Land/Clean Water-Exploring Columbus Square (future program).*

- 11 program offerings
- 207 participants

Summer 2009 children's program series for model neighborhoods
Summer 2009
Three exciting programs focusing on water and the importance of trees were offered to library, church, and Philadelphia Department of Recreation summer camps located in the model neighborhoods.
Programs: *H2O and You; Trees Are Terrific; Stepping into Nature.*

- 3 program offerings
- 34 programs taught
- 1,266 children and adults (contact times)

"All About Water & Land" program series for model neighborhood schools
Fall 2009 – Spring 2010
A series of five water-related programs were offered to Philadelphia public, charter, private, and parochial schools located in the model neighborhoods.
Programs: *Philadelphia Watersheds: a first look; Schoolyard Watershed Walk; Watershed Walkabout: the connection of land and water; Where the Dirty Water Goes!; From Street to Stream: slow the flow.*

- 5 program offerings
- Grades 3 thru 6 (primarily 4, 5, 6)
- 19 schools reached
- 160 classes taught

- 3,674 students and teachers (contact times)

"Pennypack/Poquessing Watershed Partnership" program series for schools
Fall 2009-Spring 2010
A series of six watershed-related programs were offered to four schools located near Pennypack Creek.
Programs: *Exploring the Natural Water Cycle: watersheds as landforms; Using Maps to Explore Landforms around Your School; Understanding the Watershed: making a 3-D Neighborhood Model; Environmental Factors Affecting Pennypack Creek; Macroinvertebrates in Pennypack Creek.*

- 6 program offerings
- Grade 6
- 4 schools reached
- 28 classes taught
- 861 students and teachers (contact times)

Teacher Celebration Spring Party
May 7, 2010
An evening event at the Fairmount Water Works Interpretive Center was held to thank and honor schools and teachers who participated in the *All About Water & Land* program series for model neighborhood schools.

Summer 2010 Clean Land, Clean Water summer children's program series for model neighborhoods
Summer 2010
A summer series of four water-related programs were offered to library, church, and Philadelphia Recreation Department summer camps located in the model neighborhoods.
Programs: *Greener Bubbles; Trash Toss; Big Tree Bingo; and Where Does the Water Go?*

- 4 program offerings

Stepping into Nature! Summer program
Summer 2010
A discovery walk along Fairmount Park's wooded trails at Wissahickon and Pennypack Environmental Centers was offered to Philadelphia Recreation Department summer camps throughout the city. Campers learned why clean streams are so important.
1 program offering

GREEN NEIGHBORHOODS THROUGH GREEN STREETS SURVEY

"How beautiful everything is! 100% behind this effort in all ways!" - Response on the Philadelphia Water Department's "Green Neighborhoods through Green Streets Survey." The question asked, "*Are you in favor of greening?*"

PWD developed a qualitative survey titled, Green Neighborhoods through Green Streets. The purpose of the survey was to understand how the targeted audience (City residents) feels about green stormwater infrastructure elements, such as Green Streets (e.g., likes and dislikes), and to get the survey-taker to start thinking about green stormwater infrastructure in Philadelphia neighborhoods through images. This makes the survey an educational tool, as well as serving as qualitative research. Figure II.g-9 shows a sample question from the Green Neighborhoods through Green Streets Survey.

Over 92 percent of the approximately 734 survey respondents responded positively to the green stormwater infrastructure approach. A longer on-line survey was posted on City and partner websites, in addition to a Philadelphia Water Department- hosted Facebook page, partner sites and other websites. Representatives from every zip code in the City (except for one) participated in the survey. **TABLES II.G.1-5 & 6** show sample survey results (March – August, 2009).

After viewing each set of images below, are you in favor of greening in your neighborhood?

- □ Yes
- □ No

a) What do you like about the images?
b) What don't you like about the images?

Figure II.G.1-9 Green Neighborhoods through Green Streets Survey Sample Question

Table II.G.1-5 Green Neighborhoods through Green Street Survey - Typical Responses

	On-line	Hardcopy	Overall
Likes	Most respondents stated that they were in favor of greening. Popular quotes: "trees and plants add beauty to the block" and "it makes the neighborhood more safe and more inviting"	Respondents generally are in favor of greening. Popular quotes: "we want more trees" and "greening makes the block more attractive"	92% responded positively towards greening
			15% specifically mentioned that greening will "beautify" the neighborhood
			14% specifically stated that they "want more trees" and "liked/ loved trees"
Dislikes	Most popular comments: "who will maintain this?" and "limited space available for greening on some sidewalks"	Most popular concerns: "trash and foliage come with greening" and "damage to sidewalks, home foundations or pipes due to tree roots"	23% of the respondents are worried about maintenance-related issues
			60% have concerns about greening
Total Responses	438	296	734 (Total)

Table II.G.1-6 Green Neighborhoods through Green Streets Feedback

Survey Quotes
Amazing; I think it's a no-brainer!
Bring it on... beautifying the neighborhoods, making better use of public space -- brings communities together, etc.
Greening makes the world a better, happier place.
All of it. More trees & green!
How beautiful everything is! 100% behind this effort in all ways!
I LOVE IT - what a great plan!
I love the idea! Please give us a greener Philadelphia. It would make us healthier and happier all around.
I strongly support it. In addition to what it does for storm water, it's prettier, shadier, and people are less likely to throw trash on it.
Yes, yes, a thousand times yes! We need more street trees. The corner bump-outs with trees would be WONDERFUL for overall look-and-feel in the neighborhoods (and the traffic calming benefits would be nice as well. I'm not sure where the second set of photos is, exactly, but it would be a nice improvement.
Love that there would be shade along the sidewalk, especially during the summer months when I am walking with my kids. The trees and green areas make the places seem more welcoming. And the fact that it would help with stormwater runoff is a real plus!
I LOVE THE GREEN NEIGHBORHOODS... GOOD ENERGY...A VIBRANCY... A POSITIVE FEEL!
"AFTER" images - the street views look fresher & softer; more friendly & vibrant. They indicate a community where the residents are glad to be living.
Things are prettier, more sustainable, shows community pride, [and] make the city beautiful.
Everything!!! Increase worth of home, cleaner air, calmer environment, shade in the summer.
What's not to like? It's a no-brainer.
I love plants, trees and greenery. I feel more at peace near nature.
I'm a big greening advocate do I'm totally on-board with all of these project proposals.
This work needs to be done in all neighborhoods.

GREEN STORMWATER INFRASTRUCTURE TOURS

The Philadelphia Water Department regularly offers tours to highlight local examples of green stormwater infrastructure. **APPENDIX C: PUBLIC EDUCATION & INFORMATION MATERIALS – TABLE 7** lists the tours held in 2008 and 2010.

II.G.2 Continue to Maintain Watershed Management and Source Water Protection Partnership Websites

II.G.2.1 Phillywatersheds.org / phillyriverinfo.org

OOW launched its new website, www.phillywatersheds.org, which will act as a hub for all of the related OOW and partnership websites. The website features content from all of the groups within OOW, educational tools, public meeting materials, maps and most of the reports currently available on Phillyriverinfo.org. The website also documents what issues are currently problematic for the City's watersheds, what PWD is doing to address these issues, and what citizens of Philadelphia can do to help improve watershed health.

One of the most exciting features of the website is interactive mapping. These maps are based off of the freely available, and popular, Google Maps API. Maps are available for green stormwater infrastructure projects, traditional infrastructure projects, waterways restoration projects, and community partnership projects. There are also maps available for each of the seven major watersheds within Philadelphia.

One of the main uses of the mapping system is the Combined Sewer Overflow Public Notification System, known as CSOcast. CSOcast shows CSO outfall overflow information that is retrieved from PWD's sewer monitoring network. The map is available 24 hours a day and displays the most up-to-date data available. A SWMM model was added to the CSOcast system to function as a check for the sewer monitoring data.

The new website has a section for the Rain Barrel Workshop site. This site allows citizens to register for PWD's rain barrel workshops and to find out more information about rain barrels. It also features a map showing the locations of the all the rain barrels that have been given out through the workshop program. The site has been used successfully for numerous workshops and has received great feedback from the community.

The website also contains working pages for all the watershed partnerships. These pages allow the partnerships to post meeting materials, future meeting notices, and other partnership information.

PWD is gradually phasing out its older website, phillyriverinfo.org, but that site does still contain some pertinent information.

II.G.2.2 Rivercast

RiverCast is the first operable web-based recreational warning system in the United States. Using real-time flow, precipitation, and turbidity data, RiverCast predicts bacteria levels within a section of the Schuylkill River heavily used by the public for swimming, rowing, and boating. RiverCast translates the predicted bacteria levels into one of three ratings, each of which corresponds to suggested guidelines for recreation. High bacteria levels, for example, translate to a "red" rating, in which RiverCast advises against any direct or indirect contact with the river. Over 300,000 users have visited

RiverCast, which can be accessed at www.phillyrivercast.org, since it was first released in June 2005. RiverCast guidelines offer tools for the public to make informed decisions about recreation, and thus help protect the public against illnesses caused by bacteria. Ultimately, RiverCast will help ensure continued recreational use of the Schuylkill River, while promoting public awareness of water quality concerns and indirectly engaging support for source water protection measures.

II.G.2.3 Schuylkill Action Network

Philadelphia is the furthest downstream city in the Schuylkill River watershed, which provides a source of drinking water for Philadelphia residents. The primary source of impairment of the Schuylkill watershed is stormwater, which accounts for 273 of its 1,000 total impaired stream miles. The majority of these impaired stream miles are within and just outside Philadelphia. A preliminary restoration analysis found that it would cost approximately $288 million to design and reconstruct all impaired stream miles through natural stream channel design. The Schuylkill Action Network (SAN) Stormwater Workgroup was formed to identify a cost-effective approach to stormwater management through project prioritization and planning. The workgroup is a partnership of representatives from the Philadelphia Water Department, Pennsylvania Department of Environmental Protection, conservation districts, watershed organizations, municipalities, and others groups throughout the watershed. The SAN Stormwater Workgroup's ultimate goal is to maximize reduction and/or prevention of stormwater runoff pollution.

Publicly owned lands (including schools, parks and golf courses) represent an important potential resource for addressing stormwater in the Schuylkill watershed, and are a significant focus for the SAN Stormwater Workgroup. The SAN Stormwater Workgroup identified the largest landowners in the Schuylkill watershed in order to reach the most people and make the biggest impact. Selected landowners include 61 school districts, each with several campuses, and golf courses with lands comprising 11,600 total acres located along 43 stream miles. As of 2009, with the help of a $1.15 million grant from the EPA, the workgroup implemented best stormwater management practices at seven of these priority lands while raising several hundred thousand dollars of additional funds for continued action on priority lands.

One of the key tasks of the SAN Stormwater Workgroup has been to collaboratively address stormwater issues by targeting municipalities located in Berks, Montgomery and Chester counties – areas with significantly impaired streams due to stormwater. The workgroup assisted these municipalities in adopting consistent stormwater ordinances, developing Environmental Advisory Committees and conducting other activities beyond what is required under current regulations.

In order to communitcate with SAN's Stakeholders about accomplishments of the SAN Stormwater Workgroup, the SAN is routinely updating their website. The SAN website has been redesigned by a web consulting firm with input from PWD and the SAN Planning and Education and Outreach committees. The website, www.schuylkillwaters.org, includes an internal component that allows for improved communication among SAN workgroup members and to facilitate on-the-ground work. It also includes a public component that conveys SAN's message about protecting and improving the Schuylkill River to outside audiences. The SAN website, together with phillyriverinfo.org, has taken the place of the Source Water Assessment Program websites in providing data and reports from the source water assessments for the Schuylkill River.

Other accomplishments of the SAN Stormwater Workgroup include:

- Mapping MS4 areas, PA Act 167 plan developments, and stream impairments due to stormwater contributions to identify priorities and coordinate a strategy with the SAN Education/Outreach Workgroup for MS4 outreach to municipalities. Through the municipal outreach prioritization process, partnerships between workgroup members have been strengthened and the group has begun to explore new ways to potentially improve stormwater management in the watershed, such as implementing watershed-wide Act 167 planning and developing stormwater authorities.

- Working closely with Villanova University to develop and implement the Stormwater Symposium, presented in September 2005 at Villanova University.

- Working closely with PADEP to investigate the feasibility of a watershed-wide Act 167 plan, to review and provide input on DEP's new stormwater model ordinance, and to develop ideas for a collection of demonstration BMPs for the SAN website.

- Working closely with PADEP to provide assistance and support for MS4 program administration and BMP education.

- Providing support and input for Environmental Advisory Council development in key municipalities in the watershed.

- Providing input into the Environmental Finance Center's efforts to cultivate new stormwater financing solutions.

- Developing outreach to Homeowners Associations and municipalities regarding stomwater management.

The Schuylkill Action Network (SAN) website has been redesigned by a web consulting firm with input from PWD and the SAN Planning and Education and Outreach committees. The website, www.schuylkillwaters.org, includes an internal component that allows for improved communication among SAN workgroup members and to facilitate on-the-ground work. It also includes a public component that conveys SAN's message about protecting and improving the Schuylkill River to outside audiences. The SAN website, together with phillyriverinfo.org, has taken the place of the Source Water Assessment Program websites in providing data and reports from the source water assessments for the Schuylkill River.

II.G.2.4 Early Warning System

Background

The Delaware Valley Early Warning System (EWS) is an integrated monitoring, notification, and communication system designed to provide advanced warning of surface water contamination events in the Schuylkill and lower Delaware River watersheds. The EWS was developed in 2002 with funding provided by the Pennsylvania Department of Environmental Protection (PADEP) and the United States Environmental Protection Agency (USEPA) and was deployed as a fully functional system in 2004 PWD initiated the development of the EWS after identifying the need for such a system while collaborating with upstream treatment plant operators during completion of the Source Water Assessments for the Schuylkill and Lower Delaware Rivers between 1998 and 2000. The Delaware Valley EWS covers the entire length of the Schuylkill River as well as the Delaware River from the Delaware Water Gap to just below Wilmington, Delaware.

The EWS is comprised of 4 principal components; the EWS Partnership, the notification system, the monitoring network, and the web-based database and portal. The EWS Partnership is comprised of stakeholders and includes representatives from both public and private drinking water treatment plants in the coverage area, industries who withdraw water from the Schuylkill and Delaware rivers for daily operations, and representatives of government agencies from both PA and NJ. The notification system includes both automated telephone notification and web-based notification capabilities. The monitoring network is comprised of on-line water quality and flow monitoring stations located at USGS sites and water treatment plant intakes throughout both watersheds. The web-site and database portal are the backbone of the EWS and are fully integrated with the notification system and monitoring network. Each aspect of the system is discussed in more detail below.

The telephone notification system is a powerful tool that allows a caller to initiate emergency notifications to multiple recipients through a single call. The system accepts calls from emergency responders, water utility personnel, and municipal and industrial dischargers. The system records event information via touch-tone responses to a standard question and answer process, and makes telephone and email notifications to affected EWS participants. The recent integration of the CodeRED emergency notification system allows outgoing calls to be completed in less than four minutes. This automated process reduces the burden on emergency responders and other information providers by providing multiple and redundant calls to system participants, while also reducing the possibility that a notification gets lost or mis-routed.

The EWS website provides a dynamic and interactive user interface to the EWS database, allowing users to access and share event and water quality information via the internet. Various user interface formats are available, including forms for reporting and viewing the details of a water quality event, maps to identify the location of an event, water quality graphs, and a time of travel estimator. The time of travel estimator uses real-time flow data from USGS gauging stations to provide plug-flow travel time estimates for each downstream intake based on current river conditions. These tools allow PWD and the other water purveyors within the Schuylkill and Delaware River watersheds to be more informed about water quality throughout the watershed and thereby better prepared to react to changing or emergency conditions.

The water quality monitoring network compiles both near real-time and historic water quality data. The near real-time network utilizes continuous water quality monitors that are located at select water treatment plant intakes and USGS gauging stations. The network transmits data collected at those locations to the EWS server, thus making the data accessible via the website. The water quality monitoring network provides water suppliers with near real-time information about water quality upstream of their intakes so that they can anticipate changes in water quality and adjust their treatment accordingly. Real-time monitoring is currently limited to simple water quality parameters such as turbidity and pH, but the network will be expanded in future years as monitoring technologies advance and as other monitoring needs are identified. In addition to the near real-time data, utilities will submit the results of their routine operational monitoring, creating a historical database against which real-time data can be compared. The system has the potential to incorporate sophisticated monitoring equipment like gas chromatographs and bio-monitors that can detect changes in water quality that might result from major discharges or intentional contamination.

One of the unique features of the Delaware Valley EWS is that the system operates essentially unmanned. Once an event is reported via telephone or the Internet, the system will automatically perform the time-of-travel estimations, and notify downstream users. System users can then report updates and additional information on the website as the event develops. In order to further strengthen the monitoring and notification capabilities of the EWS, PWD recently implemented the following system enhancements:

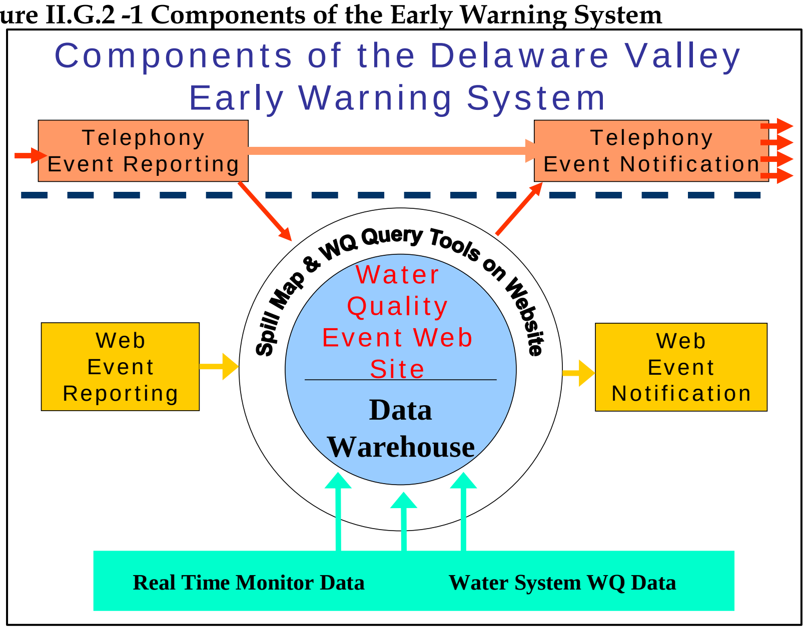
- integrating industrial users with intakes into the EWS partnership and designing an industrial user fee based on withdrawal and position in the watershed;
- adding the City of Philadelphia Office of Emergency Management (OEM) as an EWS member as part of a pilot expansion of the EWS partnership to include county OEMs;
- creating the Spill Model Analysis Tool which allows users to test the travel time of a spill without generating an event that notifies other users. This effort included incorporation the National Hydrologic Data stream network into all EWS mapping functionality, resulting in more accurate calculations of spill paths and travel times;
- creating a simplified report, making it easier for users to supply hazard information;
- adding a confidentiality disclaimer to all emails generated by the EWS; and,
- adding telephone testing to existing administrator tools and allowing users to subscribe or unsubscribe to telephone notifications generated by test events.

In addition to the above changes, PWD is currently in the process of developing a 5 year Strategic Plan for the EWS. Through the strategic planning process, PWD is evaluating the system's core functions, user base, and potential funding sources. Upgrades that are currently being considered include development of a tidal spill model for the Delaware River and programming changes that require switching the EWS GIS infrastructure to ESRI ArcGIS.

Early Warning System Protocol

The EWS can be used to fulfill several different source water protection needs. First and foremost, it is a communication and notification system that emergency response personnel and water suppliers can use to share information about source water contamination events. Second, it provides access to water quality data throughout the watershed thus alerting water suppliers to a change in water quality long before it reaches their intake. In the future, dischargers will be encouraged (preferably required) to use the EWS to make downstream notifications of overflows, spills and accidental discharges. The technical features of the EWS are illustrated in **FIGURE II.G.2.4 -1** and described in detail below.

Figure II.G.2 -1 Components of the Early Warning System



Emergency response personnel and water suppliers often observe a water quality event or are notified by the public. A water quality event can be anything from a transportation accident, to a fire, sewage overflow, or illegal dumping which results in a discharge to the river or sewer system. Upon being made aware of and confirming an event the responding party can use the EWS to notify downstream users by calling the EWS telephone notification system or by reporting the event to the EWS website (www.DelawareValleyEWS.org). In reporting the event, the responding party will supply information about the time, location, risk level, cause, and result of the event. The EWS uses the location information to identify the appropriate parties to notify. The system currently determines whether the event occurred in the Schuylkill or Delaware watershed and notifies all participating water suppliers, emergency response personnel and agencies within that watershed. In the near-future, the system will use location information to identify and notify only those participants downstream of the event. Notifications are made by phone for high risk events or by email for lower risk events (additional flexibility for notifications is a future goal of the system). If a telephone notification is delivered, the notification consists of a standard message that informs the recipient that a water quality event has occurred followed by specific information about time and location of the event and, if available, a message from the reporting party. If an email notification is sent, the email message contains critical information including the time, location and description of the event, and advises the recipient to go to the web-site for additional information. The recipient of the notification will then either call the telephone system or log onto the website to receive more information. The web-site will have an event report with all of the information that the responding party provided. The web-site also has a time-of-travel estimator that uses real-time USGS flow data to estimate the time at which the contaminant will arrive at downstream intakes. Downstream water suppliers can also access water quality data associated with the event. The water suppliers can use the time-of-travel and water quality information to plan their response strategies. As the event progresses, the information provided on the web-site can be updated by the initiator of the report or by other participants as they learn more about the event. In this way, the water supply community can communicate and be kept abreast of the event as it unfolds. All of this information exchange occurs in a secure environment.

The EWS water quality monitoring network collects continuous water quality data from select drinking water intakes along the main stem Delaware River and transmits that information to the EWS server, thus making it available to the EWS participants via the EWS web-site. Currently, there are twenty participating water utilities and fourteen participating industries in the EWS monitoring network**.** EWS users can log on to the EWS web-site on a daily basis to see water quality information from the monitoring locations, which span from Easton, Pennsylvania to Philadelphia. The EWS monitoring network currently consist of 8 water quality monitoring stations and 87 USGS sites. Access to this data allows water suppliers to identify changes in water quality associated with both natural and accidental contamination events. For example, storm events and algae events are two naturally occurring events that will impact the water treatment process. Fortunately, both are easily identifiable using simple on-line monitors like turbidity and pH. A downstream utility can track changes in these water quality parameters and gather the information necessary to gauge if and when water treatment process modifications need to be initiated. Similarly, significant accidental spills to the river may be detected through changes in pH or conductivity. In essence, the EWS water quality monitoring network enables water suppliers to be more proactive, rather than reactive, when it comes to responding to changes in water quality.

PWD worked closely with PADEP's Emergency Response team in the development of the EWS. During this process both PWD and PADEP agreed that one of the mutual goals of the system is to have dischargers add the EWS to their downstream notification list. In this way PWD could insure that downstream water suppliers receive information about overflows, spills and accidental discharges. PWD has been in the process of working with PADEP to meet this goal, which may eventually necessitate PADEP incorporating the EWS into the dischargers' permit requirements. If such a requirement is implemented, the notifying discharger would call the EWS telephone system or enter the event into the EWS web-site to initiate downstream notifications. Having dischargers contact the EWS directly will increase the number and geographic diversity of downstream notifications with just a single phone call.

The Delaware Valley EWS has tremendous potential to reduce the time in which water suppliers become aware of and react to water quality events of all kinds. The system is a tool designed to help water suppliers respond to accidental, natural, and deliberate water contamination events that cannot be prevented by standard source water protection measures. In this way, the EWS is a perfect complement to a well developed source water protection program.

II.G.3 Continue to Provide Annual Information to City Residents about Programs via Traditional PWD Publications

II.G.3.1 Billstuffers and Waterwheel Watershed Newsletters

Please refer to **SECTION II.G.1 "CONTINUE TO DEVELOP AND SHARE A VARIETY OF PUBLIC INFORMATION MATERIALS CONCERNING THE CSO LTCP"** on page 45 for information on this section.

II.G.3.2 Additional PWD and Partner Sponsored Events

PA Coast Day

The Philadelphia Water Department along with Partnership for the Delaware Estuary and Pennsylvania DEP Coastal Zone Management Program sponsored the 8th Annual Southeastern Pennsylvania Coast Day on Sunday September 20, 2009. Due to the tremendous success the previous year, the event was again advertised to every resident of Philadelphia through a flyer inside the monthly water bill. The same promotional piece was also placed at nearby hotels, museums and various other public places to promote the day, along with newspaper print advertising. The event was held at Penn's Landing, on the Delaware Riverfront with a record breaking attendance. In all, over 25 local and regional organizations took part, providing educational and interactive displays for Coast Day visitors. 1,070 people participated in enough activities at the various organizations' booths to qualify for prizes in the Clean Water Challenge.

The event also featured music, food, face painting, and crafts for kids. This year we added a third "Ride the Ducks" boat, which took 36 people every half hour on an adventure on the Delaware River. A total of 965 children and adults (many of which had never been on a boat) got to experience Philadelphia from the River's perspective. Furthermore 60 people also got to try their hand at paddling a kayak in the nearby marina. In addition to all of the activities taking place at Coast Day 550 people visited the neighboring Independence Seaport Museum (significantly higher than usual attendance) as well as over 300 adults and children took a free shuttle to the Fairmount Water Works Interpretive Center. For more information on Coast Day visit: http://www.delawareestuary.org/news_coastday.asp

Philly FUN Fishing Fest

As a result of the revitalization of our region's rivers, PWD has witnessed the return of a variety of sporting fish to the Schuylkill River and believes that this good news is worth spreading. In celebration of the improving water quality, the Philadelphia Water Department and its partners, the Fish and Boat Commission and the Schuylkill River Development Corporation – has hosted the annual Philly FUN Fishing Fest on the banks of the Schuylkill River. The event takes place in September every year. In 2009, over 200 individuals participated and approximately 65 fish were caught during the tournament.

The fishing festival is open to the public - all skill levels and ages. Prizes from various local sponsors are provided to the winners of various categories. Fishing instruction is provided by volunteers, while fishing rods are on loan and bait is donated. The event does not require a fishing license and it is free of charge.

The Fishing Fest is an effective means to educate the public on the improving water quality and aquatic resources the City offers. For more information on the Philly Fun Fishing Fest, please visit: http://www.phillyriverinfo.org/fishingfest/.

Protect Philadelphia's Hidden Streams Art Contest

The Partnership for the Delaware Estuary and Philadelphia Water Department sponsored its eleventh art contest for Philadelphia public, private and home-schooled students, grades K-12 in January 2010. Students were asked to create an original piece of artwork that shows how Philadelphians can help prevent stormwater runoff pollution. Or, participants could create an original 30-second video showcasing what pet waste does to our water and how pet owners can help by picking up after their pets. Winning artwork was used to promote pollution prevention messages on SEPTA buses, in the creation of a calendar, and will be featured at the Philadelphia International Airport's Youth Art Gallery beginning in January 2011. Along with the drawings, the calendar also provided monthly tips to help prevent water pollution. This year there were nearly 1400 drawings and videos entered into the contest, with over 20 classrooms and several home school students participating. An awards ceremony was held in April at the Fairmount Water Works Interpretive Center. Winning artwork and videos can be viewed at http://www.flickr.com/photos/delawareestuary/sets/72157623604536211/.

Stormwater Best Management Practices (BMP) Recognition Program

In 2005, PWD and partners developed the Stormwater Best Management Practices Recognition Program to recognize developers, engineers, architects, and others that are designing and implementing innovative and environmentally-friendly stormwater BMPs in southeastern Pennsylvania. Projects, such as rain gardens, green roofs, infiltration swales, and treatment wetlands - stormwater management systems based on nature's best designs are recognized to provide inspiration for future similar projects in the region. The number of submissions has grown steadily every year. Approximately 80 submissions have been received to date. The awardees are listed in **TABLE II.G.3-1**

A certificate is distributed to each awardee to recognize their good work. Each certificate recipient is also provided with an opportunity to present their awarded project at an event, such as the Urban Watersheds Revitalization Conference. The recognized projects are promoted in the PWD Water Wheel newsletter, distributed to over a half million residents and businesses in Philadelphia and on the website (http://www.stormwaterbmp.org).

Table II.G.3-1 Projects recognized through the Stormwater BMP Recognition Program in 2009-2010

Project Name	Awardee
Spring-Ford High School Basin	Montgomery County Conservation District
Mayfield Estates Basin	Perkiomen Watershed Conservancy
The Friends Center Green Roof & Stormwater Reuse	UJMN Architects
PECO Green Roof	PECO
Upper Perkiomen High School Basin & Rain Garden	Upper Perkiomen High School
Herron Playground Permeable Sufaces & Basins	Philadelphia Division of Public Property and Langan Engineering & Environmental Services
Cliveden Park Bioswales & Rain Gardens	Pennsylvania Horticultural Society
Pennswood Village Basins, Swale, Wetland & Pond	Wells Appel
Upland Square Shopping Center Rooftop Capture, Wet Pond & Channel Restoration	Nave Newell
Springside School Rain Garden	Springside School

Urban Watersheds Revitalization Conference

"The conference was one of the best I've been to in 25 years. Such a wide cross-section of people but all of us focused on the same city-improving agenda. Thanks for your efforts in making it happen."

- Comment from 2008 "Greening Our Streets" conference participant

Since 2005, the PWD, along with its partners, has hosted a conference, titled the Urban Watersheds Revitalization Conference. The event gives PWD an opportunity to explore current watershed-related themes that are relevant to the City of Philadelphia and the suburban communities that drain to the City. The conference is held at different locations and it targets the urban and suburban (or mostly developed) communities in southeastern Pennsylvania. The audience is diverse – comprised of local planners, engineers, municipal representatives, community activists, among others. The event is offered at a nominal fee or it is free of charge. Details on the past two conferences are listed in **TABLE II.G.3-2.** The next conference is planned for October, 2010.

Table II.G.3-2 2007 & 2008 Urban Watersheds Revitalization Conference

Urban Watersheds Revitalization Conference		
Conference Theme:	Greening Our Streets	Stormwater Management Regulations & Requirements
Date:	October 31, 2008	May 3, 2007
Time:	8:30am - 3:30pm	8:30am - 3:30pm
Location:	The Great Hall, Community College of Philadelphia, Spring Garden Street, Philadelphia	Kanbar Center, Philadelphia University, School House Lane, Philadelphia
Number of participants:	175	131
Result:	Many participants remarked on it being a very successful conference (see above quote).	Feedback from the participants was positive.
Promotional Material:	View Supplemental Volume 1	View Supplemental Volume 1

Educational Publications

a. Kids Let's Learn About Water Activity Booklet

One of PWD's most successful community publications is the student activity book (grades 3 – 8) "Let's Learn About Water". This publication develops the concepts of definition of a watershed, impact of non-point source pollution, and personal responsibility for protecting our water supply. It is in great demand by schools, communities and government officials. This book was developed with the Partnership for the Delaware Estuary and was funded in part through DEP Coastal Zone Management funds. The curriculum has already been used in a number of middle schools to meet state required science-based credits. In 2005, the Activity Booklet was updated and made full color. The FWWIC was also highlighted in some of the activities to encourage students to visit with their families. The booklet has been reprinted several times including 20,000 in 2008. During FY 2009 the pages of the activity booklet were clicked on 149,043 times on http://www.delawareestuary.org/pdf/ActivityBooklets/philly/pwd_activity_booklet.pdf for download.

b. Kids Schuylkill River Watersheds Maps

In FY 2007, a fold out map of the Schuylkill River Watersheds was created, printed, and inserted into the activity book whenever it is being used by students who live within that watershed. In addition to the Schuylkill Watershed Map, a map was created of the City of Philadelphia showing all of its sub watersheds and the schools located in those watersheds. This has also been a highly demanded piece by teachers. Both are still being distributed upon request.

c. Homeowner's Guide for Stormwater Management & Campus Guide to Stormwater Management

In 2004, PWD staff developed Philadelphia's first *Homeowner's Guide to Stormwater Management*. The document targets homeowners and residents that want to take an active role in helping to transform their properties and communities into healthier components of the watershed through environmentally-friendly stormwater management. The guide lays out specific steps and actions homeowners or community residents can take to improve stormwater management on their properties and in their communities.

In 2007, PWD developed a PowerPoint presentation titled "A Homeowners' Guide to Stormwater Management" to accompany the guide. This presentation was given on September 27, 2007 at the North Wales Borough Hall (Wissahickon Watershed).

Information from the Homeowner's Guide was later used to create a Campus Guide to Stormwater Management. Both of these guides provide comprehensive information for property owners to reduce the amount of stormwater runoff pollution entering local waterways from their properties.

d. Delaware Estuary Water Education Resource Guide

A directory for educators that lists materials and programs available through local non-profit organizations and governmental agencies on topics relating to water resources was updated and reprinted this year. Along with the 1500 copies that were printed and distributed, the directory is also searchable online at http://www.delawareestuary.org/pdf/ResourceGuides/2010_resource_guide.pdf. The goal of this directory is to provide teachers and other environmental educators with new ideas and resources for making environmental connections in the classroom.

e. Green Guide for Property Management

The Philadelphia Water Department (PWD) in cooperation with the Partnership for the Delaware Estuary and AKFR, Inc. just released the Green Guide for Property Management (http://www.phila.gov/water/Stormwater/pdfs/PWD_GreenGuide.pdf) a Green Business Program of PWD's Green City, Clean Waters initiative (http://www.phillywatersheds.org/what_were_doing/documents_and_data/cso_long_term_control_plan). The guide is intended for commercial property owners, providing them with ideas for reducing their stormwater fees through innovative green projects on their properties. Included in each PWD customer's monthly water bill is a charge for stormwater management services. Historically, this charge has been based on a property's water meter size, which measures the volume of drinking water being used by a property. Beginning July 1, 2010, the charges for non-residential and condominium properties will be based on a property's size and surface characteristics. More specifically, non-residential and condominium properties will be charged based on the total size of the property (known as "Gross Area") and the amount of land that doesn't allow water to soak into the ground. Land where rain and melting snow is unable to soak into the ground is referred to as "Impervious Area." Impervious Area includes

rooftops, concrete, asphalt, or any other surface where rainwater becomes polluted, runs off into storm drains, and burdens the City's sewer system. This guide is designed to assist owners who may be eligible for credits to reduce their stormwater fee. The guide can be downloaded from:
http://www.phila.gov/water/Stormwater/pdfs/PWD_GreenGuide.pdf. In addition to being available online 5,000 guides were printed for distribution in FY 2011.

Smart Boating, Clean Waters Program

PWD initiated an outreach, education, and notification program for marinas, personal watercraft users, and boaters, titled the Smart Boating, Clean Waters Program. This program is led by the Coastal Nonpoint Pollution Program (CNPP) Specialists in the region and it is funded by the Coastal Nonpoint Pollution Program (CNPP) grant awarded by PA DEP. Most of the marinas, yacht clubs, boat launch ramps and fishing locations targeted for the program in Philadelphia are located near CSO outfalls on the Delaware River.

Various educational projects have resulted from the Smart Boating, Clean Waters Program. Projects, such as a water-proof brochure titled "A Boater's Guide to Clean Waters," and user surveys and interviews with marina and yacht club operators help to advise them how to best adopt more environmentally friendly operation and maintenance practices.

Bilge Socks

In 2005, PWD staff worked with CNPP Specialists in the region to develop a bilge sock program, developing a logo to place on the bilge sock, creating an instructional tag to attach to the sock, and distributing the socks to marinas and boaters in the region. In 2006, the bilge socks were distributed to all marinas and yacht clubs in Philadelphia. In 2007, PWD partnered with the U.S. Coast Guard in order for the Coast Guard to distribute the socks. The bilge socks were also distributed at Frankford Arsenal during Safe Boating Day in June, 2007. In 2008, PWD partnered with the Penn's Landing Corporation to also help distribute socks. The 2008 Safe Boating Day took place at Penn's Landing in June 2008 and 2009, where more bilge socks were distributed.

Monofilament Line Recovery & Recycling Program

In 2007, PWD worked with CNPP Specialists in the region to develop a Monofilament Line Recovery and Recycling Program for the southeast region of Pennsylvania. In 2008, Fairmount Park received recycling bins. They were distributed throughout the park in 5 popular fishing locations in the summer of 2008. In 2009, Fairmount Park continued to collect the line.

Aquatic Invasive Species Watch Card and Posters

Aquatic Invasive Species (AIS) pose a major threat to maintaining biodiversity, particularly in Philadelphia's wetlands, streams, rivers and lakes. Pennsylvania's aquatic taxa are some of the most imperiled, with many native freshwater mussels, crayfish, and fish listed as Pennsylvania's Species of Greatest Need of Conservation. In recognition of the risk AIS pose to biodiversity, the Pennsylvania Fish and Boat Commission identified management of AIS as a priority topic.

The Philadelphia Water Department Aquatic Invasive Species program has four major tasks:

1) Prevent the spread of AIS by city employees through adopted HAACP protocols,
2) Train city employees to identify AIS and report observations to department heads,
3) Public education and outreach regarding AIS, and
4) Establish a chain of communication for the public to report observations of AIS to the appropriate agencies.

Part of the public outreach portion of this program includes an exhibit on the topic of AIS at the Fairmount Waterworks Interpretative Center, which is free to the public. The posters and complimentary educational literature was created in 2007 and the exhibit was displayed in the summer of 2008. The complimentary literature - watch cards - will be distributed to boaters and other frequent water-way users, as well as to those visiting the Water Works Interpretive Center. The watch cards are wallet-size and water-proof. The invasive species watch cards and posters that were originally designed by Sea Grant have been updated by PWD with new text and additional logos. The materials continued to be distributed in 2009-2010.

Delaware Estuary Watershed Workshop for Teachers

The 14th Annual Teacher Workshop was held July 12-16 this summer in conjunction with the Partnership for the Delaware Estuary, Bucks County Conservation District and Brandywine Creek State Park. Twenty teachers participated in the week-long workshop. Workshop activities included canoeing the Brandywine Creek, visiting water quality BMP projects, performing chemical, physical and biological analysis on a stream, learning about wetlands, dissecting oysters, discovering Schoolyard Habitats, and much more. The Philadelphia Water Department hosted the teachers on tours of the Fairmount Water Works Interpretive Center, and Southeast Water Pollution Control Plant. This segment of the teacher workshop provided the participants with crucial information on the local waterways as a source of their drinking water and the process undergone to return the water in an acceptable condition. For more information on the teachers' workshop visit:
http://www.delawareestuary.org/acivities_teachers_watershed_workshop.asp.

Philadelphia Flower Show – PWD Exhibit

Many of Philadelphia's waterways are degraded due to flash flooding, pollution, and erosion. In March 2010, the Philadelphia Water Department designed an exhibit for the Philadelphia International Flower Show titled "Healthy Stream, Healthy City, Healthy World." The exhibit showcased how modern streambed restoration techniques mimic nature with the use of stone and native plants. These "Healthy Streams" reduce the risk of flooding, supply us with drinking water, and provide a rest stop for wildlife traveling to other parts of the world. Along with educational signage placed within the exhibit, a brochure with additional information was also available to over 200,000 attendees at the show.

Safe Boating Program

PWD initiated an outreach, education, and notification program for marinas, personal watercraft users, and boaters, titled the Smart Boating, Clean Waters Program. This program is led by the Coastal Nonpoint Pollution Program (CNPP) Specialists in the region and it is funded by the Coastal Nonpoint Pollution Program (CNPP) grant awarded by PA DEP. Most of the marinas, yacht clubs, boat launch ramps and fishing locations targeted for the program in Philadelphia are located near CSO outfalls on the Delaware River.

Various educational projects have resulted from the Smart Boating, Clean Waters Program. Projects, such as a water-proof brochure titled "A Boater's Guide to Clean Waters," and user surveys and interviews with marina and yacht club operators help to advise them how to best adopt more environmentally friendly operation and maintenance practices.

Annual Water Quality Report

Every year the PWD publishes an annual drinking water quality report. This report is mailed to every resident in the city and contains a wealth of information regarding the source, safety, and contents of the City's drinking water. This report is also available year-round on the City's website www.phila.gov.

Senior Citizen Corps (SEC)

The Water Department continues to work with the Senior Citizen Corps to address stormwater pollution problems and water quality monitoring programs for the Monoshone Creek, a tributary to the Wissahickon Creek and to the Tookany Creek. The SEC performs biomonitoring, collects water samples, and conducts physical assessments of the stream. The Water Department assists SEC efforts through the provision of municipal services, education about stormwater runoff and the department's Defective Lateral Program, and mapping services such as GIS. The Corps has also partnered with PWD on its Saylor Grove Wetland Demonstration Project, assisting with public education and outreach, and providing tours to local students since the fall of 2006. The SEC, in partnership with Chestnut Hill College, also began water quality monitoring at the Saylor Grove Wetland in the summer of 2006.

Water Quality Council (formerly Citizens Advisory Council, CAC)

In 2001, the Water Quality CAC was formed from a merger of the Stormwater and the Drinking Water Quality CACs. Over the past few years, source water protection had become more of a concern for drinking water quality. The Drinking Water CACs focus has been drawn naturally toward non-point source pollution, a focus traditionally undertaken by the Stormwater CAC. Finally, this merging of the two CACs complemented the PWD's, PADEP's and EPA's new approach to looking at and addressing water quality issues on a holistic basis. The Partnership for the Delaware

Estuary facilitates what is now referred to as the Water Quality Council meetings. New projects as well as updates for ongoing programs are presented to council members for feedback. Sometimes tours of the new projects are given as well. In FY 2010 the following topics were presented:

- Parcel-Based Stormwater Billing for Commercial Properties
- Green Projects for Commercial Properties
- Fairmount Fishway Update
- Columbus Square Stormwater Planters
- Cobbs Creek Restoration
- Seeing is Believing Educational Exhibit at FWWIC
- Lead in Drinking Water
- The R. E. Roy, Floatable Skimming Vessel

The committee consists of representatives from the following groups:

- Bucks Count Water & Sewer Authority
- Center in the Park - Senior Environment Corps
- Center in the Park / EASI
- City of Philadelphia – City Council
- Community Legal Services of Philadelphia
- Delaware River Basin Commission
- Drexel University - School of Public Health
- Drexel University - Environmental Studies Institute
- DVRPC
- East Falls Tree Tenders
- Friends of High School Park
- Friends of Historic Rittenhouse Town
- Friends of Poquessing Creek Watershed
- Friends of Tacony Creek Park
- MANNA
- New Kensington CDC
- Overbrook Environmental Education Center
- PA DEP
- PA DEP Water Supply Management
- PA Immigration and Citizenship Coalition
- Partnership for the Delaware Estuary
- Penn PIRG
- Pennsylvania Horticultural Society
- Pennypack Ecological Restoration Trust
- Pennypack Environmental Center
- Philadelphia Corp for Aging
- Philadelphia Department of Public Health
- School District of Philadelphia
- Schuylkill Navy
- Schuylkill River Development Corporation

- Southhampton Watershed Association
- Stroud Water Research Center
- Tookany/Tacony-Franford Watershed
- U.S. EPA, Region 3 - Water Protection Division
- Water Resources Association of the Delaware River Basin
- Wissahickon Charter School

II.G.4 Continue to Support the Fairmount Water Works Interpretive Center

The Fairmount Water Works Interpretive Center (FWWIC) is PWD's renowned education center, located on the banks of the Schuylkill River in Philadelphia. The Center tells the story of the Schuylkill River and its human connections throughout history. Innovative exhibits and interactive educational programs meld the history, technology and science, providing education on the many issues facing the regions' urban watersheds.

The mission of the Center is to: "educate citizens to understand their community and environment, especially the urban watershed, know how to guide the community and environment in the future, and understand the connections between daily life and the natural environment."

Teachers and students are invited on an adventure to explore Water in Our World at the Fairmount Water Works Interpretive Center. Students travel through time as they learn about the role of water in Philadelphia's past, present and future.

Innovative exhibits and interactive educational programs meld the history, technology and science of providing water to a regional urban watershed. Short descriptions of of the FWWIC programs follow.

<u>Education Programs</u>

Water in Our World
This general orientation to the Interpretive Center provides the perfect overview for the teacher focusing on a variety of water issues, past, present and future. Students are introduced to a variety of concepts and vocabulary using activity booklets in exhibits on the natural water cycle, watersheds, the water use cycle, land use and pollution. They also learn about their individual relationship to local, regional and global water quality issues on Planet Earth.

Land and Water: A Delicate Balance
Every day, people make choices about how they will use the land around them - often without considering how their use of land may affect the water they drink. Students come to understand the delicate relationship of land use to water quality through a matching card activity using the exhibits in the Interpretive Center. Students will also

study a variety of maps to understand the development of land over time, and then plan fictional communities of their own in a way that would protect water quality.

From Street to Stream: Slow the Flow

Students focus on stormwater runoff (one of the greatest sources of water pollution today), watersheds, and the different kinds of land pollution that affect our water quality - past and present. Students explore, on foot, the Water Works site and surroundings as a way to better understand the concepts of point- and non-point-source pollution. The lesson will also give students a look into the Philadelphia Water Department's demonstrations of best management practices for existing and future land development.

Seeing is Believing

The FWWIC's newest permanent installation is "See Is Believing." Grants from the Claneil Foundation, Connelly Foundation, Duffield Associates and individual donors underwrote the cost of laboratory equipment and internet connections to link students and visitors at the Interpretive Center's lab to Water Department scientists for real-time experiments and programs.

Fairmount Fish Ladder

The fish ladder at the Fairmount Dam, reconstructed by the Army Corps of Engineers, will officially open in the spring, to the delight of migrating species. A new outdoor classroom will allow visitors closer views of the shad and other migratory fish as they make their way upstream. For more information on the Fairmount Fish Ladder please refer to **SECTION III.C.2.5** on page 152**.**

Web-based Programs

A partnership with Global Education Motivators (GEM) and Internet for Educational Institutions (MAGPI) enable the FWWIC to offer lessons and programs in real time through video-conferencing technology. The FWWIC has connected with schools in Pennsylvania, Kentucky, New York, Paraguay and Mexico and the United Nation's office in Rome. In addition, the FWWIC has a two-year relationship with Community College of Philadelphia, hosting a two-day educational program as part of an environmental conservation class.

Weekends

Quiet moments are rare at the Interpretive Center. On weekends visitors enjoy Saturday family programs and the Sunday film series. The Schuylkill Soundings programs for adults bring authors, scientists, artists and the occasional musical group to the Interpretive Center. The Urban Shad Watch in March is a sure sign spring has come. Also in March, the FWWIC celebrates World Water Day.

Partnerships

The FWWIC partners with regional, national and international organizations to present innovative programs. Among them are the Pennsylvania Horticultural Society, Partnership for the Delaware Estuary, The United Nations Association of Greater

Philadelphia, Oliver Evans Society of Industrial Archaeology, Schuylkill River Greenway Association, Society of American Military Engineers, American Institute of Landscape Architects, Society for Environmental Graphic Designers, East Coast Greenway Association, Garden Workers of America, Institute for Collaborative Education, Schuylkill River National and State Heritage Area, Delaware River Basin Commission, The Philadelphia Water Department's Office of Watersheds, the Fairmount Park Council for Historic Sites, the Department of Environmental Protection and the Environmental Protection Agency.

Schuylkill Soundings
In 2006, the FWWIC began its Schuylkill Soundings program – a series of informative presentations on environmental projects, issues and challenges in the region.

Table II.G.4-1 2010 Schedule of Schuylkill Soundings Presentations at the Fairmount Water Works

Presenter	Date	Topic
Dr. Danielle Kreeger, PDE	February 17	Fresh Water Mussel Recovery in the Delaware Estuary – A Fundraiser for the Partnership for the Delaware Estuary (PDE)
Glenn Abrams	March 17	The Greening of Philadelphia through Sustainable Stormwater Management
Joe Perillo and Lance Butler	April 21	Bringing in the Shad and the Renewed Fairmount Dam Fishway
Gary Burtlingame	May 19	Safe Drinking Water – What's in your Tap? Understanding PWD's Consumer Confidence Report
Chris Crockett and Paul Kohl	June 16	PWD's Glass of Sunshine – Solar Energy Projects at Baxter and SEWPCP

Table II.G.4-2 2009 Fairmount Water Works Interpretive Center Visitors

2009 Fairmount Water Works Interpretative Center Visitors	
School Groups	154 classes, totaling 6,982 students
Special Exhibits	5,194
Special Events	2,549
Visiting Authors, Lecturers, Environmental Leaders	168
Community Programs	3,375
General Visitors	25,675
2009 Total Visitors	**39,068**

A breakdown of a sample of the programs follows:

Teacher Trainings:

- Aquatic Invasive Species
- Zebra/Quagga Mussels
- Global Passport to Clean Water

Special Exhibits:

- Delaware Estuary Calendar Art Exhibit
- Black History Month Exhibit
- Women in Science and Engineering Exhibit

Special Events:

- Philadelphia Global Water Initiative Reception
- World Water Day Celebration
- Urban Shad Watch

II.H Public Notification to Ensure that the Public Receives Adequate Notification of CSO Occurrences and CSO Impacts (NMC 8)

As discussed in **SECTION II.G.1** of this report, PWD has developed and will continue to develop a series of informational brochures and other materials about its CSO discharges and the potential affects of these discharges on the receiving waters. The brochures provide phone contacts for additional information. The opportunity to recruit citizen volunteers to check or adopt CSO outfalls in their watersheds (i.e., notifying the PWD of dry weather overflows, etc.) will be explored through the watershed partnership framework. Brochures and other educational materials discuss the detrimental affects of these overflows and request that the public report these incidences to the department. In addition, PWD has enlisted watershed organizations to assist in this endeavor. PWD will continue this focus to raise the level of citizen awareness about the function of combined and stormwater outfalls through a variety of educational mediums. The watershed partnerships will also continue to be used for this type of education.

II.H.1 Launch a Proactive Public Notification Program Using Numerous Media Sources

PWD is advancing a proactive public notification program that uses print, internet, outfall signage, and other media to distribute information on the locations of CSOs, information on hazards, and potential public actions.

The program consists of backgrounders, billstuffers, and waterwheels distributed to partners and the public. PWD's phillywatersheds.org acts as a hub for all OOW and partnership websites to inform the public about projects in the City's watersheds. The website also features CSOcast, a system that notifies the public of any overflows that occur in any of the City's 164 outfalls. RiverCast is another web-based system that forcasts the water quality of the Schuylkill River.

Please refer to **SECTION II.G.3 – "CONTINUE TO PROVIDE ANNUAL INFORMATION TO CITY RESIDENTS ABOUT PROGRAMS VIA TRADITIONAL PWD PUBLICATIONS"** on page 69 for additional information on PWD's public notification.

Please refer to **SECTION III.C.3.5 "INTERPRETIVE SIGNAGE"** on page 158 for information on the pilot CSO signage project.

Please refer to **SECTION II.G.2 "CONTINUE TO MAINTAIN WATERSHED MANAGEMENT AND SOURCE WATER PROTECTION PARTNERSHIP WEBSITES"** on page 62 for information on the web and telephone based Early Warning System for water suppliers and industrial users and OOW website development.

II.H.2 Expand the Internet-Based Notification System (Rivercast) to the Tidal Section of the Lower Schuylkill River

The Philadelphia Water Department developed a unique, web-based water quality forecasting system for the Schuylkill River called RiverCast (www.phillyrivercast.org). Based on real-time turbidity, flow, and rainfall data, it provides up-to-the-hour public service information on the estimated current fecal coliform concentrations in the river and the acceptable types of recreation based on those conditions. The system is designed to maximize accuracy while avoiding recommendations that suggest water quality is better than it is likely to be (avoidance of false positives). The Philly RiverCast is a forecast of water quality that predicts potential levels of pathogens in the Schuylkill River between Flat Rock Dam and Fairmount Dam (i.e., between Manayunk and Boathouse Row).

In order to expand RiverCast, the PWD has developed another internet-based notification system called CSOcast, which reports on the overflow status of outfalls in every CSO shed. The purpose of this notification system is to alert the public of possible CSOs from Philadelphia's combined sewer system outfalls. When a combined sewer outfall is overflowing, and up to a period of 24 hours following a rainfall event, it is unsafe to recreate in the water body due to possible pollutant contamination.

Instead of using water quality parameters to forecast conditions, CSOcast relies on a network of flow sensors throughout the city to notify the public when overflows are occurring. This public notification system is based on PWD analysis of monitoring network data which is used to determine the likelihood of combined sewer overflows. The PWD has maintained an extensive permanent monitoring network since 1995 including level sensors which record data throughout the combined sewer system. PWD currently operates and maintains monitoring equipment at, or near, the 164 combined sewer outfalls throughout the city. The data used to identify overflows is collected from PWD's extensive sewer monitoring and rain gage network. Data is processed in real time using common database software and Philadelphia's watershed and wastewater conveyance model, which was developed through U.S. EPA's Storm Water Management Model (SWMM). SWMM model output is used to validate flow monitoring data, ensuring a second level of accuracy. The data on the website is updated daily.

The website is built using the Google Maps API which allows for the dynamic loading of geographically referenced data that can be viewed with a familiar and user-friendly interface.

During the past fiscal year, CSOcast reported on all 24 rain gages and 147 monitors twice a day. The system failed to report in January 2010 when it was down for maintenance. The Philadelphia Combined Sewer Overflow Public Notification System is a pilot program. The PWD is constantly updating and improving the notification system as well as the flow monitoring network in order to deliver the best information possible to the public.

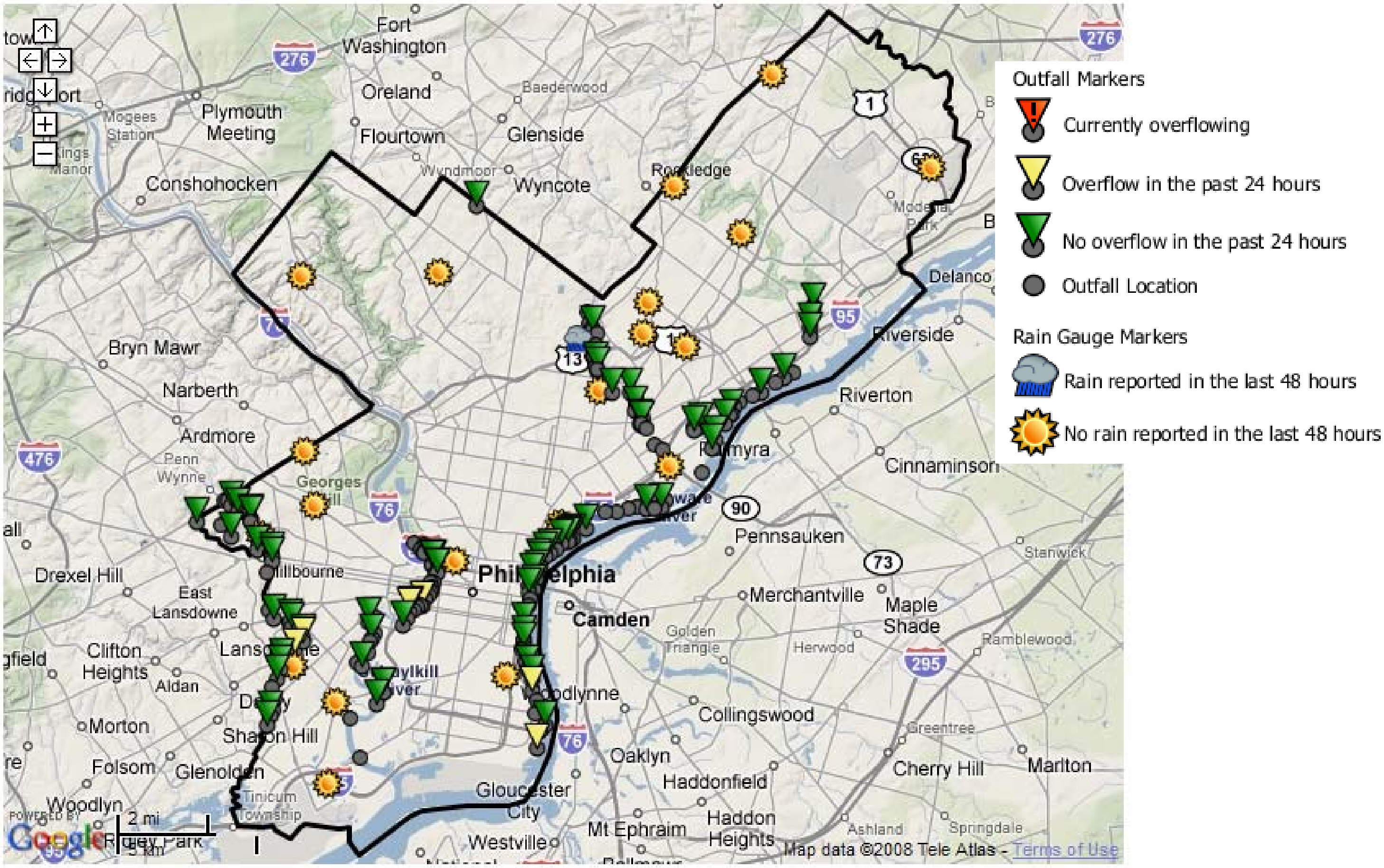


Figure II.H-1 Screen capture of the CSOcast website

The Green icon represents an outfall that has not overflowed in the last 24 hours. The Yellow icon represents an outfall that has overflowed in the last 24 hours but is not necessarily currently overflowing. The Red icon represents an outfall that is currently overflowing. The Gray icon represents an outfall where data is not currently available – for these sites, outfalls in close proximity can be referenced for an approximation of overflow status.

II.I Monitoring to Effectively Characterize CSO Impacts and the Efficacy of CSO Controls (NMC 9)

II.I.1 Report on the Status and Effectiveness of Each of the NMCs in the Annual CSO Status Report

The CSO Annual Status Report, combined with the Stormwater Annual Status Report, will be submitted in September of each year, documenting the previous fiscal year activities.

III Implementation of the LTCP

III.A CSO LTCP Update - Report on the progress of the LTCP Update

PWD has completed the Philadelphia Combined Sewer Overflow (CSO) Long Term Control Plan Update (LTCPU) as of September 1st, 2009. The CSO LTCPU details PWD's plan to increase capture and reduce CSOs through a variety of infrastructure. The evaluation of alternative control measures was consistent with the guidance provided in Chapter 3 of the Combined Sewer Overflows: Guidance for Long-Term Control Plan, Office of Water EPA 832-B-95-002, September, 1995 ("Guidance for LTCP"). Additionally, the plan addressed the following components:

a) PWD conducted flow monitoring and assessed the performance of the CSO control alternatives and the efficacy of implemented controls with a hydrologic and hydraulic model of the collection system.

b) Evaluated the technical applicability and feasibility of the full range of alternatives. Alternatives included projects that:

i. Link the City's development and land management practices to achieve CSO reductions through the application of innovative storm water management regulations and low impact development and re-development practices.

ii. Directly restore aquatic ecosystems through stream rehabilitation and wetland construction.

iii. Expand its collection and treatment systems to increase the capture and treatment of combined sewage and ensure adequate transport capacity for dry and wet weather flows.

c.) Assessed the watershed wide reductions in pollutant loads achieved by the CSO controls and other controls as developed in the watershed management plans.

d.) Evaluated the Project Costs for each alternative or mix of alternatives.

e.) Analyzed the benefits of the additional treatment applied to wet-weather flow through its secondary treatment processes and assessed the performance of the CSO controls.

f.) The watershed partnerships were utilized for evaluation and prioritization of management alternatives including additional CSO controls.

g.) Characterization of each individual watershed's physical, chemical, and biological components.

h.) Assessment of the financial capability to establish the burden of compliance on both ratepayers and the permittee.

i.) Schedule of implementation of the selected CSO control alternative.

The full Philadelphia Combined Sewer Overflow Long Term Control Plan Update report can be found at the following address: http://www.phillywatersheds.org/what_were_doing/documents_and_data/cso_long_term_control_plan.

Between September 1, 2009 and June 30, 2010, PWD responded to written questions and met with PADEP staff on request to clarify information in the LTCPU and to discuss any additional requirements needed for NPDES compliance beyond what was included in the LTCPU.

III.B Capital Improvement Projects

The Capital Improvement's phase of the PWD's CSO strategy is focused on technology-based capital improvements to the City's sewerage system that will further increase its ability to store and treat combined sewer flow, reduce inflow to the system, eliminate flooding due to system surcharging, decrease CSO volumes and improve receiving body water quality. PWD will continue to implement CSO capital improvement projects that were planned during the previous permit cycle and plan to develop, propose, and implement additional capital projects to continue to increase the capture and treatment of combined sewage.

III.B.1 On-going Capital Improvement Projects

III.B.1.1 Completion and Operation of the Real-time Control Center

Please refer to **SECTION II.B.4 - FULLY INTEGRATE THE REAL-TIME CONTROL FACILITY INTO THE OPERATIONS OF PWD** on page 27 in the CSO portion of the Annual Report for information pertaining to this topic.

III.B.1.2 Rehabilitate and Maintain the Monitoring Network

Please refer to **SECTION II.B.2 - CONTINUE TO OPERATE AND MAINTAIN A NETWORK OF PERMANENT AND TEMPORARY FLOW MONITORING EQUIPMENT** on page 19 in the CSO portion of the Annual Report for information pertaining to this topic.

III.B.1.3 WPCP Wet Weather Treatment Maximization (NE)

The plant stress-testing project established:

- Maximum and average flows that should be treated in various unit processes for current and future operations;
- Ranges of hydraulic, solids, and BOD_5 loads that could be applied to the various unit processes and yet obtain maximum removal efficiencies in each unit process;
- Changes in plant processes and operations (such as increased loads, MLSS levels, changes in sludge wasting, return activated sludge ratios, detention times, etc.) that would increase removal efficiencies; and
- Magnitudes of excess capacity, if any, in each unit operation of the plant (increased flow through plant process units) that could be achieved and still meet the discharge permit requirements for each plant.

The results of stress testing allow for a determination of existing and future optimum flows, loads, and operations of the various unit processes. The identification of choke points, deficiencies and unit process capacities are provided in the stress testing summary report that has been developed for each WPCP. Specific WPCP capital improvement projects (CIP) have been identified as potential projects resulting from the findings of the stress testing which were provided as part of the summary reports. The actual need for additional CIPs, and the resulting prioritization of the CIPs and the budgeting, appropriation of monies, scheduling and actual implementation of the CIPs was accomplished within the context of the overall watershed approach to CSO abatement defined in the LTCP.

CH2MHill submitted the final reports for each of the three WPCPs on May 1, 2001. The reports provided the following information: project objectives and methodology, current performance, maximum instantaneous flow, current sustainable treatment capacity, and potential upgrades. The report also included hydraulic and treatment throughput capacities for each plant process, capacity limiting factors, and the potential operating modifications or capital projects whose purpose would be to increase plant throughput.

Recommended modifications or upgrades were prioritized and categorized into those potential projects that could be considered for either immediate implementation, resulting in enhanced treatment, or capital improvement projects that could also increase treatment capability but would require PWD expenditures. The various CIPs were also categorized by four treatment objectives including: process improvements, peak primary treatment capacity, peak secondary treatment capacity, and wet weather treatment capacity. This second categorization provided anticipated combined CIP costs for each of the treatment objectives as well as the peak treatment capacities.

Table III.B-1 Potential Upgrade Options at the NE Plant identified in the Stress Test

Option Number	Description	Priority Classification	Estimated Conceptual Cost
1	Improve mixing in mixed liquor channel to secondary clarifiers 9 through 16	A	$472,000
2	Polymer addition on Set 1 secondary clarifiers to maintain effluent quality	B	$22,000
3	Separate flow measurement of secondary effluent from sets 1 and 2	C	currently undetermined
4	Automation of step feed operation for aeration tanks	A/B	$161,000
5	Modify Set 2 secondary effluent channels to reduce hydraulic restrictions under high flow conditions	B/D	$223,000
6	Modify the existing RAS system in the secondary clarifiers	C	$2,183,000
7	Provide a second conduit to the Set 2 primary clarifiers to convey additional flow to Set 2 Primary tanks	D	$3,312,000
8	Reduce losses and increase capacity between the grit tanks and Set 1 clarifiers by installing another conduit and venturi meter	D	$707,000
9	Provide a bypass from the primary effluent channels to the chlorine contact chamber	D	$8,291,000
10	Provide separate primary sludge thickening	D	$12,254,000
11	Reuse abandoned ABCD tanks in wet weather treatment facility	C	$5.0 - 10.0 million
12	Increase raw sewage pumping and screening by:	D	-
12a	50 mgd	D	$10.0 - 20.0 million
12b	150 mgd	-	$20.0 - 24.0 million
12c	300 mgd	-	$36.0 - 40.0 million

III.B.1.3.1 Evaluate Stress Test Report options in the LTCPU

The LTCPU submission on September 1, 2009 included a forward-looking framework for the evaluation and selection of cost-effective wet-weather treatment technologies at the three existing WPCPs to support the development of a long-term wet-weather treatment strategy. LTCPU Supplemental Documentation Volumes 9 through 11, available at : http://www.phillywatersheds.org , document evaluation of a range of wet-weather treatment options for each facility and provide an overall treatment strategy sufficient to support the PWD CSO LTCP Update process. The LTCPU examined treatment technologies that can be reasonably applied on the existing plant footprint and within reasonably obtainable land adjacent to the WPCPs. The LTCPU provided baseline information that can be used for the future development of a long-term wet-weather treatment facility plan for the Northeast, Southeast, and Southwest WPCPs.

The objectives of the planning-level study included in the LTCPU were to:

1. Document existing conditions at the plants utilizing information in the existing stress test reports (dated 2001) and the NE Plant Expansion Study (March 2007) and noting capital and operational changes made to these facilitates subsequent to these reports.

2. Identify and review the range of technologies applicable to the treatment of wet-weather flows, up to the maximum limits imposed by available land.

3. Perform a preliminary screening and recommend technologies for further evaluation across a full range of criteria.

4. Short-list treatment options to carry forward for further evaluation.

5. Conduct site visits, as appropriate, for technologies selected.

6. Select preferred technologies and develop concept-level sizing and performance criteria along a range of incrementally higher flows.

7. Prepare conceptual-level design, capital, and operating cost estimates.

8. Integrate the wet-weather treatment plan into the overall LTCPU approach and plan.

Wet weather treatment capacity expansion at each of the Water Pollution Control Plants was incorporated into several alternatives (combinations of control technologies including source control, treatment, transmission, and storage) in the CSO Long Term Control Plan Update (LTCPU). Several wet weather treatment technologies were evaluated: Vortex Swirl Concentrators, Conventional Clarifiers, Chemically Enhanced Primary Treatment with Conventional Clarifiers, and Ballasted Flocculation. Section 8 option I-35 of the LTCPU document summarizes the wet weather expansion capacity at each of the Water Pollution Control Plants in more detail and LTCPU Supplemental Documentation Volumes 9 through 11 are the individual full reports. Each document can be found at http://www.phillywatersheds.org/what_were_doing/documents_and_data/cso_long_term_control_plan.

III.B.1.3.2 Implement Options 1, 2, and 4 from the Stress Test Report

Options 1, 2, and 4 from the Stress Test Report have been implemented.

Option 2 - Polymer addition on Set 1 secondary clarifiers to maintain effluent quality was completed in 2000 and has been in operation since that time.

Option 1 (Improve mixing in mixed liquor channel to secondary clarifiers 9 through 16) and Option 4 (Improve step feed modes during wet weather events by converting the manual gate operators to motor driven operators) work was done under PWD Work #71033 – General construction for aeration system rehabilitation at Northeast Water Pollution Control Plant and #71034 - Electrical work for aeration system rehabilitation at Northeast Water Pollution Control Plant. The purpose of this project was to renew the secondary treatment system which includes new air grid system and diffusers and selector technology. Course bubble diffusers were installed in both Final Sedimentation Tank - Set 2 mixed liquor channels. New motor gate operators were installed on the "A" and "C" bay inlet gates on the west side of the aeration tanks. The Mechanical work was done by C&T Associates, Inc. for a total cost of $9,483,859.31. The electrical work was done by Philips Bros. Elec. Contrs., Inc. for a total cost of $800,439.90. The Notice to Proceed for this project was issued in February 2003 and the construction was complete by January 2006.

III.B.1.3.3 Plan, Design, and Construct Options 2 & 7 of the Stress Test Report to Increase the Secondary Plant Capacity to 435 MGD

The Northeast WPCP Stress Test report, completed in 2000, included as upgrade option #2 the modification of Set 2 secondary effluent channels to reduce hydraulic restrictions under high flow conditions. This was to be accomplished through the modification or elimination of the "double decker" effluent channel in order to reduce head loss. After conducting an in-depth hydraulic analysis, including computation flow dynamic (CFD) modeling, the observed head loss was determined to be attributable instead to the bulkhead and the nonsymmetrical conduit base elevations. These restrictions will be removed through the rerouting of the return activated sludge (RAS) piping and the construction of a new effluent conduit. PWD Design Branch has completed the design, and the Projects Control Unit is preparing to put out bids for this project (#70169). The estimated completion of work date is October 2011.

Identified as upgrade option #7 in the 2000 Northeast WPCP Stress Test, the purpose of this project is to increase the hydraulic throughput capacity of the Set 2 primary clarifiers by constructing four, 48" diameter conduits between junction chamber C and the Set 2 primary influent channel. This will introduce flow to the clarifiers in a more uniform fashion. PWD Design Branch has completed the design, and the Projects Control Unit is preparing to put out bids for this project (#70168 - mechanical and electrical). The estimated completion of work date is January 2012.

III.B.1.3.4 Explore increasing the preliminary treatment primary treatment and final effluent disinfection treatment capacities in excess of the existing secondary treatment capacity at the WPCP

On April 1, 2009 the PA DEP has issued a letter accepting the concept of the bypass of secondary treatment for 100 MGD of additional wet weather flow. A Water Quality Management (WQM) permit amendment must follow before construction of the bypass conduit. In order to increase primary treatment and final effluent disinfection treatment capacities, PWD will first significantly increase the flow into the plant by rehabilitating an existing force main in the Frankford high-level sewer. The force main rehab design is completed and has been sent to PWD Projects Control Unit (#71079)

A new pretreatment facility will also be designed and constructed to remove grit and screenings from the additional flow through Frankford high-level sewer. Following pretreatment, the increased flow into the plant will then enter the Set 2 clarifiers. Disinfection will be achieved in the bypass itself and in the chlorine contact chamber at the effluent of the plant. A detailed study, utilizing computation fluid dynamic (CFD) modeling, is currently being completed for the chlorine contact chamber and the final effluent pier.

A preliminary design was completed for the construction of a second pretreatment facility and a diversion chamber from the Frankford high-level sewer. Due to land area constraints, additional land will be need to be acquired for this facility. The necessary land parcels were identified and Projects Control is working towards this land acquisition, once they receive a funding source. After land acquisition, the final design will be completed in 6 months, followed by construction within a year and a half.

III.B.1.3.5 Initiate the Facility Planning and Design for the By-pass Conduit

Identified as Option 12 in the 2000 NE WPCP Stress Test report, this upgrade will include the construction of bypass conduits connecting the Set 1 and Set 2 primary effluent channels directly to the chlorine contact chamber. This upgrade will enable the bypass of secondary treatment during high flow events will ensuring solids removal and disinfection.

A CFD model was completed to show the hydraulic feasibility of a bypass conduit from Set 1 primary effluent conduit to the chlorine contact chamber. The conduits have been sited and a consultant is designing the conduits, chemical feed system, and flow control systems. A disinfection study is underway to estimate the required chlorine dosage for the bypass conduit and size the new chemical feed system. These upgrades are anticipated to be complete by December of 2017.

III.B.1.3.6 Report to the DEP the Status of these Projects in the Annual Status Reports when Major Work Elements are Completed

The CSO Annual Status Report, combined with the Stormwater Annual Status Report, will be submitted in September of each year, documenting the previous fiscal year activities.

III.B.1.4 85% Capture (NE) - 85% Flow Capture Technical Report

The technical memo documenting 85% capture in the Pennypack was completed in August 2008 and submitted to the DEP on August 15, 2008. This technical memo documents the completed alterations to the CSO system and models the estimated capture using high, median, and low flow estimates. Based on the modeling results, the percent capture from the Pennypack CSOs is between 70% and 92% capture using the high and low modeling estimates. The median estimate shows approximately an 85% CSO capture in the Pennypack.

III.B.1.5 In-Line System Storage Projects (NE)

III.B.1.5.1 Construction and Implementation of Tacony Creek Park (T-14)

The T-14 trunk sewer system conveys combined sewage from the largest combined sewershed in the PWD collection system. Currently, CSO outfall T-14, a 21′ by 24′ sewer, discharges into the Tacony Creek during periods of moderate to heavier rainfall. T-14 has a volume of approximately 10 million gallons and to use as much of this storage as possible, a control structure is needed in the sewer. Installation of a crest gate is proposed in order to retain flow within the sewer. This gate will reduce CSO discharges to the creek by utilizing the relief sewer for in-system storage. This control technology provides an additional margin of protection against dry weather overflows while still maintaining flood protection for upstream communities. The crest gate retains the stored flow in the relief sewer and a new connector pipe drains the stored flow to an existing nearby interceptor.

This project will reduce the discharge of combined sewage into Tacony Creek, one of the more-sensitive water bodies exposed to CSO discharges in the City of Philadelphia. The gate installation at T-14, combined with the Rock Run project, will result in a reduction of roughly 600MG of CSO discharges annually. This represents a 12% reduction in the average annual volume of CSO and a significant reduction in the pollutant discharge (bacteria and organic matter from untreated wastes, litter and other solid materials in both wastewater and stormwater runoff, etc.) at this location near an area where golfing and other recreational activities frequently occur. Since this project modifies an existing structure rather than constructing a new one, it provides very cost-effective control.

The engineering firm of O'Brien & Gere completed the bid documents for this project in December of 2007. This project was bid in August 2008 with a notice to proceed issued March 31, 2009. JPC Group Inc. won the contract with a bid of $3,965,000. As of FY2010, the new operations' building has been completed. The crest and sluice gates have been installed. Shop drawings for the new hydraulic power unit (HPU) and Programmable Logic Controller (PLC) have been approved. Once the installation of the HPU and PLC units is completed, the testing and training will commence. The project is scheduled to be on-line and in service by October 2010.

III.B.1.5.2 Construction and Implementation of Rock Run Relief (R-15)

The Rock Run Relief Sewer provides flood relief to combined sewer areas upstream of regulator T-8 in the Northeast Drainage District (NEDD). Currently, CSOs discharge into the Tacony Creek at the Rock Run Relief Sewer outfall – an 11′ by 14′ sewer - during periods of moderate or greater rainfall. Installation of an inflatable dam in the Rock Run Relief Sewer allows for utilization of approximately 2.3 million gallons of in-system storage to retain combined flows during a majority of these wet weather events. The inflatable dam stores combined flows in the relief sewer until storm inflows have subsided and capacity exists in the Tacony Interceptor for conveyance of combined flows to the Northeast Water Pollution Control Plant (NEWPCP). This control technology provides an additional margin of protection against dry weather overflows while maintaining flood protection for upstream areas.

This project will reduce the discharge of combined sewage into Tacony Creek, one of the more-sensitive water bodies exposed to CSO discharges in the City of Philadelphia. An estimated average annual reduction in CSO volume of 190 MG, from 1040 to 850 MG/year, is achieved at the Rock Run Relief Sewer outfall through use of the available in-system storage volume. This represents a reduction of roughly 20% in the average annual volume of CSO and a significant reduction in the pollutant discharge (bacteria and organic matter from untreated wastes, litter and other solid materials in both wastewater and stormwater runoff, etc.) at this location near an area where golfing and other recreational activities frequently occur. Since this project modifies an existing structure rather than constructing a new one, it provides very cost-effective control.

A design memorandum was completed that documents the expected environmental benefits of the Rock Run Relief Project, quantifies the flooding risks associated with the project, and documents the recommended control logic for the inflatable dam's operation and drain-down control. In support of this memorandum, several alternative control logics for the inflatable dam operation and drain-down gate were investigated to develop a logic that minimized the risks of flooding, increased Rock Run Relief storage utilization, and eliminated adverse affects of the project at other CSO regulators on the Tacony Creek. Hatch Mott MacDonald was the design engineer on this project.

On June 13, 2006, the project construction bid was awarded to AP Construction in the amount of $3,665,000. Notice to proceed was issued 12/13/2006. The job was listed as substantially complete on 9/26/2008. Subsequent electrical problems with the HPU, which delayed placing the project on line, have recently been diagnosed and corrected. Preparations to place the project on line were completed 8/5/2010; the system was placed into service on 8/11/10. The 120- day test period is currently underway.

III.B.1.6 Real Time Control (RTC) and Flow Optimization for the Southeast Drainage (SE)

Since no project with this name exists, this may actually be referring to the Real Time Control (RTC) and Flow Optimization for the Southwest Drainage (SW) which will be discussed further in this report.

III.B.1.7 WPCP Wet Weather Treatment Maximization (SW)

III.B.1.7.1 Implementation of the Southwest Plant Stress Test Report Option 1

The SW Stress Test identified 7 potential upgrade options at the Southwest WPCP.

Table III.B-2 Potential upgrade options at the SW Plant as identified in the Stress Test

Option Number	Description	Priority Classification	Estimated Conceptual Cost
1	Replace caulking on secondary clarifier launders to improve flow distribution	A	$1,640,000
2	Provide preliminary treatment for the BRC centrate that is recycled in the plant	B/C	$8,585,000
3	Modify existing RAS system in the secondary clarifiers	C	$4,256,000
4	Provide primary effluent bypass to secondary clarifiers	D	$902,000
5	Provide separate facilities for primary sludge thickening	D	$9,892,000
6	Resolve hydraulic limitations between primary clarifiers and aeration basin	D	$5,429,000
7	Provide and additional effluent pump at the effluent pumping station	D	$806,000

The purpose of this project was to implement Option 1 - to inspect and repair leaking weirs and concrete surfaces in the final sedimentation tanks at the Southwest Plant. The leaking through the weirs was causing short circuiting through the tanks and thus adversely impacting solids settling. This work was done under PWD Work #73018 – SW Concrete Repairs in Final Sedimentation Tanks. The contractor for the construction was Ross Araco Corp. The Notice to Proceed was issued in August of 2000 and the project was completed by April 2002. The total cost of the project was $1,640,980.

III.B.1.7.2 Analyze wet weather treatment capacity expansion as part of LTCPU

Please refer to **SECTION III.B.1.3.1 "EVALUATE STRESS TEST REPORT OPTIONS IN THE LTCPU"** on page 89 in the CSO portion of the Annual Report for information on how wet weather treatment capacity expansion was analyzed as part of the LTCPU.

III.B.1.8 Real Time Control (RTC) and Flow Optimization for the Southwest Drainage (SW) - Implementation of Projects for Real Time Control (RTC) and Flow Optimization for the Southwest Drainage District

A number of interrelated projects in the Southwest Drainage District (SWDD) were determined to enhance the operation of the high-level and low-level collection systems and consequently maximize capture and treatment of wet-weather flows at the SWWPCP. Each of the high-level interceptor systems that discharge to the SWWPCP can influence the hydraulic capacity and treatment rate of the other high-level interceptor systems, as they compete for capacity in the Southwest Main Gravity (SWMG) into the plant. Therefore, several integrated projects were proposed to establish a protocol for prioritizing flow from each interceptor system. The RTC system will control the Triple Barrel reach of the SWMG and will control the diversion from the SWMG to the Lower Schuylkill West Side Interceptor (LSWS), thereby enabling use of the full capacities of these interconnected conduits during wet-weather.

The SWDD RTC conceptual design memorandum outlines recommendations for the modifications to the SWDD collection system in three phases. Phase I includes enlarging the DWO pipe and raising the diversion dam at the C17 regulator, modifying the operation of CSPS based on the level in the CCLL interceptor, and regulating inflows from S27 to the SWMG using a DWO sluice gate under RTC. In addition, installation of a side-overflow weir at the West Barrel at the 70th & Dicks Triple Barrel and opening the East and Center Barrels for dry weather flow is encompassed in Phase I of the RTC project. Phase II concentrates on decreasing overflows in the LSWS by enlarging the S45 DWO pipe and regulating inflows using a gate. The strategy for Phase II also incorporates closing DWO shutter gates at S43 and S47. The 3rd phase of the RTC conceptual design is enlargement of the S38 DWO pipe and regulation of flows using a computer-controlled DWO gate.

<u>Phase I</u>

C17

The contract award for this project was $1.7 million. On 8/19/05, the gate on the 66 inch reinforced concrete DWO pipe was installed and functioning to specification. On 1/9/06, the old dam and 20 inch DWO pipe upstream of the new gate & dam were sealed and removed from service. The project was closed out on September 3, 2006.

Operation changes to the Central Schuylkill Pump Station (CSPS) will be evaluated after construction is complete on the 70th and Dicks Triple Barrel.

S27

This regulator is currently operating under local control. Future modifications will be evaluated after completion of the work done on S45.

70th and Dicks Triple Barrel (Projects # 75021 & 75022)
The design for the rehabilitation of the DWO sluice gate chamber was completed with the aid of the consulting engineering firm of Gannett Fleming and was bid through Projects Control in April of 2006. The bid was awarded to JPC Group in the amount of $1,729,530. A construction notice to proceed was issued in November 2006. Three existing sluice gates have now been replaced with three new sluice gates. Under this contract, each gate has been equipped with a new electric actuator and is motorized. The gates are to be controlled from the RTC at Flow Control. There is also an electrical control box on site so that the gates can be controlled locally from street level at 70th and Dicks. The control box has been installed on the side lawn of 2700 South 70th St. There are also several other small items that were completed under this contract (i.e. new sump pumps to pump water out of the control chamber where the actuators are located, new seals and hatches to prevent sewer water from penetrating control chamber). The project was substantially completed on November 17th, 2008. Project #75021 was closed out on March 30, 2010 and Project #75022 was closed out on April 12, 2010.

Phase II

S45 (Project #40433)
The S45 chamber at 67th Street regulates the flow of combined sewage into the LSWS interceptor. The chamber modifications included upsizing the DWO pipe from 24 to 36 inches and the installation of a manual gate to control inflows into the LSWS interceptor. Design was completed in 2008 by the consultant engineering firm of Hatch Mott MacDonald. Bid documents were forwarded to Projects Control in January 2008. This project was bid in July 2008. The low bidder was A.P. Construction at a cost of $535,000. The notice-to-proceed for construction was issued on December 9, 2008. The project was substantially completed on September 30, 2009. Punch list remains to be completed on the open contract.

S43 & S47
Modifications to S43 and S47 will be evaluated after completion of the work done on S45.

Phase III

S38
After extensive hydrologic and hydraulic modeling, it was determined that modifications to S38 are unnecessary. The goal of maximizing flow to the SW Plant through the Lower Schuylkill West Side Interceptor can be achieved solely through modifications to the S45 regulating chamber.

III.B.1.9 RTC/Main Relief Sewer Storage (SW) - Construction and Implementation of Main Relief Sewer Storage and Real-time Control

Please refer to **SECTION II.B.5.1 "MAIN RELIEF"** on page 28 of the CSO portion of the Annual Report for information pertaining to this topic.

III.B.1.10 Eliminate CSO/Dobsons Run Project (SW) - Construction and Implementation of the Dobson's Run Project

Stokely & Roberts (R22) - Dobson's Run Phase I

This project will eliminate 2 of the City's intercepting chambers and will completely eliminate CSO overflows at R22, resulting in a 173-MG reduction in overflow volume on an average annual basis.

This project entails the reconstruction of the storm and sanitary sewer from Wissahickon Ave. to Roberts Ave. and elimination of the overflow chamber located at Stokely & Roberts (R22). The contract was awarded to A.P. Construction and construction commenced on 7/18/1996. The construction, including the elimination of the R22 chamber, was completed on 10/4/1998 at a total cost of $7,040,000. The estimated construction cost was $5.8 million.

Kelly Drive (S01T) - Dobson's Run Phase II & Phase III

Phase II of the Dobson's Run Reconstruction consists of the sewer reach from Henry Ave. to Kelly Drive and eliminates branch sewer contributions of sanitary sewage from reaching temporary CSO S01T. Phase III will eliminate all CSO discharge from occurring at S01T. In order to take advantage of economies of scale, design work for Phase II and III of Dobson's Run has been combined into one project because both phases involve tunneling. The project consists of tunneling beneath 32nd St., Allegheny Ave. and the Laurel Hill Cemetery to a new storm water outfall on Kelly drive. The new sewer redirects storm water away from properties surrounding Ridge Ave. and Scotts Lane. This section of the Dobson Run system augments the function of the storm water system that conveys drainage to the Schuylkill River from the Philadelphia neighborhoods of East Falls, Nicetown, and Germantown.

The design engineer was the team of CMX (former Schoor DePalma) and Dawn Engineering. The project was bid on December 5th, 2006 with the low bidder being the joint venture of JPC/JAY DEE at the amount of $36.4 million. The contract was awarded in February 2007 for a bid price was $36.4 million, with a contingency that brings the limit of contract to $38.5 million. The project, which included tunneling, outfall and drop structure, was substantially completed as of 07/01/10 and is now in operation.

III.B.1.11 Eliminate CSO/Main and Shurs Off-Line Storage (SW) - Construction and Implementation of the Main and Shurs Off-line Storage Project

The Main Interceptor Sewer, which is located along the Schuylkill River adjacent to the Manayunk Canal in the northwest section of Philadelphia, conveys sewage from collection systems which serve the northwest section of the City. During extreme wet weather events, the Main Interceptor Sewer exceeds its capacity and overflows occur at relief point R20 into a storm sewer upstream of storm water outfall S-052-5. To abate the hydraulic overload conditions in the Main Interceptor Sewer, the PWD has proposed construction of a three million gallon offline storage tank which will capture and store excess flows thereby eliminating surcharges and preventing overflow conditions at relief point R20. The 3 million gallon concrete storage tank, head house building, and a performing arts center are to be constructed on Venice Island, an artificial island between the Manayunk Canal and the Schuylkill River created when the Manayunk Canal was dug out.

The storage tank will accommodate sanitary sewer/combined sewer overflow (SSO/CSO) that currently averages approximately 10 million gallons of untreated wastewater each year and will return it to PWD's Southwest WWTP. Placed back on top of the tank after construction will be several recreation areas, a new performing arts center, and a head house building to provide public space in the Manayunk region of Philadelphia.

During the second half of 2009 and the first half of 2010, PWD staff and the consultant design team have expended considerable effort finalizing, reviewing, and coordinating the contract documents for this challenging, multi-discipline project. The final bid documents for this project are expected to be transmitted to the PWD's Projects Control Unit in September of 2010 to start the advertising and bidding process for this project. The following table gives a summary of progress to date on the various drawing sets that make up this project:

Table III.B-3 Design Progress for Main and Shurs Off-line Storage

Design Element	Engineering Consultant	No. of Drawings	% Complete
General	Hazen And Sawyer	4	100
Civil Land Development	Hunt Engineering	40	99
Landscaping	Andropogon	83	100
Geotechnical	NTH Consultants	11	100
Structural - CSO Basin & Head House	Hazen And Sawyer	38	100
Architectural - Head House	Hazen And Sawyer	32	100
Mechanical - CSO Basin & Head House	Hazen And Sawyer	19	100
Electrical - CSO Basin & Head House	Hazen And Sawyer	17	100
Instrumentation - CSO Basin & Head House	Hazen And Sawyer	5	100
HVAC - CSO Basin & Head House	Hazen And Sawyer	16	100
Plumbing - CSO Basin & Head House	Hazen And Sawyer	4	100
Performing Arts Center - Structural	Joseph Barbato Associates	14	98
Performing Arts Center - Architectural	Buell Kratzer Powell	33	98
Performing Arts Center - Rigging	Scheu Consulting Services	7	100
Performing Arts Center - Electrical	Agnelo Gomez Consulting Engineers	17	100
Performing Arts Center - Theatrical Lighting	The Lighting Practice	3	100
Perfroming Arts Center - Sound System	Metropolitan Acoustics	11	100
Performing Arts Center - HVAC	Mark Ulrick Engineers	8	100
Performing Arts Center - Plumbing	Mark Ulrick Engineers	6	100
Performing Arts Center - Fire Protection	M&S Engineering Services	4	100
	Total Drawings	**372**	

In addition to coordinating the construction bid documents, considerable effort has been applied to obtain the many permits and approvals necessary to construct this project. As of August 2010, the following permits and approvals have been obtained:

- City of Philadelphia Art Commission approval
- City of Philadelphia Historic Commission approval
- City of Philadelphia Streets Department approval
- City of Philadelphia Planning Commission approval
- City of Philadelphia Zoning approval
- Delaware River Basin Commission (DRBC) approval
- PADEP Water Quality Management Permit
- PADEP Water Obstruction and Encroachment Permit

The following approvals which are being worked on currently are expected shortly:

- PWD Storm Water approval (final review complete and waiting for approval letter)
- PADEP NPDES and Soil Erosion Permit
- City of Philadelphia License & Inspections Building Permit
- Norfolk Southern approval (new water service crossing tracks at Cotton Street)
- Realen Properties (right-of-way at Cotton Street)

The consent order issued for Main and Shurs also includes sewer relinings to be done around R-20 in an effort to reduce inflow and infiltration. One of the current relining projects is in the Upper Schuylkill Intercepting Sewer. The relining will include Nixon St, Main St, Domino Lane, Rector St, Levering St, Leverington Ave, and Parker Ave.
A Notice to Proceed for the project was issued on 11/9/2009 and construction started on 2/27/2010 with a planned completion date of 9/5/2010.

Another sewer relining project at Wilde St., Ridge Ave., Dupont St, Silverwood St near R-20 is currently in Projects Control.

III.B.2 New Capital Improvement Projects to be Included in LTCPU

III.B.2.1 Asset and Capacity Management Program - Implement a Comprehensive Geographic Information System (GIS) of the City sewer system, Implement a Comprehensive Sewer Assessment Program (SAP), and Continue to Institutionalize a Comprehensive Monitoring and Modeling Program

The PWD has begun implementation of a comprehensive asset and capacity management program. Please refer to the following sections for more information on our programs.

Please refer to **II.A.1 – "IMPLEMENT A COMPREHENSIVE GEOGRAPHIC INFORMATION SYSTEM (GIS) OF THE CITY SEWER SYSTEM"** on Page 15 for more information on this topic.

Please refer to **SECTION II.A.2 "IMPLEMENT A COMPREHENSIVE SEWER ASSESSMENT PROGRAM (SAP)""** on Page 15 for more information on this topic.

Please refer to **II.B – "CONTINUE TO INSTITUTIONALIZE A COMPREHENSIVE MONITORING AND MODELING PROGRAM"** on Page 19 for more information on this topic.

III.B.2.1.1 Inflow/Infiltration (I/I) Controls

Opportunities exist to reduce CSO impacts by means of reducing the entry of stormwater runoff, rainfall-derived I/I, and groundwater into the sewer system. Appropriate measures will be identified, evaluated, and implemented, where appropriate and cost-effective. There are four basic approaches to CSO control through I/I reduction:

1. Reduce the entry of stormwater runoff (including perennial stream baseflow) into the combined sewer system by diverting streamflow directly to a receiving stream.

2. Reduce the entry of groundwater to the combined sewers, interceptor sewers, and/or upstream separate sanitary sewers.

3. Reduce the entry of rainfall-derived I/I from upstream sanitary sewer systems.

4. Monitor and study the tidal inflows from river levels exceeding emergency overflow weir elevations at tide gates.

Each of the above methods enables CSO reduction by effectively increasing the capacity in the intercepting sewers and WPCPs available for the capture and treatment of combined wastewater.

Since I/I is relatively clean water that occupies conveyance and treatment capacity, eliminating it from the system frees up capacity for the more contaminated combined wastewater. This reduces CSO discharges and enables greater pollutant capture throughout the combined sewer system. An additional benefit of reduced infiltration (and diversion of any perennial streamflow) is the reduction in the operating costs associated with continuously pumping and treating these flows.

Tide Inflow

The System Inventory and Characterization Report (SIAC) identified 88 CSOs influenced by the tides. Many of these sites have openings above the tide gate. During extreme high tides inflow into the trunk sewer can occur. During these events, significant quantities of additional flow can be conveyed to the treatment plant and thus reduce capacity for storm flow, as well as increasing treatment costs. A program was previously implemented to install tide gates, or other backflow prevention structures, at regulators having an emergency overflow weir above the tide gate. This program, completed in June 1999, protects all openings up to 1.5′ City Datum and results in significant inflow reductions. PWD currently inspects and maintains the tide gates to ensure their continued performance.

Sewer Assessment Program

The permittee has implemented a comprehensive sewer assessment program (SAP) to provide for continued inspection and maintenance of the collection system using closed circuit television. The SAP is one of the tools used to indentify and remediate areas of I/I as well as guide the capital improvement program to ensure that the existing sewer systems are adequately maintained, rehabilitated, and reconstructed. Please refer to **SECTION II.A.2 "IMPLEMENT A COMPREHENSIVE SEWER ASSESSMENT PROGRAM (SAP)"** on page 15 for more information on this program.

City Wide GIS Mapping

The PWD utilizes the comprehensive Geographic Information System (GIS) of the City sewer system to target locations for inspection and potential maintenance where I/I may be a problem. Two such examples, are intake walls; locations where springs and creeks directly enter the sewer system, and creek crossings; locations where sewers travel directly under a waterbody.

Infrastructure Assessments

PWD actively conducts efforts to inventory and prioritize sewerage infrastructure potentially affected by either infiltration or exfiltration through spatial data collection for all points that either hydraulically alter the flow of the creek or infrastructure points that are affected by stream migration. These studies have identified over 300 points in the Cobbs Watershed (completed in 2002), 1000 points in the Tookany/Tacony-Frankford Watershed (2004), over 2000 points in Wissahickon Watershed (2005-2006), over 3000 points in Pennypack Watershed (2007-2008) and approximately 1200 points of infrastructure in the Poquessing Watershed (2008).

The data collected includes the spatial locations along the waterbody of all bridges, channelization, confluences, culverts, dams, manholes, outfalls, and pipes. In addition to spatial locations and depending on the type of infrastructure point, the following information is also collected: size, material type, length and height of exposed portion, condition, presence and quality of dry weather flow, bank location, level of submergence, digital photos, descriptions, and additional field notes. Corrective actions are taken when points of concern are identified.

Interceptor Relining

As a part of PWD's commitment to achievement of Target A (Improvement of water quality and aesthetics in dry weather) in both the Cobbs and Tacony-Frankford watersheds, the integrated watershed management plans include commitments to relining the interceptors that run along the mainstems of each.

Benefits:

- Decrease pollutant loads to surface waters by decreasing exfiltration

- Decrease amount of flow in sewer system by decreasing Inflow/Infiltration (I/I)
- Rehabilitation of sewers will increase the efficiency of the sewer system

Planning and Design is underway for the relining of the entire length of interceptor within Philadelphia in the Cobbs and Tacony-Frankford Watersheds. For planning purposes, the interceptors within both watersheds were split into sections/projects of approximately 1.5 miles in length, with plans to reline one section per year. In the Cobbs Watershed, two of these segments have already been relined, one in 1999 and the other in 2004 at a cost of $3,500,000. The 4 remaining sections/projects in the Cobbs Watershed will take place starting in 2010/2011. The total estimated cost of these projects is $12,500,000. The Tacony-Frankford Watershed interceptor was split into 5 sections/projects and relining of the first segment began in March 2010. The total estimated cost of these projects is $20,600,000. The following tables describe the interceptor relining project within each watershed and the figures provide a map view.

Table III.B.2-1 Cobbs Watershed Sewer Relining Project Data

Project Title	Design Status:	Construction Status:	Extents:
40518 - Cobbs Creek Interceptor Phase 1 CIPP Lining Contract	Design Complete	In Projects Control	63rd and Market to 62nd and Baltimore
40612 - Cobbs Creek Intercepting Sewer Lining Phase 2	Design 30 % Complete	-	61st and Baltimore to 60th and Warrington
40613 - Cobbs Creek Interceptor Lining Phase 3	Design 30 % Complete	-	City Avenue to D R/W in former 67th Street
40614 - Cobbs Creek Intercepting Sewer Lining Phase 4 (Indian Creek Branch)	Design 30 % Complete	-	City Avenue to D R/W in former 67th Street

Table III.B.2-2 Tacony – Frankford Watershed Sewer Relining Project Data

Project Title	Design Status:	Construction Status:	Extents:
40615 - Tacony Creek intercepting Sewer Lining Phase 1	Design Complete	NTP as of 9/30/2009	Chew & Rising Sun to I & Ramona
40616 - Tacony Creek intercepting Sewer Lining Phase 2	Design 70% Complete	-	2nd St & 64th Ave to Chew & Rising Sun; DRW Mascher to Tacony Interceptor; Cheltenham Ave to Crescentville & Godfrey
40617 - Tacony Creek intercepting Sewer Lining Phase 3	Design Started	-	I & Ramona to O & Erie
40618 - Upper Frankford LL Collector/Tacony Intercepting Sewer Lining Phase 4	Design Started	-	Castor & Wyoming to Frankford/Hunting Park
46019 - Upper Frankford Creek LL Collector/Tacony Intercepting Sewer Lining Phase 5	Design Started	-	Frankford/Hunting Park to Luzerne & Richmond

Figure III.B.2-1 - Segment Order for Relining in the Cobbs Creek

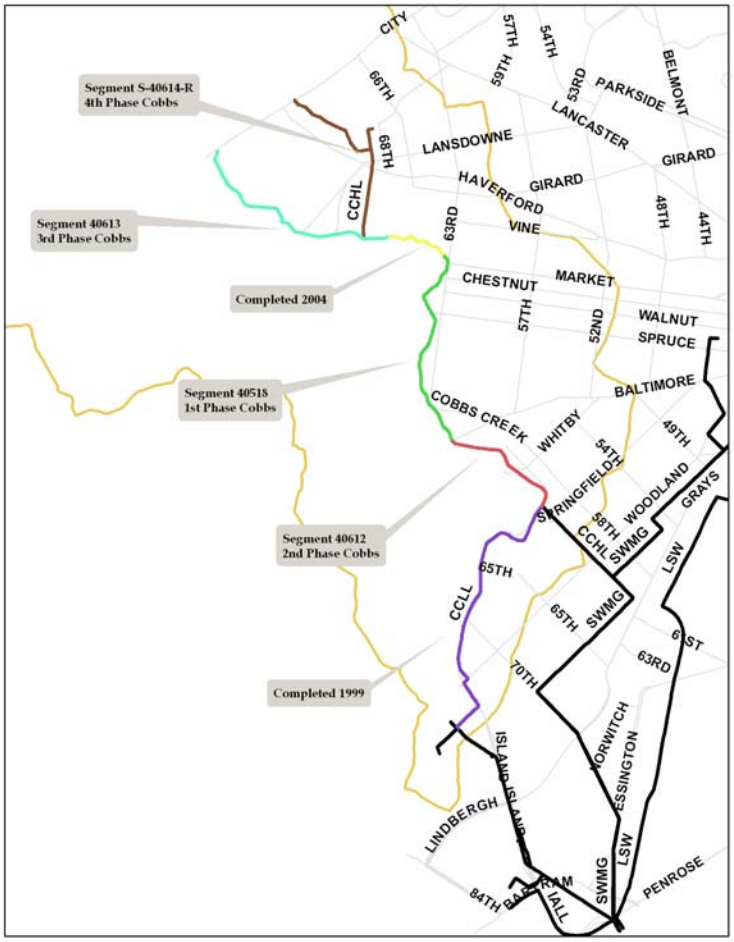
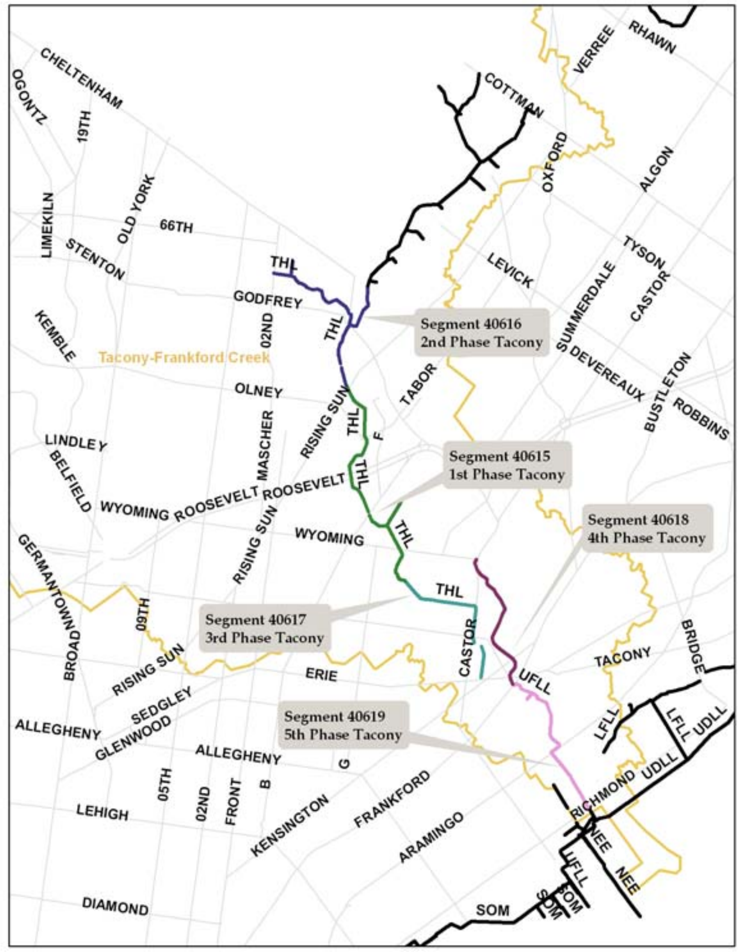


Figure III.B.2-2 - Segment Order for Relining in the Tacony – Frankford Creek



Mill Creek Diversion Project

The PWD is working with the Philadelphia division of the United States Army Corp of Engineers (USACE) to conduct a feasibility study of stopping stream flow from entering into the Mill Creek combined sewer. The proposed project is to divert and attenuate the stream flow generated in Montgomery County from the combined sewer by constructing an alternate channel to either the Schuylkill River via City Line Avenue or to the East Branch of Indian Creek. Diverting flow from the combined sewer to the East Branch of Indian Creek will increase base flows in the Indian Creek and possibly improve habitat conditions and water quality, while decreasing the quantity of CSO discharge to the Schuylkill River during storm events. The final report will outline the options evaluated and the pros and cons of each. The final report is currently on hold due to the USACE's attention on projects in the Cobbs Creek Watershed required by stimulus funding but expects to wrap-up the study once the priority projects have been completed.

PC-30 Relief Sewer

PWD is in the process of constructing a parallel relief sewer to eliminate overflows at manhole PC-30 as per a consent order issued by the DEP on 9/26/2007. The overflows at PC-30 are caused by a combination of various factors which influence the hydraulic carrying capacity of the Poquessing Creek Interceptor during wet weather events. These factors include excessive wet weather flows discharged to the interceptor above manhole PC-30 from the municipalities located in Bucks and Philadelphia Counties in addition to insufficient peak wet weather carrying capacity in the interceptor. To abate hydraulic overflow conditions in the Poquessing Interceptor, PWD has proposed measures to reduce I/I in the interceptor during wet weather events. The parallel relief sewer being constructed in State Road will be approximately two miles in length and will capture and convey extraneous wet weather flows to the Upper Delaware low-level interceptor. The contract was awarded to JPC Group, Inc on 7/16/2009 with a Notice to Proceed issued on 9/30/2009. The box sewer construction has since commenced. The relay of water mains has been substantially completed. The 54in. and 60in. connecting sewer piping from existing to the new tank is approximately 50% complete. This project should be completed in 2011.

There are also several sewer lining projects being done under the consent order for PC-30 area in conjunction with the relief sewer being constructed. The sewer linings at Cottman Ave which is a major source of I/I, will have significant reduction of I/I related overflows. A Notice to Proceed was issued on 8/11/2010 with construction anticipated to start in September 2010.

Sewer linings at Colman Rd, Colman Place, Colman Terrace, Basile Rd, London Road, Narcissus Road, Red Lion, Derry Terrace, Fairdale Road, Morning Glory, Academy Road, and Comly Rd along with several other streets around the PC-30 area are currently in Projects Control.

Other Sewer Relining Projects

Relining Sewers helps to reinforce, seal and rehabilitate the existing sewers. Specifically it prevents inflow and infiltration (I/I) to allow the full pipe capacity to be reserved for sanitary and storm flow. Apart from those being done under consent orders, there are several sewer lining projects in the City that originate from sewer maintenance issues like street cave-ins, depressions, backups, as well as sewer assessment meetings. The sewer lining project at Frankford Ave consists of 195 feet of 60 inch pipe from an outfall along the bridge at Frankford and Solly Ave to regulator P-01, and is currently in Projects Control. There is also gunite lining being done in Dauphin St, D St, and 63rd St which will also include installation of flap valves, manholes and joint grouting in the Main Relief Sewer. As of 8/17/2010 bidding has opened for this project.

Sewer relining projects are also being done around R-20 as part of the consent order issued for Main and Shurs. More information on these projects can be found in **SECTION III.B.1.11 "ELIMINATE CSO/MAIN AND SHURS OFF-LINE STORAGE"** on page 98.

III.B.2.1.2 Sewer Separation

Sewer separation was studied and modeled as one of the options in the LTCPU and deemed cost prohibitive. No sewer separation projects have been identified or implemented during the reporting period.

III.B.2.1.3 New Storage Facilities

PWD is continuing to investigate opportunities to construct off-line CSO storage facilities to maximize existing sewer treatment capacity and increase the volume of CSO captured and treated.

Venice Island Storage Tank

Please refer to **SECTION III.B.1.11 "CONSTRUCTION AND IMPLEMENTATION OF THE MAIN AND SHURS OFF-LINE STORAGE PROJECT"**on page 98 for information pertaining to this topic.

Tacony-Frankford Storage Feasibility Study

PWD is currently working with the Army Corp of Engineers on a feasibility study to identify cost-effective options for reduction of wet weather water pollution and peak flow volumes into PWD's combined sewer system within the Tacony-Frankford Watershed. Two options that this feasibility study analyzes are off-line storage facilities. The first is a 60MG storage tank located at "Logan Triangle", an area where sinking homes were demolished and the land currently remains empty. This storage facility would reduce combined sewer discharges to the Tacony Creek by 600 million gallons per year from, eliminate the need for approximately $26 million of new fill for the site, and provide a stable foundation for future redevelopment of the neighborhood.

The second tank option being considered is 13.5MG storage tank under "Old Frankford Creek". Currently there are four regulators with outfalls along Old Frankford Creek:

F21, F23, F24 and F25. Collecting these outfalls in a storage tank beneath the creek would potentially reduce overflows from these outfalls by 600 MG per year.

A third, non-storage option, the dechannelization of the bottom of lower Frankford Creek is also being studied.

Due to the attention by the Army Corp to projects in the Cobbs Creek Watershed required by stimulus funding, the Tacony feasibility study has been put on hold. The Army Corp expects to complete the study once the priority projects have been completed.

III.C Watershed-Based Management - Continue to Apply the Watershed Management Planning Process and Produce and Update to the Watershed Implementation Plans

Watershed management fosters the coordinated implementation of programs to control sources of pollution, reduce polluted runoff, and promote managed growth in the City and surrounding areas, while protecting the region's drinking water supplies, fishing and other recreational activities, and preserving sensitive natural resources such as parks and streams. The City of Philadelphia has embraced a comprehensive watershed characterization, planning, and management program committed to address a multitude of overlapping regulatory requirements including EPA's Combined Sewer Overflow (CSO) Control Policy, Phase I and Phase II Stormwater Regulations, Storm Water Management PA Act 167, TMDL(s), PA Act 537 Sewage Facilities Planning and drinking water source protection programs. Coordination of these different programs has been greatly facilitated by PWD's creation of the Office of Watersheds (OOW). This organization is composed of staff from the PWD's planning and research, CSO, collector systems, laboratory services, and other key functional groups, allowing the organization to combine resources to realize the common goal of watershed protection. OOW is responsible for characterization and analysis of existing conditions in local watersheds to provide a basis for long-term watershed planning and management.

The City of Philadelphia has committed to developing an Integrated Watershed Management Plan (IWMP) for each of the 5 major waterways that drain to the City of Philadelphia, including the Cobbs, Tookany/Tacony-Frankford, Wissahickon, Pennypack and Poquessing as well as Implementation Plans (IPs) for the Schuylkill and Delaware Rivers.

PWD's IWMP planning process is based on a carefully developed approach to meet the challenges of watershed management in an urban setting. It is designed to meet the goals and objectives of numerous water resources related regulations and programs, and it utilizes adaptive management approaches to prescribe implementation recommendations. Its focus is on attaining priority environmental goals in a phased approach, making use of the consolidated goals of the numerous existing programs that directly or indirectly require watershed planning. They are designed to meet the goals and objectives of numerous water resource related regulations and programs and draw from the similarities contained in many watershed-based planning approaches authored by the Pennsylvania Department of Environmental Protection (PADEP) and the U.S. Environmental Protection Agency (USEPA). Further, watershed planning is mandated by the CSO policy and guidance documents and also is consistent with the current Clean Water Act (CWA) and its regulations, as well as the priorities announced by EPA's Office of Water (See EPA's Watershed Approach Framework, Office of Water, June 1996).

Water bodies receiving CSO discharges in the PWD service area include the Cobbs/Darby Creeks, the Pennypack Creek, the Tacony/Frankford Creeks, the Schuylkill River and the Delaware River. Although they do not have CSO discharges, the Wissahickon and Poquessing Creeks are important waterways within the PWD service area and PWD has committed to developing integrated watershed management planning approaches for each of these watersheds through the City's Stormwater Permit. There are 164 point sources of CSO discharge from the PWD sewer system to these waterways. **TABLE III.C-1** below indicates the number of CSO point sources and the number of major separate stormwater outfalls on each waterway, as identified in the City's NPDES permits.

Table III.C-1 - CSO and Stormwater Point Source Discharges to Tributaries

Waterway	Number of CSO Point Sources	Number of Major Stormwater Outfalls
Delaware/Schuylkill Rivers (tidal)	94	30
Cobbs/Darby Creeks	34	3
Tacony/Frankford Creeks	31	23
Pennypack Creek	5	129
Schuylkill River (non-tidal)	0	52
Poquessing Creek	0	139
Wissahickon	0	61

III.C.1 LAND: Wet-Weather Source Control

Watershed management fosters the coordinated implementation of programs to control sources of pollution, reduce polluted runoff, and promote managed growth in the City and surrounding areas, while protecting the region's drinking water supplies, fishing and other recreational activities, and preserving sensitive natural resources such as parks and streams.

Watershed planning includes various tasks ranging from monitoring and resources assessment to technology evaluation and public participation. PWD has established a Planning Approach for developing IWMPs that addresses requirements of each of the following programs including TMDL(s), Phase I and Phase II Stormwater Regulations, PA Act 537 Sewage Facilities Planning, Storm Water Management PA Act 167, EPA's

Combined Sewer Overflow (CSO) Control Policy and drinking water source protection program. This IWMP development process is outlined below:

Establishment of Watershed Stakeholder Partnership

Stakeholder support is critical to the success of this type of regional planning initiative. A diversity of stakeholder perspectives must be involved with the development of each stage in the planning process in order to ensure that the plan is representative of stakeholder interests. This stakeholder buy-in is most critical to ensuring ultimate implementation of the plan. Recognizing this, PWD has helped to develop stakeholder watershed partnerships for each watershed where an IWMP is being initiated. At a minimum, a Watershed Partnership should be comprised of representatives from each of the following: federal, state, and local government agencies, industries, local businesses, nonprofit organizations and watershed residents, as well as any other interested stakeholders in the watershed.

Table III.C-2 Watershed Partnerships and Status

Watershed Partnership	Status
Darby-Cobbs Watershed Partnership	Initiated in 1999; Public Education and Outreach Committee and Steering Committees convened on a quarterly basis
Tookany/Tacony-Frankford Watershed Partnership	Initiated in 2000; as of 2007 this partnership had evolved into an independent 501(c)3 nonprofit organization with a mission of implementing the Integrated Watershed Management Plan for the TTF Watershed
Pennypack Creek Watershed Partnership	Initiated in 2004 for the development of a River Conservation Plan; re-convened in 2008 for the development of an Integrated Watershed Management Plan
Wissahickon Creek Watershed Partnership	Initiated in 2005 for the development of an Integrated Watershed Management Plan
Poquessing Creek Watershed Partnership	Initiated in 2006 for the development of a River Conservation Plan; to be reconvened in 2009 for the development of an Integrated Watershed Management Plan
Delaware Direct Stakeholder Partnership	Initiated in 2007 for the development of a River Conservation Plan for the Delaware Direct drainage area of the City of Philadelphia
Schuylkill Action Network	Large-scale stakeholder initiative initiated in 2003; supported by PWD.

The Watershed Partnerships are designed to provide a forum for stakeholders to work together to develop strategies that embrace the dual focus of improving stream water quality and the quality of life within their communities. The partnership is charged with driving the process and ensuring that the process remains representative of the diversity of stakeholder perspectives. The partnerships discuss priorities and the actions necessary to make the plan successful. These actions become a part of the implementation strategy, and address the desire to improve the water and land environment through a number of avenues. The ultimate goal is to cultivate a partnership committed to implementing the plan once completed.

Tookany/Tacony-Frankford Watershed Partnership

In 2000, the PWD launched the Tookany/Tacony-Frankford Watershed Partnership (TTF) with its partners, as an effort to connect diverse stakeholders as neighbors and stewards of the watershed. The partnership was integral in developing the Tookany/Tacony-Frankford Integrated Watershed Management Plan (TTF IWMP).

In 2005, the TTF Partnership formally incorporated as an independent non-profit, composed of environmental organizations, community groups, government entities, and other watershed stakeholders. Now the Partnership has embarked on implementing the TTF IWMP and advancing a wide range of initiatives for the good of the watershed

This partnership has elected a Board of Directors and has received its tax-exempt status as the first multi-municipal Watershed Partnership in the region and this year hired its first Executive Director of the organization. The Executive Director began working for the organization in the spring of 2007. The mission of the Partnership is the implementation of the watershed management plan.

The mission of the TTF Watershed Partnership is

"To increase public understanding of the importance of a clean and healthy watershed; to instill a sense of appreciation and stewardship among residents for the natural environment; and to improve and enhance our parks, streams, and surrounding communities in the Tookany/Tacony-Frankford watershed."

Table III.C-3 Current members of Tookany-Tacony/Frankford Partnership

Abington Township	Ogontz Avenue Revitalization Corporation
Awbury Arboretum	PA DEP
Cheltenham Township	PA Environmental Council
FPC, Env. Stewardship and Ed. Division	PA Horticultural Society
Frankford Group Ministry	Philadelphia Water Department
Friends of Tacony Creek Park	Rockledge Borough
Jenkintown Borough	Senior Environmental Corps.
Melrose Park Neighbors Association	US Environmental Protection Agency
Montgomery County Commissioners	US National Park Service
Montgomery County Conservation District	

This nonprofit organization has begun to organize itself into various working committees under the direction of the Board of Directors. Thus far, the committees consist of the Executive Committee and Planning and Performance. This organization has applied for several grants and funding programs over the past year, including the National Park Service's Community Planning Grant – which funds the development of a

"Communications Plan" for the group. The partnership also applied to the USEPA's Targeted Watershed Initiative Grant for project implementation funding.

The Tookany/Tacony-Frankford Watershed Partnership was convened for the nearly 60 meetings and events over the past year. A full listing of these events can be found in **APPENDIX C – PUBLIC EDUCATION & INFORMATION MATERIALS: TABLE 8** on Page 14.

Darby – Cobbs Watershed Partnership

In 1999, the Philadelphia Water Department initiated the Darby-Cobbs Watershed Partnership in an effort to connect residents, businesses, and government as neighbors and stewards of the watershed. Since then, the partnership has been active in developing a vision for the watershed and guiding and supporting subsequent planning activities within the watershed. The partnership functions as a consortium of proactive environmental groups, community groups, government agencies, businesses, residents and other stakeholders who have an interest in improving the Darby-Cobbs Watershed. Over the course of the last nine years, this partnership has provided a driving force for stakeholder planning and implementation of the Darby Cobbs Integrated Watershed Management Plan (DC IWMP).

The Darby Cobbs Watershed Partnership (DCWP) mission is:

"To improve the environmental health and safe enjoyment of the Darby Cobbs Watershed by sharing resources through cooperation of the residents and other stakeholders in the Watershed. The goals of the initiative are to protect, enhance, and restore the beneficial uses of the Darby-Cobbs waterways and riparian areas."

A range of public education and outreach activities and events have resulted from the watershed planning approach in the Darby Cobbs Watershed.

Darby-Cobbs Watershed Partnership met on December 7, 2009 to address Cobbs Creek restoration plan, Army Corps sediment assessment project, and MS4 tracking system coordination.

Stormwater Best Management Practice Project events:

- Rutledge Triangle Park BMP ribbon cutting event on July 16, 2009.
- Yeadon Municipal Building BMP ribbon cutting event on December 7, 2009.

Darby-Cobbs Watershed Partnership Public Education and Outreach Committee meetings on April 1, April 26, and May 24, 2009 held to identify projects, focused on promotion of Delaware County Greenway Trail and Cobbs Creek restoration plan. Specific activities and accomplishments of committee include:

- Backyard stream buffer workshop held for Overbrook Neighborhood on May 27, 2010.

- Advocated for a creek related theme for the SEPTA Art-in-Transit project at 63rd Street and Market (above Cobbs Creek). Awarded project does feature a Creek related image.
- Facilitated information gathering and sharing regarding Astra Foods Plant violation (grease discharge into Cobbs Creek) in Upper Darby Township.
- Awarded Community Design Collaborative Grant for a redevelopment design for former SEARS property.
- Awarded DEP Environmental Education grant for work in Indian Creek.

Model Neighborhood Coalition outreach activities:

- Service Area Briefing to West Philly Neighborhood Advisory Council – September 8, 2009
- Recognition Ceremony for Cobbs Creek Model Neighborhood Petition Submission –

Outreach to Delaware County Regional Water Quality Control Authority (DELCORA) regarding sanitary and stormwater issues.

- Initial meeting with DELCORA held on March 23, 2009 to explore regional overlap between sanitary/stormwater issues.

Pennypack Creek Watershed Partnership

The Pennypack Watershed covers 56 square miles and covers portions of 11 municipalities and the City of Philadelphia. The watershed is located within the lower Delaware River Basin and discharges into the Delaware River in the City of Philadelphia. PWD led an effort to develop a RCP for this watershed, which was completed in 2005.

A range of public education and outreach activities and events have resulted from the watershed planning approach in the Pennypack Watershed. Please refer to the following list for a description of the watershed-related events and activities that took place over the past year.

Pennypack Watershed Partnership meetings:

- December 17, 2009 (to address Act 167 plan development including BMP inventory)
- June 15, 2010 (focused on key BMP and stream restoration projects and link to Act 167 project inventory).

Pennypack Greenway Partnership Meetings held on a monthly basis at Pennypack Ecological Restoration Trust and other Pennypack Watershed locations. Collaboration with Pennypack Watershed Partnership that addresses greenway, trails, stormwater, and other environmental issues (meetings held on July 9, 2009, September 23, 2009, Oct 28, 2009, January 7, 2010, March 18, 2010, April 28, 2010, and June 15, 2010).

Pennypack Partnership Public Education and Outreach Committee (PEO) meeting on September 30, 2009 held with Poquessing Watershed Partnership to identify education events. PEO activities included:

- March 24, 2010 Hatboro-Horsham Green Futures Fair for high school students.
- May 1, 2010 Blair Mill Elementary School Watershed Day event (stream buffer and wetland plantings, and initiation of meadow demonstration project).

Poquessing Creek Watershed Partnership

The final Poquessing Creek Watershed River Conservation Plan (RCP) was completed in July, 2007. The final RCP report was submitted to the Department of Conservation and Natural Resources in the winter of 2007 and is on the Pennsylvania Rivers Registry.

Prior to the completion of the report, a photo contest was held in the summer of 2006 to build awareness of the beauty of the Poquessing Watershed. The winning photographs from the contest were subsequently placed in the 2008 Poquessing RCP Calendar, which was developed by the RCP Team in the fall of 2007 as an additional outreach tool. The calendar includes the recommendations that resulted from the RCP, along with the Executive Summary of the Plan. It was distributed widely, to every RCP participant and partner in the watershed.

A range of public education and outreach activities and events have resulted from the watershed planning approach in the Poquessing Watershed. Please refer to the following list for a description of the watershed-related events and activities that took place over the past year.

Poquessing and Pennypack backyard buffer program workshops, coordinated by Tony Federicci of URS. This program launched in January 2009 with following 2009-10 events:

- Thirty-three landowners signed up to participate in backyard buffer program. Landowners visited by URS consultants who evaluated backyard buffer management practices.
- July 22, 2009 Living Streamside Workshop held for the two watersheds for backyard buffer landowners and other interested community members.

Poquessing Watershed Partnership meetings:

- October 7, 2009 meeting focused on meadow creation, stream buffer program, and preview of Act 167 planning.
- February 5, 2010 meeting to kick-off Act 167 Stormwater Management Plan.

Poquessing Watershed Partnership Public Education and Outreach Committee meeting on September 30, 2009 held with Pennypack Watershed Partnership to identify education events.

- Committee formed that organized the Watershed Day Event "Going Back to Our Roots" at Saint Christopher's Elementary School and Cranaleith Meditation Center Group procured TreeVitalize funding and held an April 30, 2010 planting and rain barrel installation event at the two properties.

Delaware Direct Watershed Partnership

The Delaware Direct Watershed Partnership was formed in the fall of 2007 to support the River Conservation planning process for the Delaware Direct River Conservation Plan. A myriad of stakeholders are involved– non-profits, state and local government, in addition to community representatives. Each of the stakeholders represents a current planning initiative, such as the GreenPlan Philadelphia, the Central Delaware Master Plan, and the DRBC Water Resources Plan, among others. Through the Partnership, the representatives come together in a coordinated manner to communicate the best possible method to achieve protection of the natural resources and their sustainability in the urbanized Delaware Direct Watershed.

Delaware Direct Watershed Partnership meetings over the past year:

- December 2, 2009 kick-off meeting.
- March 31, 2010 meeting focused on goals/objectives, Green Streets, and stakeholder updates.
- June 9th meeting focused on goal/objectives completion, Pier 53 update, and Green Street prioritization.

Presentation to Central Delaware Advisory Group (CDAG) on May 13, 2010 to discuss overlap between CDAG waterfront activities and PWD stormwater management activities.

Wissahickon Creek Watershed Partnership

The Wissahickon Watershed Partnership was convened in 2005 for the purposes of guiding the development of a watershed-wide Integrated Watershed Management Plan. Over the past 5 years it has been determined that due to the complexity of regulatory obligations facing this drainage area, PWD would move forward with developing a watershed plan for the portion of the drainage area within its' jurisdiction while the upstream portion of the watershed concludes a number of ongoing initiatives. PWD will continue to convene the Wissahickon Watershed Partnership over the coming years in hopes that the upstream portion of the watershed will come together to formulate a complimentary implantation approach in order to realize a watershed-wide restoration vision.

The Wissahickon Watershed Partnership is convened on a quarterly basis.

Wissahickon Watershed Partners:

Abington Township
Ambler Wastewater Treatment Plant
Clean Water Action
Fairmount Park Commission
Friends of the Wissahickon
F X Browne, Inc.
Lansdale Borough
Lower Gwynedd Township
McNeil CSP
Merck, Inc.
Montgomery County Conservation District
Montgomery County Planning Commission
Morris Arboretum
North Wales Borough
North Wales Water Authority
PA DEP
PA Environmental Council
Philadelphia University
Philadelphia Water Department
Schuylkill Center for Environmental Education
Schuylkill Riverkeeper
Senior Environmental Corps, Center in the Park
Temple University, Center for Sustainable Communities
Upper Dublin Township
Upper Gwynedd Township
US Environmental Protection Agency
Whitemarsh Township
Whitpain Township
Wissahickon Restoration Volunteers
Wissahickon Valley Watershed Association

The Education and Outreach Committee of the Wissahickon Watershed Partnership continues to meet and develop materials and programs.

Wissahickon Watershed Partnership Public Education and Outreach Committee meeting on September 22, 2009; focused on identifying educational program ideas. Follow-up included:

- PWD and Friends of Wissahickon coordinated to develop talking points/literature for Trail Ambassador program that addresses watershed issues.

Wissahickon Watershed Partnership Meeting, December 8, 2009 Partnership meeting that focused on stormwater BMP and stream restoration projects across the watershed.

Environmental Advisory Committee watershed wide collaboration; meetings and discussions focused on ordinance revisions and stormwater basin retrofits:

- July 15, 2009 and October 27, 2009 partner EAC meetings focused on ordinance changes for Ambler, Upper Dublin, and Abington.

Wissahickon Roundtable Better Site Design. Follow-up to workshops held during previous year with municipalities (Whitemarsh, Upper Dublin, Whitpain, and Springfield), developers, agencies, non-profit organizations, and other stakeholders. Workshops had focused on updating site development ordinances in ways that protect environmental resources:

- Roundtable report summarizing ordinance update opportunities and needs completed June 2010 and distributed to municipalities to follow-up with ordinance updates.

PWD/Exelon/Schuylkill River Heritage Area Basin Retrofit Program. Stormwater basin retrofit activities focused on construction-related activities at municipal basins:

- Regular communication with Upper Dublin Township regarding Aiden Lair basin retrofit construction tasks, including supporting planting and maintenance activities (March 4, 2010 planning meeting and May 21, 2010 planting)
- Regular communications with Whitpain Township and North Wales Borough to facilitate pre-construction activities (February 5, 2010 planning meeting, February 18, 2010 planning teleconference, and other telephone and electronic correspondences with municipalities and North Wales private basin owner).

MS4 Management System pilot launch, working with eight municipalities either through consulting engineers or directly with municipality. Partnership municipalities include Upper Dublin and Lower Gwynedd Townships. Project goal is to establish electronic reporting system for MS4 permit reporting and for stormwater best management practice tracking. FY09-10 work included launch of pilot program to test commercial system and adapt it for Pennsylvania municipalities:

- October 27, 2009 kick off webinar and stakeholder/municipal meeting.
- December 3, 2009 outreach meeting to PA Department of Environmental Protection.
- December 10, 2009 webinar and outreach meeting.
- Pilot organized during spring 2010 for early July 2010 kick-off.

Integration with First Suburbs, an organization advocating for more resources for inner ring suburbs, including stormwater management resources. The group is active in partnership watersheds:

- Pennsylvania Environmental Council attended First Suburb planning meetings (February 13, 2010 in Upper Darby and May 26, 2010 in Feasterville), and drafted stormwater infrastructure platform language that was subsequently adopted by the First Suburbs group.

Development of sediment credit system, Development and promotion of a sediment credit system for Wissahickon municipalities to use as a TMDL compliance strategy. System includes a sediment TMDL compliance pathway via stormwater volume control, and includes a volume control project inventory. The following presentations on the system were held:

- Aug 13, 2009 meeting with Cheltenham, Rudy Kastenhuber and others
- Aug 20, 2009 meeting with Larry Communale and others of Lower Gwynedd Township.
- Aug 25, 2009 meeting with Susan Patton and others from North Wales Township.
- Oct 14, 2009 presentation at Villanova Stormwater Symposium.
- Sept 24, 2009 booth at the Montgomery County Association of Township officials.
- April 14, 2010 presentation to Wissahickon municipalities at Lower Gwynedd Township building.

Schuylkill Watershed Partnership (Philadelphia-Based Partnership)

Key Person Interviews were conducted to gather information on stakeholder watershed issues and concerns. The following interviews were conducted:

- Manayunk Development Corp, Schuylkill River Project, East Falls Development Corporation, March 9, 2010.
- Fairmount Park and Schuylkill River Development Corporation, March 15, 2010.
- Bartram's Garden and Southwest Community Development Corporation, April 1, 2010.
- American Cities Foundation and Overbrook Environmental Education center, May 6, 2010.
- University City District, June 22, 2010.

Assessment of Current Watershed Status; Identification of Problems

PWD implements a detailed monitoring program in each planning shed that includes chemical, biological and physical assessments to characterize the current state of the watershed and identify existing problems and their sources.

Data Collection, Organization, and Analysis

Development of the CCR includes the collection and organization of existing data on surface water hydrology and quality, wastewater collection and treatment, stormwater control, land use, stream habitat and biological conditions, and historic and cultural resources in order to gain an understanding of existing data, which will serve as a historic reference data set for comparison against newly collected information. Additionally, existing ordinances, regulations, and guidelines pertaining to watershed management at federal, state, basin commission, county, and municipal levels are examined for coherence and completeness in facilitating the achievement of watershed planning goals. Data are collected from various agencies and organizations in a variety of forms, ranging from reports to databases and Geographic Information System (GIS) files.

This data is then supplemented by PWD's extensive physical, chemical and biological monitoring program, which is initiated for roughly one year in each watershed. A compendium document is produced following the analysis of all collected data; this document titled the Comprehensive Characterization Report (CCR) is shared with watershed partners for comments and feedback. These CCR documents are available on the partnership website at http://www.phillywatersheds.org . The CCR assessment serves to document the watershed baseline prior to implementation of any plan recommendations, allowing for the measure of progress as implementation takes place upon completion of the plan. The CCR status of each watershed is:

Table III.C-4 CCR Status of each Watershed

Darby-Cobbs	Completed 2004
Tookany/Tacony-Frankford	Completed 2005
Wissahickon	Completed 2007
Pennypack	Completed 2009
Poquessing	Completed 2010

<u>Watershed Planning Process</u>

Development of Plan Goals, Objective, Indicators and Options

PWD's watershed-wide goal setting process begins with the development of a "base set" of goals for the watershed – incorporating all available goal related statements captured within existing plans and reports. This base set of goals is then presented to the stakeholder group for evaluation. A facilitated discussion is held during which the partners are invited to add to this list of goals and finally to adopt this master list as the initial goal set for the watershed area.

Often times, this stakeholder insight may reveal "information gaps" not addressed by problem analysis that requires additional data collection. Ultimately, with stakeholder collaboration, a final list of goals is established that should reflect the multitude of stakeholder interests in the watershed.

The following example clarifies the difference between a goal and an objective for the purposes of the PWD Watershed Planning process:

Goal: These are to be general and not specifically measurable. Goals represent a series of "wishes" for the watershed. (e.g. Improve water quality)

Objective: Objectives translate the goal statements into measurable parameters. The objective should lead toward the establishment of a target value and could help to establish a trend over time. There can be multiple objectives for a single goal. (e.g. Meet state numeric criteria for bacteria in dry weather.)

Based on the preceding descriptions, each of the stakeholder goals is further evaluated and translated into objectives so that progress would be measurable as management options are implemented in the future.

Management Option: A management option is a technique, measure, or structural control that addresses one or more objectives (e.g., a stormwater best management practice (BMP) that is installed, an ordinance that gets passed, or an educational program that gets implemented).

Each objective is then evaluated for the identification of potential management options that could be implemented to achieve measurable progress toward the goal. This evaluative process results in a comprehensive list of potential options that will need to be individually evaluated for feasibility under the conditions of a given watershed area.

Indicator: Indicators can be used to characterize the current condition of a watershed area and can be used to measure progress toward achieving goals as management options are implemented. (e.g. Percentage of samples meeting state criteria for bacteria)

A list of indicator measures is developed to address each of the objectives so that as management options are implemented, progress can be measured toward attainment of the watershed goal.

Screening of Management Options

Clear, measurable objectives provide guidance for developing options designed to meet the watershed goals. Lists of management options are developed to meet each of the goals and objectives established for the watershed and once evaluated, only those options deemed feasible and practical are considered in the final list of management options. Options were developed and evaluated in three steps:

1. Development of a Comprehensive Options List. Virtually all options applicable in the urban environment are collected. These options are identified from a variety of sources, including other watershed plans, demonstration programs, regulatory programs, literature, and professional experience.

2. Initial Screening. Some options can be eliminated as impractical for reasons of cost, space required, or other considerations. Options that already planned and/or committed to, are mandated by another program, or are agreed upon as vital are chosen for inclusion in the final list as not needing further evaluation. The remaining options are screened for applicability to the watershed as well as for their relative cost and the degree to which they meet the project objectives. Only the most cost-effective options are considered further.

3. Detailed Evaluation of Structural Options. Structural best management practices for stormwater management are subjected to a modeling analysis as necessary to assess effects on runoff volume, peak stream velocity, and pollutant loads at various levels of coverage.

Water Quality Goal Setting Update

PWD's stakeholder goal setting process is one that has been refined with each watershed plan undertaken. PWD has an established a guiding set of seven "Umbrella Goals" for the IWMP process. These goals were originally established in 2002 by the Darby-Cobbs Watershed Partnership – then upheld by the Tookany/Tacony-Frankford Partnership in 2003, then adopted by the Pennypack and Poquessing River Conservation Planning processes in 2006-2008. PWD has determined that these "Umbrella Goals" because of their broadly worded nature should be utilized to guide the City's IWMP planning process, objective development and ultimately implementation commitments.

Wissahickon Creek Watershed

As documented in the FY07 Stormwater Annual Report, PWD initiated a watershed-wide goal setting process with the Wissahickon Watershed Partnership in winter/spring 2007 which resulted in a list of stakeholder goals, which consisted of 23 stakeholder goals for the Wissahickon Creek Watershed. These goals have been arranged such that they fit under the broader headings of the "Umbrella Goals".

Table III.C-5 Proposed Goals and Objectives for the Philadelphia Portion of the Wissahickon Creek Integrated Watershed Management Plan

IWMP "Umbrella" Goal	Wissahickon Watershed Partnership Goal Subset for City of Philadelphia	Measurable Objectives for the City of Philadelphia to Guide Implementation Process
Water Quality and Pollutant Loads. Improve stream quality to reduce the effects on public health and aquatic life.	Protect drinking water quality	• Continue to meet requirements of the LT2ESWTR
	Protect drinking water taste and odor	• Limit geosmin concentrations to <10ng/L between April and May
	Improve and protect surface water quality	• Meet state numeric criteria for bacteria in dry weather. • Meet State Water Quality Standards for dissolved oxygen • Meet state criteria for pH at all sites and times. • Remove Wissahickon Creek from the state list of impaired waters.
	Eliminate untreated sewage discharges to Wissahickon Creek	• Eliminate cross-connections of sanitary to storm sewers. • Eliminate sanitary sewer discharges to the stream in dry weather.
Instream Flow Conditions. Reduce the impact of urbanized flow on living resources.	Improve and maintain baseflow through increased infiltration to support water quality and aquatic community health.	• Maintain average annual dry weather flow, excluding treated wastewater effluent, at a minimum average annual flow of 59 cfs at the mouth. • Reduce amount of Directly Connected Impervious Cover (DCIA) by 1%.

IWMP "Umbrella" Goal	Wissahickon Watershed Partnership Goal Subset for City of Philadelphia	Measurable Objectives for the City of Philadelphia to Guide Implementation Process
Streamflow and Living Resources. Improve stream habitat and integrity of aquatic life.	Restore aquatic ecosystem health	• Increase benthic quality index to 80% of reference reaches. • Increase IBI to 40 averaged at all sampling sites.
Stream Corridors. Protect and restore stream corridors, buffers, floodplains, and natural habitats including wetlands.	Reduce channel erosion and sediment loads caused by runoff	• Reduce annual sediment load from overland flow by 10%. • Reduce annual sediment load from channel erosion by 75%
	Improve aquatic habitat	• Restore X miles of stream channel and habitat such that habitat scores are X% comparable to reference conditions.
Flooding. Identify flood prone areas and decrease flooding by similar measures	Reduce the frequency and severity of damaging (out of bank) flooding	• Reduce [flooding indicator] to [value at a specific location]. • Prioritize most vulnerable areas and ensure flood mitigation planning
Quality of Life. Enhance community environmental quality of life.	Improve awareness of watershed issues at a local level (municipalities and stakeholders)	• Convene a watershed partnership stakeholder forum • Establish a partnership website to serve as an information resource
	Make stormwater/watershed related educational opportunities available to every stakeholder in the watershed	• Educate residents about benefits of rain barrel installation; have 10% of watershed resident install rain barrels on their homes. • Develop and implement at least 3 stormwater management/ watershed issues related workshops within each 5 year implementation planning timeline
Stewardship, Communication, and Coordination. Foster community stewardship and improve inter-municipal, inter-county, state-local, and stakeholder cooperation and coordination on a watershed basis.	Increase preparedness for natural hazards, spills, discharges and terrorism	• Obtain agreements from the 5 WWTPs and industrial users sign up as users or the Early Warning System emergency reporting phone number • Increase the amount of continuous water quality data collected from the Wissahickon Creek (Reactivation of Ft. Washington USGS gauge station) • Utilize fish biomonitoring station to assess water quality

IWMP "Umbrella" Goal	Wissahickon Watershed Partnership Goal Subset for City of Philadelphia	Measurable Objectives for the City of Philadelphia to Guide Implementation Process
	Increase communications within the watershed	• Create a Wissahickon Creek "event notification system" for the public

PWD has been working on developing an implementation commitment to address the City's sediment load reductions as prescribed by the Wissahickon TMDL for Siltation in the shorter term, but will be developing a longer-term watershed-wide approach for addressing these goals by completing a Wissahickon IWMP along-side the Act 167 Stormwater Management Plan – scheduled to be initiated in fall 2010.

Pennypack Creek Watershed

In the spring of 2008, PWD initiated a watershed-wide stakeholder goal setting process for the Pennypack Creek Watershed as a part of the IWMP development process. The purpose was to derive a comprehensive watershed-wide "wish list" of goals for the watershed. These goals are not intended to be specifically measurable at this time. Upon completion of the watershed-wide goal setting process, the planning team will evaluate and translate each of them into measurable "objectives" so that progress would be assessable as management options are implemented in the future. Utilizing the input from the Pennypack Watershed Partnership, this goal setting process was designed to be inclusive of a multitude of stakeholder perspectives.

PWD staff prepared for the goal setting process by reviewing existing watershed plans and reports. Since the Pennypack Creek River Conservation Plan was recently completed (2005) and that planning initiative included a stakeholder goal setting process, the RCP goals were deemed an appropriate starting point from which stakeholders could begin evaluating for completeness. These goals along with others culled from additional existing sources such as the Pennypack Greenway Partnership's Strategic Planning process and the Pennypack stakeholder "Key Person Interviews" were synthesized into a list of broad goals and measurable objectives and shared with the watershed stakeholders for evaluation.

A diversely representative group consisting of roughly 27 stakeholders actively participated in the goal setting process. Of these, 7 participants represented municipalities within the drainage area, 2 represented nonprofit organizations, 2 represented the PADEP, 5 represented Bucks and Montgomery County agencies, 1 attended on behalf of a Pennsylvania State legislator's office, 1 represented a golf course, 2 represented local parks and 5 represented City of Philadelphia agencies. This stakeholder assemblage is currently evaluating a final "wish list" consisting of 8 broad goals for the Pennypack Creek Watershed.

Table III.C-6 Draft Pennypack Watershed Stakeholders Goals and Objectives

Habitat and Ecological Protection/Restoration • Improve Stream Habitat and Restore Aquatic Communities • Restore Ecological Integrity • Protection and enhancement of high quality sites
Stormwater Management • Improve In-stream Flow Conditions • Stormwater management planning
Improvement of Water Quality • Improve Water Quality and Reduce Pollutant Loads
Erosion Reduction • Improve and Protect Stream Corridors
Flooding • Mitigate Flooding
Open Space Preservation, Recreation and Cultural Opportunities • Enhance and Improve Recreational Opportunities • Permanently preserve land to ensure a protected greenway • Preserve cultural and historic resources • Build a Trial • Enhancement of tributary streams and mainstem of Pennypack Creek
Quality of Life • Enhance Quality of life for Watershed Residents
Stakeholders Involvement • Improve Stewardship, Communication and Coordination among Watershed Stakeholders and Residents • Increase understanding of, affinity for and commitment to natural systems

In the fall of 2008 the Pennypack Watershed Partnership were reconvened to approve this list of proposed goals and adopt them as representative of stakeholder goals for the watershed. These goals will be reevaluated in the winter of 2010 upon review of the PCWCCR by the watershed stakeholders. At that time goals will be prioritized and measurable objectives can be defined for each approved goal.

Poquessing Creek Watershed

The Poquessing Creek Watershed Partnership was re-convened by PWD on June 9th, 2009. At this meeting the Integrated Watershed Management Process was introduced to the stakeholders. The Partnership will be convened on the winter of 2011 in order to develop a preliminary set of stakeholder goals to guide the planning process.

Implementation Planning - Development of Target Approach for Meeting Goals and Objectives

Through PWD's experience in working with stakeholder groups in goal prioritization and option evaluation, they have learned that stakeholder priorities can at times differ from those identified by the data driven problem identification process. PWD has developed an approach that is able to address what often emerges as a set of high priority stakeholder concerns while simultaneously addressing the scientifically defined priorities. By defining three distinct "targets" to meet the overall plan objectives, priorities identified by stakeholders could be addressed simultaneously with those identified through scientific data. Two of the targets were defined so that they could be fully met through implementation of a limited set of options, while the third target would best be addressed though an adaptive management approach. In addition to the three Targets – a fourth category has been developed to capture the more programmatic implementation options related to planning, outreach, reporting, and continuation of the Watershed Partnership.

Targets are defined here as groups of objectives that each focus on a different problem related to the urban stream system. They can be thought of as different parts of the overall goal of fishable and swimmable waters through improved water quality, more natural flow patterns, and restored aquatic and riparian habitat. By defining these targets, and designing alternatives and an implementation plan to address the targets simultaneously, the plan will have a greater likelihood of success. It also will result in realizing some of the objectives within a relatively short time frame, providing positive incentive to the communities and agencies involved in the restoration, and more immediate benefits to the people living in the watershed.

PWD's IWMP planning targets are defined below:

Program Support (Planning, Outreach & Reporting)
A number of implementation options deemed appropriate for a given watershed are "programmatic" in nature. While these options may support achievement of Targets A, B, and/or C, implementation of these options alone would not result in achievement of a particular Target. These "Program Support" associated options include items such as monitoring, reporting, feasibility studies, outreach/education, and continuation of the Watershed Partnership.

Target A: Dry Weather Water Quality and Aesthetics
Streams should be aesthetically appealing (look and smell good), be accessible to the public, and be an amenity to the community. Target A was defined with a focus on trash removal and litter prevention, and the elimination of sources of sewage discharge during dry weather. Access and interaction with the stream during dry weather has the highest priority, because dry weather flows occur about 60-65% of the time during the course of a year. These are also the times when the public is most likely to be near or in contact with the stream.

Target B: Healthy Living Resources
Improvements to the number, health, and diversity of the benthic macroinvertebrate and fish species needs to focus on habitat improvement and the creation of refuges for organisms to avoid high velocities during storms. Fluvial geomorphological studies, wetland and streambank restoration/creation projects, and stream modeling should be

combined with continued biological monitoring to ensure that correct procedures are implemented to increase habitat heterogeneity within the aquatic ecosystem.
Improving the ability of an urban stream to support viable habitat and fish populations focuses primarily on the elimination or remediation of the more obvious impacts of urbanization on the stream. These include loss of riparian habitat, eroding and undercut banks, scoured streambed or excessive silt deposits, channelized and armored stream sections, trash buildup, and invasive species. Thus, the primary tool to accomplish Target B is stream restoration.

Target C: Wet Weather Water Quality and Quantity
The third target is to restore water quality to meet fishable and swimmable criteria during wet weather. Improving water quality and flow conditions during and after storms is the most difficult target to meet in the urban environment. During wet weather, extreme increases in streamflow are common, accompanied by short-term changes in water quality. Target C must be approached somewhat differently from Targets A and B. Full achievement of this target means meeting all water quality standards during wet weather, as well as elimination of flood related issues. Meeting these goals will be difficult. It will be expensive and will require a long-term effort. A rational approach to achieve this target includes stepped implementation with interim goals for reducing wet weather pollutant loads and stormwater flows, along with monitoring for the efficacy of control measures.

PWD has committed to developing and executing four sequential 5-year Implementation Plans for the City of Philadelphia portion of the drainage area within each planning shed. Thus far Implementation Plans have been developed for the Cobbs and Tookany/Tacony-Frankford Watersheds (available at www.phillywatersheds.org); the plans have matching implementation timelines, running from 2006 through 2011, and an implementation plan for the Wissahickon Creek Watershed is in development. Adaptive management will be utilized as necessary at each 5-year planning interval to ensure that progress is being achieved.

Table III.C-7 - Planning being completed in each watershed

Watershed	Preliminary Reconnaissance	Watershed Monitoring Program	River Conservation Plan	Watershed Management Plan	Implementation Commitment Status
Delaware River (tidal, non-tidal)	Monitoring Only		Initiated in 2008	Implementation plan to be developed following completion of RCP	To be developed in 2010/2011
Cobbs-Darby Creeks	2003	2003	Darby RCP completed in 2005 by Darby Creek Valley Association	Completed 2004	1st 5-year Implementation Plan developed and committed to; 2006-2011
Tacony-Frankford Creeks	2000/2001	2004	Completed in 2004	Completed 2005	1st 5-year Implementation Plan developed and committed to; 2006-2011
Pennypack Creek	2002	2007-2008	Completed in 2005	Initiated in winter 2008, to be completed by 2011/2012	To be developed 2012
Schuylkill River (tidal, non-tidal)	Monitoring Only		Completed in 2001 by the Academy of Natural Sciences, Natural Lands Trust, and the Conservation Fund	Implementation Plan to be developed for the City of Philadelphia portion of the drainage area in 2011/2012	To be developed 2011/2012
Poquessing Creek	2001	2008-2009	Completed in 2007	To be initiated in spring 2009, scheduled for completion in 2012	To be developed 2012
Wissahickon Creek	2001	2005-2006	Completed in 2000 by FPC	Initiated in 2005, anticipated completion along-side Act 167 plan – 2012/2013.	Wissahickon TMDL implementation commitment to be developed in 2011/2012; IWMP implementation plan to be completed in 2013

III.C.1.1 Ordinance and Regulations Modifications - Continue to review and revise stormwater management regulations for development and redevelopment

PWD's Stormwater Management Regulations, effective January 1, 2006, provided the PWD with an opportunity to ensure development/redevelopment that protects our water resources, reduces neighborhood flooding, and improves the quality of life in our communities. The Stormwater Management Regulation is triggered by projects which involve earth disturbance 15,000 square feet or greater, infill projects which involve earth disturbance between 5,000 and 15,000 square feet, or projects which involve earth disturbance over 1 acre and require a PA DEP NPDES permit. PWD is considering additional ways to improve and strengthen its stormwater programs during the LTCPU process by looking at reducing the minimum area to trigger the stormwater regulations to 5000 ft^2. Additional incentives are being considered to further stimulate innovative stormwater designs, including:

• Fee in lieu: allowing stormwater controls to be transferred to another location if efficiency is improved
• Green permit expediting: green designs are fast tracked through the permit review process
• Evaluate the potential for linking green stormwater infrastructure to other incentives related to zoning, such as density/setback incentive bonuses for increased stormwater control beyond the minimum requirements.

The full stormwater regulations for the City of Philadelphia can be found at
http://www.phillyriverinfo.org/Programs/SubprogramMain.aspx?Id=Regulations

Please refer to the Stormwater Management Report **SECTION F.5.B "POST-CONSTRUCTION STORMWATER MANAGEMENT IN NEW DEVELOPMENT AND REDEVELOPMENT"** on page 279 for more information on the Stormwater Management Regulations.

III.C.1.2 Conduct workshops on LID

The Plan Review team holds weekly Plan Review walk-in hours each week on Tuesdays from 11am – 1pm. The development community is invited to discuss general and technical details about their projects. Guidance is given by PWD staff on stormwater management implementation.

III.C.1.3 Implementation of Stormwater BMPs and LID - Continue to implement best management and LID demonstration

Parcel-based Stormwater Billing

For many years, the Water Department has recovered the costs for the operation and maintenance of its stormwater system components (pipes, storm drains, pump stations, treatment facilities, and billing) through a service charge related to our customers' water meter size. This method was considered a reasonable means to approximate the relative contribution of a property to stormwater runoff volumes since properties with larger water meters are usually larger parcels of impervious land. In 1994, the Water Department convened a diverse group of stakeholders, the Stormwater Charge Citizens Advisory Council (CAC), to make recommendations for improving the stormwater charge methodology.

The CAC recommended that the City use a formula based billing approach to more accurately calculate the relative volume of stormwater generated from a property. The CAC recommended that 80 percent of the stormwater costs be recovered based on a property's impervious area and 20 percent of the stormwater costs be based on the property's gross area. The CAC recognized that providing a detailed analysis of each of the City's 450,000 residential properties would be expensive and not provide a significant improvement in the fairness of the residential property based charge. They recommended that the City's residential properties be treated as a single parcel with total gross area and imperviousness area factors with the total cost divided among all residences. This recommendation was implemented in the FY 2002 tariff and resulted in a decrease in stormwater costs to residences and other smaller meter customers.

At the time when the FY 2002 rates were being developed, the City did not have accurate or adequate parcel information to transition from a meter based charge to a property based stormwater charge among its non-residential customers. Accordingly, the meter based charge was maintained to distribute the stormwater-related costs among non-residential customers. In early 2006, the Water Department began the process of validating the City's parcel data information with the Bureau of Revisions and Taxes (BRT) database and orthographic (impervious) information. The impervious area information was procured from the contracted flyover of the City in 2004. Water Department staff has analyzed the approximately 85,000 non-residential parcels to determine, on an individual customer basis, the stormwater runoff contribution of each large customer parcel. The new stormwater charge will be calculated using the following formula:

Stormwater Charge = ((Total Parcel Area / 500) * Gross Area Rate) + (Parcel Impervious Area / 500) * Impervious Area Rate)

The Water Department will transition to stormwater charges among its large meter, non-residential customer base over a four year period beginning in FY 2011. Accordingly, the first bills based on this new methodology went out July 1st, 2010. Below is a chart describing the phase-in:

Table III.C.1-1 Phase-in to the New Billing System

Duration	Meter Size Based Stormwater Charge (Old Method)	Parcel Area Based Stormwater Charge (New Method)	Total Monthly SWMS Charge
July 1, 2010 through June 30, 2011	75%	25%	100%
July 1, 2011 through June 30, 2012	50%	50%	100%
July 1, 2012 through June 30, 2013	25%	75%	100%
July 1, 2013 through June 30, 2014	0%	100%	100%

This transition will result in more equitable stormwater charges that closely match the cost of managing stormwater runoff from each property. For those customers that will see noticeable increases in their stormwater fees, the department will assist in identifying opportunities on their property to decrease the amount of their impervious area and thus decrease their stormwater fees.

The Water Department is going to charge a stormwater fee to properties that do not presently have a water/sewer account. These parcels generate stormwater runoff that is managed by the City and therefore should be reasonably charged for such service. Current non-customers include parking lots, utility right-of-ways, and vacant lands. Large meter customers have recognized this discrepancy and demanded these currently unbilled parcels share the cost burden of stormwater management. The Water Department is applying the same formula to these properties as is being applied to all other non-residential customers.

The CAC also encouraged the City to provide a means for customers to ease the burden of property based stormwater charges. Customers who have the ability to decrease the amount of directly connected impervious area (hard surfaces that direct runoff to the City's sewer system) on their property may do so using any number of stormwater management practices (rain gardens, infiltration islands, porous asphalt and sidewalks, vegetated swales, green roofs). Once a property has been retrofit with any of these features, the Water Department will re-evaluate the property's stormwater fee based on the remaining unmanaged impervious area and the total area of the property.

In addition to the data processing and maintenance necessary to ensure the successful implementation of this project, PWD has ensured public outreach to potentially affected customers be made a priority. During the lead-up to the launch of this project in July 2011, PWD held numerous public meetings and reached out to individual customers who will see a significant increase in the stormwater portion of their bills. PWD also retained a consultant design firm to offer a free site inspection and conceptual stormwater management design that, if implemented, will reduce their stormwater charge.

If a property owner feels their stormwater bill is being improperly calculated, they can submit an appeal through the PWD Stormwater Appeals program. This program allows property owners to submit corrections to the PWD maintained gross and impervious area, the BRT maintained property ownership information, and the PWD maintained water account data. If a correction is order, once it is made, the stormwater bill for the property is recalculated.

BMP and LID projects

A comprehensive list of BMP projects are presented in **TABLES: III.C.1-2** and **III.C.1-3** below. The tables include projects in both MS4 as well as combined sewersheds since the projects, regardless of location within the City, present an opportunity to assess implemented technologies. The assessments can then be used to select appropriate practices for improving water quality and quantity. Additional information regarding each project can be found in **APPENDIX D – BMP PROJECTS**. Completed projects are presented in **TABLE: III.C.1-2** and potential projects are listed by name, watershed, and project stage in **TABLE: III.C.1-3**. The five project stages presented in **TABLE: III.C.1-3** are: construction complete, design complete, in construction, in design, and ongoing.

Construction Complete: The project has been fully constructed
Design Complete: The project has been fully designed and is ready for contractor bids
In Construction: The project is currently under construction in FY 2009
In Design: The project is currently being designed by PWD staff and partners in FY 2009
Ongoing: The project is still undergoing multiple stages of design or construction

In addition, a map of BMP locations are shown in **FIGURE: III.C.1-1** with current statuses.

Since the FY 2009 Stormwater Annual Report, great progress has been made in the construction, design, and initiation of new wet weather BMPs. Since FY 2009, 10 new projects have been added to the 'in design' stage, 1 new project has been added to the 'design complete' stage, and 2 new projects have been added to the 'in construction' stage. In addition to new projects, of those presented in FY 2009, 2 projects have moved from 'design complete' to 'construction complete' stage, 4 projects have moved from 'in design' to 'design complete' stages, 1 project has moved from 'in design' to 'in construction / design complete' stages, 4 projects have moved from 'design complete' to 'in construction' stages, 1 project has moved from "in design" to the "ongoing" stage to better reflect the project status, 1 project has moved from the "ongoing" stage to "design complete," and 1 project was removed from the "ongoing" list as it has been broken into specific projects in the "in design" and "design complete" stages. 1 project presented in FY 2009 was removed from the 'in design' list as the project was taken on by a partner agency.

Please refer to **APPENDIX D – BMP PROJECTS** for fact sheets describing all of the projects below.

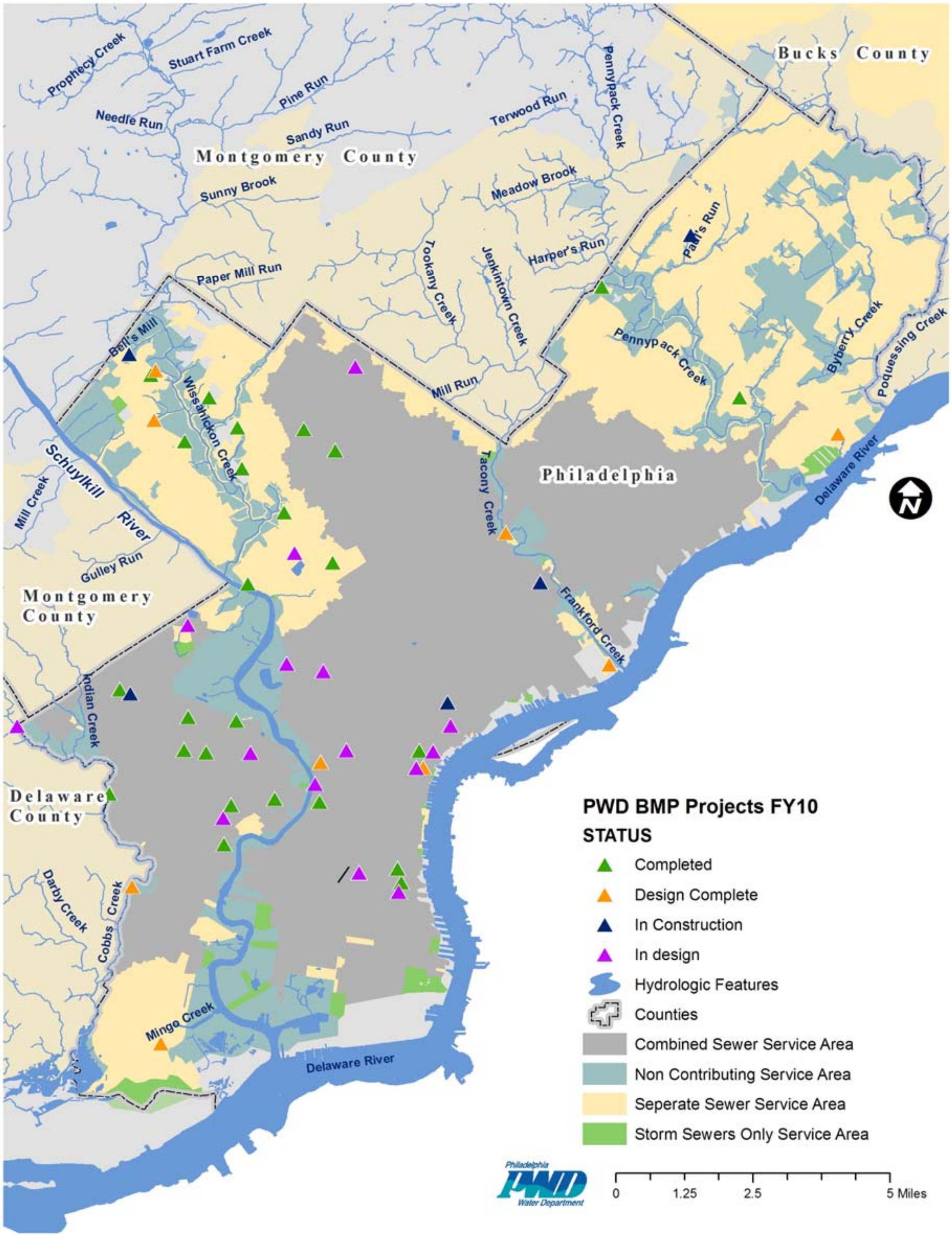
Table III.C.1-2 PWD Completed Stormwater BMP Projects

Project Name	Watershed	Shed Type
47th & Grays Ferry Rain Garden	Schuylkill	Combined
Allens Lane Art Center Porous Basketball Court	Wissahickon	Separate
BLS Meadow	Tacony-Frankford	Combined
Clark Park Infiltration Project	Schuylkill	Combined
Cliveden Park Stormwater Project	Tacony-Frankford	Combined
Columbus Square Streetscape	Delaware	Combined
Courtesy Stables Runoff Treatment Project	Wissahickon	Separate
East Falls Parking Lot Bio-retention	Schuylkill	Separate
Fox Chase Farms Riparian Buffer Project	Wissahickon	Separate
Greenfield Elementary School	Schuylkill	Combined
Herron Playground Porous Basketball Court	Delaware	Combined
Jefferson Square Raingarden	Delaware	Combined
Liberty Lands Stormwater Project	Delaware	Combined
Marshall Road Stream Restoration	Cobbs	Combined
Mill Creek Playground Porous Basketball Court	Schuylkill	Combined
Mill Creek Farm	Schuylkill	Combined
Monastery Stables Stormwater Diversion & Detention Project	Wissahickon	Separate
N. 50th St. Retrofit (Tree Planting, Garden, & Rain Barrels)	Schuylkill	Combined
Overbrook Environmental Education Center	Schuylkill	Combined
Penn Alexander School (Porous Paving & Raingarden)	Schuylkill	Combined
Pennypack Park Wetland & Pervious Parking Lot	Pennypack	Separate
Saylor Grove Stormwater Treatment Wetland	Wissahickon	Separate
School of the Future (Green Roof & Cistern)	Schuylkill	Combined
Springside School Stormwater Improvements	Wissahickon	Separate
Waterview Recreation Center Streetscape	Tacony-Frankford	Combined
W.B. Saul High School	Wissahickon	Separate
West Mill Creek Infiltration Tree Trench	Schuylkill	Combined
Wissahickon Charter School Rain Garden	Schuylkill	Separate

Table III.C.1-3 Current PWD Stormwater BMP Projects

Project Name	Project Stage	Watershed	Shed Type
16th St from Snyder Ave to Jackson St Green Streets	In construction	Schuylkill	Combined
Bells Mill Stream Restoration	In construction	Wissahickon	Separate
BLS Streetscape – stormwater planters & tree trenches	In construction	TTF	Combined
Hartranft School Green Streets	In construction	Delaware	Combined
Lancaster Ave. Streetscape (59th -63rd)	In construction	Schuylkill	Combined
Queen Lane Streetscape	In Construction	Schuylkill	Separate
Schissler Recreation Center – Big Green Block	In Construction / Design Complete	Delaware	Combined
Baxter Visitor's Parking Lot	Design complete	Delaware	Separate
Belfield Ave from Chew Ave to Walnut Ln Green Streets	Design complete	TTF	Combined
Ben Franklin Blvd Streetscaping	Design complete	Schuylkill	Combined
Blue Bell Tavern Park Stormwater Improvements	Design complete	Cobbs	Combined
Cathedral Run Watershed Restoration	Design complete	Wissahickon	Separate
Delaware Ave Extension Bioretention Swales	Design complete	Delaware	Separate
Madison Memorial Park	Design complete	Delaware	Combined
Passyunk Ave. Stormwater Improvements	Design complete	Schuylkill	Combined
Tacony Creek Whitaker Ave. Stream Restoration	Design complete	TTF	Combined
Wise's Mill Watershed Restoration	Design complete	Wissahickon	Separate
12th St from Dickinson St to Tasker St Green Streets	In design	Delaware	Combined
39th and Olive Recreation Center Improvements	In design	Schuylkill	Combined
3rd and Fairmount Ave Intersection Green Streets	In design	Delaware	Combined
Anna B. Day School Green Streets	In design	TTF	Combined
Barry Playground Stormwater Improvements	In design	Schuylkill	Combined
Belmont WTP Streetscapes	In design	Schuylkill	Separate
Bodine High School Green Streets	In design	Delaware	Combined
Cherry Street Connector	In design	Schuylkill	Combined
Chew Playground Green Streets	In design	Schuylkill	Combined
Clark Park Permeable Sidewalk and Infiltration Trench	In design	Schuylkill	Combined
Clemente Park Infiltration Tree Trenches	In design	Schuylkill	Combined
Columbus Square Raingarden	In design	Delaware	Combined
Darby Cobbs Stream Restoration	In design	Cobbs	Separate
Dickinson Square Streetscaping	In design	Delaware	Combined
Epiphany of Our Lord School Green Streets	In design	Delaware	Combined
Francis Scott Key School Green Streets	In design	Delaware	Combined
Germantown Avenue Streetscaping	In design	Delaware	Combined
John F. Kennedy Blvd from 30th St to 32nd St Green Streets	In design	Schuylkill	Combined
Mander Recreation Center	In design	Schuylkill	Combined
Redd Rambler Run Stream Restoration	In design	Pennypack	Separate
Thompson and Columbia Bumpouts	In design	Delaware	Combined
Wakisha Charter School and Dendy Recreation Center Green Streets	In design	Delaware	Combined
Welsh School Green Streets	In design	Delaware	Combined
Spring Garden Greenway	Ongoing	Delaware	Combined

Figure: III.C.1-1 BMP Locations & Project Stage



PWD's Land-based Program

The PWD's Land-based Program is part of a major city initiative to transform Philadelphia into one of the most sustainable cities in the country. The Land-based Program can be thought of as a series of individual programs, each targeting a different source of stormwater runoff. There are 10 key programs and associated subprograms that will be utilized to help PWD and the City of Philadelphia manage the existing impervious area.

With the development of the LTCPU, PWD will be detailing the Land-based Program and the tools that are needed to implement each program. The 10 major programs of the land-based Program are: Green Streets, Green Alleys and Driveways, Green Schools, Public Facilities, Green Parking, Public/Open Spaces, Green Homes, Green Industry, Green Businesses and Commerce, and Green Institutions.

III.C.1.4 Catch Basin Control Program - Continue to maintain the trapped inlets

Please refer to CSO **SECTION II.F.1 "CONTROL THE DISCHARGE OF SOLIDS AND FLOATABLES BY CLEANING INLETS AND CATCH BASINS"** on page 35.

III.C.1.5 Impervious Cover Disconnection - Evaluate the feasibility of separating the stormwater runoff from large impervious land tracts for management and direct discharge

PWD is working to separate the stormwater runoff from large impervious land using many different approaches such as a new parcel-based stormwater billing system, plan review for development and re-development incentives, and working with PennDOT on the I95 improvements.

Parcel-based Stormwater Billing

Please refer to **SECTION III.C.1.3 "IMPLEMENTATION OF STOMWATER BMPS AND LID - CONTINUE TO IMPLEMENT BEST MANAGEMENT AND LID DEMONSTRATION"** on page 130 for information on Parcel-based Stormwater Billing.

I95 Redevelopment

PWD anticipates the disconnection of a significant portion of the Delaware Waterfront as a result of a unique series of events and coordinated planning efforts that have provided the opportunity to add new storm sewer system to drain stormwater on Interstate 95 (I-95) and the waterfront area east to the Delaware River. This will result in the removal of up to 2% of the combined sewer service area of the City of Philadelphia.

PennDOT is re-constructing the I-95 corridor within the City of Philadelphia to improve traffic flow, reduce dropped lanes on the interstate and re-design interchanges to alleviate traffic on the local roads. In order to meet Philadelphia's stormwater regulations (enacted January 1, 2006), PennDOT will pipe stormwater generated from the highway directly to the Delaware River. Since their stormwater drainage system is designed to prevent flooding on the elevated highway, the stormwater pipes will be large in diameter. PennDOT has agreed to work with PWD to over-size the stormwater pipes to the river. The increased capacity in these stormwater conveyance pipes will accommodate stormwater runoff from all future riverfront development between the interstate and the River, disconnecting the area from Philadelphia's combined sewer system.

All development or redevelopment projects regulated by the 2006 stormwater regulations are required to build two lateral pipes to the curb line, one for sanitary wastewater and a second for stormwater, regardless if the project is located in a separate or combined sewer area. Therefore if the waterfront development projects occur even before the new separate stormwater pipes are constructed, disconnection of the waterfront area will be mandated.

The schedule of disconnection from the CSO system will depend on PennDOT's construction project and outside forces affecting waterfront development, requiring continuous PWD coordination. PennDOT has proposed a general schedule of design and construction of six sections, from Race Street north to Academy Boulevard; and has hired engineering firms to manage the design of each section. **TABLE III.C.1-4 AND FIGURE III.C.1-2** illustrates the proposed schedule for the planned and designed segment of construction. PennDOT is starting on the re-design and construction of the Cottman-Princeton Interchange (CPR) and the Girard Interchange (GIR), and will follow with the interchange and highway areas in between. The segments south of Vine Street will be bid, designed and constructed throughout the later years of the LTCPU implementation period.

Table III.C.1-4 Proposed Schedule for I-95 Expansion

Section	Phase	Concept	Technical	Design Review
Cottman to Academy	RS1-RS3	N/A	N/A	Approved
Girard Avenue Interchange	GR0	N/A	N/A	Approved
Girard Avenue Interchange	GR1	Approved	Rejected 4/6/2010	Waiting for submittal
Cottman Princeton Interchange	CP1	N/A	N/A	Approved
Cottman Princeton Interchange	CPU	N/A	N/A	Combined with CP2
Cottman Princeton Interchange	CP2	Approved	Received 2/4/10 Approved	Waiting for submittal

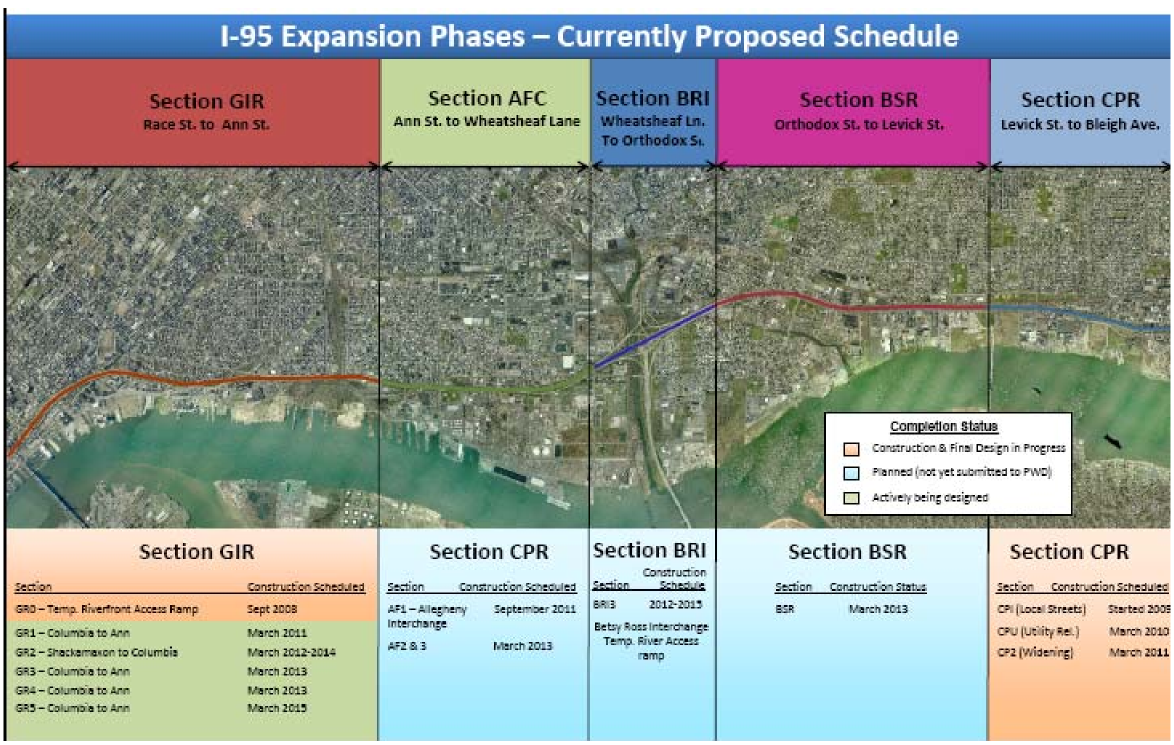


Figure III.C.1.-2 Proposed Schedule for I-95 Expansion Phases

This project all serves an example of how major capital investments from government agencies can leverage private investment in Philadelphia as a result of the Green City, Clean Waters Program.

Plan Review

Under Philadelphia's new stormwater management regulations, development and redevelopment is helping to significantly reduce the amount of directly-connected impervious cover.

Please refer to the Stormwater portion of the Annual Report **SECTION F.5 "POST-CONSTRUCTION STORMWATER MANAGEMENT IN NEW DEVELOPMENT AND REDEVELOPMENT"** for more information on PWD's Plan Review work on page 279.

III.C.1.6 Reforestation - Work to implement reforestation demonstration projects to provide additional tree canopy

BMP Projects

The OOW is actively involved in numerous projects throughout the city that are increasing the urban tree canopy. These projects include planting street trees, installing stormwater management tree trenches, constructing vegetated bioswales, and other plantings. Current projects that are completed or in progress include Baltimore Avenue, Union Hill, Rittenhouse Square, Waterview Recreation Center, West Mill Creek, 47th and Gray's Ferry, and Columbus Square. Many similar projects are currently in the planning stage including Blue Bell Triangle, Liberty Lands, Passyunk and 28th, 61st, and 63rd, Queen Lane, and Belmont treatment plant.

Please refer to **SECTION III.C.1.3 – IMPLEMENTATION OF STORMWATER BMPS AND LID** on page 132 for information on BMP projects.

Tree Planting

PWD has also been increasing the amount of green infrastructure installations in the City. Green infrastructure diverts stormwater runoff into a vegetated system where it either infiltrates into ground or is stored and slowly released back into the sewer system. Green infrastructure projects have both stormwater management benefits, as well as community greening benefits. In FY 2010, PWD worked with Greenfield Elementary School on the installation of a rain garden in their playground that included 17 new trees. In addition to this, 12 trees were planted in single-unit stormwater tree pits near Konrad Square and 4 stormwater planters were constructed on a block of Columbus Square Park. PWD also designed stormwater tree trenches for 6 locations, 7 stormwater planters, and 6 vegetated bumpouts. Construction of these projects will be completed in FY 2011. These projects will result in the planting of 50 new trees.

Upcoming stream restoration and wetland creation projects will also results in substantial tree and shrub planting in and around stream corridors throughout the City of Philadelphia. The Whitaker Avenue Stream Restoration project, to be constructed in

FY 2011, will include planting of 752 trees and 2,256 shrubs. The Wises Mill Wetland Creation and Stream Restoration project, to be constructed in FY 2011, will result in the planting of 104 trees and 223 shrubs. The Cathedral Run Stormwater Treatment, to be constructed in FY 2011, will include 42 trees and 11 shrubs. Finally, the Bells Mill Stream Restoration, to be constructed in FY 2011-12, will result in the planting of 2,158 trees and 8,118 shrubs.

PWD also provides support for tree plantings, such as supplying University City Green and others with 100 shovels for volunteer plantings. PWD also encourages tree planting on private development by giving credits toward their stormwater management requirements.

The current city administration has adopted a goal of increasing urban tree canopy to 30% which is equal to planting an additional 300,000 trees city wide. This is a goal the PWD supports and will facilitate as possible.

<u>Tree Vitalize</u>

PWD is an active partner and supporter of the Tree Vitalize program. Tree Vitalize was developed by the Pennsylvania Department of Conservation and Natural Resources to increase the tree canopy in the five county Philadelphia area. Tree Vitalize partners with numerous community groups throughout this area in order to work toward planting trees in neighborhoods lacking sufficient tree canopy.

III.C.2 WATER: Ecosystem Restoration and Aesthetics

III.C.2.1 Waterways Restoration Team - Continue the assignment of a dedicated clean-up team to remove cars, shopping carts, and other debris, from CSO receiving waters

Please refer to **Section II.F.2 "CONTINUE TO FUND AND OPERATE THE WATERWAYS RESTORATION TEAM (WRT)"** on **PAGE 36** for information pertaining to the Waterways Restoration Team.

III.C.2.2 Waterways Restoration Team - Evaluate the capabilities of this crew in performing minor stream bank and bed repair around outfall pipes and to remove debris at these outfalls

Please refer to **Section II.F.2 "CONTINUE TO FUND AND OPERATE THE WATERWAYS RESTORATION TEAM (WRT)"** on page 36 for information pertaining to the Waterways Restoration Team.

III.C.2.3 Stream Habitat Restoration - Propose and implement demonstration projects to address habitat degradation by engineering the stream channels to modern day flows and directly reconstructing the aquatic habitat

PWD is currently employing natural stream channel design (NSCD) and associated stormwater management BMPs as a means to improve the health of aquatic communities in receiving waters with degraded flow and habitat alterations due to stormwater runoff. NSCD aims to restore receiving waters in several ways, including the reconstruction of stream geometry to accommodate present day flows, reestablishing stream access to the flood plain, installing in-stream energy dissipating devices, and creating low velocity nulls by using vernal pools to achieve flood attenuation and treatment. The exploration of the NSCD technique is required in Section 2, Step 3b of the City of Philadelphia MS4 NPDES permit. The permit requires the City to employ and evaluate NSCD as a viable rehabilitation option for channelized, eroded, scoured, silted, and inhospitable streams within Philadelphia County. These techniques are being deployed by PWD to work toward improving the healthy living resources of Philadelphia, including the number, health, and diversity of benthic invertebrates and fish species in watersheds impacted by stormwater. In addition to meeting permit requirements, the Marshall Road, Wise's Mill, Whitaker Avenue, Redd Rambler, and Cathedral Run stream restoration projects carried out by PWD will hopefully demonstrate to neighboring communities the environmental benefits of NSCD.

Cobbs Creek Stream Restoration

In 2008, PWD contracted with the joint venture team of Biohabitats and O'Brien & Gere to guide the long-term vision of aquatic ecological restoration work planned in the Cobbs Creek Watershed. Over the next 20 years, PWD intends to implement natural stream channel and wetland design work along the main stem of the Cobbs Creek within the City of Philadelphia. Anticipated benefits of this riparian corridor restoration are reduced stream bank erosion, decreased channel deposition and scour, and restoration of the natural functions of aquatic habitat and ecosystems.

The joint venture team has been contracted to implement the assessment and project feasibility phase of the plan. During FY 2010, PWD completed the *Cobbs Creek Stream Restoration Feasibility Study*. The project area for this Study includes the stream corridor and floodplain from City Line Avenue to Woodland Avenue, representing more than seven miles of stream. The final report documents impairments throughout the project area and provides conceptual recommendations. Throughout FY 2010, PWD has been conducting outreach with applicable stakeholders along the entire corridor and has been working to prioritize recommended actions moving forward. PWD, in partnership with the Philadelphia Department of Parks and Recreations, plans to begin the design phase on multiple reaches of Cobbs Creek in FY 2011.

Tacony Creek Stream Restoration

In 2008, PWD contracted with the Stantec to guide the long-term vision of aquatic ecological restoration work planned in the Tacony Creek Watershed. Over the next 20 years, PWD intends to implement natural stream channel and wetland design work along the main stem of the Tacony Creek within the City of Philadelphia. Anticipated benefits of this riparian corridor restoration are reduced stream bank erosion, decreased channel deposition and scour, and restoration of the natural functions of aquatic habitat and ecosystems.

During FY 2010, PWD completed the *Tacony Creek Restoration and Ecosystem Enchancement Program Feasibility Study*. This document provides a comprehensive vision of the biological, physical, social impairments present within the Tacony Creek corridor from Cheltenham Avenue to Castor Avenue. Upon assessing these impairments, the Study presents and maps restoration opportunities throughout each individual defined reach. Moving forward, PWD, in partnership with the Philadelphia Department of Parks and Recreations, plans to begin the design phase on a reach of Tacony Creek in FY 2011.

Marshall Road

The concept behind this project was to implement a sustainable approach to stream habitat restoration that would mitigate the impacts of urban development and related hydrologic and hydraulic modifications. By enlisting the members of the Darby-Cobbs Watershed Partnership and national experts, this local watershed restoration effort restored 1000 linear feet of the Cobbs Creek stream corridor between Pine Street and Cedar Avenue using natural restoration techniques. The primary goal of this project was to identify and document existing stream conditions, develop conceptual alternatives, prepare final design and construction drawings, and stabilize a reach of Cobbs Creek using fluvial geomorphologic principals and natural channel design techniques. In general, this approach to stream bank stabilization combines the disciplines of fluvial geomorphology, hydraulics, hydrology, and applied ecology. This approach depends on accurate identification of stream classification type, an understanding of hydrologic actions within the watershed and their effects on a stream channel, and clearly defined restoration goals. Sound fluvial geomorphologic principles and an understanding of the natural stream system are integral to creating a stable stream channel that facilitates the restoration of the riparian ecosystem. This project was constructed during the Fall 2004, with additional planting occurring during the Spring 2005.

During the FY 2009 monitoring period, PWD implemented its full NSCD Physical/Biological/Habitat monitoring protocol to comprehensively assess the performance of this natural stream channel design project. This effort, conducted in June, 2009, is summarized in a comprehensive monitoring report which is available upon request. During FY 2010, annual monitoring was conducted. This included quarterly photo monitoring at designated photo points, as well as comprehensive physical monitoring of the restoration site, which was performed in April, 2010. During FY 2011, PWD will be updating the comprehensive monitoring report with the monitoring data collected during FY 2010 and will continue with the implementation of the Physical/Biological/Habitat monitoring protocol.

Whitaker Avenue

The Tacony Creek – Whitaker Avenue stream restoration project is situated in the Tacony Creek Park located of Roosevelt Boulevard (US 1) downstream of the Whitaker Avenue Bridge and upstream of the Wyoming Avenue Bridge in northeastern Philadelphia. This project will implement a sustainable approach to stream habitat restoration that will mitigate the impacts of urban development and related hydrologic and hydraulic modifications over approximately 2,000 feet of stream length. PWD has assembled a project team to develop an approach for the restoration of Tacony Creek that encompasses the replication of natural hydrologic and ecological cycles, sustainability, enhancement to riparian and in-stream aquatic habitat, improved aesthetics, and significant cost savings over structural solutions. The results of this approach include not just stable stream bank geometry, but also long term ecological stability.

The project site involves 2 stakeholders, Fairmount Park Commission and the Scattergood Foundation, both of whom are partners in working to see this project to fruition.

During FY 2009, PWD finally received joint permit approval from PADEP and USACE. In addition, final plans and specifications were completed. In FY 2010, PWD entered into a cost-share construction agreement with USACE to implement the Whitaker Avenue stream restoration design. After extensive review by USACE, the project was bid and awarded. During FY 2011, PWD expects the project to be constructed and will begin monitoring.

Redd Rambler

Over the last three and a half years, PWD has worked diligently with the 89 property owners that border this stream. While this has caused significant delays in the design process, PWD also has felt that these efforts have been worthwhile in ensuring the resident's confidence in the stewardship of the City and its environment.

At this time last year, PWD was dealing with property owners along the stream corridor to get the necessary level of project buy-in. Unfortunately, due to the significant land ownership issues associated with this project, there have significant delays that may actually affect the feasibility of this project. PWD has continued to work with the residents adjacent to Redd Rambler to obtain Temporary Construction Access agreements along the entire project area. While we have received more than 60% of the necessary agreements, the remaining residents have been hesitant to provide PWD with permission to perform work in all areas. In addition, PWD will still require legislation to be passed in City Council to extend Right-of-Way in some areas to assure that PWD can continue to operate and maintain this project in the future. Each of the issues has indefinite time frames associated with them. During FY 2010, PWD continued to work with property owners adjacent to Redd Rambler Run in attempt to get full buy-in on the project. Unfortunately, multiple key property owners were not supportive of this project and it was put on hold in February 2010.

Bell's Mill

Bells Mill is a 2nd order tributary to Wissahickon Creek. The tributary arises from an outfall near the intersection of Lykens and Bells Mill roads. The restoration/stabilization design for Bells Mill Run will focus on specific restoration areas. Streambank stabilization will make use of standard rock vanes, "J" vanes, cross vanes, wing deflectors, root wads, grade control measures and live branch layers. These structures will allow for improved habitat and sediment transport dynamics while protecting critical sewer infrastructure.

In FY 2008, PWD started the design process on restoring approximately 6,000 feet of impaired stream of Bell's Mill Run, a tributary in the Wissahickon Creek Watershed that flows directly into Wissahickon Creek. During FY 2009, PWD continued the design process on this stream. To date, PWD has completed the 60% Design and has submitted to PADEP for permitting. During FY 2010, PWD finalized the design of this project. It is expected that during FY 2011, this project will be bid and construction will commence.

III.C.2.4 Wetland Enhancement and Construction - Propose and implement wetland enhancement and construction projects to remove pollutants, mitigate peak flow rates, reduce runoff volume, and provide considerable aesthetic, and wildlife benefits

Saylor Grove Wetland in Wissahickon Watershed

A one-acre stormwater wetland was constructed in the fall of 2005 on a parcel of Fairmount Park known as Saylor Grove. The wetland is designed to treat a portion of the 70 million gallons of stormwater generated in the sewershed per year before it is discharged into the Monoshone Creek. The Monoshone Creek is a tributary of the Wissahickon Creek- a source of drinking water for the City of Philadelphia. The function of the wetland is to treat stormwater runoff in an effort to improve source water quality and to minimize the impacts of storm-related flows on the aquatic and structural integrity of the riparian ecosystem. This project is a highly visible urban stormwater BMP retrofit in the Wissahickon Watershed.

During the FY 2009 reporting period, PWD resurveyed the Saylor Grove to determine the amount of sedimentation taking place within the facility. Approximately 22,000 cubic feet of material accumulated within the first two and a half years since construction. In addition, invasive plant species have colonized within the facility. During the FY 2010 reporting period, PWD dredged portions of the stormwater wetland, removing more than 150 tons of sediment. Invasive species management was also conducted in partnership with the Fairmount Park. PWD also continued water level monitoring in support of calibrating the H&H model for the facility.

Wises Mill Wetland in Wissahickon Watershed

Wises Mill Run is a steep first-order tributary to the mainstem of the Wissahickon Creek. The Wises Mill Run watershed consists of a 92 acre southern portion and a 169 acre northern portion that merge just north of Wises Mill Road before meeting the

Wissahickon Creek. Both branches are negatively affected by urbanization and large storm events. Severe entrenchment has occurred in both branches and excessive amounts of sediment have been transported to the Wissahickon Creek. Picking up on the restoration work on the 250 foot reach constructed by PWD's Waterways Restoration Team, during FY 2008, PWD commenced the design of a stormwater treatment wetland on a 2-acre area of Fairmount Park. The wetland will infiltrate, detain, and treat a portion of stormwater from a 90-acre watershed prior to discharging to the headwaters of Wises Mill's lower branch. In addition, this effort aims to restore and stabilize areas of Wises Mill Run that have been significantly undermined by stormwater infrastructure and dams on this stream. These efforts will target several hundred feet of stream along the 6,800 foot long tributary to Wissahickon Creek. Overall, sediment erosion will be reduced and aquatic and macro-invertebrate life will be improved.

During FY 2010, PWD received final necessary permits, and bid and awarded this project. In FY 2011, PWD expects to complete construction of the Wises Mill Wetland.

Cathedral Run Stormwater Wetland

Cathedral Run is a 1st order tributary to Wissahickon Creek. The stream originates from springs downstream of Courtesy Stables near the intersection of Cathedral and Glen Campbell Roads. PWD is designing a stormwater treatment wetland just west of the current location of outfall W-076-01. The wetland will be located in a natural depression area, approximately one acre in size. The project will provide more than 94,445 ft^3 of storage and will substantially reduce flows to an impaired reach of Cathedral Run. During dry weather, the facility will provide one acre of valuable wet meadow habitat. During FY 2010, PWD received final necessary permits, and bid and awarded this project. In FY 2011, PWD expects to complete construction of the Cathedral Run Stormwater Wetland.

Gorgas Run Stormwater Wetland and Stream Restoration

Gorgas Run is a steep headwater tributary to the Wissahickon Creek with a drainage area of 499 acres. Due to high peak stormwater flows, Gorgas Run has been severely degraded and is rated as an 'F' Type stream channel. To mitigate the impacts of development in the Gorgas Run watershed, PWD is proposing to create a stormwater treatment wetland facility to manage stormwater prior to discharge into Gorgas Run. The facility could potentially provide over 200,000 ft^3 of treatment volume, significantly reducing the peak flows and volumes impacting Gorgas Run, and eventually Wissahickon Creek. In addition, PWD is proposing to apply NSCD principles to restore the 1,800 feet of stream channel that encompasses Gorgas Run. In combining these efforts, PWD believes that the quality of both Gorgas Run and Wissahickon Creek will be improved. During FY 2010, PWD began conceptual design of this project, which included topographic survey, soil borings, and groundwater monitoring wells. During FY 2011, PWD expects to move toward final design plans and submit all necessary permit applications, with hopes of constructing this project during FY 2012-13.

Indian Creek Stream Daylighting & CSO Storage Project

The Cobbs Creek Integrated Watershed Management Plan dated June 2004 recommends implementation of this project as a means to reduce streambank and channel deposition and scour, and to protect and restore the natural functions of aquatic habitat and ecosystems, streambanks, and stream channels. Without implementation of this project, the Cobbs Creek and Indian Creek Watersheds will continue to degrade in terms of environmental quality, aquatic habitat, and public health and safety preventing the City from obtaining its goal of reduction or elimination of point source discharges of pollutants to its watersheds.

This project involves the design and construction of approximately 650 to 1,000 feet of new stream channel that connects the West Branch Indian Creek to the East Branch Indian Creek and bypasses the combined sewer system. The project would divert the creek out of the existing 700-foot brick culvert and restore the surrounding stream channel, which is severely degraded and prone to flooding. In addition, the vacated culvert will serve as storage for the majority of CSO discharges from C_05 during wet weather and release the flow back to the collection system as capacity becomes available for conveyance to the Southwest Water Pollution Control Plant (SWWPCP). PWD initiated the project as part of its watershed management program, completing the preliminary design effort.

PWD quantified the estimated improvements to CSO overflows using the period 1990-91, 93-94, 96 & 98. This 6-year period is representative of the long-term rainfall record observed at the Philadelphia International Airport and is consistently used by PWD when quantifying CSO abatement. Through these proposed modifications, 180,000 gallons of storage will be available to store flow from the SWO of regulator C_05 that would otherwise discharge directly to Indian Creek. With this amount of storage available, average annual overflow frequency from C_05 would decrease from 24 per year to 3 per year with a reduction in discharge volumes from 2.9 to 1.2 million gallons per year.

One of the major goals of PWD is the reduction or elimination of point source discharges of pollutants to its watersheds. This is especially important in the more sensitive receiving streams and tributaries that are found in the Cobbs Creek watershed. The daylighting of the West Branch Indian Creek will provide a convenient and cost-effective opportunity of achieving this goal.

The benefits of both the modification of existing infrastructure and the day-lighting of West Indian Creek include:

- Stream bed and bank stabilization.
- Habitat creation/enhancement.
- Elimination of the maintenance/debris accumulation at the culvert intake wall.
- An average annual CSO volume reduction from 2.9 to 1.2 million gallons (58% reduction) from regulator C_05.
- An average annual reduction in CSO frequency reduction from 24 to 3 overflows per year from regulator C_05.

During FY 2010, PWD entered into a design-construction agreement with USACE-Philadelphia District to move towards implementing this project and the preliminary design was completed. During FY 2011, PWD will continue to work with USACE to finalize the design of this project.

Watershed Mitigation Registry

The City of Philadelphia's Watershed Mitigation Registry (WMR) is an innovative OOW program initiated in 2007. The WMR aims to provide environmental restoration and improvement projects to offset wetland and open water losses caused by development or redevelopment throughout the Philadelphia area. Environmental improvement projects could include restored or replacement wetlands, but also can include stream and riparian corridor restoration projects. The intent of the WMR is to facilitate the matching of projects that the City of Philadelphia has determined to be high priority elements of its Integrated Watershed Management Plans (IWMPs) with those mitigation needs that arise from waterfront development and projects, transportation improvement projects, or other development and redevelopment projects. The selection process requires close coordination among the developer, the City of Philadelphia, the Pennsylvania Department of Environmental Protection (PADEP), and the US Army Corps of Engineers (USACE). An important part of the process is the development of a procedure to compare the value of the losses at the proposed development or redevelopment site with the environmental value that would be achieved at proposed mitigation projects. This procedure has been completed and is awaiting comments. As Philadelphia developed over the past 200 years, many of its streams, riparian corridors and aquatic resources have been lost or degraded. The remaining aquatic and riparian areas are critical resources to the region. Major impacts include the impairment of almost every mile of stream within Philadelphia, impediments to migratory fish passage, loss of habitat and wetlands, degraded water quality, etc. Even remaining areas of high value are threatened, such as the impacts of future degradation of the Cobbs Creek on Heinz Wildlife Refuge.

Though the past impacts have been considerable, significant opportunities to restore and improve the riparian corridors and aquatic resources within Philadelphia are available and are being strongly supported by a range of initiatives Since 1997, the City of Philadelphia has invested millions of dollars in creating watershed management plans to advance the restoration of riparian environmental resources. Since 1997, the Philadelphia Water Department (PWD) and the Fairmount Park Commission (FPC) have invested millions of dollars in creating environmental resource inventories (including wetland inventories) for the City of Philadelphia, and integrated watershed management plans for environmental and aquatic resource impact recovery. These plans are based on park master plans, source water protection plans, river conservation plans, and recent field work. Efforts by PWD and FPC parallel other City planning initiatives such as GreenPlan Philadelphia, which is the City's comprehensive open space plan.

Planning work is also being conducted to identify stream and wetland enhancement opportunities, which are compiled into a Watershed Mitigation Registry. Philadelphia's

Watershed Mitigation Registry takes a watershed approach to aquatic resource protection by considering the entire riparian system and its ecosystems as interdependent. This approach is consistent with federal guidelines for wetlands mitigation. Implementation of projects organized within a comprehensive watershed management framework help achieve greater environmental benefit at reduced cost by addressing environmental, regulatory, and local community concerns in an integrated fashion.

The project registry is designed to function in a similar manner to wetland mitigation banks, with important differences. Unlike mitigation banks that consist of completed wetland projects ready for purchase, the mitigation registry presents conceptual plans for projects ready to be designed and constructed. These plans encompass a range of riparian corridor improvements, including new and restored aquatic habitats, streambanks, wetlands, and flood and stormwater management. Although much research has been conducted to characterize the relative effectiveness of different wetlands types at performing a range of different environmental functions, no single method provides a technique for assessing the effectiveness of riparian corridor improvements to mitigate impacted wetlands.

The combined result of the City's planning efforts is the identification of numerous areas targeted for restoration and enhancement, many of which are now listed in the WMR for the Philadelphia Region. Thus far the WMR has compiled 272 targeted areas identified in the aforementioned inventories and management plans. Targeted areas are categorized as wetland creation (72), wetland enhancement (88), wetland enhancement – invasive management (24), tidal mudflat - wetland restoration (33), stream restoration (41), stream daylighting (2), pond buffer (2), and wetland preservation (4). The WMR functions as a straightforward way to search for a project by watershed, project type, project size, and a variety of other variables. Reports, which include pictures and a potential project description, are automatically generated based on queries allowing information to be disseminated to interested parties in a timely fashion.

A registry program utilizing these projects would help achieve greater environmental benefit at reduced cost by addressing environmental and/or regulatory requirements in an integrated fashion. Selected projects could achieve goals encompassed by FPC Master Plans, PWD's SMP, CSOMP, and water quality goals and pollutant reduction targets set by total maximum daily loads (TMDLs). These projects will also help mitigate damage to the environment caused by infrastructure improvements, create economic benefits, and improve recreational value. In addition, many of these projects are located in areas with low income and minority neighborhoods that would be enhanced by the proposed upgrades.

During FY 2009, PWD worked with multiple interested parties on the implementation of projects at some of the registry locations. For the most part, these parties represented developers with wetland mitigation needs for their projects based on permit requirements imposed by USACE and PADEP.

During FY 2010, PWD began to investigate the feasibility of sponsoring an In-lieu Fee (ILF) Program following the guidelines set forth by USACE/EPA regulations. A draft prospectus was developed and informally reviewed by USACE and PADEP. As discussion occurred between PWD, PADEP, and USACE, it became apparent that a partnership between PADEP and PWD may be the most appropriate vehicle to implement a viable ILF program in the Philadelphia region. In FY 2011, PWD plans to work with PADEP to define PWD's role as a local sponsor of the PADEP's statewide program.

Tidal Schuylkill Wetland Restoration

Historically, freshwater tidal wetlands extended from Trenton, New Jersey to Chester, Pennsylvania, but urbanization has reduced the area by 95%, with only small remnants of freshwater tidal wetlands on the Pennsylvania side of the Delaware River. Approximately 76% of the land area surrounding the tidal portion of the Schuylkill River is urban or residential. The banks along the lower reach, from the Delaware River confluence to stream mile 5, are dominated by industrial uses such as oil refineries. Continuing upstream, the River runs though Center City Philadelphia, a heavily developed area. The tidal Schuylkill is impacted by urban runoff, industrial sources, and combined sewer overflows.

Wetlands are essential habitat highly utilized by fish for foraging, nesting, spawning, and refuge from predators or environmental extremes (i.e. temperature). Particularly for migratory fish, wetlands play an important role in establishing a safe and productive migratory corridor to and from spawning grounds. Tidal freshwater wetlands are also important habitat for migratory birds and waterfowl. The Philadelphia area is within the Atlantic Flyway and important during both northbound and southbound migrations.

PWD assessed the tidal Schuylkill River for existing wetland areas and potential wetland restoration areas in October 2006. One existing wetland area (0.5 acre) and 13 wetland restoration areas (29.2 acres) were identified and mapped. The area between the Mingo Creek surge basin and the main channel of the Schuylkill River ranked first priority for wetland restoration.

The project area was surveyed in May and October 2007 in order to identify and delineate suitable planting areas. A staff gage was installed at that time and monitored during a tidal period to estimate maximum and minimum water depths. A planting plan was created based on maximum water levels and land ownership. Only the portion of the site owned by the City of Philadelphia was considered for planting. Grazing by Canadian geese was considered a barrier to a successful planting and goose exclusion fence was installed in 16ft grids in an attempt to overcome this issue.

PWD was awarded a grant from National Fish and Wildlife Foundation through the Delaware Estuary Watershed Grants Program for a sum of $21,000. The grant funded the purchase of vegetation native to the Philadelphia area as well as goose exclusion fence and other necessary supplies.

The project area was planted by PWD staff in May and June 2008. Vegetation chosen for the site includes: spatterdock (Nuphar advena/lutea), pickerelweed (Pontederia cordata), duck potato (Sagittaria latifolia), and arrow arum (Peltandra virginica). Monitoring of the area will be carried out twice a month through August 2008 and then will be reduced to once a month, during the growing season, through 2011.

During the initial monitoring period, it became evident that grazing was still a major factor influencing the early growth and establishment of the selected vegetation. A compounding stressor to plant persistence was the height of tide in the area. The plants chosen for the site were not able to thrive in the extremes of water cover in the planting area. Some species (e.g., , Spatterdock) demonstrated a weak growth form that resulted in leggy open foliage as opposed to the tight clumping growth seen in lower tidal portions of the Schuylkill and Delaware Rivers. Foliage that did not suffer from stunted growth was heavily grazed by waterfowl and perhaps fish and reptiles. This grazing occurred despite the installation of a protective fence. Another significant impediment to the establishment of an emergent plant community was the presence of flotsam carried in by the tide and during periods of high flow. This material, some of it quite large, destroyed both the protective fencing and the associated vegetation. It is noteworthy that some of the fenced areas did in fact thrive after a top cover of fishing line and string were installed over the plants. This top cover minimized the impacts from birds and assisted with the re-establishment of certain plant species prior to winter die-off.

The second phase of the suitability study was contingent upon the relative success of any remaining emergent vegetation becoming established after the first growing season. Unfortunately, the entire planting area was obliterated by flotsam that had accumulated during the winter period. The planting grids were essentially scoured away by large debris. Only a few remnant posts were left in place. All of the fence material was eliminated and a majority of the posts that held the fence were either missing or driven deeply into the substrate. Visual inspections revealed that none of the plantings persisted through the second season.

It is apparent that the persistence and stability of submersed and emergent plant communities within the tidal reaches of the Schuylkill River is highly predicated on the establishment of a stable and well-defined system of protective measures that can attenuate tidal influences, minimize wave action and deflect large heavy objects. The current study reinforces this theory that without these measures, establishment of an intertidal wetland community is not feasible.

III.C.2.5 Fish Passage Projects - Evaluate the benefits of projects that improve migratory fish passage in a manner consistent with the watershed management plans

<u>Fish Passage on Cobbs Creek</u>

The PWD is investigating the option of a project to create fish passage on the Cobbs Creek. The purpose of the Cobbs Creek fish passage restoration project would be to investigate, select, design, and construct the best alternative to reestablish fish passage on Cobbs Creek. Two small dams represent opportunities to improve fish passage on Cobbs Creek. The lower dam, Woodland Dam, located close to the Cobbs Creek Parkway and Woodland Avenue, is the first impediment to fish passage on Cobbs Creek. It is a low concrete structure below which the creek is tidal. The upper dam, Millbourne Dam, situated on Cobbs Creek near 65th and Race Streets, is a rock structure. Both dams are owned by the City of Philadelphia's Fairmount Park. In August 2009, PWD entered into a design agreement with USACE to develop a fish passage solution at the Woodland Dam. During September, 2009, PWD conducted a fish assessment of the area below and above the Woodland Dam to determine the Dam's impact on fish passage. PWD and USACE also worked with the PA Historical and Museum Commission (PHMC) and PADEP to determine what action would be needed to permit modification to the Woodland Avenue Dam. In April, 2010, a Phase 1 Archeological Survey was completed and submitted to PHMC in June, 2010. Over the coming year, a design solution will be developed and PWD hopes to enter into a construction agreement with USACE, such that this project may be brought to fruition.

PWD Sanitary Line Natural Rock Ramp Fishway

After Frankford and Rhawn St. dam remnants were removed in 2006, the downstream-most obstruction to anadromous fish passage in Pennypack Creek Watershed was a PWD sanitary sewer line approximately 450m upstream of the former Frankford Ave. dam. Because this is an active sewer line that would be expensive to relocate, a rock ramp fishway was constructed in 2007 to raise the water surface elevation and provide fish passage at this site.

PWD has completed phase 1 of the physical monitoring activities planned for the rock ramp. A stream gage has been installed to record stream stage which will be correlated to the nearby Rhawn St. USGS gage station. A detailed post-construction survey of the rock ramp is underway in order to support a River 2D hydraulic model of the rock ramp. Preliminary work has shown that a very high spatial resolution of survey points is required to accurately model the effects of the individual boulders in the rock arches with River 2D, so additional surveys and alternative modeling approaches are being evaluated. PWD hopes to estimate velocities within the rock ramp at varying flow conditions and compare physical conditions to fish swimming capabilities.

PWD has also conducted rapid, non-quantitative fish surveys in the tidal Pennypack Creek by boat and tote barge electrofishing since 2006. While a small number of anadromous and semi-migratory fish species have been collected, there is thus far no evidence of a spawning run of Hickory shad having been established in Pennypack Creek. It is possible that Hickory shad stocked in Pennypack Creek have failed to "imprint" on Pennypack Creek and have joined Delaware River Runs, though thus far no otolith-tagged fish released in Pennypack Creek have been collected from either the Delaware River or major tributaries where collection and subsequent tag verification is performed by PFBC. It is also possible that Hickory shad fry are not surviving to maturity. Hickory shad are stocked at a much earlier phase of development than

American shad and thus may be more susceptible to mortality, whether due to predation, lack of appropriate food, poor water quality, or physical habitat factors.

In March 2010, PWD received notification from PFBC that, due to lack of funding, Hickory shad fry would not be stocked in Pennypack Creek in 2010. The future of shad restoration in Pennypack Creek is thus uncertain unless additional sources of funding are found. Hope remains that adult Hickory shad will be found in Pennypack Creek in order to justify additional research and/or stocking of Hickory shad.

Fairmount Fish Ladder

The Fairmount Dam fishway is situated within the Philadelphia City limits on Fairmount Park property. Completed in 1979, the fish ladder was constructed on the western side of the Fairmount Dam. The fish ladder has been maintained largely by the voluntary efforts of the Friends of the Fairmount Fish Ladder. Effects of time and natural forces damaged the fish ladder and the degradations severely limited the ladder's efficiency at passing migratory fish species.

In 2002, PWD partnered with the Philadelphia District, U.S. Army Corps of Engineers, to improve and revitalize the Fairmount Dam Fishway, pursuant to Section 1135 of the Water Resources Development Act of 1986. During 2003, PWD entered into an agreement with Alden Research Laboratories to model the current hydrologic conditions within the fishway and provide model alternatives based on expertise from the United States Fish and Wildlife Service. Between 2003 and 2005, scientists and engineers from USACE completed final designs for the fishway restoration project, including the creation of an outdoor educational area adjacent to the fishway.

In March 2008, ABC Construction began staging for the preliminary construction phase of the project and on May 18th 2009, PWD and partners on the project celebrated the completion of this restoration project. Structural modifications, increased attraction flow, and real-time monitoring capabilities have been incorporated into the new design. Moreover, an intensive biomonitoring strategy and educational outreach program have been implemented to estimate populations, assess fish passage efficiency by migratory and resident species, and to increase public involvement and awareness.

In September 2009, PWD and U.S. Army Corps of Engineers entered a joint agreement to modify the existing entrance channel gate structure in the tidal portion of the Schuylkill River. Modifications include the re-design and fabrication of the gate, upgrades to the existing actuator and installation of the structure within the fishway exit channel. These modifications were performed to increase fish passage efficiency while also addressing various operation and maintenance issues. Completion of installation is anticipated for the fall of 2010.

III.C.2.6 Riparian Buffer Creation and Enhancement - Continue programs for the restoration and protection of the natural lands that buffer each of the area waterways to reduce pollution, prevent erosion of the banks, provide wildlife food and cover, and shade the adjacent water, moderating temperatures for aquatic species

Environment, Stewardship & Education Division

The Philadelphia Water Department continues to support the Environment, Stewardship & Education Division of the Fairmount Park Commission, which undertakes a broad range of environmental restoration activities throughout the park system. These activities occur primarily on the 5,600 acres of natural lands in the system's seven largest watershed and estuary parks. These are Poquessing Creek, Pennypack, Tacony Creek, Wissahickon Valley, Fairmount (East/West), Cobbs Creek and Franklin Delano Roosevelt parks.

The restoration activities include:

- Controlling and removing exotic invasive plants and replacing them with species native to Philadelphia County.
- Increasing the density and diversity of native plants in riparian zones, forests and other areas.
- Converting mown lawn to meadows where the lawn is not currently used for active recreation.
- Managing meadows, including periodic mowing to control tree growth.
- Constructing new and restoring/expanding existing wetlands.
- Removing or modifying existing dams.
- Restoring eroded/degraded stream channels and stabilizing streambanks using bioengineering techniques.
- Repairing and stabilizing erosion gullies on forested slopes.
- Constructing berms, diversions, grassed waterways, infiltration trenches and filter strips to control stormflow from impervious services and mown areas.
- Controlling access to reduce trash dumping and damage by vehicles.

Riparian Buffer component of Stream Restorations

Riparian buffer enhancement will be included in all stream restorations that are completed. Typically, riparian buffer enhancement activity includes invasive species management, live-stake planting, tree and shrub planting, and native seed mix application. Invasive species management usually begins one to two years prior to construction. Once the construction of the stream restoration project is complete, the landscaping plan is implemented which includes all of the applications mentioned above.

Please refer to **SECTION III.C.2.3 STREAM HABITAT RESTORATION –**on page 141 for more information on stream restoration projects.

Please refer to **SECTION III.C.2.4 WETLAND ENHANCEMENT AND CONSTRUCTION** on page 144 for more information on how riparian buffer projects will be included in the Watershed Mitigation Registry.

WRT projects

Please refer to **SECTION II.F.2 "CONTINUE TO FUND AND OPERATE THE WATERWAYS RESTORATION TEAM"**on page 36 for information on this topic.

III.C.3 Other Watershed Projects

III.C.3.1 River Conservation Plan - Continue to work in partnership with local partners to complete and implement River Conservation Plans (RCPs)

Darby Creek RCP

A River Conservation Plan was completed by the Darby Creek Valley Association (DCVA) for the Darby Creek watershed drainage area in 2005.

Tacony-Frankford RCP

The Tacony-Frankford River Conservation Plan (RCP) is a holistic plan to improve the Tacony-Frankford watershed. It is developed through a collaborative process of local organizations and residents, and addresses various types of projects that will make the watershed a better place to live. It addresses history, water quality, culture, art, parks, trails, youth education, municipal education, and more.

The goal is to create a grassroots driven watershed conservation plan. The plan reflects the character of the watershed and the issues and concerns of the residents of the watershed. The planning process also creates or enhances partnership possibilities among plan participants.

The RCP was completed in July of 2004.

Pennypack RCP

The Pennypack Partnership developed a request for proposals for a consultant to lead the data collection and public outreach components of the plan, under the guidance of the RCP team. The consultant F.X. Browne, Inc. was selected to oversee both the data collection and public outreach components of the RCP and began this work in the Fall 2003. In January 2004, the first RCP Steering Committee took place and a public outreach schedule and suggested public workshops were discussed and planned for the spring. In 2005, a number of public outreach and education events took place, including:

– April 2005 Stream Restoration Workshop

– April 2005 Watershed Friendly Homeowners Workshop

– September 2005 Fish Shocking Demo on Pennypack and presentation of draft plan

– September 2005 Presentation of draft plan at Pennypack Trust Ecological Restoration Plant Sale

– October 2005 Presentation of draft plan at Montco Trout Unlimited

– October 2005 Presentation of draft plant at annual Applefest Celebration at Fox Chase Farms

The RCP Plan was completed in December 2005. Work to implement some of its recommendations will continue into the future and will act as a platform for the development of a watershed management plan.

Poquessing RCP

The final Poquessing Creek Watershed River Conservation Plan (RCP) was completed in July 2007. The final RCP report was submitted to the Department of Conservation and Natural Resources in the winter of 2007 to be considered for the Pennsylvania Rivers Registry.

Prior to the completion of the report, a photo contest was held in the summer of 2006 to build awareness of the beauty of the Poquessing Watershed. The winning photographs from the contest were subsequently placed in the 2008 Poquessing RCP Calendar, which was developed by the RCP Team in the fall of 2007 as an additional outreach tool. The calendar includes the recommendations that resulted from the RCP, along with the executive summary of the plan. It was distributed widely to every RCP participant and partner in the watershed.

The following public meetings/events took place in the last phase of the RCP, in the spring of 2007:

– RCP Public Meeting #2/ History of Watershed Presentation
April 5, 2007
Community College of Philadelphia, Philadelphia

– RCP Public Meeting #3/Land Management Workshop
April 25, 2007
Community College of Philadelphia, Philadelphia

– RCP Public Meeting #4/Native Plants Workshop & Rain Barrel Workshop
May 5, 2007
Academy Ave. & Torrey Road, Philadelphia

The following steering committee meetings took place in the last phase of the RCP:

– Steering Committee Meeting #7
February 7, 2007
Glen Foerd Mansion, Philadelphia

– Steering Committee Meeting #8
July 10, 2007
Glen Foerd Mansion, Philadelphia

A Backyard Buffer presentation was presented to the Friends of Poquessing on June 5, 2008 at the Community College of Philadelphia.

Delaware Direct RCP

In the spring of 2007, CH2M Hill (formerly Cahill Associates), along with the Pennsylvania Horticultural Society, were hired by Philadelphia Water Department to lead the Delaware Direct RCP. By the end of June 2007, the RCP Team (PWD and consultants) determined that a unique RCP strategy would be desirable for this watershed due to the number of planning efforts currently in place and the complexity of issues in and along Philadelphia's waterfront. As a result, the RCP Team modified the scope of the RCP in order for it to include more of an emphasis on the implementation of the Philadelphia GreenPlan recommendations. The data collection and public participation commenced in the fall of 2007. The final report is expected to be submitted in the fall of 2010.

Delaware Direct Watershed River Conservation Plan meetings and events to date:

Steering Committee Meeting #1
- November 15, 2007
- Pennsylvania Horticultural Society

Steering Committee Meeting #2
- February 20, 2008
- Pennsylvania Horticultural Society

Steering Committee Meeting #3
- September 24, 2008
- Pennsylvania Horticultural Society

Steering Committee Meeting #4
- November, 2009
- Pennsylvania Horticultural Society

Focus Group/Workshop #1: Ecology and Riverfront Design –
Case Study Pulaski Park
- April 30, 2008
- Pennsylvania Horticultural Society

Focus Group/Workshop #2: The Built Environment –
Advanced Parking Lot Design
- June 4, 2008
- Independent Seaport Museum

Focus Group/Workshop #3: Mobility and Connections
Green Streets and Riverfront Connections
- July 31, 2008
- Penn Treaty Park

Public Meeting #1: Healthy Neighborhoods
- December 3, 2008
- Center for Architecture

Watershed Walk #1
- July 31, 2008
- From multiple locations to Penn Treaty Park
- Estimated 40 participants

Watershed Walk #2
- April 25, 2009
- From Penn Treaty Park through neighborhoods surrounding Fishtown
- Estimated 200 participants

III.C.3.2 Watershed Information Center - Create a website to serve as a Watershed Information and Technology Center

Please reference **SECTION II.G.2 "CONTINUE TO MAINTAIN WATERSHED MANAGEMENT AND SOURCE WATER PROTECTION PARTNERSHIP WEBSITES"**on page 62 and **SECTION II.H.2 "EXPAND THE INTERNET-BASED NOTIFICATION SYSTEM (RIVER CAST) TO THE TIDAL SECTION OF THE LOWER SCHUYLKILL RIVER"** on page 83 for additional information on PWD's Watershed Information Centers.

III.C.3.3 Integrated Water Use Status Networks - Pilot a communication and water quality monitoring network that supports the identification and analysis of water quality events

PWD has two communication and water quality monitoring networks. One system, Rivercast, supports the identification and analysis of water quality events to support water use status decisions (swimming, triathlons, rowing, etc.) and makes this information available in real time to the public. The other system, Early Warning System, is used to monitor water quality and notify water systems about such events as hazardous substance spills or sudden changes in water quality.

Please refer to **SECTION II.G.2 "CONTINUE TO MAINTAIN WATERSHED MANAGEMENT AND SOURCE WATER PROTECTION PARTNERSHIP WEBSITES"** on Page 62 for details about these communication and water quality monitoring systems.

III.C.3.4 Integrated Water Use Status Networks - Evaluate the technical and fiscal needs to expand the network into additional receiving waters where recreational uses are taking place.

In order to expand RiverCast, the PWD has developed another internet-based notification system called CSOcast, which reports on the overflow status of outfalls in every CSO shed. The purpose of this notification system is to alert the public of possible CSOs from Philadelphia's combined sewer system outfalls.

Please refer to **SECTION II.H.2 "EXPAND THE INTERNET-BASED NOTIFICATION SYSTEM (RIVERCAST) TO THE TIDAL SECTION OF THE LOWER SCHUYLKILL RIVER"** on Page 83 for information pertaining to this topic.

III.C.3.5 Interpretive Signage - Continue to implement interpretive signage

<u>CSO Outfall Signage</u>

The CSO signage project was initiated to inform the public of the potential hazards of contact with the stream during combined sewer overflow events. The signs, placed at outfalls that are accessible by the public, let people know that during wet weather it is possible for polluted water to flow from the outfall and that it would be hazardous to their health to contact the water during such events. It also requests that the Water Department is informed of any overflows during dry weather and provides an emergency contact number.

The CSO signage project was a pilot project aimed at determining if outfall signage was a feasible way to accomplish public notification of combined sewer overflows. The PWD, in conjunction with the Fairmount Park Commission, installed 13 signs at CSO outfalls throughout the city. Locations for placement of these signs were selected based on factors such as high visibility, known recreational areas, and volume of the combined sewer overflow. Installation of the CSO signage was done in summer 2007 and a follow-up survey of the signage sites was completed in October 2007. During this survey, each of the CSO signage sites was visited and photos were taken to confirm the status of the signs that were installed. Survey of the sites determined that several of the signs were removed or vandalized. Of the 13 signs that were installed, 5 were vandalized or removed during the short amount of time between installation and the survey.

Although signage is seen as a simple, low-cost, visual way to raise awareness of combined sewer outfalls, this pilot project has highlighted the difficulties in using signage as a public notification system in Philadelphia due to the poor durability of the signs in the field.

In 2008, a billstuffer was included in all PWD bills on the CSO Signage Public Notification project as well as answering additional questions such as '*What is a Combined Sewer Overflow (CSO)?*', '*What is the goal of the Signage Program?*', '*Can I swim in the water near a CSO?*', '*Is it safe for my dog to drink the water near a CSO?*', and '*Can I eat the fish?*'.

CSO Identification Signage

Signage was installed at each of Philadelphia's CSO outfalls, with the exception of 8 difficult to reach sites. The CSO outfalls now have identification signs displaying their outfall ID number. These signs are very useful when the public is reporting a problem at an outfall since they are able to accurately identify the outfall. This helps to alleviate communication problems between the public and the PWD responders.

Tookany/Tacoy-Frankford Watershed Signage

The PWD and the Tookany/Tacony-Frankford Watershed Partnership have installed signs at bridge crossings throughout the Tookany/Tacony-Frankford Watershed to help residents and visitors learn the names of local streams and rivers in their neighborhood, raise awareness of local watersheds, connect residents and visitors with local waterways, and encourage them to protect water resources. A total of 10 signs have been placed on state-owned roads - one in either direction - in 5 locations throughout the watershed: Roosevelt Boulevard between F and Bingham Streets, Adams Avenue between Newtown Avenue and Crescentville Road, Whitaker Avenue between Torresdale and Hunting Park Avenues, and Torresdale Avenue between Hunting Park and Frankford Avenues. The Tookany/Tacony-Frankford Watershed drains 29 square miles in Philadelphia and Montgomery counties. The watershed has a diverse population that includes portions of the inner city as well as suburban communities.

Restoration Locations Signage

Interpretive signage planning for several BMP projects was initiated in FY2010, including interpretive signage at the Columbus Square stormwater planter BMP, which will be installed in Fall of 2010. A request for proposals is currently being written calling for conceptual planning and design services for a signage system providing a variety of signage options for all existing and future BMPs. Additionally, the request for proposals will call for fabrication of interpretive signage for many of the existing BMP project sites. The goal is that all major BMP installations will have accompanying interpretative signage. Signs have been installed at previous restoration sites such as the Saylor Grove Stormwater Wetland.

III.C.3.6 Interpretive Centers - Continue to support existing educational interpretive centers to educate citizens about their community and the water environment

Please refer to **SECTION II.G.3 – "CONTINUE TO PROVIDE ANNUAL INFORMATION TO CITY RESIDENTS ABOUT PROGRAMS VIA TRADITIONAL PWD PUBLICATIONS"** on page 69 for information on PWD's support of existing educational centers including the Clean Water Theatre and other public outreach tools.

Please refer to **SECTION II.G.4 "CONTINUE TO SUPPORT THE FAIRMOUNT WATER WORKS INTERPRETIVE CENTER"** on page 78 for more information.

III.C.3.7 Basin-Specific Stormwater Management Plans (ACT 167) - Continue to support the State Act 167 Storm water Management Planning process and integrate the results of these efforts into the watershed management plans and implementation plans

Recognizing the adverse effects of excessive stormwater runoff resulting from development, the Pennsylvania General Assembly approved the Stormwater Management Act, P.L. 864, No. 167 on October 4, 1978. Act 167 provides for the regulation of land and water use for flood control and stormwater management purposes. It imposes duties, confers powers to the Department of Environmental Protection (DEP), municipalities and counties, and provides for enforcement and appropriations. All counties must, in consultation with its municipalities, prepare and adopt a stormwater management plan for each of its designated watersheds. Within six months following adoption and approval of a watershed stormwater plan, each municipality is required to adopt or amend stormwater ordinances as laid out in the plan

The City of Philadelphia is committed to supporting the development of Act 167 Stormwater Management Plans for each of the watersheds that drain to the City, including:

- Cobbs Creek,
- Darby Creek,
- Delaware River,
- Pennypack Creek,
- Poquessing Creek,
- Schuylkill River,
- Tacony/Frankford Creek, and
- Wissahickon Creek.

The City of Philadelphia signed a Phase 1 Agreement with the DEP in July, 2008 committing to the completion of a City-wide Act 167 planning process. This City-wide Act 167 will account for the City of Philadelphia Stormwater Regulations and will lay the groundwork for additional watershed-basin specific planning to follow. A Phase 2 agreement was conformed in April, 2009 which helped to outline a schedule for completing basin specific Act 167 plans over the coming 5 years.

Darby-Cobbs Creek

An Act 167 Stormwater Management Plan was completed for the Darby-Cobbs Watershed in January 2005, led by Delaware County Planning Department with Borton Lawson Engineering as technical consultant. This completed plan can be viewed at the Delaware County Planning Department's website at: www.co.delaware.pa.us/planning/watersheditems

The Darby-Cobbs watershed lies within 26 municipalities in Delaware County, 2 municipalities in Chester County, 2 municipalities in Montgomery County, and 1 municipality in Philadelphia County as follows:

Table III.C.3-1 Municipalities within Darby-Cobbs Watersheds

Delaware County	**Chester County**
Aldan Borough	Easttown Township
Morton Borough	Tredyffrin Township
Clifton Heights Borough	**Montgomery County**
Newtown Township	Lower Merion Township
Collingdale Borough	Narberth Borough
Norwood Borough	**Philadelphia County**
Colwyn Borough	City of Philadelphia
Prospect Park Borough	
Darby Borough	
Radnor Township	
Darby Township	
Ridley Township	
East Lansdowne Borough	
Ridley Park Borough	
Folcroft Borough	
Rutledge Borough	
Glenolden Borough	
Sharon Hill Borough	
Haverford Township	
Springfield Township	
Lansdowne Borough	
Tinicum Township	
Marple Township	
Upper Darby Township	
Millbourne Borough	
Yeadon Borough	

Tookany/Tacony-Frankford Creek

The development of the Act 167 Plan for this watershed was jointly led by PWD and the Montgomery County Planning Commission; Borton Lawson Engineering was hired as technical consultant. The main objective of this stormwater management plan is to control stormwater runoff on a watershed-wide basis rather than on a site-by-site basis, taking into account how development and land cover in one part of the watershed will affect stormwater runoff in all other parts of the watershed. This plan was completed March 2008 and is currently under evaluation by PADEP and municipal partners. To view the entire TTF Act 167 Stormwater Management Plan, please visit: www.phillywatersheds.org

The Tookany/Tacony-Frankford Watershed encompasses a total area of approximately 32.96 square miles and includes the following major tributaries: Jenkintown Creek, Rock Creek, Mill Run, and Baeder Creek.

Table III.C.3-2 Municipalities within Tookany/Tacony-Frankford Watershed

Abington Township	Rockledge Borough
Cheltenham Township	Springfield Township
Jenkintown Borough	City of Philadelphia

Pennypack Creek

In the fall of 2008, PWD initiated an Act 167 Stormwater Management Plan for this watershed. PWD is acting as municipal lead for plan development, and has partnered with the Montgomery County Planning Commission and Bucks County Planning Commission in order to complete the plan. The stakeholder Watershed Planning Advisory Committee (WPAC) has been convened in order to help guide the process, which is expected to be wrapped up in late 2010/2011.

The Pennypack Creek Watershed is located in the southeastern corner of Pennsylvania with approximately 56.3 square miles of drainage area.

Table III.C.3-3 Municipalities within Pennypack Watershed

Montgomery County	**Bucks County**
Abington Township	Upper Southampton Township
Bryn Athyn Borough	Warminster Township
Hatboro Borough	
Horsham Township	**Philadelphia County**
Jenkintown Borough	City of Philadelphia
Lower Moreland Township	
Rockledge Borough	
Upper Dublin Township	
Upper Moreland Township	

Poquessing Creek

In the fall of 2009, PWD initiated an Act 167 Stormwater Management Plan for this watershed. PWD is acting as municipal lead for plan development, and has partnered with the Bucks County Planning Commission in order to complete the plan. The stakeholder Watershed Planning Advisory Committee (WPAC) has been convened in order to help guide the process, which is expected to be wrapped up in late 2011/2012

The Poquessing Creek Watershed is located in Pennsylvania, with portions of its drainage area in Philadelphia, Montgomery and Bucks counties. The watershed encompasses approximately 21.5 square miles of drainage area. Its designated uses are warm water fishery, migratory fishes, trout stock fishery and as a tributary to the Delaware River, the creek also serves as a source of drinking water.

Table III.C.3-4 Municipalities within Poquessing Watersheds

Montgomery County	**Bucks County**
Lower Moreland Township	Bensalem Township
	Lower Southampton Township
Philadelphia County	
City of Philadelphia	

Wissahickon Creek

In the fall of 2010, PWD will initiate an Act 167 Stormwater Management Plan for this watershed. PWD is acting as municipal lead for plan development, and has partnered with the Montgomery County Planning Commission in order to complete the plan. A Watershed Planning Advisory Committee (WPAC) will be convened in order to help guide the process, which is expected to be wrapped up in late 2012/2013.

Wissahickon Creek begins in Montgomery Township and flows for approximately 27 miles where it meets with the Schuylkill River at the end of Lincoln Drive. The Wissahickon Creek Watershed encompasses an area of 64 square miles, which includes 15 municipalities in Montgomery County and the City of Philadelphia.

Table III.C.3-5 Municipalities within Wissahickon Watershed

Montgomery County	Philadelphia County
Abington Township	City of Philadelphia
Ambler Borough	
Cheltenham Township	
Horsham Township	
Lansdale Borough	
Lower Gwynedd Township	
Montgomery Township	
North Wales Borough	
Springfield Township	
Upper Dublin Township	
Upper Gwynedd Township	
Upper Moreland Township	
Whitemarsh Township	
Whitpain Township	
Worcester Township	

Schuylkill River

The portion of the Schuylkill River Watershed within the City of Philadelphia will be covered by the City of Philadelphia county-wide Act 167 and is currently covered by the City of Philadelphia Stormwater Regulations.

Delaware River

The portion of the Delaware River Watershed within the City of Philadelphia will be covered by the City of Philadelphia county-wide Act 167 and is currently covered by the City of Philadelphia Stormwater Regulations.

III.C.3.8 Sewage Facility Planning - Continue to review sewage facility planning modules and downstream sewage conveyance and treatment facilities to ensure that adequate capacity exists within these systems to accommodate flow

PWD employs a full-time state certified Sewage Enforcement Officer (Eric Ponert - Cert. No. 03590) who continues to require/review sewage facilities planning modules for new land developments within Philadelphia and, in conjunction with PWD's Office of Watersheds and Planning and Research Department, reviews downstream sewage conveyance and treatment facilities. These reviews are conducted to ensure adequate capacity exists within the sewage systems to accommodate flow from new land developments within Philadelphia and tributary municipalities. PWD maintains a database and hard-copy files which include all submitted/reviewed modules for land developments within Philadelphia and requests for capacity certification from tributary municipalities.

III.C.4 Monitoring and Assessment

III.C.4.1 NPDES – Quarterly Special Discharge Monitoring Report

PWD is committed to submitting the Quarterly Special Discharge Monitoring Report documenting the Department's CSO discharges during the specified time periods. This report is due 45 days after the end of the each quarter, thus a report is submitted 4 times a year by February 15, May 15, August 15, and November 15. PWD is working to switch to eDMRs, in which quarterly reports are due 28 days after the end of each quarter, by January 28, April 28, July 28, and October 28.

III.C.4.2 NPDES - Annual CSO Status Report

Monitoring and characterization of CSO impacts from a combined wastewater collection and treatment system are necessary to document existing conditions and to identify water quality benefits achievable by CSO mitigation measures. The tables included in the following section represent the average annual CSO overflow statistics for period July 1 2009 – June 30 2010 as required in the NPDES Permit. The table has been reorganized to present overflows by the specific receiving water into which the CSOs from a given interceptor system discharge. In order to be consistent, the column headings are presented in the same format found in the System Hydraulic Characterization (SHC) and NMC Documentation.

a. Annual summary of the frequency and volume of CSO discharges

Table III.C.4-1 Overflow Summary for 7/1/09 – 6/30/2010

Outfall	Frequency (Overflows per yr)	Duration (hrs)			SWO Volume (ft^3)		
		Total	Min	Max	Total	Min	Max
C_FRA	15	12.25	0.25	1.5	2396390	5263.2	646968
C_FRTR	86	593	0.5	31.75	37858835	9.9	3112498
C01	23	24.25	0.25	2.75	981734	373.5	163765
C02	11	6.75	0.25	1.5	85914	107.1	25645
C04A	23	39	0.25	4.75	4172899	468.9	638498
C05	20	25	0.25	3	1123268	19.8	166402
C06	59	203.5	0.25	16.25	9649608	371.7	718270
C07	24	49	0.5	5.75	3098908	10323	301461
C09	36	72.75	0.25	7	3454540	6.3	354365
C10	22	42.75	0.25	6	318633	77.4	40100
C11	45	153	0.25	13.5	24384765	2262.6	2075431
C12	44	128	0.25	13.25	4089641	92.7	383401
C13	35	78.75	0.25	9.5	2686170	1.8	306820
C14	38	98.5	0.25	12.25	4420603	28.8	533229
C15	27	36	0.25	4.25	530937	3.6	89517
C16	6	2.75	0.25	1	40466	8.1	15736
C17	56	276.5	0.25	23.25	56551133	8.1	6111779
C18	37	60	0.25	5.5	4273106	0.9	632154
C19	22	21.25	0.25	2.75	1349364	1639.8	272304
C20	21	22.5	0.25	3	681025	7.2	128747
C21	22	27.25	0.25	3.25	984953	118.8	175091
C22	39	77.25	0.25	8.5	3119448	281.7	406402
C23	14	24	0.25	3.5	346309	112.5	59333
C25	25	63.5	0.25	7.75	4271531	432	703699
C28A	22	17.75	0.25	2.25	159790	109.8	30542
C29	51	195.75	0.25	16	3223291	0.9	348395
C30	35	129.25	0.25	13.25	1753945	2.7	219677
C31	46	112.5	0.25	12.25	3068801	28.8	295985
C32	33	63	0.25	6.75	3234587	1928.7	390173
C33	23	30.5	0.25	3.75	1269911	2253.6	189759
C34	17	18.25	0.25	2.5	880070	1570.5	160287
C35	16	12.75	0.25	1.5	214275	239.4	47003
C36	16	16	0.25	2.5	333000	363.6	62396
C37	23	22.5	0.25	2.75	380434	97.2	64675
D_FRW	51	130.25	0.25	13	23770238	64.8	1698831
D02	44	289.5	0.25	24.5	30185438	8606.7	2604719
D03	48	318.25	0.25	26.75	9651757	1567.8	911831
D04	33	163.75	0.25	18	802113	1486.8	95778

Outfall	Frequency (Overflows per yr)	Duration (hrs)			SWO Volume (ft^3)		
		Total	Min	Max	Total	Min	Max
D05	54	390	0.25	32	87166239	4990.5	8151011
D06	27	59.75	0.25	7.25	1083822	768.6	149033
D07	37	101.75	0.25	12.75	28469165	18045.9	2894501
D08	49	186.25	0.25	18.25	1747156	1.8	200508
D09	10	4	0.25	0.75	153848	948.6	31293
D11	25	49	0.25	7.75	5470647	9882.9	605561
D12	48	94.25	0.25	9.25	331494	5.4	38941
D13	23	17	0.25	2.5	484296	22.5	82004
D15	23	17.25	0.25	2.5	1299050	1162.8	215040
D17	45	141	0.25	15.25	10143451	2947.5	901763
D18	50	148	0.25	15.5	7257963	0.9	574378
D19	49	189	0.25	16.5	6318900	193.5	519610
D20	36	73.25	0.5	8.25	3729628	836.1	357668
D21	44	124.5	0.25	14	7881195	1194.3	680631
D22	68	544.25	0.5	42.25	36893689	700.2	3213059
D23	45	69.25	0.25	6.5	425299	8.1	52525
D25	68	469	0.5	29.5	1.65E+08	650.7	10311879
D37	49	284.5	0.25	25.5	36095256	1793.7	2945446
D38	49	186.75	0.5	17	34955958	9614.7	2932216
D39	53	248.75	0.75	20.75	44532758	8515.8	3112533
D40	64	342.75	0.25	29.25	3886823	0.9	288939
D41	52	206.5	0.25	16.75	6213065	230.4	502008
D42	22	22.75	0.25	2.75	404157	281.7	61733
D43	18	24.5	0.5	2.75	304587	131.4	55543
D44	41	80.25	0.25	7.25	7503816	567	915867
D45	47	139.5	0.25	12.5	68849957	3514.5	5168907
D46	25	33.5	0.25	4.25	1133669	369	149964
D47	67	388	0.25	28.5	12527054	17.1	782632
D48	46	116	0.25	11.5	25511371	1545.3	1961128
D49	11	8.75	0.25	1.25	146238	198	29878
D50	24	23.5	0.25	2.75	544239	783.9	69251
D51	65	653.75	3	34.25	3646838	86.4	262400
D51A	55	220.25	0.5	14.75	3007199	2.7	305787
D52	26	27.75	0.25	3	677113	161.1	87395
D53	12	14.25	0.5	2.25	2508201	11561.4	353300
D54	22	34.75	0.25	4.25	12316471	19249.2	2512855
D58	30	49.75	0.25	5.5	1677082	337.5	426784
D61	42	78.75	0.25	7.25	1393987	9	330746

Outfall	Frequency (Overflows per yr)	Duration (hrs)			SWO Volume (ft^3)		
		Total	Min	Max	Total	Min	Max
D62	32	38.5	0.25	4	536867	630	144006
D63	36	104.5	0.25	11.5	21943869	5318.1	4478404
D64	35	46.5	0.25	3.5	341114	1.8	100659
D65	34	73.5	0.25	7.5	12667581	843.3	2884311
D66	36	110.25	0.5	12.5	12644185	6129	2396775
D67	35	75.5	0.25	6.75	5513982	2232	1117276
D68	47	232.75	0.5	25	35458226	8367.3	3354216
D69	29	68	0.25	7	9153635	3269.7	2016838
D70	21	47.75	0.75	5	11117095	17531.1	2933428
D71	41	139.5	0.5	17.75	13102252	7309.8	2141295
D72	19	59.75	0.5	9.5	9631573	4346.1	3173527
D73	40	188.25	0.75	22.5	26676603	22773.6	3978348
F_FRFG	71	556	0.25	41.25	2.29E+08	388.8	20327382
F03	39	59	0.25	5	5584630	80.1	616450
F04	58	227	0.25	20.75	11613885	73.8	1171337
F05	59	247.25	0.25	23.75	1261484	4.5	129361
F06	28	34.5	0.25	3.5	822083	174.6	99747
F07	41	81.5	0.25	9.75	3033387	86.4	324852
F08	36	69	0.25	8.75	1652230	29.7	171504
F09	54	214.5	0.25	20.25	1442147	432.9	157870
F10	58	290.5	0.25	26.5	3677333	4.5	383014
F11	61	413.75	0.25	35.75	19288805	5.4	2026432
F12	28	42.25	0.5	5.25	830118	1503.9	94839
F13	47	115.5	0.25	13	2122313	53.1	224080
F21	65	394.25	0.25	30.75	1.38E+08	3527.1	12200260
F23	45	104.75	0.25	9.75	2384087	887.4	246969
F24	46	87.25	0.25	8.25	1073526	38.7	110039
F25	13	15	0.25	2.75	2760959	5189.4	552787
P01	23	16.25	0.25	2.75	413613	18.9	60758
P02	48	95.25	0.25	8	2197997	24.3	352814
P03	31	60.75	0.25	7	734462	11.7	122634
P04	16	42.75	0.5	6.25	3172789	2282.4	718763
P05	30	138	0.25	15.25	13800038	358.2	2025640
S_FRM	15	22.25	0.25	3.5	15614039	1728	4457699
S01	50	161.75	0.5	12.75	23818636	849.6	2270330
S01T	42	63	0.25	5	4647356	9	990534.6
S02	53	156.5	0.25	13	1693645	4.5	123870
S03	20	9	0.25	1.25	180118	123.3	33802

Outfall	Frequency (Overflows per yr)	Duration (hrs)			SWO Volume (ft^3)		
		Total	Min	Max	Total	Min	Max
S04	70	369.5	0.25	26.75	3783865	0.9	242010
S05	66	322	0.75	24.5	43813193	4872.6	2924402
S06	66	261.75	0.25	21	18623116	972	1266231
S07	24	31.5	0.25	3.75	2466977	45.9	323145
S08	42	64.75	0.25	5	301568	0.9	31255
S09	40	70.25	0.25	6.75	9332726	6909.3	791007
S10	58	195.75	0.25	14.75	3840273	67.5	268716
S11	57	187.5	0.25	14.75	1497292	26.1	143621
S12A	50	75.75	0.25	6.5	1064110	10.8	85982
S13	26	15.75	0.25	2	504773	246.6	76933
S14	65	298	0.5	23.25	4081559	221.4	247772
S15	28	30.5	0.25	3.25	430300	123.3	46394
S16	66	229	0.25	17.5	1691051	1.8	110154
S17	30	33.75	0.25	3.5	936088	7.2	99017
S18	54	198.5	0.25	14.75	8839387	128.7	674825
S19	29	28.25	0.25	3.25	421990	243	44593
S20	74	482.25	0.25	29.25	24883141	360	1567400
S21	27	23.5	0.25	2.5	259731	8.1	41070
S22	47	84	0.25	7.5	3754636	9	353176
S23	58	169.75	0.25	13.25	1987982	2.7	146442
S24	44	79.25	0.25	6.75	1180076	16.2	127664
S25	47	103	0.5	8.5	2583020	347.4	237381
S26	65	370.25	0.75	27.75	23490315	2997	1508704
S30	10	5.75	0.25	1.75	232085	299.7	55384
S31	54	157.25	0.25	12.75	6469786	3.6	525709
S32	21	18.75	0.25	2.5	442770	35.1	103223
S33	67	317.75	0.25	22.25	23744298	127.8	2374147
S36A	62	286.75	0.25	20.75	11915774	35.1	1701665
S37	56	219.25	0.5	17.25	5295093	58.5	882828
S38	32	43	0.25	4.5	7664566	707.4	1328299
S42	40	114.75	0.25	10.75	16133009	18	3807184
S42A	67	421.5	0.25	29	30835487	10.8	3996842
S44	39	126.75	0.25	13.25	14175734	3628.8	2729453
S45	40	115.5	0.25	12.5	33798629	10462.5	5066681
S46	25	52	0.25	4.75	4996744	100.8	1318721
S50	60	349.75	0.25	28	2.06E+08	12472.2	15070945
T_FRRR	36	47.25	0.25	4.5	11238389	60.3	1400092
T01	59	266.5	0.25	23.5	9995473	0.9	1009923

Outfall	Frequency (Overflows per yr)	Duration (hrs)			SWO Volume (ft^3)		
		Total	Min	Max	Total	Min	Max
T03	56	126.5	0.25	14	5084394	399.6	474312
T04	54	138.5	0.25	16.5	3492735	5.4	338292
T05	45	57.5	0.25	7	2026803	136.8	263030
T06	42	75.75	0.25	9.5	13790507	29.7	1459090
T07	17	10.75	0.25	1.25	375630	483.3	87283
T08	66	427.25	0.5	35.75	1.28E+08	2965.5	11891498
T09	44	61.75	0.25	7.5	1453533	313.2	151683
T10	60	198.5	0.25	17.75	4024429	76.5	341119
T11	52	117.5	0.25	12	2318990	422.1	203299
T12	16	13.5	0.25	2.25	173792	716.4	34489
T13	54	181.5	0.5	16.75	7792538	740.7	634764
T14	57	268	0.5	22.25	2.43E+08	3240	21016138
T15	52	160	0.25	17.25	11031615	7.2	904662

b. Update of the CSO frequency and volume for a typical hydrologic year

*This analysis was preformed by the first iteration of a model conversion model. This model accounts for evaporation during any wet weather period which was not done in previous models. A typical year is a simulated year where the rainfall is average throughout the year.

Table III.C.4-2 Overflow Summary for a Typical Year

Regulator	Frequency	SWO Duration (hrs)	Overflow Volume (MG)	Percent Capture
C01	17	12.5	2.54	88.99%
C02	4	1.5	0.15	94.77%
C04	20	22.25	3.30	82.04%
C04A	12	13.5	7.19	97.11%
C05	13	13.25	2.92	86.18%
C06	56	151	41.13	55.87%
C07	21	33.75	10.64	69.39%
C09	32	51.5	12.30	77.94%
C10	15	27.25	1.16	29.95%
C11	41	101.5	99.06	66.70%
C12	39	81.25	15.43	69.94%
C13	29	52	9.16	75.85%
C14	30	62.25	20.16	70.56%
C15	17	28.5	2.15	76.58%
C16	3	1.25	0.04	98.32%
C17	52	224.75	271.46	68.74%
C18	27	50.75	19.06	78.17%

Regulator	Frequency	SWO Duration (hrs)	Overflow Volume (MG)	Percent Capture
C19	20	17.25	4.96	91.13%
C20	13	16	2.42	89.61%
C21	15	20.75	3.75	87.02%
C22	35	62.5	14.90	70.37%
C23	11	19	1.47	-4.80%
C24	20	51.75	10.50	61.80%
C25	12	19.25	5.08	88.13%
C26	5	8.25	0.58	88.23%
C27	7	8.5	1.54	92.75%
C28A	20	12.25	0.55	96.25%
C29	50	150.75	15.38	44.12%
C30	28	93.75	8.17	54.45%
C31	40	74.75	11.16	65.29%
C32	31	45.75	10.78	76.32%
C33	20	17.5	3.52	86.17%
C34	12	6.5	2.07	91.47%
C35	10	5	0.45	88.97%
C36	10	6	0.65	89.56%
C37	15	10.5	0.94	87.76%
D02	35	214.25	177.95	32.71%
D03	43	246.75	48.90	29.83%
D04	22	107.75	3.79	70.55%
D05	58	338.75	476.10	41.38%
D06	16	39.25	6.27	70.70%
D07	26	67.75	133.42	76.05%
D08	45	133.75	8.67	50.43%
D09	6	3	0.70	96.84%
D11	13	31	25.45	82.21%
D12	46	79.5	1.31	87.79%
D13	9	12.75	1.56	92.88%
D15	9	13.75	5.05	91.64%
D17	45	124.5	49.73	78.04%
D18	49	134	44.12	75.04%
D19	49	174.75	37.31	74.31%
D20	34	61.25	19.69	76.36%
D21	42	105.5	44.24	69.48%
D22	73	488	239.40	46.21%
D23	41	55	2.29	85.06%
D24	26	30.5	1.17	76.99%
D25	65	392	934.59	45.86%
D37	52	241.5	189.79	39.51%
D38	42	155.25	186.28	56.30%
D39	52	217.75	244.84	70.96%

Regulator	Frequency	SWO Duration (hrs)	Overflow Volume (MG)	Percent Capture
D40	61	293.25	21.32	52.67%
D41	55	172.5	33.08	61.01%
D42	18	13.5	1.67	85.63%
D43	13	13	1.17	88.17%
D44	35	62.25	33.05	64.07%
D45	41	111	345.83	83.13%
D46	19	22.75	4.89	80.09%
D47	67	322.75	66.01	53.56%
D48	38	84.5	123.06	70.91%
D49	8	3.75	0.69	89.03%
D50	16	12.75	2.16	82.90%
D51	66	585.25	20.32	67.44%
D51A	53	179.5	13.79	81.28%
D52	19	18.25	3.14	81.54%
D53	7	5	9.04	94.03%
D54	18	21	45.84	86.08%
D58	23	33.75	7.39	78.83%
D61	38	57.75	6.58	72.01%
D62	27	28.25	2.44	76.92%
D63	33	78	104.21	70.46%
D64	26	35.25	1.54	83.25%
D65	25	50.25	56.06	74.11%
D66	32	76.5	57.77	71.71%
D67	31	57.75	25.43	76.07%
D68	47	184.75	185.97	59.12%
D69	22	45	39.08	80.02%
D70	21	28.25	42.55	85.37%
D71	34	97.5	62.15	67.18%
D72	16	30.25	35.24	85.54%
D73	39	141.75	132.84	62.55%
F03	32	42	18.78	74.47%
F04	65	211.75	71.97	61.57%
F05	66	241.5	8.97	63.89%
F06	20	29	5.97	52.70%
F07	41	73.25	21.25	73.72%
F08	40	65.75	11.72	77.58%
F09	60	205.75	10.20	68.52%
F10	64	284.75	26.45	49.37%
F11	68	387.5	134.28	52.04%
F12	30	39.25	5.90	73.37%
F13	45	98	11.36	67.11%
F14	35	42.5	2.29	76.14%
F21	63	332	764.94	51.29%

Regulator	Frequency	SWO Duration (hrs)	Overflow Volume (MG)	Percent Capture
F23	43	89.75	11.36	62.19%
F24	44	70.75	5.06	69.96%
F25	9	15.25	17.79	90.44%
P01	18	12	4.11	91.27%
P02	46	90	19.90	74.01%
P03	20	50.25	6.09	69.08%
P04	11	36	24.09	15.02%
P05	23	99.75	90.64	29.98%
R01	65	202.5	10.33	64.89%
R01A	75	400	97.24	51.87%
R02	66	196	1.28	66.84%
R03	43	60.5	0.63	85.10%
R04	81	455.25	12.67	56.10%
R05	69	237.25	3.07	71.01%
R06	45	104.5	33.39	82.43%
R07	16	8.5	12.50	97.03%
R08	25	33.25	83.82	93.45%
R09	15	68	1.87	92.34%
R10	46	124.75	3.79	87.74%
R11	33	41	8.83	85.39%
R11A	7	3	0.09	99.34%
R12	16	11.75	7.15	98.16%
R12R	9	11.25	61.10	45.38%
R13	36	56.5	58.38	92.65%
R13A	11	5.5	3.79	99.15%
R14	44	97.75	48.76	95.10%
R15	21	31.25	47.53	94.34%
R18	68	477	1420.62	68.20%
R20	8	17.75	1.49	99.53%
R21	1	0.25	0.31	99.95%
R24	10	4	4.52	98.09%
S01	40	104	90.68	70.53%
S01T	34	54.75	21.06	87.71%
S02	49	123.5	8.38	64.19%
S03	13	5.75	0.86	92.28%
S04	70	307.25	19.63	66.11%
S05	64	269	229.01	59.48%
S06	64	209.25	96.13	60.22%
S07	15	19.25	10.03	80.97%
S08	33	49.5	1.36	81.00%
S09	34	52.75	43.11	75.14%
S10	55	155.75	18.99	67.12%
S11	55	149.5	7.48	65.61%

Regulator	Frequency	SWO Duration (hrs)	Overflow Volume (MG)	Percent Capture
S12	39	54.25	1.95	34.48%
S12A	38	45	3.22	83.89%
S13	16	7.5	2.39	91.24%
S14	65	242.75	21.35	48.78%
S15	20	19	1.83	87.80%
S16	64	179	8.71	70.90%
S17	21	22.5	4.07	86.31%
S18	49	160.75	43.21	75.57%
S19	20	17.75	1.84	83.92%
S20	73	401	135.10	39.45%
S21	21	14.5	1.15	87.64%
S22	37	62.75	17.22	82.25%
S23	55	134.5	9.97	67.57%
S24	36	57.75	5.36	68.73%
S25	40	77.5	11.81	81.71%
S26	64	309.5	121.69	56.94%
S27	65	313.25	965.65	59.82%
S28	8	3.75	0.60	96.77%
S30	8	3.5	0.66	94.07%
S31	53	125.75	31.49	72.23%
S32	15	11.25	1.42	85.68%
S33	63	265	124.51	21.34%
S34	71	368.25	122.08	48.56%
S35	5	3	0.18	95.68%
S36	27	30	2.05	64.19%
S36A	61	257	53.49	57.37%
S37	56	190	23.60	60.14%
S38	26	31	25.67	73.22%
S39	15	17	6.52	90.20%
S40	12	7.75	3.81	92.37%
S42	34	91	72.55	74.00%
S42A	69	375.5	159.39	52.78%
S43	57	271.5	70.66	42.43%
S44	41	97.75	61.29	67.48%
S45	40	82.5	144.11	74.85%
S46	23	39.25	15.50	80.06%
S47	58	408.25	80.76	5.85%
S50	59	275.5	1025.79	17.14%
S51	7	3	0.23	94.03%
T01	65	217.25	47.28	57.42%
T03	59	120.5	23.90	68.11%
T04	58	136.25	16.42	60.22%
T05	42	48.75	8.69	74.42%

Regulator	Frequency	SWO Duration (hrs)	Overflow Volume (MG)	Percent Capture
T06	36	53.25	61.89	74.17%
T07	8	5.75	1.18	91.57%
T08	69	370.5	679.21	55.40%
T09	38	50.25	6.19	77.12%
T10	63	195.75	20.68	52.25%
T11	54	87.25	10.06	65.18%
T12	8	5.25	0.42	90.75%
T13	61	157.5	36.02	60.33%
T14	62	232.75	1155.82	65.93%
T15	54	131.25	46.11	60.37%

c. Summary of the in-stream impacts and effectiveness of CSO controls and restoration projects.

Discharges resulting from combined sewer overflows can have negative biological and physical impacts on streams. CSOs tend to diminish water quality decreasing both the number and diversity of fish and macro invertebrate species. In addition, the excessively high flows resulting from CSOs tend to produce degrading, incised stream channels that do not readily access the floodplain.

As CSO controls and stream restoration projects are implemented, PWD expects to demonstrate improvements of existing biological and physical stream impairments. The extent of these improvements will be measured through regular monitoring to establish the overall effectiveness of these interventions.

d. An annual summary of the information provided in the Special Discharge Monitoring report including:

i. Rainfall data - total inches (to the nearest 0.01 inch) that fell each day and month for the period of the reports.

Table III.C.4-3 PWD Raingage records by date

Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
7/1/2009	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0			0.0		0.0	0.0	0.0	0.0	0.3
7/2/2009	0.3	0.3	0.7	0.6	0.5	1.2	0.2	0.3	0.6	0.5	0.3	0.5	0.5	0.5	0.6	0.3	0.6	0.6	0.3	0.6	0.7	0.8	0.2	0.6
7/7/2009				0.0			0.0	0.0			0.0						0.0							
7/11/2009			0.2	0.2		0.0	0.1	0.1	0.0	0.3	0.1		0.1	0.1	0.0	0.0	0.1	0.1	0.2	0.2	0.2	0.0		0.3
7/12/2009	1.0	1.3	1.1	1.2	0.8	1.2	1.0	1.1	1.6	1.0	1.4	0.8	1.2	1.1	1.0	1.3	1.2	1.1	1.6	1.2	1.6	1.6	0.8	0.9
7/15/2009					0.0							0.0												
7/16/2009	0.0	0.0	0.3	0.4	0.1	0.2	1.7	1.2	0.3	0.3	0.9	0.1	0.5	1.0	0.3	0.3	0.7	0.3	1.3	0.1	0.7	0.3	0.2	0.1
7/17/2009	0.2	0.5	0.7	0.5	0.2	0.7	0.5	0.5	0.9	0.7	0.6	0.2	0.5	0.5	0.3	0.4	0.5	0.8	0.6	0.1	0.3	0.7	0.2	0.2
7/18/2009																								0.0
7/21/2009	0.2	0.1	0.9	0.9	0.6	0.3	0.6	0.6	0.3	0.9	0.6	0.6	0.7	0.6	0.7	0.7	0.6	0.8	0.8	1.2	0.5	0.1	0.1	0.7
7/22/2009				0.0				0.0		0.1	0.0			0.0							0.0			
7/23/2009	0.1	0.1	0.4	0.4	0.1	0.1	0.3	0.5	0.1	0.6	0.6	0.1	0.7	0.2	0.1	0.0	0.6	0.1	0.1	0.1	0.1	0.0	0.0	0.1
7/24/2009	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/25/2009	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
7/26/2009	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.2	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.4	0.1	0.1	0.1
7/27/2009				0.0		0.0				0.0									0.0	0.0		0.0		
7/28/2009																		0.5						
7/29/2009	0.6	0.8	0.4	0.5	0.5	0.3	0.5	0.4	0.5	0.4	0.4	0.5	0.3	0.4	0.4	0.6	0.4	0.7	0.5	0.7	0.1	0.2	0.7	0.4
7/30/2009				0.0		0.0														0.0				0.0
7/31/2009	1.7	1.4	0.9	0.9	1.6	0.3	1.1	0.9	1.1	1.3	0.9	1.6	0.8	1.1	1.5	1.4	0.4	0.8	1.2	1.0	1.3	1.0	1.5	0.9
8/1/2009				0.0						0.0										0.0		0.0		
8/2/2009	1.5	1.3	1.1	1.2	1.7	1.6	1.2	1.2	1.5	2.1	1.1	1.7	1.1	1.5	1.5	1.4	1.1	1.4	2.5	1.2	4.6	1.8	1.5	1.0
8/3/2009				0.0																0.0	0.0			
8/6/2009	0.2	0.2	0.1	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0.2	0.2	0.3	0.2	0.2	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.1
8/9/2009	2.2	2.6	1.1	1.1	1.7	2.0	2.1	1.8	2.0	1.2	1.8	1.7	1.3	2.3	2.5	1.8	1.7	2.6	2.3	0.5	2.4	2.4	2.7	0.5
8/12/2009	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.1		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.1	0.0	0.0
8/13/2009	0.2	0.2	0.7	0.7	0.2	0.4	0.4	0.3	0.2	0.8	0.3	0.2	0.4	0.3	0.1	0.3	0.5	0.4	0.4	1.0	0.9	0.3	0.1	0.9
8/14/2009			0.0	0.0						0.0	0.0							0.0		0.0				
8/18/2009	0.3	0.3	0.0	0.1	0.3	0.4	0.1	0.1	0.3	0.1	0.1	0.3	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.1
8/19/2009	0.2	0.4		0.0	0.1		0.0			0.0		0.1	0.0	0.0	0.1	0.2	0.0					0.0	0.1	0.0

8/21/2009	0.1	0.3	0.2	0.3	0.2	0.4	0.1	0.1	0.4	0.2	0.2	0.2	0.3	0.1	0.1	0.1	0.3	0.4	0.3	0.4	0.7	0.4	0.1	0.4
8/22/2009	3.2	2.7	1.7	1.9	2.3	2.1	2.6	2.1	1.7	2.1	2.1	2.3	1.6	1.7	2.7	3.0	1.8	1.6	1.8	2.2	3.0	3.4	1.6	2.0
8/23/2009			0.0	0.0							0.0										0.0			0.0
8/28/2009	0.7	0.4	0.4	0.4	1.3	0.6	0.5	0.4	0.5	0.5	0.4	1.3	0.4	0.5	0.6	0.5	0.5	0.5	0.4	0.4	0.5	0.6	1.2	0.6
8/29/2009	3.4	1.6	0.6	0.8	3.8	2.3	1.4	1.3	1.9	0.4	1.0	3.8	0.8	0.7	1.9	1.8	1.3	2.1	0.8	0.6	0.7	2.1	2.7	0.3
8/30/2009		0.0	0.0	0.0	0.0		0.1	0.0		0.0	0.1	0.0	0.0		0.1		0.0		0.0	0.0	0.0	0.0		0.0
9/9/2009		0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.2	0.0	0.0	0.0				0.1	0.1		0.4	0.1	0.0	0.2
9/10/2009	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
9/11/2009	2.3	2.4	1.8	1.9	2.3	2.4	2.1	2.0	2.2	2.3	2.2	2.3	2.0	1.9	2.2	1.9	2.1	2.2	2.1	1.6	2.4	2.2	1.8	1.2
9/12/2009	0.1	0.1	0.2	0.2		0.2	0.2	0.1	0.1	0.2	0.2		0.2	0.1	0.1	0.1	0.1	0.2	0.3	0.2	0.3	0.2	0.1	0.2
9/13/2009			0.0	0.0		0.0		0.0	0.0				0.0	0.0	0.0	0.0	0.0		0.0			0.0		
9/14/2009																								0.5
9/16/2009		0.0	0.7	0.6	0.0	0.1	0.3	1.2	0.0	0.2	1.0	0.0	0.9	0.1	0.0		0.7	0.3	0.6	0.4	0.3	0.0		0.1
9/17/2009						0.0	0.0		0.0					0.0				0.0			0.0	0.0		
9/18/2009																		0.5						
9/20/2009				0.0						0.0														
9/21/2009							0.0																	
9/23/2009	0.1											0.0		0.1	0.5	0.5							0.1	
9/24/2009	0.1	0.1	1.2	1.2		0.3	0.9	0.7	0.2	1.0	0.7	0.0	1.0	0.6	0.3	0.2	1.2	0.4	1.0	1.2	0.8	0.2	0.1	0.7
9/25/2009					0.1							0.1												
9/26/2009	0.1	0.2	0.2	0.1		0.2	0.2	0.2	0.2	0.2	0.2		0.2	0.2	0.2	0.2	0.2	0.2	0.2		0.2	0.2	0.2	0.2
9/27/2009	0.9	0.9	0.9	0.6	0.0	0.9	0.9	0.7	0.8	1.0	0.9	0.1	0.9	0.8	0.9	1.0	0.9	0.9	0.9		0.8	0.9	0.9	1.0
9/28/2009	0.3	0.3	0.4	0.3	0.0	0.3	0.4	0.4	0.3	0.4		0.0	0.4	0.4	0.4	0.4	0.4	0.3	0.3		0.4	0.4	0.3	0.3
9/29/2009				0.0	0.0					0.0		0.0			0.5									
9/30/2009					0.1	0.0						0.1			0.0	0.0						0.0		
10/2/2009				0.0		0.0				0.0								0.1	0.0		0.0	0.0		
10/3/2009	0.0	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.1
10/4/2009				0.0			0.0			0.0										0.0				
10/5/2009					0.0							0.0												
10/7/2009	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1
10/9/2009	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
10/10/2009	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.0

10/15/2009	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.8	0.7	0.9	0.8	0.6	0.7	0.7	0.7	0.7	0.8	0.7	0.8	0.7	0.9	0.7	0.7	0.7
10/16/2009	0.5	0.5	0.1	0.1	0.4	0.3	0.1	0.1	0.3	0.1	0.1	0.4	0.1	0.2	0.2	0.3	0.1	0.2	0.1	0.0	0.2	0.5	0.5	0.0
10/17/2009	0.8	1.0	0.7	0.7	0.7	1.0	0.8	0.7	1.0	0.8	0.8	0.7	0.7	0.7	0.8	0.8	0.7	0.9	1.0	0.6	1.1	1.0	0.8	0.7
10/18/2009	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2
10/22/2009																		0.5						
10/23/2009	0.0	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.1	0.0	0.2
10/24/2009	1.5	1.7	1.5	1.6	1.7	1.7	1.5	1.3	1.5	1.5	1.4	1.7	1.4	1.3	1.7	1.8	1.7	1.4	1.8	1.7	1.8	1.7	1.8	1.5
10/27/2009	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.7	0.6	0.7	0.7	0.7	0.7	0.6	0.7
10/28/2009	1.2	1.3	1.1	1.1	1.4	1.2	1.1	1.0	1.2	1.2	1.2	1.4	1.1	1.2	1.2	1.3	1.1	1.2	1.2	1.1	1.1	1.2	0.7	1.1
10/29/2009				0.0			0.0			0.0	0.0		0.0					0.0	0.0	0.0	0.0	0.0		
10/31/2009	0.2	0.4	0.3	0.3	0.2	0.3	0.4	0.2	0.3	0.4	0.3	0.2	0.3	0.3	0.4	0.4	0.4	0.2	0.2	0.3	0.2	0.3	0.3	0.3
11/1/2009	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
11/2/2009			0.0	0.0		0.0			0.0	0.0			0.0					0.0			0.0	0.0		
11/3/2009				0.0						0.0										0.0				
11/5/2009						0.0	0.0											0.0				0.0		
11/7/2009																						0.0		
11/11/2009	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.1	0.1	0.1	0.1
11/12/2009	0.4	0.4	0.3	0.3	0.4	0.3	0.4	0.3	0.4	0.3	0.3	0.4	0.3	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.2
11/13/2009	0.2	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
11/14/2009	0.2	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.2	0.2	0.1	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1
11/18/2009				0.0																0.1				
11/19/2009	0.1	0.2	0.1	0.1	0.1	0.3	0.1	0.1	0.4	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.4	0.0	0.3	0.3	0.2	0.2
11/20/2009	0.9	0.6	0.5	0.6	0.8	0.4	0.8	0.6	0.5	0.6	0.7	0.8	0.6	0.7	0.8	0.9	0.6	0.5	0.4	0.6	0.4	0.6	0.9	0.6
11/23/2009	0.2	0.2	0.1	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1
11/24/2009	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0.2	0.1	0.0
11/25/2009	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2		0.2
11/26/2009				0.0					0.0				0.0	0.0								0.0		
11/27/2009	0.0	0.0			0.0	0.1						0.0				0.0						0.0		
11/30/2009	0.2	0.2	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.4	0.3	0.2	0.3	0.3	0.2	0.2	0.3	0.3	0.4	0.3	0.4	0.3		0.3
12/2/2009	0.6	0.7	0.6	0.7	0.7	0.7	0.7	0.2	0.6	0.8	0.7	0.7	0.6	0.6	0.7	0.7	0.6	0.8	0.7	0.7	0.8	0.7	0.6	0.7
12/3/2009	0.4	0.4	0.5	0.5	0.5	0.4	0.4	0.2	0.4	0.6	0.5	0.5	0.5	0.5	0.4	0.5	0.5	0.4	0.5	0.5	0.5	0.4	0.4	0.5
12/5/2009	0.5	0.5	0.6	0.5	0.6	0.2	0.5	0.5	0.5	0.4	0.5	0.6	0.5	0.6	0.6	0.5	0.6	0.3	0.3	0.6	0.1	0.5	0.5	0.2

12/6/2009			0.0	0.0		0.1				0.1									0.1	0.0	0.1	0.1		0.1
12/7/2009				0.0		0.2		1.7		0.1									0.0		0.2			0.1
12/8/2009						0.0															0.1			
12/9/2009	2.1	2.3	2.1	1.7	2.4	2.3	2.1	1.4	2.2	2.1	2.2	2.4	2.1	2.1	2.1	2.3	2.2	2.5	2.4	0.7	2.1	2.4	1.9	2.1
12/10/2009					0.0							0.0												
12/13/2009	1.1	1.2	1.1	1.1	1.2	1.1	1.1	0.9	1.1	1.2	1.1	1.2	1.1	1.1	1.2	1.2	1.2	1.2	0.9	1.2	1.0	1.2	1.1	1.1
12/15/2009																					0.0			
12/18/2009				0.0																0.0				
12/20/2009	0.1	0.0		0.0	0.0	0.0	0.0	0.1	0.1		0.0	0.0	0.0	0.0	0.1		0.0	0.1	0.0		0.0		0.0	
12/21/2009	0.0	0.0	0.0	0.0		0.1	0.0	0.1	0.0		0.1		0.0		0.0	0.1	0.0	0.0	0.0		0.0	0.0	0.0	0.1
12/22/2009			0.0	0.0		0.0			0.0		0.0		0.0		0.1	0.0	0.0	0.0						0.1
12/23/2009																						0.0		
12/24/2009				0.0		0.0	0.0		0.0		0.0							0.0			0.0			0.0
12/25/2009	0.3	0.3	0.3	0.3	0.4	0.5	0.3	0.2	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.2	0.5
12/26/2009	1.8	2.0	1.9	2.0	2.2	2.3	1.8	1.4	2.0	2.0	2.2	2.2	2.2	1.8	1.8	1.9	2.0	2.1	2.2	2.0	2.1	2.2	1.6	2.0
12/27/2009	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.0		0.0	0.0	0.1
12/31/2009	0.3	0.3	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2
1/1/2010	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0		0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1		0.0		0.1
1/5/2010																		0.0						
1/8/2010		0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.1	0.0	0.0	0.0		0.0		0.0	0.1	0.0	0.0		0.1	0.0	0.0
1/17/2010	0.8	0.9	0.8	1.0	1.1	0.9	0.8	0.8	0.8	1.0	0.9	1.1	0.9	0.9	0.9	0.9	0.9	0.7	0.9	0.8	0.9	1.0	0.6	0.8
1/18/2010	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1/19/2010											0.0													
1/20/2010																				0.0				
1/24/2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0		0.0
1/25/2010	1.5	1.5	1.7	0.7	1.8	1.6	1.7	0.9	1.5	1.9	1.8	1.7	1.6	1.6	1.4	1.8	1.8	1.6	1.6	1.6	2.3	1.6	1.4	1.6
1/26/2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1/31/2010																						0.0	0.0	
2/1/2010						0.0												0.0						
2/2/2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2/3/2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2/5/2010	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

2/6/2010	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
2/9/2010	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
2/10/2010	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
2/11/2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2/12/2010									0.0															
2/14/2010	0.0				0.0					0.0		0.0						0.0			0.0	0.0	0.0	0.0
2/15/2010	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2/16/2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2/17/2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2/18/2010							0.0	0.0																
2/19/2010																						0.0		
2/22/2010	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.2	0.2	0.1	0.2	0.2	0.1	0.2
2/23/2010	1.0	1.0	1.1	0.9	1.0	1.1	1.1	1.1	1.0	1.3	1.1	1.0	1.1	1.1	1.1	1.1	1.1	0.9	1.1	0.9	1.2	1.1	0.8	0.9
2/24/2010			0.0	0.0		0.0		0.0	0.0	0.0	0.0		0.0	0.0			0.0	0.0	0.0	0.0	0.0	0.0		0.0
2/25/2010	0.2	0.2	0.3	0.4	0.3	0.3	0.3	0.3	0.2	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.3	0.1	0.2	0.4	0.2	0.3	0.2	0.3
2/26/2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2/27/2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/2/2010		0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0
3/3/2010	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0
3/12/2010	0.5	0.6	0.4	0.4	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.5	0.4	0.5	0.5	0.5	0.4	0.5	0.4	0.5	0.6	0.4	0.4
3/13/2010	2.8	3.0	2.4	2.0	2.8	2.7	2.9	2.9	2.8	2.5	2.9	2.8	2.8	2.4	3.1	2.9	2.9	2.0	3.1	2.0	3.2	3.1	1.8	2.5
3/14/2010	0.3	0.3	0.7	0.4	0.3	0.3	0.5	0.7	0.3	0.7	0.8	0.3	0.9	0.5	0.4	0.3	0.9	0.4	0.6	0.4	0.4	0.3	0.4	0.4
3/15/2010	0.3	0.3	0.2	0.2	0.3	0.4	0.3	0.3	0.3	0.2	0.3	0.3	0.2	0.4	0.3	0.3	0.3	0.2	0.3	0.2	0.4	0.4	0.3	0.2
3/16/2010								0.0		0.0			0.0									0.0		
3/22/2010	0.9	0.9	1.4	1.2	1.1	1.1	1.1	1.1	0.9	1.4	1.2	1.1	1.1	1.1	1.0	1.1	1.3	1.2	1.2	1.1	1.0	1.0	1.0	1.5
3/23/2010	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3/24/2010																			0.0					
3/26/2010	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
3/28/2010	0.3	0.3	0.2	0.4	0.3	0.4	0.3	0.3	0.3	0.4	0.4	0.3	0.3	0.0	0.3	0.3	0.3	0.4	0.4	0.3	0.4	0.4	0.3	0.3
3/29/2010	1.6	1.6	1.5	1.7	1.6	1.6	1.7	1.6	1.5	1.9	1.8	1.6	1.3	0.9	1.5	1.7	1.5	1.7	1.6	1.5	1.5	1.6	1.5	1.8
3/30/2010	0.8	0.8	1.5	0.7	0.7	1.4	1.2	1.4	1.3	1.5	1.6	0.7	1.5	1.5	0.9	0.9	1.3	0.7	1.3	1.8	1.2	1.4	0.6	1.3
3/31/2010	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

4/6/2010	0.0	0.0			0.0							0.0		0.0	0.0	0.0						0.0	0.0	
4/8/2010	0.0	0.0				0.0								0.0				0.0	0.0		0.0	0.0	0.0	
4/9/2010	0.5	0.6	0.5	0.6	0.7	0.5	0.6	0.5	0.5	0.6	0.5	0.7	0.6	0.7	0.7	0.6	0.7	0.4	0.5	0.6	0.5	0.5	0.5	0.5
4/10/2010			0.0							0.0														
4/11/2010			0.0	0.0		0.0		0.0	0.0	0.0			0.0		0.0	0.0	0.0				0.0			
4/13/2010	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1
4/14/2010			0.0			0.0	0.0			0.0	0.0			0.0					0.0		0.0			
4/16/2010	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.1
4/17/2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/19/2010														0.0										
4/21/2010	0.1	0.2	0.0	0.2	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.0		0.2	0.1	0.1	0.1	0.1	0.0	0.1	0.2	0.2	0.1
4/22/2010	0.0	0.1			0.0	0.0			0.0			0.0				0.0				0.0		0.0	0.1	0.0
4/25/2010	0.9	0.8	0.9	1.0	1.0	0.8	0.8	0.7	0.7	0.9	0.9	1.0	0.7	1.2	0.8	0.8	0.9	0.8	0.8	0.9	0.7	0.8	0.9	0.9
4/26/2010	0.8	0.8	0.7	0.9	0.9	0.8	0.8	0.6	0.8	0.6	0.7	0.9	0.5	0.8	1.0	1.0	0.8	0.7	0.7	0.7	0.6	0.9	0.8	0.6
4/27/2010	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1		0.0
5/3/2010	1.0	1.0	0.9	0.8	1.1	1.1	1.0	0.9	1.0	0.9	1.0	1.0	0.6	0.9	1.1	1.2	1.0	0.9	0.9	0.8	0.9	1.2	0.8	0.6
5/11/2010	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.3	0.3	0.2	0.3	0.2	0.1	0.1
5/12/2010	0.4	0.4	0.4	0.3	0.4	0.3	0.3	0.3	0.2	0.4	0.3	0.4	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.5	0.3	0.3	0.4	0.5
5/13/2010													0.0											
5/14/2010	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.2			0.1	0.2	0.1	0.3	0.0	0.0	0.2	0.1	0.1		0.0	0.0	0.4	0.1
5/15/2010				0.0		0.1	0.1	0.0	0.1		0.0			0.1	0.0	0.1	0.1	0.0	0.0		0.0	0.1		
5/17/2010		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5/18/2010	0.7	0.7	0.7	0.8	0.8	0.7	0.6	0.5	0.6	0.8	0.7	0.5	0.5	0.6	0.6	0.7	0.7	0.6	0.7	0.7	0.7	0.6	0.6	0.7
5/19/2010										0.0	0.0		0.0	0.0			0.0			0.0				0.0
5/22/2010	0.0	0.0	0.0		0.0	0.1	0.0		0.1	0.0	0.0	0.1		0.0		0.0	0.0	0.1	0.0		0.1	0.0	0.0	0.0
5/23/2010	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1		0.1	0.0	0.0	0.1	0.0	0.2		0.2	0.1	0.1	0.0
5/24/2010	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0		0.0		0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.0
5/27/2010	0.1	0.1	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.1		0.0				0.0	0.0	0.0	0.1	0.0	0.2	0.0
5/29/2010			0.1	0.0						0.1	0.0		0.0						0.0	0.1				0.2
5/30/2010	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.0	0.1	0.4	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0.1	0.2	0.1	0.1	0.1
5/31/2010																				0.1				
6/1/2010	0.2	0.2	0.1	0.4	0.4	0.1	0.7	0.4	0.1	0.3	0.3		0.2	0.1	0.2	0.4	0.7	0.4	0.2	0.1	0.3	0.1		

6/2/2010																								0.0
6/3/2010			0.0	0.1		0.0	0.1	0.1	0.0	0.0	0.1		0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.1	0.0		
6/9/2010	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.3	0.5	0.8	0.5	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.7	0.5	0.5	0.5	
6/10/2010																				0.0				0.0
6/13/2010	0.8	0.8	0.3	0.7	0.5	1.1	0.4	0.2	1.1	0.6	0.2	0.5	0.2	0.9	0.4	0.5	0.5	0.5	0.5	1.3	0.7	1.1	0.3	1.1
6/14/2010																								0.0
6/16/2010										0.0														0.0
6/17/2010		0.0	0.0	0.0	0.0	0.0		0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0		
6/22/2010																				0.0				0.0
6/23/2010																		0.0			0.0			
6/24/2010	1.1	0.8	0.1	0.1	0.7	1.0	0.2	0.3	1.5	0.1	0.2	1.0	0.1	0.2	0.0	0.7	0.2	0.2	0.5	0.0	0.7	1.6	1.0	0.0
6/27/2010									0.0						0.0	0.0								
6/28/2010	0.5	0.1	0.1	0.1	0.3	0.2	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.0		0.0	0.1	0.1	0.2	0.2			0.2	0.1
7/1/2010					0.1																			

Table III.C.4-4 PWD Raingage records by year and Month

Year	Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
2009	7	4.2	4.5	5.5	5.5	4.6	4.4	6.1	5.7	5.7	6.4	6.0	4.5	5.6	5.6	5.0	5.0	5.2	5.8	6.7	5.3	6.0	5.0	3.8	4.5
2009	8	12.0	10.1	6.1	6.7	11.8	9.9	8.5	7.5	8.8	7.5	7.1	11.7	6.1	7.6	10.0	9.4	7.4	9.2	8.7	6.9	13.0	11.4	10.7	5.9
2009	9	3.9	4.1	5.5	5.0	2.7	4.7	5.0	5.5	4.1	5.6	5.6	2.7	5.5	4.4	5.2	4.3	5.7	5.1	5.7	3.5	5.7	4.3	3.4	4.4
2009	10	5.8	6.6	5.4	5.7	6.1	6.4	5.7	5.1	6.1	6.2	5.7	6.1	5.5	5.4	6.1	6.4	6.0	6.3	6.3	5.7	6.5	6.7	5.6	5.4
2009	11	2.5	2.4	1.8	2.0	2.3	2.3	2.3	1.9	2.5	2.2	2.3	2.3	2.1	2.1	2.4	2.5	2.0	2.1	2.0	1.9	2.1	2.5	2.1	1.8
2009	12	7.1	7.5	7.4	7.2	8.3	8.2	7.2	6.9	7.5	7.7	8.0	8.3	7.5	7.3	7.4	7.8	7.7	7.9	7.6	6.1	7.3	8.0	6.7	7.6
2010	1	2.4	2.4	2.7	1.8	2.9	2.7	2.7	1.8	2.5	3.0	2.9	2.9	2.6	2.6	2.4	2.9	2.8	2.5	2.7	2.5	3.2	2.8	2.1	2.6
2010	2	3.5	3.6	3.7	3.7	3.6	3.7	3.6	3.7	3.6	4.0	3.7	3.6	3.7	3.7	3.6	3.6	3.7	3.4	3.6	3.6	3.8	3.8	3.4	3.5
2010	3	7.9	8.2	8.5	7.1	8.2	8.6	8.8	8.9	8.3	9.4	9.6	8.2	8.8	7.4	8.3	8.4	9.3	7.1	9.3	8.0	9.0	9.1	6.5	8.6
2010	4	2.6	2.8	2.5	3.0	3.1	2.6	2.6	2.0	2.6	2.6	2.5	3.1	2.1	3.1	2.9	2.9	2.9	2.4	2.3	2.7	2.3	2.8	2.8	2.3
2010	5	2.6	2.8	2.5	2.5	2.7	2.7	2.5	2.2	2.5	2.9	2.6	2.5	1.6	2.7	2.5	2.7	2.7	2.6	2.6	2.4	2.9	2.7	2.7	2.3
2010	6	3.1	2.5	1.3	1.8	2.4	2.9	2.0	1.4	3.2	1.8	1.4	2.2	1.2	1.8	1.2	2.2	2.0	1.9	2.0	2.3	2.3	3.3	1.9	1.2

ii. The total number of regulator inspections conducted during the period of the report.

Please refer to **SECTION II.A.3.1 "CSO REGULATOR INSPECTION & MAINTENANCE PROGRAM"** on page 17 for information on this section. Also refer to page 2 of **APPENDIX A** for the total number of regulators inspected during the reporting period.

iii. A list of blockages (if any) corrected or other interceptor maintenance performed, including location, date and time corrected, and any discharges to the stream observed.

Please refer to **SECTION II.A.3.1 "CSO REGULATOR INSPECTION & MAINTENANCE PROGRAM"** on page 17 for information on this section. Also refer to page 3 of **APPENDIX A** for the total number of regulators inspected during the reporting period.

e. *Dry-weather overflows - for all dry weather overflows, indicate the location, date and time discovered, date and time corrected/ceased, and action(s) taken to prevent their re-occurrence.*

Please refer to page 10 of **APPENDIX A** for a detailed listing of Dry-Weather overflows.

f. Wet-weather overflows - using calibrated models of the combined sewer system, provide a summary of the annual CSO frequency, volume, and percent capture of combined sewer flows.

Please refer to section *a* **Table III.C.4-1** on page 166 for the list of wet-weather overflows for the estimated average annual frequency and volume statistics for the past fiscal year.

Table III.C.4-5 Listing of all CSO permitted outfalls

Point Source #	Outfall Latitude	Outfall Longitude	Regulator Location	Discharges to:	Interceptor	Outfall Name
NPDES Permit #0026689 - Northeast						
2	39d 58m 50s	75d 4m 58s	Castor Ave. and Balfour St.	Delaware River	Somerset	D_17
3	39d 58m 45s	75d 5m 6s	Venango St. NW of Casper St.	Delaware River	Somerset	D_18
4	39d 58m 41s	75d 5m 15s	Tioga St. NW of Casper St.	Delaware River	Somerset	D_19
5	39d 58m 43s	75d 5m 28s	Ontario St. NW of Casper St.	Delaware River	Somerset	D_20
6	39d 58m 44s	75d 5m 41s	Westmoreland St. NW of Balfour St.	Delaware River	Somerset	D_21
7	39d 58m 42s	75d 5m 53s	Allegheny Ave. SE of Bath St.	Delaware River	Somerset	D_22
8	39d 58m 38s	75d 6m 12s	Indiana Ave. SE of Allen St.	Delaware River	Somerset	D_23
10	39d 58m 38s	75d 6m 28s	Cambria St. E of Melvale St.	Delaware River	Somerset	D_25
11	40d 1m 18s	75d 1m 44s	Cottman St. SE of Milnor St.	Delaware River	Upper Delaware Low Level	D_02
12	40d 1m 14s	75d 2m 0s	Princeton Ave SE of Milnor St.	Delaware River	Upper Delaware Low Level	D_03
13	40d 1m 8s	75d 2m 13s	Disston St. SE of Wissinoming St.	Delaware River	Upper Delaware Low Level	D_04
14	40d 0m 58s	75d 2m 34s	Magee St. SE of Milnor St.	Delaware River	Upper Delaware Low Level	D_05
15	40d 0m 53s	75d 2m 46s	Levick St. SE of Milnor St.	Delaware River	Upper Delaware Low Level	D_06
16	40d 0m 44s	75d 3m 5s	Lardner St. SE of Milnor St.	Delaware River	Upper Delaware Low	D_07

					Level	
17	40d 0m 38s	75d 3m 13s	Comly St. SE of Milnor St.	Delaware River	Upper Delaware Low Level	D_08
18	40d 0m 34s	75d 3m 18s	Dark Run La and Milnor St.	Delaware River	Upper Delaware Low Level	D_09
19	40d 0m 21s	75d 3m 28s	Sanger St. SE of Milnor St.	Delaware River	Upper Delaware Low Level	D_11
20	40d 0m 2s	75d 3m 43s	Bridge St. Se of Garden St.	Delaware River	Upper Delaware Low Level	D_12
21	39d 59m 53s	75d 3m 47s	Kirkbride St. and Delaware Ave.	Delaware River	Upper Delaware Low Level	D_13
22	39d 59m 24s	75d 4m 4s	Orthodox St. and Delaware Ave.	Delaware River	Upper Delaware Low Level	D_15
23	40d 2m 36s	75d 1m 15s	Frankford Avenue & Ashburner Street	Pennypack Creek	Pennypack	P_01
24	40d 2m 36s	75d 1m 16s	Frankford Avenue & Holmesburg St.	Pennypack Creek	Pennypack	P_02
25	40d 2m 13s	75d 1m 19s	Torresdale Ave. NW of Pennypack Ck.	Pennypack Creek	Pennypack	P_03
26	40d 2m 23s	75d 1m 21s	Cottage Avenue & Holmesburg Avenue	Pennypack Creek	Pennypack	P_04
27	40d 2m 2s	75d 1m 21s	Holmesburg Ave SE of Hegerman St	Pennypack Creek	Pennypack	P_05
28	40d 4m 34s	75d 9m 44s	Williams Avenue SE of Sedgewick	Tacony Creek	Frankford High Level	T_01
29	40d 2m 28s	75d 6m 56s	Complost Ave West of Tacony Creek	Tacony Creek	Frankford High Level	T_03
30	40d 2m 11s	75d 6m 48s	Rising Sun Ave East of Tacony Creek	Tacony Creek	Frankford High Level	T_04
31	40d 2m 9s	75d 6m 48s	Rising Sun Ave West of Tacony Creek	Tacony Creek	Frankford High Level	T_05
32	40d 2m 3s	75d 6m 41s	Bingham Street East of Tacony Creek	Tacony Creek	Frankford High Level	T_06

33	40d 1m 51s	75d 6m 43s	Tabor Road West of Tacony Creek	Tacony Creek	Frankford High Level	T_07
34	40d 1m 42s	75d 6m 47s	Ashdale Street West of Tacony Creek	Tacony Creek	Frankford High Level	T_08
35	40d 1m 37s	75d 6m 48s	Roosevelt Blvd. West of Tacony Creek	Tacony Creek	Frankford High Level	T_09
36	40d 1m 37s	75d 6m 47s	Roosevelt Blvd. East of Tacony Creek	Tacony Creek	Frankford High Level	T_10
37	40d 1m 29s	75d 6m 43s	Ruscomb Street East of Tacony Creek	Tacony Creek	Frankford High Level	T_11
38	40d 1m 23s	75d 6m 41s	Whitaker Avenue East of Tacony Creek	Tacony Creek	Frankford High Level	T_12
39	40d 1m 22s	75d 6m 42s	Whitaker Avenue West of Tacony Ck	Tacony Creek	Frankford High Level	T_13
40	40d 0m 59s	75d 6m 28s	I Street & Ramona Ave.	Tacony Creek	Frankford High Level	T_14
41	40d 0m 57s	75d 6m 20s	J Street & Juniata Park	Tacony Creek	Frankford High Level	T_15
42	40d 0m 57s	75d 5m 51s	Castor Avenue at Unity Street Circle	Frankford Creek	Upper Frankford Low Level	F_03
43	40d 0m 52s	75d 5m 42s	Wingohocking St East of Adams Ave	Frankford Creek	Upper Frankford Low Level	F_04
44	40d 0m 41s	75d 5m 41s	Bristol Street West of Adams Avenue	Frankford Creek	Upper Frankford Low Level	F_05
45	40d 0m 25s	75d 5m 33s	Worrel Street East of Frankford Creek	Frankford Creek	Upper Frankford Low Level	F_06
46	40d 0m 26s	75d 5m 34s	Worrel Street West of Frankford Creek	Frankford Creek	Upper Frankford Low Level	F_07
47	40d 0m 21s	75d 5m 36s	Torresdale Ave & Hunting Park Ave	Frankford Creek	Upper Frankford Low Level	F_08
48	40d 0m 19s	75d 5m 34s	Frankford Ave North of Frankford Ck	Frankford Creek	Upper Frankford Low Level	F_09
49	40d 0m 19s	75d 5m 35s	Frankford Ave South of Frankford Ck	Frankford Creek	Upper Frankford Low Level	F_10
50	40d 0m 15s	75d 5m 26s	Orchard Street South of Vandyke	Frankford Creek	Upper Frankford Low	F_11

			Creek		Level	
51	39d 59m 56s	75d 5m 14s	Sepviva Street North of Butler Street	Frankford Creek	Upper Frankford Low Level	F_12
52	39d 59m 49s	75d 5m 3s	Duncan Street Under Delaware Exp.	Frankford Creek	Lower Frankford Low Level	F_13
54	40d 0m 16s	75d 4m 15s	Wakeling Street NW of Creek Basin	Frankford Creek	Lower Frankford Low Level	F_21
55	40d 0m 19s	75d 4m 5s	Bridge Street NW of Creek Basin	Frankford Creek	Lower Frankford Low Level	F_23
56	40d 0m 18s	75d 4m 5s	Bridge Street SE of Creek Basin	Frankford Creek	Lower Frankford Low Level	F_24
57	40d 0m 15s	75d 4m 15s	Ash Street West of Creek Basin	Frankford Creek	Lower Frankford Low Level	F_25
58	40d 0m 30s	75d 3m 20s	Levick St. & Everett Ave.	Delaware River	Wakling Relief Sewer	D_FRW
59	40d 2m 16s	75d 6m 53s	Nedro Ave & 7th St.	Tacony Creek	Rock Run Flood Relief Sewer	T_FRRR
60	40d 0m 36s	75d 5m 44s	Castor Ave. & East Hunting Park Ave.	Frankford Creek	Frankford High Level Relief Sewer	F_FRFG
NPDES Permit # 0026662 – Southeast						
2	39d 58m 9s	75d 7m 19s	Dyott Street & Delaware Ave.	Delaware River	Lower Delaware Low Level	D_38
3	39d 58m 7s	75d 7m 23s	Susquehanna Ave. East of Beach Street	Delaware River	Lower Delaware Low Level	D_39
4	39d 58m 5s	75d 7m 26s	Berks Street East of Beach Street	Delaware River	Lower Delaware Low Level	D_40
5	39d 58m 3s	75d 7m 37s	Palmer Street East of Beach Street	Delaware River	Lower Delaware Low Level	D_41
6	39d 57m 54s	75d 7m 42s	Columbia Avenue East of Beach Street	Delaware River	Lower Delaware Low Level	D_42
7	39d 57m 56s	75d 7m 48s	Marlborough Street & Delaware Ave	Delaware River	Lower Delaware Low Level	D_43
8	39d 57m	75d 7m 54s	Shackamaxon St East of Delaware	Delaware River	Lower Delaware Low	D_44

	53s		Ave		Level	
9	39d 57m 48s	75d 8m 0s	Laurel Street & Delaware Avenue	Delaware River	Lower Delaware Low Level	D_45
10	39d 57m 41s	75d 8m 11s	Penn Street & Delaware Avenue	Delaware River	Lower Delaware Low Level	D_46
11	39d 57m 37s	75d 8m 9s	Fairmont Ave West of Delaware Ave	Delaware River	Lower Delaware Low Level	D_47
12	39d 57m 28s	75d 8m 13s	Willow Street West of Delaware Ave	Delaware River	Lower Delaware Low Level	D_48
13	39d 57m 24s	75d 8m 20s	Callowhill Street & Delaware Avenue	Delaware River	Lower Delaware Low Level	D_49
14	39d 57m 21s	75d 8m 13s	Delaware Avenue North of Vine Street	Delaware River	Lower Delaware Low Level	D_50
15	39d 57m 11s	75d 8m 17s	Race Street West of Delaware Avenue	Delaware River	Lower Delaware Low Level	D_51
16	39d 57m 7s	75d 8m 25s	Delaware Avenue & Arch Street	Delaware River	Lower Delaware Low Level	D_52
17	39d 56m 57s	75d 8m 23s	Market Street & Front Street	Delaware River	Lower Delaware Low Level	D_53
20	39d 56m 50s	75d 8m 24s	Front Street South of Chestnut Street	Delaware River	Lower Delaware Low Level	D_54
21	39d 56m 26s	75d 8m 32s	South Street & Delaware Avenue	Delaware River	Lower Delaware Low Level	D_58
22	39d 56m 12s	75d 8m 33s	Catharine Street East of Swanson Street	Delaware River	Lower Delaware Low Level	D_61
23	39d 56m 10s	75d 8m 32s	Queen Street East of Swanson Street	Delaware River	Lower Delaware Low Level	D_62
24	39d 56m 5s	75d 8m 33s	Christian St West of Delaware Avenue	Delaware River	Lower Delaware Low Level	D_63
25	39d 55m 59s	75d 8m 35s	Washington Ave East of Delaware Ave	Delaware River	Lower Delaware Low Level	D_64
26	39d 55m 45s	75d 8m 29s	Reed Street East of Delaware Avenue	Delaware River	Lower Delaware Low Level	D_65

27	39d 55m 37s	75d 8m 28s	Tasker Street East of Delaware Avenue	Delaware River	Lower Delaware Low Level	D_66
28	39d 55m 26s	75d 8m 21s	Moore Street East of Delaware Avenue	Delaware River	Lower Delaware Low Level	D_67
33	39d 54m 6s	75d 8m 12s	Pattison Avenue & Swanson Street	Delaware River	Lower Delaware Low Level	D_73
36	39d 58m 21s	75d 6m 58s	Cumberland St East of Richmond St	Delaware River	Lower Delaware Low Level	D_37
37	39d 57m 12s	75d 8m 24s	Race Street West of Delaware Avenue, North of D-51	Delaware River	Lower Delaware Low Level	D_51A
29	39d 55m 13s	75d 8m 20s	Snyder Avenue & Delaware Avenue	Delaware River	Oregon	D_68
30	39d 54m 60s	75d 8m 13s	Delaware Ave North of Porter Street	Delaware River	Oregon	D_69
31	39d 54m 44s	75d 8m 15s	Oregon Avenue & Delaware Avenue	Delaware River	Oregon	D_70
32	39d 54m 33s	75d 7m 59s	Bigler Street & Delaware Avenue	Delaware River	Oregon	D_71
34	39d 54m 24s	75d 8m 8s	Packer Avenue East of Delaware Ave	Delaware River	Oregon	D_72
NPDES Permit # 0026671 - Southwest						
2	39d 56m 17s	75d 12m 17s	Reed Street & Schuylkill Avenue	Schuylkill River	Lower Schuylkill East Side	S_31
3	39d 55m 54s	75d 12m 28s	35th St. and Mifflin St.	Schuylkill River	Lower Schuylkill East Side	S_36A
4	39d 55m 41s	75d 12m 38s	Vare Avenue & 29th Street	Schuylkill River	Lower Schuylkill East Side	S_37
5	39d 55m 12s	75d 12m 5s	Passyunk Avenue & 29th Street	Schuylkill River	Lower Schuylkill East Side	S_42
6	39d 55m 12s	75d 12m 5s	Passyunk Avenue & 28th Street	Schuylkill River	Lower Schuylkill East Side	S_42A
7	39d 54m 57s	75d 12m 16s	26th Street 700′ North of Hartranft St	Schuylkill River	Lower Schuylkill East Side	S_44

8	39d 53m 53s	75d 12m 39s	Penrose Avenue & 26th Street	Schuylkill River	Lower Schuylkill East Side	S_46
9	39d 57m 38s	75d 10m 50s	24th Street 155′ South of Parktown Pl	Schuylkill River	Central Schuylkill East Side	S_05
10	39d 57m 39s	75d 10m 49s	24th Street 350′ South of Parktown Pl	Schuylkill River	Central Schuylkill East Side	S_06
11	39d 57m 39s	75d 10m 50s	24th Street East of Schuylkill River	Schuylkill River	Central Schuylkill East Side	S_07
12	39d 57m 29s	75d 10m 43s	Race Street & Bonsall Street	Schuylkill River	Central Schuylkill East Side	S_08
13	39d 57m 30s	75d 10m 45s	Arch Street West of 23rd Street	Schuylkill River	Central Schuylkill East Side	S_09
14	39d 57m 16s	75d 10m 49s	Market Street 25′ East of 24th Street	Schuylkill River	Central Schuylkill East Side	S_10
15	39d 57m 11s	75d 10m 51s	24th St. N of Chestnut St. Bridge	Schuylkill River	Central Schuylkill East Side	S_12A
16	39d 57m 7s	75d 10m 52s	Sansom Street West of 24th Street	Schuylkill River	Central Schuylkill East Side	S_13
17	39d 57m 5s	75d 10m 53s	Walnut Street West of 24th Street	Schuylkill River	Central Schuylkill East Side	S_15
18	39d 57m 1s	75d 10m 56s	Locust Street & 25th Street	Schuylkill River	Central Schuylkill East Side	S_16
19	39d 56m 57s	75d 11m 0s	Spruce Street & 25th Street	Schuylkill River	Central Schuylkill East Side	S_17
20	39d 56m 52s	75d 11m 5s	Pine Street West of Taney Street	Schuylkill River	Central Schuylkill East Side	S_18
21	39d 56m 49s	75d 11m 9s	Lombard Street West of 27th Street	Schuylkill River	Central Schuylkill East Side	S_19
22	39d 56m 47s	75d 11m 12s	South Street East of 27th Street	Schuylkill River	Central Schuylkill East Side	S_21
23	39d 56m 44s	75d 11m 18s	Schuylkill Avenue & Bainbridge Street	Schuylkill River	Central Schuylkill East Side	S_23
24	39d 56m	75d 11m	Schuylkill Avenue & Christian	Schuylkill River	Central Schuylkill East	S_25

	34s	28s	Street		Side	
25	39d 56m 29s	75d 11m 35s	Ellsworth St West of Schuylkill Avenue	Schuylkill River	Central Schuylkill East Side	S_26
26	39d 58m 1s	75d 11m 17s	Mantua Avenue & West River Drive	Schuylkill River	Central Schuylkill West Side	S_01
27	39d 57m 54s	75d 11m 7s	Haverford Avenue & West River Drive	Schuylkill River	Central Schuylkill West Side	S_02
28	39d 57m 51s	75d 11m 4s	Spring Garden St W of Schuylkill Expy	Schuylkill River	Central Schuylkill West Side	S_03
29	39d 57m 53s	75d 11m 4s	Powelton Ave W of Schuylkill Expy	Schuylkill River	Central Schuylkill West Side	S_04
30	39d 57m 16s	75d 10m 53s	Market St West of Schuylkill Expy	Schuylkill River	Central Schuylkill West Side	S_11
31	39d 57m 5s	75d 10m 58s	Schuylkill Expressway & Walnut Street	Schuylkill River	Central Schuylkill West Side	S_14
32	39d 56m 51s	75d 11m 14s	440' Northwest of South Street	Schuylkill River	Central Schuylkill West Side	S_20
33	39d 56m 46s	75d 11m 22s	660' South of South St E of Pennfield	Schuylkill River	Central Schuylkill West Side	S_22
34	39d 56m 43s	75d 11m 26s	1060' South of South St E of Pennfield	Schuylkill River	Central Schuylkill West Side	S_24
35	39d 56m 32s	75d 12m 27s	46th Street & Paschall Avenue	Schuylkill River	Southwest Main Gravity	S_30
36	39d 56m 36s	75d 12m 18s	43rd St. and Locust St.	Schuylkill River	Southwest Main Gravity	S_50
37	39d 56m 13s	75d 12m 23s	49th Street South of Botanic Street	Schuylkill River	Lower Schuylkill West Side	S_32
38	39d 56m 8s	75d 12m 24s	51st Street South of Botanic Street	Schuylkill River	Lower Schuylkill West Side	S_33
39	39d 55m 43s	75d 12m 45s	56th Street East of P&R Railroad	Schuylkill River	Lower Schuylkill West Side	S_38
40	39d 54m 39s	75d 12m 55s	64th St. and Buist Ave.	Schuylkill River	Lower Schuylkill West Side	S_45

41	39d 56m 10s	75d 14m 6s	60th Street & Cobbs Creek Parkway	Cobbs Creek	Cobbs Creek High Level	C_18
51	39d 58m 51s	75d 16m 4s	City Line Avenue & 73rd Street	Cobbs Creek	Cobbs Creek High Level	C_01
52	39d 58m 51s	75d 16m 1s	City Line Ave 100' South Side of Creek	Cobbs Creek	Cobbs Creek High Level	C_02
54	39d 58m 30s	75d 15m 26s	Lebanon Ave Southwest of 73rd Street	Cobbs Creek	Cobbs Creek High Level	C_05
55	39d 58m 31s	75d 15m 25s	Lebanon Avenue & 68th Street	Cobbs Creek	Cobbs Creek High Level	C_06
56	39d 58m 26s	75d 15m 26s	Lansdowne Avenue & 69th Street	Cobbs Creek	Cobbs Creek High Level	C_07
57	39d 57m 51s	75d 14m 56s	54th Street & Cobbs Creek	Cobbs Creek	Cobbs Creek High Level	C_09
58	39d 57m 50s	75d 14m 53s	Gross Street & Cobbs Creek	Cobbs Creek	Cobbs Creek High Level	C_10
59	39d 57m 43s	75d 14m 53s	Cobbs Creek Pky South of Market St	Cobbs Creek	Cobbs Creek High Level	C_11
60	39d 57m 27s	75d 14m 60s	Spruce Street & Cobbs Creek	Cobbs Creek	Cobbs Creek High Level	C_12
61	39d 56m 45s	75d 14m 58s	62nd Street & Cobbs Creek	Cobbs Creek	Cobbs Creek High Level	C_13
62	39d 56m 36s	75d 14m 50s	Baltimore Avenue & Cobbs Creek	Cobbs Creek	Cobbs Creek High Level	C_14
63	39d 56m 31s	75d 14m 26s	59th Street & Cobbs Creek Parkway	Cobbs Creek	Cobbs Creek High Level	C_15
64	39d 56m 26s	75d 14m 23s	Thomas Avenue & Cobbs Creek	Cobbs Creek	Cobbs Creek High Level	C_16
65	39d 56m 13s	75d 14m 6s	Beaumont Street & Cobbs Creek	Cobbs Creek	Cobbs Creek High Level	C_17
66	39d 58m 29s	75d 16m 48s	Cobbs Creek Pky S of City Line Ave	Cobbs Creek	Cobbs Creek High Level	C_31
67	39d 58m	75d 15m	Brockton Road & Farrington Road	Cobbs Creek	Cobbs Creek High Level	C_33

	12s	56s				
68	39d 58m 40s	75d 15m 44s	Woodcrest Avenue & Morris Park	Cobbs Creek	Cobbs Creek High Level	C_34
69	39d 58m 47s	75d 15m 54s	Morris Park West of 72nd Street & Sherwood Road	Cobbs Creek	Cobbs Creek High Level	C_35
70	39d 58m 49s	75d 15m 35s	Woodbine Ave South of Brentwood Rd	Cobbs Creek	Cobbs Creek High Level	C_36
71	39d 57m 55s	75d 15m 15s	Cobbs Creek Parkway South of 67th & Callowhill Streets	Cobbs Creek	Cobbs Creek High Level	C_37
72	39d 58m 22s	75d 16m 11s	Cobbs Creek Parkway & 77th Street	Cobbs Creek	Cobbs Creek High Level	C_32
82	39d 58m 38s	75d 15m 28s	Malvern Ave. and 68th St.	Cobbs Creek	Cobbs Creek High Level	C_04A
42	39d 55m 57s	75d 14m 19s	Mount Moriah Cemetary & 62nd Street	Cobbs Creek	Cobbs Creek Low Level	C_19
43	39d 55m 46s	75d 14m 39s	65th Street & Cobbs Creek Parkway	Cobbs Creek	Cobbs Creek Low Level	C_20
44	39d 55m 37s	75d 14m 40s	68th Street & Cobbs Creek Parkway	Cobbs Creek	Cobbs Creek Low Level	C_21
45	39d 55m 27s	75d 14m 46s	70th Street & Cobbs Creek Parkway	Cobbs Creek	Cobbs Creek Low Level	C_22
46	39d 55m 15s	75d 14m 52s	Upland Street & Cobbs Creek Parkway	Cobbs Creek	Cobbs Creek Low Level	C_23
47	39d 55m 1s	75d 14m 49s	Woodland Avenue East of Island Ave.	Cobbs Creek	Cobbs Creek Low Level	C_25
49	39d 54m 44s	75d 14m 56s	Claymont Street & Grays Avenue	Cobbs Creek	Cobbs Creek Low Level	C_29
50	39d 54m 34s	75d 15m 1s	77th Street West of Elmwood Avenue	Cobbs Creek	Cobbs Creek Low Level	C_30
78	39d 54m 49s	75d 14m 50s	Island Ave. Southeast of Glenmore Ave	Cobbs Creek	Cobbs Creek Low Level	C_28A
75	39d 57m 59s	75d 11m 3s	16th St. & Clearfield St.	Schuylkill River	Main Relief Sewer	S_FRM

83	39d 56m 31s	75d 14m 25s	56th St. & Locust	Cobbs Creek	Thomas Run Relief Sewer	C_FRTR
84	39d 57m 49s	75d 14m 53s	Arch Street & Cobbs Creek	Cobbs Creek	Arch Street Relief Sewer	C_FRA

g. Chronic or continuous discharges - Provide the status and corrective actions taken at all sites identified as being chronic or continuous discharges, including an estimate of flow and duration.

The only known chronic discharges are Main and Shurs and PC-30. For information on corrective actions, please refer to **SECTION III.B.1.11 'ELIMINATE CSO/MAIN AND SHURS OFF-LINE STORAGE (SW) - CONSTRUCTION AND IMPLEMENTATION OF THE MAIN AND SHURS OFF-LINE STORAGE PROJECT"** on page 98 and **SECTION III.B.2.1.1 "INFLOW/INFILTRATION (I/I) CONTROLS- PC-30 RELIEF SEWER"** on page 107.

Table III.C.4-6 SSO Statistics for Period July 1 2009 – June 30 2010

Main & Shurs					
Event No.	Start of Overflow Date Time	End of Overflow Date Time	Event Duration (hours:mins)	Flow Volume (ft^3)	Flow Volume (Millions of gallons)
1	8/2/09 11:12 AM	8/2/09 11:52 AM	0:40	9637	0.0721
2	8/9/09 7:57 AM	8/9/09 9:24 AM	1:27	11932	0.0893
3	10/24/09 5:47 PM	10/24/09 6:24 PM	0:37	3559	0.2700
4*	12/9/09 6:15 AM	12/9/09 9:15 AM	3:00	14111	0.1056
5	3/13/10 2:32 PM	3/13/10 4:30 PM	1:57	10603	0.0793
6	3/29/10 1:10 AM	3/29/10 1:20 AM	0:10	57	0.0004

*** The monitoring sensor at this site failed from the beginning of December until 12/10/2009. By analyzing the rainfall data for the period from 12/01/2009 - 12/10/2009 and applying the model, we have determined that a overflow most likely occurred during the 12/09/2009 storm.**

PC-30					
Event No.	Start of Overflow Date Time	End of Overflow Date Time	Event Duration (hours:mins)	Flow Volume (ft^3)	Flow Volume (Millions of gallons)
1	8/2/09 1:05 PM	8/2/09 3:17 PM	2:12	129127	0.9660
2	8/22/09 2:55 AM	8/22/09 3:02 AM	0:07	1188	0.0100
3	10/24/09 8:25 PM	10/24/09 8:42 PM	2:18	163875	1.2259
4	12/9/09 6:42 AM	12/9/09 12:15 PM	5:32	456714	3.4200
5	12/13/09 3:30 PM	12/13/09 7:17 PM	3:47	209172	1.5600
6	12/26/09 8:07 AM	12/27/09 2:37 AM	18:30	1404282	10.5054
7	1/25/10 10:35 AM	1/25/10 2:45 PM	4:10	276593	2.0692
8	2/23/10 6:20 PM	2/23/10 10:55 PM	4:35	162528	1.2159
9	3/13/10 8:07 AM	3/15/10 1:40 AM	17:32	1085487	8.1205
10	3/22/10 6:35 PM	3/23/10 1:15 AM	6:40	90511	0.6771
11	3/29/10 1:27 AM	3/30/10 10:47 PM	21:20	1139341	8.5234

h. Documentation showing the continued implementation of the Nine Minimum Controls.

Please refer to **SECTION II OF THIS REPORT 'IMPLEMENTATION OF THE NINE MINIMUM CONTROLS (NMCS)'** on page 14**.**

i. Long Term Control Plan Implementation - The permittee shall submit information that describes the efforts to update and implement the CSO LTCP. The permittee shall continue to update implementation schedules as part of the Annual CSO status report."

Please refer to **SECTION III.A "CSO LTCP UPDATE - REPORT ON THE PROGRESS OF THE LTCP UPDATE"** on page 86 for information on the status of the LTCPU.

III.C.4.3 Rotating Basin Approach to Watershed Monitoring - Continue to implement a rotating basin approach to watershed monitoring in CSO receiving waters in order to characterize the impact of CSO discharges and other pollutant/pollution sources and the efficacy of CSO controls and watershed restoration practices.

The Rotating Basin Approach as described in earlier Integrated Watershed Management Plans was a laudable goal; this watershed-focused approach has proven to be infeasible from a data acquisition standpoint, due to the additional time required to collect continuous and wet weather targeted water quality data. Furthermore, a program which focuses on a single watershed at a time is hard to justify given the needs of monitoring stormwater BMPs implemented throughout the City under the CSO Long Term Control Plan and various Integrated Watershed Management Plans.

The "Comprehensive Watershed Monitoring Program" replaced the Rotating Basin Approach which is a watershed monitoring strategy developed by the Philadelphia Water Department to comply with both the City's stormwater and CSO permit requirements and to assist with the Sourcewater Protection Program's objectives. This approach outlines a five-year plan (*i.e.*, 2010-2015) including time-lines, goals and objectives for the monitoring program, changes and/or additions to the current strategy and budgetary considerations. The Philadelphia Water Department will continue to work with the Southeast Regional Office of the Department of Environmental Protection to finalize this monitoring strategy.

Please refer the SW portion of the Annual Report **SECTION F.2.STEP 1.B – MONITORING & SAMPLING** on page 228 for information about Comprehensive Watershed Monitoring Program.

STORMWATER MANAGEMENT PROGRAM ANNUAL REPORT

Part I Permit Conditions

Section A Applicability And Limitations On Coverage

The City will comply with the permit language on what are authorized and what are unauthorized stormwater discharges.

Section B Legal Authority

The City maintains adequate legal authority to enforce the Stormwater Management Program, in accordance with the National Pollutant Discharge Elimination System (NPDES) regulations 40 Code of Federal Regulations CFR122.26(D)(2)(i). Legal authority to operate and maintain the Stormwater Management Program includes various ordinances, regulations, and policies enforced by City departments, many of them in place prior to the EPA Stormwater Regulation. The ordinances and regulations may be found at www.Phila.gov.

This Annual Report is submitted to the Pennsylvania Department of Environmental Protection (PADEP), in accordance with requirements of the City of Philadelphia's NPDES Stormwater Management Permit No. PA 0054712. This Report is a compilation of the progress made on the Stormwater Management Program, during the reporting period from July 1, 2009 to June 30, 2010.

Section C Effluent Limitations

Section D Sediment Total Maximum Daily Load (TMDL) for Wissahickon Creek

The City has developed and implemented a program designed to achieve the first goal of the sediment TMDL effort which requires the City "to establish baseline data on the City's contribution of sediment loading and flow variations". The City conducted a feasibility study to determine MS4 outfalls and tributaries to the Wissahickon Creek (within Philadelphia) that cause an adverse impact to in-stream habitats as a result of transport of sediment and/or stream-bank erosion. The study initiated in October 2005 which includes an evaluation of the outfalls and tributaries that have the greatest potential for improvement through implementation of BMPs and/or other methods.

As a result of the study, the City has designed and implemented a monitoring plan that includes modeling results and monitoring for Total Suspended Solids (TSS) and flow at selected MS4 outfalls and at the confluence of selected tributaries to the Wissahickon Creek during various flow events (low flow, normal flow, and storm flow). The following provides a brief summary of the major elements, actions, and findings of the sediment and stream restoration feasibility study. A technical report summarizing two years of the sediment study was produced in February 2009, entitled Wissahickon Creek Watershed: TMDL Sediment Monitoring Report was submitted in the 2009 annual report and will be available on the **ADDITIONAL DOCUMENTS FOLDER ON THE SUPPLEMENTAL CD**. Updates based on data acquired between July 1 2009 and June 30 2010 are presented in the following summary of the sediment and stream restoration feasibility study including the additional data that was collected in August 2009.

D.i. Conduct a Wissahickon Sediment TMDL Feasibility study and submit report

Summary of Sediment and Stream Restoration Feasibility Study

Study Objectives

- To identify stream reaches with the most degradation and the greatest potential for restoration
- To estimate sediment loads originating from streambank erosion.
- To establish stage-discharge and discharge-TSS rating curves for tributaries
- To provide an objective means of ranking the stream reaches for restoration

Study Approach

The TMDL is based on models used to estimate Total Suspended Solids (TSS) originating from stream bank erosion and stormwater runoff. PWD developed an approach based on field data and modeling, with conclusions tested using each of the following approaches:

- SWMM modeling was performed on three tributaries (Wises Mill, Cathedral and Bells Mill) to estimate runoff loads and flows from outfalls and tributaries. SWMM models were utilized to determine bankfull discharge as well as verify flood flow and flood hazard conditions.

- Stream assessment techniques (BEHI scores) and Rosgen derived stream bank erosion rates to estimate in-stream TSS load (can be applied to entire watershed).

- Bank pin measurements to verify or improve BEHI score approach (reality check on BEHI based estimates).

- Estimate of total volume of soil eroded from pre-development conditions to current stream profile. This was used to estimate time to reach current stream profile using estimated erosion rates from BEHI (an independent reality check on the estimated erosion rate using an entirely different approach).

Estimated Outfall Loadings and Runoff

Methods used to develop stormwater outfall flows and loads are described in detail in the Wissahickon Creek Watershed Comprehensive Characterization Report (WCWCCR). Drainage area and estimated mean annual runoff volume for each outfall, estimated mean annual pollutant loads for each outfall and a summary of the total number of outfalls per tributary are reported in tabular form.

Please refer to the **SUPPLEMENTAL CD OR THE 2009 CSO/SW ANNUAL REPORT RESPONSE** for more details on the Feasibility Study.

In-Stream Loading Assessment Techniques

There are two elements to the monitoring program designed to assess in-stream loading of TSS. The first estimates the sediment load originating from stream banks. The second estimates the total sediment load being carried by the stream. PWD employed the Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS) as defined by Rosgen (1996) to predict erosion rates and classify the erosion potential of the tributaries. Three hundred and sixty eight reaches in 12 tributaries have been assessed using BEHI and NBS criteria. Reaches were assessed based on visual inspection of obvious signs of erosion. BEHI and NBS scores were grouped as very low, low, moderate, high, very high or extreme. Reaches not assessed with BEHI and NBS criteria were assessed with modified BEHI criteria. Modified visual assessments were meant to be rapid assessments and relied on a combination of bank angle, weighted root density, surface protection, and the best professional judgment of the PWD staff to categorize a bank as having very low, low, moderate, high, very high, or extreme erosion potential.

A combination of the assessment types was used to predict the sediment load originating from streambank erosion. Predictions were based on measured streambank erosion rates in a reference stream in Colorado (Rosgen, 1996). The total sediment load predicted for 12 Wissahickon tributaries within Philadelphia County was 4.2 millions pounds per year.

Bank Profile Measurements

Bank pins were installed in Monoshone, Kitchens Lane, Gorgas Lane, Cresheim, Valley Green, Hartwell, Wises Mill, Cathedral Run, Rex Ave, Thomas Mill, Bells Mill, and Hillcrest in an effort to measure streambank erosion at these sites. A total of 82 bank pin sites were chosen to reflect varying BEHI and NBS scores in order to validate and calibrate the prediction model. Twenty-two bank pin sites were installed during the fall of 2005, and 60 bank pin sites were installed during the summer of 2006. A detailed explanation of how to install and analyze bank pin data can found in the Wissahickon Creek Watershed: TMDL Sediment Monitoring Report located in the **ADDITIONAL DOCUMENTS FOLDER ON THE SUPPLEMENTAL CD**. The current bank pin installation locations can be seen in **FIGURE D-1** on the following page.

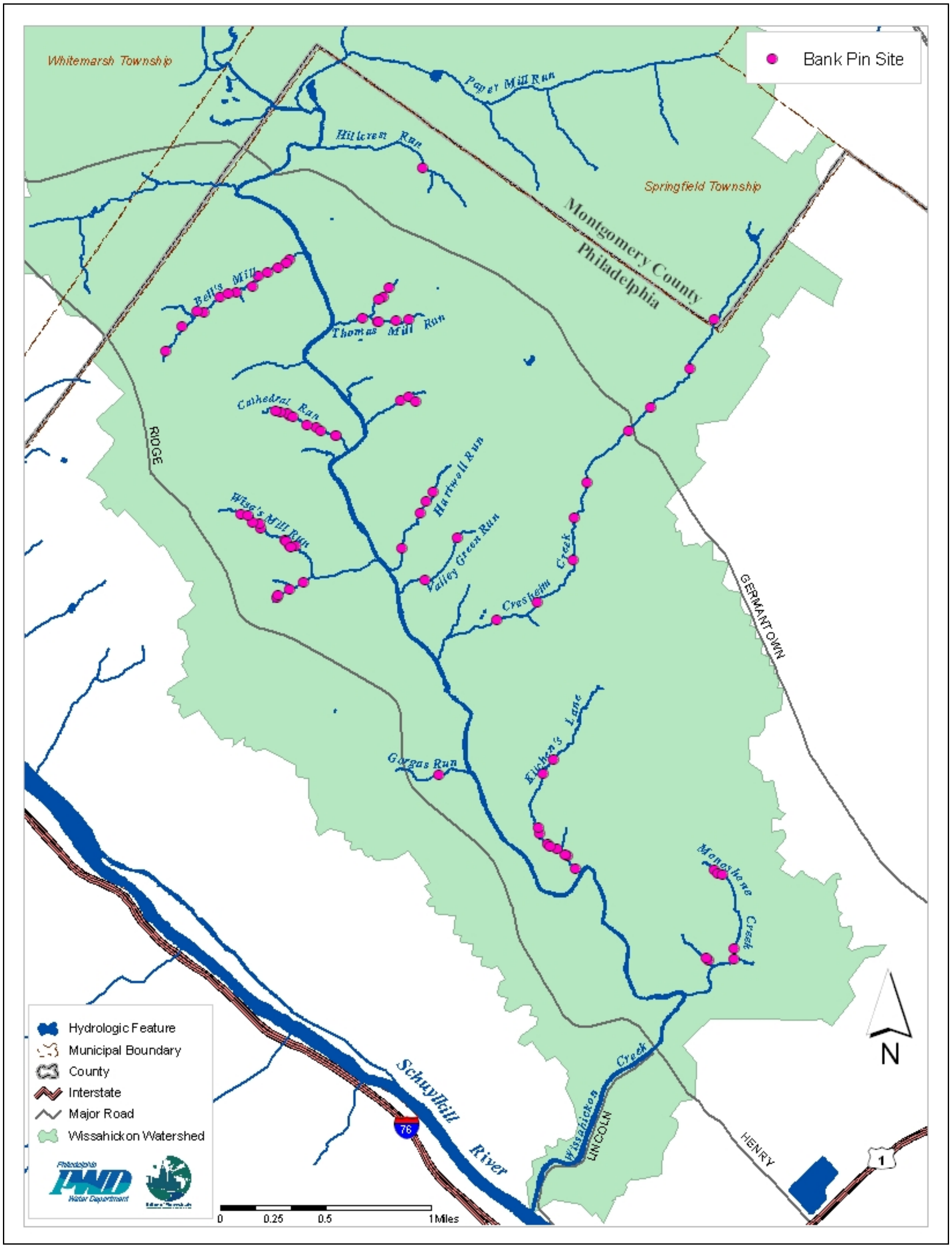


Figure D-1 Bank Pin Locations

Bank profiles at bank pin sites were measured annually to determine erosion rates. Erosion rates were calculated by entering the bank profile measurements into RIVERMorph 4.0 (RIVERMorph, LLC). RIVERMorph's 'Banks' module was used to estimate the lateral erosion rate for all of the bank pin locations. The estimated sediment load was then calculated (**EQUATION 1**).

Bank Erosion (lb/yr) = 96.3 (BLH) *where*:

Sediment Density = 96.3 lb/ft^3 (Rosgen, 1996)
B = Average Lateral Erosion Rate (ft/yr)
L = Bank Length (ft)
H = Bank Height (ft)

Erosion rates for banks that were not represented by bank pin location were determined by applying the average lateral erosion rate measured at bank pin locations, as grouped by BEHI class. The calculations used to determine the extrapolated erosion estimates are discussed in detail in Section 2.6 of the Wissahickon Creek Watershed: TMDL Sediment Monitoring Report located in the **ADDITIONAL DOCUMENTS FOLDER ON THE SUPPLEMENTAL CD**. Using this method, a total sediment load of 2.1 million pounds of sediment per year is estimated to originate from streambank erosion.

Stage Discharge and Sediment Discharge Rating Curves

In order to estimate the total suspended sediment load in the stream, a stage-discharge and a sediment-discharge rating curve will be generated. Stage data will be used in conjunction with the rating curves to calculate an estimated sediment load per year.

Stage data from Bells Mill, Cathedral Run, Wises Mill, Monoshone, Gorgas Lane, Kitchens Lane, and Cresheim tributaries were recorded near the Wissahickon confluence downstream of all stormwater outfalls. Stage was measured every six minutes by either an ultrasonic down-looking water level sensor or a pressure transducer and recorded on a Sigma620. PWD staff periodically downloaded stage data and performed quality assurance. Any data determined to be incorrect was removed and saved in another location.

Stage recording devices were installed in Bells Mill, Cathedral Run, Wises Mill, and Monoshone from summer 2005 to summer 2007. Stage recording devices were also installed in Gorgas Lane Run, Kitchens Lane Run and Cresheim Creek from summer 2007 to summer 2008. Stage-discharge rating curves were established in the Cathedral, Wises Mill and Bells Mill tributaries following a modified version of the USGS protocol (Buchanan and Somers 1969). These three curves were evaluated and it was determined that the stage-discharge curves did not provide any additional information for analysis in the sediment study.

In order to estimate suspended sediment loading, automated water collection devices (ISCO model no. 6712) were used to collect water samples during wet weather events in the Wissahickon Creek tributaries. In the attempt to characterize an entire storm event, automated samplers were triggered by a 0.2 ft elevation change in stream height and collected samples every 20 minutes for the first hour. Following this step, samples were then collected every 2-4 hours until discharge returned to base flow conditions. Sediment-discharge rating curves were established in the Cathedral, Wises Mill and Bells Mill tributaries following a modified version of the USGS protocol (Buchanan and Somers 1969). These three curves were evaluated and it was determined that the sediment-discharge curves did not provide any additional information for analysis in the sediment study.

The location of installed samplers can be seen in **FIGURE D-2**.

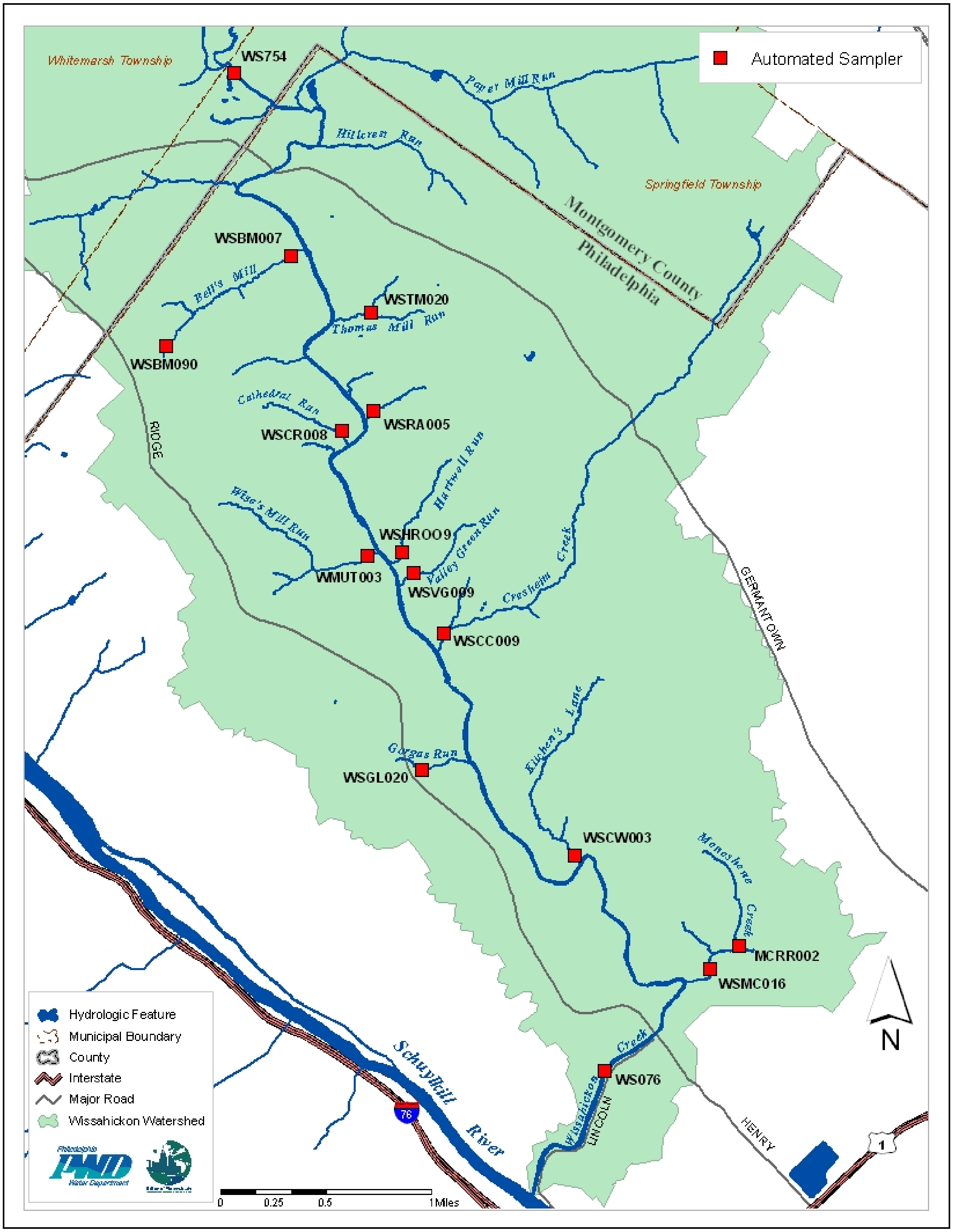


Figure D-2 Automatic Sampler Locations

Tributary Restoration Potential Ranking

Any stream channel and corridor restoration plan for the Wissahickon requires a ranking of tributaries. EVAMIX has been chosen to rank the restoration potential of tributaries and stream reaches. EVAMIX is a matrix-based, multi-criteria evaluation program that makes use of both quantitative and qualitative criteria within the same evaluation; regardless of the units of measure. The algorithm behind EVAMIX is unique in that it maintains the essential characteristics of quantitative and qualitative criteria, yet is designed to eventually combine the results into a single appraisal score. This critical feature gives the program much greater flexibility than most other matrix-based evaluation programs, and allows the evaluation team to make use of all data available to them in its original form.

Methods used to develop tributary restoration potential ranking are described in detail in the **ADDITIONAL DOCUMENTS FOLDER ON THE SUPPLEMENTAL CD**. EVAMIX was created as an initial ranking tool to compare the different tributaries. The sediment study has been further enhanced with the calculated sediment load estimates for each tributary to more accurately rank the tributaries. This information will be utilized in the development of the Wissahickon Creek Integrated Watershed Management Plan's (WCIWMP) implementation commitment.

Sediment Loading and Erosion Results

After the completion of the August 2008 bank pin readings, the sediment load and erosion estimates were calculated and produced in the Wissahickon Creek Watershed: TMDL Sediment Monitoring Report which is located in the **ADDITIONAL DOCUMENTS FOLDER ON THE SUPPLEMENTAL CD**.

D.ii. Wissahickon Sediment TMDL Monitoring plan implementation

Wissahickon Sediment TMDL Monitoring plan implementation and outline submission

Future Sampling

In efforts to comply with the Wissahickon Creek Sediment TMDL and the continuing goal of reducing sediment load from tributaries within City boundaries, PWD is in the process of developing a long-term implementation and monitoring strategy, which will be closely associated with the Wissahickon Creek Integrated Watershed Management Plan (WCIWMP) and its associated Implementation Plan(s) that PWD is developing. PWD's IWMPs are produced with an anticipated 20 year implementation timeline addressed through four subsequent 5-year Implementation Plans (**TABLE D-1**). The tributary restoration approach will be driven by the WCIWMP's Implementation Plans.

Outlined within this report is an implementation strategy that will carry forth through the end of this Stormwater Permit cycle. Subsequent Stormwater Permits will reference the WCIWMP and Implementation Plans for up-to-date implementation and monitoring strategies.

Table D-1 Timeline Strategy for Monitoring Components of the Wissahickon TMDL

Monitoring Program	**2005**				**2006**				**2007**				**2008**				**2009**				**2010**			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Tributary Prioritization																								
BEHI/NBS Studies			■	■	■	■																		
Bank Profile Measurements				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Stream Modeling			■	■	■	■	■																	
Flow Monitoring																								
Discharge Rating Curve		■	■	■	■	■	■	■	■	■	■	■	■	■	■									
Continuous Stage Recording		■	■	■	■	■	■	■	■	■	■	■	■	■	■									
Sediment Transport Rates																								
TSS Rating Curve				■	■	■	■	■	■	■	■	■	■	■	■									
BMP Monitoring																								
Post Construction TSS Monitoring																								■
Post Construction Bank Profile																								■
Measurements																								■
Post Construction Stream Modeling																								■

Continued Bank Pin Program

PWD established 82 bank pin sites throughout 12 Wissahickon Creek tributaries within Philadelphia County. The main objective of the bank pin program is to quantify the load of sediment originating from streambank erosion within the Wissahickon tributary system. Another objective of the bank pin program is to define a local relationship between measured stream bank erosion and qualitative stream bank erosion (using Rosgen's BEHI/NBS method). PWD established bank pin sites in areas that were assessed to have a range of BEHI/NBS scores in order to better estimate the true standard deviations and arrive at a relationship between the empirical bank pin data and the visual assessment.

Bank profiles at bank pin sites will be measured annually in order to calculate yearly erosion rates and sediment loads. Erosion rates and sediment loads are calculated from the bank profile measurements following the protocol outlined in the Wissahickon Creek Watershed: TMDL Sediment Monitoring Report which is located in the **ADDITIONAL DOCUMENTS FOLDER ON THE SUPPLEMENTAL CD**.

Continuous Stage Data

Stage data continues to be collected from Bells Mill, Wises Mill, Cathedral, Monoshone, Gorgas Lane, Kitchens Lane, and Cresheim Creek. Stage data was recorded at designated monitoring sites using a fixed Sigma ultrasonic sensor and/or pressure transducer. Stage data was downloaded monthly and QA/QC was performed by PWD staff.

Stage- Discharge and Sediment-Discharge Rating Curve

Stage-discharge and sediment-discharge rating curves for Bells Mill, Cathedral, and Wises Mill were completed following a modified version of the USGS protocol (Buchanan and Somers 1969). These three curves were evaluated and it was determined that the stage-discharge and sediment-discharge curves did not provide any additional information for analysis in the sediment study. Therefore, the sediment-discharge and stage-discharge rating curves were not created for the remaining tributaries with Philadelphia County city limits.

August 2009 Bank Profile Update

During the week of August 10th, 2009, PWD revisited the 81 bank pin monitoring locations installed during 2005 and 2006 in the Monoshone, Kitchens Lane, Gorgas Lane, Cresheim, Valley Green, Hartwell, Wises Mill, Cathedral Run, Rex Ave, Thomas Mill, Bells Mill, and Hillcrest tributaries. At each location, bank profile measurements were taken, if possible, and a digital photo was taken. Updated bank profiles for each bank pin location are included in **APPENDIX F – WISSAHICKON CREEK WATERSHED: TMDL - ADDENDUM.**

Of the 81 sites revisited by PWD, 30 sites were either damaged or lost. A damaged site was classified as a site in which the toe pin was removed from its initial location, thereby making any future measurement impossible. In most of these instances, the bank pins installed were still present. A lost site was classified as one in which no evidence of its profile was present. In these cases, both toe pins and banks pins were not able to be identified in the field. The longest monitoring interval measured at each bank pin location is listed in **APPENDIX F – WISSAHICKON CREEK WATERSHED: TMDL - ADDENDUM.**

PWD believes that the majority of the damage at these sites was associated with a large rain event that took place on Sunday, August 2, 2009. This rain event produced 4.6 inches of rain in the northwestern portion of Philadelphia, which encompasses the monitoring area of this study. Flow measurement at USGS Gage 01474000 (Wissahickon Creek at Mouth, Philadelphia, PA) peaked at 6,900 cfs on August 2, 2009. This discharge represented a 9-Year storm based upon Bulletin 17B Guidelines. Visual observations and anecdotal evidence suggested extraordinary flood damage present throughout the Wissahickon Park system which would support the extensive damage observed at the bank pin monitoring locations.

The average monitoring period for a bank pin location was 31 months. The minimum monitoring period was 12 months and the maximum monitoring period was 45 months. For the 30 monitoring locations where re-measurement was not possible, the lateral erosion rate for the longest observation period at that location was used for further calculation.

The predicted stream bank erosion rates for these tributaries were calculated using the same methods detailed in this report, with one exception. In original report, the 81 remaining bank pin monitoring locations were divided into groups: Low, Moderate, and High. These groups were based on the BEHI field assessment. Further statistical analysis showed that the Low and Moderate groups were not statistically independent of one another. These groups were merged leaving two distinct groups, Low and High. In addition, statistical outliers were defined and removed for each group. In this addendum, the use of the Low and High groups has been modified. To establish a more comprehensive lateral erosion rate estimate for the study area, all monitoring locations have been classified as one group. The average lateral erosion rate of this group has been calculated using the most recent bank profile measurements of August, 2009 at all 81 monitoring locations. This decision was based on the subjective nature of the visual assessment and BEHI assessment protocols utilized in the prediction portion of this study. Additionally, this decision was supported by the lack of recent data at the 30 destroyed monitoring locations, making any correlation between BEHI rating and lateral erosion rate speculative, at best. In addition, because of the catastrophic damage observed in the latest round of monitoring, statistical outliers were not removed.

The sample (n=81) did not exhibit characteristics emblematic of a normally distributed population (Shapiro-Wilk: W=0.63, p=0.00000, Skewness = -4.02, Kurtosis = 30.81). The average lateral erosion rate was -0.0562 ft/yr (+/- 0.0809 ft/yr). The extrapolated lateral erosion rate produced an annual loading of 3.32 million pounds per year (+/- 4.42 million pounds per year) (**TABLE D-2**).

Table D-2: 2008, 2009 Stream bank erosion estimate comparison

Tributary	Total Erosion (lb/yr)	
	2008	***2009***
Bell's Mill	150,000	420,000
Cathedral Road Run	160,000	150,000
Cresheim Creek	530,000	840,000
Gorgas Run	160,000	170,000
Hartwell Run	110,000	200,000
Hillcrest	28,000	90,000
Kitchen's Lane	170,000	200,000
Monoshone Creek	57,000	160,000
Rex Ave	100,000	150,000
Thomas Mill Run	170,000	320,000
Valley Green Run	100,000	140,000
Wise's Mill Run	400,000	490,000
Total	**2,100,000**	**3,300,000**

To assess the normalized erosion potential of each tributary, the erosion rate per acre of drainage area per year and the erosion rate per foot of stream length per year were calculated (**TABLE D-3, FIGURE D-3, FIGURE D-4)** allowed direct comparison between each of the tributaries with respect to both watershed size and the length of the tributary. For example, in 2008, Cresheim Creek had the highest total erosion at 840,000 pounds of sediment per year simply because it was the longest tributary within Philadelphia. After the erosion rate per foot of stream length was calculated, Cresheim Creek ranked eighth out of the twelve tributaries.

Table D-3: 2008, 2009 Erosion per drainage area and stream length

Tributary	Drainage Area (Acres)	Stream Length (feet)	2008			2009		
			Erosion Rate (lb/yr)	Erosion Rate Per Acre	Erosion Rate Per Foot of Stream	Erosion Rate (lb/yr)	Erosion Rate Per Acre	Erosion Rate Per Foot of Stream
Bell's Mill	323	6,722	150,000	464	22	420,000	1,307	63
Cathedral Run	160	2,790	160,000	1,000	57	150,000	913	52
Cresheim Creek	1,218	16,431	530,000	435	32	840,000	690	51
Gorgas Run	499	2,170	160,000	321	74	170,000	345	79
Hartwell Run	217	3,530	110,000	507	31	200,000	918	56
Hillcrest	144	5,272	28,000	194	5	90,000	597	16
Kitchen's Lane	234	7,753	170,000	726	22	200,000	850	26
Monoshone Creek	1,056	6,926	57,000	54	8	160,000	156	24
Rex Ave	137	1,903	100,000	730	53	150,000	1,131	81
Thomas Mill Run	104	4,008	170,000	1,635	42	320,000	3,058	79
Valley Green Run	128	2,874	100,000	781	35	140,000	1,086	48
Wise's Mill Run	446	7,056	400,000	897	57	490,000	1,090	69
Total / Average	**4,666**	**67,435**	**2,100,000**	**645**	**37**	**3,300,000**	**1,012**	**54**

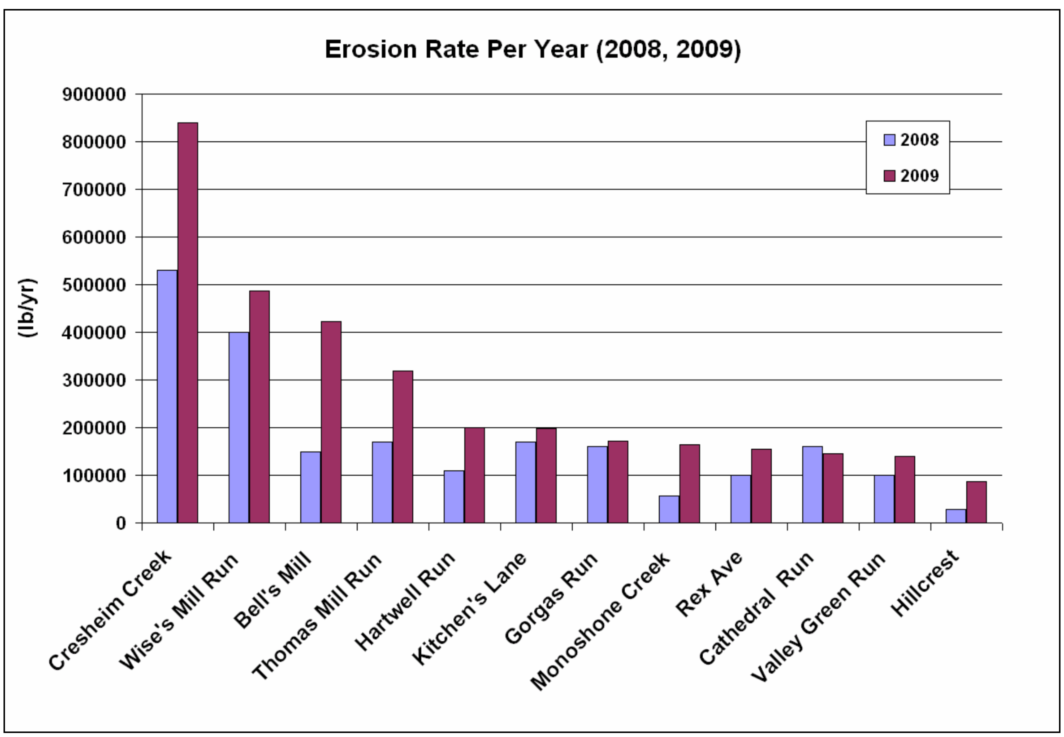


Figure D-3: Average Annual Erosion Rate

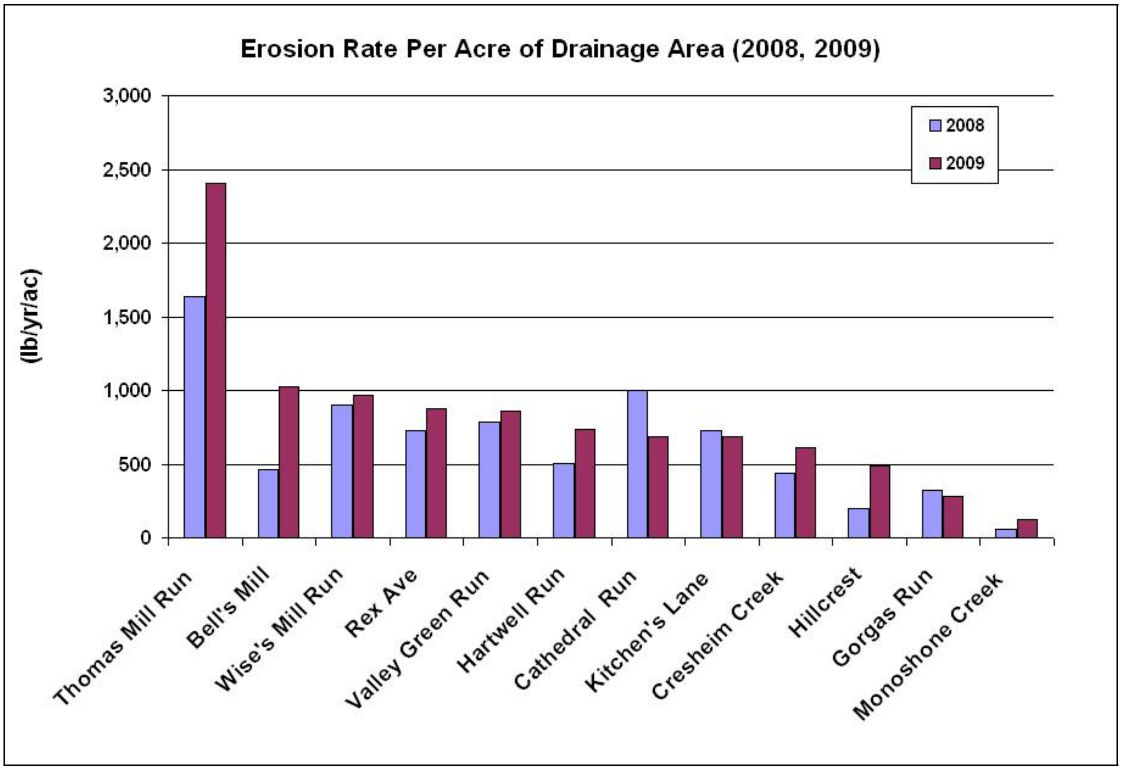


Figure D-4: Erosion Rate Per Acre of Drainage Area (2008, 2009)

Sediment TMDL - Establish baseline data and evaluate & implement BMPs, evaluate benefits, report annually

The final objective of the TMDL monitoring program is to measure the efficacy of Best Management Practices (BMPs) and their benefit in terms of sediment reduction in the Wissahickon Creek Watershed. To meet this objective PWD will use the natural stream channel design (NSCD) principles and monitoring methodology described in CSO portion of the annual report **SECTION III.C.2.3 – STREAM HABITAT RESTORATION**. The exploration of the NSCD technique is required in **SECTION 2, STEP 3B** of the City of Philadelphia MS4 NPDES permit. **SECTION F.2.STEP 3.B**. outlines the physical and biological/habitat monitoring methods that will be used to examine the functionality of BMPs in the Wissahickon Creek Watershed.

PWD is working toward achieving instream erosion load reductions using stream restoration approaches. PWD has some small-scale restoration projects that have recently been completed in the Wissahickon Watershed by the PWD's Waterways Restoration Team (WRT). We are also working on developing stream bank restoration designs for two tributaries to Wissahickon Creek, Bells Mill and Wises Mill.

Please refer the CSO portion of the Annual Report **III.C.2.3 – STREAM HABITAT RESTORATION** on page 141 for information about these stream bank restoration designs.

Table D-4 Small-scale Restoration Projects completed in Wissahickon by WRT

Project	Watershed	Description
Wises Mill Run	Wissahickon Creek	Lower segment; interim stabilization
Gorgas Run	Wissahickon Creek	Interim stabilization; infrastructure protection with boulders
Rex Avenue Restoration	Wissahickon Creek	Stabilization and habitat creation along the west bank of the Wissahickon Creek mainstem.
Carpenters Woods Outfalls	Wissahickon Creek	Stabilization of stormwater outfalls including stream restoration using NSCD principles.

PWD is working toward achieving overland runoff loading reductions through the use of stormwater treatment wetlands. PWD anticipates installing stormwater treatment wetlands to treat overland runoff and reduce sediment loadings to the creek. Treatment wetlands can be constructed adjacent to waterways to receive excess flows during large storm events, and pocket wetlands can be built to receive stormwater flows from adjacent sub-watershed areas. In addition, wetland habitats can be designed to accommodate diverse habitats and increase the healthy living resources of the Wissahickon Creek Watershed. Two proposed stormwater wetland creation projects in the Wissahickon Watershed include one on Wise's Mill and another on Cathedral Run.

Please refer the CSO portion of the Annual Report **SECTION III.C.2.4 – WETLAND ENHANCEMENT AND CONSTRUCTION** on page 144 for information about these stream bank restoration designs.

In addition, PWD has many proposed, ongoing, or completed SW BMP projects in the watershed to reduce stormwater runoff. These projects are listed in **SECTION III.C.1.3 – IMPLEMENTATION OF STORMWATER BMPS AND LID** on page 132**.**

Highlights of some recently completed stormwater management demonstration projects in the Wissahickon include:

- Allens Lane Art Center Porous Basketball Court
- Courtesy Stables Runoff Treatment Project
- Fox Chase Farms Riparian Buffer Project
- Monastery Stables Stormwater Diversion & Detention Project
- Saylor Grove Stormwater Treatment Wetland

- Springside School Stormwater Improvements
- W.B. Saul High School

And finally, implementation of the City's Stormwater Regulations will continue to improve stormwater quality and quantity impacts as redevelopment and development continues across the City. PWD is tracking the stormwater management practices implemented by private development to address the regulations. Of particular interest are green approaches that encourage the return of rainfall back to the hydrologic cycle through evapotranspiration or distributed infiltration. Implementation of the stormwater management regulations present the opportunity to get privately owned properties within the Wissahickon Creek Watershed to assist in achievement of the City's TMDL commitment.

PWD is in the process of developing an implementation plan through the Integrated Watershed Management Planning process, which will include PWD's commitments to addressing their Wissahickon TMDL obligations. Upon drafting this implementation plan, PWD will submit it for review by the PADEP. The goal of PWD's implementation approach is to take a multi-faceted approach to reducing the amount of sediment in the Wissahickon, both from overland runoff and from instream erosion sources. PWD would use this implementation plan to commit to sediment load reductions through implementation measures including stream restoration, land based projects and implementation of the Stormwater Regulations, with the use of adaptive management to achieve them.

Section E Pollutant Minimization Plan (PMP) for Polychlorinated Biphenyls (PCBs) in the City's Municipal Separate Storm Sewer System (MS4)

Submit a Pollutant Minimization Plan for PCBs

The City has polychlorinated biphenyl (PCB) Pollutant Minimization Plans in effect under each of the three Water Pollution Control Plants individual NPDES permits which set forth a more stringent plan than is requested within the City's MS4 NPDES Permit. For additional information on the City's PCB PMP, see the City's NPDES permits for each of its three wastewater treatment plants:

NEWPCP	PA0026689
SEWPCP	PA0026662
SWWPCP	PA0026671

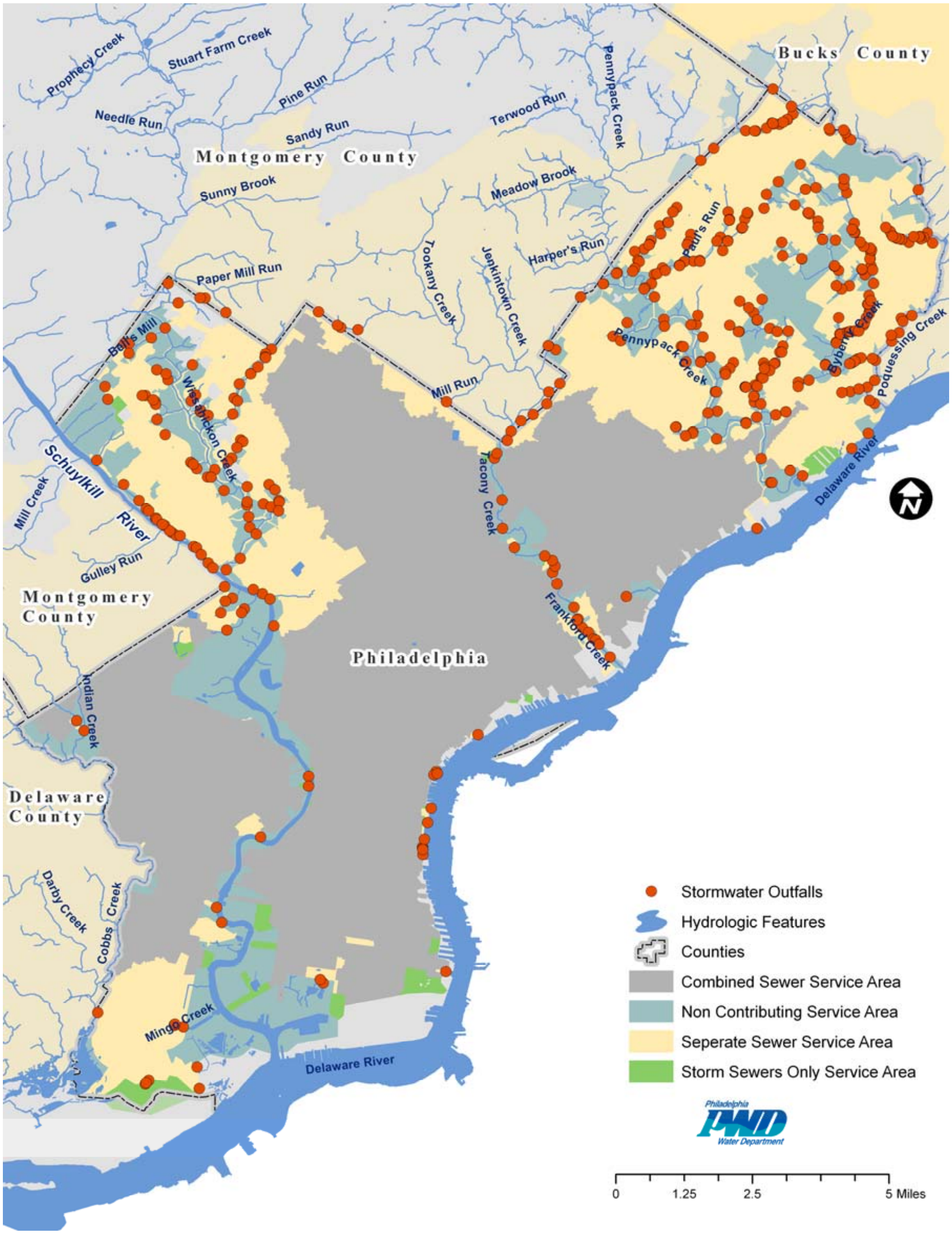
E.1 City PMP Contact Information:

Keith Houck, Manager
(215) 685 - 4910
Industrial Waste Unit
Aramark Tower, 4th Floor
1101 Market Street
Philadelphia, PA 19107

E.2 City of Philadelphia MS4 Service Area

The City's municipal sanitary separate sewer system (MS4) comprises about 40% of Philadelphia County and also accepts some water from surrounding communities. The MS4 includes the 434 permitted stormwater outfalls. A map of the MS4 service area referencing all outfalls is shown in **FIGURE E-1**.

Figure E-1 MS4 with all SW outfalls



E.3 / E.4 Known Locations of PCB Releases/Containments

Within the City's MS4 service area, there are no known materials, equipment, processes, soil areas or facilities that are known to be releasing, directly or indirectly. To that effect, there are also no known PCB sources within its MS4 system that the City believes may require some degree of control to reduce its discharge. However the City has compiled a list of known locations where PCB material, equipment, processes, soil area, or facilities are or have been located (**APPENDIX E – PCB SOURCES AND INSPECTIONS)**. This list has been compiled from 2 lists discussed below:

Description of "Devices" List

This list is a compilation of information obtained from USEPA, PADEP, DRBC, Partnership for the Delaware Estuary, the Philadelphia Fire Department, the Philadelphia Department of Public Health and PECO, along with PWD's inventory of PCB-containing equipment. The sites listed are those within PWD's MS4 service area and at which PCB-containing devices may exist. In accordance with PWD's PCB Pollutant Minimization Plan (PCB PMP) which was submitted to DRBC on September 30, 2005, PWD's Industrial Waste Unit (IWU) will visit the listed sites over a five-year period to determine the status of each site's PCB-containing devices. IWU will characterize that status using a list of forty (40) descriptors to determine the site's potential as a possible source of PCBs. Appropriate corrective steps will be taken for any site found to be releasing or having the potential to release PCBs.

Description of "Health Dept." List

This list contains sites at which the Philadelphia Department of Public Health has some record of a past PCB release. In accordance with PWD's PCB PMP mentioned above, IWU will visit the listed sites over a two-year period to determine the status of each and will recommend additional risk reduction measures where appropriate.

E.5 In- stream PCB sampling

The City collected and analyzed twelve (n=12) in-stream samples for PCBs during the spring of 2009.

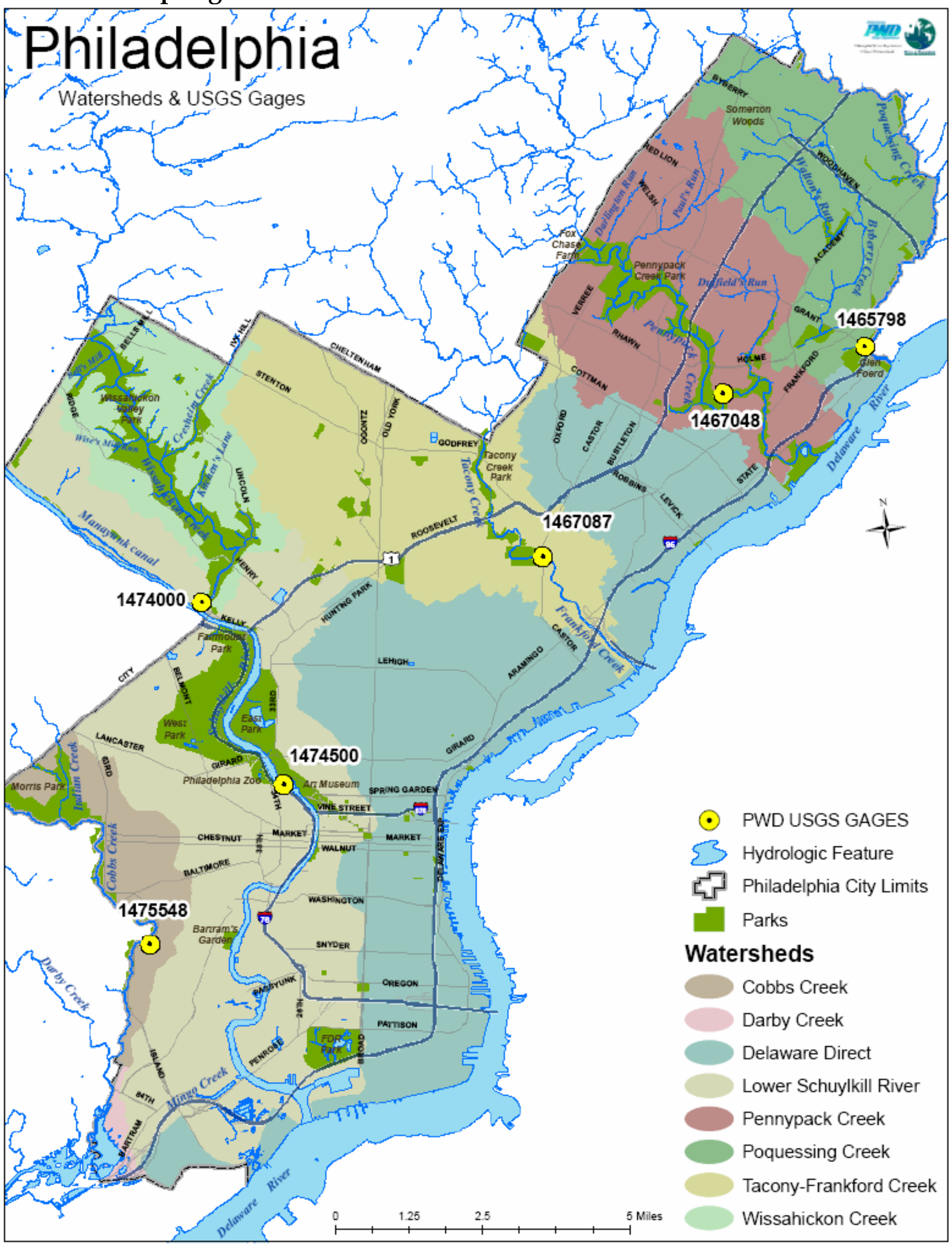
PCB Sampling Locations

Six monitoring locations were selected for sampling, and are listed in **TABLE E-1**. Each sampling site was stationed at the furthest downstream USGS gage station in each of the City's six watersheds (**FIGURE E-2**).

Table E-1: PWD PCB Monitoring Locations

Watershed	PWD USGS Gages	Field ID
Cobbs Creek	1475548	COBB 355
Pennypack Creek	1467048	PENN 175
Poquessing Creek	1465798	POQU 150
Lower Schuylkill River	1474500	SCHU 154
Tacony-Frankford Creek	1467087	TACO 250
Wissahickon Creek	1474000	WISS 135

Figure E-2 PCB Sampling Locations



PCB Sampling Period

During the reporting period, in-stream samples were collected at the predetermined locations during dry weather conditions and immediately following a significant wet-weather event. A wet weather event was defined as any precipitation event greater than 0.5 inches of rainfall in a 24-hour period. Dry- weather and wet-weather samples were collected on April 28th and May 7th, 2009, respectively (n=12 samples). In addition to the twelve samples collected, two additional trip blank samples were collected during both dry and wet conditions (n=4).

PCB Sampling Technique 1668A

To determine surface water concentrations of PCBs, PWD will be using the standard operating procedures and analysis techniques outlined by the United States Environmental Protection Agency's (USEPA) Method 1668A. This congener-specific method is used to determine the twelve PCBs designated as toxic by the World Health Organization plus the remaining 197 chlorinated biphenyl congeners. Method 1668A allows estimation of homolog totals by level of chlorination and estimation of total PCBs.

PCB Sampling Analysis

In-stream samples and trip blank samples were sent to AXYS Analytical, LTD. (Sidyney, Canada) for PCB analysis. To determine surface water concentrations of polychlorinated biphenyls (PCBs), AXYS Analytic, LTD used the standard operating procedures and analysis techniques outlined by the United States Environmental Protection Agency's (USEPA) Method 1668A. This congener-specific method was used to determine the twelve PCBs designated as toxic by the World Health Organization (WHO) plus the remaining 197 chlorinated biphenyl congeners (CBs). Moreover, this method allowed estimation of homolog totals by level of chlorination (LOC) and estimation of total CBs in a sample by summation of the concentrations of the CB congeners and congener groups.

Analytical Results

On July 23rd, 2009, PWD's Office of Watersheds received all data from AXYS Analytical, LTD. pertaining to the in-stream PCB samples and will be included on the CD attached to this report. **TABLE E-2** shows the total PCB results by sample location and date. Results are developed in terms of non-detects for congeners expressed as zero, and in terms of non-detects for congeners expressed and one half of the estimated method detection limit[1]. **TABLE E-3** shows the results for the Penta homolog.

Table E-2: Total PCBs Sample Results

Field ID	Sample Date	Dry/Wet	TOTAL PCBs (pg/L)	
			U=0	U=EDL/2
COBB 355	April 28, 2009	DRY	1,604	1,617
COBB 355	May 7, 2009	WET	8,884	8,892
WISS 135	April 28, 2009	DRY	1,067	1,084
WISS 135	May 7, 2009	WET	12,676	12,693
SCHU 154	April 28, 2009	DRY	1,400	1,419
SCHU 154	May 7, 2009	WET	10,768	10,775
POQU 150	April 28, 2009	DRY	743	756
POQU 150	May 7, 2009	WET	4,605	4,615
PENN 175	April 28, 2009	DRY	935	950
PENN 175	May 7, 2009	WET	36,352	36,364
TACO 250	April 28, 2009	DRY	2,739	2,750
TACO 250	May 7, 2009	WET	3,861	3,870

Table E-3: Penta Homalog Results

	Wet Weather		Dry Weather	
	Conc_Found	Conc_Found	Conc_Found	Conc_Found
Tributary	U=0	U=EDL/2	U=0	U=EDL/2
COBB355	2.094	2.095	0.176	0.181
WISS135	3.185	3.186	0.182	0.185
SCHU 154	2.891	2.892	0.273	0.278
POQU 150	1.208	1.210	0.152	0.155
PENN 175	16.593	16.595	0.228	0.230
TACO 250	0.929	0.930	0.329	0.331

E.6 Develop Report on Control of PCB Discharges

The City has created a document that reports all the known PCB sources within the MS4 system that requires some control measure to reduce its discharge of PCBs. This report and plan of action is described within the PCB PMP, can be located in the **ADDITIONAL DOCUMENTS FOLDER ON THE SUPPLEMENTAL CD.**

E.7 Work with DRBC to Create PMP Template

As the City moves forward in implementing the PCB PMP, it looks forward to continuing to enlist the cooperation of stakeholders throughout the Delaware Estuary in developing a template for other MS4 systems. PWD's PCB PMP was also submitted to the DRBC on September 30, 2005.

E.8 Annually Document PCB PMP Compliance

During FY 2010, PWD IWU performed 49 site inspections of potential PCB sources. A list and a map of potential sources of PCB and when they were inspected can be found in **APPENDIX F – PCB SOURCES AND INSPECTIONS**. Additional information on PCB sources including a description of known sources is provided in the PWD PCB PMP, can be located in the **ADDITIONAL DOCUMENTS FOLDER ON THE SUPPLEMENTAL CD.**

Section F Stormwater Management Program

F.1. Source Identification

Presented is a description of the City of Philadelphia municipal separate storm sewer system (MS4) including the sewershed, combined sewer system sewershed, non-contributing areas, and watershed boundaries. The following tables presents a summary of the Philadelphia infrastructure and MS4 system, including; stormwater outfalls, lengths of sanitary sewer, and lengths of stormwater sewer within Philadelphia and contributing neighboring townships. These areas are depicted in **FIGURE F-1** on the following page.

Table F-1 Infrastructure Area of Philadelphia and Neighboring Contributors

Watershed	Square Miles of Philadelphia and Contributing Area Infrastructure				
	MS4 Area	Combined Area	Un-Sewered Area	Stormwater Only Area	Non-Contributing Area
Darby-Cobbs	86.0	4.4	0	0	1.4
Delaware Direct	39.9	22.0	0	0.4	0.1
Pennypack	21.7	0.6	0	0.2	4.9
Poquessing	28.5	0	0	0	4.0
Schuylkill	15.3	17.3	0	1.5	11.1
Tacony	1.6	19.7	0	0	1.4
Wissahickon	14.0	0.0	1.1	0	2.9
Total	207.0	64.0	1.1	2.1	25.8

Table F-2 Description of MS4 Infrastructure

Watershed	Miles of Pipe			MS4 Outfalls	
	Stormwater	Sanitary	Total MS4	Within City	Outside City
Darby-Cobbs	5.9	6.2	12.1	3	0
Delaware Direct	14.5	12.8	27.3	19	0
Pennypack	144.0	267.1	429.1	129	1
Poquessing	242.1	188.0	430.1	139	1
Schuylkill	144.0	145.6	289.7	52	0
Tacony	57.8	57.0	114.8	23	11
Wissahickon	95.7	126.1	221.8	61	3
Total	722.1	802.8	1524.9	425	17

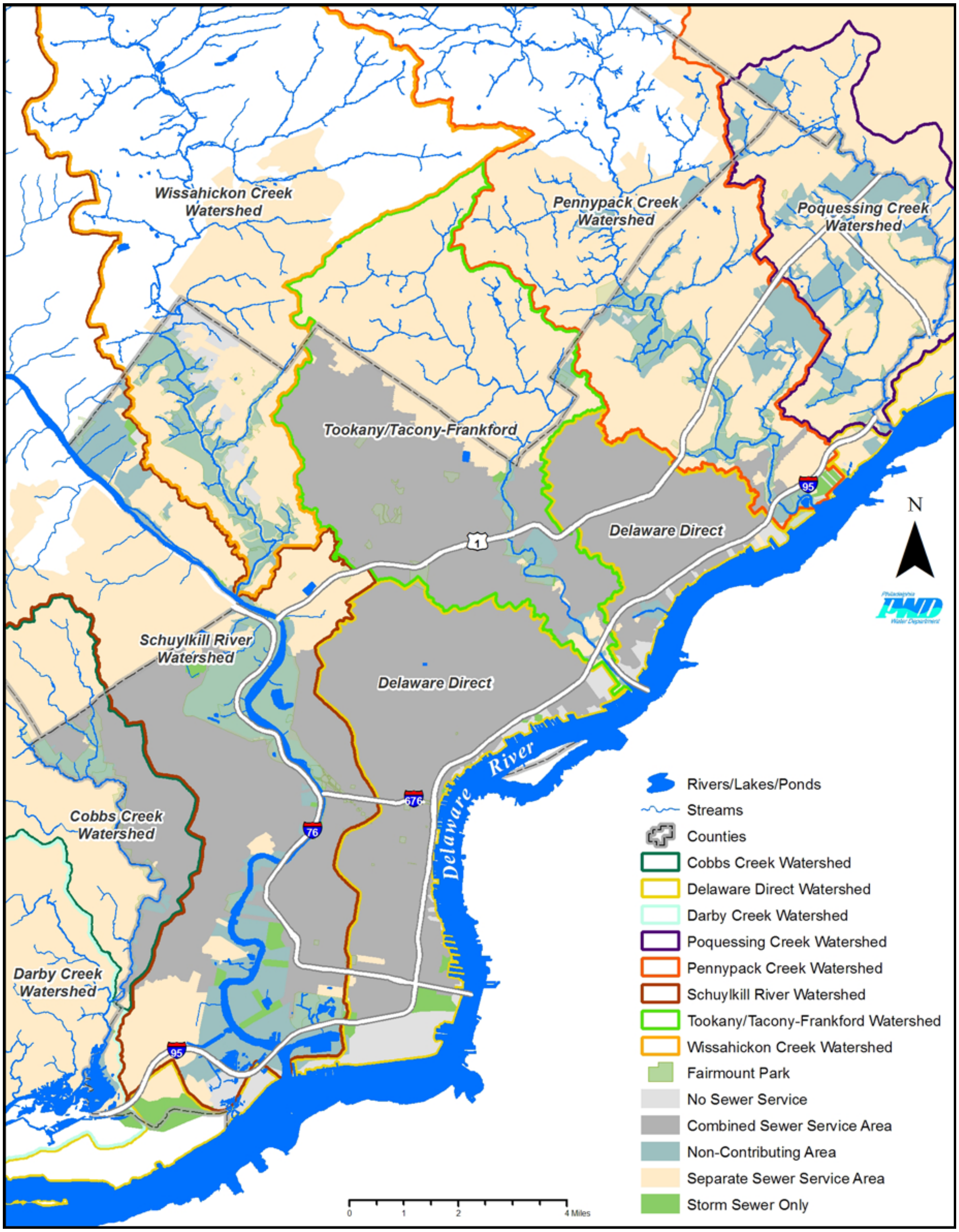


Figure F-1 Philadelphia Infrastructure System Areas

GIS Data Layers and Filenames Submitted on **SUPPLEMENTAL CD** within a GeoDatabase

GIS Data Feature Classes within Geodatabase named: AnnualReport_PWD_2010.mdb

- DVRPC_luphi05
- FY10_ES
- FY09_TA_Approved_Sites
- Known_Historical_PCB_Locations_2010
- Major_Watersheds_2010
- OWS_GISDATA_OWS_Hydro_Line
- OWS_GISDATA_OWS_Hydro_Poly
- PermittedDischargersFY10
- Philadelphia_Detention_Basins
- Philadelphia_Imperviousness
- Philadelphia_Population_2000_Census
- Philadelphia_Sewersheds
- Stormwater_Outfalls
- Wissahickon_Point_Sources
- Philadelphia BMPs
- PWD_Monitoring_2010

PWD has included the GIS layers referenced above on the **SUPPLEMENTAL CD** to this report in response to the requirements of the Permit.

DVRPC_luphi05

This layer presents land use delineated from aerial photography captured in 2005 within Philadelphia County. The source of this data is the Delaware Valley Regional Planning Commission. Metadata contained within this file further explains the source and processing of this data.

FY10_ES

This layer presents the locations of erosion and sedimentation inspections carried out at construction sites within Philadelphia in FY 2010. The contents of this layer are discussed in **SECTION F.5** on page 277.

FY10_TA_Approved_Sites

This layer presents the locations of projects issued post construction stormwater management technical approvals by the Philadelphia Water Department in FY 2010. The contents of this layer are discussed in **SECTION F.5** on page 277.

FY10_IWU_Spills

This layer presents the locations of spills documented by PWD Industrial Waste Unit within Philadelphia in FY 2010. The contents of this layer are discussed in **SECTION F.7** on page 292.

FY10_Spills
This layer presents the locations of Sewage Pollution Incidents documented by PWD within Philadelphia in FY 2010.The contents of this layer are discussed in **SECTION F.8.G** on page 309.

Known_Historical_PCB_Locations_2010
This layer presents the location of all known and historical polychlorinated biphenyl (PCB) locations within Philadelphia. The contents of this layer are discussed in **SECTION E**.

Major_Watersheds_2010
This layer presents the delineation of the Philadelphia County and surrounding counties boundaries of the Darby-Cobbs, Delaware-Direct, Pennypack, Poquessing, Schuylkill, Tacony-Frankford, and Wissahickon watersheds.

OWS_GISDATA_OWS_Hydro_Line
This layer presents the boundaries of Philadelphia County and surrounding watershed hydrology in a polyline based shapefile.

OWS_GISDATA_OWS_Hydro_Poly
This layer presents the boundaries of Philadelphia County and surrounding watershed hydrology in a polygon based shapefile.

PermittedDischargersFY10
This layer presents the location within Philadelphia of all permitted Dischargers FY09. The contents of this layer are discussed in **SECTION F.2.STEP 1.C** on page 230**.**

Philadelphia Detention Basins
This layer presents the location of all stormwater detention basins within Philadelphia County.

Philadelphia Imperviousness
This layer presents percent imperviousness and the amount of impervious area in Philadelphia County.

Philadelphia_Population_2000_Census
This layer presents the results of the 2000 Census in Philadelphia County.

Philadelphia Sewersheds
This layer presents the boundaries of the MS4, combined sewer, un-sewered, non-contributing, and stormwater only areas within Philadelphia County and the neighboring contributing areas.

PWD_BMP_Projects

This layer presents the locations of existing and proposed BMPs sorted by their current status (completed, in construction, in design, ongoing) within Philadelphia County and the neighboring contributing areas.

PWD_Monitoring_2010

This layer presents the locations of the PWD's chemical, fish, macroinvertebrate, and algae sampling sites. The contents of this feature class are discussed in Section J.

Stormwater_Outfall_422

This layer presents locations of all permitted stormwater outfalls within Philadelphia County and the neighboring contributing areas.

Wissahickon Point Sources

This layer presents permitted Point source locations within the Wissahickon Watershed.

GIS Stormwater Data Conversion Geodatabase Layers

GIS Data Feature Classes within Geodatabase named: StormwaterDataConversion.mdb

DataConv_GISAD_stBasin
DataConv_GISAD_stBoring
DataConv_GISAD_stCasin
DataConv_GISAD_stChamber
DataConv_GISAD_stCulvert
DataConv_GISAD_stDisconnectedInlet
DataConv_GISAD_stFitting
DataConv_GISAD_stFlare
DataConv_GISAD_stForceMain
DataConv_GISAD_stGravityMain
DataConv_GISAD_stHostPipe
DataConv_GISAD_stManhole
DataConv_GISAD_stManholeOther
DataConv_GISAD_stInlet
DataConv_GISAD_stInletPipe
DataConv_GISAD_stMeterChamber
DataConv_GISAD_stOffsetAccess
DataConv_GISAD_stOpenChannel
DataConv_GISAD_StormNetwork_Junctions
DataConv_GISAD_stOutfall
DataConv_GISAD_stPointFeature
DataConv_GISAD_stPump
DataConv_GISAD_stRainGauges
DataConv_GISAD_stStructure
DataConv_GISAD_stTunnel
DataConv_GISAD_stVentPipe
DataConv_GISAD_stVirtualLink
DataConv_GISAD_stVirtualNo

F.2. Discharge Management, Characterization, and Watershed-Based Assessment And Management Program

F.2.Step 1. Preliminary Reconnaissance: Permit Issuance Through End of Year 2

F.2.Step 1.a. Pennypack, Poquessing, Wissahickon WMP preliminary reconnaissance - Land use and resource mapping

The City has conducted extensive mapping of information relevant to stormwater management planning. Previously discussed in **SECTION F.1** of this document, the GIS files include MS4 outfalls and contributing drainage areas, land use, population, monitoring locations, and other relevant layers. The maps and supporting GIS layers are included in the accompanying CD. These figures are in **APPENDIX F – LAND USE AND RESOURCE MAPPING**, separated by watershed.

F.2.Step 1.b. Pennypack, Poquessing, Wissahickon WMP preliminary reconnaissance - Preliminary physical, chemical, and biological quality assessment

Comprehensive Watershed Monitoring Program

The City of Philadelphia recognizes the potential impacts of discharges from stormwater, CSO and other discharges and conditions that affect drinking water and other designated uses of our waterways.

Comprehensive assessment of our waterways is integral to planning for the long-term health and sustainability of our water systems. The Philadelphia Water Department (PWD) considers such assessments as essential to raising awareness in Southeastern Pennsylvania as to the impact that land development activities are having on waterbody health. By measuring all factors that contribute to supporting fishable, swimmable, and drinkable water uses, appropriate management strategies can be developed for each watershed land area that Philadelphia shares.

Specifically, biological monitoring is a useful means of detecting impacts to the aquatic ecosystems necessary for sustainable fisheries and other designated uses. Biological communities respond to wide variety of chemical, physical and biological factors in the environment and can reveal natural and anthropogenic stressors. In this respect, resident biota in a water body act as natural monitors of environmental quality and can reveal the effects of episodic and cumulative pollution and habitat alteration.

Bio-assessments, however, must be integrated with appropriate chemical and physical measures, land use characterizations, and pollutant source information necessary to establish linkages between stressors and environmental quality. These linkages can then be used to create decision-making frameworks for selecting restoration techniques that are appropriately balanced between in-stream restoration, land-based management practices, and new water and sewer infrastructure.

From 1999 to 2009, PWD has implemented a comprehensive watershed assessment strategy, integrating biological, chemical and physical assessments to provide both quantitative and qualitative information regarding the aquatic integrity of the Philadelphia regional watersheds. This information is published in Comprehensive Characterization Reports (CCR) and used to plan improvements to watersheds in the Southeast Region of Pennsylvania.

Background

The Philadelphia Water Department has carried out extensive sampling and monitoring programs to characterize conditions in seven local watersheds **(FIGURE F.2.STEP 1.B-1),** both within the county boundaries and outside counties/municipalities. The program is designed to document the condition of aquatic resources and to provide information for the planning process needed to meet regulatory requirements of EPA and PADEP. The program includes hydrologic, water quality, biological, habitat, and fluvial geomorphological aspects. The Office of Watersheds is well suited to manage the program because it merges the goals of the city's stormwater, combined sewer overflow, and source water protection programs into a single unit dedicated to watershed-wide characterization and planning.

Under the provisions of the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) requires permits for point sources that discharge to waters of the United States. In the six watersheds entering Philadelphia, stormwater outfalls and wet weather sewer overflow points discharging to surface waters are classified as point sources and are regulated by NPDES.

EPA's Combined Sewer Overflow Control Policy, published in 1993, provides the national framework for regulation of CSOs under NPDES. The Policy guides municipalities, state and federal permitting agencies in meeting the pollution control goals of the CWA in as flexible and cost-effective a manner as possible. As part of the program, communities serviced by combined sewer systems are required to develop long-term CSO control plans (LTCPs) that will result in full compliance with the CWA in the long term, including attainment of water quality standards. PWD completed its LTCP in 1997 and is currently implementing its provisions. The strong focus of the National CSO Policy on meeting water quality standards is a main driver behind PWD's water quality sampling and monitoring program.

Regulation of stormwater outfalls under the NPDES program requires operators of medium and large municipal stormwater systems or MS4s to obtain a permit for discharges and to develop a stormwater management plan to minimize pollution loads in runoff over the long term. Partially in administration of this program, PA DEP assigns designated uses to water bodies in the state and performs ongoing assessments of the condition of the water bodies to determine whether the uses are met and to document any improvement or degradation. These assessments are performed primarily with biological indicators based on the EPA's Rapid Bio-assessment Protocols (RBPs) and physical habitat assessments.

PWD's Office of Watersheds (OOW) and Bureau of Laboratory Services (BLS) are responsible for characterization and analysis of existing conditions in local watersheds to provide a basis for long-term watershed planning and management. The extensive sampling and monitoring program described in this section is designed to provide the data needed for the long-term planning process.

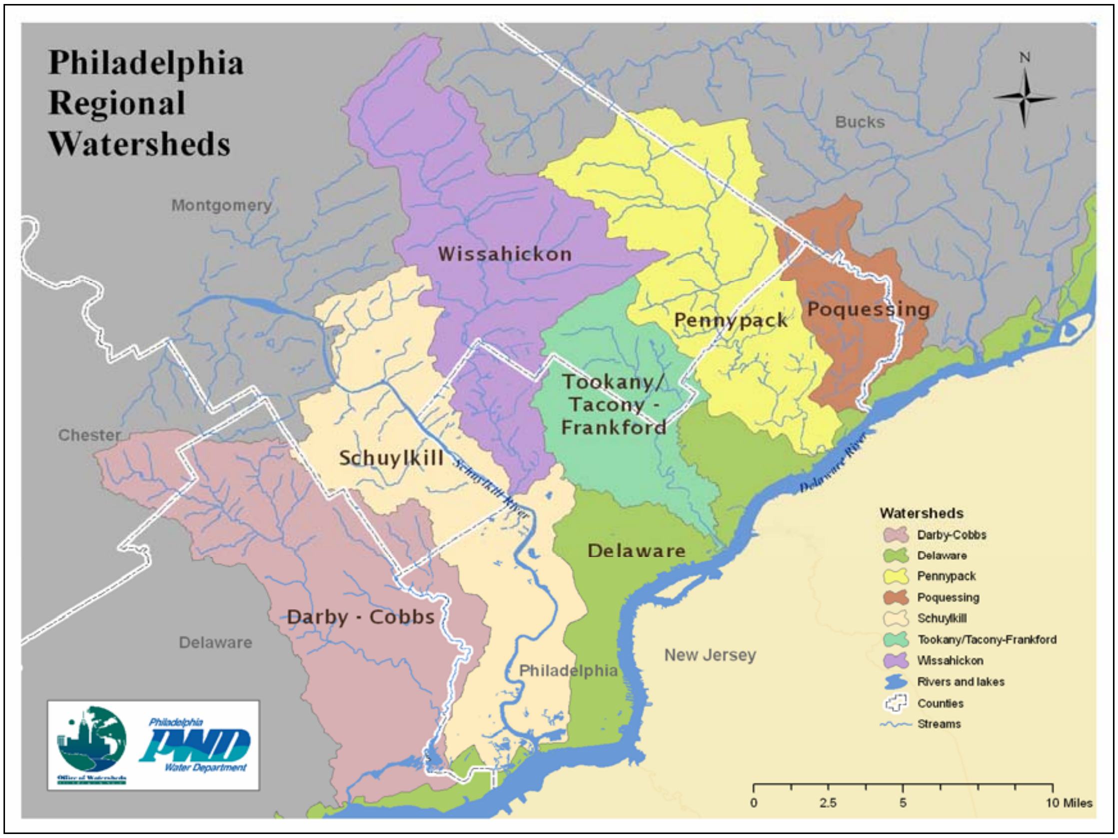


Figure F.2 Step1.b-1 Philadelphia Regional Watersheds

<u>Water Quality Sampling and Monitoring</u>

Guiding Principles of Urban Water Chemistry Assessment

PWD water chemistry assessment activities are guided by recognition of the fact that water quality changes dramatically during wet weather. Water quality assessment procedures must advance our understanding of wet weather effects on stream water quality as well as our stormwater and sewer infrastructure. PWD's water quality assessment strategy has been designed to facilitate separate analyses of dry weather (i.e., baseflow) and wet weather water quality conditions. This program has evolved over time, as personnel and technological improvements have improved our abilities to collect more data from an increasing number of sampling locations in a more efficient manner. Automated sampling, in particular, has greatly increased the temporal resolution of stormwater sampling at multiple sampling locations for a single storm event.

Discrete Water Chemistry Assessment

During the 2002-2007 assessment cycles, a series of four weekly surface water grab samples were manually collected during winter, spring and summer at several locations in each watershed (n=12 sampling events at each location). These samples were termed "discrete interval" samples as the sampling was conducted on a weekly basis regardless of weather conditions. This sampling program represented the finest watershed-wide spatial resolution of all of PWD's water quality monitoring activities. Parameters (**TABLE F.2.STEP 1.B-1**) were chosen because state water quality criteria apply to them or because they are known or suspected to be important in urban watersheds. These discrete interval water chemistry assessment data represent the most complete modern water chemistry grab sample dataset for the majority of Philadelphia's watersheds.

In 2006, PADEP published a review of statistical techniques and provided guidelines for water chemistry statistical analysis when the goal is determining whether a site is meeting its designated use or not (PADEP 2006). This document described attainment and non-attainment of water quality criteria as mutually exclusive cases, and presented a statistical framework for evaluation of the hypothesis that a stream is or is not attaining its designated use. PWD made slight modifications to the 2008 sampling regime in order to better comply with these guidelines by ensuring that a minimum of 8 samples be collected in dry weather, baseflow conditions at each monitoring station, allowing both dry weather and wet weather conditions to be evaluated with the state-recommended statistical methods. Pennypack and Poquessing-Byberry Creek watershed data were collected according to these guidelines.

Now that all CCRs have been completed (Poquessing-Byberry Creek Watershed CCR completed September 2010) there is reduced demand for intensive watershed-wide chemistry assessment until it is necessary to revisit and collect more data from these monitoring locations for updating indicator status for Watershed Management Plans (**SECTION III.C.3.7- BASIN-SPECIFIC STORMWATER MANAGEMENT PLANS**). However, PWD will continue to maintain quarterly baseflow water chemistry assessment at sites in the PWD USGS gage network. These data will be useful as a long-term record of water quality changes in the region.

Integrated Watershed Management Plans (IWMP) for the Cobbs and Tookany/Tacony-Frankford Creek Watersheds were completed in 2004 and 2005. Watershed 5-Year Implementation Plans (IP) were completed for both watersheds in 2006. IWMPs initially recommended a five year interval for watershed-scale re-assessments and indicator status updates, but that interval was determined to be too aggressive. The initial re-assessment monitoring interval recommendation was changed to ten years, in recognition of the fact that watershed-wide assessments are best suited to characterize coarse-scale water quality and biological community health.

Table F.2.Step 1.b -1 Chemical Analytes Collected During Chemical Monitoring Programs

Parameter	Units	Discrete Grab	Wet Weather Targeted	USGS Quarterly Grab	Continuous *in situ* & USGS gages
Alkalinity	mg/L	X			
Aluminum	mg/L	X	X		
Dissolved Aluminum	mg/L	X			
Ammonia	mg/L as N	X	X	X	
Arsenic	mg/L	X	X		
Dissolved Arsenic	mg/L	X			
BOD5	mg/L	X	X		
Cadmium	mg/L	X	X		
Dissolved Cadmium	mg/L	X			
Calcium	mg/L	X	X		
Chromium	mg/L	X	X		
Dissolved Chromium	mg/L	X			
Specific Conductance	µS/cm	X		X	X
Copper	mg/L	X	X		
Dissolved Copper	mg/L	X			
E. coli	CFU/100mL	X	X	X	
Enterococci	CFU/100mL			X	
Fecal Coliform	CFU/100mL	X	X	X	
Hardness	mg/L $CaCO_3$	X	X		
Iron	mg/L	X	X		
Dissolved Iron	mg/L	X			
Lead	mg/L	X	X		
Dissolved Lead	mg/L	X			
Magnesium	mg/L	X			
Manganese	mg/L	X	X		
Dissolved Manganese	mg/L	X			
Nitrate	mg/L	X	X	X	
Nitrite	mg/L	X	X		
Orthophosphate	mg/L	X	X	X	
Dissolved Oxygen	mg/L	X		X	X
pH	pH units	X		X	X
Total Phosphorus	mg/L	X	X		
Sodium	mg/L	X			
Suspended Solids	mg/L	X	X	X	
Total Solids	mg/L	X	X		
Temperature	°C	X		X	X
TKN	mg/L	X	X		
Turbidity	NTU	X	X	X	X
Zinc	mg/L	X	X		
Dissolved Zinc	mg/L	X			

Allowing ten years before re-assessment will potentially allow for a greater number of IWMP and CSO LTCP projects to be completed, and allow PWD to focus monitoring efforts on evaluating the performance of stormwater BMPs and restoration projects, as well as the tidal Schuylkill and Delaware Rivers which have not been assessed as well as smaller wadeable streams. As described in the "Comprehensive watershed Monitoring Program: Proposed Strategy 2010-2015", PWD's current proposed strategy for watershed assessments also includes a less intense, but ongoing monitoring effort within each watershed, primarily through a partnership with the USGS. Results from grab samples collected quarterly September 2009-June 2010 at all USGS gages in the PWD/USGS Coopeerative water Quality Monitoring Program are presented in **APPENDIX G – PWD QUARTERLY DRY WEATHER WATER QUALITY MONITORING PROGRAM**.

The proposed strategy for watershed assessments 2010-2015 includes resuming watershed-scale grab sampling at several stations within each target watershed on a weekly basis in three seasons, with accommodations made to ensure that a minimum of 8 samples be collected in dry weather conditions. This program will resume in Cobbs Creek Watershed in 2012. (**TABLE F.2.STEP 1.B -3 PROPOSED WATERSHED MONITORING TIMELINE 2008-2016)**. These watershed scale re-assessment and subsequent indicator status update reports should complement the "adaptive management" approach favored by the IWMP implementation process, and allow for the locations and methods of assessment to be changed, depending upon the number of projects implemented and their spatial distribution within the watershed. It is hoped that these data will be useful as a long-term record of water quality changes in the region, more appropriate for assessing the goals of a City-wide distributed green infrastructure program than an approach which focuses on individual watersheds.

Continuous Water Quality Assessment

In addition to discrete chemical sampling, PWD incorporated *in situ* continuous water quality monitoring at strategic locations within each watershed as part of the 1999-2009 comprehensive monitoring strategy. Using submerged instruments (YSI 6600, 6600 EDS and 600 XLM Sonde), dissolved oxygen, temperature, pH, conductivity, depth (stage) and turbidity were logged at 15-minute intervals. The instruments were deployed for approximately two weeks, retrieved and replaced with fresh calibrated instruments in order to produce nearly seamless temporal data. Continuous water quality monitoring has been completed for Darby-Cobbs, Tookany/Tacony-Frankford, Wissahickon, Pennypack, and Poquessing-Byberry Watersheds.

Long-term continuous monitoring for TMDL compliance and building a long-term water quality data record for the aforementioned watersheds will be accomplished in 2010-2015 through a partnership with the USGS. Results from July 1, 2009 – June 30, 2010 are presented in **APPENDIX H – PWD/USGS COOPERATIVE WATER QUALITY MONITORING PROGRAM ANNUAL SUMMARY.** Continuous water quality instruments will also be utilized in evaluating the performance of certain stormwater BMPs and assessing conditions in tidal portions of the Schuylkill and Delaware Rivers as well as Frankford Creek.

Wet Weather Event Sampling

The third water quality component of PWD's comprehensive monitoring strategy 1999-2009 was collecting water samples during wet weather flows. Automated samplers (Isco, Inc. models 6712, 6700) were deployed throughout the targeted watersheds and used to collect samples during runoff-producing rain events. This automated system obviated the need for staff to manually collect samples, thereby greatly increasing sampling efficiency. Automated samplers were programmed to commence sampling with a small (~0.1ft.) increase in stage. Once sampling was initiated, a computer-controlled peristaltic pump and distribution system collected grab samples at 30 min. to 1 hr. intervals, the actual interval being adjusted on a site by site basis according to "flashiness". Adjustment of rising-limb hydrograph sampling interval allows optimum characterization of water quality responses to stormwater runoff and wet weather sewer overflows. Due to sample volume restrictions, fewer chemical analyses were performed on samples collected in wet weather (**TABLE F.2.STEP 1.B -1**).

The primary use of automated samplers in the 2010-2015 period is assessment of stormwater BMP performance. Automated samplers have been successfully deployed at the Saylor Grove Stormwater Treatment Wetland, and it is expected that as additional stormwater BMPs are constructed, automated samplers will be the primary means of evaluating water quality performance. As an added advantage, data which are logged from the pressure transducer that is used to initiate sampling provide the input for the water quantity/hydrologic performance evaluation.

Currently, plans are in place to construct large stormwater treatment wetlands in the Wissahickon Creek Watershed at Wise's Mill Run and Cathedral Run. Automated samplers will be used to collect samples from the influent and effluent until a sufficient number of storm events have been captured to evaluate stormwater treatment wetland performance. If this research shows a reasonable level of consistency, there may be a reduced need to monitor additional stormwater BMPs with such a complicated and expensive monitoring system.

Automated samplers were also used extensively in tributaries to Wissahickon Creek to develop relationships between turbidity and TSS. TSS and turbidity were more closely correlated in mainstem samples than in the tributaries, however, the latter correlation was still significant (Log transformed) ($r(58)=0.80$, $p<0.001$). It is likely that additional samples would strengthen this relationship, as tributaries have not been sampled during larger storm events. These strong correlations between TSS and Turbidity support the future use of turbidity as an indicator of TSS concentration. TSS monitoring is one component of The City of Philadelphia's plan for evaluation of projects which are implemented to achieve sediment TMDL goals.

Biological Monitoring

PWD integrated biological assessments into the monitoring strategy for the IWMPs as a means of characterizing health of biological communities, identifying potential physical impairments or chemical stressors, and as a "baseline" for measuring the effects of future restoration projects. The biological monitoring protocols employed by PWD are based on methods developed by the United States Environmental Protection Agency (Barbour *et al*. 1999) and the Pennsylvania Department of Environmental Protection. These procedures are as follows:

- Rapid Bio-assessment Protocol III (Benthic Macroinvertebrate Sampling)
- Rapid Bio-assessment Protocol V (Fish Sampling)
- Periphyton Assessment (Algae Monitoring)

Macroinvertebrate Assessments

In 2007, PADEP shared a new set of protocols for Benthic Macroinvertebrate Assessments, with significant changes to field sampling, laboratory, and data analysis techniques (PADEP 2007). PWD adopted these Instream Comprehensive Evaluation (ICE) sampling and data analysis techniques for 2007 and 2008 monitoring activities in Pennypack Creek and Poquessing-Byberry Creek Watersheds. With the ICE method, sample results are compared to an Index of Biotic Integrity (IBI) for Wadeable Freestone Riffle-Run Streams that is intended to be used statewide, without regard for regional or climatic influences. The IBI is sensitive to effects of season and drainage area, as index scores generally tend to decline in larger streams and during the warmer months. In both cases, these effects are more pronounced at high quality sites.

The ICE method requires a sample size of 200±20% individuals, while macroinvertebrate samples processed by PWD 1999-2006 were subsampled with minimum 100 individual sample size. Due to this discrepancy, re-sampling or other normalization procedures may need to be used with the data collected according to the new DEP Assessment protocol to maintain compatibility with pre-established IWMP indicators for Indicator Status Update reports. Preliminary work with ICE metrics shows streams used by PWD as reference sites (*e.g.*, French Creek and tributaries to French Creek) are narrowly meeting their aquatic life designated use or in some cases classified as “impaired” under the new assessment method. Comprehensive assessments of the Pennypack and Poquessing-Byberry Watershed included separate metrics compared to the PADEP ICE protocol as well as the reference site-based metric comparison used during the original baseline assessments and Integrated Watershed Management Plans (PWD 2009, PWD 2010).

Integrated Watershed Management Plans (IWMP) for the Cobbs and Tookany/Tacony-Frankford Creek Watersheds were completed in 2004 and 2005. Watershed Management Implementation Plans were completed for both watersheds in 2006. IWMPs initially recommended a five year interval for re-assessments and Indicator Status Updates, but that interval was determined to be too aggressive, at least for the initial Indicator Status Updates. The initial re-assessment monitoring interval recommendation was changed to ten years, in recognition of the fact that watershed-scale assessments are best suited to characterize larger-scale water quality and biological community health.

Allowing ten years before re-assessment will potentially allow for a greater number of IWMP and CSO LTCP projects to be completed. Re-assessment and subsequent Indicator Status Reports should complement the "adaptive management approach", and allow for the locations and methods of assessment to be changed, depending upon the number of projects implemented and their spatial distribution.

In recent years, agencies tasked with evaluating water quality have attempted to incorporate statistical sampling designs, or a "probabilistic" approach, to selecting sampling sites (Paulsen 2008, Borsuk *et al*. 2001) rather than relying on fixed sites. Statistical sampling design is particularly important when the goal of monitoring is to make an estimate of the percentage of waters affected by pollution. Another advantage of probabilistic study design is that the assessment units are distributed over a larger geographic area. When monitoring efforts are directed at individual watersheds on a rotating basis, as has been the case with PWD's Comprehensive assessment program, the possibility arises that larger scale patterns may be missed. For example, the effects of floods or drought conditions are widespread, but only the watershed that is being monitored within the same time period will have data reflecting these effects. Disadvantages of a probabilistic approach include the technical demands of establishing and randomly selecting from geographic data sets containing all possible sampling locations as well as additional field reconnaissance work when conduct the actual monitoring.

As described in the PWD Comprehensive Monitoring Program: Proposed Monitoring Strategy 2010-2015, PWD's approach is intended to be a compromise, recognizing the benefits of collecting data from randomly selected sites but also the importance of maintaining a consistent monitoring effort at consistent locations over time. This plan is based on a similar monitoring program which USGS has implemented in Chester County (Reif 2002, Reif 2004). The plan also reflects the manpower constraints of collecting and processing samples with the PADEP ICE protocol. It is hoped that this compromise approach will achieve some of the benefits of a randomized approach, while providing periodic re-evaluation of our watersheds required to inform the watershed planning process and comply with environmental mandates.

Fish Assessments

From 1999 through 2009 PWD, sampled fish communities in wadeable segments of each of Philadelphia's watersheds using USEPA Rapid Bioassessment V Methods (RBP V). Results of these samples are presented in the Darby-Cobbs, Tookany-Tacony/Frankford, Wissahickon, and Pennypack Creek Watershed Comprehensive Characterization Reports (CCR) (PWD 2003, 2005, 2007, 2009). The Poquessing Creek Watershed CCR was completed in September 2010. PWD also has conducted additional non-quantitative fish assessments in tidal areas of the Delaware and Schuylkill Rivers, as well as quantitative monitoring of fish utilization of the Fairmount Fishway. The latter program is discussed in more detail in section III.C.2.5 on Page 140..

Consistent with the rationale of an extended interval for macroinvertebrate re-assessments, as described above, fish re-assessments will also be conducted within targeted watersheds on a ten year interval. Other projects where RBP fish surveys may be helpful in assessing BMP performance include streambank restoration projects along Tacony and Cobbs Creeks as well as fish habitat and passage improvements in Pennypack Creek. Fish assessments are generally not appropriate for monitoring of very small, and particularly of small high gradient, stream segments, so the primary means of evaluating biological health and success of stream restoration projects in small streams is macroinvertebrate assessment.

Algae Assessments

From 2002 through 2009, PWD collected algal periphyton samples from a small number of sites in selected watersheds using components of USEPA Rapid Bioassessment Protocol 6.1 (laboratory-based approach). Algal periphyton are collected from natural substrates and biomass is estimated based on quantitative chlorophyll-a and total chlorophyll analysis. Periphyton sampling is performed primarily to address the question of whether anthropogenic nutrient sources are causing eutrophication, which may result in violations of water quality criteria for dissolved oxygen, pH, and have adverse effects on aquatic food webs. Large concentrations of chlorophyll indicate excessively dense algal growth, which may help explain observed aquatic life impairments.

Beginning in 2005, PWD began providing samples of algal periphyton to the Patrick Center of the Academy of Natural Sciences of Philadelphia, phycology section, for taxonomic identification of diatoms and soft algae, as well as the determination of intercellular nutrient (C,N,P) concentrations of algal periphyton. Algal taxonomic data are analyzed for standard measures of community structure and also compared to autecological information and indices developed through USGS National Water Quality Assessments (Porter 2008).

Physical Monitoring

Habitat Assessments

Habitat assessments are conducted at each monitoring site based on the Environmental Protection Agency's Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers (Barbour et al., 1999). Reference conditions are used to normalize the assessment to the "best attainable" situation. Habitat parameters are separated into three principal categories: (1) primary, (2) secondary, and (3) tertiary parameters:

- Primary parameters are those that characterize the stream "microscale" habitat and have greatest direct influence on the structure of indigenous communities.
- Secondary parameters measure "macroscale" habitat such as channel morphology characteristics.
- Tertiary parameters evaluate riparian and bank structure and comprise three categories: (1) bank vegetative protection, (2) grazing or other disruptive pressure, and (3) riparian vegetative zone width.

In 2007, PADEP shared a new set of protocols for Physical Habitat Assessments that differ slightly from those in the RBPs. Some individual habitat metrics were split into separate categories, while others had slight changes to the condition description text. PWD adopted these new sampling techniques for 2008 monitoring activities in Poquessing-Byberry Creek Watershed which are presented in the Poquessing Creek Watershed CCR. Normalization procedures may be used with the data collected according to the new DEP Assessment protocol to maintain compatibility with pre-established IWMP indicators for Indicator Status Update reports.

Habitat Suitability Index (HSI)
In addition to habitat assessments, Habitat Suitability Index (HSI) models, developed by the U.S. Fish and Wildlife Service (USFWS), have been incorporated into the monitoring program. Based on empirical data and supported by years of research and comprehensive review of scientific literature, these models present numerical relationships between various habitat parameters and biological resources, particularly gamefish species and species of special environmental concern. To date, HSI have applied to Darby-Cobbs, Tookany/Tacony-Frankford, Wissahickon, and Pennypack Creek Watersheds. The Poquessing-Byberry Watershed Comprehensive Characterization Report approach attempted to simplify the application of fish habitat suitability analysis to generalized guilds, as described below.

Physical Habitat Survey and Integrated Flow Modeling
PWD performed very detailed physical survey of sites (n=6) where fish were collected in Poquessing Creek Watershed in 2008. PWD applied a depth-averaged finite element flow model (River 2D) to assess habitat conditions under baseflow conditions for the Poquessing Creek watershed Comprehensive Characterization Report in 2010. Additional research is needed in order to parameterize physical habitat suitability models for various aquatic life groups of concern, but PWD is presently applying generalized "guild" characteristics which are intended to represent the habitat requirements of groups of similar species.

Fluvial Geomorphologic (FGM) / Infrastructure Analysis
To date, FGM analysis has been conducted on the Darby-Cobbs, Tookany/Tacony-Frankford Wissahickon, Pennypack and Poquessing-Byberry Creeks. Analysis was conducted in order to characterize channel morphology, disturbance, stability, and habitat parameters as well as to provide a template for hydrologic and hydraulic modeling and serve as a baseline for assessing channel bank and bed changes. Data provided from the FGM analyses will also serve to develop reach rankings within each watershed in order to prioritize restoration strategies.

Summary of Monitoring Locations

Biological, physical and chemical monitoring locations are based on 3 criteria: 1) appropriate habitat heterogeneity; 2) access availability; and 3) proximity to USGS stream gaging stations and PADEP 305b monitoring sites. In general, the number of monitoring sites is proportional to the size of the drainage and the watershed's link magnitude (*i.e.*, number of 1st order streams).

A river mile-based naming convention has been created for sampling and monitoring sites in the regional watersheds. The naming convention includes a two letter prefix denoting major watershed, one or more optional letters denoting a tributary stream, and a series of digits to represent the distance from the mouth of the stream in hundredths of a mile. For example, site DCC110:

"DC" stands for the Darby-Cobbs watershed.

"C" stands for Cobbs Creek.

"110" places the site 1.10 miles upstream of the mouth of Cobbs Creek, where it flows into Darby Creek.

TABLE F.2.STEP 1.B-3 explains the current number of assessment sites in each watershed relative to the various monitoring programs.

Table F.2.Step 1.b -3 Number of Monitoring Locations Relative to the Monitoring Program

Watershed	Monitoring Program								
	Biological			Chemical			Physical		
	RBP III	RBP V	Algae	Discrete	Continuous	Wet Weather	Habitat	HSI Index	FGM
Darby-Cobbs	17	9	0	9	5	5	17	9	95
Tacony-Frankford	12	7	4	9	8	6	12	7	102
Wissahickon	32	10	5	10	6	8	32	10	230
Pennypack	20	11	4	13	4	4	20	11	130
Poquessing	13	7	4	7	3	3	13	N/A	160
Tidal Schuylkill	N/A	4	N/A	4	2	2	N/A	N/A	N/A

N/A Not Applicable

Monitoring Time Line Strategy

Prior to the creation of PWD's Comprehensive Watershed Monitoring Program, baseline assessments were conducted in all of the Philadelphia regional watersheds to assess the degree, location and type of impairments occurring within each system. Baseline assessments, encompassing benthic, fish, habitat and discrete water quality monitoring, were routinely completed on a watershed within one year. With the addition of continuous and wet-weather water quality monitoring, periphyton assessments, and specialized physical assessment programs (*e.g.*, FGM assessments), comprehensive characterization reports (CCRs) were typically accomplished on a two-year timeline (**TABLE F.2.STEP 1.B-3**)

Table F.2.Step 1.b -3 Proposed Watershed Monitoring Timeline 2010-2016

Watershed	Program Components	2010				2011				2012				2013				2014				2015				2016			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Cobbs	BMP Monitoring																												
	Quarterly WQ Grab sampling																												
	Continuous WQ Monitoring																												
	Annual WQ Summary																												
	Bioassessment																												
	Bioassessment Data Analysis																												
	IWMP Indicator Status Update																												
Tacony-Frankford	BMP Monitoring																												
	Quarterly WQ Grab sampling																												
	Continuous WQ Monitoring																												
	Annual WQ Summary																												
	Bioassessment																												
	Bioassessment Data Analysis																												
	IWMP Indicator Status Update																												
Wissahickon	BMP Monitoring																												
	Quarterly WQ Grab sampling																												
	Continuous WQ Monitoring																												
	Annual WQ Summary																												
	Tributary Assessment																												
	Tributary Data Analysis																												
	Bioassessment																												
	Bioassessment Data Analysis																												
	IWMP Indicator Status Update																												

Goals and Measures of Success

The proposed watershed monitoring strategy is an integrated approach which will improve the evaluations of non-point source pollution controls and the combined effectiveness of current point and non-point source controls. Similarly, biological attributes can be used to measure site-specific ecosystem responses to remediation or mitigations directed at reducing non-point source pollution impacts. Through the monitoring programs described in this permit cycle, PWD will be able to measure the relative success of remediation and restoration programs occurring within the Philadelphia regional watersheds. As a major stakeholder in the watersheds, PWD will also be able to provide insight and direction for smaller communities within the watersheds and parties involved in the watershed approach.

Reporting

PWD published the Poquessing Creek Watershed Comprehensive Characterization Report in September 2010. Results of continuous and quarterly grab sampling water chemistry analysis conducted in partnership with the USGS are presented in Appendices **APPENDIX H – PWD/USGS COOPERATIVE WATER QUALITY MONITORING PROGRAM ANNUAL SUMMARY** and **G – PWD QUARTERLY DRY WEATHER WATER QUALITY MONITORING PROGRAM** , respectively.

F.2.Step 1.c. Pennypack, Poquessing, Wissahickon WMP preliminary reconnaissance - Inventory of Point and Non-Point sources

There are 127 NPDES permitted dischargers in Philadelphia, as shown in **APPENDIX I**. This listing was downloaded from the EPA envirofacts website (http://oaspub.epa.gov/enviro/ef_home2.water). Only 50 of these dischargers are located in MS4 areas, with the remaining dischargers located in the CSO areas or areas of direct drainage to a waterway.

The City is also actively involved in developing annual and seasonal estimates of non-point source pollutants. The results of this analysis are described in the hydrologic models in **SECTION F.2.STEP 2.C/D/E.**

F.2.Step 1.d Pennypack, Poquessing, Wissahickon WMP preliminary reconnaissance - Preliminary problem assessment

Wissahickon Creek Watershed

A Comprehensive Characterization Report was completed for the Wissahickon Creek Watershed in February 2007 which included analysis of data collected over the 2005-2006 monitoring period and presented a characterization of problems within this watershed area. The comprehensive characterization report is currently available to the public through the internet at the following address: http://www.phillywatersheds.org/doc/Wissahickon_CCR.pdf.

Pennypack Creek Watershed

A Comprehensive Characterization Report was completed for the Pennypack Creek Watershed in June 2009 which included analysis of data collected over the 2007-2008 monitoring period and presented a characterization of problems within this watershed area. The comprehensive characterization report is currently available to the public through the internet at the following address: http://www.phillywatersheds.org/doc/Pennypack_CCR_Entire.pdf.

Poquessing Creek Watershed

PWD completed a Comprehensive Characterization Report (CCR) for the Poquessing-Byberry Watershed in September 2010. Two copies of the Poquessing-Byberry Watershed CCR will be submitted to the Department along with this annual report. This report will serve as the technical framework for the Poquessing Creek Integrated Watershed Management Plan (PCIWMP). The technical report will also provide state and federal agencies and local officials with a succinct problem statement, outlining the biological, physical and chemical integrity of the system and the potential sources of impairment. The Poquessing CCR is disseminated to the public through the internet at the following address: http://www.phillywatersheds.org/doc/Poquessing_CCR.pdf

F.2.Step 2. Watershed Plan Development: Permit issuance through end of year 4

F.2.Step 2.a. Pennypack, Poquessing, Wissahickon Watershed Plan Development - Monitoring and Sampling

Current activities of the PWD center on analyzing and summarizing data collected from the Poquessing Creek watershed in preparation for a comprehensive baseline characterization. To meet the regulatory requirements and long-term goals of its stormwater, and drinking water source protection programs, PWD has embraced a comprehensive watershed characterization, planning, and management program for the Poquessing Creek Watershed. Watershed management fosters the coordinated implementation of programs to control sources of pollution, reduce polluted runoff, and promote managed growth in the city and surrounding areas, while protecting the region's drinking water supplies, fishing and other recreational activities, and preserving sensitive natural resources such as parks and streams. PWD has helped form watershed partnerships with surrounding urban and suburban communities to explore regional cooperation based on an understanding of the impact of land use and human activities on water quality.

Coordination of these different programs has been greatly facilitated by PWD's creation of the Office of Watersheds (OOW), which is composed of staff from the PWD's planning and research, CSO, collector systems, laboratory services, and other key functional groups. One of OOW's responsibilities is to characterize existing conditions in local watersheds to provide a basis for long-term watershed planning and management. The focus of OOW during FY 2009 and FY 2010 is the Poquessing Creek Watershed.

OOW is developing a series of Integrated Watershed Management Plans (IWMPs)for each of the City's watersheds. Cobbs Creek was the first watershed for which a Comprehensive Characterization Report and IWMP were completed; the Tookany/Tacony-Frankford Watershed Partnership was second to complete an IWMP and CCR. The WCWCCR, completed in February 2007, was third in this series of technical documents, and the Pennypack and Poquessing Creek watershed CCRs were completed in June 2009 and September 2010, respectively. While IWMPs have not yet been completed for the Wissahickon, Pennypack or Poquessing Creek Watersheds yet, these Comprehensive Characterization Reports will complement IWMPs by characterizing a watershed's land use, geology, soils, topography, demographics, meteorology, hydrology, water quality, ecology, fluvial geomorphology, and pollutant loads. These reports are intended as a single compilation of background and technical documents that can be periodically updated as additional field work or data analyses are completed.

Water Quality Sampling and Monitoring

In order to comply with the State-regulated stormwater permit obligations, PWD worked with USGS to record continuous water quality data at eleven gage stations in the Philadelphia region during July 2009 through November 2010 and March 2010 through June 2010. Water quality grab samples were also collected quarterly at all USGS gage stations in September and December 2009, March and June 2010. Water quality sampling was conducted throughout 2009 in Poquessing Creek Watershed. A watershed-wide comprehensive water quality characterization program was completed for Poquessing Creek Watershed, while wet weather water quality sampling for sediment TMDL and BMP monitoring continued in Wissahickon Creek Watershed. The sampling and monitoring sites are presented in **APPENDIX J - MONITORING LOCATIONS**. A list of the parameters sampled during the discrete, continuous, and wet weather sampling can be found in **TABLE F.2.STEP.2.A-1**. Three types of sampling were performed as discussed below. Parameters were chosen based on state water quality criteria or because they are known or suspected to be important in urban watersheds.

Discrete Water Chemistry Assessment

In order to characterize conditions throughout the Philadelphia region and build a long-term record of water quality, PWD initiated a quarterly baseflow water quality sampling program at eleven USGS gage stations. This program marks a transition from focusing on one specific watershed per monitoring season to a broader regional water quality assessment approach. Each USGS/PWD cooperative monitoring gage site was sampled once during the course of a few hours, to allow for travel time and sample processing/preservation.

Continuous Water Quality Assessment

Physicochemical properties of surface waters are known to change over a variety of temporal scales, with broad implications for aquatic life. Several important, state-regulated parameters (*e.g.*, dissolved oxygen, temperature, and pH) may change considerably over a short time interval, and therefore cannot be measured reliably or efficiently with grab samples. In order to characterize conditions throughout the

Philadelphia region and build a long-term record of water quality, PWD initiated a continuous water quality monitoring program at eleven USGS gage stations. This program marks a transition from focusing on one specific watershed per monitoring season to a broader regional water quality assessment approach. Each USGS/PWD cooperative monitoring gage site (site map reference) records water quality data for dissolved oxygen, temperature, flow, pH, and specific conductance. Selected locations are also instrumented for turbidity, precipitation and photosynthetically active radiation (PAR). These data are made available to the public in near real-time on the internet at http://pa.water.usgs.gov/pwd/.

In addition to monitoring water quality continuously at USGS gaging stations, PWD continued deployments of *in situ* self-contained data logging continuous water quality monitoring Sondes (YSI Inc. Models 6600, 6600 EDS, 600XLM) in the tidal Schuylkill River and Frankford Creek.

Wet Weather Event Sampling

Automated samplers (Isco, Inc.) were used to collect samples from the Stormwater treatment wetland at Saylor Grove in the Monoshone Creek Watershed (tributary to Wissahickon Creek). Wet weather data collection in tributary sites is on-going, along with the streambank erosion component of PWD's sediment source assessment (**SECTION F.1**). These data will allow characterization of water quality responses to stormwater runoff.

Automated samplers are equipped with vented in-stream pressure transducers that allowed sampling to commence beginning with an increase in stage. Once sampling was initiated, a computer-controlled peristaltic pump and distribution system collected the first 4 grab samples at 40 minute intervals and the remaining samples at 1 hr. intervals.

Biological Assessments

Macroinvertebrate Assessments

During March 2007, PWD conducted Rapid Bioassessment Protocols (RBP III) at twelve (n=12) locations within Poquessing Creek Watershed (**APPENDIX J**). Surveys were conducted at 8 mainstem locations and 4 tributary locations. Two of the 5 tributary sites are located within Philadelphia County. PWD also collected macroinvertebrate samples from Cobbs Creek at Marshall Rd for post construction monitoring of stream restoration activities and Tacony Creek at Whitaker Avenue for documentation of baseline pre-construction conditions.

Fish Assessments

Between 6/1/08 and 6/23/08, PWD biologists conducted fish assessments at six (n=6) locations within Poquessing-Byberry Creek Watershed (**APPENDIX J**). PWD also collected fish samples from Cobbs Creek at Marshall Rd for post construction monitoring of stream restoration activities and Tacony Creek at Whitaker Avenue for documentation of baseline pre-construction conditions. All surveys were conducted using electrofishing gear as described in EPA RBP V (Barbour, et al. 1999).

Algae Assessments
Periphyton communities were sampled from Poquessing sites PQ865, PQ115, and PQB025, chiefly to assess the role of periphyton regulating stream metabolism. Sites were chosen based on proximity to continuous water quality monitoring stations, but some adjustments were made in order to situate the periphyton sampling locations in areas with sufficient depth and substrates and to attempt to control for differences in canopy cover.

PWD's 2007-8 periphyton monitoring in Poquessing and Pennypack Creek Watersheds was enhanced with partnerships from the Philadelphia Academy of Natural Sciences (ANS) and Widener University. PWD collected estimates of periphyton chlorophyll-a at four sites in spring and summer (24 periphyton samples total), while the ANS laboratory analyzed periphyton intercellular nutrient ratios (C:N:P).

Physical Assessments

Habitat Assessments
Immediately following benthic macroinvertebrate sampling procedures, habitat assessments were completed at twelve (n=12) sites in Poquessing Creek Watershed as well as Cobbs Creek at Marshall Rd. and Tacony Creek at Whitaker Ave. (**APPENDIX J**). Habitat assessments were based on the Environmental Protection Agency's Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers (Barbour et al. 1999). Physical habitat assessments were performed at each benthic macroinvertebrate sampling location. Reference conditions were used to normalize the assessment to the "best attainable" situation.

Habitat parameters were separated into three principal categories: (1) primary, (2) secondary, and (3) tertiary parameters. Primary parameters are those that characterize the stream "microscale" habitat and have greatest direct influence on the structure of indigenous communities. Secondary parameters measure "macroscale" habitat such as channel morphology characteristics. Tertiary parameters evaluate riparian and bank structure and comprise three categories: (1) bank vegetative protection, (2) grazing or other disruptive pressure, and (3) riparian vegetative zone width.

Physical Habitat Survey and Integrated Flow Modeling
PWD performed very detailed physical survey of sites (n=6) where fish were collected in Poquessing Creek Watershed in 2008 and used a depth-averaged finite element flow model (River 2D) to assess habitat conditions under baseflow conditions for the Poquessing Creek watershed Comprehensive Characterization Report in 2010. Additional research is needed in order to parameterize physical Habitat Suitability Models for various aquatic life groups of concern.

Fluvial Geomorphologic (FGM) / Infrastructure Analysis
In FY 2008, infrastructure assessments were completed in the entire Pennypack and Poquessing Creek watershed, modeled after the effort completed in FY 2006-2007 in the Wissahickon Creek watershed. In order to document infrastructure throughout the basin, PWD staff walked along stream segments with GPS, digital photography, and

portable computer equipment, compiling an inventory of every infrastructure feature encountered. These features included bridges, culverts, dams, stormwater outfalls and drain pipes greater than 8" in diameter, sewers, pipe crossings, confluences, manholes, and areas where one or more of the stream banks were artificially channelized. The end product of this effort is a complete GIS coverage with associated digital photographs of each feature.

FGM assessment work on the Wissahickon was furthered through the QA/QC of field data moving towards the compilation of the final report. Unfortunately, the final report's compilation was delayed by errors in bankfull identification by PWD's field team. This necessitated the re-surveying of bankfull at each of the 213 cross-sections established within the Wissahickon Creek Watershed. This process took place from November, 2007 through April, 2008. Because of the large amount of data associated with project, PWD has decided to present and discuss this data on a subwatershed scale. To create a template for future reports, the Trewellyn Creek watershed was used. In FY 2010, PWD completed a final report for the Lower Wissahickon watershed, which was defined as all areas of the watershed present within Philadelphia. This document is attached as **APPENDIX K- WISSAHICKON CREEK STEAM ASSESSMENT STUDY**.

FGM assessment work on the Pennypack was furthered through the QA/QC of field data moving towards the compilation of the final report. Unfortunately, the final report's compilation was delayed by errors in bankfull identification by PWD's field team. This necessitated the re-surveying of bankfull at each of the 128 cross-sections established within the Pennypack Creek Watershed. This process took place from April, 2008 through June, 2008. During FY 2011, PWD plans to complete a final report documenting this effort for the Lower Pennypack watershed, which was defined as all areas of the watershed present within Philadelphia.

In FY 2007, a geomorphologic stream survey, consisting of the assessment of approximately 50 miles of stream channel within the watershed, was completed on the Poquessing Creek. The stream survey was completed during the period February – April 2007. The Main Stem of Poquessing Creek is approximately 12 miles in length, with approximately 38 miles of tributaries that stem from it. A majority of the watershed is located in Philadelphia County, with small portions in both Bucks and Montgomery Counties. Field crews consisting of personnel from the Philadelphia Water Department conducted the geomorphologic survey. The geomorphologic survey involved walking the entire length of the main stems of the Poquessing Creek, its large tributaries, and some unnamed smaller tributaries to record specific information about the channel and surrounding habitat. One representative stream channel cross section was measured per reach, with 160 reaches and most reaches being smaller than 2000 feet in length. Measured field data was collected to determine stream channel types for each reach and to help evaluate channel stability. Qualitative habitat data was also collected. The data collected from this study is currently being processed and analyzed. This survey and assessment will aid in the determination of the flow patterns in the Poquessing Watershed which will allow for the conceptual planning of projects that will mitigate the effects of storm flow on the stream by decreasing the erosive effects of the stormwater, decreasing the quantity of water that reaches the streams, and stabilizing and restoring the banks using natural techniques to withstand storm flows. It will also provide data that will help in the development of an approach for the restoration of Poquessing Creek with an emphasis on hydraulic sustainability, enhancement to riparian habitat, improved aesthetics, and biological improvement. PWD plans to eventually compile this data in a report on the Philadelphia portion of the Poquessing watershed once the Pennypack report has been completed.

Monitoring Time Line Strategy

As discussed in **SECTION 2: STEP 1 (PART B)** of the City's Stormwater Permit, PWD completed The Poquessing Creek Watershed Comprehensive Characterization Report in 2010. Completion of the Poquessing Creek watershed Characterization report marks the end of a decade-long research effort to characterize conditions in Philadelphia's streams. Various planning initiatives have been based upon these technical documents and many pilot –scale BMP projects have been constructed and are being actively monitored.

As described in PWD's "Comprehensive Watershed Monitoring Program: Proposed Strategy 2010-2015", the scale of watershed stressors is so expansive and individual BMP projects so limited in size, PWD is focusing its monitoring efforts at maintaining a "sentinel" monitoring presence in each of the City's watersheds rather than dedicating monitoring efforts to individual watersheds. This regional monitoring approach has been greatly enhanced through a partnership with USGS. Continuous water quality data are collected from 11 USGS gaging stations, and quarterly baseflow water samples are analyzed for microbial and nutrient parameters of concern. PWD also continues to assess performance of stormwater BMP projects as they are constructed.

Reporting

PWD completed a Comprehensive Characterization Report (CCR) for the Poquessing-Byberry Watershed in September 2010. Two copies of the Poquessing-Byberry Watershed CCR will be submitted to the Department along with this annual report. The technical report will also provide state and federal agencies and local officials with a succinct problem statement, outlining the biological, physical and chemical integrity of the system and the potential sources of impairment. The Poquessing CCR is disseminated to the public through the internet at the following address: http://www.phillywatersheds.org/doc/Poquessing_CCR.pdf

F.2.Step 2.b. Pennypack, Poquessing, Wissahickon Watershed Plan Development - Quality Assurance/Quality Control (QA/QC) and Data Evaluation

OOW and the Bureau of Laboratory Services (BLS) have planned and carried out an extensive sampling and monitoring program to characterize conditions in Pennypack and Poquessing-Byberry Creek Watershed. The program includes hydrologic, water quality, biological, habitat, and fluvial geomorphological components. Again, because the OOW has merged the goals of the city's stormwater, combined sewer overflow, and source water protection programs into a single unit dedicated to watershed-wide characterization and planning, it is uniquely suited to administer this program.

Sampling and monitoring follow the Quality Assurance Project Plan (QAPP) and Standard Operating Protocols (SOPs) as prepared by BLS. These documents cover the elements of quality assurance, including field and laboratory procedures, chain of custody, holding times, collection of blanks and duplicates, and health and safety. They are intended to help the program achieve a level of quality assurance and control that is acceptable to regulatory agencies. More information regarding Standard Operating Procedures (SOPs) for chemical and biological assessments is available from BLS.

Water Quality Criteria for Poquessing Creek Watershed

An analysis was conducted on the water quality data collected in the Poquessing Creek watershed in 2008 and 2009. Using the data collected from discrete wet and dry weather sampling, comparisons have been made to PADEP water quality standards. National water quality standards and reference values were used where state water quality standards were not available. The water quality standards or reference values and their sources are listed in **F.2.STEP 2.B-1**. These data are presented in **SECTION 4** of the Poquessing-Byberry Watershed Comprehensive Characterization Report (CCR).

Table F.2.Step 2.b.-1 Water Quality Standards and Reference Values

Parameter	Criterion	Water Quality Criterion or Reference Value	Source
Alkalinity	Minimum	20 mg/L	PA DEP
Aluminum	Aquatic Life Acute Exposure Standard	750 ug/L	PA DEP
Aluminum	Aquatic Life Chronic Exposure Standard	87 ug/L (pH 6.5-9.0)	53FR33178
Chlorophyll a	Reference reach frequency distribution approach for Ecoregion IX, subregion 64, 75th percentile	3 ug/L, (Spectrophotometric) ***	EPA 822-B-00-019
Dissolved Cadmium	Aquatic Life Acute Exposure Standard	0.0043 mg/L*	PA DEP
	Aquatic Life Chronic Exposure Standard	0.0022 mg/L*	PA DEP
	Human Health Standard	0.010 mg/L*	PA DEP
Dissolved Chromium	Aquatic Life Acute Exposure Standard	0.015 mg/L*	PA DEP
	Aquatic Life Chronic Exposure Standard	0.010 mg/L*	PA DEP
Dissolved Copper	Aquatic Life Acute Exposure Standard	0.013 mg/L *	PA DEP
	Aquatic Life Chronic Exposure Standard	0.0090 mg/L *	PA DEP
	Human Health Standard	1000 mg/L	PA DEP
Dissolved Iron	Maximum	0.3 mg/L	PA DEP

Dissolved Lead	Aquatic Life Acute Exposure Standard	0.065 mg/L *	PA DEP
	Aquatic Life Chronic Exposure Standard	0.025 mg/L *	PA DEP
	Human Health Standard	50 mg/L	PA DEP
Dissolved Zinc	Aquatic Life Acute Exposure Standard	0.120 mg/L *	PA DEP
	Aquatic Life Chronic Exposure Standard	0.120 mg/L *	PA DEP
	Human Health Standard	5000 mg/L	PA DEP
Dissolved Oxygen	Average Min (August 1 to February 14)	5 mg/L	PA DEP
	Instantaneous Min (August 1 to February 14)	4 mg/L	PA DEP
	Average Min (February 15 to July 31)	6 mg/L	PA DEP
	Instantaneous Min (February 15 to July 31)	5 mg/L	PA DEP
Fecal Coliform	Maximum	200/100mL (Swimming season) or 2000/100mL (Non-swimming season)	PA DEP
Fluoride	Maximum	2.0 mg/L	PA DEP
Iron	Maximum	1.5 mg/L	PA DEP
Manganese	Maximum	1.0 mg/L	PA DEP
NH3-N	Maximum	pH and temperature dependent	PA DEP
NO2-3-N	Nitrates – Human Health Consumption for water + organisms	2.9 mg/L ***	EPA 822-B-00-019
NO2 + NO3	Maximum (Public Water Supply Intake)	10 mg/L	PA DEP
Periphyton Chl-a		Ecoregion IX – 20.35 mg/m2	EPA 822-B-00-019
pH	Acceptable Range	6.0 - 9.0	PA DEP
TDS	Maximum	750 mg/L	PA DEP
Temperature		Varies w/ season. **	PA DEP
TKN	Maximum	0.675 mg/L ***	EPA 822-B-00-019
TN	Maximum	4.91 mg/L ***	EPA 822-B-00-019
TP	Maximum	140 ug/L ***	EPA 822-B-00-019
TSS	Maximum	25 mg/L	Other US states
Turbidity	Maximum	8.05 NTU ***	EPA 822-B-00-019

* - Water quality standard requires hardness correction; value listed is water quality standard calculated at 100 mg/L CaCO3 hardness

** - Additionally, discharge of heated wastes may not result in a change of more than 2°F during a 1-hour period.

*** - Ecoregion IX, subregion 64 seasonal median

F.2.Step 2.c. Pennypack, Poquessing, Wissahickon Watershed Plan Development - Watershed Modeling

F.2.Step 2.d. Pennypack, Poquessing, Wissahickon Watershed Plan Development - Estimate of Loadings from the City's MS4 System

F.2.Step 2.e. Pennypack, Poquessing, Wissahickon Watershed Plan Development - Water Body Modeling

PWD's approach to resolving impacts of stormwater discharges is one part of a carefully developed approach to meeting the challenges of watershed management in an urbanized setting. Designed to meet the goals and objectives of numerous, water resources related regulations and programs, the method recommends the use of adaptive management approaches to implement recommendations on a watershed-wide basis. Its focus is on attaining priority environmental goals in a phased approach, making use of the consolidated goals of the numerous existing programs that directly or indirectly require watershed planning. Central to the approach is development of IWMPs for each of the watersheds that drains to the City of Philadelphia.

The IWMP approach has four major elements, each with multiple tasks specific to the planning efforts within the watershed.

- Data collection, organization and analysis
- Systems description
- Problem identification and development of plan objectives
- Strategies, policies and approaches

Data Collection, Organization and Analysis

The collection and organization of existing data on surface water hydrology and quality, pollutant loads, wastewater collection and treatment, stormwater control, land use, stream habitat and biological conditions, and historic and cultural resources is a critical step in the watershed characterization process. In addition, existing rules, regulations, and guidelines pertaining to watershed management at federal, state, basin commission, county, and municipal levels are examined for coherence and completeness in facilitating the achievement of watershed planning goals.

Data are collected by many agencies and organizations in various forms, ranging from reports to databases and Geographic Information System (GIS) files. Field data collection efforts were undertaken throughout the study, and expanded as data gaps were identified.

Systems Description

The planning approach for an urban stream must focus on the relationship between the natural watershed systems (both groundwater and surface water) and the constructed systems related to land use that influence the hydrologic cycle, such as water supply, wastewater collection and treatment, and stormwater collection. A critical step in the planning process is to examine this relationship in all its complexity.

PWD's extensive physical, chemical and biological monitoring program is initiated for roughly one year in each watershed. A compendium document is produced following the analysis of all collected data; this document titled the Comprehensive Characterization Report (CCR) is shared with watershed partners for comments and feedback. These CCR documents are made available on PWD's Watershed Information Center website at www.PhillyWatersheds.org. The CCR assessment serves to document the watershed baseline prior to implementation of any plan recommendations, allowing for the measure of progress as implementation takes place upon completion of the plan.

Problem Identification and Development of Plan Objectives

Existing problems and issues of water quality, stream habitat, and streamflow related to the urbanization of the watershed can be identified through analyses of:

- Prior studies and assessments
- Existing data
- New field data
- Stakeholder input

Problems and issues identified through data analysis must be compared with those brought forward by stakeholders. An initial list of problems and issues then are transformed into a preliminary set of goals and objectives. These goals and objectives may reveal data gaps and may require additional data collection and analysis. Ultimately, with stakeholder collaboration, a final list of goals and objectives is established that reflects the conditions of the watershed. These goals and objectives are prioritized by the stakeholders based on the results of the data analysis.

Strategies, Policies and Approaches

Once a list of planning objectives is selected based on the sound scientific analysis and consensus among stakeholders, effective sets of management alternatives are developed to meet the agreed upon objectives. These alternatives are made up of a combination of implementation options that may include suggested municipal actions, recommendations on water supply and wastewater collection system improvements, potential measures to protect water quality from point sources, best management practices for stormwater control, measures to control sanitary sewer overflows, changes to land use and zoning, stream channel and stream bank restoration measures, etc.

An Integrated Watershed Management Plan will provide a list of implementation options that have been deemed appropriate for the given watershed area. Recommended implementation options these will be presented as a watershed-wide set of "guidelines" for implementation over the 20-year horizon. The City of Philadelphia will commit to implementing packages of these recommended options in the way of 4 sequential 5-year Implementation Plans for each watershed.

Wissahickon Watershed

A detailed hydrologic model has been developed for the Wissahickon watershed using EPA's Stormwater Management Model (SWMM). The outputs of this model can be found in the Wissahickon Creek Watershed Comprehensive Characterization Report (WCWCCR) online at http://www.phillywatersheds.org/what_were_doing/documents_and_data/watershed_plans_reports. Pollutant loads for all storm water outfalls in this watershed were estimated using NetSTORM (computer program for precipitation data assessment and rapid long-term urban runoff simulation), result of this model can be found in the **ADDITIONAL DOCUMENTS FOLDER ON THE SUPPLEMENTAL CD**.

Pennypack Watershed

The modeling of stormwater volumes within the Pennypack Creek watershed is currently at the data analysis stage. Cross-section data from the Pennypack Creek was collected in the summer and fall of 2007. Modeling was initiated in spring 2008 and results are presented in the Pennypack Creek Watershed Comprehensive Characterization Report (PCWCCR) and are available online at http://www.PhillyWatersheds.org. Pollutant loads for all storm water outfalls in this watershed were estimated using NetSTORM (computer program for precipitation data assessment and rapid long-term urban runoff simulation), result of this model can be found in the **ADDITIONAL DOCUMENTS FOLDER ON THE SUPPLEMENTAL CD**.

Poquessing Watershed

A loading analysis of the Poquessing Creek watershed was included as a part of the data collection and analysis process central to the development of the Poquessing Creek Comprehensive Characterization Report. Pollutant loads for all storm water outfalls in this watershed were estimated using NetSTORM (computer program for precipitation data assessment and rapid long-term urban runoff simulation), result of this model can be found in Poquessing Creek Comprehensive Characterization Report which will be included with the report and also will be available online at http://www.PhillyWatersheds.org.

F.2.Step 2.f. Pennypack, Poquessing, Wissahickon Watershed Plan Development - Problem Definition and Water Quality Goal Setting

<u>Problem Definition</u>

Wissahickon Creek Watershed

As described in the FY08 Annual Report, the extensive monitoring program initiated by PWD in the Wissahickon Creek Watershed between 2005 and 2006 culminated with the production of the WCWCCR, which highlighted a multitude of water quality related issues within the watershed drainage. As stated in the WCWCCR, "problems faced by the Wissahickon Creek Watershed stem from many sources; primarily, the creek suffers from physical disturbance due to urbanization and excess nutrient input from municipal wastewater treatment plants." These effects are evident in the comprehensive assessment of the aquatic habitat, biological communities and water chemistry documented in this report. Please review the entire report at the following address: http://www.PhillyWatersheds.org

At the completion of the data gathering and analysis process conducted for development of the WCWCCR, PWD began to assess additional data needs to better understand problems that exist in the Montgomery County portion of the watershed. Significant data gaps emerged necessary for understanding the needs specific to the upstream portion of the watershed, including flooding, inconsistencies in ordinances and water quality impairments. Additionally complicating the watershed-wide collaborative planning process is the status of the Wissahickon TMDL for nutrients – currently under review and potential revision. This made it difficult to bring the permitted dischargers on board with supporting the planning process as they still did not know what would be required of them in the future. It was beyond PWD's scope and available staff resources to develop comprehensive assessments of the Montgomery County specific issues, and without commitment from the upstream municipalities to assist in data collection and analysis and ultimately to implementation of recommendations, PWD was unable to commit to this undertaking.

PWD has elected to move forward with developing an implementation commitment to address the City's obligations related to the Wissahickon TMDL for Siltation. Over the coming years, many ongoing initiatives in the upstream portion of the watershed be completed, each of which producing data that could help to fill some of these data gaps in order to identify problems and their sources for this portion of the watershed. PWD will continue to convene the WWP over the coming years in hopes that as data gaps are filled, the WWP will take the lead in developing a complementary implementation approach for the upstream portion of the watershed.

Pennypack Creek Watershed

An extensive monitoring program was initiated by PWD in the Pennypack Creek Watershed between 2007 and 2008 which has culminated in the production of the Pennypack Creek Watershed Comprehensive Characterization Report PCWCCR (spring 2009). The PCWCCR highlighted a multitude of water quality related issues within the watershed drainage. As stated in the PCWCCR, "The watershed suffers from physical disturbance due to urbanization and excess nutrient input from municipal wastewater and stormwater runoff. These effects are evident in the comprehensive assessment of aquatic habitat, water quality, and biological communities documented in this report. Healthy aquatic ecosystems cannot thrive in physically unstable habitats or when streamflow is dominated by treated municipal wastewater that does not maintain healthy stream chemistry." This report forms a technical basis for the forthcoming Pennypack Creek Integrated Watershed Management Plan (PCIWMP), a plan for restoration and enhancement of the creek and its watershed. Please review the entire report at the following address: http://www.PhillyWatersheds.org

Poquessing Creek Watershed

An extensive monitoring program was initiated by PWD in the Poquessing Creek Watershed between 2008 and 2009 which has culminated in the production of the Poquessing Creek Watershed Comprehensive Characterization Report PCWCCR (Fall 2010). The PCWCCR highlighted a multitude of water quality related issues within the watershed drainage. As stated in the PCWCCR, "The watershed suffers from physical disturbance due to urbanization and stormwater runoff. These effects are evident in the comprehensive assessment of aquatic habitat, water quality, and biological communities documented in this report. Healthy aquatic ecosystems cannot thrive in physically unstable habitats or when streamflow is dominated by treated municipal wastewater that does not maintain healthy stream chemistry." This report forms a technical basis for the forthcoming Poquessing Creek Integrated Watershed Management Plan (PCIWMP), a plan for restoration and enhancement of the creek and its watershed. Please review the entire report at the following address: http://www.PhillyWatersheds.org.

Water Quality Goal Setting

Please refer the CSO portion of the Annual Report **SECTION III. C.1 – LAND: WET-WEATHER SOURCE CONTROL** on page 110 for information about water quality goal setting for the Pennypack, Poquessing, & Wisshickon Watersheds.

F.2.Step 2.g. Pennypack, Poquessing, Wissahickon Watershed Plan Development - Technology Evaluation

An integral component of developing the Watershed Management Plans is implementing appropriate stormwater management options in response to the key stormwater issues identified under Step 1 of the NPDES permit. The overall goal for mitigating stormwater is to improve the quality of runoff and decrease the quantity and rate of runoff as it reaches the receiving water bodies through the MS4. There are numerous approaches to achieving these stormwater runoff improvements. The City is responsible for ensuring that any technology that is implemented to address stormwater issues is also evaluated for its effectiveness. What has become increasingly evident over the past year is the contribution of private development in addressing stormwater runoff problems. A discussion of the programs, technology and approaches implemented to date are included specifically within this section and also as part of the Best Management Practices narrative located in **SECTION F.8** on **PAGE 299.**

PWD is committed to a balanced "land-water-infrastructure" approach to achieve its watershed management goals. This method includes infrastructure-based approaches where appropriate, but relies on a range of land-based stormwater management techniques and physical reconstruction of aquatic habitats where appropriate.

Below is a list of the land-based options (source controls) that are being considered for implementation and the associated category that each option is in.

- Flow reduction: Catch basin modifications
- Flow reduction: Sump pump disconnect
- Flow reduction: Catch basin and storm inlet maintenance
- Flow reduction: Illicit connection control
- Flow reduction: Roof leader disconnect program
- Flow reduction: Street storage (catch basin inlet control)
- Flow reduction: Offload groundwater pumpage
- Flow reduction: Stream diversion
- Flow reduction: Groundwater infiltration reduction
- Flow reduction: Reduction of contractual flow
- Low impact development/ re-development/retrofit: Require existing resources inventory, sketch plan, initial meeting
- Low impact development/ re-development/retrofit: Require integrated site design
- Low impact development/ re-development/retrofit: Require post-construction stormwater management
- Low impact development/ re-development/retrofit: Post-construction inspection and enforcement
- Low impact development/ re-development/retrofit: Demonstration Projects on Public Lands
- Low impact development/ re-development/retrofit: Large-Scale Implementation on Public Lands
- Low impact development/ re-development/retrofit: Street Trees and Street Greening
- Low impact development/ re-development/retrofit: Revise Stormwater Rate Structure
- Low impact development/ re-development/retrofit: Stormwater Management Incentives for Retrofit
- Public education: Water Efficiency
- Public education: Catch Basin Stenciling
- Public education: Community Cleanup and Volunteer Programs
- Public education: Pet Waste Education
- Public education: Public Notification and Signage

- Public education: Litter and Dumping Education
- Public education: School-Based Education
- Good housekeeping: Loading, Unloading, and Storage of Materials
- Good housekeeping: Spill Prevention and Response
- Good housekeeping: Street Sweeping Programs
- Good housekeeping: Vehicle & Equipment Management
- Good housekeeping: Private Scrapyard Inspection and Enforcement
- Good housekeeping: Employee training
- Good housekeeping: Record keeping and reporting
- Good housekeeping: Flow diversion and exposure minimization structures
- Good housekeeping: Responsible landscaping practices on public lands
- Good housekeeping: Responsible bridge and roadway maintenance
- Pollution prevention: Require industrial pretreatment
- Pollution prevention: On-lot disposal (septic system) management
- Pollution prevention: Household hazardous waste collection
- Pollution prevention: Oil/water separator/WQ inlets
- Pollution prevention: Industrial stormwater pollution prevention
- Pollution prevention: Litter and illegal dumping enforcement
- Pollution prevention: Require construction-phase stormwater/E&S controls

Many of the water-based options focus on improving aquatic habitats including water quality. Below is a list of the water-based options that are being considered for implementation and the associated category that each option is in.

- Instream: Dam modification/removal
- Instream: Daylight orphaned storm sewers
- Instream: Stream cleanup and maintenance
- Instream: Channel stabilization and habitat restoration
- Instream: Channel realignment and relocation
- Instream: Plunge pool removal
- Instream: Improvement of fish passage
- Instream: Instream aeration
- Instream: Sidestream aeration
- Riparian: Constructed wetlands along stream corridors

- Riparian: Wetland restoration along tidal rivers
- Riparian: Enhance stream corridor recreational and cultural resources
- Riparian: Wetland improvement
- Riparian: Invasive species management
- Riparian: Reforestation

Below is a list of the infrastructure-based options that are being considered for implementation and the associated category that each option is in.

- Nine Minimum Controls: Nine Minimum Controls
- Operation and Maintenance: Inspection and Cleaning of Combined Sewers
- Operation and Maintenance: Combined Sewer Rehabilitation
- Operation and Maintenance: Regulator/Pump Station Inspection/Maintenance/Repairs
- Operation and Maintenance: Outfall Maintenance Program
- Operation and Maintenance: House Lateral Repairs
- Sewer Separation: Permitted Discharge to Receiving Water for Waterfront Properties
- Sewer Separation: Separation of Sanitary Sewage and Stormwater on Development Sites
- Sewer Separation: Separate Street Runoff from Combined System
- Sewer Separation: Complete Separation into Sanitary and Storm Sewer Systems
- Sewer Separation: Permitted Discharge to Receiving Water for Waterfront Interstate Highways
- Outfall Consolidation/Elimination: Outfall and Regulator Consolidation
- Storage: Instream Storage Technologies
- Storage: In-Line Storage in Interceptor or Trunk Sewer
- Storage: Earthen Basins
- Storage: Offline Covered Storage Basins
- Storage: Offline Open Storage Basins
- Storage/Transmission: Deep Tunnels
- Storage/Transmission: Real Time Control
- Transmission: Parallel Interceptors
- Transmission: Remove Flow Bottlenecks
- Transmission: Diversion of Trunk Flow Directly to WPCP

- Treatment at Discharge Point: Vortex Separators
- Treatment at Discharge Point: Swirl Concentrators

Household Hazardous Waste Collections

During FY 2010, the City of Philadelphia held 7 Household Hazardous Waste Collection events, during which hazardous waste and computer material were collected and disposed of properly. These materials include oil, paint, and other toxic household substances. A summary of the collections over the last 7 fiscal years is provided below in **TABLE F.2.STEP 2.G-1**. More information on this program & other streets department programs including recycling and collection schedules are available to the public at http://www.philadelphiastreets.com/.

Table F.2.Step 2.g-1 Household Hazardous Waste Collection Statistics (FY 2004 - 2010)

HHW Program Collection Summary		# of Attendees	Quantity Accepted (lbs)		
			HHW	Computers	Total
FY 2004 Total		3,365	284,696	47,593	284,696
FY 2005 Total		3,740	280,722	30,793	315,255
FY 2006 Total		3,866	306,707	67,319	374,026
FY 2007 Total		3,358	240,198	59,660	299,858
FY 2008 Total		3,372	254,055	136,249	390,304
FY 2009 Total		3,711	250,903	237,270	488,173
FY 2010 Total		3,942	296,541	274,443	570,984
FY 2009 Collection Event Details		**# of Attendees**	**Quantity Accepted (lbs)**		
Location	**Date**		**HHW**	**Computers**	**Total**
State Road and Ashburner (Thurs.)	7/24/08	672	48,398	10,295	58,693
22nd & York	8/08/08	225	17,589	7,897	25,486
63rd Street	10/08/08	230	10,881	7,430	18,311
Delaware and Wheatsheaf	11/08/08	580	41,729	11,107	52,836
State Road and Ashburner (HHW)	4/18/09	962	69,267	11,980	81,247
1st Highway Yard 4800 Parkside Ave	5/23/09	317	22,803	7,499	30,302
Domino And Umbria	6/27/09	725	40,236	10,430	50,666
Computers at Drop-off Sites	Year-wide			170,632	170,632
Total		**3,711**	**250,903**	**237,270**	**488,173**
FY 2010 Collection Event Details		**# of Attendees**	**Quantity Accepted (lbs)**		
Location	**Date**		**HHW**	**Computers**	**Total**
State Road and Ashburner (Thurs.)	7/23/09	749	53,918	8,728	62,646
22nd & York	9/26/09	300	23,828	5,800	29,628
63rd Street	10/24/09	380	30,333	5,590	35,923
Delaware and Wheatsheaf	11/07/09	468	33,686	14,970	48,656
State Road and Ashburner (HHW)	4/24/10	869	62,577	12,810	75,387
1st Highway Yard 4800 Parkside Ave	5/22/10	350	32,740	10,245	42,985
Domino And Umbria	6/26/10	826	59,459	16,300	75,759
Computers at Drop-off Sites	Year-wide			200,000	200,000
Total		**3,942**	**296,541**	**274,443**	**570,984**

Infrared Analysis

In January 2010, a thermal imaging survey funded by PWD took place on the rivers and creeks throughout Philadelphia and the neighboring communities into which these waterways extend. The purpose of this survey was to quickly and efficiently locate potential sources of liquid contamination which would later be field-verified and addressed as necessary. A similar survey took place in 2004 and 2006.

The 2010 thermal imaging survey was completed on January 16th by Hot/Shot Infrared Inspections Inc. The survey covered the watersheds of Poquessing Creek, Pennypack Creek, Tookany/Tacony-Frankford Creek, Wissahickon Creek, Cobbs Creek, the Lower Schuylkill River, and the lower Delaware River for a total of 524 river miles. Aerial infrared photos, taken by helicopter, were analyzed to locate areas where thermal anomalies or hotspots exist. These thermal anomalies are indicative of potential liquid contamination of surface water and may be caused by leaking sewer lines, septic fields, storm sewers, unidentified surface or subsurface outfalls in the form of pipes or drains, or any other detectable source of liquid that may be of interest. The anomalies may also be natural sources of liquid discharge such as groundwater seeps.

The deliverables from the survey consisted of the raw IR video imagery, digital captures of the IR images of suspected anomalies, a Google Earth map showing the location of each anomaly, a text file of geo-coordinates and anomaly number for each anomaly noted on the maps, and a short report describing the conditions of the flight. This information allows field crews to easily locate and investigate the exact nature of each thermal anomaly so that appropriate decisions can be made regarding remediation of surface water contamination problems.

Additional maps were created showing each of the anomalies as well as the surrounding infrastructure in order to help find the source of the anomaly. 74 thermal anomalies were observed within Philadelphia and 354 were identified outside the City. PWD has investigated each anomaly within the City and corrective actions are being taken as necessary. PWD has also shared the results of this survey with the surrounding communities and municipalities in hopes of assisting them with their municipal stormwater permit obligations.

Floatables Controls

Please refer the CSO portion of the Annual Report **SECTION II.F – CONTROL OF SOLID AND FLOATABLE MATERIALS IN CSOS (NMC6) ON** page 35 for information about this topic.

F.2.Step 2.h. Pennypack, Poquessing, Wissahickon Watershed Plan Development - Economic Assessment and Funding Requirements

As watershed management plans are completed for the Wissahickon, Pennypack and Poquessing watersheds each report will include an assessment of implementation funding needs over the 20 year implementation horizon as well as the PWD implementation funding commitment for each watershed. The assessment will also detail funding requirements including identification of known and potential funding sources necessary for successful plan implementation. As watershed plans are completed, the funding commitments made by PWD will be detailed in subsequent annual reports.

PENNVEST

The City of Philadelphia was approved for a $30 million loan administered by PENNVEST (Pennsylvania Infrastructure Reinvestment Authority) in April 2009. These funds are dedicated to the implementation of innovative, green stormwater infrastructure projects throughout Philadelphia.

F.2.Step 2.i. Pennypack, Poquessing, Wissahickon Watershed Plan Development - Public involvement

Public involvement, including education and outreach, is detailed in **SECTION F.2.STEP 3 INTEGRATED STORMWATER MANAGEMENT PLANS** and **SECTION F.8L MISCELLANEOUS PROGRAMS AND ACTIVITIES.**

F.2.Step 3. Watershed Plan Implementation and Performance Monitoring: Permit issuance through expiration

F.2.Step 3. i Pennypack, Poquessing, Wissahickon - Watershed Plan Implementation and Performance Monitoring

Please refer the CSO portion of the Annual Report **SECTION III.C – WATERSHED – BASED MANAGEMENT** on page 109 for information about watershed plan implementation and performance monitoring.

F.2.Step 3.a. Pennypack, Poquessing, Wissahickon - Watershed Plan Implementation and Performance Monitoring - Dry Weather Water Quality and Aesthetics

F.2.Step 3.a.i. Operate the Defective Lateral Program

Over the last permit year, the City has continued to successfully operate its Defective Lateral Program. A detailed discussion of this program is provided within this report in **SECTION F.3 - DETECTION, INVESTIGATION, AND ABATEMENT OF ILLICIT CONNECTIONS AND IMPROPER DISPOSAL** on page 267.

F.2.Step 3.a.ii. Debris removal from waterways impacted by storm water discharges

Please refer the CSO portion of the Annual Report **SECTION II.F – CONTROL OF SOLID AND FLOATABLE MATERIALS** on page 35 for information about debris removal from waterways impacted by storm water discharges.

F.2.Step 3.a.iii. Lincoln Drive sewer relining

In the spring of 2003, the City conducted CCTV sewer exams of both the storm and sanitary systems under Lincoln Drive. Given the high vehicle volume on this major artery for the City, this was a very difficult and time-consuming effort as all exams had to be done during weekends. A leak from the sanitary interceptor under Lincoln Drive, in the vicinity of Johnson Street, into the storm system was detected. The CCTV examinations showed that the integrity of the sanitary sewer was generally in excellent condition except for one area where bricks appeared to be missing in the vicinity of where the infiltration into the storm system was noted.

The City decided to move forward with a lining contract to address this situation. The contract provided for the lining of 3,160 feet of 2'-6" brick interceptor sewer under Lincoln Drive from Washington Lane (Paper Street only) to Arbutus Street. This scope included the entire length of sanitary sewer that is not physically lower in depth than the storm sewer system. The contract was bid, awarded, and completed in Fiscal Year 2004.

F.2.Step 3.a.iv. Stormwater outfall dry weather flow inspections

The City maintains a stormwater outfall monitoring system in compliance with the MS4 permit issued by the Pennsylvania Department of Environmental Protection. All 434 of City's permitted stormwater outfalls are routinely inspected such that all outfalls are inspected at least once per permit cycle. Those with dry weather discharges are sampled for fecal coliform and fluoride analysis. The results of these samples are reported on a quarterly basis and summarized in this annual report.

Please reference **SECTION F.3 - DETECTION, INVESTIGATION, AND ABATEMENT OF ILLICIT CONNECTIONS AND IMPROPER DISPOSAL** on page 267 for a more detailed discussion of this subject.

F.2.Step 3.a.v. Defective Lateral Program priority outfalls sampling

Outfalls are prioritized for investigative work by the Defective Lateral and Abatement Program. In addition, outfalls identified as priority outfalls under the MS4 permit are sampled quarterly and summarized annually.

The City also investigates all potential reports of an illicit discharge from the stormwater system through either the Industrial Waste Unit or the Sewer Maintenance Unit.

Please reference **SECTION F.3 - DETECTION, INVESTIGATION, AND ABATEMENT OF ILLICIT CONNECTIONS AND IMPROPER DISPOSAL** on page 267 for a more detailed discussion of this subject

F.2.Step 3.a.vi. Priority Outfall Closure Testing

Investigation will continue within each particular outfall area (sewershed) until the City believes that the outfall area may be closed. Closure of the defective laterals effort in a certain outfall area shall be as provided in the "Framework for Screening, Finding, and Abating Stormwater Pollution." During FY10, no outfalls were removed from the priority area designation therefore no priority outfall closure testing was conducted.

Please reference **SECTION F.3 - DETECTION, INVESTIGATION, AND ABATEMENT OF ILLICIT CONNECTIONS AND IMPROPER DISPOSAL** on page 267 for a more detailed discussion of this subject.

F.2.Step 3.b. Healthy Living Resources

F.2.Step 3.b.i. Develop integrated storm water management plans

Please refer the CSO portion of the Annual Report **SECTION III.C.3.7** on page 161 for information about stormwater management plans.

F.2.Step 3.b.ii. Assess the benefits of implementing a Natural Stream Channel Design (NSCD)

Please refer the CSO portion of the Annual Report **SECTION III.C.2.3 – STREAM HABITAT RESTORATIION** on page 141 for information the Natural Stream Channel Design.

F.2.Step 3.b.iii. Assess the effectiveness of the NSCD restoration approach

As each of PWD's NSCD projects are constructed, PWD realizes the importance of extensive monitoring and O&M that accompanies such projects. It is very rare that such projects do not require additional "tweaking" or maintenance. In addition, each project provides the opportunity to learn about what techniques do and do not work in their respective hydrologic and hydraulic regimes. In order to assess the effectiveness of these NSCD projects, PWD will conduct post implementation monitoring at each site that will include the measurement of relevant biological, habitat, and physical parameters to be used in comparison to pre-construction conditions.

NSCD Physical Monitoring

The physical monitoring component of PWD's NSCD monitoring program will be modeled after those methods specifically described in River Assessment and Monitoring or RAM (Rosgen, 2008). The RAM manual provides the framework for a comprehensive monitoring protocol that allows for a replicable dataset to be created allowing for independent valuation of a project's performance over time.

Specifically, the method will include the following data collection efforts:

- Establishment & Survey of permanent cross-sections at riffles, runs, pools, and glides
- Survey of Longitudinal profile along the entire project reach
- Individual pebble counts at riffles, runs, pools, glides
- Bar Sample/Pavement-Sub Pavement sampling
- BEHI/NBS Assessment
- Establishment of and occupation of permanent photo points

This dataset will allow for further data analysis and the completion of an annual monitoring report that will include:

- Narrative Report
- Sketch Map
- Stream Classification
- River reach summary and dimensionless ratios
- Velocity computation form
- Cross-section data & graphs
- Longitudinal profile data and graph
- Pebble Count data and graph
- Stream Stability Indices
- BEHI & NBS worksheets and Stream Erosion Predictions
- Bar Sample data and graph
- Stream Sediment Competency Assessment
- Photos from established photo points

NSCD Biological/Habitat Monitoring

The Biological and Habitat monitoring component of PWD's NSCD monitoring program will be modeled after components of the PADEP Instream Comprehensive Evaluation (ICE) found in Appendix A of the 2006 PADEP Bureau of Water Standards and Facility Regulation Instream Comprehensive Evaluation Surveys. Specifically, PWD will perform qualitative habitat assessments and collect benthic macroinvertebrates according to the "wadeable freestone" and "riffle run" protocols (Appendices A, B, H, of the aforementioned document). Monitoring will be conducted in early spring at five year intervals following project construction. At sites that support native fish communities or propagation and passage of migratory fish, PWD will periodically sample fish populations and fish habitat at the discretion of the PA Fish and Boat Commission.

In addition to the benthic macroinvertebrate metrics described in PADEP 2006 Appendix H, PWD will collect benthic macroinvertebrates from regional reference sites representative of the best attainable biological condition in order to continue with the assessment methods and address indicators established in Integrated Watershed Management Plans. For more imformation on implemented NSCD, please refer the CSO portion of the Annual Report **SECTION III.C.2.3 – STREAM HABITAT RESTORATIION** on page 141 .

F.2.Step 3. c. Wet Weather Water Quality and Quantity

F.2.Step 3.c.i Implement various types of storm water BMP projects

Implement several BMP projects

PWD and it's partners implements several BMP projects throughout the City, for a full listing of both completed & current BMP projects, please refer to the CSO portion of the Annual report **SECTION III.C.1.3 – IMPLEMENTATION OF BMPS AND LID** on page 132.

In addition to the implementation of the NSCD projects discussed above, the City also understands the need to address wet weather water quality and quantity issues prior to the flow entering its rivers and streams. In such, the City has implemented various BMP projects in which PWD has partnered with groups in each watershed.

In addition to wet weather BMPs in 2003 PWD created the Waterways Restoration Team (WRT), which consists of crews devoted to removing trash and large debris (*e.g.*, cars, shopping carts and appliances) from the streams and tributaries within the City. The team also performs restoration work around PWD's storm and combined sewer outfalls, eliminating plunge pools and streambanks eroded around outfall headwalls. The team works in partnership with Fairmount Park staff and the various "Friends of the Parks" groups to maximize resources and the positive impacts to our communities. The team performs stream clean up work in the City's streams – Cobbs, Wissahickon, Tacony, Pennypack, and Poquessing Creeks, and their tributaries, in addition to the Manayunk Canal. Detail information on the status and description of the restoration and stabilization projects implemented by the WRT since their inception in 2003 can be found in the Combined Sewer Management section the report in **SECTION III C.2.2**. on page 36.

Monitor three demonstration BMPs

Saylor Grove Stormwater Treatment Wetland

In addition to implementing various types of BMP as described above, the City is interested in observing overall BMP performance by monitoring the efficacy of different kinds of BMPs. Thus far the operation of the Saylor Grove Wetland has been a success. The wetland was designed to treat a portion of the 70 million gallons of urban stormwater generated in the storm sewershed per year before it is discharged into the Monoshone Creek. During the FY 2009 reporting period, PWD resurveyed the Saylor Grove to determine the amount of sedimentation taking place within the facility. Approximately 22,000 cubic feet of material was accumulated within the facility over its first two and a half years of performance. In addition, some invasive species have colonized within the facility. During the FY 2010 reporting period, PWD dredged portions of the stormwater wetland, removing more than 150 tons of sediment. Invasive species management was also conducted in partnership with the Fairmount Park. PWD also continued water level monitoring in support of calibrating the H&H model for the facility. A complete monitoring report documenting PWD's monitoring at Saylor Grove can be found in **APPENDIX L-SAYLOR GROVE STORMWATER TREATMENT WETLAND.**

Marshall Road Stream Restoration

During the FY 2009 monitoring period, PWD implemented its full NSCD Physical/Biological/Habitat monitoring protocol to comprehensively assess the performance of this natural stream channel design project. This effort, conducted in June, 2009, is summarized in a comprehensive monitoring report which is available upon request. During FY 2010, annual monitoring was conducted. This included quarterly photo monitoring at designated photo points, as well as comprehensive physical monitoring of the restoration site, which was performed in April, 2010. During FY 2011, PWD will be updating the comprehensive monitoring report with the monitoring data collected during FY 2010 and will continue with the implementation of the Physical/Biological/Habitat monitoring protocol. The FY2010 Marshall Road Monitoring Report can be found in **APPENDIX M**.

Columbus Square Streetscape

PWD is currently monitoring the functionality of the stormwater planters at Columbus Square using several approaches. During construction of the planters, soil moisture probes were installed at various depths within the planter. These probes will allow PWD to determine the rate of saturation vertically through the planter to better predict storage volumes and overflow rates from planter systems. A pressure transducer will also be installed in observation well locations. This will allow PWD to monitor the rate at which the stone storage bed beneath the planters fills and empties. The pressure transducer and soil moisture probes will provide continuous data on actual storm events. However, hydrants will also be used to perform more controlled testing of the site. This monitoring is on-going. Additional data must be collected before final analysis can be performed.

Other BMPs

PWD has also worked with community and institutional partners on monitoring of two additional BMPs. The monitoring at these sites has been focused on the water quality provided by vegetated stormwater management systems. The sites include a rain garden and cistern installation at Liberty Lands Park, which is being monitored by the Northern Liberties Neighborhood Association (NLNA) and a rain garden located in a traffic triangle at 47th St. and Gray's Ferry Ave, which is being monitored by graduate students at Drexel University.

At Liberty Lands Park runoff from the adjacent street and sidewalk is diverted into a rain garden where water filters through the soil before it fills a 6,000 gal cistern that was installed by NLNA. Since the water is used to irrigate the park, there is some small potential for human contact. With this in mind, NLNA has had the water tested for certain contaminents such as heavy metals, total coliform and e. coli. The results of this testing are provided in **APPENDIX N – NLNA CISTERN WATER TESTING.**

A traffic triangle at 47th St and Gray's Ferry Ave was converted into a rain garden that treats runoff from the adjacent streets and sidewalks in 2007. In the summer of 2009, the site was used by graduate students at Drexel University to study the affects of concentrated infiltration on groundwater recharge quality. Water. In the Summer of 2009, samples were taken at the surface, at approximately 1 foot beneath the surface and at approximately 2 feet beneath the surface during storm events. Because of inadequate number storm events, this research is ongoing.

Work with Partners

Program Support (Planning, Outreach & Reporting) - Continue to Support Watershed Partnerships

Please refer the CSO portion of the Annual Report **SECTION III.C.1– ESTABLISHMENT OF WATERSHED STAKEHOLDER PARTNERSHIP** on page 110 for information working with partners.

F.3. DETECTION, INVESTIGATION, AND ABATEMENT OF ILLICIT CONNECTIONS AND IMPROPER DISPOSAL

The City of Philadelphia's Defective Lateral Detection and Abatement Program was developed under the City's initial Municipal Separate Storm Sewer System (MS4) permit signed in 1995 and further refined under a Consent Order & Agreement (COA), reached with the Pennsylvania Department of Environmental Protection (PADEP) on June 30, 1998. On March 18, 2004, the COA was officially terminated. However, the City has remained faithful to the terms of that agreement and many of the COA requirements have now been incorporated into the City's new MS4 permit. As in previous years, during FY 10, the results of dry weather outfall and subsystem sampling were used to evaluate priorities for the Defective Lateral Detection and Abatement Program. A copy of the Defective Lateral Group's Annual Report will be included as **APPENDIX O – FY2010 DEFECTIVE LATERALS ANNUAL REPORT.**

Staffing

As in prior years, the City maintains up to 4 crews dedicated to the identification and abatement of defective connections. Additional resources such as CCTV truck and crews are regularly assigned as needed to assist the program.

Funding

In addition to the staff resources dedicated to the identification and abatement of defective connections, the City funds abatement of owner-occupied, residential cross connections through the Cross Connection Repair Program. Funding for cross connection abatement and other customer assistance programs is budgeted at $2.5 million annually. During the reporting period, 41 abatements were completed under the program, at an average cost of $6,069, for a total cost of $280,970.

F.3.a. Prevention of Illicit Discharges

F.3.a.i. Sewer and Lateral Inspections

The City requires plumbing permits for connections to the municipal sewer system. The permit affords the property owner an inspection of the plumbing work performed. Corrections of defective connections are confirmed to ensure that the ultimate discharge to the receiving waters does not contain sanitary waste.

F.3.b. Investigation of Illicit Discharge Sources

F.3.b.i. Rank the MS4 outfalls according to their priority for corrective actions

The City maintains a stormwater outfall monitoring system in compliance with the MS4 permit issued by the Pennsylvania Department of Environmental Protection. All 434 of City's permitted stormwater outfalls are routinely inspected such that all outfalls are inspected at least once per permit cycle. Those with dry weather discharges are sampled for fecal coliform and fluoride analysis. Outfalls are prioritized for investigative work by the Defective Lateral and Abatement Program. In addition, outfalls identified as priority outfalls under the MS4 permit are sampled quarterly.

The City also investigates all potential reports of an illicit discharge from the stormwater system through either the Industrial Waste Unit or the Sewer Maintenance Unit. The City investigates and reports all discovered illicit discharges to receiving waters. During FY 10, the City investigated at least 15 reported sewage discharges.

In addition to programs above, the City also has initiated a monitoring and modeling effort within the separate sanitary sewer areas to target specific areas where infiltration and/or ex-filtration may be likely. In the summer of 1999, the City initiated a portable flow-monitoring program to augment monitoring data that was collected by an existing network of permanent monitoring sites at fixed locations. Under this program, fifteen (15) American Sigma 920 portable flow monitors were purchased. These monitors have multiple sensors that use a combination of pressure transducer and ultrasonic technologies for measuring depths and Acoustic-Doppler technology for velocity measurement. Additionally, a consultant, Camp Dresser & McKee, was chosen to assist the City in the startup of this program. Data from this program is routinely analyzed and compared to data provided from the City's extensive Stormwater Management Model (SWMM) hydraulic model.

One of the goals of the monitoring program was for the City's in-house instrument technicians to receive training and experience in the proper setup, use, maintenance, and trouble-shooting of flow monitoring equipment. Beginning with the third round of deployments in October 2000, the City's personnel began running this program completely in-house.

Another initiative started by the City is a very large undertaking to evaluate and enhance our existing sewer assessment program. The City awarded a contract for $5.7 Million over two years to the engineering firm of Hazen & Sawyer Environmental Engineers & Scientists to inspect approximately 200 miles of sewers in 9 pilot areas using CCTV equipment. Four of these areas (Manayunk, Rhawnhurst, Oak Lane, and Bustleton) are in separate storm and sewer system areas. Additionally, the consultant provided training to the City's in-house sewer inspection personnel on the standard NASSCO rating system. This consultant's work was completed FY 06 and the City is now running the entire program in-house.

F.3.b.ii. Investigate dry weather flow to identify sewer lateral defects

During FY 10 the Defective Connections Abatement staff, performed 3,585 tests. Of these tests, 3,580 were new connections tested and the remaining were revisited because of the need for additional testing. Of the confirmed connections, 59 (1.6 %) were found defective. The total cost for the 42 abatements performed in FY 10, both residential and commercial, was $280,970. Results of this fiscal year's program can be observed in **TABLE F.3.B.II-1**.

Table F.3.b.ii-1 Cross Connection Repair Program

Quarter	2009-3	2009-4	2010-1	2010-2	FY '10 Total
Date Coverage	Jul09-Sep09	Oct09-Dec09	Jan10-Mar10	Apr10-Jun10	
Completed Tests *	909	856	874	946	3585
Confirmed Connections	908	856	874	941	3580
Cross Connection Identified	16	14	10	19	58
% of Defective Connections	1.8%	1.6%	1.1%	2.0%	1.6%
Abatements **	28	15	10	9	47
Average # of days to abate	14	27	26.7	19.6	22.1

*Completed Tests includes revists of connections

**Cross connections abated my have been identified in the prior fiscal year

Outfall Investigations

During FY 10, 44 outfalls were inspected and 44 were sampled due to observed dry-weather flow under the Permit Inspection Program. In addition, 237 outfalls were inspected and 121 sampled due to observed dry-weather flow under the Priority Outfall quarterly sampling program during FY 10. These samples are used to evaluate priorities for the Defective Lateral Detection and Abatement Program. A summary table of the progress of the Defective Lateral Detection and Abatement Program from FY 05-FY 10 as well as a synopsis of the work in the priority areas is provided below.

Table F.3.bii-2 Summary of Defective Lateral Detection and Abatement Program FY 2005-FY 2010

	# Cross Connections Abated		Total Cost of Abatements
	Residential	Commercial	
FY 2005	48	5	$169,955
FY 2006	66	3	$333,094
FY 2007	78	0	$388,844
FY 2008	45	8	$ 187,539
FY 2009	88	13	$395,249
FY 2010	42	5	$280,970
Total	367	34	$ 1,755,651

In the past four reporting periods, PWD has abated 367 cross connections at a cost of $1,755,651.

T-088-01 (7th & Cheltenham Avenue)

In this priority outfall area, as of June 30, 2010, 2,829 properties have had complete tests as defined by the MS4 permit. Of these properties, 132 (4.7%) have been found to have defective laterals and all but one have been abated.

Additionally, at the end of Fiscal Year 2002, six (6) dry weather diversion devices were installed to intercept contaminated flow within the storm system from five identified areas and redirect the flow into the sanitary system. These devises are inspected regularly by the City's Collector System Flow Control Unit. Two (2) additional dry weather diversion devices were installed in July 2010. The locations of these devices, the number of inspections, blockages, and discharges found in FY 10 are listed below:

Table F.3.b.ii-3 Dry Weather Diversion Device Installation Locations

Location	ID#	Inspections	Blockages	Discharges
Plymouth Street, West of Pittville Ave.	CFD-01	44	10	0
Pittville Avenue, South of Plymouth St.	CFD-02	47	13	0
Elston Street, West of Bouvier Street	CFD-03	45	4	0
Ashley Street, West of Bouvier Street	CFD-04	41	3	0
Cheltenham Ave, East of N. 19 Street	CFD-05	41	3	0
Verbena Street, South of Cheltenham Ave.	CFD-06	40	0	0
IFO 600 W Cheltenham Ave.*	CFD-07	N/A	N/A	N/A
IFO 6819 N 07th Street*	CFD-08	N/A	N/A	N/A

* CFD-07 & CFD-08 were installed in July 2010 and thus have no data for FY10.

Fecal coliform sampling at this outfall continues quarterly. Results for the outfall samples are listed below:

Table F.3.b.ii-4 T-088-01 Quarterly Fecal Coliform Sampling

Date	Outfall (Fecal Colonies per 100 ml)
9/21/09	77,000
12/29/09	1,000
3/25/10	480
6/3/10	12,300

As part of the City's efforts to improve conditions at this outfall, stream embankment repairs and elimination of the pooling area on the outfall apron were proposed. Design work for these improvements was completed and the project was bid in Fiscal Year 2003. Construction was completed in Fiscal Year 2005.

W-060-01 (Monastery Avenue)

In this priority outfall area, as of June 30, 2010, 611 properties have had complete tests as defined by the MS4 permit. Of these properties, 16 (2.6%) have been found to have defective laterals. All 16 have been abated.

Additionally, two (2) dry weather diversion devices were installed to intercept contaminated flow within the storm system and redirect the flow into the sanitary system. These devises are inspected regularly by the City's Collector System Flow Control Unit. The locations of these devices and the number of inspections, blockages, and discharges in FY 10 are listed below:

Table F.3.b.ii-5 W-06-01 Inspections

Location	ID#	Inspections	Blockages	Discharges
Jannette Street, West of Monastery Ave.	MFD-01	40	2	0
Green Lane, North of Lawnton Street	MFD-02	40	1	0

Fecal coliform sampling at this outfall continues quarterly. Results for the outfall samples are listed below:

Table F.3.b.ii-6 W-06-01 Quarterly Fecal Coliform Sampling

Date	Outfall (Fecal Colonies per 100 ml)
9/21/09	23,000
12/29/09	50
3/25/10	90
6/3/10	700

Monoshone Creek Outfalls

Of the seven stormwater outfalls that discharge to the Monoshone Creek, the focus of the City's efforts is primarily just one outfall, W-068-05. This outfall is the largest in the watershed and essentially constitutes the headwaters of the creek since the historic creek has been encapsulated into this storm system and daylights at this outfall. This outfall is also the source of the majority of the fecal contamination in the creek. For this priority outfall, as of June 30, 2009, 2,742 properties have had complete tests as defined by the MS4 permit. Of these properties, 92 (3.4%) have been found to have defective laterals and all have been abated.

The City was also concerned about the erosion that had been occurring to the channelized section of Monoshone Creek at the W-068-05 outfall. The erosion had created a large pool at the outfall that the City believed exasperated the nuisance odors experienced and created an unsafe condition for small children that might wade in the creek. After discussion with the local community group, the Friends of the Monoshone, the City decided to make repairs to the channelized section to remove the pool and shore up the retaining walls. This work was designed as part of the sewer-lining contract above and performed at the same time.

Since that time, periodic follow up examinations of the storm system during dry weather periods have been conducted by the Industrial Waste Unit in attempts to locate additional isolated areas where fecal contamination may be occurring.

Additionally, the City of Philadelphia completed construction of a 1-acre stormwater treatment wetland this past year at outfall W-060-10. This wetland treats the dry weather flow fed by springs in this outfall as well as the wet weather runoff from the outfall's 156-acre drainage area. During and following the construction of this wetland, the City has been continuing to investigate dry weather contaminations within this outfall area.

Fecal coliform sampling at these outfalls continues quarterly. A listing of the results for the W-068-05 outfall samples in FY 10 are listed below:

Table F.3.b.ii-7 W-068-05 Quarterly Fecal Coliform Sampling

Date	Outfall (Fecal Colonies per 100 ml)
9/21/09	1,100
12/29/09	200
3/25/10	4,100
6/03/10	>200,000

Monoshone Study

In FY 2006, PWD conducted and completed an analysis of the 82 defective lateral abatements and sewer relining work performed in the sewershed of outfall W-068-04/05 which discharges to the Monoshone Creek in the Wissahickon Creek watershed. The purpose of this analysis was to determine the water quality improvements achieved as a result of this work and to compare this improvement with the additional water quality benefits anticipated from the Saylor Grove Stormwater Wetland BMP, also located in the Monoshone. Significant reductions were achieved in fecal coliform concentrations and loadings in outfall W-068-04/05 as a result of defective lateral abatements, sewer relining, and the Saylor Grove Stormwater Wetland BMP. The entire Monoshone Creek Study can be found in **ADDITIONAL DOCUMENTS FOLDER ON THE SUPPLEMENTAL CD**.

Additionally in May of 2009, PWD began publishing a quarterly water quality update for the Monoshone Watershed to share to the public and local environmental or local environmental organizations such as the Senior Environment Corps (SEC) and Chestnut Hill College (CHC). To date PWD has issued 4 Monoshone Watershed - Quarterly Water Quality Updates, copies of reports will be included in **APPENDIX P**.

End of Pipe Anti-microbial Pilot Study

In FY 2006, PWD purchased anti-microbial filtration fabric for installation in Monoshone Creek outfall W-068-05 to evaluate the effectiveness of this technology in reducing fecal coliform contributions to the Monoshone Creek from outfalls with defective laterals. The filtration fabric is surface bonded with an anti-microbial agent which kills bacteria upon contact. PWD completed an initial installation of a limited quantity of this product at the end of outfall W-068-05 in FY 2006 and collected water quality samples of the dry weather outfall flow upstream and downstream of the filtration fabric to assess product performance. The initial deployment failed to demonstrate product effectiveness in reducing fecal coliform and E. coli concentrations as was anticipated. After consulting with the manufacturer, it was decided that due the high volume of water consistently present in this outfall, more of this product should be utilized than was initially deployed. In FY 2007, more filtration fabric was deployed using a new configuration recommended by the manufacturer and sampling resumed. Final sampling and evaluation of this product will be completed in FY 2008.

Following sampling conducted in FY 08, PWD has decided to discontinue the pilot study of anti-microbial fabric. Sampling conducted during FY 07 and FY 08 did not identify a reduction in fecal coliform and E. coli concentrations at W-068-05 due to the anti-microbial properties of the filtration fabric. Upon review of the data and consultation with the manufacturer, the technology was determined to be unsuitable for the intended use at W-068-05.

Manayunk Canal Outfalls

Of the 13 stormwater outfalls that discharge into the Manayunk Canal, the City is focusing on 7 that have recorded dry weather flow with some amount of fecal contamination. These outfalls and the results of fecal sampling are listed below:

Table F.3.b.ii-8 Manayunk Canal Outfall Fecal Sampling Results

Outfall	Outfall Fecal Colonies per 100 mL			
	8/21/09	12/28/09	3/10/10	6/16/10
S-058-01	2,100	<100	10	1,000
S-059-01	3,60	<100	945	2,000
S-059-02	23,000	49,000	5,900	42,000
S-059-03	1,800	6,600	145	31,000
S-059-04	730	15,000	9,600	>200,000
S-059-05	180	1,800	100	8,500
S-059-09	900	<100	10	600

In these 7 outfalls, as of June 30, 2009, 2,444 properties have had complete tests as defined by the MS4 permit. Of these properties, 59 have been found to have defective laterals and subsequently abated.

P-090-02 (Sandy Run)

The City has previously installed a dry weather diversion device to intercept contaminated flow within the storm system and redirect the flow into the sanitary system. This devise is inspected regularly by the City's Collector System Flow Control Unit and continues to function properly. The number of inspections in Fiscal Year 2010 was 35. There were 2 blockage and 0 discharges reported in conjunction with these inspections.

<u>SAP Request</u>

In FY 2010, the PWD Sewer Maintenance Unit received 55 requests for a SAP, all 55 SAP were completed. Please refer to **SECTION II.A.2 "IMPLEMENT A COMPREHENSIVE SEWER ASSESSMENT PROGRAM (SAP)"** on page 15 for more information on this program.

F.3.b.iii. Update the SOP for illicit connections detection and identification is updated as necessary

The Standard Operating Procedure/Methods (SOP) for illicit connection detection and identification required no updates during FY2010.

F.3.c. Definitions used in this section

F.3.d. Abatements

F.3.d.i. Written notice about sewer lateral defects

Cross connections that are identified by the investigation program described above are referred to the City's Plumbing Repair Programs (PRP) unit for abatement. The PRP unit handles all correspondence and communications with the property owner.

F.3.d.ii. Residential Properties Cross Connections abatement

<u>Abatement of Residential Cross Connections</u>

The City maintains a Defective Lateral and Abatement Program in compliance with the MS4 permit issued by the Pennsylvania Department of Environmental Protection. The City requires abatement of all residential defective connections upon discovery. An annual funding allotment of $2.5 Million is available through customer assistance programs in the form of City-funded cross connection abatements and HELP loans. Information on the assistance programs accompanies the homeowner's notification of defect. The City also publicizes the assistance programs through bill stuffers to ratepayers, and through public education events. The City also maintains the legal authority to take administrative action to cease the pollution condition. During the FY 10 reporting period, the City funded abatement of 42 residential cross connections at an average cost of $4,479.99, for a total cost of $394,239.30.

F.3.d.iii. Commercial and industrial properties Cross Connections abatement

<u>Abatement of Commercial and Industrial Cross Connections</u>

The City maintains a Defective Lateral and Abatement Program in compliance with the MS4 permit issued by the Pennsylvania Department of Environmental Protection. The City requires prompt abatement of all commercial and industrial defective connections upon discovery, and maintains the legal authority to take administrative action to cease the pollution condition. During the FY 10 reporting period, the City funded abatement of 5 commercial cross connections at an average cost of $79.69, for a total cost of 1,010.00.

F.3.d.iv. Residential Properties Cross Connections abatement schedule

When the City goes out to a property to perform a dye test, in which a cross connection result is found, this information (location, date, and site description) will be entered into an electronic database which will generate reports and letters to notify the property owner, Notice of Defect. If the defect is an external connection (internal connection must repaired at the property owner's expense and inspected within the 120 days of notice) then the Plumbing repair unit will be notified within a week of Notice of Defect and will schedule the property for repair. The electronic database is used to keep track of the case specification, the cost for the repair, who and when the repair was done to ensure that all defects are abated within the 120 day timeframe.

F.3.d.v. Cross Connections abatement confirmation testing

Following a completed cross connection abatement, a subsequent test must be performed in order to confirm that that cross connection has been properly mitigated. If the abatement is conducted by PWD personnel, the confirmation dye test is normally performed by an experienced PWD inspector immediately following abatement completion (that same day). If the abatement is conducted by a private company, property owner must contact PWD after abatement was performed such that a PWD inspector can perform confirmation testing.

F.3.e. Defective Connection Program Reporting

F.3.e.i. Illicit connection program quarterly report

Results of the Defective Lateral Connection Program are submitted four times a year to Andrew Sinclair at the Pennsylvania Department of Environmental Protection (PADEP) as part of the reporting requirements of the City of Philadelphia NPDES Storm Water Management Permit No. PA 0054712. The report covers three-month periods staring in January, April, July, and October which are submitted no later than 45 days from the end of the reporting period. The Quarterly reports were submitted as required during FY2010, **APPENDIX Q** contains all these reports.

F.3.e.ii. Illicit connection program quarterly report contents

The following information is included in the quarterly report: Details of significant work performed during the previous quarter on all MS4 outfalls, including the following: Summary information about source investigation efforts through dye testing, inspections, field screening, etc. This should include a numerical summary of properties determined to be properly connected, and properties with defects, as determined during the reporting period. The outfall areas in which work was conducted during the reporting period should be identified; Summary information, including a numerical summary of source corrections (abatements) achieved through homeowner notification, enforcement, or City sponsored construction; For those outfalls (sewersheds) that have been identified as "priority" outfalls, include a progress assessment and other comments as appropriate; Results of all outfall sampling and inspections performed during the reporting period; A summary of all sewer chokes, or other problems not related to defective laterals, that resulted in the discharge of sanitary sewage directly or indirectly to a stream; A discussion of the City's goals for the upcoming quarter.

F.4. Monitor and Control Pollutants from Industrial Sources

F.4.a. Applications/Permits

The City obtains NPDES permits/discharge information from industries if they contribute significant amounts stormwater into the City's sewer system. Industries that contribute stormwater directly into a waterway or discharge non-industrial waste into the system usually coordinate directly with the Department. A list of NPDES permits that involve stormwater associated with industrial activities in the City were obtained from the Department's website and are listed in **APPENDIX I – NPDES PERMITTED DISCHARGERS**.

F.4.b. Inspections

F.4.b.i. Industrial inspections

The Philadelphia Local Emergency Planning Committee (PLEPC) is the entity tasked with meeting the responsibilities of SARA Title III. Under PLEPC, the Fire Department representative is the individual that carries out the inspections. IWU regulates about 150 "Significant" Industrial Users that discharge to the sanitary system.

F.4.b.ii. Update industrial waste inspection forms

The City has updated its Industrial Waste Inspection Forms used during inspections which take place during enforcement activities as part of its Pretreatment program. The updated form was faxed to Jennifer Fields, Regional Manager, PADEP on March 29th, 2006. A copy of the Industrial Waste Inspection Forms was submitted in FY2009 CSO/SW Annual Report but can also be found in Additional Documents folder in the **SUPPLEMENTAL CD**.

F.4.c. Monitoring/Enforcement

F.4.c.i. Industrial DMR submission

When necessary, the City shall request DMRs or additional sampling from the Department for surrounding industries to ensure compliance with NPDES effluent limitations.

F.4.c.ii. NPDES permits enforcement

Should City personnel observe a violation of NPDES permit terms and conditions, the City will report the violation immediately and notify the interested and downstream parties, including the Department.

F.5. MONITOR AND CONTROL STORM WATER FROM CONSTRUCTION ACTIVITIES

As a result of extensive efforts throughout Pennsylvania to improve and protect overall watershed health the relative condition of streams and rivers has been investigated and classified. Each stream has been identified by the State as whether or not it is attaining its designated use as a swimmable, fishable waterbody. Furthermore, those streams listed as not attaining their designated use were assessed as to which primary pollutants were attributed to the impairments. The majority of stream miles throughout Philadelphia are listed as impaired due to urban runoff. Uncontrolled and untreated urban runoff presents an ongoing negative impact to the receiving streams as a result of increased impervious areas providing a greater rate and volume of runoff reaching the surface waters through the municipal separate storm sewer system.

PWD and watershed partners located within the Darby-Cobbs Creek watershed collaborated under the Act 167 Watershed Management Planning effort led by Delaware County Planning Commission and developed a comprehensive document inclusive of a stormwater Ordinance. The stormwater Ordinance expanded upon the State model Ordinance by addressing issues identified with respect to the Watershed. PWD committed to enacting the Darby-Cobbs Creek Watershed Management Plan by signing a resolution in August, 2005 followed by adoption of the Stormwater Regulations that became effective as of January 1st 2006. A copy of the resolution along with excerpts of Ordinance and Regulation language were delivered to the State in compliance with the NPDES permit on December 23rd, 2006.

Stormwater runoff is a concern both during construction and after construction. Active construction sites are the primary contributor of sediment to our waterways. The role of PWD in the plan review process has provided vastly improved oversight of site controls during earth disturbance activities and will assist in improving water quality. Additionally, post-construction stormwater management plan review now extends beyond peak rate control and encompasses water quality and water quantity technical requirements for more frequent storm events. Efforts continue to be focused on improving plan review for both E & S as well as post-construction stormwater management. The following discussion documents the progress made so far in terms of stormwater runoff from construction activities including the collaboration between City Departments as well as between the City and State agencies.

During Fiscal Year 2010 PWD performed numerous tasks in direct compliance with the NPDES Permit as well as tasks supporting continuance and improvement of a growing stormwater management program and watershed program. Some of the Fiscal Year 2010 activities include the following:

- Enforced stormwater Regulations that are in compliance with the State Model Stormwater Ordinance
- Collaborated with multiple city departments to reduce barriers to low impact development

- Increased the erosion and sedimentation control inspection program
- Reviewed Stormwater Management Plans (E & S and post-construction stormwater management) for compliance with the Regulations
- Coordinated reviews with PADEP on NPDES permit applications
- Held weekly open walk-in meetings which provide the development community with an opportunity to discuss stormwater management designs and ask stormwater policy questions, among other items.
- Updated Fact sheets and pamphlets on topics related to the changes in stormwater policies.
- Maintained and improved a website for receiving PWD project submittals online

The following discussion specifically documents progress made so far in terms of stormwater runoff from construction activities including the collaborative between City Departments as well as between the City and State agencies. A summary of all plan review activities in FY 2010 is presented in **TABLE F.5-1** at the conclusion of this section

Table F.5-1 Summary of Plan Review Activities throughout FY 2010

	Jul. '09	Aug. '09	Sep. '09	Oct. '09	Nov. '09	Dec. '09	Jan. '10	Feb. '10	Mar. '10	Apr. '10	May. '10	Jun. '10	FY 10 Total
Conceptual Review Stage													
Approvals	9	11	11	11	5	11	8	6	9	5	11	4	101
Rejections	30	29	33	29	24	26	22	23	33	25	23	26	323
Reviews	39	40	44	40	29	37	30	29	42	30	34	30	424
New Project Submittals	24	24	14	22	11	17	15	16	13	17	17	16	206
Average Review Time (days)	2.5	2.6	5.7	2.5	3.2	2.5	2.5	3.8	2.4	3.2	3.2	3.4	3.1
Post Construction Stormwater Management Plan Review Stage													
Administrative Screenings	7	13	3	5	16	11	11	16	6	8	4	7	107
Technical Approvals Issued	9	5	7	9	5	4	9	3	3	8	6	9	77
Rejections	32	34	25	22	18	16	27	22	20	32	26	16	290
Full Technical Reviews	43	42	33	33	27	21	36	25	25	42	32	25	384
New Project Submittals Received	6	7	3	4	8	7	7	11	5	7	4	3	72
Average Number of Reviews per Approval	3.9	4.2	5.6	4.9	5.0	4.8	4.0	3.7	3.7	3.8	4.5	4.4	4.4
Average Approval Time (days)	117	121	303	136	303	95	81	82	51	98	105	112	136
Acres of Earth Disturbance Approved	13.6	24.9	34.6	25.7	6.2	4.7	10.0	12.9	8.9	70.5	45.1	19.4	276.5
Acres of Green Roofs Approved	0.1	1.0	0.2	0.7	0.0	0.4	1.0	0.1	0.0	0.2	0.3	0.1	4.0
Acres of Porous Pavement Approved	0.7	0.0	0.6	0.8	0.0	0.2	1.0	0.6	0.0	0.0	0.2	0.3	4.4
Erosion and Sedimentation Inspections													
New Sites Inspected	4	5	1	9	4	5	8	2	5	7	5	5	60
Complaint Inspections	1	1	0	0	1	0	0	0	1	1	1	0	6
Total Inspections	128	84	93	114	97	87	127	28	74	59	48	46	985
Inspections at Project Sites with MS4 Sewers	50	28	33	41	30	31	36	3	13	8	10	11	294
Inspections at Project Sites with Combined Sewer	53	41	43	45	44	41	59	22	49	41	29	26	493
DEP Reviews													
New Coordinated Reviews	9	9	5	3	4	7	5	16	2	5	8	4	77
Erosion and Sedimentation Plan Review													
Defer to DEP	2	4	3	1	2	1	1	2	4	2	3	1	26
Approved	5	2	2	3	3	4	5	0	1	2	3	3	33
Rejected	4	10	5	6	7	5	7	3	6	11	4	5	73
Not Applicable	3	4	12	9	3	8	4	1	12	7	4	6	73

Please note: In FY10, PWD changed the Technical Screening to more of an administrative check to better mirror the DEP's administrative check. PWD Screenings are no longer included in the Technical Review count.

F.5.a. Construction Site Runoff Control

PWD reviews Erosion and Sedimentation (E&S) Plans for sites disturbing between 15,000 square feet and one acre of earth while following policies and practices as provided within the PADEP E&S Control Manual. As a result of plan review and coordination with the State, scheduled site inspections as well as timely responses to active construction site complaints have continued as part of the stormwater management program during FY 2010.

During each site visit the inspector communicates with the construction manager and requests to see a copy of the on-site E&S Plan. Photographs are taken documenting site conditions and included as part of the inspection report. The City inspection report form is adapted directly from the PADEP form. Copies of the inspection report detailing out-of-compliance items are distributed to the site manager and maintained as part of an electronic project file. Failure to adhere to the recommendations of the inspection reports can result in a 7 Day Notice and ultimately a Stop Work Order. A 7 Day Notice gives the construction manager seven days to correct an E&S problem on site. If the problem is not correct in seven days, PWD will issue a Stop Work Order which forces all construction activities to cease until the E&S problem has been corrected.

E&S Inspections were conducted as part of an established inspection regimen and as scheduled meetings, meeting follow-ups, responses to complaints and coordinated visits with the PADEP designated engineer. Based upon the FY 2010 inspections, the major compliance issues continue to include improper use of silt fences, inadequate or lack of inlet protection, contractor not following the on site E&S Plan and a complete absence of E&S controls. The sites visited cover all of Philadelphia including both separate storm sewer areas and combined sewer areas as depicted in **FIGURE F.5.A-1**.

As the E&S Control program moves forward, scheduled inspections and responses to complaints will be addressed separately. Plan reviews will continue for projects between 15,000 square feet and one acre of earth disturbance. Coordinated site visits between PWD and PADEP will continue throughout the permit cycle as needed and documented accordingly.

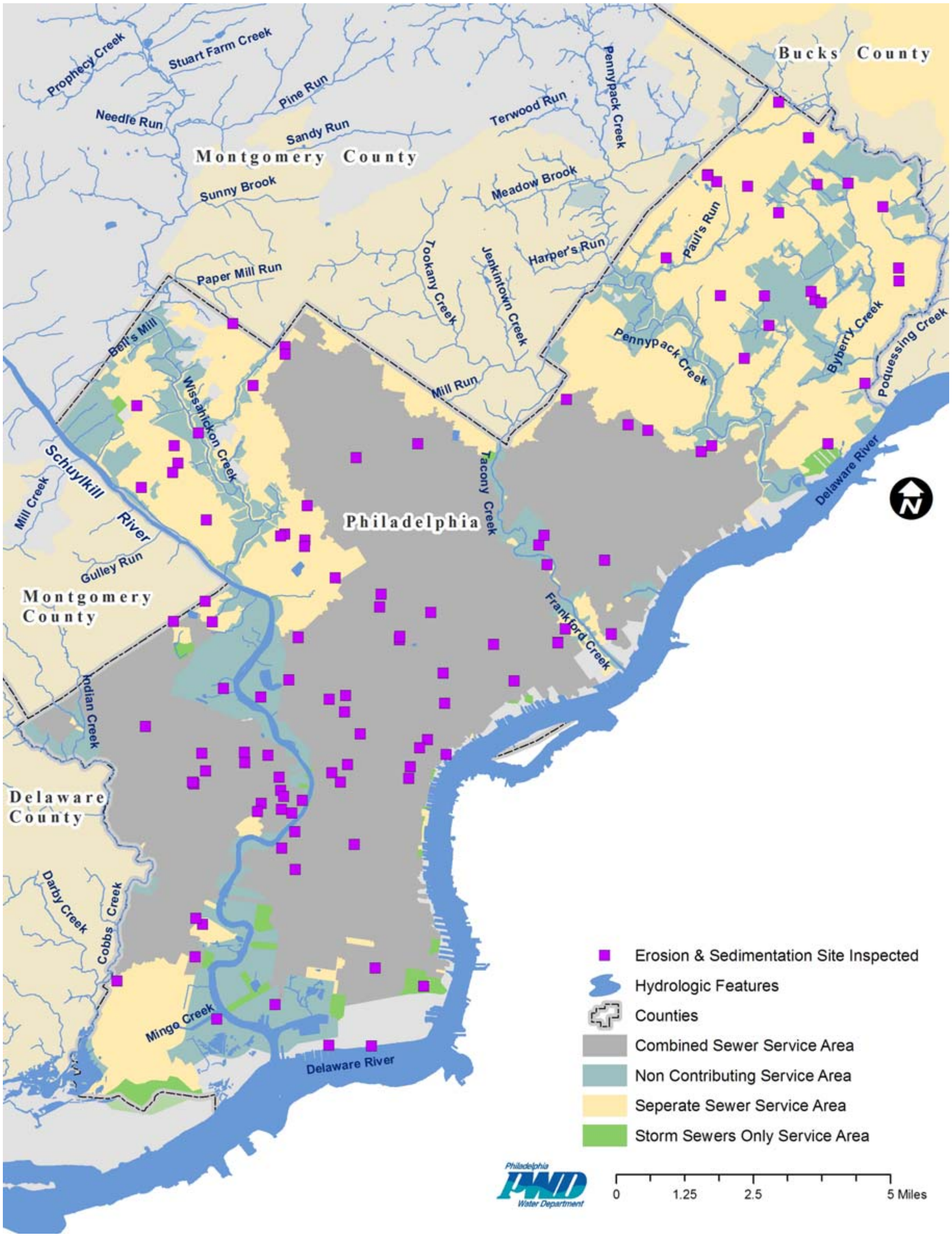


Figure F.5.a-1 Erosion and Sedimentation Site Inspections

F.5.b. Post-Construction Stormwater Management in New Development and Redevelopment

The adoption of City wide Stormwater Regulations as of January 1st 2006 enabled Philadelphia to review plans for both new and redevelopment sites ensuring that water quality and quantity are part of the management plan. The Regulations focus on the Post-Construction Stormwater Management Plan (PCSMP), which addresses more than the typical peak rate controls previously required. The role of stormwater management has been expanded to address smaller more frequent storms in terms of water quality volume and channel protection for all development projects throughout the City. The Philadelphia Stormwater Regulations are available online at http://www.phila.gov/water/pdfs/pwd_regulations6.pdf.

The Stormwater Regulations have been enacted to address the following technical components:

Water quality: The 1st inch of precipitation over directly connected impervious cover must be recharged. Where recharge is not feasible or limited then any remaining volume is required to be subjected to an acceptable water quality practice.

Channel Protection: The 1-year, 24-hour storm must be detained and slowly released over a minimum of 24-hours and maximum of 72-hours.

Flood Control: Watersheds that have been part of an Act 167 planning effort are to follow the model results for flood management districts. In Philadelphia, Darby and Cobbs creeks watershed are subject to specified management districts. Projects outside of Darby-Cobbs watershed are currently treated as either a district controlling post-development peaks to pre-development peaks or are considered appropriate for direct discharge.

Non-structural Site Design: Projects are required to maximize the site potential for stormwater management through appropriate placement and integration of stormwater management practices.

In addition to the technical criteria, stormwater management requirements are clearly identified as applying to both new development and redevelopment projects. PWD in collaboration with other City departments recognized the need to appropriately insert PWD into the development process in order to inform the development community of the stormwater requirements before extensive investment into the design has been expended. Under this premise PWD divided the Stormwater Plan review into two components: the first being a conceptual review tied to the zoning permit; the second being the full technical plan review requiring approval prior to the building permit.

Any project exceeding one acre of earth disturbance is required to obtain a PADEP NPDES General Permit for control of stormwater runoff during construction activities. The City may not release the building permit until the NPDES permit has been issued. As a result, a large collaborative effort has been initiated between PWD and PADEP in coordinating plan reviews between departments.

Implementation of the Stormwater Regulations will continue to improve stormwater quality and quantity impacts as redevelopment and development continues across the

City. PWD is tracking the stormwater management practices implemented by private development to address the regulations. Of particular interest are green approaches that encourage the return of rainfall back to the hydrologic cycle through evapotranspiration or distributed infiltration. As of Fiscal Year 2010 Annual Report, PWD's records indicate that projects are proposing use of pervious paving for a total of 27.2 acres and installation of green roofs at a total of 14.7 acres. As PWD works on improving the plan review process to provide greater incentives for incorporating green approaches for managing stormwater the number of green roofs and area of porous paving will see great increases throughout the permit cycle.

Quantifying the impact of the Regulations in terms of total acres developed, area removed from contributing to the combined sewer system, volume of water quality managed, volume of stormwater infiltrated, increase in management approaches (i.e. structural basins, green roofs, porous paving, rain gardens) will be incorporated into reports in upcoming years.

F.5.c. Applications/Permits

Conceptual plans are submitted online and must receive approval prior to obtaining a Zoning permit from Licenses and Inspections. The conceptual plan review phase enables PWD to clearly inform the applicant of stormwater management requirements applicable to their specific project. During FY 2010, 206 unique projects were submitted to PWD for conceptual review through the program's website.

Once conceptual approval has been received then the project can submit a full technical plan set addressing the stormwater regulations and other City plan requirements. PWD approved 77 full technical plans during FY 2010. It should be noted that this number does not include plans re-submitted for review, some of them multiple times. The distribution of development projects that submitted post-construction stormwater management plans for review is presented in **FIGURE F.5.C-1, TABLE F.5.C-1 & 2.**

Since the beginning of the year there have been 77 coordinated permit applications submitted to PADEP that are undergoing a joint stormwater management review as shown in **TABLE F.5-1**.

Table F.5.c-1 Approved Stormwater Plan Location Summary by Contributing Area

Drainage Type	Number of Locations
Combined Sewer Area	45
Non-Contributing Area	14
Separate Sewer Area	16
Storm Only Area	2
Total	77

Table F.5.c-2 Approved Stormwater Plan Location Summary by Watershed

Drainage Watershed	Number of Locations
Cobbs Creek	2
Delaware River	25
Poquessing Creek	6
Pennypack Creek	7
Schuylkill River	26
Tacony/Frankford Creek	4
Wissahickon Creek	7
Total	77

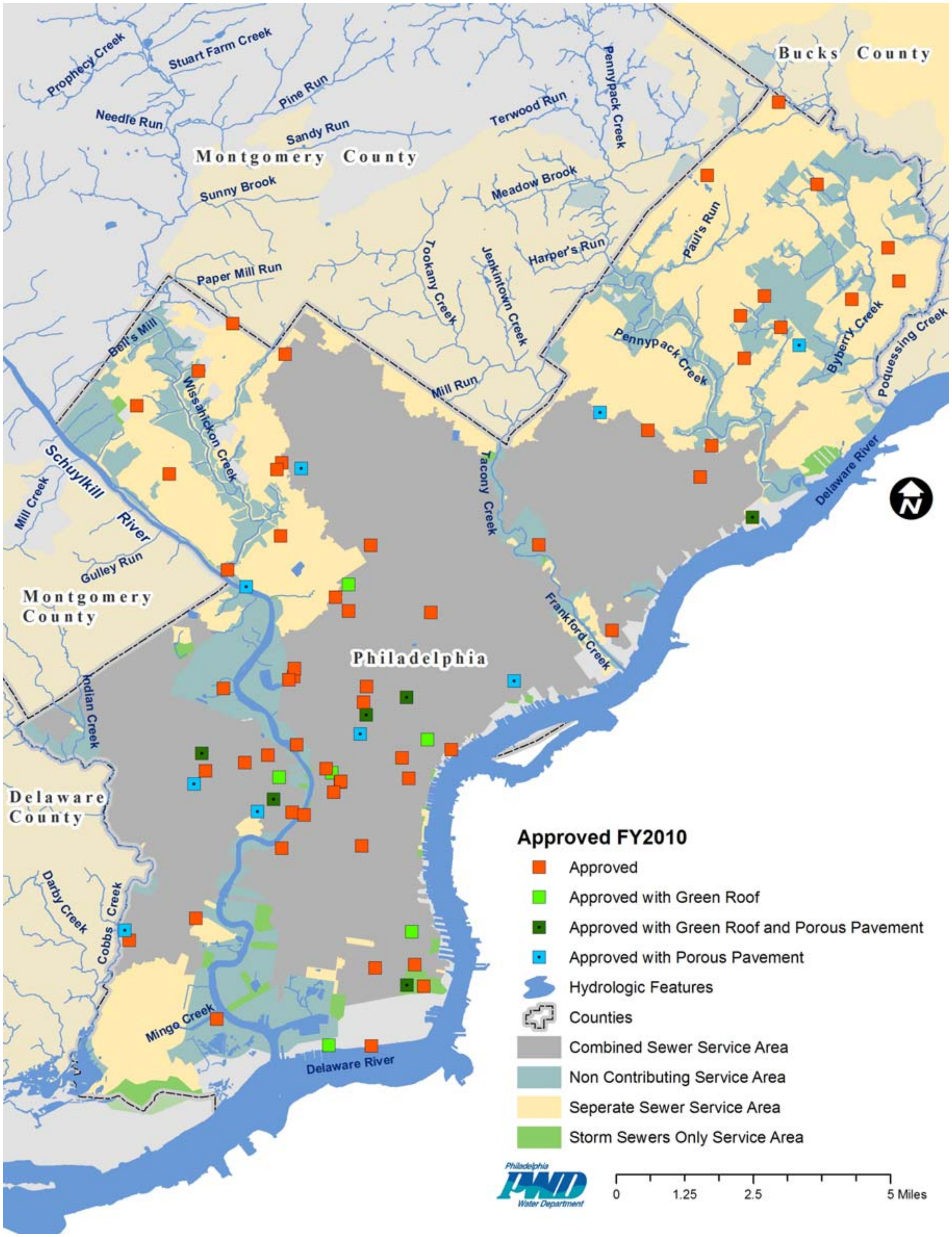


Figure F.5.c-1 Locations of Approved Post-Construction Stormwater Management Plans

F.5.d. Inspections

A total of 106 E&S Control Plans were reviewed during this reporting cycle. Inspectors conducted 985 site inspections. Many sites were visited multiple times to ensure compliance with appropriate E&S controls (**TABLE F.5.D-1**).

Table F.5.d-1 Erosion and Sedimentation Inspection Site Location Summary

Drainage Type	Number of Locations
Combined Sewer Area	59
Non-Contributing Area	17
Separate Sewer Area	35
Storm Only Area	1
Total Locations	112

F.5.e. Monitoring/Enforcement

In FY10, PWD issued a total of four 7-Day Notices for E&S violations on four construction sites. Only one site was issued a Stop Work Order for E&S violations.

F.5.f. NPDES Permit Requests

PWD continues to serve as the Conservation District for the City of Philadelphia for NPDES Construction Permitting Requirements and Chapter 102 Regulations relating to Erosion Control. The City receives notifications through Act 14, Municipal Notification, by applicants applying for a permit to discharge stormwater from construction activities. The notifications are reviewed and recorded as part of the data collection process for a known development proposal.

Not only does PWD receive notifications but also coordinates review of NPDES application plan sets and calculations. Since a post-construction stormwater management plan must be submitted to both the state and the municipality for sites disturbing over one acre of earth, the City recognizes the importance of ensuring both municipal and state engineers are reviewing the same plans and are aware of each others technical requirements.

F.5.g. Storm Water BMP handbook and Construction Site BMP Sediment & Erosion Control Checklist

PWD released the Stormwater Management Guidance Manual (Manual) in concert with the Stormwater Regulations going into effect as of the first of January 1st 2006. The Manual was created with a focus on urban stormwater management and includes Stormwater Management Practice details, development processes in the City, calculation worksheets and supporting reference material.

The Manual is intended to be a dynamic document allowing updates as needed with the most recent version available for electronic download at http://phillyriverinfo.org/Programs/SubprogramMain.aspx?Id=StormwaterManual. The Manual provides guidance for the entire site design process, beginning with initial site design considerations, through the post-construction stormwater management plan submittal elements, and ultimately the acquisition of stormwater plan approval. Tools are provided to assist in completion and submittal of a stormwater management plan consistent with the intent of the City. They include flowcharts to guide the developer through the process, worksheets to assist with calculations, and checklists to ensure the plan is complete. The tools work together to address stormwater management on the development site from concept to completion.

F.6. Watershed, Combined Sewer Overflow (CSO), And Source Water Protection Programs

The Philadelphia Water Department (PWD) manages and operates three waste pollution control plants, three drinking water treatment plants, and miles of underground distribution and collection infrastructure. However, PWD is not just a provider of drinking water and wastewater treatment. PWD, through the Office of Watersheds (OOW), strives to reduce the amount of point and non-point discharges entering regional waterways and improve the environmental health of the region so that all waters are fishable and swimmable. OOW appropriates the human and financial resources of PWD towards programs that aim to reduce the impact of point and non-point source pollution and contaminated runoff in a broad effort to enhance the health of the Philadelphia region's waterways. The main programs within OOW, in addition to the Stormwater Management Program (SMP), that work together to improve regional ecological health, water quality, and sustainability are: the Delaware Valley Early Warning System, Schuylkill Action Network, Combined Sewer Overflow (CSO) Management Program, Watershed Planning, Source Water Protection Program, and Wetlands Mitigation Registry. The SMP and OOW programs work in tandem when producing watershed plans, annual permit compliance reports, demonstration best management practices, and public education and outreach events. Following is a description of the Delaware Valley Early Warning System, Schuylkill Action Network, CSO Management Program, Source Water Protection Program, and the Watershed Mitigation Registry OOW programs, the achievement they have earned, and their future direction and goals. The Watershed Planning Program is presently explained in detail throughout **SECTION F.2** on page 223of this report.

<u>Source Water Protection Program</u>

Philadelphia Water Department's Source Water Protection Program embodies the department's multi-barrier approach to ensuring the safety and quality of Philadelphia's drinking water, whose source consists of the Schuylkill and Delaware Rivers. Philadelphia's Source Water Program staff work closely with the department's treatment plant managers and operators to anticipate and respond to emergencies and challenges to conventional treatment techniques. Program staff have a thorough understanding of Philadelphia's water supply including ambient water quality conditions, major sources of actual and potential contamination, water availability, flow patterns and management policies, and tidal and reservoir impacts. The program's multi-barrier approach to protecting source waters includes the following components: gauging the impact of future influences, such as climate change, natural gas extraction, and carbon sequestration, on the water supply system; establishing short-term and long-term water quality and quantity standards for Philadelphia's source waters; employing research, regional partnerships, outreach and education, lobbying, advanced technologies, on-the-ground implementation, monitoring and other tools to achieve these standards; and, assessing alternatives to current sources and/or treatment measures when standards cannot be met using available source water protection techniques or current conventional treatment technology.

The success of the Source Water Protection Program's organized and comprehensive approach is evident in the integrity of the Delaware and Schuylkill Rivers as drinking water supplies. The Source Water Protection Program began in 1998 with the responsibility of completing Source Water Assessments for 52 drinking water intakes in the Schuylkill and Delaware Rivers. This effort resulted in the identification of the primary sources of contamination in the rivers that serve as PWD's drinking water sources. Between 2003 and 2007, Source Water Protection Plans were completed for the Delaware and Schuylkill Rivers to identify strategies for addressing the water quality and quantity concerns outlined in the Source Water Assessments. The Schuylkill and Delaware Source Water Assessments and Protection Plans can be found online at www.phillywatersheds.org.

The Source Water Assessments and Protection Plans are fundamental elements of PWD's Source water Protection Program, however, the program itself encompasses a much wider range of projects related to research, on-the-ground implementation, partnership workgroups, and in-city initiatives. Since inception, the Source Water Protection Program has implemented numerous local and watershed-wide BMPs, developed partnerships to address regional water quality and quantity concerns, created an advanced water quality early warning system to support drinking water treatment operations along with an associated system for recreational water quality advisories, and conducted research, monitoring, and analyses for a broad range of issues related to drinking water treatment support and regulatory compliance. PWD's partnerships have proved imperative to implementation of source water protection projects that are located beyond Philadelphia's jurisdictional boundaries. The largest, and perhaps most influential of these partnerships is the Schuylkill Action Network (SAN). SAN is a regional partnership that addresses source water quality challenges by working with state agencies, local watershed organizations, businesses, academics, water suppliers, local and state governments, regional agencies, and federal government to transcend regulatory and jurisdictional boundaries in the strategic implementation of protection measures. In 2005, the EPA awarded PWD a $1.15 million Schuylkill Watershed Initiative Grant (SWIG) which was largely used to implement SAN restoration projects in the areas of agriculture, abandoned mine drainage, and stormwater.

Schuylkill Action Network

Please refer the CSO portion of the Annual Report **SECTION II.G.2.3 – SCHUYLKILL ACTION NETWORK** on page 63 for information about this topic

Delaware Valley Early Warning System

Please refer the CSO portion of the Annual Report **SECTION II.G.2.4 – EARLY WARNING SYSTEM** on page 65 for information about this topic.

RiverCast

Please refer the CSO portion of the Annual Report **SECTION II.H.2 – EXPAND THE INTERNET-BASED NOTIFICATION SYSTEM** on page 83 for information about RiverCast

Combined Sewer Overflow Management Program

The Combined Sewer Overflow Management Program, CSOMP, within the Office of Watersheds at the Philadelphia Water Department works to implement technically viable, cost-effective improvements and operational changes that mitigate the impacts of combined sewer overflows. Please refer to **SECTION I "MANAGEMENT AND CONTROL OF CSOs"** on page 14 in the CSO section of this document for additional information regarding the CSOMP.

Watershed Mitigation Registry

Please refer the CSO portion of the Annual Report **SECTION III. C.2.4 – WETLAND ENHANCEMENT AND CONSTUCTION** on page 144 for information about the Watershed Mitigation Registry

F.7. MISCELLANEOUS PROGRAMS AND ACTIVITIES

F.7.a. Pollutant Migration/Infiltration to the MS4 System

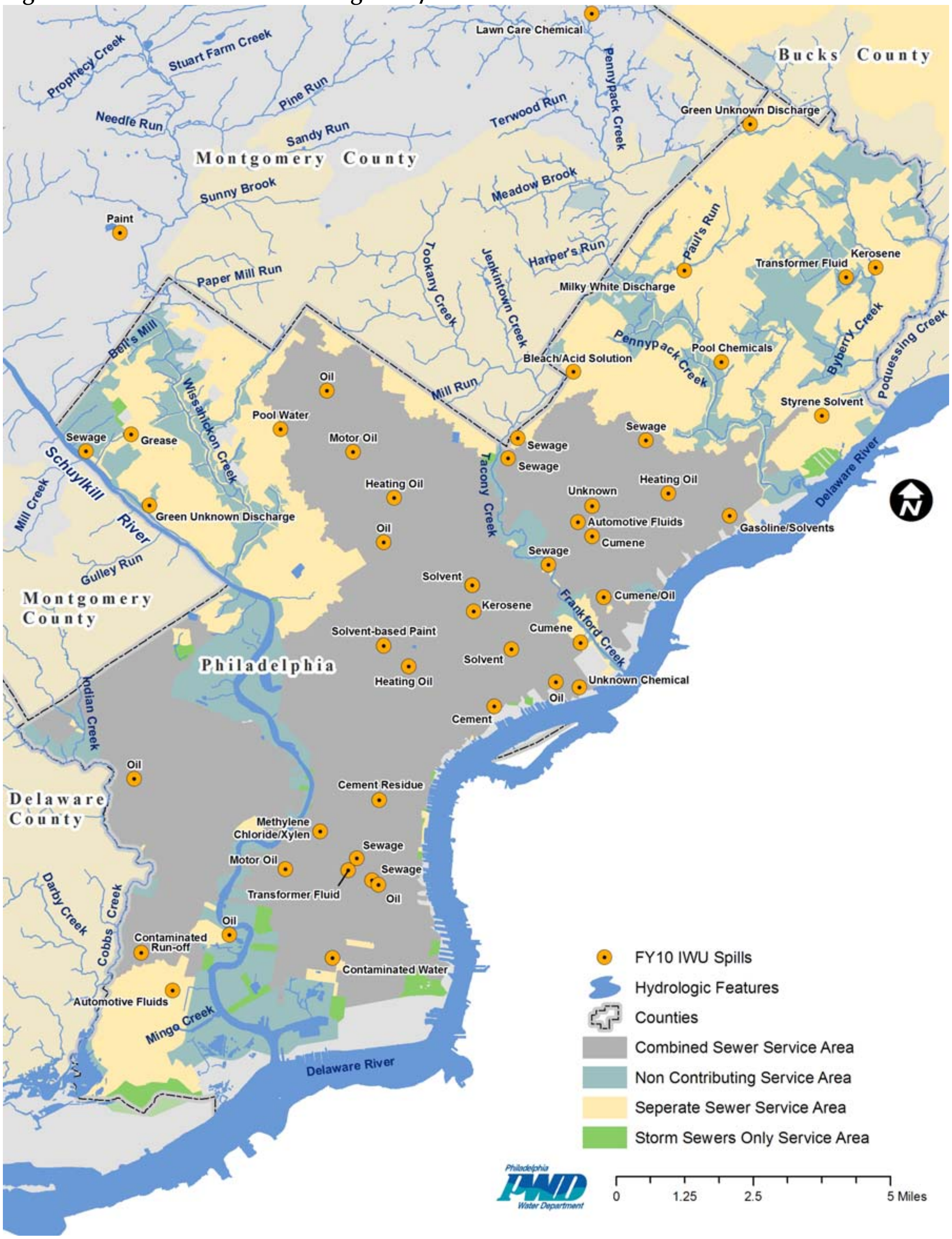
The Industrial Waste Unit (IWU) within the Philadelphia Water Department (PWD) responds to all citizen complaints of liquid, solid, or gaseous pollutants within Philadelphia. The IWU coordinates with neighboring communities in the event that a pollutant may drain into the Philadelphia MS4 system. The IWU unit uses a variety of pollution sensing, testing, and removal techniques to mitigate the impacts of spills to the MS4 system, combined system, and receiving waters. Presented in **TABLE F.7.A-1** below is a list of all pollutant migration events in FY 2010. The locations of all events are presented on the following page in **FIGURE F.7.A-1**.

Table F.7.a-1 Pollutant Migration/Infiltration to the MS4 System

Date	Location	Pollutant	Drainage Type
7/1/2009	3200 block of Collins St.	Solvent	CSO
7/13/2009	2700 block of Reed St	Motor Oil	CSO
8/3/2009	River Rd. & Nixon St	Sewage	Non-Contributing
8/6/2009	SW outlet to the Wissahickon Creek	Paint	Non-Contributing
8/17/2009	Pioneer & Byberry Rds.	Lawn Care Chemical	Non-Contributing
8/29/2009	Byberry Creek	Transformer Fluid	Non-Contributing
8/30/2009	Sunoco's 'M' sewer	Cumene	CSO
9/10/2009	400 East Tioga Street	Green Unknown Discharge	CSO
9/10/2009	1100 block of S. 13th St	Sewage	CSO
9/10/2009	Chestnut & Salford Sts	Oil	CSO
9/18/2009	900 block of Reed St	Sewage	CSO
9/23/2009	800 block of Bleigh Ave	Bleach/Acid Solution	MS4
9/25/2009	725 Dickinson St.	Oil	CSO
10/5/2009	Margaret and Bermuda Streets	Cumene/Oil	CSO
10/6/2009	21st and South Sts.	Methylene Chloride/Xylene	CSO
10/6/2009	Eva & Minerva Sts.	Grease	MS4
10/16/2009	400 East Tioga Street	Kerosene	CSO
10/19/2009	3010 E. Ontario St	Oil	CSO
10/29/2009	1300 W. Lehigh Ave.	Solvent-based Paint	CSO
11/3/2009	10th & Cuthbert Sts.	Cement Residue	CSO
11/3/2009	3646 Newberry Rd	Kerosene	MS4
11/9/2009	1201 East Johnson Street.	Oil	CSO
11/9/2009	2600 block of Tilton	Cement	CSO
11/11/2009	Pool and Liner Co. on Linden Ave	Styrene Solvent	MS4
11/17/2009	400 East Tioga Street	Green Unknown Discharge	CSO
11/20/2009	5698 Rising Sun Avenue	Sewage	CSO

12/2/2009	7169 State Rd.	Gasoline/Solvents	CSO
12/3/2009	Fountain & Umbria Sts.	Green Unknown Discharge	MS4
12/8/2009	13000 Blakeslee Ct	Green Unknown Discharge	MS4
12/9/2009	Wakeling St. sewer	Cumene	MS4
12/14/2009	Blue Grass Shopping Center	Milky White Discharge	MS4
12/15/2009	4416 N.16th. St.	Oil	CSO
1/4/2010	6646 Frankford Avenue	Heating Oil	CSO
1/18/2010	400 East Tioga Street	Solvent	CSO
1/29/2010	5100 block of Oxford Ave	Car Engine Fluid	CSO
2/19/2010	Navy Yard	Contaminated Water	CSO
2/20-25/2010	400 East Tioga Street	Green Unknown Discharge	CSO
3/2/2010	Bloyd St. and E. Locust Ave	Motor Oil	CSO
3/2/2010	1538 E. Cheltenham Ave.	Unknown Chemical	CSO
3/12/2010	3245 S. 74th St	Automotive Fluids	MS4
3/19/2010	7200 block of Bustleton Ave.	Sewage	CSO
3/25/2010	61st. St. & Passyunk Ave	Oil	CSO
3/29/2010	Margaret and Bermuda Streets	Cumene	CSO
3/30/2010	Frankford Creek Outfall Discharge	Sewage	Non-Contributing
4/9/2010	Broad & Wharton Sts.	Transformer Fluid	CSO
4/15/2010	5200 block of N 15th St	Heating Oil	CSO
4/30/2010	Venango & Delaware	Unknown Chemical	CSO
5/1/2010	400 E. Tioga St.	Green Unknown Discharge	CSO
5/11/2010	736 Dunksferry Road, Bensalem	Red Unknown Discharge	Non-Contributing
5/17/2010	Winchester St Home	Pool Chemicals	MS4
5/18/2010	2529 South 72nd Street	Contaminated Run-off	CSO
5/24/2010	Storm Sewer on Westview St	Pool Water	MS4
5/27/2010	5976 Reach St.	Sewage	MS4
6/9/2010	2400 block of N.7th St.	Heating Oil	CSO

Figure F.7.a-1 FY 2010 Pollutant Migration/Infiltration Event Locations



F.7.b. Public Education and Awareness

Please refer the CSO portion of the Annual Report **SECTION II.G** on page 45 for information about this topic.

F.7.b.i. Public Education Literature

Please refer the CSO portion of the Annual Report **SECTION II.G** on page 45 for information about this topic.

F.7.c. Pesticides, Herbicides, and Fertilizer Controls

F.7.c.i. Integrated Pest Management protocol

The City currently does not practice the Integrated Pest Management (IPM) protocol with respect to the application of pesticides to agriculture, due to the fact that the City does not use pesticides or conduct any practices that require the use of the IPM protocol. The City is currently focusing on invasive plant management through the use of herbicide to remove invasive plants.

The Vector Control unit of the Philadelphia Health Department uses larvicides, Bacillus Sphaericus (brand name Vectolex) and Methoprene (brand name Altosid), to prevent mosquito breeding. The larvicides are approved for use in the stormwater catch basins and are applied as such. The Integrated Pest Management protocol is followed when using the larvicides by inspecting the catch basins before treatments, using the least toxic or non-toxic product, and submitting a request for repairs when necessary. The Integrated Pest Management protocol is adhered to with the use of these larvicides as no oils or organo-phosphate products are used.

All of the Vector Control field staff are certified pest control applicators in accordance with Pa Department of Agriculture. In order to maintain this certification, on-going training is required. The Philadelphia Health Department holds several on-site trainings per year for staff.

F.7.c.ii. Education materials to private pesticide users

Golf courses comprise a major land use within the Schuylkill River watershed. Golf course management techniques, particularly with regard to pesticide application, turf management, and water use significantly impact the quality and quantity of runoff leaving a golf course and entering nearby streams and rivers. To address this concern, the PWD holds an annual Golf Course Certification workshop through the Audubon Cooperative Sanctuary Program (ACSP). The ACSP is a voluntary education and certification program whose purpose it is to educate, provide conservation assistance to and positively recognize golf course managers for improving environmental management practices and conservation efforts as they pertain to outreach and education, wildlife and habitat management, chemical use reduction and safety, water conservation, and water quality management. The annual workshop introduces golf course managers to the certification program and provides detailed information on key components of the certification process and important principles of environmentally responsible management. To date, PWD has held five annual workshops in different parts of the Schuylkill River watershed. The 5th annual workshop was held at Bala Golf Course in Philadelphia in the April 2008. Twenty golf courses from around the region sent representatives to participate in workshop.

In FY10, the ACSP visited cemeteries, golf courses and a few parks including the Morris and Awbury Arboretum to provide certification guidance. They also offered a series of workshops over this period. Curently PWD has issued a RFP for a ACSP-like program to provide provide hands-on guidance and Audobon certification to cemeteries and golf-courses in Philadelphia, so that they may obtain partial to full credit on their water bills.

F.7.d. Snow Management Plan

The City of Philadelphia, like many other northeastern cities in the US, often faces winter storms that bring potentially dangerous accumulations of ice, sleet, freezing rain, and snow. Such events carry the potential to virtually paralyze the metropolitan area. In order to mitigate the impact of these storms, the Streets Department has prepared a Snow and Ice Removal Operations Plan which provides a detailed outline of the City's response to adverse winter weather conditions. A copy of the current plan was provided in the 2009 CSO/SW Annual Report and will also be included in the Additional Documents folder in the **SUPPLEMENTAL CD**. The Street Department will be preparing a new plan that should be completed October 2010, Philadelphia will provide a copy when it becomes available.

F.7.e. Municipal/hazardous Waste, Storage, Treatment, and Processing Facilities

PWD performed inspections on three (3) facilities during the month of August 2010 that were suspected to be locations that waste is transferred to in the MS4 area. The three facilities were located in the Northeast at State Rd & Ashburner St, the Northwest at Domino Ln & Umbria St., & the Southwest on 63rd St (NW of Passyunk Ave.)

Two of the facilities (Northeast & Southwest) are not truly waste, storage, or disposal facilities, they are used to store and service Trash Trucks, salt piles are also kept here for winter applications. For the most part, the facilities were clean and did not pose a potential for pollution beyond normal parking areas for large vehicles. At the Southwest facility there is catch basin directly in front of the Salt Storage and also a catch basin directly in front of an oil storage tank. During inspection it also appeared that one of the Biodiesel Fuel Pumps was leaking.

The Domino Lane (Northwest) site is the only waste transfer station left in the city that is city owned. The majority of the yard is serviced by area drains that are connected to the sanitary sewer. The process areas do not drain to the Storm Sewer. There is a lower parking area that is serviced by an area drain and a pair of trench drains. All of these are connected to a storm sewer. The lower area serviced by these drains is the main parking area for the trash trucks and other Streets vehicles for the yard. A fuel cell on a vehicle was discovered on this inspection that would likely go to the storm sewer, similar to any other parking lot for trucks. One area of concern is the fuel pumps on this yard. They are a 24 hour operation and are serviced by an area drain that leads to the Sanitary Sewer. In the event of a spill, the pumps can be shut down by an electrical cut off. Since the pumps are a 24 hour operation and the yard is only an 8 hour operation there are 16 hours when the site is monitored by "injured on duty" employees. These employees are told how to shut down the pumps if there is a leak or similar failure. There is no Fleet garage on the site.

None of the facilities had any prepared spill contingency plans.

Following these inspections, the Inspection form used by IWU was altered so it fits this inspection effort more appropriately. In addition PWD will look into inspecting yard that PWD does not own or manage since these areas have greatest potential for pollution to exist.

F.8. BEST MANAGEMENT PRACTICES (BMPs)

The City is charged with implementing a wide range of BMPs for improving the quality, quantity and rate of stormwater runoff entering the MS4. . Within **SECTION F.8**, each of the Permit specified BMPs is documented with regard to their scope, level of implementation and project updates for this Annual Report year. The City will continue to evaluate the effectiveness of each BMP as it is implemented. In addition to the required list of BMPs, the City is also including discussions of BMPs implemented outside of the MS4 areas. It is in the best interest of the City to evaluate all BMPs and use that information to improve and enhance all City Program goals regardless of whether they are required by regulation. When applicable, the BMP will provide previous year data collected along with a discussion of the overall effectiveness.

F.8.a. Storm Sewer Discharge Ordinance

In May of 2005 the City signed a resolution for the Darby and Cobbs Creeks Watershed Stormwater Management Plan as part of the Stormwater Management Act 167 planning effort. Under the Watershed Plan a detailed stormwater ordinance was developed that exceeded requirements set forth by the State Model Stormwater Ordinance under the National Pollution Discharge Elimination System (NPDES) Phase II requirements. Philadelphia recognized the importance of implementing city-wide policy that uniformly addresses stormwater management and adopted Stormwater Regulations on September 5th 2005 that was effective on January 1st, 2006. The authority to adopt stormwater regulations is found within Title 14 Zoning and Planning Code under §14-1603.1 Stormwater Management Controls as referred to in the Storm Water Management Control Plans (6.)(c.)(1.) section.

F.8.a.i. Submit storm sewer discharge ordinance

The Storm Sewer Discharge Ordinance was submitted during the first year of the permit and there are several methods in place to ensure compliance with Philadelphia's storm sewer discharge policies. To begin with integration into the already existing development process for Philadelphia was a critical component for complying with stormwater policy. Key staff members have been consistently serving on the Water Departments development review committee to represent stormwater requirements from a technical perspective. Follow up associated with the committee meeting includes communication with engineers, review of submitted plans and ultimate approval or disapproval of stormwater management plans. Outside of the Water Department, discussions with Licenses and Inspections (L & I) along with City Planning have allowed the addition of water department approvals, which include stormwater issues, being required before critical steps of the development process.

Inspections and enforcement actions provide an additional component to ensuring compliance. The Industrial Waste Unit continues to be the lead organization for inspecting and enforcing pollution discharges to the separate storm sewer system. As we move into the New Year extensive efforts to coordinate with industrial waste staff will assist in addressing a portion of our compliance needs. Also, an Erosion and

Sedimentation Inspector is in place at the Water Department who is actively reviewing plans, visiting sites and preparing inspection reports. For sites that remain out of compliance after several notifications and enforcement actions through L & I the City will turn to the State for more stringent penalties and enforcement actions. The coordinated plan review efforts between the Water Department and Southeast Regional Office of the Pennsylvania Department of Environmental Protection in terms of erosion and sedimentation control plans and post-construction stormwater management plans is another avenue where compliance is being strengthened.

In support of the policy change the Water Department has added documentation and notifications to a website (http://www.phila.gov/water/pdfs/pwd_regulations.pdf) in order to provide the development community a means of accessing the most recent stormwater management information. Part of this website includes notifications of upcoming workshops and stormwater update sessions which aim to update the development community on stormwater standards for plan submittals. The workshop venue has provided opportunity to inform the engineers, architects, developers, owners and so forth, about additional technical criteria that will be required as well as present approaches to meeting the technical requirements

F.8.b. Commercial and Residential Source Controls

F.8.b.i. Mingo Creek Surge Basin

In FY 2000, a needs-analysis was completed for the dredging of the Mingo Creek basins. Survey drawings showing the plan and elevation views of the Surge Basin, indicate minimal material deposited in the bed of the basin. In fact there was an indication of basin bed erosion. Based on these findings, dredging of the basin was not recommended. However, additional field investigations reveal pockets of deposition in the basin, suggesting the need for additional study. In June 2001 the basins were dewatered so that visual observations could be made and photos taken of existing conditions.

PWD is considering a study to assess the feasibility of retrofitting the basin to improve water quality. The study identified that better methods are needed to determine actual sediment depths within the basins, and research of suitable vegetation survivability in the basin's typical flow regime. PWD investigated a methodology to collect a bathymetric profile of the basin topology in FY 2003.

PWD's generation of a comprehensive model of the contributing MS4 to the Mingo Creek Surge Basin has been temporarily interrupted due to the loss of critical personnel. Generation of this model is planned to resume upon replenishment of staffing, since further understanding of this system's flow regime, potential restrictive characteristics, and conveyance infrastructure longevity, are critical components in identifying possible maintenance and system enhancement locations.

PWD is currently working with the Philadelphia International Airport (PHL), as part of the Green Airport Committee, to enhance the water quality of the stormwater discharges generated from the 28% of the Mingo Creek Surge Basin drainage area owned by PHL.

As part of this committee, PWD is involved in early stage planning of stormwater quality management and stormwater conveyance system capacity enhancements associated within the airport restructuring projects.

During August of 2009, the Basin was dewatered to inspect the sediment levels. The basin sediment appears to have not changed since previous inspections; therefore no further accumulation has been occurring. Photos from this inspection can be found in the **ADDITIONAL DOCUMENTS FOLDER ON THE SUPPLEMENTAL CD**.

F.8.b.ii. Existing privately owned structural controls

Stormwater Basins Inspection Program

PWD is responsible for the inspection of existing structural controls for compliance with the City's Storm Sewer Discharge Ordinance. PWD is also responsible for requiring operations and maintenance (O & M) agreements for new projects proposing stormwater structural controls.

The authority for the City to require stormwater structural controls is within the City Code and Charter §14-1603.1 Storm Water Management Controls (Stormwater Ordinance). Within this section there are specific criteria for operation and maintenance plans as well as inspections. During this permit cycle, Philadelphia updated the City's Stormwater Ordinance by implementing Stormwater Regulations (effective January 1, 2006) which meet the more stringent criteria of the State Model Ordinance and local Act 167 Plans. The Regulations require recording of an O & M Agreement against the property.

The change in stormwater management requirements has created two general categories of stormwater structural controls. One set is existing stormwater structures built according to the Stormwater Ordinance and the other set is new stormwater structures built according to the Regulations. In this annual reporting year, PWD performed inspections of the existing stormwater structural controls and has improved the inspections program framework for new stormwater structural controls.

Existing Stormwater Structural Controls

In 2009, PWD inspected 172 privately owned existing stormwater structural controls. The inspections were conducted over the course of 6 months and included infrastructure verification, photographic documentation and inspection report creation. The stormwater structural controls were classified into groups determined by the amount of maintenance work needed to bring the practice back to optimal functionality in accordance with the Stormwater Ordinance. The stormwater controls were classified as fitting into one of three categories:

1. *No work needed* - Stormwater structure is well maintained. No additional maintenance activities are required.

2. *Minor work needed* - Stormwater structure requires minor maintenance activities related to cleaning infrastructure, clearing vegetation and removing accumulated

sediment. Anticipate a low level of time and money expenditures to bring the structure back to proper functioning condition.

3. *Major work needed* - Stormwater structure requires structural changes and/or repairs. Anticipate a significant investment of time and money to restore the structure to proper functioning condition.

In 2010, letters were sent to the majority of property owners notifying them of the inspection results and identifying any key maintenance issues to be addressed. PWD has remained responsive to property owners seeking to perform necessary corrective actions to improve system performance. The privately owned existing stormwater structural controls will continue to be inspected no less than once every five years.

New Stormwater Structural Controls

Development projects designing and constructing new stormwater structural controls to meet the Regulations are required to submit an O & M Agreement. The O & M Agreement is to be recorded against the property preserving the location of stormwater management systems with the land. After implementing the Regulations in 2006 and completing two years of development plan review, PWD reassessed the business process associated with the O & M Agreements. It was determined that the Agreements were not recordable documents since the form did not comply with the document format accepted by the Philadelphia Department of Records. PWD revised the O & M Agreement and has been successfully recording the documents to date. Since the Regulations were enacted, over 125 projects have had O&M Agreements recorded as part of the deed.

PWD refers to the O & M Agreement and approved post construction stormwater management (PCSM) Plan when performing inspections both during construction and once the site is completely stabilized. PWD recognizes the importance of inspecting the construction of stormwater management practices in order to ensure the approved PCSM Plan is being properly implemented. PWD requires a pre-construction meeting prior to commencement of earth moving activities. During the pre-construction meeting both the Erosion and Sedimentation (E & S) Control Plan and the PCSM Plan are discussed. The inspector covers the need to schedule an inspection of the stormwater structural controls during critical stages of construction. Coordination of site E & S controls in relation to the PCSM Plan is a key factor contributing to the long term O & M of stormwater structural controls.

Part of the inspection program growth during FY10 included conducting inspections of stormwater structural controls during construction. Critical stages of construction were identified depending on the stormwater practice proposed for the site. PWD technical plan review staff conducted site visits for 20 active projects, totaling 28 inspections of stormwater structural controls. Technical plan review staff were on-site to verify construction according to the approved plan or to discuss necessary corrective actions for the project. Implementation of inspections of stormwater structural control construction has provided valuable input to the inspection program. For example, critical stages of subsurface system construction have been identified as the highest priority type of inspection.

Development projects approved under the Regulations by PWD have been installed for less than 5 years, even under the oldest project scenario. Therefore, inspections for O & M activities are part of the inspection program framework and will be conducted under upcoming annual reporting years. Inspections of the new stormwater structural controls will be performed at least once every 5 years.

Wissahickon Creek Detention Basin Inventory and Retrofit Program

PWD developed a replicable approach for generating an inventory of existing stormwater management facilities within a watershed and then prioritizing the facilities for retrofit with structural and nonstructural stormwater best management practices aimed at enhancing groundwater recharge and water quality treatment of stormwater runoff and implemented it in the Wissahickon Creek Watershed. The study area for this initiative was limited to the sub-watershed drainage areas of the tributary streams flowing to the Wissahickon Creek, specifically excluding basins draining to the mainstem. The study focused on first and second order stream locations where implementation benefits could be maximized. (Funding for this study was provided by a US EPA 104b3 grant administered by PA DEP.)

The initiative involved development of a process in which a desktop analysis of Geographic Information Systems (GIS) data layers was utilized to identify a preliminary set of basins and a field assessment protocol was developed to visit each basin to collect information relevant to retrofit priority. Data collected about each basin was fed into an evaluative matrix program where fifteen weighted criteria were applied to each basin to prioritize the 153 basins in the inventory for retrofit. A ranked output was produced at both the watershed-wide as well as the individual municipal level; basins were ranked with high, medium and lower priority for retrofit. Information about three types of basin retrofits and benefits associated with each type for a given basin size. It will be up to the implementers of each basin retrofit to evaluate the appropriate measures for implementation in a basin given the existing conditions of the basin.

For more information on this initiative, a copy of the final report and all appendices as well as downloadable GIS data, please visit: www.watershedscience.info/basininventory

Wissahickon Detention Basin Retrofit and Technical Assistance Program

PWD funded a Technical Assistance Program to follow up on the recently completed Inventory of Existing Stormwater Management Facilities with Retrofit Potential within the Wissahickon Creek designed to assist watershed stakeholders (specifically municipalities) in making use of the information in moving toward implementation of basin retrofits. The Basin Inventory initiative concluded by stating that all basins considered for retrofit would require a detailed, site-specific feasibility study and engineering design in order to proceed and that existing conditions such as flooding, groundwater contamination, karst geology, proximity to drinking water intakes, groundwater wells, and many other factors must be considered in order to deem the basin appropriate for retrofit implementation. This program was intended to provide stakeholders with the tools necessary to perform such site specific feasibility studies.

Technical assistance is provided to partners in the form of site visits, conceptual and final project designs, workshops, and a brochure. Three or four municipally-owned facilities will be guided through the site assessment and design process to prepare for retrofit implementation. This Technical Assistance Program was initiated in the spring of 2008 and came to a close on June 30th, 2008. At the close of this initiative, the Pennsylvania Environmental Council secured additional funds to continue this program in the coming year and actually construct 2-3 retrofits within the Wissahickon Creek Watershed.

Progress to date on basin retrofits:

PWD/Exelon/Schuylkill River Heritage Area Basin Retrofit Program
Stormwater basin retrofit activities including training and construction-related activities, focusing on municipal basins:

- Basin Retrofit Field Training including field review of basin retrofit concepts focusing on Village Circle basin design, July 9, 2008 at Village Circle stormwater basin, Whitpain.
- Neighborhood briefing on Village Circle basin retrofit, June 26, 2008 at Village Circle stormwater basin, Whitpain.
- Public award ceremony for Exelon-Schuylkill River Heritage Area grants including basin retrofit program, August 26, 2008 at Perkiomen Conservancy in Schwenksville.
- Upper Dublin Council review of Aiden Lair Park basin retrofit project and match, fall 2008, Upper Dublin Township Building. Basin retrofit agreement signed by Township in March 2009,
- Whitpain Council review of Village Circle basin retrofit project and match, fall 2008, Whitpain Township Building. Basin retrofit agreement signed by Township on March 3, 2009.
- North Wales Borough Council review of Center Street basin retrofit project, May 2008, North Wales Borough Hall. Basin retrofit agreement signed by Borough on May 27, 2008. Landowner partnership agreement also signed in May 2008. (North Wales was pre July 2008)
- Center Street basin design review meetings held with landowners at site, with last meeting held on March 3, 2009.
- Fall 2009 Aidenn Lair Park Basin retrofit underway.
- Spring 2010 Aidenn Lair Park Basin retrofit construction resumed (i.e. planting)
- June 2010 North Wales Borough hired new Borough engineer. Engineer & PEC working to finalize the center St basin design

- August 30, 2010 Public Relations Event at Aidenn Lair Park in which Exelon-Schuylkill River Hertiage Foundation announced grants recipients and attendees/dignatories participated in atour of the basin.
- Fall 2010 Volunteer and township staff will continue basin planting activites
- September 25, 2010 Neighborhood watershed education – outreach event at the Aidenn Lair Park.

F.8.b.iii. Structural controls impact

The City maintains all city-owned structural controls, which presently consists of the Mingo Creek Surge Basin. Maintenance consists primarily of scheduled preventative maintenance of the pumping station to support its intended purpose of flood control. More detailed information about the Mingo Creek Surge Basin can be found in **SECTION F.8.B.I MINGO CREEK SURGE BASIN** on page 298.

F.8.c. Development plans review

PWD and the City Planning Commission provide review of drainage plans for new development. The drainage plans addresses both flood control and potential stormwater pollutants under the authority delegated 14-1603.1 of the Philadelphia Code and Charter. Please refer to **SECTION F.5 – MONITOR STORMWATER FROM CONTRUCTION ACTIVITIES** on page 277 for additional information. .

F.8.d. Operate and maintain public roadways

F.8.d.i. Deicing Practices and Salt Storage

The Streets Department has an established snow category system that defines the response to winter storms based on severity and accumulations. There are 5 snow categories, ranging from an event of sleet and freezing rain to an event of 12 inches of snow or more. Depending on the event, the response can include brine application, salting of roadways (with a mix of salt and anti-skid material), plowing, and snow-lifting operations that include storage of snow on city property or melting of snow at storm water inlet locations pre-arranged with the Water Department. Details of the snow response can be found in the Streets Department document entitled "Snow and Ice Operations Plan." A copy of the current plan can be found in the **ADDITIONAL DOCUMENTS FOLDER IN THE SUPPLEMENTAL CD**. The Street Department will be preparing a new plan that should be completed October 2010,. Philadelphia will provide a copy when it becomes available.

F.8.d.ii. Street and Inlet Cleaning Practices

<u>Require weekly cleaning of commercial, conduct annual cleaning of residential streets and inlets</u>

During FY 2010, the Streets Department continued its street cleaning programs that target street debris and litter. With its fleet of mechanical sweepers, the department provides daily street cleaning in Center City, and on major arteries and commercial corridors throughout the city. Many residential streets are also mechanically cleaned on a weekly basis. In FY 2010, a total 36,030 miles were cleaned.

In addition to the Streets Department's street cleaning effort, the University City District (UCD) conducts sidewalk cleaning. The 27 men and women of the Public Space Maintenance (PSM) team work seven days a week, 8 a.m. to 4:30 p.m. sweeping sidewalks and removing graffiti. Heavily-trafficked commercial streets and areas adjacent to university campuses receive daily sweeping with pans and brooms and mechanical cleaning. Other areas with a high density of rental properties are cleaned at least twice weekly with machines (some areas are cleaned daily). In total, approximately 160 square blocks are maintained.

In the spring, PSM staff conducts a war against weeds, clearing excessive weeds from sidewalks and tree wells. In the fall, Student Move-In and leaf collection create especially intense work periods. PSM workers also assist with special events such as providing power, water, and cleaning for the Clark Park Farmers' Market. The UCD maintenance shop is located at 4056 Powelton Avenue. For more information on PSM's programs, please visit: http://www.universitycity.org/ucd_programs/public_space.

The Center City District (CCD) has conducts sidewalk cleaning. The CCD deploys over 100 uniformed workers who manually sweep downtown sidewalks and operate specialized equipment on two overlapping shifts, seven days a week, providing up to 14 hours of services per day.
Mechanical sidewalk sweepers are deployed every morning so that Center City starts clean every day.
Throughout the day, CCD's uniformed cleaners manually sweep all sidewalks at least three times. The "pan and broom brigade" also sweeps sidewalks in prime entertainment and dining areas in the evenings during the warm weather months. All sidewalks also get a monthly power washing, except in winter, to remove accumulated stains, gum and grime.

Through a variety of fee-for-service arrangements, CCD crews clean several adjacent commercial and residential areas and provide a 24-hour deployment to clean the three and a half mile long underground subway concourse and Center City's two regional rail stations.

Public awareness of litter

The City promotes, develops, and implements litter reduction programs, in an effort to increase public awareness of litter as a source of stormwater pollution. There are 500 solar-powered, compaction litter receptacles in Center City, and over 700 standard litter baskets in other commercial districts throughout the city. The Philadelphia More Beautiful Committee organizes neighborhood cleaning events citywide. In the 2009 Clean Block season,–10,040 blocks were cleaned by 62,440 volunteers. 980 tons of trash were collected and removed. Also in 2010, on April 10, the city held its third annual Philly Spring Cleaning day, a citywide anti-litter event partnering various city agencies and neighborhood community groups.

The Streets Department announced in March 2010, UnLitter Us, the first sustained public service campaign to rid the City of litter. The message is carried through block-by-block community programs, social networking programs such as facebook and twitter, PSAs from spoken artists, rhythmically talking about the beauty of a clean city, and urging people to use a trash can. For information on the UnLitter program visit: http://www.philadelphiastreets.com/unlitter-us-programs.aspx.

F.8.d.iii. Maintain all city-owned storm sewer inlets

Please refer the CSO portion of the Annual Report **SECTION II. F.1 – CONTROL OF DISCHARGE OF SOLIDS AND FLOATABLES BY CLEANING OF INLET AND CATCH BASINS** on page 35 for information about this topic.

F.8.e. Animal Waste and Code Enforcement

F.8.e.i. Educational material regarding control of animal waste

The City of Philadelphia actively enforces code which covers the regulation of animal waste. The Philadelphia Code and Charter Chapter 10.100 – Animals and Chapter 10.700 – Refuse and Littering address the proper clean-up of pet waste and applicable fines and penalties. In addition, signs advertising the said penalties are displayed city-wide in any effort to prevent residents from violating this statute. The City of Philadelphia also provides the text of this code online at http://municipalcodes.lexisnexis.com/codes/philadelphia/.

Dog Waste Control Program

In FY 2010 a new program to address dog waste in targeted neighborhoods was created. Through a pilot project in Delaware, the Partnership for the Delaware Estuary found that most dog-owners are completely unaware of the connection of dog waste to water pollution. Many articulated that they cleanup in public areas as a common courtesy, but were unaware that the dog waste in their yards could be a potential source of stormwater runoff pollution. After that pilot program, a similar need was identified in Philadelphia. Five thousand "Bags on Board" and educational tip cards were produced and purchased for distribution at the FWWIC and various public events. The "Bags on Board" is a roll of 15 dog waste collection bags that conveniently clips onto a dog leash. The refills are available at most local pet shops. The educational tip card that is being distributed with the units not only explains the effects of dog waste on local waterways, but also provides a list of other daily actions that can be modified slightly to reduce stormwater runoff pollution. This program is beneficial in educating dog-owners on other sources of stormwater runoff pollution and how these non-point source pollutants affect the local waterways and the Delaware Estuary. Due to the high demand in 2007 an additional 5000 "Bags on Board" and accompanying tip cards were ordered in June of 2009.

The conceptual stages of a new dog waste reduction outreach and media campaign program were started in early 2010. In the summer of 2010 PWD will launch a "spokesdog" competition. PWD will be looking for two eco-friendly dogs and their caretakers to help educate their bark park buddies on keeping Philadelphia's waterways clean. One dog will be chosen from each of the two source water protection neighborhoods, Manayunk and East Falls. The outreach campaign will consist of online submission and voting with educational information on the importance of picking up after your dog mixed in throughout. Information on submitting your dog to be "Philly Water's Best Friend" will be available along with Bags on Board and educational information at all pet care companies in the source water neighborhoods. Spokesdogs will be selected at an event in each neighborhood the following spring. For more information see http://www.phillywatersheds.org/spokesdog.

PWD has developed the *Homeowner's Guide to Stormwater Management*. This Guide has a section on dealing with Pet Waste. It talks about how pet waste negatively affects our waterways and what pet owners can do to clean up the waste and dispose of it. We have estimated that over 10,000 guides have been distributed to date.

F.8.f. Flood Management and Flood Control Devices

F.8.f.i. Structures built within the floodplain

All buildings within or close to the 100 Year Flood Plain area which requires a Zoning Permit or a Building Permit or both should be reviewed to determine if Floodplain Regulations applies. The City's Licensees and Inspection department will send all applicants with properties located in or close to the 100 Year Flood Plain to the Philadelphia City Planning Commission (PCPC) for review. If the property is determined to be within the Floodway or Floodway Fringe, structures built on the allowable property will be built at least one-foot above the Base Flood Elevation (BFE) or floodproofed such that plan complies to 14-1606 and any special Building code requirements.

F.8.f.ii. Evaluate new and existing structural drainage controls

Please refer the CSO portion of the Annual Report Section **II. B.3.3 – STORM FLOOD RELIEF** on page 21 for more information about the SFR projects and details on evaluating structural drainage controls.

F.8.f.iii. Streambank Restoration and Wetland Enhancement

Please refer the CSO portion of the Annual Report **SECTION III. C.2.3 – STREAM HABITAT RESOTRATION** on page 141 for information pertaining to streambank restoration.

Please refer the CSO portion of the Annual Report **SECTION III.C.2.4 – WETLAND ENHANCEMENT AND CONSTRUCTION** on page 144 for information pertaining to wetland enhancement.

F.8.g. Sanitary Infiltration Controls

F.8.g.i. Limit sanitary infiltration

Improper disposal of liquid wastes can result in the microbiological and chemical contamination of the drinking water supply, potential for disease, vector breeding, degradation of air quality, hazards to wildlife, degradation of recreational resources, creation of public nuisances, and economic distress to the community. This program is of major concern as it impacts the health of both the City of Philadelphia and appertaining communities and requires interrelationships among federal, state and local agencies, as well as industry.

Based upon these concerns, interventions will be employed that prevent the degradation of surface and groundwater by the inadequate treatment of sewage or site runoff, provide oversight for the construction and operation of individual On-Lot Sewage Disposal Systems (OLDS), and provide an immediate response to all reports of unintentional spills, to prevent their entrance into surface or ground water. Inspection, education and consultative services as well as a review of citizen reports of degraded water quality issues will be managed.

F.8.g.ii. Inspection and remediation of on-lot septic/disposal systems

The On-lot Sewage Disposal System program allows for the supervision of the design and installation of new systems to prevent sewage from being discharged onto the ground and also entails the identification, evaluation and recommendation of remedial actions which are available to homeowners with malfunctioning systems. This program also enables permitting and monitoring of storage tanks and portable toilets.

Educational materials emphasizing water conservation and On-Lot Sewage Disposal System maintenance requirements are provided with each permit application to inform the homeowner of the importance of preventing a malfunction. A liaison is maintained with the PA DEP, Philadelphia Water Department and City Planning Commission concerning the prevalence of malfunctions within certain geographical areas in the City. An extension of the municipal sewerage system is recommended to the Philadelphia Water Department for those areas where homes are experiencing malfunctions and no practical means are available for their correction.

Activities:

- Review plans, observe tests, issue permits and observe the installation of all new On-Lot Sewage Disposal Systems to assure their conformance with PA Acts 537 and 149 and the PA DEP regulations.
- Respond to complaints or reports of malfunctioning On-Lot Sewage Disposal Systems within 24 hours of receipt of this notice.
- Evaluate malfunctioning On-Lot Sewage Disposal Systems and provide a notification to the homeowner, which includes recommendations on abatement actions.

- Where appropriate, initiate enforcement action when non-compliance persists, by issuing notices, conducting administrative hearings or conferences, or requesting court action.
- Provide the training opportunities needed to maintain PA DEP certification as a Sewage Enforcement Officer for each employee actively engaged in the On-Lot Sewage Disposal System permitting program.
- Conduct evaluation of On-Lot Systems in selected geographic areas to determine the necessity for extensions of the Philadelphia sewer system.

Achieved:

- During the 2010 fiscal year, from 7/1/09 to 6/30/10, 6 applications were received for the installation of on-lot sewage disposal systems and 5 permits were issued and 1 was denied.
- Staff members routinely attend training mandated by the PA DEP to maintain their Sewage Enforcement Officer certification.

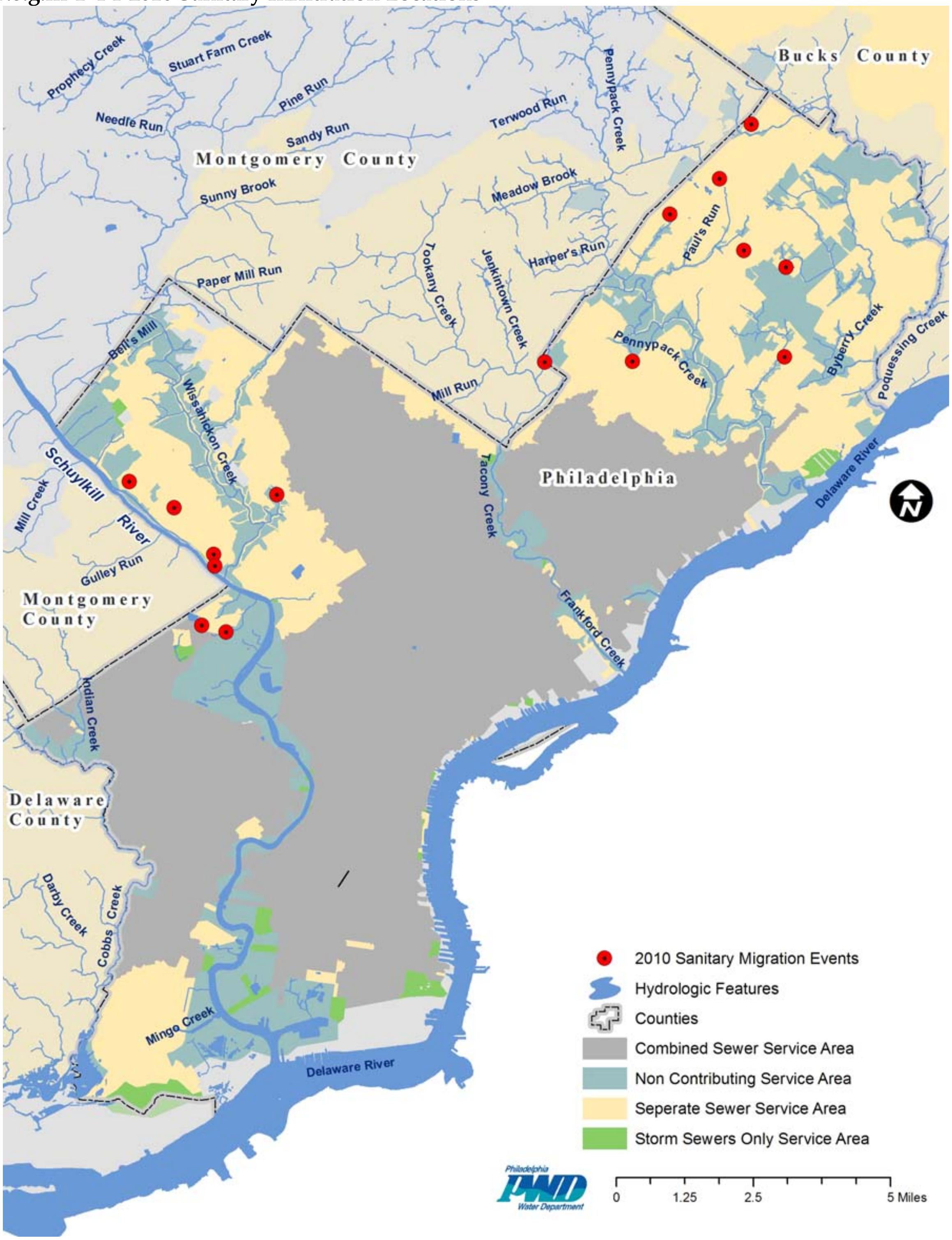
F.8.g.iii. Investigate, remediate, and report sanitary infiltration

The Industrial Waste Unit (IWU) within the Philadelphia Water Department (PWD) responds to all citizen complaints of liquid, solid, or gaseous pollutants within Philadelphia. The Collector Systems maintains and manages a database called the Sewage Pollution Incident & Location Log (SPILL) which reports information about unintentional sanitary discharges which includes date reported, problem location, spill type, description, and abatement date. Presented in **TABLE F.8.G.III-1** below is the information /output found on the SPILL database of reported sewage pollution incidents in FY 2010.

Table F.8.g.iii-1 FY 2010 Sanitary Infiltration Events

Report Date	Reported By	Problem Location	Type Spill	Spill Destination	Effected Outfall	Discharge (GPM)	Abatement Date
6/19/2010 12:00 PM	BOATER	RIDGE AVE. @ MANAYUNK AVE.	CHOKED SEWER	OUTFALL TO STREAM	S-052-05	7	6/19/2010
6/5/2010 11:30 AM	CITIZEN	9725 LARAMIE ST	CHOKED SEWER	OVER LAND TO STREAM	P-112-03	1	6/5/2010 2:30 PM
4/26/2010 3:30 AM	ALARM SYSTEM	NON-SEWER SPILL - FORD RD PUMP STATION WELL	PUMP STATION SSO	OVER LAND TO STREAM	S-046-09	141	4/26/2010 7:00 AM
3/24/2010 10:30 AM	PRIVATE PLUMBER	LINCOLN DRIVE @ MORRIS ST.	CHOKED SEWER	OUTFALL TO STREAM	W068-05	3	3/24/2010 12:30 PM
3/23/2010 5:40 PM	CITIZEN	11301 NORCOM RD.	CHOKED SEWER	OUTFALL TO STREAM	Q-110-01	3	3/23/2010 9:30 PM
1/28/2010 10:00 AM	CITIZEN	INTERSECTION 0F ANNAPOLIS & BROOKDALE RD.	CHOKED SEWER	OVER LAND TO STREAM	P-101-02	0.75	1/28/2010 2:00 PM
1/19/2010 12:00 PM	CITIZEN	9900 HALDEMAN AVE.	CHOKED SEWER	OUTFALL TO STREAM	P-105-13A	1	1/19/2010 1:00 PM
12/28/2009 11:30 AM	CHELTENHA M SUPERINTEN DANT	201 COTTMAN AVE.	CHOKED SEWER	OUTFALL TO STREAM	Out of City	2	12/28/2009 11:30 PM
12/26/2009 11:00 AM	CITIZEN	300 LEVERINGTON AVE	CHOKED SEWER	OUTFALL TO STREAM	S-059-04	5	12/28/2009 2:00 PM
11/18/2009 12:40 PM	CHARTER SCHOOL	1443 RHAWN ST	CHOKED SEWER	OUTFALL TO STREAM	P-090-02	1	11/18/2009 2:10 PM
10/13/2009 3:10 PM	CITIZEN	300 DOMINO LA	DEFECTIV E SEWER PIPE	OVER LAND TO STREAM	S-058-01	< 2	10/13/2009 6:00 PM
10/9/2009 12:00 PM	VACTOR OPERATOR	10666 HALSTEAD ST	CHOKED SEWER	N/A	P-113-04	1	10/9/2009
8/30/2009 3:00 AM	EMERGENCY DESK	4200 MONUMENT ROAD	DEFECTIV E SEWER PIPE	OVER LAND TO COMBINED SYSTEM	S-20-011	1	8/30/2009 12:00 PM
8/26/2009 2:40 PM	CITIZEN	13360 PHILMONT AVE	CHOKED SEWER	BASEMENT	Q-120-02	N/A	8/26/2009 6:40 PM
8/16/2009 9:00 AM	EMERGENCY DESK	5101 ROCHELLE AVE	CHOKED SEWER	OUTFALL TO STREAM	S-052-05	20	8/16/2009 11:46 AM

Figure F.8.g.iii-1 FY 2010 Sanitary Infiltration Locations



F.8.h. Spill Prevention and Response

The City's response plan to respond to and contain harmful spills that may discharge to the municipal separate storm sewer system is managed by the Philadelphia Local Emergency Planning Committee. PWD is represented by the Industrial Waste Unit, whose personnel are charged with response to such events. The plan for spill response in Philadelphia is the Citywide Hazmat Response Plan - Annex F to the City's Emergency Operations Plan, found in **ADDITIONAL DOCUMENTS FOLDER IN THE SUPPLEMENTAL CD.**

In order to protect the Philadelphia Water Department's structures and treatment processes, IWU personnel respond to oil and chemical spills and other incidents that have the potential to threaten the water supply or impact the sewer system, twenty-four hours per day, seven days per week. They supervise cleanup activities and assess environmental impact. The inspectors also investigate various other types of complaints. Please refer to **SECTIONS F.7.A AND F.8.J** for information regarding the nature of IWU responses during FY 2010.

F.8.i. Public Reporting of Illicit Discharges, Improper Disposal

The City vigorously encourages public citizens to report the occurrence of illicit discharges that may impact the sewer system and water bodies. To facilitate the timely reporting of such events, PWD operates a 24 Hour/Day, 7 Day/Week Municipal Dispatcher to handle reports from the public. The direct numbers for the Dispatcher are (215) 686-4514 or (215) 686-4515. In addition, a customer service hotline is also operated that provides the ability to connect to the Dispatcher. This information is distributed in mailings, as well as online at http://www.phila.gov/water/contact_us.html.

Upon the reporting of such an incident, a PWD inspector is immediately dispatched to the site to investigate and determine the source of the discharge, as well as the extent of impact on the receiving water body. Each incident is logged into an electronic database that enables tracking of the details of each occurrence.

Philly 311

In addition the numbers listed above, Philly311 was created helps eliminate the need to sort through the 500 phone numbers and hotlines available to contact the City government. Call 3-1-1 and a customer service specialist will connect you to the information and services you need. For more information on uses of Philly 311 please visit: http://www.phila.gov/311/.

F.8.j. Used Oil and Toxic Material Disposal

The City continues to facilitate the proper disposal of used oil and other toxic materials. This program includes collections events, distribution of educational materials, the operation of a website, and a hotline accessible to the public.

The Streets Department conducts Household Hazardous Waste (HHW) Events several times throughout the city where people can properly dispose of used oil and other toxic materials. For more information on the FY10 HHW event please refer to **SECTION**

F.2.STEP 2.G on page 258 or visit the Streets Department's website at http://www.philadelphiastreets.com/hazardous-waste.aspx.

F.8.k. Storm Water Inlet Labeling/Stenciling

Philadelphia resident's received brochures in their water bills throughout February and March (2010), inviting them to voluntarily participate in Storm Drain Marking to help educate the public about reducing stormwater runoff pollution. Over 350 volunteer groups registered to participate this year for an estimated total of over 11,000 storm drains marked. Supplies and additional educational materials were distributed in April (2010). Volunteers completed their projects and returned Final Reports to get their "Yo! No Dumping, Drains to River" t-shirts. The t-shirts are an extra thank you to the volunteers and also are wearable advertisements for Philadelphia Water Department, Storm Drain Marking Project and stormwater runoff pollution prevention.

Section G Assessment of Controls

Annually estimate pollutant loadings & reductions from stormwater management plan

The City of Philadelphia has implemented multiple best management practices (BMPs), technologies, plan review methods, and watershed planning efforts in order to achieve the goals of the NPDES Permit. The goals of the permit aim to improve the quality of stormwater runoff, and to reduce the quantity and rate of stormwater reaching the MS4 system and receiving waters.

Each section of this Annual Report presents not only the projects and activities of the Stormwater Management Program, but also the effectiveness and success of the multiple BMPs, technologies, planning efforts, and miscellaneous programs in order to track the progress of the Stormwater Management Program.

Section H Fiscal Resources

H.1 Maintain adequate program funding

The Stormwater Management Program is funded from the City's Water Fund, supported by revenue from water and sewer rates. The Water and Wastewater Funds are required under the General Ordinance to be held separate and apart from all other funds and accounts of the City. The Fiscal Agent and the funds and accounts therein shall not be commingled with, loaned or transferred among themselves or to any other City funds or accounts except as expressly permitted by the General Ordinance. During the reporting period, the City provided fiscal resources needed to support operation and maintenance of the Stormwater Management Program as outlined in **TABLE H-1** below. The table presents fiscal year budgets for both the reporting year as well as the upcoming fiscal year.

Table H-1 Fiscal Resources

Program	**FY 2010 Budget**	**FY 2011 Budget**
Office of Watersheds	$9.585 Million	$10.517 Million
Collector Systems Support	$1.184 Million	$0.653 Million
Sewer Maintenance and Flow Control	$22.668 Million	$23.611 Million
Inlet Cleaning	$4.568 Million	$4.452 Million
Abatement of Nuisances	$6.916 Million	$7.187 Million
Sewer Reconstruction	$22.5 Million	$22.5 Million
Public Affairs and Education	$5.099 Million	$5.467 Million
Total	$72.520 Million	$74.387 Million

H.2 Annually submit fiscal analysis

The conditions of the NPDES permit are able to be achieved through appropriate budget planning supporting the projects and assessments critical to a successful program. Any funding changes will be included as part of subsequent annual reports.

APPENDIX A – FISCAL YEAR 2010 FLOW CONTROLS UNIT ANNUAL REPORT

PWD FLOW CONTROL UNIT

COMBINED SEWER OVERFLOW MAINTENANCE

FISCAL YEAR 2010

PART 1					PHILADELPHIA WATER DEPARTMENT						Section 1	
DRY WEATHER STATUS					WASTE AND STORM WATER COLLECTION							
REPORT					FLOW CONTROL UNIT							

COLLECTOR	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Totals
UPPER PENNYPACK - 5 UNITS													
INSPECTIONS	15	10	11	11	11	17	12	18	18	13	17	11	164
DISCHARGES	0	0	0	0	0	0	0	0	0	0	0	0	0
BLOCKS CLEARED	1	0	0	0	0	1	0	0	0	0	0	0	2
UPPER DELAWARE LOW LEVEL - 12 UNITS													
INSPECTIONS	28	20	28	26	23	35	38	41	36	35	33	31	374
DISCHARGES	0	0	0	0	0	0	0	0	0	0	0	0	0
BLOCKS CLEARED	4	2	0	1	0	3	0	0	0	0	0	0	10
LOWER FRANKFORD CREEK - 6 UNITS													
INSPECTIONS	16	9	13	13	6	14	12	18	31	15	6	15	168
DISCHARGES	0	0	0	0	0	0	0	0	0	0	0	0	0
BLOCKS CLEARED	6	0	4	2	0	3	0	0	0	0	1	1	17
LOWER FRANKFORD LOW LEVEL - 10 UNITS													
INSPECTIONS	23	16	17	22	15	23	24	23	31	24	16	26	260
DISCHARGES	0	1	0	0	0	0	0	0	0	0	0	0	1
BLOCKS CLEARED	0	2	1	4	1	2	0	0	0	0	0	0	10
FRANKFORD HIGH LEVEL - 14 UNITS													
INSPECTIONS	41	55	29	28	23	27	28	33	35	43	18	37	397
DISCHARGES	3	2	0	0	0	0	1	0	0	2	0	0	8
BLOCKS CLEARED	0	4	1	0	0	0	2	0	0	1	0	0	8
SOMERSET - 9 UNITS													
INSPECTIONS	33	29	22	33	22	23	25	28	29	24	27	27	322
DISCHARGES	0	0	0	0	0	0	0	0	0	0	0	0	0
BLOCKS CLEARED	0	4	2	2	2	5	4	0	3	2	1	3	28
LOWER DELAWARE LOW LEVEL - 33 UNITS													
INSPECTIONS	89	81	93	78	106	101	66	97	98	65	76	81	1031
DISCHARGES	0	0	0	0	0	0	0	0	1	0	1	0	2
BLOCKS CLEARED	1	3	5	4	6	1	0	0	2	1	2	4	29
CENTRAL SCHUYLKILL EAST - 18 UNITS													
INSPECTIONS	79	54	65	78	57	90	61	87	81	71	43	62	828
DISCHARGES	0	0	0	0	0	0	0	0	0	0	0	0	0
BLOCKS CLEARED	10	5	4	1	1	2	0	0	5	1	1	0	30
LOWER SCHUYLKILL EAST - 9 UNITS													
INSPECTIONS	25	24	21	24	29	29	15	26	27	21	23	25	289
DISCHARGES	0	0	0	0	0	0	0	0	0	0	0	0	0
BLOCKS CLEARED	2	5	4	0	3	4	1	0	3	0	1	1	24
CENTRAL SCHUYLKILL WEST - 9 UNITS													
INSPECTIONS	28	50	31	41	31	30	34	32	35	23	22	25	382
DISCHARGES	0	2	0	0	0	0	0	0	0	0	0	0	2
BLOCKS CLEARED	1	9	5	0	0	0	1	1	1	0	1	0	19
SOUTHWEST MAIN GRAVITY - 10 UNITS													
INSPECTIONS	40	36	40	49	39	44	31	34	43	37	37	32	462
DISCHARGES	0	0	0	0	0	0	0	0	0	0	0	0	0
BLOCKS CLEARED	2	2	5	1	0	1	0	0	5	0	0	0	16
LOWER SCHUYLKILL WEST - 4 UNITS													
INSPECTIONS	28	24	19	17	20	27	14	20	31	23	25	20	268
DISCHARGES	0	1	0	0	0	0	0	0	0	0	0	0	1
BLOCKS CLEARED	1	0	1	1	2	0	1	1	1	0	0	1	9
COBBS CREEK HIGH LEVEL - 23 UNITS													
INSPECTIONS	79	76	48	74	63	74	62	46	100	49	44	43	758
DISCHARGES	1	1	0	0	0	0	0	0	1	0	0	1	4
BLOCKS CLEARED	1	3	1	2	2	4	1	0	1	2	0	1	18
COBBS CREEK LOW LEVEL - 13 UNITS													
INSPECTIONS	28	35	30	31	25	22	24	16	23	18	18	16	286
DISCHARGES	0	0	0	0	0	0	0	0	0	0	0	0	0
BLOCKS CLEARED	0	2	1	2	0	0	0	0	0	1	1	2	9
RELIEF SEWERS - 26 UNITS													
INSPECTIONS	57	25	46	55	52	72	43	43	59	52	46	52	602
DISCHARGES	0	0	0	0	1	0	0	0	0	0	0	0	1
BLOCKS CLEARED	0	2	0	0	0	0	0	0	0	0	0	0	2
TOTALS / MONTH for 201 REGULATOR UNITS													Totals
TOTAL INSPECTIONS	609	544	513	580	522	628	489	562	677	513	451	503	6591
TOTAL DISCHARGES	4	7	0	0	1	0	1	0	2	2	1	1	19
TOTAL BLOCKS CLEARED	29	43	34	20	17	26	10	2	21	8	8	13	231
AVER. # of INSP. / BC	21	13	15	29	31	24	49	281	32	64	56	39	54
DISC / 100 INSPECTIONS	0.7	1.3	0.0	0.0	0.2	0.0	0.2	0.0	0.3	0.4	0.2	0.2	0.3

SITE	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL	AVER	DTR
UPPER PENNYPACK 5 NEWPC UNITS															
P01	3	3	2	2	2	3	2	3	3	2	3	2	30	2.5	12.2
P02	3	2	2	2	2	3	2	3	3	2	3	2	29	2.4	12.6
P03	3	2	2	2	2	6	2	3	4	3	3	2	34	2.8	10.7
P04	3	2	3	3	3	3	4	6	4	3	4	3	41	3.4	8.9
P05	3	1	2	2	2	2	2	3	4	3	4	2	30	2.5	12.2
UPPER DELAWARE LOW LEVEL 12 NEWPC UNITS															
D02	2	1	3	3	3	3	6	6	4	3	5	4	43	3.6	8.5
D03	2	2	2	2	2	3	4	3	3	2	3	2	30	2.5	12.2
D04	4	2	3	3	3	3	3	4	4	3	3	3	38	3.2	9.6
D05	3	2	3	2	6	2	3	2	3	7	5	2	40	3.3	9.1
D06	2	2	2	2	1	3	2	3	3	4	4	2	30	2.5	12.2
D07	2	2	3	2	1	3	2	5	3	3	3	4	33	2.8	11.1
D08	2	2	2	2	1	3	4	3	3	3	2	2	29	2.4	12.6
D09	2	2	2	2	1	3	2	3	3	2	2	4	28	2.3	13.0
D11	2	1	2	2	2	3	3	2	3	2	2	2	26	2.2	14.0
D12	2	2	2	2	1	3	3	3	2	2	1	2	25	2.1	14.6
D13	2	1	2	2	1	3	3	3	2	2	2	2	25	2.1	14.6
D15	3	1	2	2	1	3	3	4	3	2	1	2	27	2.3	13.5
LOWER FRANKFORD CREEK 6 NEWPC UNITS															
F13	3	3	2	3	1	2	2	4	5	3	1	3	32	2.7	11.4
F14	3	1	3	2	1	5	2	2	5	2	1	2	29	2.4	12.6
F21	2	1	2	2	1	1	2	3	6	3	1	2	26	2.2	14.0
F23	4	1	2	2	1	2	2	3	5	2	1	2	27	2.3	13.5
F24	2	1	2	2	1	2	2	3	6	2	1	4	28	2.3	13.0
F25	2	2	2	2	1	2	2	3	4	3	1	2	26	2.2	14.0
LOWER FRANKFORD LOW LEVEL 10 NEWPC UNITS															
F03	2	1	2	2	1	2	3	2	2	3	3	3	26	2.2	14.0
F04	2	1	2	2	1	2	2	2	2	2	1	2	21	1.8	17.4
F05	3	1	2	2	3	2	4	2	4	3	2	4	32	2.7	11.4
F06	3	1	2	2	2	2	3	2	3	3	2	3	28	2.3	13.0
F07	1	1	1	2	1	2	2	2	2	2	1	2	19	1.6	19.2
F08	2	6	1	2	1	3	2	2	3	2	1	2	27	2.3	13.5
F09	4	2	2	4	2	5	2	3	8	3	2	3	40	3.3	9.1
F10	2	1	2	3	1	1	2	3	3	2	1	2	23	1.9	15.9
F11	2	1	1	1	1	2	2	2	2	2	1	2	19	1.6	19.2
F12	2	1	2	2	2	2	2	3	2	2	2	3	25	2.1	14.6
FRANKFORD HIGH LEVEL 14 NEWPC UNITS															
T01	2	1	1	2	1	2	1	2	2	3	1	3	21	1.8	17.4
T03	3	2	2	2	2	2	3	2	4	6	1	4	33	2.8	11.1
T04	2	3	2	2	2	2	4	3	2	4	1	4	31	2.6	11.8
T05	2	2	1	2	1	2	2	2	2	4	1	2	23	1.9	15.9
T06	2	3	1	1	1	2	2	3	2	4	1	2	24	2.0	15.2
T07	1	2	1	1	1	2	1	2	2	3	1	2	19	1.6	19.2
T08	1	2	2	1	2	2	2	2	3	3	1	2	23	1.9	15.9
T09	1	7	1	1	1	2	1	2	2	3	1	2	24	2.0	15.2
T10	2	3	2	2	2	2	4	3	3	4	2	3	32	2.7	11.4
T11	2	2	2	2	2	2	2	2	3	2	2	3	26	2.2	14.0
T12	3	9	2	2	1	2	1	1	3	2	2	4	32	2.7	11.4
T13	16	15	10	8	4	2	3	3	3	2	2	4	72	6.0	5.1
T14	2	2	1	1	1	2	1	3	2	1	1	1	18	1.5	20.3
T15	2	2	1	1	2	1	1	3	2	2	1	1	19	1.6	19.2

11 TOTAL DISCHARGES FOR NE & SE DISTRICTS

0.9 AVERAGE DISCHARGES PER MONTH

13.0 AVER. DAYS BEFORE RETURNING TO SITE

3.7 AVER. INSPECTIONS PER DAY PER CREW

DTR = DAYS TO RETURN TO SITE

I/D/C = INSPECTIONS PER DAY PER CREW

I/D = INSPECTIONS PER DISCHARGE

SITE	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL	AVER	DTR
SOMERSET LOW LEVEL 9 NEWPC UNITS															
D17	5	4	3	5	3	4	4	3	6	5	5	5	52	4.3	7.0
D18	4	4	2	3	2	2	2	4	3	3	3	2	34	2.8	10.7
D19	4	4	3	4	2	2	2	5	2	3	3	2	36	3.0	10.1
D20	4	4	3	7	2	4	4	5	7	4	6	5	55	4.6	6.6
D21	2	1	2	2	4	1	2	3	2	2	2	2	25	2.1	14.6
D22	3	3	3	2	2	2	2	3	2	2	2	2	28	2.3	13.0
D23	4	2	2	3	2	3	3	2	3	2	2	4	32	2.7	11.4
D24	4	2	2	1	2	2	2		2	2	2	2	23	2.1	15.9
D25	3	5	2	6	3	3	4	3	2	1	2	3	37	3.1	9.9
LOWER DELAWARE LOW LEVEL 33 SEWPC UNITS															
D37	4	3	6	4	4	7	5	6	5	1	4	5	54	4.5	6.8
D38	5	4	4	3	3	4	3	5	4	4	4	2	45	3.8	8.1
D39	3	5	6	6	4	4	2	3	20	5	3	6	67	5.6	5.4
D40	3	7	3	4	3	2	3	3	3	2	5	3	41	3.4	8.9
D41	4	2	2	2	3	3	2	3	1	1	2	2	27	2.3	13.5
D42	2	1	2	2	3	2	2	3	1	1	2	2	23	1.9	15.9
D43	2	1	2	2	4	2	2	4	1	1	2	2	25	2.1	14.6
D44	6	3	3	4	4	3	3	4	5	5	5	4	49	4.1	7.4
D45	9	2	3	5	5	4	2	3	3	5	5	3	49	4.1	7.4
D46	2	2	2	2	3	4	2	3	1	1	3	2	27	2.3	13.5
D47	3	2	2	2	3	4	3	5	1	1	2	2	30	2.5	12.2
D48	6	7	5	5	4	5	2	3	8	7	6	6	64	5.3	5.7
D49	2	2	2	3	3	4	2	3	3	1	3	2	30	2.5	12.2
D50	2	3	4	1	3	3	2	3	3	2	5	2	33	2.8	11.1
D51	1	3	2	1	2	4	2	3	1	1	2	1	23	1.9	15.9
D52	1	3	2	1	3	3	2	2	1	1	1	2	22	1.8	16.6
D53	4	2	2	1	3	3	2	2	1	1	2	2	25	2.1	14.6
D54	1	3	1	1	3	3	2	2	3	1	1	2	23	1.9	15.9
D58	2	3	2	3	4	4	2	3	2	2	2	3	32	2.7	11.4
D61	2	2	2	1	3	3	2	2	1	2	1	2	23	1.9	15.9
D62	1	2	2	1	4	3	1	2	1	1	1	2	21	1.8	17.4
D63	2	2	3	2	5	4	2	2	5	3	5	5	40	3.3	9.1
D64	2	1	2	1	3	3	1	2	1	4	1	2	23	1.9	15.9
D65	1	1	2	1	3	3	1	2	1	1	1	2	19	1.6	19.2
D66	3	1	2	1	3	3	1	2	1	1	1	2	21	1.8	17.4
D67	2	1	2	2	3	2	2	3	4	1	1	2	25	2.1	14.6
D68	2	3	6	4	3	2	2	2	2	2	1	3	32	2.7	11.4
D69	3	2	7	3	4	2	2	4	4	1	1	2	35	2.9	10.4
D70	2	3	4	2	4	2	2	3	5	3	1	2	33	2.8	11.1
D71	3	2	2	3	2	2	2	4	3	1	1	1	26	2.2	14.0
D72	2	1	2	3	3	1	2	3	2	1	1	1	22	1.8	16.6
D73	2	2	2	2	2	3	1	3	1	1	1	2	22	1.8	16.6
D75													0	0.0	
TOTAL	245	220	213	211	206	240	205	258	278	219	193	228	2716		
I/D/C	4.0	3.6	3.5	3.5	3.4	3.9	3.4	4.2	4.6	3.6	3.2	3.7			
UP	15	10	11	11	11	17	12	18	18	13	17	11	164	2.7	11.3
UDLL	28	20	28	26	23	35	38	41	36	35	33	31	374	2.6	12.1
LFC	16	9	13	13	6	14	12	18	31	15	6	15	168	2.3	13.1
LFLL	23	16	17	22	15	23	24	23	31	24	16	26	260	2.2	14.7
FHL	41	55	29	28	23	27	28	33	35	43	18	37	397	2.4	14.5
SLL	33	29	22	33	22	23	25	28	29	24	27	27	322	3.0	11.0
LDLL	89	81	93	78	106	101	66	97	98	65	76	81	1031	2.6	12.7

SITE	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
UPPER PENNYPACK 5 NEWPC UNITS													
P01													0
P02													0
P03													0
P04													0
P05													0
UPPER DELAWARE LOW LEVEL 12 NEWPC UNITS													
D02													0
D03													0
D04													0
D05													0
D06													0
D07													0
D08													0
D09													0
D11													0
D12													0
D13													0
D15													0
LOWER FRANKFORD CREEK 6 NEWPC UNITS													
F13													0
F14													0
F21													0
F23													0
F24													0
F25													0
LOWER FRANKFORD LOW LEVEL 10 NEWPC UNITS													
F03													0
F04													0
F05													0
F06													0
F07													0
F08		1											1
F09													0
F10													0
F11													0
F12													0
FRANKFORD HIGH LEVEL 14 NEWPC UNITS													
T01													0
T03										1			1
T04										1			1
T05													0
T06													0
T07													0
T08													0
T09		1											1
T10							1						1
T11													0
T12	1	1											2
T13	2												2
T14													0
T15													0

													TOTAL
UP	0	0	0	0	0	0	0	0	0	0	0	0	0
UDLL	0	0	0	0	0	0	0	0	0	0	0	0	0
LFC	0	0	0	0	0	0	0	0	0	0	0	0	0
LFLL	0	1	0	0	0	0	0	0	0	0	0	0	1
FHL	3	2	0	0	0	0	1	0	0	2	0	0	8
SLL	0	0	0	0	0	0	0	0	0	0	0	0	0
LDLL	0	0	0	0	0	0	0	0	1	0	1	0	2

SITE	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SOMERSET LOW LEVEL 9 NEWPC UNITS													
D17													0
D18													0
D19													0
D20													0
D21													0
D22													0
D23													0
D24													0
D25													0
LOWER DELAWARE LOW LEVEL 33 SEWPC UNITS													
D37													0
D38													0
D39									1				1
D40											1		1
D41													0
D42													0
D43													0
D44													0
D45													0
D46													0
D47													0
D48													0
D49													0
D50													0
D51													0
D52													0
D53													0
D54													0
D58													0
D61													0
D62													0
D63													0
D64													0
D65													0
D66													0
D67													0
D68													0
D69													0
D70													0
D71													0
D72													0
D73													0
D75													0
													TOTAL DISC
	3	3	0	0	0	0	1	0	1	2	1	0	11

NO OF UNITS IN DISTRICT BLOCKED													TOTAL
UP	0	0	0	0	0	0	0	0	0	0	0	0	0
UDLL	0	0	0	0	0	0	0	0	0	0	0	0	0
LFC	0	0	0	0	0	0	0	0	0	0	0	0	0
LFLL	0	1	0	0	0	0	0	0	0	0	0	0	1
FHL	2	2	0	0	0	0	1	0	0	2	0	0	7
SLL	0	0	0	0	0	0	0	0	0	0	0	0	0
LDLL	0	0	0	0	0	0	0	0	1	0	1	0	2

SITE	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
UPPER PENNYPACK 5 NEWPC UNITS													
P01													0
P02													0
P03	1					1							2
P04													0
P05													0
UPPER DELAWARE LOW LEVEL 12 NEWPC UNITS													
D02													0
D03	1			1		1							3
D04	1												1
D05													0
D06													0
D07													0
D08		1				1							2
D09													0
D11													0
D12													0
D13													0
D15	2	1				1							4
LOWER FRANKFORD CREEK 6 NEWPC UNITS													
F13			1	1		1							3
F14	3		2			2							7
F21													0
F23	2			1							1		4
F24	1		1									1	3
F25													0
LOWER FRANKFORD LOW LEVEL 10 NEWPC UNITS													
F03													0
F04													0
F05				1	1								2
F06		1											1
F07													0
F08				1									1
F09		1		2		2							5
F10			1										1
F11													0
F12													0
FRANKFORD HIGH LEVEL 14 NEWPC UNITS													
T01													0
T03													0
T04													0
T05													0
T06													0
T07													0
T08													0
T09		1											1
T10							1			1			2
T11													0
T12													0
T13		3	1				1						5
T14													0
T15													0

8.667 AVERAGE BLOCKAGES PER MONTH

SITE	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
SOMERSET LOW LEVEL 9 NEWPC UNITS													
D17		1	2			1			3	1	1	2	11
D18					1	1	1						3
D19		2		1		1	1						5
D20				1		2	1			1		1	6
D21		1											1
D22													0
D23							1						1
D24													0
D25					1								1
LOWER DELAWARE LOW LEVEL 33 SEWPC UNITS													
D37			1										1
D38													0
D39		1			1				1				3
D40		1		1	1								3
D41					2	1							3
D42													0
D43													0
D44				1									1
D45													0
D46													0
D47													0
D48		1	1	1						1	1	3	8
D49			1										1
D50													0
D51													0
D52													0
D53													0
D54													0
D58													0
D61												1	1
D62					1								1
D63			1										1
D64											1		1
D65													0
D66	1												1
D67													0
D68													0
D69					1								1
D70			1						1				2
D71													0
D72				1									1
D73													0
D75													0
													TOTAL
	12	15	13	13	9	15	6	0	5	4	4	8	104

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
UP	1	0	0	0	0	1	0	0	0	0	0	0	2
UDLL	4	2	0	1	0	3	0	0	0	0	0	0	10
LFC	6	0	4	2	0	3	0	0	0	0	1	1	17
LFLL	0	2	1	4	1	2	0	0	0	0	0	0	10
FHL	0	4	1	0	0	0	2	0	0	1	0	0	8
SLL	0	4	2	2	2	5	4	0	3	2	1	3	28
LDLL	1	3	5	4	6	1	0	0	2	1	2	4	29

SITE	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL	AVER	DTR
CENTRAL SCHUYLKILL EAST SIDE 18 SWWPC UNITS															
S05	4	5	4	5	4	5	3	6	6	5	3	4	54	4.5	6.8
S06	4	6	4	4	4	5	3	6	5	5	3	4	53	4.4	6.9
S07	4	6	4	4	4	5	4	6	5	5	3	4	54	4.5	6.8
S08	5	4	4	4	4	5	3	6	5	4	2	4	50	4.2	7.3
S09	4	3	4	3	2	5	3	3	4	3	4	4	42	3.5	8.7
S10	4	3	4	4	3	5	2	3	5	3	3	4	43	3.6	8.5
S12	5	4	4	5	4	6	3	6	6	4	3	4	54	4.5	6.8
S12A	5	4	4	5	4	6	3	6	5	4	2	4	52	4.3	7.0
S13	5	4	4	5	4	7	4	5	5	4	3	3	53	4.4	6.9
S15	5	4	4	5	4	6	5	5	4	4	4	3	53	4.4	6.9
S16	4	1	3	4	2	4	3	3	3	3	2	3	35	2.9	10.4
S17	4	1	3	4	3	4	3	3	3	4	2	2	36	3.0	10.1
S18	4	1	3	4	2	4	2	5	3	4	1	2	35	2.9	10.4
S19	5	1	4	6	4	7	4	6	5	5	2	3	52	4.3	7.0
S21	5	2	4	4	3	4	5	6	5	5	2	3	48	4.0	7.6
S23	4	1	2	4	2	4	4	5	6	3	2	3	40	3.3	9.1
S25	4	2	3	4	2	4	4	4	4	3	1	2	37	3.1	9.9
S26	4	2	3	4	2	4	3	3	2	3	1	6	37	3.1	9.9
LOWER SCHUYLKILL EAST SIDE 9 SWWPC UNITS															
S31	4	3	4	3	4	4	2	7	7	5	4	4	51	4.3	7.2
S35	4	3	3	3	4	4	2	3	3	3	2	3	37	3.1	9.9
S36	1	2	1	2	1	2	1		1	1	1	2	15	1.4	24.3
S36A	4	3	3	3	4	4	2	4	3	3	3	3	39	3.3	9.4
S37	1	2	1	2	1	2	1		1	1	1	2	15	1.4	24.3
S42	3	4	3	3	6	4	2	4	4	3	3	3	42	3.5	8.7
S42A	3	3	3	3	4	4	2	5	4	3	3	3	40	3.3	9.1
S44	1	2	1	2	1	2	1		1	1	1	2	15	1.4	24.3
S46	4	2	2	3	4	3	2	3	3	1	5	3	35	2.9	10.4
CENTRAL SCHUYLKILL WEST 9 SWWPC UNITS															
S01	5	15	7	7	6	5	6	5	5	2	3	3	69	5.8	5.3
S02	5	6	1	4	5	5	5	5	5	2	3	3	49	4.1	7.4
S03	6	2	1	4	3	3	3	4	4	1	3	3	37	3.1	9.9
S04	2	3	2	4	3	4	3	4	3	2	1	2	33	2.8	11.1
S11	2	2	2	4	2	2	3	4	4	2	2	2	31	2.6	11.8
S14	2	2	3	3	2	1	2	3	3	2	2	2	27	2.3	13.5
S20	2	2	3	2	1	2	2	1	2	2	2	2	23	1.9	15.9
S22	2	9	6	7	5	4	5	3	5	5	3	4	58	4.8	6.3
S24	2	9	6	6	4	4	5	3	4	5	3	4	55	4.6	6.6
SOUTHWEST MAIN GRAVITY 10 SWWPC UNITS															
S27	2	1	5	4	3	4	4	3	3	3	2	2	36	3.0	10.1
S28	2	1	4	4	4	2	3	3	2	3	2	2	32	2.7	11.4
S30	2	1	4	4	3	3	3	3	2	2	2	2	31	2.6	11.8
S34	2	2	3	4	3	2	3	1	5	2	2	2	31	2.6	11.8
S39	2	4	3	5	3	4	2	1	2	3	2	2	33	2.8	11.1
S40	2	1	2	4	3	3	1		1	1	2	2	22	2.0	16.6
S43	2	1	2	4	4	2	2	2	2	2	2	2	27	2.3	13.5
S47	2	3	1	4	3	3	2	2	3	2	2	2	29	2.4	12.6
S50	15	17	10	8	7	12	8	11	13	11	12	10	134	11.2	2.7
S51	9	5	6	8	6	9	3	8	10	8	9	6	87	7.3	4.2
LOWER SCHUYLKILL WEST SIDE 4 SWWPC UNITS															
S32	7	4	5	5	5	5	3	5	7	6	6	5	63	5.3	5.8
S33	6	5	5	4	5	10	4	6	8	7	7	5	72	6.0	5.1
S38	7	12	5	4	5	7	3	5	7	4	8	5	72	6.0	5.1
S45	8	3	4	4	5	5	4	4	9	6	4	5	61	5.1	6.0

SITE	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL	AVER	DTR
COBBS CREEK HIGH LEVEL 23 SWWPC UNITS															
C01	3	4	2	4	3	3	3	3	5	2	2	2	36	3.0	10.1
C02	3	4	2	5	3	3	3	1	5	2	2	2	35	2.9	10.4
C04	3	3	2	3	2	4	3	3	5	2	2	2	34	2.8	10.7
C04A	3	3	2	3	2	2	3	2	5	2	1	1	29	2.4	12.6
C05	3	3	2	3	2	2	2	3	5	2	1	1	29	2.4	12.6
C06	4	4	3	3	3	5	3	4	5	3	2	3	42	3.5	8.7
C07	4	4	1	3	3	4	3	4	6	3	2	3	40	3.3	9.1
C09	3	3	2	3	3	4	2	2	3	3	2	3	33	2.8	11.1
C10	3	3	2	4	2	5	1	2	3	2	2	2	31	2.6	11.8
C11	3	2	1	3	2	3	1	2	3	2	2	1	25	2.1	14.6
C12	3	2	1	3	2	2	1	2	3	2	2	1	24	2.0	15.2
C13	3	4	2	3	2	2	1	2	3	2	2	1	27	2.3	13.5
C14	4	3	3	2	3	5	2	1	6	2	2	2	35	2.9	10.4
C15	4	2	3	3	3	3	3	1	2	2	2	1	29	2.4	12.6
C16	3	2	3	3	3	3	3	1	2	2	2	1	28	2.3	13.0
C17	2	2	3	3	3	3	2	2	2	2	1	1	26	2.2	14.0
C31	4	4	2	3	3	4	5	2	7	2	3	4	43	3.6	8.5
C32	4	4	2	3	3	3	3	2	5	2	1	1	33	2.8	11.1
C33	4	4	2	3	3	4	4	2	5	2	3	2	38	3.2	9.6
C34	4	4	2	3	4	3	4	1	5	2	2	2	36	3.0	10.1
C35	4	4	2	3	3	2	4	1	5	2	2	2	34	2.8	10.7
C36	4	4	2	5	3	2	3	1	5	2	2	2	35	2.9	10.4
C37	4	4	2	3	3	3	3	2	5	2	2	3	36	3.0	10.1
COBBS CREEK LOW LEVEL 13 SWWPC UNITS															
C18	2	2	3	3	3	3	2	2	2	2	4	1	29	2.4	12.6
C19	2	2	3	3	1	1	2	1	2	2	2	1	22	1.8	16.6
C20	2	3	4	4	2	2	2	2	2	2	1	3	29	2.4	12.6
C21	2	2	2	2	2	2	2	2	2	2	1	1	22	1.8	16.6
C22	2	3	2	2	2	3	2	2	2	1	1	1	23	1.9	15.9
C23	2	3	2	2	2	3	2	1	2	1	1	1	22	1.8	16.6
C24	2	2	2	3	2	1	2	1	2	1	1	1	20	1.7	18.2
C25	3	3	2	2	3	2	2	2	2	2	2	2	27	2.3	13.5
C26	2	3	2	2	1	1	2	1	2	1	1	1	19	1.6	19.2
C27	3	3	2	2	2	1	2	1	2	1	1	1	21	1.8	17.4
C28A	2	3	2	2	1	1	2	1	1	1	1	1	18	1.5	20.3
C29	2	3	2	2	2	1	1		1	1	1	1	17	1.5	21.5
C30	2	3	2	2	2	1	1		1	1	1	1	17	1.5	21.5
TOTAL	307	299	254	314	264	316	241	261	340	242	212	223	3273		
I/D/C	3.4	3.3	2.8	3.4	2.9	3.5	2.6	2.9	3.7	2.7	2.3	2.4			
CSES	79	54	65	78	57	90	61	87	81	71	43	62	828	3.8	8.2
LSES	25	24	21	24	29	29	15	26	27	21	23	25	289	2.7	14.2
CSW	28	50	31	41	31	30	34	32	35	23	22	25	382	3.5	9.7
SWMG	40	36	40	49	39	44	31	34	43	37	37	32	462	3.9	10.6
LSW	28	24	19	17	20	27	14	20	31	23	25	20	268	5.6	5.5
CCHL	79	76	48	74	63	74	62	46	100	49	44	43	758	2.7	11.3
CCLL	28	35	30	31	25	22	24	16	23	18	18	16	286	1.9	17.1

7 TOTAL DISCHARGES IN SW DISTRICT — DTR = DAYS TO RETURN TO SITE

0.6 AVERAGE DISCHARGES PER MONTH — I/D/C = INSPECTIONS PER DAY PER CREW

10.9 AVER. DAYS BEFORE RETURNING TO SITE — I/D = INSPECTIONS PER DISCHARGE

3.0 AVER. INSPECTIONS PER DAY PER CREW

SITE	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
CENTRAL SCHUYLKILL EAST SIDE 18 SWWPC UNITS													
S05													0
S06													0
S07													0
S08													0
S09													0
S10													0
S12													0
S12A													0
S13													0
S15													0
S16													0
S17													0
S18													0
S19													0
S21													0
S23													0
S25													0
S26													0
LOWER SCHUYLKILL EAST SIDE 9 SWWPC UNITS													
S31													0
S35													0
S36													0
S36A													0
S37													0
S42													0
S42A													0
S44													0
S46													0
CENTRAL SCHUYLKILL WEST 9 SWWPC UNITS													
S01		1											1
S02													0
S03													0
S04													0
S11													0
S14													0
S20													0
S22		1											1
S24													0
SOUTHWEST MAIN GRAVITY 10 SWWPC UNITS													
S27													0
S28													0
S30													0
S34													0
S39													0
S40													0
S43													0
S47													0
S50													0
S51													0
LOWER SCHUYLKILL WEST SIDE 4 SWWPC UNITS													
S32													0
S33													0
S38		1											1
S45													0

SITE	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
COBBS CREEK HIGH LEVEL 23 SWWPC UNITS													
C01													0
C02													0
C04													0
C04A													0
C05													0
C06													0
C07													0
C09													0
C10													0
C11													0
C12													0
C13		1											1
C14	1								1				2
C15													0
C16													0
C17													0
C31												1	1
C32													0
C33													0
C34													0
C35													0
C36													0
C37													0
COBBS CREEK LOW LEVEL 13 SWWPC UNITS													
C18													0
C19													0
C20													0
C21													0
C22													0
C23													0
C24													0
C25													0
C26													0
C27													0
C28A													0
C29													0
C30													0
													TOTAL DISC
	1	4	0	0	0	0	0	0	1	0	0	1	7

NO OF UNITS IN DISTRICT BLOCKED													TOTAL
CSE	0	0	0	0	0	0	0	0	0	0	0	0	0
LSE	0	0	0	0	0	0	0	0	0	0	0	0	0
CSW	0	2	0	0	0	0	0	0	0	0	0	0	2
SWG	0	0	0	0	0	0	0	0	0	0	0	0	0
LSW	0	1	0	0	0	0	0	0	0	0	0	0	1
CCHL	1	1	0	0	0	0	0	0	1	0	0	1	4
CCLL	0	0	0	0	0	0	0	0	0	0	0	0	0

NO OF DISCHARGES IN DISTRICT													TOTAL
CSE	0	0	0	0	0	0	0	0	0	0	0	0	0
LSE	0	0	0	0	0	0	0	0	0	0	0	0	0
CSW	0	2	0	0	0	0	0	0	0	0	0	0	2
SWG	0	0	0	0	0	0	0	0	0	0	0	0	0
LSW	0	1	0	0	0	0	0	0	0	0	0	0	1
CCHL	1	1	0	0	0	0	0	0	1	0	0	1	4
CCLL	0	0	0	0	0	0	0	0	0	0	0	0	0

SITE	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
CENTRAL SCHUYLKILL EAST SIDE 18 SWWPC UNITS													
S05											1		1
S06	1	1											2
S07		1	1										2
S08									1				1
S09													0
S10													0
S12	1												1
S12A													0
S13													0
S15		2	1										3
S16	1								1				2
S17													0
S18	1								1				2
S19	1				1								2
S21				1									1
S23	2		1			2			2	1			8
S25	3	1											4
S26			1										1
LOWER SCHUYLKILL EAST SIDE 9 SWWPC UNITS													
S31	1	1	1		1	3							7
S35									1				1
S36									1			1	2
S36A		1	1		1								3
S37													0
S42			1		1	1			1				4
S42A	1	2	1								1		5
S44		1											1
S46							1						1
CENTRAL SCHUYLKILL WEST 9 SWWPC UNITS													
S01		2	1										3
S02		3											3
S03	1												1
S04													0
S11									1		1		2
S14			2					1					3
S20													0
S22		3	1										4
S24		1	1				1						3
SOUTHWEST MAIN GRAVITY 10 SWWPC UNITS													
S27			1										1
S28			1			1							2
S30			2										2
S34									1				1
S39				1									1
S40													0
S43			1										1
S47		1											1
S50	2	1							2				5
S51									2				2
LOWER SCHUYLKILL WEST SIDE 4 SWWPC UNITS													
S32			1					1	1				3
S33				1	2							1	4
S38	1						1						2
S45													0

10.42 AVERAGE BLOCKAGES PER MONTH

SITE	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
COBBS CREEK HIGH LEVEL 23 SWWPC UNITS													
C01													0
C02						1							1
C04													0
C04A													0
C05													0
C06				1	1	1							3
C07													0
C09		1											1
C10													0
C11													0
C12													0
C13													0
C14	1	1	1							1			4
C15													0
C16													0
C17													0
C31									1				1
C32						1							1
C33						1							1
C34		1			1								2
C35							1					1	2
C36				1									1
C37										1			1
COBBS CREEK LOW LEVEL 13 SWWPC UNITS													
C18													0
C19											1	1	2
C20		1	1	1						1		1	5
C21													0
C22													0
C23													0
C24													0
C25		1											1
C26													0
C27													0
C28A													0
C29				1									1
C30													0
TOTAL	17	26	21	7	8	11	4	2	16	4	4	5	125

CSE	10	5	4	1	1	2	0	0	5	1	1	0	30
LSE	2	5	4	0	3	4	1	0	3	0	1	1	24
CSW	1	9	5	0	0	0	1	1	1	0	1	0	19
SWG	2	2	5	1	0	1	0	0	5	0	0	0	16
LSW	1	0	1	1	2	0	1	1	1	0	0	1	9
CCHL	1	3	1	2	2	4	1	0	1	2	0	1	18
CCLL	0	2	1	2	0	0	0	0	0	1	1	2	9

June 2009 RELIEF SEWER MONTHLY INSPECTION

SITE	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
THOMAS RUN RELIEF SEWER													
R01	3	1	2	3	4	4	3	3	4	2	3	2	34
R02	3	1	2	3	5	4	3	3	4	2	2	2	34
R03	3	1	2	3	3	4	3	3	4	2	2	2	32
R04	3	1	2	3	3	3	2	1	3	2	2	2	27
R05	3	1	2	2	3	3	2	1	3	2	2	2	26
R06	3	1	2	2	3	3	2	1	3	2	2	2	26
MAIN RELIEF SEWER													
R07	2	2	2	2	2	2	2	1	3	2	2	3	25
R08	2	2	2	2	1	3	2	1	3	2	2	3	25
R09	2	2	2	2	1	3	2	1	3	3	2	3	26
R10	2	2	2	2	1	3	2	1	2	2	2	2	23
R11	2	1	2	2	1	3	2	1	2	2	2	2	22
R11A	2		2	2	1	3	2	1	2	3	2	2	22
R12	2		2	2	1	3	1	1	2	3	2	2	21
WAKLING RELIEF SEWER													
R13	1	1	1	2	3	3	1	1	2	1	1	2	19
R14	1	1	1	2	3	3	1	1	2	1	1	2	19
ROCK RUN STORM FLOOD RELIEF SEWER													
R15	3	1	2	2	2	3	2	4	2	1	2	2	26
OREGON AVE RELIEF SEWER													
R16	2	1	2	1		3	1	1	1		1	1	14
R17	2	1	2	1		3	1	1	1		1	1	14
FRANKFORD HIGH LEVEL RELIEF SEWER													
R18	3	1	2	2	2	4	2	3	2	12	2	2	37
32ND ST RELIEF SEWER													
R19	3	1	2	2	2	1	1	3	2	1	4	2	24
MAIN STREET RELIEF SEWER													
R20	3	1	1	3	3	1	1	3	2	1	1	2	22
SOMERSET SYSTEM DIVERSION CHAMBER													
R21													0
TEMPORARY REGULATOR CHAMBER													
R22													
R23	2	1	1	3	1	1	1	3	1		1	3	18
ARCH ST RELIEF SEWER													
R24	2		2	2	3	3	1	1	2	3	2	2	23
16TH & SNYDER													
R25	2		2	2	2	3	1	1	2	2	2	2	21
GRANT & STATE RD. RELIEF													
R26	1	1	2	3	2	3	2	2	2	1	1	2	22
TOTAL	57	25	46	55	52	72	43	43	59	52	46	52	602
AVER	2.1	0.9	1.7	2.0	1.9	2.7	1.6	1.6	2.2	1.9	1.7	1.9	1.9

RELIEF SEWER MONTHLY DISCHARGE

SITE	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
THOMAS RUN RELIEF SEWER													
R01													0
R02					1								1
R03													0
R04													0
R05													0
R06													0
MAIN RELIEF SEWER													
R07													0
R08													0
R09													0
R10													0
R11													0
R11A													0
R12													0
WAKLING RELIEF SEWER													
R13													0
R14													0
ROCK RUN STORM FLOOD RELIEF SEWER													
R15													0
OREGON AVE RELIEF SEWER													
R16													0
R17													0
FRANKFORD HIGH LEVEL RELIEF SEWER													
R18													0
32ND ST RELIEF SEWER													
R19													0
MAIN STREET RELIEF SEWER													
R20													0
SOMERSET SYSTEM DIVERSION CHAMBER													
R21													0
TEMPORARY REGULATOR CHAMBER													
R22													0
R23													0
ARCH ST RELIEF SEWER													
R24													0
16TH & SNYDER													
R25													0
GRANT & STATE RD. RELIEF													
R26													0
TOTAL	0	0	0	0	1	0	0	0	0	0	0	0	1
UNITS	0	0	0	0	1	0	0	0	0	0	0	0	

June 2009 RELIEF SEWER MONTHLY BLOCKS CLEARED

PAGE 7

SITE	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
THOMAS RUN RELIEF SEWER													
R01													0
R02													0
R03													0
R04		1											1
R05		1											1
R06													0
MAIN RELIEF SEWER													
R07													0
R08													0
R09													0
R10													0
R11													0
R11A													0
R12													0
WAKLING RELIEF SEWER													
R13													0
R14													0
ROCK RUN STORM FLOOD RELIEF SEWER													
R15													0
OREGON AVE RELIEF SEWER													
R16													0
R17													0
FRANKFORD HIGH LEVEL RELIEF SEWER													
R18													0
32ND ST RELIEF SEWER													
R19													0
MAIN STREET RELIEF SEWER													
R20													0
SOMERSET SYSTEM DIVERSION CHAMBER													
R21													0
TEMPORARY REGULATOR CHAMBER													
R22													0
R23													0
ARCH ST RELIEF SEWER													
R24													0
16TH & SNYDER													
R25													0
GRANT & STATE RD. RELIEF													
R26													0
TOTAL	0	2	0	0	0	0	0	0	0	0	0	0	2
AVER	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

FY2010 CSO Dry Weather Discharges

Discharge Observed		Discharge Stopped		Last Inspection						
DateDO	TimeDO	DateDS	TimeDS	DateLI	TimeLI	SiteID	Collector	TypeUnit	Location	Comment
07/07/09	10:10 AM	07/07/09	12:40 PM	06/22/09	09:20 AM	C-14	CCHL	SLOT	Baltimore Ave. & Cobbs Creek	DEBRIS AND SMALL LOG IN SLOT.
07/16/09	08:40 AM	07/16/09	09:30 AM	06/26/09	10:40 AM	T-12	FHL	SLOT	Whitaker Ave. E of Tacony Creek	TREE BRANCHES AND DEBRIS IN SLOT.
07/18/09	11:00 AM	07/18/09	12:50 PM	07/16/09	09:40 AM	T-13	FHL	SLOT	Whitaker Ave. W of Tacony Creek	WOOD AND DEBRIS IN SLOT.
07/27/09	01:10 PM	07/27/09	06:00 PM	07/24/09	08:50 AM	T-13	FHL	SLOT	Whitaker Ave. W of Tacony Creek	DWO PIPE BLOCKED WITH DEBRIS.
08/03/09	09:00 AM	08/03/09	09:50 AM	07/17/09	08:50 AM	T-12	FHL	SLOT	Whitaker Ave. E of Tacony Creek	ROCKS AND GRIT IN SLOT BOX.
08/06/09	12:50 PM	08/06/09	04:30 PM	07/29/09	11:30 AM	C-13	CCHL	SLOT	62nd St. @ Cobbs Creek	SLOT BOX FULL OF GRIT.
08/07/09	11:40 AM	08/07/09	02:00 PM	07/31/09	01:40 PM	S-01	CSW	B & B	Mantua Ave. & West River Dr.	SHUTTERGATE STUCK IN CLOSE POSITION.
08/11/09	09:10 AM	08/11/09	12:20 PM	08/07/09	09:10 AM	S-38	LSWS	B & B	56th St. E of P&R RR	TREE BRANCHES AND DEBRIS BLOCKING DWO PIPE.
08/11/09	01:40 PM	08/11/09	02:50 PM	08/03/09	01:00 PM	S-22	CSW	B & B	660 ft S of South St E of Penn Field	SHUTTER GATE STUCK IN CLOSE POSITION.
08/12/09	12:30 PM	08/12/09	01:30 PM	07/15/09	09:00 AM	F-08	LFLL	WH-S	Erie Ave. & Hunting Park Ave.	TREE BRANCHES AND DEBRIS BLOCKING DWO OUTLET PIPE.
08/18/09	02:30 PM	08/18/09	03:40 PM	07/17/09	10:50 AM	T-09	FHL	SLOT	Roosevelt Blvd. W of Tacony Creek	SLOT BOX FILLED WITH GRIT.
11/05/09	02:10 PM	11/05/09	05:20 PM	10/29/09	02:20 PM	R-02		DAM	56th St. & Spruce St. (North)	BUCKET,JACKET,TRASH AND DEBRIS BLOCKING PIPE.
01/26/10	01:30 PM	01/26/10	05:30 PM	01/12/10	11:40 AM	T-10	FHL	SLOT	Roosevelt Blvd. E of Tacony Creek	DWO PIPE BLOCKED WITH DEBRIS AND BOTTLES.
03/17/10	09:00 AM	03/17/10	08:30 PM	03/16/10	09:20 AM	D-39	LDLL	B & B	Susquehanna Ave. E of Beach St.	DEBRIS BLOCKAGE IN DWO PIPE.
03/17/10	02:20 PM	03/17/10	03:00 PM	03/04/10	11:10 AM	C-14	CCHL	SLOT	Baltimore Ave. & Cobbs Creek	GRIT AND DEBRIS IN SLOT.
04/09/10	11:00 AM	04/09/10	11:10 AM	04/08/10	02:20 PM	T-04	FHL	SLOT	Rising Sun Ave. E of Tacony Creek	DEBRIS IN SLOT.
04/28/10	02:20 PM	04/28/10	03:00 PM	04/14/10	09:20 AM	T-03	FHL	SLOT	Champlost Ave. W of Tacony Creek	GREASE IN SLOT.
05/14/10	09:20 AM	05/14/10	02:10 PM	05/05/10	11:20 AM	D-40	LDLL	SLOT	Berks St. E of Beach St.	WATER MAIN BREAK ON DELAWARE AND BERKS, UNIT COULD NOT HANDLE FLOW.
06/29/10	03:30 PM	06/29/10	04:40 PM	06/17/10	11:40 AM	C-31	CCHL	SLOT	Cobbs Creek Park S of City Line Ave.	WOOD, CLOTHES AND DEBRIS IN SLOT. WOOD IN DWO.

Collector System - Flow Control Unit - Miscellaneous Major Maintenance - FY 2010

SOMERSET GRIT CHAMBER - GRIT REMOVAL REMOVAL

DATE	TONS
1/21/2009	50.0 EST
5/6/2009	50.0 EST
6/25/2009	50.0 EST
1/29/2010	50.0 EST
4/9/2010	50.0 EST
7/21/2010	50.0 EST

CSO B&B REGULATOR PREVENTATIVE MAINTENANCE

SITE	DATE
S-45	2/2/2009
S-33	2/19/2009
S-50	2/19/2009
D-65	2/19/2009
D-18	2/24/2009
S-22	2/25/2009
S-44	2/25/2009
D-47	3/17/2009
D-48	3/17/2009
S-34	3/17/2009
D-52	3/18/2009
D-19	3/19/2009
S-47	3/20/2009
D-4	3/23/2009
D-41	3/23/2009
D-44	3/23/2009
S-6	3/23/2009
S-7	3/23/2009
S-33	3/23/2009
D-62	3/24/2009
S-9	3/24/2009
S-38	3/25/2009
S-33	7/20/2009
S-50	7/20/2009
D-61	7/22/2009
D-66	7/22/2009
S-16	7/23/2009
S-18	7/23/2009
S-23	7/23/2009
S-47	7/23/2009
D-66	7/27/2009
D-72	7/28/2009
D-19	7/29/2009
S-38	8/7/2009
D-47	9/9/2009
D-20	10/26/2009
S-31	11/5/2009
S-46	11/5/2009
F-14	11/9/2009
D-21	11/16/2009
D-37	11/16/2009
D-67	11/16/2009
D-68	11/16/2009
D-48	11/18/2009
D-49	11/18/2009
D-50	11/18/2009
D-51	11/18/2009
D-58	11/18/2009
D-61	11/18/2009
S-1	11/19/2009
S-2	11/19/2009
S-42	11/20/2009
D-41	11/20/2009
S-22	11/23/2009
S-24	11/23/2009
S-42A	11/23/2009
S-43	11/23/2009
D-63	11/28/2009
D-70	11/28/2009
D-37	1/21/2010
D-37	3/24/2010
S-42	3/24/2010
S-50	3/24/2010
S-1	3/27/2010
S-2	3/27/2010
D-64	4/16/2010
D-68	4/23/2010
S-5	4/28/2010
S-6	4/28/2010
S-7	4/28/2010
S-33	4/28/2010
D-39	4/28/2010
D-17	4/28/2010
D-38	4/29/2010
D-18	4/30/2010
S-42	5/6/2010
S-9	5/21/2010
S-15	5/21/2010

CSO TIDE GATE PREVENTATIVE MAINTENANCE

SITE	DATE
D-41	10/15/2008
D-39	11/19/2008
S-7	11/19/2008
D-38	11/20/2008
S-45	11/20/2008
S-33	3/17/2009
D-47	3/17/2009
D-48	3/17/2009
D-52	3/18/2009
D-18	4/30/2010

COMPUTER CONTROL CHAMBER PREVENTATIVE MAINTENANCE

SITE	DATE	SITE	DATE
D-9	8/25/2008	D-2	8/26/2009
D-11	8/25/2008	D-3	8/26/2009
D-15	8/25/2008	D-5	8/1/2009
D-3	8/26/2008	D-7	8/20/2009
D-5	8/26/2008	D-9	8/20/2009
D-7	8/26/2008	D-11	8/1/2009
D-2	8/27/2008	D-15	8/1/2009
F-25	8/27/2008	F-25	8/31/2009
D-9	9/17/2008	D-2	9/28/2009
D-11	9/17/2008	D-3	9/28/2009
D-15	9/17/2008	D-5	9/23/2009
D-3	9/18/2008	D-7	9/25/2009
D-5	9/18/2008	D-9	9/23/2009
D-7	9/18/2008	D-11	9/29/2009
D-2	9/19/2008	D-15	9/25/2009
F-25	9/19/2008	F-25	9/29/2009
D-2	10/15/2008	D-2	10/21/2009
D-3	10/15/2008	D-3	10/21/2009
D-5	10/15/2008	D-5	10/21/2009
D-7	10/16/2008	D-7	10/23/2009
D-9	10/16/2008	D-9	10/22/2009
D-11	10/16/2008	D-11	10/23/2009
D-15	10/17/2008	D-15	10/28/2009
F-25	10/17/2008	F-25	10/28/2009
D-2	11/18/2008	D-2	11/18/2009
D-3	11/18/2008	D-3	11/19/2009
D-9	11/18/2008	D-5	11/20/2009
D-7	11/19/2008	D-7	11/23/2009
D-11	11/19/2008	D-9	11/18/2009
D-15	11/20/2008	D-11	11/19/2009
F-25	11/20/2008	D-15	11/23/2009
D-2	12/8/2008	F-25	11/20/2009
D-3	12/8/2008	D-2	12/22/2009
D-5	12/8/2008	D-3	12/22/2009
D-7	12/9/2008	D-5	12/23/2009
D-9	12/9/2008	D-7	12/23/2009
D-11	12/9/2008	D-9	12/16/2009
D-15	12/10/2008	D-11	12/16/2009
F-25	12/10/2008	D-15	12/17/2009
D-7	1/9/2009	F-25	12/17/2009
D-11	1/9/2009	D-2	1/26/2010
F-25	1/9/2009	D-3	1/22/2010
D-2	1/21/2009	D-5	1/22/2010
D-3	1/21/2009	D-7	1/27/2010
D-5	1/21/2009	D-9	1/27/2010
D-9	1/22/2009	D-11	1/19/2010
D-15	1/22/2009	D-15	1/27/2010
D-3	2/9/2009	F-25	1/28/2009
D-2	2/10/2009	D-2	2/22/2010
D-5	2/10/2009	D-3	2/19/2010
D-9	2/17/2009	D-5	2/19/2010
D-11	2/17/2009	D-7	2/18/2010
D15	2/17/2009	D-9	2/17/2010
D-7	2/18/2009	D-11	2/18/2010
F-25	2/18/2009	D-15	2/17/2010
D-11	3/13/2009	F-25	2/22/2010
D-15	3/13/2009	D-2	3/18/2010
F-25	3/13/2009	D-3	3/18/2010
D-7	3/18/2009	D-5	3/17/2010
D-9	3/18/2009	D-7	3/19/2010
D-2	3/19/2009	D-9	3/17/2010
D-3	3/19/2009	D-11	3/19/2010
D-5	3/19/2009	D-15	3/26/2010
D-11	4/14/2009	F-25	3/26/2010
D-15	4/14/2009	D-2	4/27/2010
D-7	4/20/2009	D-3	4/28/2010
D-9	4/20/2009	D-5	4/28/2010
D-2	4/21/2009	D-7	4/29/2010
D-3	4/21/2009	D-9	4/27/2010
D-5	4/21/2009	D-11	4/29/2010
F-25	4/27/2009	D-15	4/30/2010
D-2	5/18/2009	F-25	4/30/2010
D-3	5/18/2009	D-2	6/3/2010
D-11	5/18/2009	D-3	6/7/2010
D-5	5/19/2009	D-5	6/7/2010
D-7	5/19/2009	D-7	6/10/2010
D-9	5/19/2009	D-9	6/4/2010
D-15	5/20/2009	D-11	6/4/2010
F-25	5/20/2009	D-15	6/3/2010
D-9	7/27/2009	F-25	6/10/2010
D-11	7/27/2009		
D-7	7/29/2009		
D-15	7/29/2009		
F-25	7/29/2009		
D-2	7/30/2009		
D-3	7/30/2009		
D-5	7/30/2009		

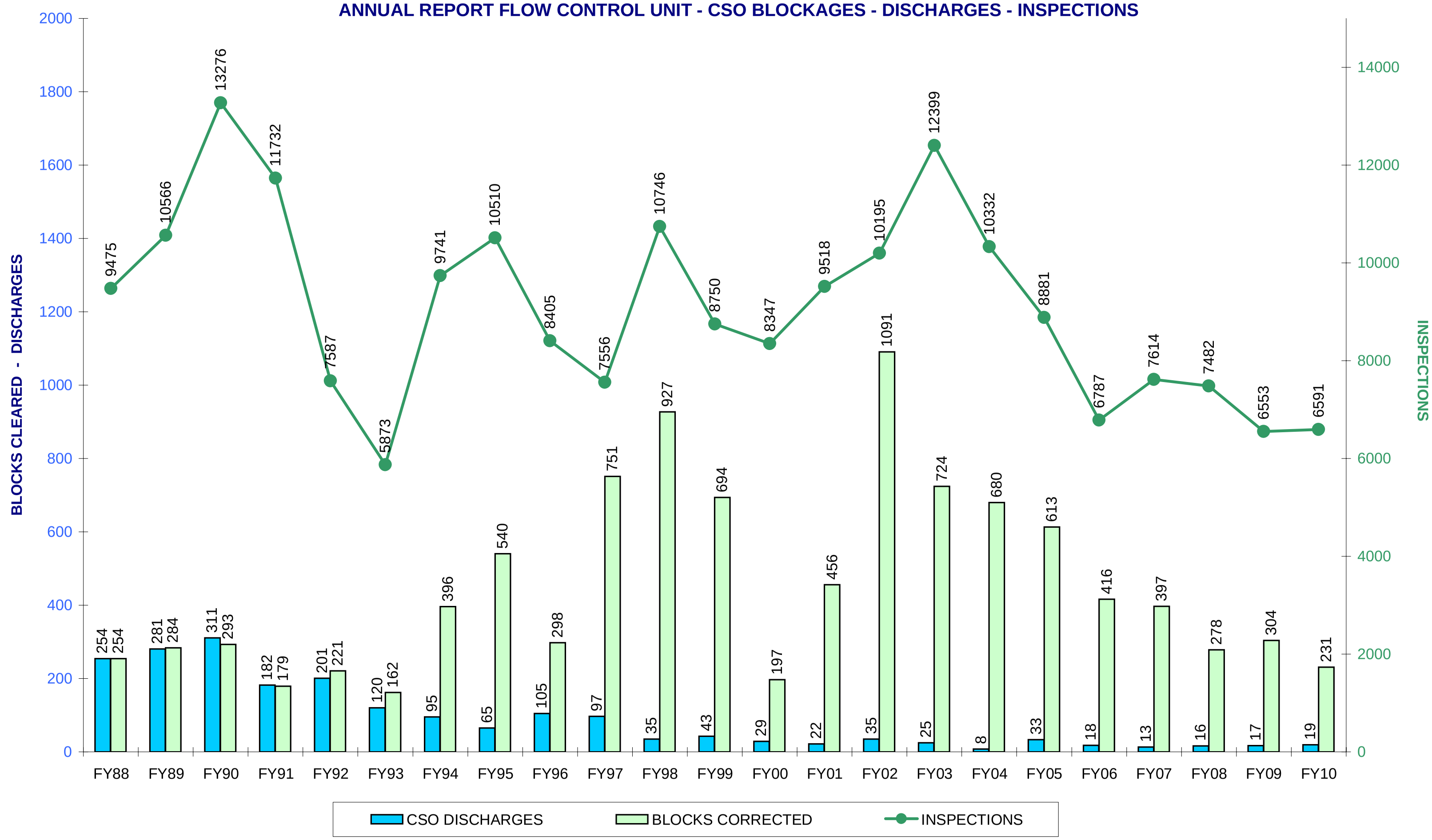
CSO OUTFALL - DEBRIS GRILL PREVENTATIVE MAINTENANCE

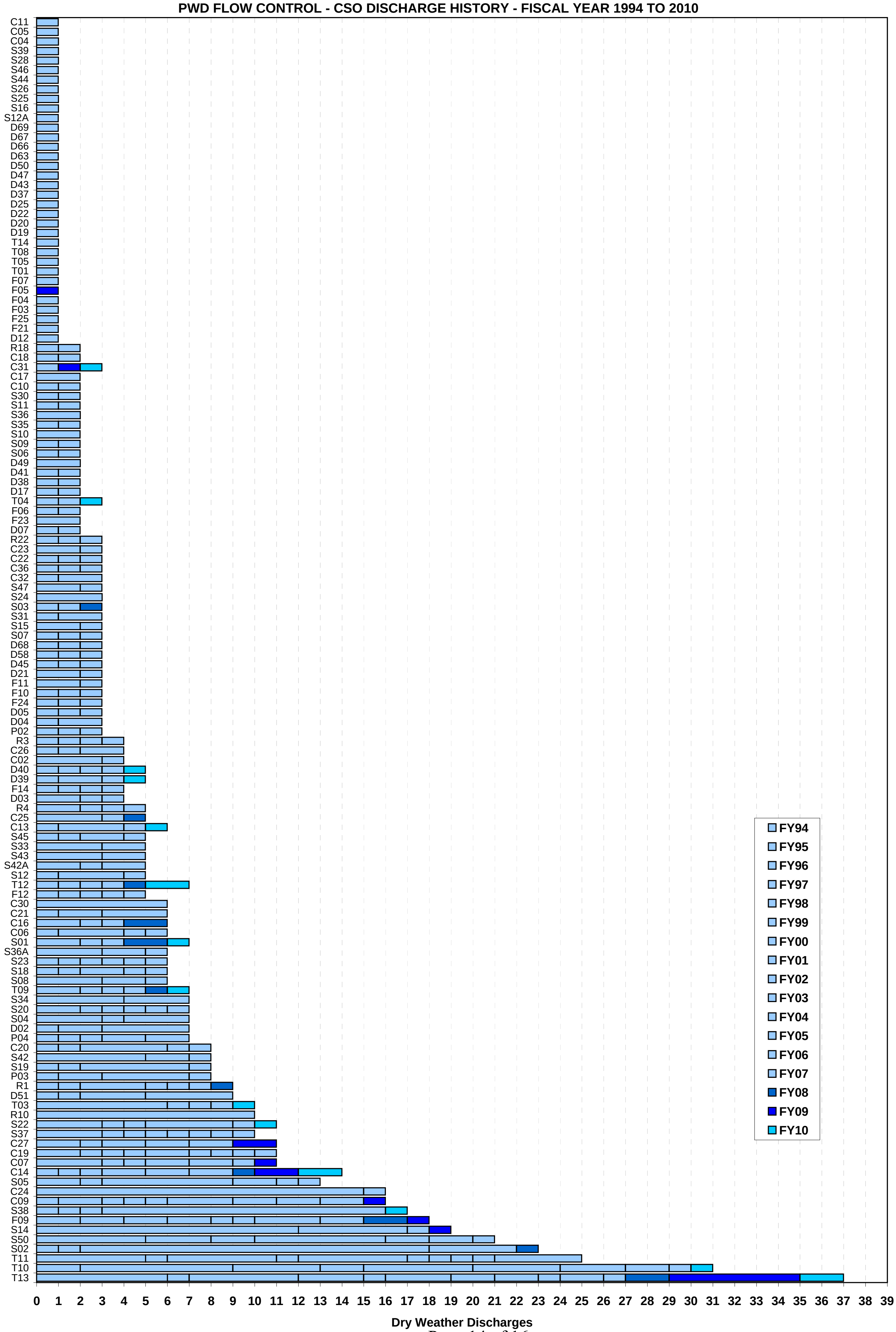
SITE	DATE
F-05	7/10/2008
T-08	7/16/2008
Sandy Run	7/18/2008
F-05	7/29/2008
F-05	8/12/2008
Sandy Run	8/21/2008
F-05	9/11/2008
T-08	9/17/2008
F-05	9/18/2008
Sandy Run	10/15/2008
F-05	10/16/2008
T-08	10/23/2008
Sandy Run	10/24/2008
F-05	10/29/2008
Sandy Run	11/20/2008
F-05	12/9/2008
Sandy Run	12/17/2008
F-05	12/26/2008
T-08	12/31/2008
F-05	2/10/2009
T-08	2/17/2009
F-05	3/9/2009
Sandy Run	3/13/2009
F-05	3/13/2009
F-05	4/13/2009
F-05	4/27/2009
F-05	5/8/2009
T-08	5/14/2009
T-08	5/29/2009
F-05	6/9/2009
T-08	6/9/2009
Sandy Run	6/11/2009
F-05	6/22/2009
T-08	6/25/2009
Sandy Run	6/26/2009
F-05	7/8/2009
Sandy Run	7/14/2009
T-08	7/15/2009
Sandy Run	7/23/2009
T-08	8/18/2009
Sandy Run	8/20/2009
T-08	1/12/2010
Sandy Run	1/14/2010
F-05	1/22/2010
F-05	1/26/2010
T-08	1/26/2010
Sandy Run	1/26/2010
Sandy Run	2/2/2010
Sandy Run	3/2/2010
F-05	3/5/2010
T-08	3/9/2010
Sandy Run	3/18/2010
F-05	3/25/2010
F-05	4/15/2010
T-08	4/20/2010
Sandy Run	4/22/2010
F-05	4/27/2010
T-08	4/30/2010
Sandy Run	5/6/2010
F-05	5/12/2010
T-08	5/14/2010
Sandy Run	5/17/2010
Sandy Run	5/20/2010
Sandy Run	6/1/2010
Sandy Run	6/3/2010
F-05	6/8/2010
Sandy Run	6/15/2010
F-05	6/23/2010
T-08	6/25/2010
Sandy Run	6/29/2010
F-05	7/16/2010
Sandy Run	8/2/2010
F-05	8/10/2010

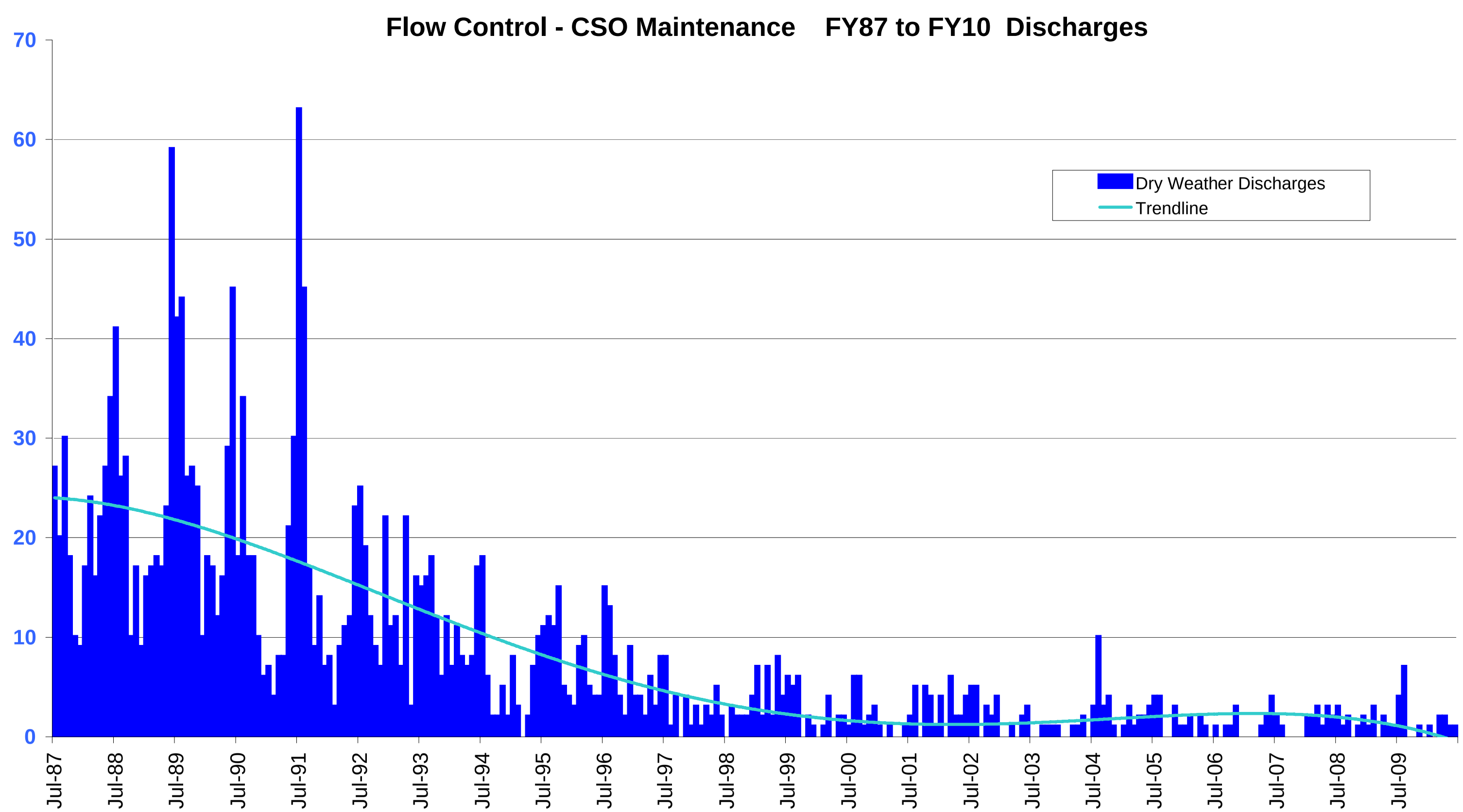
T-04 DEBRIS NET FLOATABLES REMOVAL

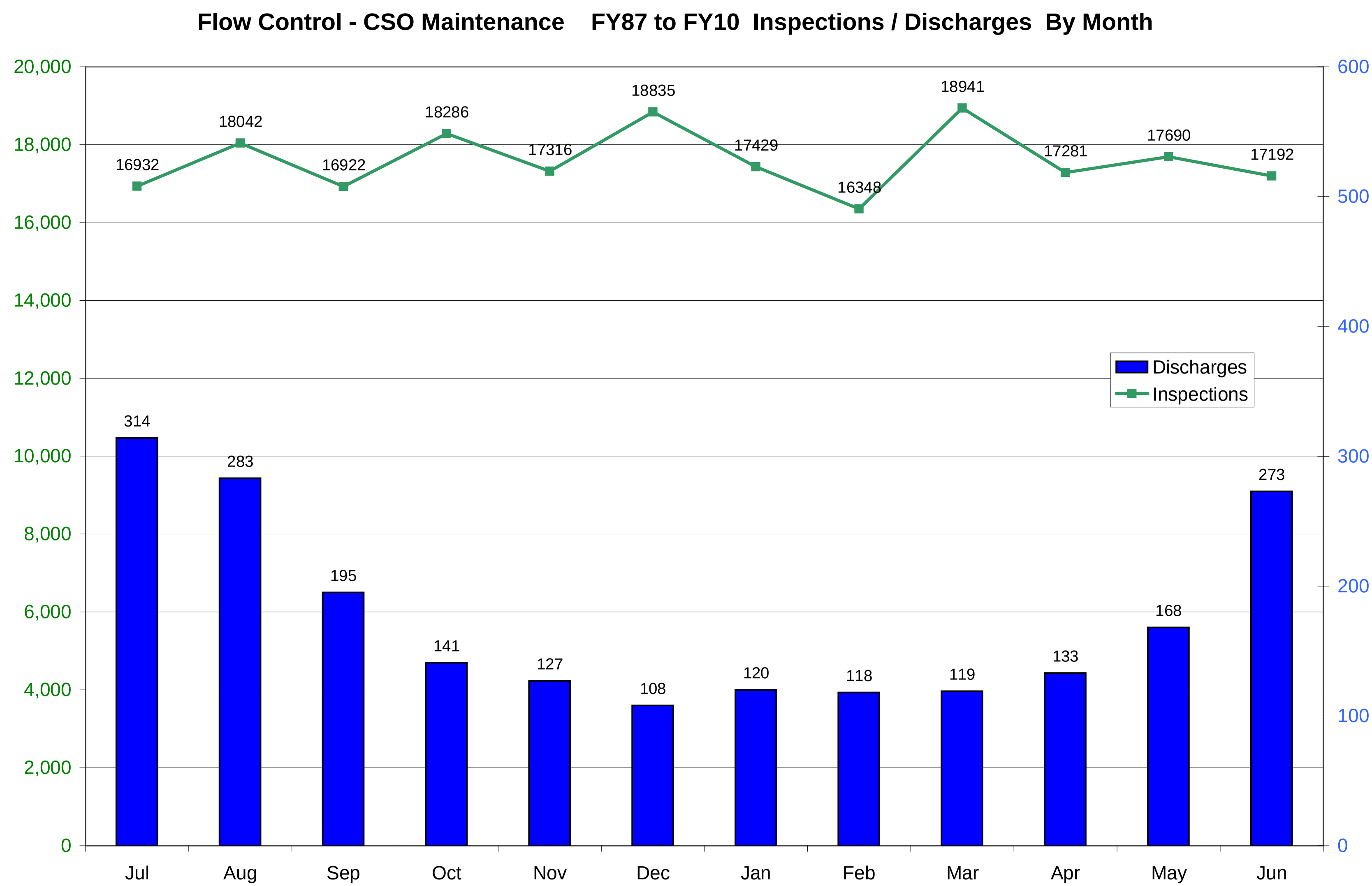
DATE	TOTAL WEIGHT
9/8/2008	81
12/13/2008	97
8/4/2009	57
1/6/2010	240
6/16/2010	150
8/6/2010	110

FISCAL YEAR 2010
ANNUAL REPORT FLOW CONTROL UNIT - CSO BLOCKAGES - DISCHARGES - INSPECTIONS




PWD FLOW CONTROL - CSO DISCHARGE HISTORY - FISCAL YEAR 1994 TO 2010
C11
C05
C04
S39
S28
S46
S44
S26
S25
S16
S12A
D69
D67
D66
D63
D50
D47
D43
D37
D25
D22
D20
D19
T14
T08
T05
T01
F07
F05
F04
F03
F25
F21
D12
R18
C18
C31
C17
C10
S30
S11
S36
S35
S10
S09
S06
D49
D41
D38
D17
T04
F06
F23
D07
R22
C23
C22
C36
C32
S47
S24
S03
S31
S15
S07
D68
D58
D45
D21
F11
F10
F24
D05
D04
P02
R3
C26
C02
D40
D39
F14
D03
R4
C25
C13
S45
S33
S43
S42A
S12
T12
F12
C30
C21
C16
C06
S01
S36A
S23
S18
S08
T09
S34
S20
S04
D02
P04
C20
S42
S19
P03
R1
D51
T03
R10
S22
S37
C27
C19
C07
C14
S05
C24
C09
S38
F09
S14
S50
S02
T11
T10
T13
FY94
FY95
FY96
FY97
FY98
FY99
FY00
FY01
FY02
FY03
FY04
FY05
FY06
FY07
FY08
FY09
FY10
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
Dry Weather Discharges


Flow Control - CSO Maintenance FY87 to FY10 Discharges
70
60
50
40
30
20
10
0
Dry Weather Discharges
Trendline
Jul-87
Jul-88
Jul-89
Jul-90
Jul-91
Jul-92
Jul-93
Jul-94
Jul-95
Jul-96
Jul-97
Jul-98
Jul-99
Jul-00
Jul-01
Jul-02
Jul-03
Jul-04
Jul-05
Jul-06
Jul-07
Jul-08
Jul-09



Flow Control - CSO Maintenance FY87 to FY10 Inspections / Discharges By Month
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
600
500
400
300
200
100
0
16932
18042
16922
18286
17316
18835
17429
16348
18941
17281
17690
17192
314
283
195
141
127
108
120
118
119
133
168
273
Discharges
Inspections
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun

APPENDIX B – FLOW MONITORING

Page

APPENDIX B - Table 1 - Listing of Monitored Outlying Community Connections

Site ID	Connection Type	Township	Location	Address
MA1	STD	Abington	Buckly Drive & Pine Rd	9650 Pine Rd.
MA2	MTR	Abington	Pine Road & Pennypack Creek	8700 Pine Rd
MA3	STD	Abington	Shady Lane & Pine Road	8400 Pine Rd.
MA4	STD	Abington	Pine Road & Lee Lynn La.	9200 Pine Rd.
MAx1	STD	Abington	Strahle & Rockwell	
MB1	MTR	Bucks Co.	Totem Rd. & Neshaminy Cr.	
MBE1	MTR	Bensalem	Byberry Grounds	16000 Carter Rd
MBE2	MTR	Bensalem	Dunks Ferry Road	1400 Worthington
MBE3	MTR	Bensalem	Emerson & Evelyn	Emerson
MBE4	MTR	Bensalem	Red Lion & Frankford	490 Bristol Rd.
MBE5	MTR	Bensalem	Grant & James	5050 Grant Av
MBE6	MTR	Bensalem	Gravel Pike @ Poquessing Creek	4800 Byberry Rd
MBE7	MTR	Bensalem	Townsend Road @ Poquessing Creek	13000 Townsend Rd
MBE8	MTR	Bensalem	Bensalem Shopping Ctr.	
MBE9	MTR	Bensalem	Elmwood Apartments	
MBE10	MTR	Bensalem	Colonial Ave	
MBE11	MTR	Bensalem	Betz Laboratories	
MBE12	MTR	Bensalem	Creekside Apartments North	
MBE13	MTR	Bensalem	Rt 1 West Side of Highway	
MBE14	MTR	Bensalem	Old Lincoln Hwy & Old Trevose Rd	
MBE15	MTR	Bensalem	Knights Rd & Poquessinng Creek	
MBE16	MTR	Bensalem	Creekside Apartments South	
MC1	MTR	Cheltenham	Bouvier & Cheltenham	1900 Cheltenham Av
MC2	MTR	Cheltenham	Tookany Creek & Cheltenham	194 E Cheltenham Av
MC3	MTR	Abington	Fillmore & Shelmire (Abington flow)	7400 Fillmore
MCx1	STD	Cheltenham	Cottman (Out)	
MCx2	STD	Cheltenham	County Line & Franklin (Out)	
MCx3	STD	Cheltenham	County Line & Washington (Out)	Washington & Hasbrook
MCx4	STD	Cheltenham	Kerper (Out)	Unruh & Hasbrook
MCx5	STD	Cheltenham	Passmore (Out)	
MCx6	STD	Cheltenham	Devereaux (Out)	
MCx7	STD	Cheltenham	Comly (Out)	
MD1	MTR	Delaware Co.	DELCORA	SWWPC Plant
ML1	MTR	Lower Merion	51st Street & City Line	2490 N 51St St
ML2	STD	Lower Merion	59th Street & City Line	5868 City Line
ML3	MTR	Lower Merion	63rd Street & City Line	2139 N 63Rd St
ML4	MTR	Lower Merion	66th Street & City Line	6600 City Line Av
ML5	MTR	Lower Merion	73rd Street & City Line	7268 City Line Av

Site ID	Connection Type	Township	Location	Address
ML6	MTR	Lower Merion	Conshohocken & City Line	4900 City Line
ML7	MTR	Lower Merion	Presidential & City Line	3499 City Line
MLM1	MTR	Lower Moreland	Philmont & Byberry	Woodhaven
MLM2	MTR	Lower Moreland	Lower Moreland PS @ Welsh & Huntington Pk	
MLM3	STD	Lower Moreland	Ramage Run & City Boundry	
MLM4	STD	Lower Moreland	Moreland Rd. & Pine Rd.	
MLM5	STD	Lower Moreland	Jonathan place	
MLM6	Unknown	Lower Moreland	Pine & Radburn Rd	
MLM7	Unknown	Lower Moreland	Welsh Road and City Line	
MS1	STD	Springfield	Thomas & Northwestern	198 W. Northwestern
MS2	MTR	Springfield	Northwestern & Wissahickon Cr.	9404 Northwestern
MS3	MTR	Springfield	Erdenheim & Stenton	Erdenheim & Stenton
MS4	STD	Springfield	Mermaid La. & Stenton	7700 Stenton
MS5	STD	Springfield	Winston & Stenton	8200 Stenton
MS6	MTR	Springfield	Woodbrook & Stenton	7601 Stenton Av
MS7	Unknown	Springfield	Willow Grove & Stenton	
MS8	STD	Springfield	Ridge Ave Connections	Ridge & Northwestern
MSH1	MTR	Southhampton	Trevose Rd. & Poquessing Creek E side	Trevose Rd & Stream Ridge Ln.
MSH2	STD	Southhampton	Lukens St. & Trevose Rd.	Trevose Rd & Lukens St.
MSHX_1	STD	Southhampton	Overhill Ave & County Line Rd (Out)	
MSHX_2	STD	Southhampton	County Line & Trevose Rd. (Out)	
MUD1-N	MTR	Upper Darby	60Th & Cobbs Creek	6001 S. Cobbs Creek Pky.
MUD1-S	MTR	Upper Darby	60Th & Cobbs Creek	6001 S. Cobbs Creek Pky.
MUD1-O	MTR	Upper Darby	60Th & Cobbs Creek Overflow	6001 S. Cobbs Creek Pky.
MP796	MTR	PIDC - PNBC	Phila. Naval Business Ctr. @ PS 796	4801 S. 13Th Street

*STD – temporary flow monitor

**MTR – Permanent monitor

APPENDIX B - Table 2 - Listing of Combined Sewer Monitors

Site Name	Interceptor	Waterbody	Measurement Name	Measurement Type
C01	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
C01	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C02	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
C02	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C04	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
C04	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C04A	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
C04A	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C05	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
C05	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C06	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
C06	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C07	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
C07	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C09	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
C09	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C10	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
C10	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C11	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
C11	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C12	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL

Site Name	Interceptor	Waterbody	Measurement Name	Measurement Type
C12	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C13	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
C13	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C14	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
C14	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C15	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
C15	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C16	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
C16	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C17	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
C17	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C18	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
C18	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C19	Cobbs Creek Low Level	Cobbs Creek	SWO LEVEL	LEVEL
C19	Cobbs Creek Low Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C20	Cobbs Creek Low Level	Cobbs Creek	SWO LEVEL	LEVEL
C20	Cobbs Creek Low Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C21	Cobbs Creek Low Level	Cobbs Creek	SWO LEVEL	LEVEL
C21	Cobbs Creek Low Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C22	Cobbs Creek Low Level	Cobbs Creek	SWO LEVEL	LEVEL

Site Name	Interceptor	Waterbody	Measurement Name	Measurement Type
C22	Cobbs Creek Low Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C23	Cobbs Creek Low Level	Cobbs Creek	SWO LEVEL	LEVEL
C23	Cobbs Creek Low Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C24	Cobbs Creek Low Level	Cobbs Creek	SWO LEVEL	LEVEL
C24	Cobbs Creek Low Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C25	Cobbs Creek Low Level	Cobbs Creek	SWO LEVEL	LEVEL
C25	Cobbs Creek Low Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C26	Cobbs Creek Low Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C27	Cobbs Creek Low Level	Cobbs Creek	SWO LEVEL	LEVEL
C27	Cobbs Creek Low Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C28A	Cobbs Creek Low Level	Cobbs Creek	SWO LEVEL	LEVEL
C28A	Cobbs Creek Low Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C29	Cobbs Creek Low Level	Cobbs Creek	SWO LEVEL	LEVEL
C29	Cobbs Creek Low Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C30	Cobbs Creek Low Level	Cobbs Creek	SWO LEVEL	LEVEL
C30	Cobbs Creek Low Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C31	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
C31	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C32	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
C32	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C33	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL

Site Name	Interceptor	Waterbody	Measurement Name	Measurement Type
C33	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C34	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
C34	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C35	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
C35	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C36	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
C36	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
C37	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
C37	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
D02	Upper Delaware Low Level	Delaware River	DWO GATE POSITION	POSITION
D02	Upper Delaware Low Level	Delaware River	DWO LEVEL	LEVEL
D02	Upper Delaware Low Level	Delaware River	SWO GATE POSITION	POSITION
D02	Upper Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D02	Upper Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D03	Upper Delaware Low Level	Delaware River	DWO GATE POSITION	POSITION
D03	Upper Delaware Low Level	Delaware River	DWO LEVEL	LEVEL
D03	Upper Delaware Low Level	Delaware River	SWO GATE POSITION	POSITION
D03	Upper Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D03	Upper Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D04	Upper Delaware Low Level	Delaware River	DWO GATE POSITION	POSITION
D04	Upper Delaware Low Level	Delaware River	DWO LEVEL	LEVEL

Site Name	Interceptor	Waterbody	Measurement Name	Measurement Type
D04	Upper Delaware Low Level	Delaware River	SWO GATE POSITION	POSITION
D04	Upper Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D04	Upper Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D05	Upper Delaware Low Level	Delaware River	DWO GATE POSITION	POSITION
D05	Upper Delaware Low Level	Delaware River	DWO LEVEL	LEVEL
D05	Upper Delaware Low Level	Delaware River	SWO GATE POSITION	POSITION
D05	Upper Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D05	Upper Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D06	Upper Delaware Low Level	Delaware River	DWO LEVEL	LEVEL
D06	Upper Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D06	Upper Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D07	Upper Delaware Low Level	Delaware River	DWO GATE POSITION	POSITION
D07	Upper Delaware Low Level	Delaware River	DWO LEVEL	LEVEL
D07	Upper Delaware Low Level	Delaware River	SWO GATE POSITION 1	POSITION
D07	Upper Delaware Low Level	Delaware River	SWO GATE POSITION 2	POSITION
D07	Upper Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D07	Upper Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D08	Upper Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D08	Upper Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D09	Upper Delaware Low Level	Delaware River	DWO GATE POSITION	POSITION
D09	Upper Delaware Low Level	Delaware River	DWO LEVEL	LEVEL

Site Name	Interceptor	Waterbody	Measurement Name	Measurement Type
D09	Upper Delaware Low Level	Delaware River	SWO GATE POSITION	POSITION
D09	Upper Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D09	Upper Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D11	Upper Delaware Low Level	Delaware River	DWO GATE POSITION	POSITION
D11	Upper Delaware Low Level	Delaware River	DWO LEVEL	LEVEL
D11	Upper Delaware Low Level	Delaware River	SWO GATE POSITION	POSITION
D11	Upper Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D11	Upper Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D12	Upper Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D12	Upper Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D13	Upper Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D13	Upper Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D15	Upper Delaware Low Level	Delaware River	DWO GATE POSITION	POSITION
D15	Upper Delaware Low Level	Delaware River	DWO LEVEL	LEVEL
D15	Upper Delaware Low Level	Delaware River	SWO GATE POSITION	POSITION
D15	Upper Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D15	Upper Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D17	Somerset	Delaware River	SWO LEVEL	LEVEL
D17	Somerset	Delaware River	TRUNK LEVEL	LEVEL
D18	Somerset	Delaware River	SWO LEVEL	LEVEL
D18	Somerset	Delaware River	TRUNK LEVEL	LEVEL

Site Name	Interceptor	Waterbody	Measurement Name	Measurement Type
D19	Somerset	Delaware River	SWO LEVEL	LEVEL
D19	Somerset	Delaware River	TRUNK LEVEL	LEVEL
D20	Somerset	Delaware River	SWO LEVEL	LEVEL
D20	Somerset	Delaware River	TRUNK LEVEL	LEVEL
D21	Somerset	Delaware River	SWO LEVEL	LEVEL
D21	Somerset	Delaware River	TRUNK LEVEL	LEVEL
D22	Somerset	Delaware River	SWO LEVEL	LEVEL
D22	Somerset	Delaware River	TRUNK LEVEL	LEVEL
D23	Somerset	Delaware River	SWO LEVEL	LEVEL
D23	Somerset	Delaware River	TRUNK LEVEL	LEVEL
D24	Somerset	Delaware River	SWO LEVEL	LEVEL
D24	Somerset	Delaware River	TRUNK LEVEL	LEVEL
D25	Somerset	Delaware River	SWO LEVEL	LEVEL
D25	Somerset	Delaware River	TRUNK LEVEL	LEVEL
D37	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D37	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D38	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D38	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D39	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D39	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D40	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL

Site Name	Interceptor	Waterbody	Measurement Name	Measurement Type
D40	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D41	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D41	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D42	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D42	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D43	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D43	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D44	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D44	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D45	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D45	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D46	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D46	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D47	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D47	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D48	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D48	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D49	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D49	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D50	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D50	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL

Site Name	Interceptor	Waterbody	Measurement Name	Measurement Type
D51	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D51	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D51A	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D52	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D52	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D53	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D53	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D54	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D54	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D58	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D58	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D61	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D61	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D62	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D62	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D63	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D63	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D64	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D64	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D65	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D65	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL

Site Name	Interceptor	Waterbody	Measurement Name	Measurement Type
D66	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D66	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D67	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D67	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D68	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D68	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D69	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D69	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D70	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D70	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D71	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D71	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D72	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D72	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
D73	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
D73	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
F03	Lower Frankford Low Level	Frankford Creek	SWO LEVEL	LEVEL
F03	Lower Frankford Low Level	Frankford Creek	TRUNK LEVEL	LEVEL
F04	Lower Frankford Low Level	Frankford Creek	SWO LEVEL	LEVEL
F04	Lower Frankford Low Level	Frankford Creek	TRUNK LEVEL	LEVEL
F05	Lower Frankford Low Level	Frankford Creek	SWO LEVEL	LEVEL

Site Name	Interceptor	Waterbody	Measurement Name	Measurement Type
F05	Lower Frankford Low Level	Frankford Creek	TRUNK LEVEL	LEVEL
F06	Lower Frankford Low Level	Frankford Creek	SWO LEVEL	LEVEL
F06	Lower Frankford Low Level	Frankford Creek	TRUNK LEVEL	LEVEL
F07	Lower Frankford Low Level	Frankford Creek	SWO LEVEL	LEVEL
F07	Lower Frankford Low Level	Frankford Creek	TRUNK LEVEL	LEVEL
F08	Lower Frankford Low Level	Frankford Creek	SWO LEVEL	LEVEL
F08	Lower Frankford Low Level	Frankford Creek	TRUNK LEVEL	LEVEL
F09	Lower Frankford Low Level	Frankford Creek	SWO LEVEL	LEVEL
F09	Lower Frankford Low Level	Frankford Creek	TRUNK LEVEL	LEVEL
F10	Lower Frankford Low Level	Frankford Creek	SWO LEVEL	LEVEL
F10	Lower Frankford Low Level	Frankford Creek	TRUNK LEVEL	LEVEL
F11	Lower Frankford Low Level	Frankford Creek	SWO LEVEL	LEVEL
F11	Lower Frankford Low Level	Frankford Creek	TRUNK LEVEL	LEVEL
F12	Lower Frankford Low Level	Frankford Creek	SWO LEVEL	LEVEL
F12	Lower Frankford Low Level	Frankford Creek	TRUNK LEVEL	LEVEL
F13	Lower Frankford Creek	Frankford Creek	DWO LEVEL	LEVEL
F13	Lower Frankford Creek	Frankford Creek	SWO LEVEL	LEVEL
F13	Lower Frankford Creek	Frankford Creek	TRUNK LEVEL	LEVEL
F14	Lower Frankford Creek	Frankford Creek	SWO LEVEL	LEVEL
F14	Lower Frankford Creek	Frankford Creek	TRUNK LEVEL	LEVEL
F21	Lower Frankford Creek	Frankford Creek	SWO LEVEL	LEVEL

Site Name	Interceptor	Waterbody	Measurement Name	Measurement Type
F21	Lower Frankford Creek	Frankford Creek	TRUNK LEVEL	LEVEL
F23	Lower Frankford Creek	Frankford Creek	SWO LEVEL	LEVEL
F23	Lower Frankford Creek	Frankford Creek	TRUNK LEVEL	LEVEL
F24	Lower Frankford Creek	Frankford Creek	SWO LEVEL	LEVEL
F24	Lower Frankford Creek	Frankford Creek	TRUNK LEVEL	LEVEL
F25	Lower Frankford Creek	Frankford Creek	DWO GATE POSITION	POSITION
F25	Lower Frankford Creek	Frankford Creek	SWO GATE POSITION 1	POSITION
F25	Lower Frankford Creek	Frankford Creek	SWO GATE POSITION 2	POSITION
F25	Lower Frankford Creek	Frankford Creek	SWO LEVEL	LEVEL
F25	Lower Frankford Creek	Frankford Creek	TRUNK LEVEL	LEVEL
P01	Pennypack	Pennypack Creek	SWO LEVEL	LEVEL
P01	Pennypack	Pennypack Creek	TRUNK LEVEL	LEVEL
P02	Pennypack	Pennypack Creek	SWO LEVEL	LEVEL
P02	Pennypack	Pennypack Creek	TRUNK LEVEL	LEVEL
P03	Pennypack	Pennypack Creek	SWO LEVEL	LEVEL
P03	Pennypack	Pennypack Creek	TRUNK LEVEL	LEVEL
P04	Pennypack	Pennypack Creek	SWO LEVEL	LEVEL
P04	Pennypack	Pennypack Creek	TRUNK LEVEL	LEVEL
P05	Pennypack	Pennypack Creek	SWO LEVEL	LEVEL
P05	Pennypack	Pennypack Creek	TRUNK LEVEL	LEVEL
R01	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL

Site Name	Interceptor	Waterbody	Measurement Name	Measurement Type
R01	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
R01A	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
R01A	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
R02	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
R02	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
R03	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
R03	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
R04	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
R04	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
R05	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
R05	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
R06	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
R06	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
R07			SWO LEVEL	LEVEL
R07			TRUNK LEVEL	LEVEL
R08			SWO LEVEL	LEVEL
R08			TRUNK LEVEL	LEVEL
R09			SWO LEVEL	LEVEL
R09			TRUNK LEVEL	LEVEL
R10	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
R10	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
R11	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
R11	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL

Site Name	Interceptor	Waterbody	Measurement Name	Measurement Type
R11A	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
R11A	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
R12	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
R12	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
R13	Upper Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
R13	Upper Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
R13A	Upper Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
R13A	Upper Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
R14	Upper Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
R14	Upper Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
R15	Frankford High Level	Tacony Creek	SWO LEVEL	LEVEL
R15	Frankford High Level	Tacony Creek	TRUNK LEVEL	LEVEL
R16	Lower Delaware Low Level	Delaware River	SWO LEVEL	LEVEL
R16	Lower Delaware Low Level	Delaware River	TRUNK LEVEL	LEVEL
R17			SWO LEVEL	LEVEL
R17			TRUNK LEVEL	LEVEL
R18	Frankford High Level	Tacony Creek	SWO LEVEL	LEVEL
R18	Frankford High Level	Tacony Creek	TRUNK LEVEL	LEVEL
R19			SWO LEVEL	LEVEL
R19			TRUNK LEVEL	LEVEL
R20	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
R20	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL

Site Name	Interceptor	Waterbody	Measurement Name	Measurement Type
R24	Cobbs Creek High Level	Cobbs Creek	SWO LEVEL	LEVEL
R24	Cobbs Creek High Level	Cobbs Creek	TRUNK LEVEL	LEVEL
R25			SWO LEVEL	LEVEL
R25			TRUNK LEVEL	LEVEL
S01	Central Schuylkill West Side	Schuylkill River	SWO LEVEL	LEVEL
S01	Central Schuylkill West Side	Schuylkill River	TRUNK LEVEL	LEVEL
S02	Central Schuylkill West Side	Schuylkill River	SWO LEVEL	LEVEL
S02	Central Schuylkill West Side	Schuylkill River	TRUNK LEVEL	LEVEL
S03	Central Schuylkill West Side	Schuylkill River	SWO LEVEL	LEVEL
S03	Central Schuylkill West Side	Schuylkill River	TRUNK LEVEL	LEVEL
S04	Central Schuylkill West Side	Schuylkill River	SWO LEVEL	LEVEL
S04	Central Schuylkill West Side	Schuylkill River	TRUNK LEVEL	LEVEL
S05	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S05	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S06	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S06	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S07	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S07	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S08	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S08	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S09	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S09	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL

Site Name	Interceptor	Waterbody	Measurement Name	Measurement Type
S10	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S10	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S11	Central Schuylkill West Side	Schuylkill River	SWO LEVEL	LEVEL
S11	Central Schuylkill West Side	Schuylkill River	TRUNK LEVEL	LEVEL
S12	Central Schuylkill West Side	Schuylkill River	SWO LEVEL	LEVEL
S12	Central Schuylkill West Side	Schuylkill River	TRUNK LEVEL	LEVEL
S12A	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S12A	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S13	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S13	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S14	Central Schuylkill West Side	Schuylkill River	SWO LEVEL	LEVEL
S14	Central Schuylkill West Side	Schuylkill River	TRUNK LEVEL	LEVEL
S15	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S15	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S16	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S16	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S17	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S17	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S18	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S18	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S19	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL

Site Name	Interceptor	Waterbody	Measurement Name	Measurement Type
S19	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S20	Central Schuylkill West Side	Schuylkill River	SWO LEVEL	LEVEL
S20	Central Schuylkill West Side	Schuylkill River	TRUNK LEVEL	LEVEL
S21	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S21	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S22	Central Schuylkill West Side	Schuylkill River	SWO LEVEL	LEVEL
S22	Central Schuylkill West Side	Schuylkill River	TRUNK LEVEL	LEVEL
S23	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S23	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S24	Central Schuylkill West Side	Schuylkill River	SWO LEVEL	LEVEL
S24	Central Schuylkill West Side	Schuylkill River	TRUNK LEVEL	LEVEL
S25	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S25	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S26	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S26	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S27	Central Schuylkill East Side	Schuylkill River	DWO LEVEL	LEVEL
S27	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S27	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S28	Central Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S28	Central Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S30	Southwest Main Gravity	Schuylkill River	SWO LEVEL	LEVEL

Site Name	Interceptor	Waterbody	Measurement Name	Measurement Type
S30	Southwest Main Gravity	Schuylkill River	TRUNK LEVEL	LEVEL
S31	Lower Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S31	Lower Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S32	Lower Schuylkill West Side	Schuylkill River	SWO LEVEL	LEVEL
S32	Lower Schuylkill West Side	Schuylkill River	TRUNK LEVEL	LEVEL
S33	Lower Schuylkill West Side	Schuylkill River	SWO LEVEL	LEVEL
S33	Lower Schuylkill West Side	Schuylkill River	TRUNK LEVEL	LEVEL
S34	Lower Schuylkill West Side	Schuylkill River	SWO LEVEL	LEVEL
S34	Lower Schuylkill West Side	Schuylkill River	TRUNK LEVEL	LEVEL
S35	Lower Schuylkill West Side	Schuylkill River	SWO LEVEL	LEVEL
S35	Lower Schuylkill West Side	Schuylkill River	TRUNK LEVEL	LEVEL
S36	Lower Schuylkill West Side	Schuylkill River	SWO LEVEL	LEVEL
S36	Lower Schuylkill West Side	Schuylkill River	TRUNK LEVEL	LEVEL
S36A	Lower Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S36A	Lower Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S37	Lower Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S37	Lower Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S38	Lower Schuylkill West Side	Schuylkill River	SWO LEVEL	LEVEL
S38	Lower Schuylkill West Side	Schuylkill River	TRUNK LEVEL	LEVEL
S39	Lower Schuylkill West Side	Schuylkill River	SWO LEVEL	LEVEL
S39	Lower Schuylkill West Side	Schuylkill River	TRUNK LEVEL	LEVEL

Site Name	Interceptor	Waterbody	Measurement Name	Measurement Type
S40	Lower Schuylkill West Side	Schuylkill River	SWO LEVEL	LEVEL
S40	Lower Schuylkill West Side	Schuylkill River	TRUNK LEVEL	LEVEL
S42	Lower Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S42	Lower Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S42A	Lower Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S42A	Lower Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S43	Lower Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S43	Lower Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S44	Lower Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S44	Lower Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S45	Lower Schuylkill West Side	Schuylkill River	DWO LEVEL	LEVEL
S45	Lower Schuylkill West Side	Schuylkill River	SWO LEVEL	LEVEL
S45	Lower Schuylkill West Side	Schuylkill River	TRUNK LEVEL	LEVEL
S46	Lower Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S46	Lower Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S47	Lower Schuylkill East Side	Schuylkill River	SWO LEVEL	LEVEL
S47	Lower Schuylkill East Side	Schuylkill River	TRUNK LEVEL	LEVEL
S50	Southwest Main Gravity	Schuylkill River	SWO LEVEL	LEVEL
S50	Southwest Main Gravity	Schuylkill River	TRUNK LEVEL	LEVEL
S51	Southwest Main Gravity	Schuylkill River	SWO LEVEL	LEVEL
S51	Southwest Main Gravity	Schuylkill River	TRUNK LEVEL	LEVEL

Site Name	Interceptor	Waterbody	Measurement Name	Measurement Type
T01	Frankford High Level	Tacony Creek	SWO LEVEL	LEVEL
T01	Frankford High Level	Tacony Creek	TRUNK LEVEL	LEVEL
T03	Frankford High Level	Tacony Creek	SWO LEVEL	LEVEL
T03	Frankford High Level	Tacony Creek	TRUNK LEVEL	LEVEL
T04	Frankford High Level	Tacony Creek	SWO LEVEL	LEVEL
T04	Frankford High Level	Tacony Creek	TRUNK LEVEL	LEVEL
T05	Frankford High Level	Tacony Creek	SWO LEVEL	LEVEL
T05	Frankford High Level	Tacony Creek	TRUNK LEVEL	LEVEL
T06	Frankford High Level	Tacony Creek	SWO LEVEL	LEVEL
T06	Frankford High Level	Tacony Creek	TRUNK LEVEL	LEVEL
T07	Frankford High Level	Tacony Creek	SWO LEVEL	LEVEL
T07	Frankford High Level	Tacony Creek	TRUNK LEVEL	LEVEL
T08	Frankford High Level	Tacony Creek	SWO LEVEL	LEVEL
T08	Frankford High Level	Tacony Creek	TRUNK LEVEL	LEVEL
T09	Frankford High Level	Tacony Creek	SWO LEVEL	LEVEL
T09	Frankford High Level	Tacony Creek	TRUNK LEVEL	LEVEL
T10	Frankford High Level	Tacony Creek	SWO LEVEL	LEVEL
T10	Frankford High Level	Tacony Creek	TRUNK LEVEL	LEVEL
T11	Frankford High Level	Tacony Creek	SWO LEVEL	LEVEL
T11	Frankford High Level	Tacony Creek	TRUNK LEVEL	LEVEL
T12	Frankford High Level	Tacony Creek	SWO LEVEL	LEVEL
T12	Frankford High Level	Tacony Creek	TRUNK LEVEL	LEVEL

Site Name	Interceptor	Waterbody	Measurement Name	Measurement Type
T13	Frankford High Level	Tacony Creek	SWO LEVEL	LEVEL
T13	Frankford High Level	Tacony Creek	TRUNK LEVEL	LEVEL
T14	Frankford High Level	Tacony Creek	SWO LEVEL	LEVEL
T14	Frankford High Level	Tacony Creek	TRUNK LEVEL	LEVEL
T15	Frankford High Level	Tacony Creek	SWO LEVEL	LEVEL
T15	Frankford High Level	Tacony Creek	TRUNK LEVEL	LEVEL

APPENDIX B - Table 3 Listing of all Rain Gages

Rain Gage Network		
Rain Gage	**Location**	**Percent Working**
RG_01	70th and Essington Ave	100%
RG_02	66th and Regent St	100%
RG_03	Fox Chase Rd. and Castor Ave	100%
RG_04	State Rd and Pennypack St	100%
RG_05	3rd and Mifflin St	100%
RG_06	Cardinal Ave and City Line Ave	100%
RG_07	G St. and E Annsbury St	100%
RG_08	N Water St. and E Clarkson Ave	100%
RG_09	54th and Lancaster Ave	100%
RG_10	Pine Rd and Susquehanna Rd	100%
RG_11	Rising Sun Ave and Lardner St	100%
RG_12	Pattison Ave and Columbus Blvd	100%
RG_13	Glendale Ave and Algon Ave	100%
RG_14	Delaware Ave and Lewis St	100%
RG_15	E Montgomery Ave and Thompson St	100%
RG_16	19th and Wood St	100%
RG_17	Saul St. and Benner St	100%
RG_18	Fox St. and Roosevelt Blvd	100%
RG_19	Chew Ave and Sharpnack St	100%
RG_20	Woodhaven Rd and Knights Rd	100%
RG_21	Shawmont Ave and Eva St	100%
RG_22	N 67th and Callowhill St	100%
RG_23	Penrose Ave and Mingo Ave	100%
RG_24	Lockart Rd and Lockart Ln	100%

APPENDIX B - Table 4 Listing of Pumping Station Monitoring Locations

Waste Water Stations	Location	Address	Owner
BANK STREET	Bank St. & Elbow Lane	15 S BANK ST.	PWD
BELFRY DRIVE	Belfry Dr. & Steeple Dr.	751 S MANATAWNA ST.	PWD
CSPS	University Ave. & 34th St. Bridge	600 UNIVERSITY AVE.	PWD
FORD ROAD	Ford Rd. across from West Park Hospital	3800 FORD AVE.	PWD
HOG ISLAND	Hog Island Rd. east of Airport control tower	#3 HOG ISLAND RD.	PWD
LINDEN AVENUE	Linden Ave. & Milnor St.	5200 LINDEN AVE.	PWD
LOCKART ROAD	Lockart St. & Lockart Lane @ drainage right of way	10778 LOCKART RD.	PWD
MILNOR STREET	Milnor St. between Grant Ave. & Eden St.	9647 MILNOR ST.	PWD
NEILL DRIVE	Fairmount Park at Neil Drive & Falls Road	4000 NEILL DR.	PWD
PNBC 796 MAIN	Philadelphia Naval Business Center	4801 S. 13th Street	PIDC
PNBC 542	Philadelphia Naval Business Center	1601 Langley Street	PIDC
PNBC 120	Philadelphia Naval Business Center	1700 Langley Street	PIDC
PNBC 603	Philadelphia Naval Business Center	2000 Langley Ave.	PIDC
PNBC 648	Philadelphia Naval Business Center		
POLICE ACADEMY	8501 State Rd. in the Police Academy grounds	8501 STATE RD.	Police Dept
RENNARD STREET	Philmont Shopping Center grounds	11064 RENNARD ST.	PWD
SPRING LANE	Spring Lane Meadows IFO 9017 Buttonwood Pl.	9021 Buttonwood Pl. 19128	PWD
42ND STREET	42nd St & 43rd Street	761 S. 43RD Street	PWD
Storm Water Stations	**Location**	**Address**	**Owner**
BROAD & BLVD.	Underpass at Roosevelt Blvd. & Broad St.	4251 N. BROAD ST.	Penn Dot
MINGO CREEK	Schuylkill River under the Platt Bridge	7000 PENROSE AVE.	PWD
26TH AND VARE	Underpass at Vare & 26th St.	26TH AND VARE AVE.	Penn Dot

APPENDIX B -Table 5 Listing of all Temporary Flow Monitors deployed by projects

Site Name	Start	End	Maintained By	Project
Main and Shurs	1/31/2001	replaced by permanent	PWD	R20
H09 Byberry	3/28/2007	present	PWD	PC-30
H09 Poquessing	3/13/2007	present	PWD	PC-30
Holy Family	3/13/2007	present	PWD	PC-30
47th and Aspen	3/18/2008	present	PWD	47th Fairmount Seepage Tank
47th and Fairmount	4/1/2008	present	PWD	47th Fairmount Seepage Tank
FCHL-0110	1/1/2009	1/5/2010	CSL	I/I
Q119-01-S0015	1/1/2009	1/4/2010	CSL	I/I
PC-B1130	2/14/2009	2/1/2010	CSL	I/I
C15-000018	5/29/2009	2/1/2010	CSL	CSO model calibration
C27-000010	5/29/2009	2/1/2010	CSL	CSO model calibration
C37-000010 DWO	5/29/2009	12/30/2009	CSL	CSO model calibration
D15-000020	5/29/2009	9/24/2009	CSL	CSO model calibration
D41-000010	7/1/2009	2/3/2010	CSL	CSO model calibration
S38-000015	7/15/2009	2/1/2010	CSL	CSO model calibration
T01-000015	12/17/2009	1/4/2010	CSL	CSO model calibration
T10-000010	12/23/2008	5/25/2010	CSL	CSO model calibration
T13-000015	5/28/2009	2/1/2010	CSL	CSO model calibration
C12-000020	8/29/2009	2/1/2010	CSL	CSO model calibration
D02-000020	10/9/2009	2/1/2010	CSL	CSO model calibration
D03-000010	10/9/2009	2/1/2010	CSL	CSO model calibration
D40-000010	10/9/2009	2/1/2010	CSL	CSO model calibration
Q114-12-S0010	10/9/2009	2/1/2010	CSL	I/I
W067-06-S0015	10/16/2009	11/18/2009	CSL	I/I
W068-05	10/29/2009	2/2/2010	CSL	I/I
W067-06-S0040	12/15/2009	3/17/2010	CSL	I/I
W077-02-S0060	1/8/2010	Present	CSL	I/I
C37-000010	12/30/2009	Present	CSL	CSO model calibration
IALL-B0810	1/6/2010	Present	CSL	I/I
MA_01	2/5/2010	5/7/2010	CSL	outlying community connection
MA-03	2/5/2010	5/7/2010	CSL	outlying community connection
MA-04	2/5/2010	5/7/2010	CSL	outlying community connection
MAX_1	5/11/2010	Present	CSL	outlying community connection

Site Name	Start	End	Maintained By	Project
MCX_01	2/3/2010	5/7/2010	CSL	outlying community connection
MCX_02	2/3/2010	5/7/2010	CSL	outlying community connection
MCX_03	2/3/2010	5/7/2010	CSL	outlying community connection
MCX_04	2/5/2010	5/7/2010	CSL	outlying community connection
MCX_05	2/3/2010	5/7/2010	CSL	outlying community connection
MCX_06	2/3/2010	5/7/2010	CSL	outlying community connection
MCX_07	2/5/2010	5/7/2010	CSL	outlying community connection
ML_2	2/5/2010	5/7/2010	CSL	outlying community connection
MLM_03	2/5/2010	5/7/2010	CSL	outlying community connection
MLM_04	2/4/2010	5/7/2010	CSL	outlying community connection
MLM_05	2/4/2010	5/7/2010	CSL	outlying community connection
MLM_06	2/5/2010	5/7/2010	CSL	outlying community connection
MLM_07	2/5/2010	5/7/2010	CSL	outlying community connection
MS_1	2/5/2010	5/7/2010	CSL	outlying community connection
MS_4	2/5/2010	5/7/2010	CSL	outlying community connection
MS_5	2/5/2010	5/7/2010	CSL	outlying community connection
MS_7	2/5/2010	5/7/2010	CSL	outlying community connection
MS_8	2/5/2010	5/7/2010	CSL	outlying community connection
MSH_2	2/4/2010	5/7/2010	CSL	outlying community connection
MSHX_1	2/5/2010	5/7/2010	CSL	outlying community connection
MSHX_2	2/4/2010	5/7/2010	CSL	outlying community connection
W067-06-S0035	3/18/2010	6/2/2010	CSL	I/I
USE_0365	4/30/2010	Present	CSL	I/I
T14-026945	4/30/2010	Present	CSL	Design
S50-000105	7/8/2010		CSL	CSO model calibration

S25-000015	5/14/2010	present	CSL	CSO model calibration
Site Name	**Start**	**End**	**Maintained By**	**Project**
T06-000075	5/14/2014	present	CSL	CSO model calibration
P105-06-S0035	6/11/2010	present	CSL	I/I
S05-004405	7/8/2010	present	CSL	CSO model calibration
S50-000105	7/8/2010	present	CSL	CSO model calibration
S50-011535	7/8/2010	present	CSL	CSO model calibration
W060-11-S0015	7/9/2010	present	CSL	I/I
W067-13-S0010	7/9/2010	present	CSL	I/I
D05-001187	7/7/2010	present	CSL	CSO model calibration
D25-000150	7/7/2010	present	CSL	CSO model calibration
P109-05-S0015	7/9/2010	present	CSL	CSO model calibration

APPENDIX B - Table 6 Listing of Outlying Community Contract Limits

Metered	Contract Limits					
Standardized	Instantaneous		Daily Max	Township Total		
Site ID	CFS	MGD	MGD	Inst. CFS	Inst. MGD	Daily Max MGD
MA1						
MA2						
MA3	0.185	0.12				
MA4	0.602	0.389				
MAx1	0.185	0.12				
Abington Total				9.247	5.976	4.453
MB1	85.08	54.989	37			
Bucks Total				85.08	54.989	37
MBE1						
MBE2						
MBE3						
MBE4						
MBE5			0.282			
MBE6			1.327			
MBE7			0.412			
MBE8						
MBE9						
MBE10						
MBE11						
MBE12						
MBE13						
MBE14						
MBE15						
MBE16						
Bensalem Total				11.74	7.588	6.133
MC1	2.75	1.777				
MC2	18	11.634				
MC3	0.48	0.31				
MCx1	8	5.171	Combined total for all the MCx#			
MCx2						
MCx3						
MCx4						
MCx5						
MCx6						
MCx7						
Cheltenham Total				20.75	13.411	13.411

Metered	Contract Limits					
Standardized	Instantaneous		Daily Max	Township Total		
Site ID	CFS	MGD	MGD	Inst. CFS	Inst. MGD	Daily Max MGD
MD1	155	100.179	50	155	10.179	50
ML1			5.474			
ML2			1.48			
ML3						
ML4			10.264			
ML5			1.848			
ML6			0.252			
ML7			0.84			
Lower Merion Total				31.57	20.404	14.5
MLM1						
MLM2		0.2	0.411			
MLM3						
MLM4						
MLM5						
MLM6						
MLM7						
Lower Moreland Total				8.97	5.797	2.9
MS1	4.6	2.973				
MS2						
MS3						
MS4		1.93	1.247			
MS5						
MS6						
MS7						
MS8						
Springfield Total				6.53	4.22	4.2
MSH1						38566
MSH2						
MSHX_1						
MSHX_2						
Southampton Total				15.79	10.205	7.14
MUD-N	35	22.621	17			
MUD-S	combined total for all Upper Darby Connections					
MUD-O						
MUD-1				35	22.621	17

APPENDIX C – PUBLIC EDUCATION AND INFORMATION MATERIALS

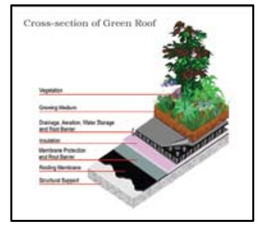
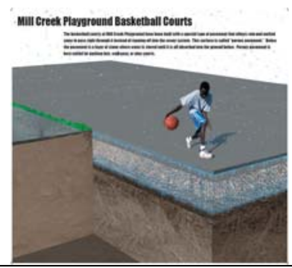
Table 1 Bill Stuffers & WaterWheels

Type	Description
Bill Stuffer I	This publication covers an introduction to the CSO LTCPU and the goals of the Philadelphia Water Department in controlling CSOs.
Bill Stuffer II (July, 2009)	The Water Revenue Bureau and the Water Department published and distributed a billstuffer that explained how their water, sewer and stormwater bill was redesigned highlight the new usage graph, easy-to-read format and clear statement of charges and account status.
Bill Stuffer III (July, 2009)	The Water Department published and distributed a billstuffer that explained the second phase of rate changes to their water and sewer rates.
Bill Stuffer IV (September, 2009)	"What You Need to Know When There's a Loss of H20" - Water Emergency Preparedness Billstuffer – The Water Department created and distributed annually to Philadelphia rate payers detailing the Water Department's procedures during a water emergency and the homeowner's responsibility with regard to their home's plumbing system.
Bill Stuffer V (September, 2009)	The Water Department published the 2nd edition of the Monoshone Watershed Quarterly Water Quality Update for the Monoshone Creek which provides updates on PWD's Saylor Grove Treatment Wetland and more detailed water sampling information that occurs around the City of Philadelphia.
Bill Stuffer VI (February, 2010)	The Water Department published the 3rd edition of the Monoshone Watershed Quarterly Water Quality Update for the Monoshone Creek which provides updates on PWD's Saylor Grove Treatment Wetland and more detailed sampling information throughout the City of Philadelphia.
Bill Stuffer VII (May, 2010)	The Water Department published the 2009 Water Quality Report, an annual consumer confidence report mandated by the federal Safe Drinking Water Act distributed each year to PWD wholesale and retail account customers, and other consumers of the city's water.
Bill Stuffer VIII (June, 2010)	The Water Department created the Stormwater Management Service Charge Residential and Non-Residential fact sheets to help educate the public on the change in the fees collected for stormwater management. The fact sheets were placed on PWD's website.

Type	Description
Bill Stuffer IX (June, 2010)	The Water Department published and distributed the Stormwater Management Service Charge billstuffer to explain to customers how the Water Department changed the way stormwater collection and treatment charges are calculated.
WaterWheel I: CSO Public Notification Means You're in the Know	This publication aims to notify the public of the CSO public notification system and covers the commonly asked questions about CSO-affected waters.
WaterWheel II (in Water Quality Report): Green Cities, Clean Waters Program	This publication covers the history of CSOs and includes a CSO Notification Card cut-out.
WaterWheel III: Clean Waters, Green Cities – Neighborhood-Friendly Solutions	This publication covers the Philadelphia Water Department's Green Streets Program.
WaterWheel IV: Green Cities, Clean Waters – Tookany/Tacony-Frankford Creek	This publication covers the Integrated Watershed Management Plan for the Tookany/Tacony-Frankford Watershed.
WaterWheel V (May, 2010)	The Water Department published Waterwheel, a newsletter detailing PWD's initiatives involving watershed stewardship and stormwater management. This issue focused on the Combined Sewer Overflow Long Term Control Plan Update entitled, Green City, Clean Waters.
Ad (August, 2009)	The Public Relations Unit placed ads announcing that public meetings would be held to gain feedback from the public on PWD's Combined Sewer Overflow Long-Term Control Plan Update. The ads appeared during the week of August 10 in the Daily News, Philadelphia Inquirer, Westside Weekly, the Philadelphia Tribune, Germantown Chronicle/Mt. Airy Independent, the Spirit Community Newspapers, Chestnut Hill Local, South Philadelphia Review, Philadelphia City Paper, Philadelphia Weekly and Al Dia Newspaper.
Media Advisory (September, 2009)	Philly Fun Fishing Fest – A media advisory was issued on September 16 inviting the media to cover the Water Department's annual Fish fest where over 150 people participated in this catch and release fishing event where prizes were awarded to the guests who caught fish in various categories. The Fishing Fest is an annual event sponsored by many area businesses and partners of PWD.

Type	Description
Press Release (September, 2009)	8th Annual Southeastern Pennsylvania Coast Day – A press release was issued on September 7 inviting the public to the 8th annual Southeastern Pennsylvania Coast Day hosted by the Philadelphia Water Department and the Partnership for the Delaware Estuary. Twenty environmental organizations from throughout the region came together to educate the public about protecting Pennsylvania's water resources. Visitors had the opportunity to have their faces painted and board a shuttle bus to the Fairmount Water Works Interpretive Center, the Water Department's premier environmental education facility.
Press Release (December, 2009)	The Water Department issued a press release to encourage residents to clear sewer inlets of debris to allow melting snow to flow into the inlets to mitigate street flooding.
Press Release (April, 2010)	The Water Department issued a press release announcing its participation in a roundtable discussion with the American Cities Foundation and other officials where the theme for the roundtable was achieving a triple bottom line through environmental, social and economic benefits of green development.
Annual Financial Report (June, 2010)	The Water Department published the 2009 Annual Financial Report which is distributed to bond rating agencies and other financial institutions. The 2009 report included information on the CSO LTCPU.
Press Release (June, 2010)	The Water Department issued a press release commenting on American Rivers designating the Upper Delaware River as among America's most endangered rivers. The Department's Deputy Commissioner of Environmental Planning Howard Neukrug remarked,"The Department will continue to work closely with its partners at the Pennsylvania Department of Environmental Protection, the EPA and the Delaware River Basin Commission to ensure that drilling is performed with full respect for our drinking water supply. It is our expectation that the health and safety of the region's drinking water will not be compromised."
Press Release (June, 2010)	The Water Department issued a press release informing the public about the completion of the Dobson's Run Storm Relief Sewer that was designed to mitigate flooding in the East Falls section of the City.
Press Release (June, 2010)	The Water Department issued a press release inviting the public to its First "Green Street" Grand Opening.
Press Release (June, 2010)	The Water Department issued a press release announcing that one of its leading scientist, Gary Burlingame, would be giving a presentation explaining the Department's annual Water Quality Report.

Table 2 Green Cities, Clean Waters Information Fair Materials

Green Cities, Clean Waters Information Fair Materials			
Green Stormwater Infrastructure Program Fact Sheet Series		Illustration: Green Roof Cross-Section	
Fact Sheet: Tacony Creek Storage		llustration: Venice Island's Green Roof Pumping Station	
Fact Sheet: Waterways Restoration Team		Mill Creek Recreation Center's Porous Basketball Court –	
Fact Sheet: Real Time Control Center		Poster: Rain Barrels	
Fact Sheet: Main Relief		Fact Sheet: Marshall Road Creek Restoration	

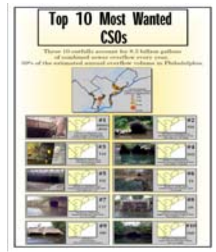
Fact Sheet: Penn Alexander's Stormwater Management BMPs		Guide: Saylor Grove Stormwater Wetland Tour Guide	
Brochure: Floatables Skimming Vessels		Poster: Top 10 CSO's of Philadelphia	
Guide: Homeowner's Guide to Stormwater Management Manual		Poster: Philadelphia's Changing Streams	
Green City, Clean Waters postcard			

Table 3 Green Cities, Clean Waters Exhibit Informational Posters

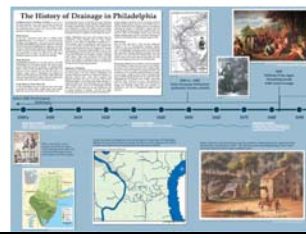
Green Cities, Clean Waters Exhibit Information Posters	
Green Cities, Clean Waters ~ Philadelphia Water Department's Combined Sewer Overflow Long Term Control Plan (an introduction to the CSO LTCPU)	
History of Drainage in Philadelphia (historical timeline)	
What the City and its partners are doing (examples of local demonstration projects that manage stormwater through a "green" approach)	
What You Can Do (examples of projects property owners can take on to manage stormwater in environmentally-friendly manners)	

Table 4 Green Cities, Clean Waters Traveling Exhibit

Green Cities, Clean Waters Advisory Committee					
Meeting:	**1**	**2**	**3**	**4**	**5**
Date:	November 13, 2007	February 20, 2008	October 8, 2008	April 9, 2009	August 5, 2009
Time:	10:00am - 12:00pm	10:00am - 12:00pm	10:00am - 12:00pm	10:00am - 12:00pm	10:00am - 12:00pm
Place:	Fairmount Water Works Interpretative Center	Fairmount Water Works Interpretative Center	Fairmount Water Works Interpretative Center	Fairmount Water Works Interpretative Center	Fairmount Water Works Interpretative Center
# of Attendees:	9	8	16	8	12
Topics Covered:	• Purpose and role of the advisory committee • Overview on CSOs • Assessment of Philadelphia's combined sewer system • Regulatory context of the LTCPU update • Watershed management approach to CSO control • CSO-related outreach materials/projects developed to date • Next steps for CSO-related public outreach • Timeline for future meetings and meeting topics	• Purpose and role of the advisory committee • Feedback on the public meeting presentation • Presentation on Philly RiverCast • Presentation on plans for Philly CSOCast	• Water quality characterization • Problem analysis • Goals developed for each targeted watershed • Presentation on Philly CSOCast • Preview of Green Cities, Clean Waters Exhibit	Public meeting presentation on CSO – control options & alternatives	• How do we promote the final public meetings? • Any final feedback to incorporate in the draft and CSO LTCPU?

Table 5:Green Cites, Clean Water Public Meetings

Green Cities, Clean Waters Public Meetings, Series #1			
Meeting:	1	2	3
Date:	April 2, 2008	April 10, 2008	April 24, 2008
Time:	10:00am - 12:00pm	10:00am - 12:00pm	10:00am - 12:00pm
Place:	Port Richmond Library, Philadelphia	FELS Community Center, Philadelphia	School of the Future, Philadelphia
Number of Attendees:	10	6	19
General Feedback:	Generally, the participants posed questions, regarding PWD's proposed tank in the area; on whether gray water systems are illegal; and provided comments on green stormwater infrastructure being a better approach and on the locations of storage tanks or diversion systems.	The participants made remarks, regarding the importance of showing specific examples of green stormwater infrastructure projects and using local project examples, so that the public can better relate to the projects.	The participants asked questions, regarding building code changes, the impacts of greening on the residential water bills, and the importance of working with neighborhood groups to maintain green stormwater infrastructure projects, in addition to the importance of educating children in school about green projects.

Green Cities, Clean Waters Public Meetings Series #2			
Meeting:	1	2	3
Date:	October 23, 2008	December 4, 2008	December 10, 2008
Time:	6:30pm - 8:30pm	5:30pm - 7:30pm	6:00pm - 8:00pm
Place:	Fairmount Water Works Interpretative Center, Philadelphia	Cobbs Creek Community Environmental Education center, Philadelphia	Center in the Park, Philadelphia
Number of Attendees:	13	14	20
General Feedback:	The participants asked questions, regarding incentives for residential/commercial properties; communication with the larger parcels that will be affected by the rate reallocation; modeling gray infrastructure; and tidal influences on the drinking water intake on the Delaware River.	The participants asked questions, regarding the function of a tank; the longevity of gray infrastructure; models and maintenance of porous asphalt; stormwater regulations; and about CSO LTCPU plans in other cities.	The participants asked questions, regarding how project sites are selected; the reasons behind residents paying for stormwater impacts, and about how other CSO cities manage with their gray projects.

Green Cities, Clean Waters Public Meetings Series #3			
Meeting:	1	2	3
Date:	June 2 2009	June 4 2009	June 10 2009
Time:	6:00pm - 8:00pm	6:00pm - 8:00pm	6:00pm - 8:00pm
Place:	Fels South Philadelphia Community Center, Philadelphia	Waterview Recreation Center, Philadelphia	Northern Liberties Community Center, Philadelphia
Number of Attendees:	7	9	14
General Feedback:			

Green City, Clean Waters Public Meetings, Series #4				
Meeting:	1	2	3	4
Date:	August 18 2009	August 19 2009	August 20 2009	August 25 2009
Time:	6:00pm - 8:00pm	6:00pm - 8:00pm	6:00pm - 8:00pm	6:00pm - 8:00pm
Place:	Waterview Recreation Center, Philadelphia	Northern Liberties Community Center, Philadelphia	Columbus Square Recreation Center, Philadelphia	Mercy Hospital, Philadelphia
Number of Attendees:	15	34	20	25
General Feedback:	Very Positive.	Very Positive.	Very Positive.	Very Positive.

Table 6: Examples of Model Neighborhoods Educational Materials

Three Typical Stormwater Management Project		Sidewalk Trees and House Sewer Laterals	
Model Neighborhoods Brochure		Street Trees in Philadelphia Background Information	
Model Neighborhoods Tree Walk on your Block		Summer Outreach Programs for Camps	
Philadelphia Street Trees		Before and After Photo Simulation	 

Table 7: Green Stormwater Infrastructure Tours

Date	Event	Number of Attendees	Description
April 6, 2008	Historic Mill Creek Watershed Tour	35	As part of a larger tour organized for a University of Pennsylvania landscape architecture class that focused on the Mill Creek watershed, students toured the Mill Creek Farm, Mill Creek Playground, Sulzberger Outdoor Classroom, Blackwell Homes, and Penn-Alexander School.
May 3, 2008	Clean Water, Green City Tour	20	Presented with White Dog Café, a tour to highlight projects that link environmental vision with economic health, and quality of life with the sustainability of our city. Sites included Waterworks Interpretive Center, Awbury Arboretum, Saylor Grove, and Penn-Alexander School.
Sept. 10, 2008	Philadelphia Green Infrastructure Tour	10	Organized for a group from New York City Parks, Conservation District, and Dept. of Environmental Protection, sites included Wissahickon Charter School, Waterview Recreation Center, Cliveden Park, Saylor Grove, and Allens Lane Arts Center.
Oct. 3, 2008	GreenPlan Philadelphia Tour	45	Organized as part of the American Society for Landscape Architects national conference, the tour highlighted several greening and vacant land management sites that integrated stormwater management, including Liberty Lands, N. 3rd Street Corridor, and North Central Philadelphia vacant land stormwater management sites.
May 5, 2009	Historic Mill Creek Watershed Tour	35	As part of a larger tour organized for a University of Pennsylvania landscape architecture class that focused on the Mill Creek watershed, students toured the Mill Creek Farm, Mill Creek Playground, Blackwell Homes, Penn-Alexander School, and Clark Park.
June 10, 2009	EPA National Stormwater Coordinators Meeting Tour	40	As part of a national EPA meeting, the tour illustrated PWD's green infrastructure program and highlighted innovative projects and partnerships. Sites included Liberty Lands, Thin Flats, Greensgrow Farm, model neighborhoods (Northern Liberties, New Kensington, and APM), Saylor Grove, and Wise's Mill.
May 15, 2010	Green Bus Tour	43	PWD led a bus tour opened to the general public with stops including: Free Library of Philadelphia's Green Roof, Green Field Elementary's Playground, Herron Playground, and Liberty Lands.

Date	Event	Number of Attendees	Description
June 6, 2010	EPA Non-Point Source Team Tour	11	Green bus tour, as requested by the EPA for Non-Point Source Program staff members. Locations visited were: Greenfield Elementary, Herron Playground, Liberty Lands, Kensington High School and Overbrook Evironmental Education Center
July 26, 2010	William Penn Foundation Tour	13	Tour funded by and for William Penn Foundation and other national foundation leaders. The Big Green Block, New Kensignton High School, Liberty Lands, and APM (Sheridan) were stops that were included in this tour.
August 2, 2010	Penn Atlantic Nursery Trade Show Tour	23	Tour requested by PANTS for their conference with stop locations including Cliveden Park, Herron Playground, and Columbus Square.
August 3, 2010	NRDC Water Advocacy Tour	4	Tour conducted by PWD designer with sites including Columbus Square, Herron Playground, and Liberty Lands.

Table 8: TTF Partnerships Events

Event Title	Date	Location	# Served	Description	Evaluation
Creek Mapping Walk	7/14/09	Tookany Creek Tributaries in Cheltenham	5 adults	Mapped tributary coordinates for creek-naming project with Cheltenham EAC	N/A
"Curly the Catfish Lesson"	8/3/09	Tabor Summer Camp	30 - 5 to 7 YOs	Gave "Curly the Catfish lesson" to 30 5-7 year-olds.	Positive feedback, requests for return visits
Invasives Removal with Nicetown Boys and Girls Club	8/4/09	Awbury Arboretum	17- 8th & 9th graders	Gave watersheds lesson and conducted invasives removal with 17 eighth and ninth graders.	N/A
Storm drain marking	8/5/09	Tabor Summer Camp	50 8-14 year-olds	Gave watersheds lesson and conducted storm drain marking with fifty 8-14 year olds.	Positive verbal feedback, requests for return visits
Chew & Belfield Block Party	8/15/09	Parking lot at Chew & Belfield	20 adults	Presented a TTF Model Neighborhood update, introduced PWD's Green Streets program, did a rain barrel demonstration and collected sign-ups for the upcoming rain barrel workshop.	6 sign-ups
Model Neighborhood Public Meeting	8/18/09	Waterview Recreation Center	20 adults	PWD gave Green Streets overview. TTF presented Model Neighborhood information.	N/A
Two Block Captain Meetings	8/24/09	Reverend Williams' home - 6211 Chew Avenue	9 adults	Gave update on TTF's Model Neighborhood project, PWD's Green Street's program and collected sign-ups for the upcoming Rain Barrel Workshop	5 sign-ups
Community meeting with SEPTA	8/27/09	R7 Washington Lane Station	10 adults	Represented TTF at community meeting regarding safety concerns.	Safety concerns addressed. Article published in Germantown News.
Ross Street Meeting	9/09/09	6300 Block of Ross Street	15 adults	PWD gave update on Green City, Clean Waters plan. TTF gave Model Neighborhood update.	15 sign-ups
Senior Environment Fair	9/18/09	Center in the Park, Senior Environment Corps	100 adults	Hosted a TTF display table with Model Neighborhood information highlighted. (6 hours.)	5 contacts added to mailing list

Stream Clean-Up	9/19/09	Wall Park	40 adults and children	Volunteer cleared trash and debris from the Tookany Creek and the surrounding area as part of Ocean Conservancy's International Coastal Cleanup with supplies provided by PA CleanWays.	1402 pounds of trash removed, 14 evaluation forms completed.
Rain Barrel Workshop	9/23/09	Waterview Recreation Center	31 families, 31 free rain barrels distributed.	Hosted Rain Barrel Workshop taught by PWD staff, Porous pavement demonstration by PHS staff, Model neighborhood presentation by TTF	31 rain barrels distributed, 18 evaluation forms completed.
Glenside Street Fair	9/26/09	Easton Road, Glenside	40 adults	Hosted TTF display table. Spoke to 40 adults.	18 contacts added to mailing list
Ross Street Meeting	10/3/09	6300 Block of Ross Street	20 adults	PWD gave update on Green City, Clean Waters plan. TTF gave Model	17 contacts added to mailing list
TTF Model Neighborhood Van Tour	10/4/09	Awbury/ Cliveden Model Neighborhood	10 adults (incl. 4 speakers)	Van tour of four demonstration sites in the Model Neighborhood presented in collaboration with Fairmount Park. (2.5 hours)	Positive verbal feedback
Watershed lesson at West Oak Lane Charter	11/13/09	West Oak Lane Charter School	85 4th grade students	Gave watershed lesson to 85 fourth grade students in partnership with Fairmount Park.	Positive verbal feedback, arranged for two follow-up visits
TOXTOUR Presentation to AWRA	11/19-11/20/09	Cedarbrook Middle School: Environment Club Philadelphia Maritime Academy Germantown Friends School	15 middle school students 170 high school students 300 elementary, middle and high school students	Christopher Swain, swimmer conservationist presented his work at numerous schools throughout Cheltenham and Philadelphia. He spoke about clean water issues, his past work swimming rivers to raise awareness, his current swim (1000+ miles down the Atlantic Coast from Boston to Washington DC), and the problems associated with common e-waste disposal techniques.	Extremely positive verbal feedback.

Interview: WXPN Radio	11/20/09	WXPN Studios in Philadelphia	TBD	TTF Associate Director Katie Donnelly was interviewed for a three minute segment on the TTF Watershed Partnership. Segment will air in mid-December	N/A
TOXTOUR, Ethical Electronics Recycling Event	11/21/09 – 11/22/09	Cedarbrook Middle School	153families	Hosted a drive to collect used electronics for ethical recycling at a fee of $1/lb.	11,052 lbs of e-waste collected $1401.81 proceeds to TTF 86 contacts added to mailing list
Watershed lesson at West Oak Lane Charter	12/4/09	West Oak Lane Charter School	85 4th grade students	Gave watershed lesson to 85 fourth grade students in partnership with Fairmount Park.	Positive verbal feedback, arranged for one follow-up visits
Bryn Mawr Watershed Lesson	12/4/09	Bryn Mawr College	30 Freshman students	Gave watershed lesson to freshman college students. Discussed the various methods to implementing stormwater management	Positive verbal feedback teacher.
Watershed lesson at West Oak Lane Charter	12/11/09	West Oak Lane Charter School	85 4th grade students	Gave watershed lesson to 85 fourth grade students in partnership with Fairmount Park.	Positive verbal feedback from students and teachers
Community Meeting w/Donna Reed Miller	1/15/10	Rev. William's Home	30 adults	Community meeting to discuss local issues. TTF presented on the Urban Energy Conservation Block Party, the Vacant Lot Transformation project, and opportunities for free Street Trees	N/A
Philadelphia Green Skills Conference	1/30/10	University of the Sciences, Philadelphia	50 adults	Sarah presented twice on "Stormwater Management for Rowhomes and Renters" in collaboration with PWD staff	N/A
Tour of Stormwater Management Features at Awbury	2/19/10	Awbury Arboretum	8 college students (Arcadia Environmental Club)	Gave a lecture on watersheds and issues facing the TTF watershed and took students on an educational tour of Awbury Arboretum's stormwater management features.	N/A

"Tapped" Screening & Tour of SW Mgmt Features at Awbury	2/20/10	Awbury Arboretum	16 High School students from Chetenham and Philadelphia	Gave a watersheds and stormwater management lesson to EarthForce's Youth Leadership Team, took students on an educational tour of Awbury Arboretum's stormwater management features, and showed them the movie, "Tapped" (about the privatization of drinking water	N/A
Meeting w/ Clearview St. Residents re: Block Party	3/6/10	6205 Clearview Street, Dessadra Smith	20 adults	Initial meeting with Clearview Street residents discussing OARC Urban Energy Conservation Block Party	15 people signed up for block party
Presentation for UPenn Green City, Clean Waters Class	3/11/10	Fairmount Water Works Interpretive Center	18 students	Fairmount Water Works Interpretive Center Discussed areas of needed improvement in watershed education and stormwater management implementation	Continued contact and possibility for volunteer work with students.
Art Contest Judging	3/17/10	Fairmount Water Works	over 700 elementary school student works were judged	Reviewed hundreds of student art contest entries about watershed stewardship as part of a panel of 8 judges from local organizations businesses and institutions. Winners' works are featured in the Partnership for the Delaware Estuary calendar.	N/A
UPenn Lecture	3/23/10	University of Pennsylvania	10 college students	Guest spoke for "Green City, Clean Waters" class at UPenn about understanding the nonprofit organization and its role in changing the world.	N/A
Belfield Block Meeting	3/31/10	6200 Block of Belfield	6 adults	With the Philadelphia Water Department presented information on the proposed Green Street program.	N/A

NBC 10 Interview	3/5/10	6211 Chew Avenue, Reverend Chester Williams House	Numerous	Terry Ruggles interviewed Reverend Williams and model neighborhood residents for NBC-10 "Good News" segment. TTF staff discussed how TTF benefits from the Reverends support and plans for the green improvements to the neighborhood	N/A
Philly Spring Cleanup/ Clearview Porch Painting	4/10/10	Produce Stand Lot, Chew Avenue, Clearview Street	approx 80 homes	In partnership with the Mayor's Annual Spring Cleanup and with help from the Water Restoration Team, TTF cleaned up waste from short dumping, cleaned the streets and painted porches on Clearview Street as part of a block beautification initiative	42 names added to mailing list
Cliveden Hills Meeting	4/12/10	True Light Church, Stenton & Ardleigh	20 adults	Presented overview of TTF Watershed Partnership and Model Neighborhood activities	18 Model Neighborhood Surveys collected
Awbury Neighbors Meeting	4/14/10	DePaul House, 5725 Sprague St. Philadelphia, PA, 19138	20 adults	Presentation of general watershed information and current plans in the model neighborhood. Discussion of how neighbors can be involved in greening.	20 Model Neighborhood Surveys collected
Cedarbrook Cleanup	4/17/10	Cedarbrook Middle School	20 middle school, 5 college students, 5 adults	Stream Cleanup behind Cedarbrook Middle School with students and watershed residents.	21 names added to the mailing list 21 evaluations completed
Academy of Natural Sciences Earth Day	4/17/10	Academy of Natural Sciences	50 people	Tabled with the Delaware Valley Earth Force Youth Leaders Team to raise awareness about the importance of drinking municipal water and the detriments of drinking tap water	6 Water Bottles Sold, approx. 50 signatures collected for petitions

Arcadia University Earth Day	4/22/10	Arcadia University	50 people	Hosted a table with general information about TTF watershed, sold metal water bottles to raise awareness about the importance of drinking tap water and collected "clean water wishes" from audience. Gave a presentation on the TTF watershed and stormwater issues and participated in panel discussion with Barb Duffy from Cheltenham EAC for a small student audience	38 contacts added to mailing list 6 water bottles sold
Arbor Day Planting with Roosevelt Middle School	4/23/10	TR Middle School, 430 E. Washington Lane	40 7th grade, 8th grade & pre-K students,4 chaperones.	Discussed the importance of planting trees for watershed health. Planted 200 seedling trees and sent 40 seedling trees home with students.	20 water bottles sold, 11 contacts added to mailing list
Cheltenham Earth Day Festival	4/24/10	Myers Elementary School	150 children and adults	Hosted a table with general information about TTF watershed and collected "clean water wishes" from audience. Sold metal water bottles with EarthForce's Youth Leadership Team to raise awareness about the importance of drinking tap water instead of bottled water	20 water bottles sold, 11 contacts added to mailing list
Jenkintown Greenfest	4/25/10	Jenkintown Town Square	50 adults and children	Hosted a table with general information about TTF watershed, sold metal water bottles to raise awareness about the importance of drinking tap water and collected "clean water wishes" from audience.	2 waterbottles sold 2 contacts added to mailing list
May Day Planting on Clearview Street	5/1/10	6200 block of Clearview Street	30 families	With donations of native tubelings from Pinelands Nursery, and annuals from Primex Garden Center and Chestnut Hill Flower & Garden, TTF hosted a container gardening workshop on Clearview Street. Residents learned how increased vegetation helps manage stormwater and arranged potted plants for their outdoor areas	Positive feedback from residents, request for similar workshops and increased beauty on the block.

Backyard Buffer Workshop	5/3/10	Curtis Arboretum, Cheltenham	19 people	TTF hosted Tony Federici in a workshop that provided environmentally friendly landscape designs and guidance focused on stormwater issues, stream bank erosion and general "green" landscaping practices.	19 names added to mailing list, 13 evaluations completed
Earth Force Youth Leaders Kickoff	5/4/10	Philadelphia Zoo	300 children	TTF helped the EarthForce Youth Leaders Team host a display and sell metal water bottles	N/A
Roosevelt Nursery Area Planting	5/8/10	Theodore Roosevelt Middle School, 430 E. Washington Lane	20 students	Planted native trees and shrubs in the nursery play area as a first step in planning an on-site outdoor classroom.	Positive feedback from students and teacher.
Clearview Cleanup	5/8/10	6200 Clearview Street	20 families	TTF hosted a block cleanup, painting and preblock party information session in order to clean and prepare the block and it's residents for the upcoming block party.	Positive feedback from residents.
Cedarbrook Lesson Day	5/11/10	Cedarbrook Middle School	100 students	Taught "What's a Watershed" lesson to 4 classes. Discussed how to implement stormwater management practices as a student and what other lifestyle choice can be made to positively affect our watershed.	Positive feedback.
Urban Energy Conservation Block Party	5/15/10	6200 Block of Clearview St	40 families	OARC and TTF provided residents with green upgrades on their properties. Upgrades included CFL bulbs, water aerators, recycling bins and rain barrels. The entire community was invited to come out and interact with environmental educators, vendors and community leaders for a fun filled day of learning, food, music, presentations, tours and much more!	Positive feedback from residents.

Wyncote Elementary Native Bird Habitat	6/3/10	Wyncote Elementary School	350 elementary school students	Assisted with the planting of a bird habitat around the flagpole at Wyncote Elementary School. The project was led by EarthForce Youth Leaders from Cedarbrook Middle School, the area was planted by Wyncote students, and the project was funded by the Audubon Society.	N/A
Urban Energy Conservation Block Party	6/5/10	7900 Block of Gilbert St	150 adults and children	TTF hosted an information table at OARC's Urban Energy Conservation Block Party. We displayed a rain barrel, disseminated information about the TTF watershed and stormwater management, and collected contact information from people who may be interested in receiving a free rain barrel.	Positive feedback from residents.
Arts in the Park	6/6/10	High School Park	100 adults and children	Hosted a table with general information about TTF watershed and the importance of stormwater management, and collected "clean water wishes" from audience.	10 contacts added to mailing list
Neighborhood Cleanup	6/11/10	Ardleigh Street	Numerous	Cleaned up trash on Ardleigh Street with Bethesda Court residents and staff.	10 bags of trash removed
Artology Lesson (6-8): Intro to Watersheds	6/29/10	Highschool Park, Tacony Creek Park	30 children grades 6-8	Summer camp lesson introducing watersheds and the challenges they face	Positive feedback from students and counselors.

APPENDIX D –BMP FACTSHEETS

Traffic Triangle Retrofit at 47th and Grays Ferry

Stormwater BMP Project

Schuylkill Watershed

Contact: Amy Leib
215.685.6035
amy.leib@phila.gov

Status: Completed

Partners:

PA Department of Environmental Protection (PADEP)
Philadelphia Department of Recreation
University City Green (UCG)
Pennsylvania Horticultural Society (PHS)
Philadelphia Streets Department
University of Sciences in Philadelphia (USP)

Traffic Triangle Retrofit at 47th and Grays Ferry…

Traffic triangles are often under-utilized parcels within the urban landscape. The vegetated, but unused traffic triangle at the intersection of 47th and Grays Ferry in West Philadelphia was retrofitted with a rain garden to provide a gateway feature for the community and nearby university while managing stormwater from the adjacent streets.

Stormwater from Paschall Street and Grays Ferry Avenue is diverted into the traffic triangle through trench drains, where it can pond and infiltrate into the soil. The gardens are planted with trees, shrubs, and herbaceous plants that will tolerate the fluctuating conditions and provide year round interest as a gateway landscape.

Benefits:

•Reduces the flow of stormwater into the combined sewer system through on-site infiltration, thus reducing overflows to the river.
•Reduces non-point source pollution from stormwater runoff through vegetation and bioretention.
•Reduces nuisance flooding on Paschall Street
•Provides a gateway feature for the West Shore Neighborhood and University of the Sciences.

Clean Water……. Green City
www.phillyriverinfo.org

Allens Lane Art Center Porous Basketball Court

Stormwater BMP Project

Wissahickon Creek Watershed

Contact: Joanne Dahme
215.685.4944
joanne.dahme@phila.gov

Status: Completed

Partners:

Councilwoman Donna Reed Miller
U.S. Environmental Protection Agency
Fairmount Park Commission (FPC)

Allens Lane Art Center Porous Basketball Court...

The Fairmount Park Commission has embarked on the complete reconstruction of the basketball court at the Allens Lane Art Center and teamed up with the Office of Watersheds to demonstrate pervious asphalt.

To improve the quality of the courts and reduce the volume of stormwater that flows into the Wissahickon Creek, the basketball courts will be retrofitted with porous asphalt over an infiltration bed. Rain that falls on the basketball courts will pass through the porous surface and be stored in a subsurface stone bed until it can soak into the ground, eventually helping to provide baseflow for the creek.

Benefits:

- The system is designed to capture most of the stormwater that falls on the two basketball courts, thereby reducing the volume and rate of stormwater that flows into Wissahickon Creek
- Rainfall is infiltrated, recharging groundwater and providing needed baseflow for Wissahickon Creek
- No puddles on the court, so players can play immediately after it rains

Clean Water........ Green City
www.phillyriverinfo.org

PWD's Bureau of Laboratory Services

Stormwater BMP Project

Tacony-Frankford Watershed

Contact: Glen Abrams
215.685.6039
Glen.Abrams@phila.gov

Status: Concept Design

Partners:

Environmental Protection Agency (EPA)

PWD's Bureau of Laboratory Services...

The Habitat Creation and Stormwater Management Demonstration project at the Philadelphia Water Department Bureau of Laboratory Services (BLS) is divided into three sub-projects: 1) Meadow Creation; 2) Stepped Rain Garden; and 3) Porous Pavers and Vegetated Swale. Nearly 1/2 acre of turf was converted to meadow and runoff from about 28,500 square feet of parking area will be managed via vegetation and infiltration by retrofitting the existing facilities.

Benefits:

•Provides demonstration of how to retrofit a parking lot to improve stormwater management
•Provides demonstration of constructing bioretention gardens on a slope and in areas with slow infiltration rates
•Illustrates an alternative to the convention lawn, particularly for institutions and corporation

Clean Water....... Green City
www.phillyriverinfo.org

Clark Park Infiltration Bed

Stormwater BMP Project

Mill Creek Watershed

Contact: Glen Abrams
215.685.6039
Glen.Abrams@phila.gov

Status: Completed

Partners:

Friends of Clark Park (FOCP)

Pennsylvania Department of Conservation & Natural Resources

Philadelphia Department of Recreation

PA Department of Environmental Protection (PADEP)

Philadelphia Capital Program Office

Clark Park Infiltration Bed...

A subsurface infiltration bed beneath a new basketball court at Clark Park will manage stormwater runoff from the basketball court, as well as from an adjacent street and parking lot. The system has been designed to capture about 1.5" of rainfall from the contributing drainage area, but with well-drained soil, it is anticipated that actual stormwater capture will be much greater.

Benefits:

- Infiltration of stormwater runoff will reduce CSO volume in one of Philadelphia's largest combined sewer areas.
- Opportunity to monitor long-term performance of a stormwater management strategy most often selected by private developers.
- Example of integrating management of runoff from the street into a planned capital improvement project on a City facility.

Clean Water........ Green City
www.phillyriverinfo.org

Cliveden Park

Stormwater BMP Project

Tacony-Frankford Watershed

Contact: Amy Leib
215.685.6035
amy.leib@phila.gov

Status: Completed

Partners:

Bank of America
Pennsylvania Department of Environmental Protection (PADEP)
Philadelphia Department of Recreation
Friends of Cliveden Park
Pennsylvania Horticultural Society (PHS)

Cliveden Park...

The stormwater demonstration project at Cliveden Park captures runoff from adjacent streets and uses the park's natural topography to detain stormwater before it flows into the combined sewer system. Small upland depressions provide water quality treatment and infiltration of stormwater, and a modified outlet structure allows water to pond in the existing wetland before it is slowly released. The system will provide stormwater volume removal through evapotranspiration and infiltration, and will reduce the flow rate to the combined sewer system during the small, frequent storms that cause the majority of combined sewer overflows. The system meets stormwater management objectives, enhances the existing wetland in the park, and is also provides an amenity for the park community.

Benefits:

•Combined sewer overflows are reduced through infiltration, evapotranspiration, and flow attenuation

•Stormwater filtration and water quality treatment

•Wetland and park enhancement

Clean Water........ Green City
www.phillyriverinfo.org

Columbus Square

Stormwater BMP Project

Lower Schuylkill Watershed

Contact: Jessica Brooks
215.685.6038
Jessica.K.Brooks@phila.gov

Status: Completed

Partners:

Capital Program Office (CPO)
Department of Recreation
Friends of Columbus Square

Columbus Square...

Stormwater planters were installed on 13th Street adjacent to the Columbus Square Recreation Center in South Philadelphia. Stormwater planters are planters that are inset in the sidewalk so they can collect and manage runoff for the street and sidewalk. Stormwater runoff is diverted into the planter, filtered through the soil, and infiltrated or slowly release back to the sewer. Columbus Square is the first location in Philadelphia to have stormwater planters installed in a public sidewalk. This location serves as a demonstration site for future installations.

Benefits:

Demonstrate new approaches to stormwater management
Reduce stormwater volume and rate to combined sewer
Manage stormwater in a known flooding area
Beautify sidewalk

Clean Water........ Green City
www.phillyriverinfo.org

Riparian Restoration at Courtesy Stables

Restoration Project

Wissahickon Creek Watershed

Contact: Kelly Anderson
215-685-6245
Kelly.Anderson@phila.gov

Status: Ongoing Initiative

Partners:

DE Estuary Grant- The National Fish & Wildlife Foundation

Fairmount Park Commission (FPC)

Friends of the Wissahickon (FOW)

Natural Resources Conservation Service

Philadelphia Water Department - OOW

Riparian Restoration at Courtesy Stables...

This project's aim is to correct problems contributing to nutrient-laden stormwater that flows from a barnyard through an adjacent wetland and into a tributary of the Wissahickon Creek. Stormwater is rerouted from the barnyard and surrounding area into a grassed waterway/filter strip where nutrients and sediment are removed and a portion of the water infiltrates into the ground before reaching the wetland. Flow from a springhouse was rerouted directly to the wetland, serving as a continuous source of clean water. Invasive plant species onsite were removed and replaced with Philadelphia-native trees and shrubs. Educational signage was erected, linking nutrient runoff reduction to improvement of the Delaware Estuary.

Benefits:

● Elimination of erosion from Courtesy Stables

● Reduced sediment, nutrient, and bacteria loads on the Wissahickon

● Enhanced stormwater infiltration

● Improved surface conditions for equestrian and pedestrian use areas

● Reduce grading and enhance stabilization through planting of native trees and shrubs

Clean Water........ Green City
www.phillyriverinfo.org

Parking Lot in East Falls

Stormwater BMP Project

Schuylkill Watershed

Contact: Amy Leib
215.685.6035
amy.leib@phila.gov

Status: Completed

Partners:

East Falls Development Corporation

Philadelphia Capital Program Office

PA Department of Environmental Protection (PADEP)

Parking Lot in East Falls...

The City of Philadelphia constructed a 50-space parking lot to serve the East Falls commercial district and Kelly Drive recreational trail users. The lot was designed with a rain garden that manages the majority of surface runoff from the parking lot. The system serves as a demonstration of an encouraged stormwater management practice and provides an opportunity for stormwater education and awareness in a riverside community. The bioinfiltration garden is located in a high traffic location and also serves as a gateway to the East Falls Neighborhood.

Benefits:

- Provides highly visible demonstration of bioretention for parking lot runoff management.
- Helps manage nonpoint source pollution in priority sourcewater area.
- Provides an attractive gateway to the East Falls neighborhood.

Riparian Restoration at Fox Chase Farms

Restoration Project

Pennypack Watershed

Contact: Kelly Anderson
215-685-6245
Kelly.Anderson@phila.gov

Status: Completed

Partners:

Fairmount Park Commission (FPC)
Philadelphia Water Department - OOW
Philadelphia School District (PSD)

Riparian Restoration at Fox Chase Farms...

Prior to project implementation, cows on Fox Chase Farm had free access to a small tributary which runs through the farm. The surrounding pasture was mowed right to the tributary's edge. This combination resulted in extremely high concentrations of fecal coliform and E. Coli in the tributary and the Pennypack Creek downstream of the farm. This project aims to reduce the impact of farm runoff through the construction of a cattle crossing over the tributary and the installation of a 1.85 acre riparian buffer. In 2002, approximately 400 trees and 700 shrubs were planted on the farm, creating a 15 yard buffer on either side of the tributary. In 2006, water lines were installed to further limit the impact of cows on the stream.

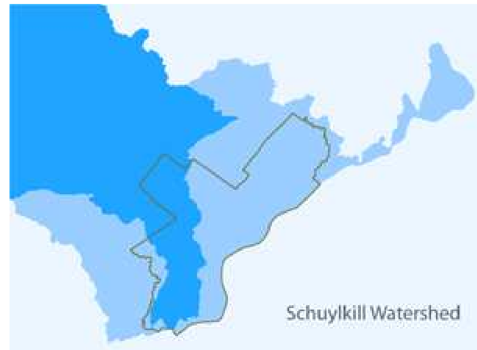
Benefits:

- Reduced concentration of nutrients and harmful pathogens from the farm entering the Pennypack Creek
- Addition of native plant species to the site
- Enhanced biological habitat in the tributary and the Pennypack
- Lower water temperatures in the Pennypack through improved shading along the tributary

Greenfield Elementary School

Stormwater BMP Project

Lower Schuylkill Watershed



Contact: Glen Abrams
215.685.6039
Glen.Abrams@phila.gov

Status: Completed

Partners:

School District of Philaldelphia (SDP)

Greenfield Elementary School...

The Greening Greenfield project primarily consists of stormwater management and landscape improvements, including the replacement of asphalt with rain gardens, pervious pavers, and porous rubber safety play surface. Furthermore, new play structures and other site furnishings were incorporated into the design. The project tranformed this urban schoolyard into an outdoor laboratory that teaches children about micro-climates, indigenous plants, and the hydrologic cycle.

Benefits:

Reducing impervious services and encouraging infiltration or detention of stormwater runoff will improve water quality and can help minimize combined sewer overflows
Integrating stormwater management into schoolyards offers good opportunities for experiential environmental education

Herron Playground

Stormwater BMP Project

Delaware Watershed

Contact: Jessica Brooks
215.685.6038
Jessica.K.Brooks@phila.gov

Status: Completed

Partners:

Philadelphia Capital Program Office

Philadelphia Department of Recreation

Herron Playground...

Herron Playground, a city-owned facility managed by the Philadelphia Department of Recreation (PDR), is located in a neighborhood served by a combined sewer system. The Philadelphia Water Department collaborated with PDR and the City's Capital Program Office to design and construct an infiltration system as part of an overall reconstruction of the Playground to manage both on-site and off-site runoff from the adjacent streets. The existing basketball court was reconstructed and resurfaced with porous asphalt. A subsurface infiltration system was installed beneath the basketball court area and to manage stormwater runoff from portions of Earp St. and American St. The total area managed is approximately 13,000 SF.

Benefits:

Reduces runoff into the combined sewer
Improved park ammenities for neighborhood
Pilot project for collaboration between City Departments

Clean Water....... Green City
www.phillyriverinfo.org

Jefferson Square Park

Stormwater BMP Project

Delaware Watershed

Contact: Glen Abrams
215.685.6039
Glen.Abrams@phila.gov

Status: Completed

Partners:

Capital Program Office (CPO)

Pennsylvania Horticultural Society (PHS)

Jefferson Square Park...

Office of Watersheds worked with the Philadelphia Capital Program Office (CPO) to incorporate stormwater management into their planned improvements at Jefferson Square Park. Stormwater management strategies included edging pedestrian walkways with pervious pavers to convey runoff to a subsurface stone bed beneath the walkways, and installation of a rain garden at the northwest edge of the park to intercept sidewalk runoff.

Benefits:

Reduction of stormwater runoff to the combined sewer
Demonstration of a pervious pavement material in a public area
Rain garden mitigates frequent sidewalk ponding

Clean Water....... Green City
www.phillyriverinfo.org

Liberty Lands

Stormwater BMP Project

Delaware Watershed

Contact: Glen Abrams
215.685.6039
Glen.Abrams@phila.gov

Status: Completed

Partners:

Northern Liberties Neighborhood Association (NLNA)

Pennsylvania Horticultural Society (PHS)

Pennsylvania Department of Environmental Protection (PADEP)

Liberty Lands...

Office of Watersheds funded the development of a master plan for Liberty Lands in Northern Liberties that provides stormwater management while addressing community objectives for the park. The first phase of implementation was a performance stage backed by a vegetated stormwater management area that manages runoff from park and an adjacent street.

Benefits:

Reduction of stormwater runoff to the combined sewer system in a neighborhood that suffers from flooding and basement back-ups

Community amenity and greening

Stream Restoration of Cobbs Creek at Marshall Road

Restoration Project **Darby-Cobbs Watershed**

Downstream view of Cobbs Creek post construction

Contact: Marc Cammarata
215.685.4948
marc.cammarata@phila.gov

Status: Completed

Partners:

Academy of Natural Sciences
City of Philadelphia
Delaware River Basin Commission (DRBC)
PA Department of Environmental Protection (PADEP)
US Fish and Wildlife Service (USFWS)
ArmyCorps of Engineers
Cobbs Cr Community Environmental Education Center (CCCEEC)
Fairmount Park Commission (FPC)
Pennsylvania Environmental Council (PEC)

Stream Restoration of Cobbs Creek at Marshall Road...

●Implemented restoration techniques targeted at removing stream impairments and restoring ecological resources.
●Served as a pilot project for habitat restoration, stream bank stabilization, natural channel design, water quality improvement, and infrastructure protection.
●Mitigated the impacts of urban runoff and non-point source pollution.
●Restored native vegetation to the riparian corridor to enhance bank stability.
●Reduced the likelihood of further stream erosion and exposure of sanitary sewage infrastructure.
●Completed a fluvial geomorphologic assessment of the Cobbs Creek to serve as a tool for integrated bank stabilization/habitat restoration for this and future projects.

Tree and shrub planting at restoration site

Benefits:

●A stable channel in dynamic equilibrium with its surrounding watershed

●Stream bank stabilization measures featuring soil bioengineering and natural channel design measures that protect infrastructure and the environment

●A healthy, vegetated riparian zone to add biological diversity to the stream system

●Enhanced, in-stream aquatic habitat

●Opportunities for the community to learn about stream ecology and morphology

US view of Cobbs Creek post construction

Clean Water....... Green City
www.phillyriverinfo.org

Porous Basketball Courts at Mill Creek Playground

Stormwater BMP Project

Multiple Watersheds

Contact: Amy Leib
215.685.6035
amy.leib@phila.gov

Status: Completed

Partners:

Councilwoman Blackwell

Philadelphia Department of Recreation

Pennsylvania Department of Environmental Protection (PADEP)

Porous Basketball Courts at Mill Creek Playground...

The porous basketball court at Mill Creek
The Mill Creek Playground is heavily used by the community for sports, activities, and meetings. The site includes two basketball courts, play equipment, a recreation center, a baseball field and a swimming pool, which were all built above the streambed of the buried Mill Creek, which is now one of the largest combined sewers in Philadelphia. The basketball courts at the playground were cracked and deteriorating, with low spots that became puddles after storms. To improve the quality of the courts and reduce the volume of stormwater that flows into the combined sewer, the basketball courts were retrofitted with porous asphalt over an infiltration bed.

Benefits:

•90 percent of the stormwater that falls on the courts infiltrates into the soil.
•Opportunity for long-term monitoring and replication at other basketball courts in the City.
•Courts dry immediately after rainstorm and create a better playing experience
•Neighbors have reported that the courts are quieter and the children like playing on them better.
•Rain that falls on the basketball courts passes through the porous surface and is stored in a subsurface stone bed until it can soak into the ground.

Clean Water....... Green City
www.phillyriverinfo.org

Mill Creek Urban Farm

Stormwater BMP Project

Schuylkill Watershed

Contact: Glen Abrams
215.685.6039
Glen.Abrams@phila.gov

Status: Completed

Partners:

A Little Taste of Everything
Neighborhood Gardens Association

Pennsylvania Horticultural Society (PHS)
Project NEAT

Councilwoman Blackwell
Pennsylvania Department of Environmental Protection (PADEP)
Philadelphia Water Department

Mill Creek Urban Farm...

The Mill Creek Urban Farm, on Brown Street between 49th and 50th streets, has revitalized 1.5 acres (11 city lots) of once vacant land. The farm improves consumer access to nutritious food while conserving natural resources and educating the community, local school groups, and the greater Philadelphia community about urban agriculture, stormwater management, and sustainable living.

The farm manages its own runoff as well as runoff from two adjacent streets in a vegetated infiltration swale along the perimeter of the property. A green roof on the farm building manages much of the roof's runoff, with the overflow collected in a cistern for irrigation. Other sustainable practices demonstrated at the farm include

Benefits:

Combined Sewer Overflow reduction through infiltration and evapotranspiration of stormwater
Nutritional access and education for the community
Education about natural resource management and sustainable living
Waste minimization and resource conservation

Clean Water........ Green City
www.phillyriverinfo.org

Monastery Stables

Stormwater BMP Project

Wissahickon Watershed

Contact: Kelly Anderson
215-685-6245
Kelly.Anderson@phila.gov

Status: Completed

Partners:

Boarders and Stewards of Monastery (BSM)
Friends of the Wissahickon (FOW)
Philadelphia Water Department - OOW
Fairmount Park Commission (FPC)
Philadelphia Saddle Club (PSC)

Monastery Stables...

The Philadelphia Water Department is partnering with the Fairmount Park Commission (FPC) to address stormwater and agricultural runoff at Monastery Stables, an FPC property along the Wissahickon Creek. Lack of proper stormwater management controls, a sloping topography towards the bordering creek, and the intensity of horse activity on the site make Monastery Stables a potentially significant source of contamination to the Wissahickon Watershed. This project introduced stormwater management controls to increase stormwater infiltration, and direct and treat stormwater runoff, reducing sediment, nutrient, and harmful pathogen loadings on the Wissahickon Creek.

Benefits:

● Reduces concentration of nutrients and harmful pathogens from the farm from entering the Wissahickon Creek.

● Enhances biological habitat in the Wissahickon Creek.

● Contaminated stormwater runoff is managed through subsurface storage tanks and vegetated swales.

Clean Water........ Green City
www.phillyriverinfo.org

Rain Barrels & Tree Program on N. 50th Street in Mill Creek Watershed

Education Project

Multiple Watersheds

Contact: Joanne Dahme
215.685.4944
joanne.dahme@phila.gov

Status: Design

Rain Barrels & Tree Program on N. 50th Street in Mill Creek Watershed...

This education/implementation project demonstrated small measures homeowners can take to improve stormwater management in their neighborhood. Participating homeowners received rain barrels and street trees for their homes. The rain barrels were connected to their porch roofs and the trees were planted in new or vacant tree pits along the block.

The project also included the re-grading of vacant parcels in the middle of the block to minimize stormwater runoff and create a community green space and gardens.

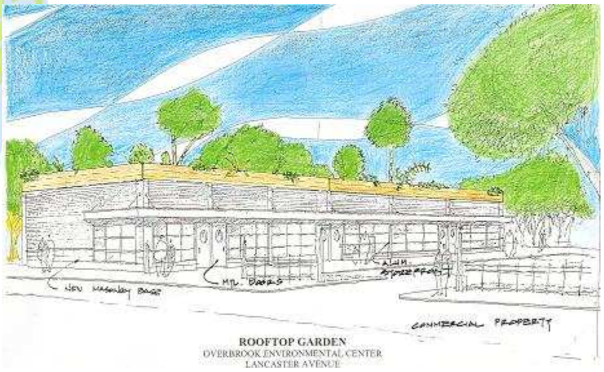
Benefits:

Demonstrate better grading and management techniques for vacant land
Increase tree canopy on rowhouse block
Educate homeowners about stormwater management

Overbrook Environmental Education Center

Stormwater BMP Project

Multiple Watersheds



Contact: Laureen Boles
215.685.6268
laureen.boles@phila.gov

Status: Concept Design

Partners:

Overbrook High School (OHS)

PA Department of Labor (DOL)

Overbrook Environmental Education Center...

The Overbrook Environmental Education Center, complete with native plantings, outdoor biology labs, and 'green' architecture, is not located on an urban commercial corridor by design. This Center demonstrates an innovative approach to quality of life issues, linking human and environmental conservation rather than viewing them as separate and distinct. The cause and effect of a poor environment affects not only the air we breathe, how we live, and what we drink, but our economy and thereby our quality of life.

Benefits:

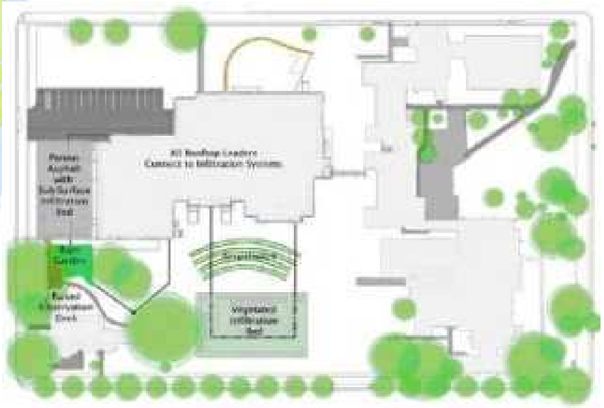
•The development of the Overbrook Environmental Education Center is an opportunity to promote economic revitalization through environmental and community improvements.

Clean Water....... Green City
www.phillyriverinfo.org

Penn Alexander School

Stormwater BMP Project

Mill Creek Watershed



Contact: Amy Leib
215.685.6035
amy.leib@phila.gov

Status: Completed

Partners:

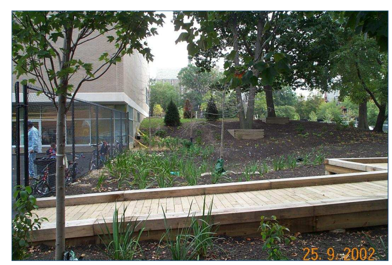
Pennsylvania Department of Environmental Protection (PADEP)

University of Pennsylvania (UPENN)

Philadelphia School District (PSD)

Penn Alexander School...

In partnership with the Philadelphia Water Department, the University of Pennsylvania and the School District of Philadelphia implemented numerous stormwater management practices during construction of the Penn Alexander School. The project includes a pervious asphalt play yard, as well as a rain garden and subsurface infiltration bed that manage roof runoff.



Benefits:

- Reduces the flow of stormwater into the combined sewer system through infiltration, thereby reducing combined sewer overflows
- Provides opportunities for on-site environmental education to elementary school children

Clean Water....... Green City
www.phillyriverinfo.org

ES&ED Verree Road Wetland and Parking Lot

Restoration Project **Pennypack Watershed**

Contact: Glen Abrams
215.685.6039
Glen.Abrams@phila.gov

Status: Monitoring

ES&ED Verree Road Wetland and Parking Lot...

A parking lot located in the floodplain of Pennypack Creek was removed to restore a floodplain wetland in the riparian area. The parking lot was reconstructed on the opposite side of the road, outside of the floodplain. The new parking lot is surfaced with pervious gravel paving and has a rain garden that captures any rainfall that runs off the parking lot.

Benefits:

•Expands an existing wetland
•Eliminates direct discharge of polluted runoff from parking lot
•Demonstrates pervious gravel paving technique

Stormwater Treatment Wetland at Saylor Grove

Restoration Project

Wissahickon Creek Watershed

Contact: Marc Cammarata
215.685.4948
marc.cammarata@phila.gov

Status: Monitoring

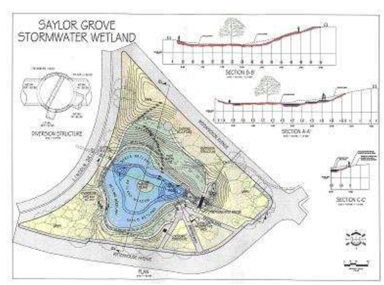
Partners:

Chestnut Hill College
Friends of the Monoshone (FOM)
PA Department of Environmental Protection (PADEP)
Senior Environment Corp
Fairmount Park Commission (FPC)
Friends of the Wissahickon (FOW)
Philadelphia Water Department
Wissahickon Restoration Volunteers (WRV)

Stormwater Treatment Wetland at Saylor Grove...

A one-acre stormwater wetland was constructed in the fall of 2005 on a parcel of Fairmount Park known as Saylor Grove. The wetland is designed to treat a portion of the 70 million gallons of urban stormwater generated in the storm sewershed per year before it is discharged into the Monoshone Creek. The Monoshone Creek is a tributary of the Wissahickon Creek- a source of drinking water for the City of Philadelphia. The function of the wetland is to treat stormwater runoff in an effort to improve source water quality and to minimize the impacts of storm-related flows on the aquatic and structural integrity of the riparian ecosystem. This project is a highly visible Urban Stormwater BMP Retrofit in the historic Wissahickon Watershed.

Benefits:



- Filter a large portion of the 70 million gallons of stormwater per year which runs off from the sewershed
- Remove total suspended solids from the Monoshone Creek
- Increase the total area of wetland habitat in the watershed
- Improve the aesthetics of the Saylor Grove area
- Improve the flow variability of storm related flows on the Monoshone Creek
- Increase the biodiversity of the park area
- Create two outdoor educational signs about the importance of wetlands and their functions
- Implement actions items of the Wissahickon River Conservation Plan
- Help improve stormwater flows into an impaired water body

Clean Water....... Green City
www.phillyriverinfo.org

School of the Future Green Roof

Stormwater BMP Project

Schuylkill Watershed

Contact: Glen Abrams
215.685.6039
Glen.Abrams@phila.gov

Status: Completed

Partners:

Delaware Valley Green Building Council (DVGBC)

Environmental Protection Agency (EPA)

Microsoft Corporation

StormCenter Communications

School of the Future Green Roof...

In 2003, the School District of Philadelphia announced an ambitious $1.5 billion capital improvement plan that includes construction of several new schools. The Delaware Valley Green Building Council and the Philadelphia Water Department worked with the District to implement environmentally sustainable building practices.
To better manage stormwater runoff, a green roof was installed over the performing arts wing. Green roofs are special roof systems that are designed to grow plants such as sedums and are useful for reducing runoff volumes. Stormwater runoff from the remainder of the school’s rooftop is collected in a large holding tank (a cistern) and used to flush the toilets in the building, thus reducing the school’s water demand

Benefits:

- Reduced stormwater runoff volumes
- Reduced demand for potable water
- Green roofs also offer other benefits including reducing energy usage for air conditioning, reducing sound reflection and transmission, providing habitat, and extending the service life of the underlying waterproofing system

Clean Water....... Green City
www.phillyriverinfo.org

Springside School (SWIG)

Education Project

Wissahickon Creek Watershed

Contact: Kelly Anderson
215-685-6245
Kelly.Anderson@phila.gov

Status: Closed

Partners:

Environmental Protection Agency (EPA)
Philadelphia Water Department - OOW
Springside School
Pennsylvania Horticultural Society (PHS)
Schuylkill Action Network (SAN)

Springside School (SWIG)...

The Springside School project includes the installation of rain gardens and flow-through planter boxes to manage stormwater runoff from impervious areas on school grounds. The project design was funded by the Schuylkill Watershed Initiative Grant and its implementation completed by the school. A rain garden was established in the parking lot by removing the existing asphalt in an area that previously had a painted circle that directed traffic flow. The addition of soil and native vegetation completed the rain garden. A portion of stormwater runoff drains from the parking lot into the rain garden, where infiltration occurs. As parking lot resurfacing projects are undertaken in the future, more runoff will be directed toward the rain garden.

Benefits:

● Parking lot rain garden reduces runoff volume through infiltration and evapotranspiration while providing traffic control and parking lot beautification

● Courtyard rain garden and flow-through planter boxes reduce peak rate of runoff, reduce runoff volume, and improve water quality

● Implementation and monitoring of stormwater practices provide educational opportunities for students at Springside School

Clean Water....... Green City
www.phillyriverinfo.org

Waterview Recreation Center

Stormwater BMP Project

Tacony-Frankford Watershed

Contact: Jessica Brooks
215.685.6038
Jessica.K.Brooks@phila.gov

Status: Completed

Partners:

Pennsylvania Horticultural Society (PHS)

Philadelphia Department of Recreation

Waterview Recreation Center...

The Office of Watersheds is working with the Philadelphia Department of Recreation (PDR) and the Pennsylvania Horticultural Society (PHS) to incorporate stormwater management into Waterview Recreation Center's master plan in ways that can demonstrate effective stormwater management strategies while enhancing recreation programs and improving site aesthetics. The following components are incorporated into the plan:

1. A subsurface infiltration tree trench and new porous concrete sidewalk to provide management of street and sidewalk runoff and provide more tree canopy.
2. Flow through planter boxes adjacent to the main building entrance to manage roof runoff and beautify the entrance.

Benefits:

- Reduce stormwater runoff to Philadelphia's combined sewer system
- Provide neighborhood greening and beautification
- Implement Tookany/Tacony Frankford Integrated Watershed Management Plan

Riparian Restoration at W.B. Saul High School

Project **Wissahickon Watershed**

Contact: Kelly Anderson
215-685-6245
Kelly.Anderson@phila.gov

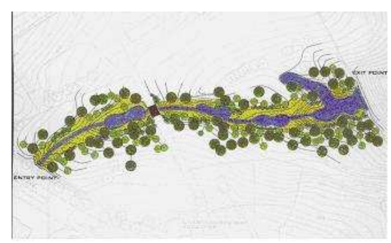
Status: Completed

Partners:

City of Philadelphia
Fairmount Park Commission (FPC)
Philadelphia Water Department - OOW
Environmental Protection Agency (EPA)
Philadelphia School District (PSD)

Riparian Restoration at W.B. Saul High School...

This project combines urban stormwater and agricultural Best Management Practices to reduce the harmful impact of the school's runoff on the Wissahickon Creek. After implementation, agricultural runoff from the livestock and farming practices, as well as stormwater runoff from the school's roofs and parking lots, are captured and treated through a series of long pools connected by wetland swales prior to discharging into the sewer.



Benefits:

- Prevents excess nutrients and harmful pathogens from entering the Wissahickon Creek
- Improves water quality of urban stormwater runoff
- Additon of native vegetation to the site
- Provides educational demonstration of the proper management of stormwater and agricultural runoff
- Creates aesthetically pleasing enhancement of the school's landscape

Clean Water....... Green City
www.phillyriverinfo.org

West Mill Creek Infiltration Tree Trench

Stormwater BMP Project

Schuylkill Watershed

Contact: Amy Leib
215.685.6035
amy.leib@phila.gov

Status: Completed

Partners:

Pennsylvania Department of Environmental Protection (PADEP)

Philadelphia Department of Recreation

Pennsylvania Horticultural Society (PHS)

West Mill Creek Infiltration Tree Trench...

Runoff from the street and sidewalk is diverted into a stormwater tree trench at the intersection of Ogden and Ramsey Streets in West Philadelphia through modified inlet structures. Trees are planted in pockets of soil within a continuous stone trench that stores stormwater until it can infiltrate. Porous pavers replaced the brick sidewalk over the trench and allow runoff from the sidewalk to infiltrate into trench. The continuous trench provides also provides the tree roots with better access to air and water.

Benefits:

•Reduces stormwater volume, thereby reducing combined sewer overflows from the Mill Creek Sewer.
•Provides healthier conditions for urban street trees
•Adds tree canopy in a dense urban area, thereby reducing urban heat island effect and improving air quality.

Clean Water........ Green City
www.phillyriverinfo.org

Harmony Garden at Wissahickon Charter School

Education Project

Schuylkill Watershed

Contact: Amy Leib
215.685.6035
amy.leib@phila.gov

Status: Completed

Partners:

CITY PLAY Landscape Design

Philadelphia Water Dept. -Office of Watersheds

Pennsylvania Department of Environmental Protection (PADEP)

Wissahickon Charter School (WCS)

Harmony Garden at Wissahickon Charter School...

Harmony Garden is an outdoor learning lab, recreation area, and stormwater management system at Wissahickon Charter School. Runoff from the school parking lot is intercepted in a series of two rain gardens that overflow to an infiltration bed beneath turfstone pavers. The surface and subsurface basins recharge stormwater runoff from the school parking lot and give the students at Wissahickon Charter School an opportunity to learn and play in a natural environment at their school.

Benefits:

- Provides onsite detention and infiltration of stormwater
- Reduces non-point source pollution from stormwater runoff through filtration and biological processes
- Provides opportunities for on-site environmental education for students and supports the environmental mission of Wissahickon Charter School

Clean Water....... Green City
www.phillyriverinfo.org

16th St from Snyder Ave to Jackson St Green Streets

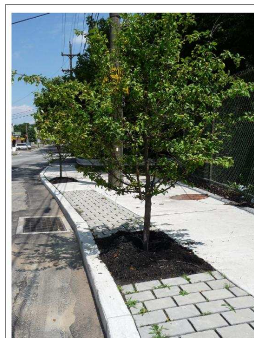
Stormwater BMP Project **Schuylkill Watershed**

Contact: Jillian Simmons
215.685.4961
Jillian.Simmons@phila.gov

Status: Construction

16th St from Snyder Ave to Jackson St Green Streets...

Streets and sidewalks are by far the largest single category of impervious cover, accounting for roughly 38% of the impervious cover within the combined sewer system. To mitigate the impact of this impervious area, PWD has developed green street designs that use a combination of vegetated and engineered strategies to manage runoff at its source. Using a variety of green stormwater infrastructure tools, including stormwater tree trenches, stormwater planters, and stormwater bumpouts, a green street captures the first inch of runoff from streets and sidewalks, infiltrates it into the soil to recharge groundwater, and reduces the amount of stormwater runoff that would otherwise make its way into Philadelphia's combined sewer system.


Stormwater Tree Trench

Benefits:

Reduce combined sewer overflows through infiltration, evapotranspiration, and extended detention of runoff from the right of way
Reduce urban heat island effect, improve air quality, and provide shade on streets
Beautify neighborhood
Provides opportunities to educate communities about water resources protection

Clean Water........ Green City
www.phillyriverinfo.org

Bells Mill Stream Restoration

Restoration Project

Wissahickon Creek Watershed

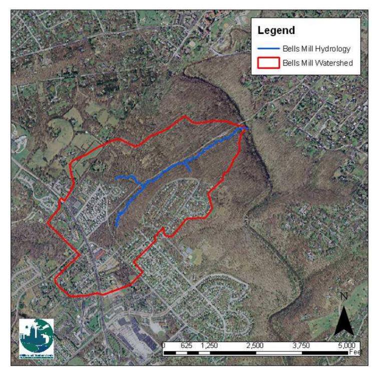
Contact: Erik Haniman
215-685-4877
Erik.Haniman@phila.gov

Status: Construction

Partners:

Fairmount Park Commission (FPC)
Philadelphia Water Department - OOW
GTS Technologies, Inc.

Bells Mill Stream Restoration...



Due to the volume and velocity of water being discharged to Bells Mill during wet weather events, the tributary is deeply entrenched and overwidened. The restoration of Bells Mill would include eliminating the scour pool below outfall W-084-02 by utilizing stone for energy dissipation. Additionally, the streambanks and bed downstream of the outfall would need to be stabilized using principles of natural stream channel design. High grades and the presence of Bells Mill road adjacent to the creek inhibit the creation of meanders. Instead, appropriate energy dissipating structures such as rock vanes and channel-spanning, keystone-anchored, step structures are proposed for installation.

Benefits:

- Increased habitat heterogeneity
- Enhanced aquatic and riparian habitat
- Increased ecological stability
- Improved biological integrity
- Minimize erosion and stabilize stream banks
- Sediment Reduction

Clean Water........ Green City
www.phillyriverinfo.org

PWD's Bureau of Laboratory Services

Stormwater BMP Project

Tacony-Frankford Watershed

Contact: Glen Abrams
215.685.6039
Glen.Abrams@phila.gov

Status: Construction

Partners:

Environmental Protection Agency (EPA)

PWD's Bureau of Laboratory Services...

The Habitat Creation and Stormwater Management Demonstration project at the Philadelphia Water Department Bureau of Laboratory Services (BLS) is divided into three sub-projects: 1) Meadow Creation; 2) Stepped Rain Garden; and 3) Porous Pavers and Vegetated Swale. Nearly 1/2 acre of turf was converted to meadow and runoff from about 28,500 square feet of parking area will be managed via vegetation and infiltration by retrofitting the existing facilities.

Benefits:

•Provides demonstration of how to retrofit a parking lot to improve stormwater management
•Provides demonstration of constructing bioretention gardens on a slope and in areas with slow infiltration rates
•Illustrates an alternative to the convention lawn, particularly for institutions and corporation

Clean Water........ Green City
www.phillyriverinfo.org

Hartranft School Green Streets

Stormwater BMP Project

Delaware Watershed

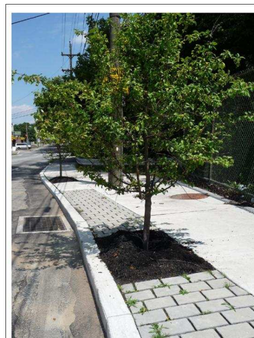
Contact: Jillian Simmons
215.685.4961
Jillian.Simmons@phila.gov

Status: Construction

Partners:

Pennsylvania Horticultural Society (PHS)

Hartranft School Green Streets...


Stormwater Tree Trench

Streets and sidewalks are by far the largest single category of impervious cover, accounting for roughly 38% of the impervious cover within the combined sewer system. To mitigate the impact of this impervious area, PWD has developed green street designs that use a combination of vegetated and engineered strategies to manage runoff at its source. Using a variety of green stormwater infrastructure tools, including stormwater tree trenches, stormwater planters, and stormwater bumpouts, a green street captures the first inch of runoff from streets and sidewalks, infiltrates it into the soil to recharge groundwater, and reduces the amount of stormwater runoff that would otherwise make its way into Philadelphia's combined sewer system.

Benefits:

Reduce combined sewer overflows through infiltration, evapotranspiration, and extended detention of runoff from the right of way
Reduce urban heat island effect, improve air quality, and provide shade on streets
Beautify neighborhood
Provides opportunities to educate communities about water resources protection

Lancaster Avenue ReStore Corridor – Green Street Demonstration Project

Stormwater BMP Project

Schuylkill Watershed

Contact: Jessica Brooks
215.685.6038
Jessica.K.Brooks@phila.gov

Status: Construction

Partners:

Philadelphia Department of Commerce
U.S. Environmental Protection Agency
Philadelphia Industrial Development Corporation

Lancaster Avenue ReStore Corridor – Green Street Demonstration Project...

Streets and sidewalks comprise about 40% of impervious surfaces within Philadelphia. Managing the stormwater runoff from these areas is critical in meeting PWD's combined sewer overflow mitigation goals. The City's "Green Streets" program will aid in determining the effectiveness of reducing stormwater flows to the combined sewer systems. PWD recognizes that such practices should realize many other environmental and community benefits.

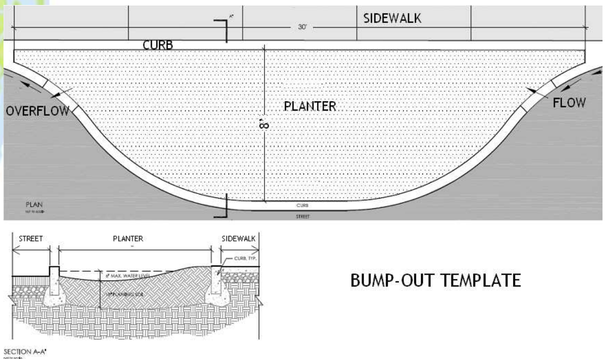
One phase of the program will work with the City's ReStore corridors program.. Green street practices, such as sidewalk rain gardens and stormwater tree trenches, will be incorporated into the corridor designs.

Benefits:

• Mitigates runoff from impervious surfaces within the public right-of-way
• Provides demonstration projects to inform larger-scale, long-term program
• Additional landscaping and tree canopy cover provide visual interest, aesthetic appeal, and mitigate the urban heat island effect
• Improves the appearance of important neighborhood commercial corridors

Queen Lane Water Treatment Plant Green Streets Project

Stormwater BMP Project **Schuylkill Watershed**



Contact: Jessica Brooks
215.685.6038
Jessica.K.Brooks@phila.gov

Status: Construction

Partners:

East Falls Development Corporation

Philadelphia Water Department

PA Department of Environmental Protection (PADEP)

U.S. Environmental Protection Agency

Queen Lane Water Treatment Plant Green Streets Project...

Streets and sidewalks comprise roughly 40% of impervious surfaces within Philadelphia. Managing stormwater runoff from these areas is crucial in meeting PWD's combined sewer overflow mitigation goals. The City's 'Green Streets' program will aid in reducing stormwater flows to the combined sewer systems. PWD recognizes that such practices should realize many more environmental and community benefits in addition to the improved water quality benefit.

The first phase of the 'Green Streets' program will implement several stormwater management practices along street frontages at PWD facilities. At the Queen Lane Water Treatment Plant, vegetated bump-outs are proposed.

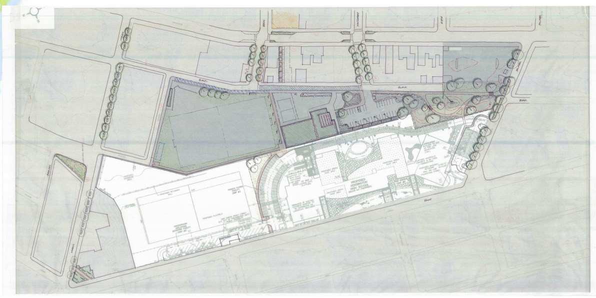
Benefits:

- Mitigates runoff from impervious surfaces within the public right-of-way
- Provides demonstration projects to inform larger-scale, long-term program
- Additional landscaping and tree canopy cover provide visual interest, aesthetic appeal, and mitigate the urban heat island effect

Clean Water........ Green City
www.phillyriverinfo.org

Schissler Recreation Center - Big Green Block

Stormwater BMP Project **Delaware Watershed**



Contact: Jessica Brooks
215.685.6038
Jessica.K.Brooks@phila.gov

Status: Construction

Partners:

New Kensington Community Development Corporation

Philadelphia Department of Recreation

Pennsylvania Horticultural Society (PHS)

Schissler Recreation Center - Big Green Block...

The Philadelphia Water Department is partnering with the Pennsylvania Horticultural Society and the New Kensington Community Development Cooperation in support of their master planning efforts for the “block” around Schissler Recreation Center. The goals of this master plan include community greening, improving access to public transportaion, and stormwater management. The master plan for the Recreation Center includes an improved parking lot, tree plantings, and pedestrian access to the Berks subway stop. The site is part of a larger effort to rejuvenate the New Kensington neighborhood. The Office of Watersheds will construct tree trenches to manage street runoff as part of the Model Neighborhood and Green Streets programs.

Benefits:

Reduce stormwater runoff through infiltration and evapotranspiration
Neighborhood greening and beautification
Increases access to public transportaion
Provides shaded areas for spectators at Recreation Center events

Clean Water........ Green City
www.phillyriverinfo.org

Baxter Treatment Plant Visitor Parking Lot

Stormwater BMP Project

Delaware Watershed

Contact: Amy Leib
215.685.6035
amy.leib@phila.gov

Status: Design

Partners:

PWD Capital Budget

Baxter Treatment Plant Visitor Parking Lot...

Runoff from the new visitors' parking lot at Baxter Treatment Plant will be managed in a large bioinfiltration area designed to infiltrate most of the stormwater that reaches it.

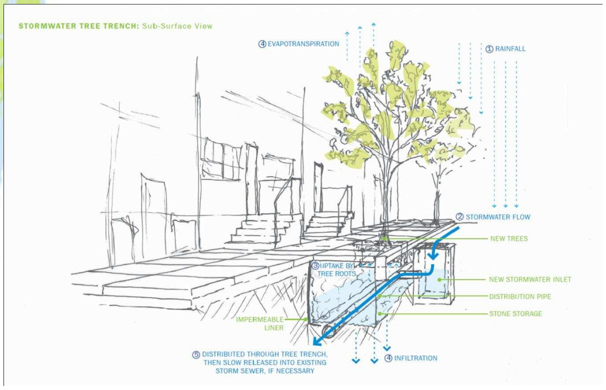
Benefits:

- Provides infiltration and volume removal of majority of stormwater from new parking lot
- Habitat restoration

Clean Water....... Green City
www.phillyriverinfo.org

Belfield Ave from Chew Ave to Walnut Ln Green Streets

Stormwater BMP Project **Tacony-Frankford Watershed**



Contact: Jillian Simmons
215.685.4961
Jillian.Simmons@phila.gov

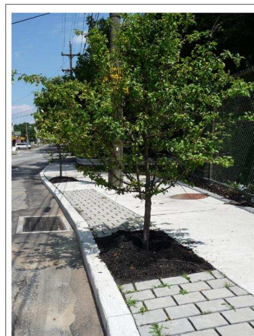
Status: Completed

Partners:

Tookany/Tacony-Frankford Watershed Partnership (TTFWP)

Belfield Ave from Chew Ave to Walnut Ln Green Streets...

Streets and sidewalks are by far the largest single category of impervious cover, accounting for roughly 38% of the impervious cover within the combined sewer system. To mitigate the impact of this impervious area, PWD has developed green street designs that use a combination of vegetated and engineered strategies to manage runoff at its source. Using a variety of green stormwater infrastructure tools, including stormwater tree trenches, stormwater planters, and stormwater bumpouts, a green street captures the first inch of runoff from streets and sidewalks, infiltrates it into the soil to recharge groundwater, and reduces the amount of stormwater runoff that would otherwise make its way into Philadelphia's combined sewer system.



Stormwater Tree Trench

Benefits:

Reduce combined sewer overflows through infiltration, evapotranspiration, and extended detention of runoff from the right of way
Reduce urban heat island effect, improve air quality, and provide shade on streets
Beautify neighborhood
Provides opportunities to educate communities about water resources protection

Clean Water........ Green City
www.phillyriverinfo.org

Office of Watersheds

Philadelphia PWD Water Department

Ben Franklin Blvd Streetscaping

Stormwater BMP Project

Schuylkill Watershed

Contact: Marc Orgovan
215-685-6378
Marc.Orgovan@phila.gov

Status: Design

Partners:

Fairmount Park Commission (FPC)

Ben Franklin Blvd Streetscaping...

The Philadelphia Water Department is collaborating with the Fairmount Park Commission on a streetscaping project along the Benjamin Franklin Parkway. The streetscaping portion of the project includes updating walkways and planting new trees. In conjunction with this work, PWD will install stormwater trenches that collect and manage runoff from the southern portion of road between 21st Street and 23rd Street. The water enters through a grate inlet and is distributed throughout the trench where it infiltrates and waters the new trees, which provide stormwater volume reduction through evapotranspiration. The trench size meets PWD goals to reduce flooding and combined sewer overflows.

Benefits:

Infiltrates water from the street which leads to less combined sewer overflows.

Removing stormwater from the city system through infiltration allows for existing infrastructure to be used without the need for expansion or upsizing.

Provides water to the street trees.

Blue Bell Tavern Triangle

Project

Darby-Cobbs Watershed

Contact: Jessica Brooks
215.685.6038
Jessica.K.Brooks@phila.gov

Status: Design

Partners:

Fairmount Park Commission (FPC)

Pennsylvania Horticultural Society (PHS)

PA Department of Environmental Protection (PADEP)

U.S. Environmental Protection Agency

Blue Bell Tavern Triangle...

The historic Blue Bell Tavern dates to 1776 and was the scene of a Revolutionary War skirmish. General George Washington and many colonial travelers rested and ate at this well-known establishment. The Tavern is now located within Cobbs Creek Park and is maintained by the Fairmount Park Commission.

Across from the Tavern is a large triangle of land that will be designed to manage runoff from the surrounding roadways through a series of curb cuts, swales, and modified storm inlets. Options for creating curb bump-out rain gardens will also be explored as another measure to mitigate runoff and provide traffic calming on Cobbs Creek Parkway.

Benefits:

- Reduce stormwater runoff to Philadelphia's combined sewer system
- Enhance an underutilized green space and create community amenity
- Implement the Cobbs Creek Integrated Watershed Management Plan

Clean Water........ Green City
www.phillyriverinfo.org

Cathedral Run Stream Restoration

Restoration Project

Wissahickon Creek Watershed

Contact: Erik Haniman
215-685-4877
Erik.Haniman@phila.gov

Status: Concept Design

Partners:

Fairmount Park Commission (FPC)

Philadelphia Water Department - OOW

Cathedral Run Stream Restoration...

Streambank restoration and stabilization of Cathedral Run is part of a larger comprehensive watershed management program. Restoration of the tributary would involve a detailed survey of the streambed and installation of appropriate structures such as rock vanes and channel-spanning, keystone-anchored, step structures to dissipate energy and protect eroding streambank. The macroinvertebrate community in Cathedral Run is severely impaired. Reduced sediment load will increase habitat heterogeneity vital for various macroinvertebrates. Once restoration is complete, a stable, sustainable environment will allow a reintroduced macroinvertebrate community to thrive.

Benefits:

- Increased habitat heterogeneity
- Enhanced aquatic and riparian habitat
- Increased ecological stability
- Improved biological integrity
- Minimize erosion and stabilize stream banks
- Sediment Reduction

Clean Water........ Green City
www.phillyriverinfo.org

Delaware Avenue Extension Project

Restoration Project

Delaware Watershed

Contact: Glen Abrams
215.685.6039
Glen.Abrams@phila.gov

Status: Proposed-Short Term

Partners:

Philadelphia Streets Department

Delaware Avenue Extension Project...

The Delaware Avenue Extension Project will extend the Avenue north from Lewis Street to Buckius Street (across a new bridge over the Frankford Creek) in Phase I and is intended to offer greater access to the currently underutilized waterfront and encourage residential and commercial redevelopment. The project will consist of a two-lane roadway, with acquisition of right-of-way for pedestrian use. If considered from the onset of design, non-structural measures, such as vegetated swales and bioretention gardens, can be the primary method of stormwater management and provide a greater measure of water quality treatment than is offered by conventional infrastructure.

Benefits:

Encouraging infiltration or detention of stormwater runoff will improve water quality and protect aquatic habitats
Integrating stormwater management into streetscape and public rights-of-way offer good opportunities for widespread watershed education
Non-structural measures can add aesthetic interest

Clean Water........ Green City
www.phillyriverinfo.org

Madison Memorial Park

Stormwater BMP Project

Delaware Watershed

Contact: Lisa Beyer

Lisa.Beyer@phila.gov

Status: Design

Partners:

Department of Recreation

Northern Liberties Neighborhood Association

Madison Memorial Park...

As part of master planning for Spring Garden Greenway between 3rd Street and the Delaware River, Madison Memorial Park at 2nd Street will be re-designed to include manage stormwater from adjacent streets.

Benefits:

- Capturing street runoff in vegetated systems helps reduce combined sewer overflows
- Integrating stormwater management into community open space offers opportunities for watershed education

Clean Water........ Green City
www.phillyriverinfo.org

Passyunk Avenue Street Realignment and Stormwater Improvements

Education Project

Delaware Watershed

Contact: Jessica Brooks
215.685.6038
Jessica.K.Brooks@phila.gov

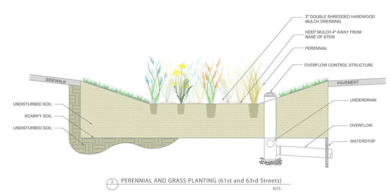
Status: Concept Design

Partners:

Philadelphia Streets Department

Passyunk Avenue Street Realignment and Stormwater Improvements...

Streets and sidewalks comprise about 40% of impervious surfaces within Philadelphia. Managing the stormwater runoff from these areas is critical in meeting PWD's combined sewer overflow mitigation goals. PWD is working with the Department of Streets to construct green infrastructure as part of a larger streetscaping project. Several intersections of Passyunk Ave. are being realigned; creating large areas of open space. PWD is collaborating with Streets to transform these spaces into raingardens that will treat runoff from other portions of the street.



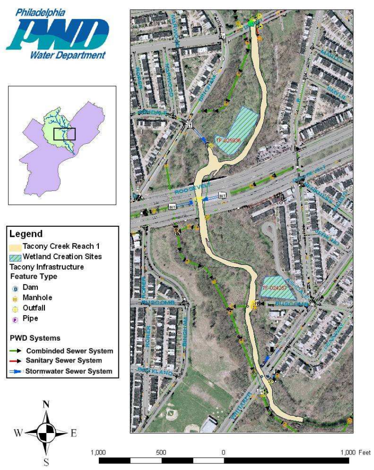
Benefits:

Mitigates runoff from impervious surfaces within the public right-of-way
Provides demonstration projects to inform larger-scale, long-term program
Additional landscaping provide visual interest, aesthetic appeal, and mitigates the urban heat island effect

Tacony Creek Stream Restoration

Restoration Project

Tacony-Frankford Watershed



Contact: Erik Haniman
215-685-4877
Erik.Haniman@phila.gov

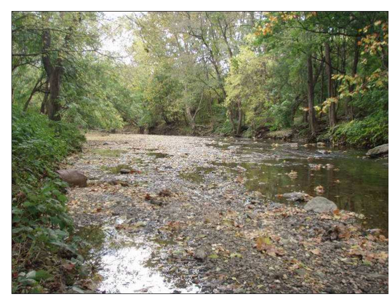
Status: Design

Partners:

Fairmount Park Commission (FPC)
Stantec
Philadelphia Water Department - OOW

Tacony Creek Stream Restoration...

This project proposal is for riparian and stream restoration of the mainstem Tacony Creek. Typical of urban streams, the Tookany/Tacony-Frankford Creek Watershed experiences a flashy hydrologic regime where the ratio of bankfull flow to baseflow far exceeds the ratio of 10:1 considered normal for healthy streams. Changes in hydrology have resulted in de-stabilization of much of the watershed. This project proposal is for riparian and stream restoration, and a native-species landscaping plan. Efforts previously addressed, including the wetland creation and stream restoration, will create habitat for aquatic organisms.



Benefits:

- Reduced erosion and sediment load
- Enhanced aquatic and riparian habitat
- Improved biological integrity
- Improved ecological stability

Clean Water........
Green City
www.phillyriverinfo.org

Wises Mill Wetland Creation and Stream Restoration

Restoration Project

Wissahickon Creek Watershed

Contact: Erik Haniman
215-685-4877
Erik.Haniman@phila.gov

Status: Design

Partners:

AKRF, Inc.

Fairmount Park Commission (FPC)

Wises Mill Wetland Creation and Stream Restoration...

Wises Mill Run consists of a 92 acre southern portion and a 169 acre northern portion that merge just north of Wises Mill Road before meeting the Wissahickon Creek. Both branches are hindered by urbanization and large storm events. As a result, severe entrenchment occurred in both branches and excessive amounts of sediment has been added to the Wissahickon Creek. This project proposes to reduce flows prior to entering the southern branch by the creation of a stormwater treatment wetland. Secondly, the restoration and stablization of the two branches will be possible by the improvement of the channel and banks to enhance water quality. Overall, sediment and erosion will be reduced, and aquatic and macroinvertebrate life will be improved.

Benefits:

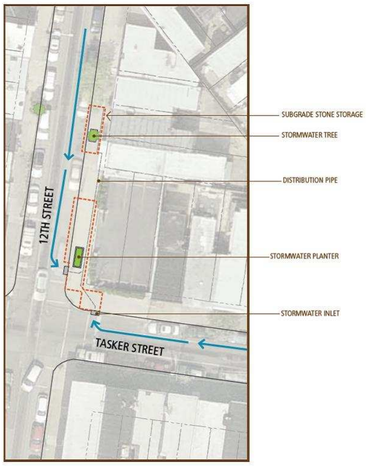
- Increased habitat heterogeneity
- Enhanced aquatic and riparian habitat
- Increased ecological stability
- Improved biological integrity
- Minimize erosion and stablize stream banks
- Sediment reduction
- Creation and enhancement of approximately 1.9 acres of wetland area
- Riparian restoration and stablization
- Storm flow reduction and treatment prior to entering Wises Mill Run

Clean Water........ Green City
www.phillyriverinfo.org

12th St from Dickinson St to Tasker St Green Streets

Stormwater BMP Project

Delaware Watershed



Contact: Jillian Simmons
215.685.4961
Jillian.Simmons@phila.gov

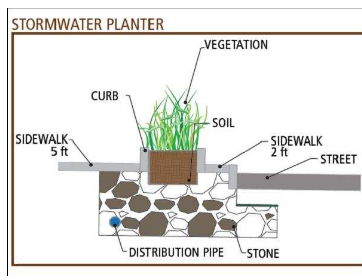
Status: Design

Partners:

Passyunk Square Civic Association

12th St from Dickinson St to Tasker St Green Streets...

Streets and sidewalks are by far the largest single category of impervious cover, accounting for roughly 38% of the impervious cover within the combined sewer system. To mitigate the impact of this impervious area, PWD has developed green street designs that use a combination of vegetated and engineered strategies to manage runoff at its source. Using a variety of green stormwater infrastructure tools, including stormwater tree trenches, stormwater planters, and stormwater bumpouts, a green street captures the first inch of runoff from streets and sidewalks, infiltrates it into the soil to recharge groundwater, and reduces the amount of stormwater runoff that would otherwise make its way into Philadelphia's combined sewer system.



Benefits:

Reduce combined sewer overflows through infiltration, evapotranspiration, and extended detention of runoff from the right of way
Reduce urban heat island effect, improve air quality, and provide shade on streets
Beautify neighborhood
Provides opportunities to educate communities about water resources protection

Clean Water........ Green City
www.phillyriverinfo.org

39th and Olive Recreation Center Improvements

Stormwater BMP Project | **Schuylkill Watershed**

Rec Center Site

Contact: Lisa Beyer

Lisa.Beyer@phila.gov

Status: Concept Design

Partners:

Philadelphia Water Department - OOW

University City Green (UCG)

39th and Olive Recreation Center Improvements...

OOW is providing design support to UC Green for their redesign of the Recreation Center Site. The project includes additional tree plantings and stormwater management designs to capture overland flow on site.

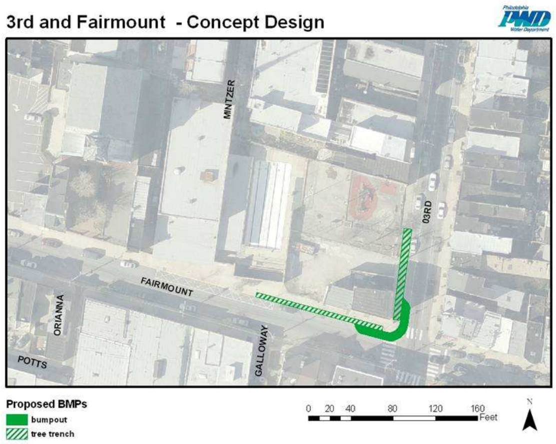
Benefits:

The project will provide additional tree coverage, capture stormwater in a combined sewer area, and infiltrate on site.

Clean Water....... Green City
www.phillyriverinfo.org

3rd and Fairmount Ave Intersection Green Streets

Stormwater BMP Project **Delaware Watershed**



Contact: Jillian Simmons
215.685.4961
Jillian.Simmons@phila.gov

Status: Design

Partners:

Northern Liberties Neighborhood Association

3rd and Fairmount Ave Intersection Green Streets...

Streets and sidewalks are by far the largest single category of impervious cover, accounting for roughly 38% of the impervious cover within the combined sewer system. To mitigate the impact of this impervious area, PWD has developed green street designs that use a combination of vegetated and engineered strategies to manage runoff at its source. Using a variety of green stormwater infrastructure tools, including stormwater tree trenches, stormwater planters, and stormwater bumpouts, a green street captures the first inch of runoff from streets and sidewalks, infiltrates it into the soil to recharge groundwater, and reduces the amount of stormwater runoff that would otherwise make its way into Philadelphia's combined sewer system.

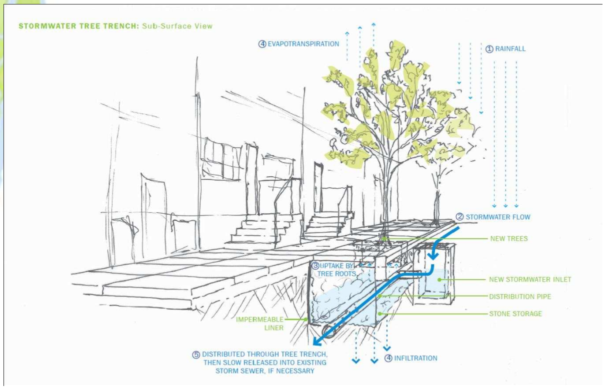
Benefits:

Reduce combined sewer overflows through infiltration, evapotranspiration, and extended detention of runoff from the right of way
Reduce urban heat island effect, improve air quality, and provide shade on streets
Beautify neighborhood
Provides opportunities to educate communities about water resources protection

Anna B. Day School Green Streets

Stormwater BMP Project

Tacony-Frankford Watershed



Contact: Chris Bergerson
215-685-6234
Chris.Bergerson@phila.gov

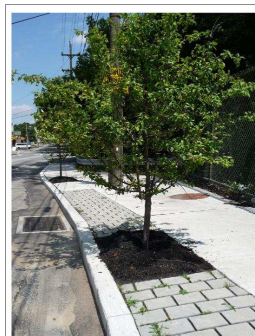
Status: Design

Partners:

Tookany/Tacony-Frankford Watershed Partnership (TTFWP)

Anna B. Day School Green Streets...

Streets and sidewalks are by far the largest single category of impervious cover, accounting for roughly 38% of the impervious cover within the combined sewer system. To mitigate the impact of this impervious area, PWD has developed green street designs that use a combination of vegetated and engineered strategies to manage runoff at its source. Using a variety of green stormwater infrastructure tools, including stormwater tree trenches, stormwater planters, and stormwater bumpouts, a green street captures the first inch of runoff from streets and sidewalks, infiltrates it into the soil to recharge groundwater, and reduces the amount of stormwater runoff that would otherwise make its way into Philadelphia's combined sewer system.



Stormwater Tree Trench

Benefits:

Reduce combined sewer overflows through infiltration, evapotranspiration, and extended detention of runoff from the right of way
Reduce urban heat island effect, improve air quality, and provide shade on streets
Beautify neighborhood
Provides opportunities to educate communities about water resources protection

Clean Water........ Green City
www.phillyriverinfo.org

Barry Playground Stormwater Management Improvements

Stormwater BMP Project

Schuylkill Watershed

Contact: Jessica Brooks
215.685.6038
Jessica.K.Brooks@phila.gov

Status: Design

Partners:

PA Department of Environmental Protection (PADEP)

U.S. Environmental Protection Agency

Philadelphia Department of Recreation

Barry Playground Stormwater Management Improvements...

Barry Playground's basketball courts are in a state of disrepair and currently drain directly to the overburdened combined sewer system. In addition, three street frontages around the playground are not planted with street trees. Planned improvements include replacing the existing basketball courts with pervious asphalt and install stormwater tree trenches/rain gardens along the three street frontages without trees to mitigate runoff from the surrounding streets. This effort is an important demonstration in Philadelphia's commitment to streetscape improvements that help manage stormwater runoff and is also an important component in PWD's combined sewer overflow long-term control plan.

Benefits:

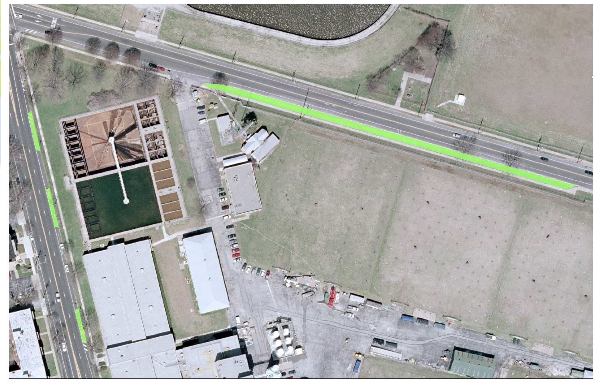
● Directly connect impervious area will be decreased by approximately 11,000 square feet by installing pervious asphalt

● Tree trenches will manage runoff from approximately 20,000 square feet of street and sidewalk area

● Additional landscaping and tree canopy cover provide visual interest, aesthetic appeal and mitigate the urban heat island effect

Belmont Water Treatment Green Streets Project

Infrastructure Project **Schuylkill Watershed**



Contact: Jessica Brooks
215.685.6038
Jessica.K.Brooks@phila.gov

Status: Concept Design

Partners:

PA Department of Environmental Protection (PADEP)

U.S. Environmental Protection Agency

Belmont Water Treatment Green Streets Project...

Streets and sidewalks comprise about 40% of impervious surfaces within Philadelphia. Managing the stormwater runoff from these areas is critical in meeting PWD's combined sewer overflow mitigation goals. The City's "Green Streets" program will aid in determining the effectiveness of reducing stormwater flows to the combined sewer systems. PWD recognizes that such practices should realize many other environmental and community benefits.

A first phase of the program will target several green street practices along street frontages at PWD facilities. At the Queen Lane Water Treatment Plant, vegetated curb extensions and tree trenches are proposed.

Benefits:

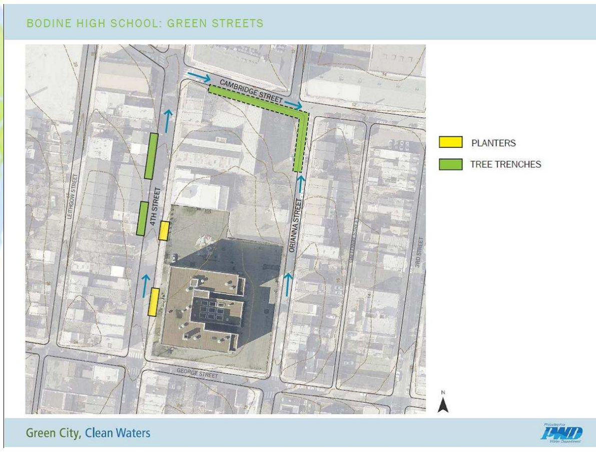
- Mitigates runoff from impervious surfaces within the public right-of-way
- Provides demonstration projects to inform larger-scale, long-term program
- Additional landscaping and tree canopy cover provide visual interest, aesthetic appeal, and mitigate the urban heat island effect

Clean Water........ Green City
www.phillyriverinfo.org

Bodine High School Green Streets

Stormwater BMP Project

Delaware Watershed



Contact: Jillian Simmons
215.685.4961
Jillian.Simmons@phila.gov

Status: Design

Partners:

CITY PLAY Landscape Design
Northern Liberties Neighborhood Association
Mural Arts Program

Bodine High School Green Streets...

Streets and sidewalks are by far the largest single category of impervious cover, accounting for roughly 38% of the impervious cover within the combined sewer system. To mitigate the impact of this impervious area, PWD has developed green street designs that use a combination of vegetated and engineered strategies to manage runoff at its source. Using a variety of green stormwater infrastructure tools, including stormwater tree trenches, stormwater planters, and stormwater bumpouts, a green street captures the first inch of runoff from streets and sidewalks, infiltrates it into the soil to recharge groundwater, and reduces the amount of stormwater runoff that would otherwise make its way into Philadelphia's combined sewer system.

Benefits:

Reduce combined sewer overflows through infiltration, evapotranspiration, and extended detention of runoff from the right of way
Reduce urban heat island effect, improve air quality, and provide shade on streets
Beautify neighborhood
Provides opportunities to educate communities about water resources protection

Clean Water........
Green City
www.phillyriverinfo.org

Cherry Street Connector

Stormwater BMP Project

Schuylkill Watershed


View of Cherry Street looking west

Contact: Lisa Beyer

Lisa.Beyer@phila.gov

Status: Design

Cherry Street Connector...

The 2300 block of Cherry Street is an historic street paved with granite block, but does not have stormsewer connections. Podning occurs at the end of the block where the ground rises for the CSX tracks. The design for Cherry Street includes a tree trench, rain garden and linear swale to manage the runoff from the street and sidewalks along the 2300 block of Cherry Street, continuing along the rail line to the river trail connection at Race Street. The vegetated system with capture surface flow, filter the stormwater through vegetation, hold the water in subsurface stone beds and overflow into the stormsewer system at Race Street.

Benefits:

Reduces flow to combined sewer at peak flow periods and filters stormwater and provides opportunity for infiltration before slow releasing to stormsewer.

Clean Water........ Green City
www.phillyriverinfo.org

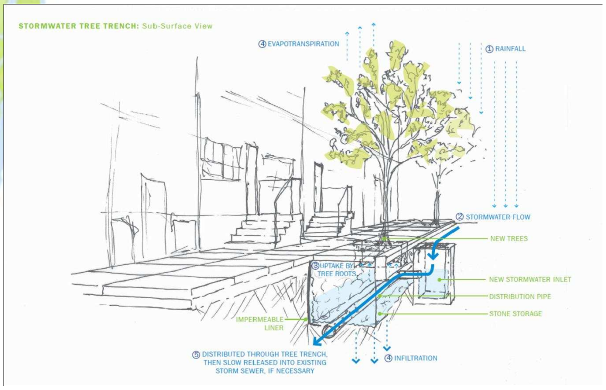
Chew Playground Green Streets

Stormwater BMP Project

Schuylkill Watershed

Contact: Jillian Simmons
215.685.4961
Jillian.Simmons@phila.gov

Status: Design

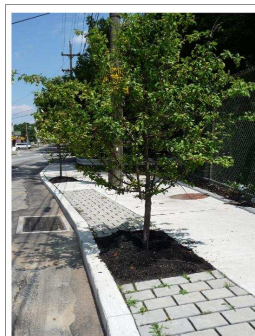


Partners:

Department of Recreation

Chew Playground Green Streets...

Streets and sidewalks are by far the largest single category of impervious cover, accounting for roughly 38% of the impervious cover within the combined sewer system. To mitigate the impact of this impervious area, PWD has developed green street designs that use a combination of vegetated and engineered strategies to manage runoff at its source. Using a variety of green stormwater infrastructure tools, including stormwater tree trenches, stormwater planters, and stormwater bumpouts, a green street captures the first inch of runoff from streets and sidewalks, infiltrates it into the soil to recharge groundwater, and reduces the amount of stormwater runoff that would otherwise make its way into Philadelphia's combined sewer system.

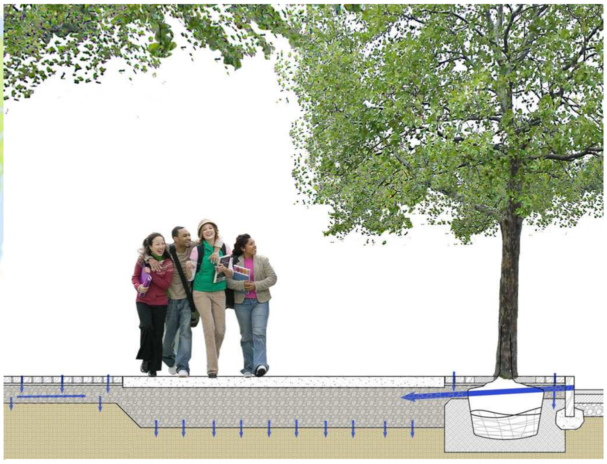

Stormwater Tree Trench

Benefits:

Reduce combined sewer overflows through infiltration, evapotranspiration, and extended detention of runoff from the right of way
Reduce urban heat island effect, improve air quality, and provide shade on streets
Beautify neighborhood
Provides opportunities to educate communities about water resources protection

Clark Park Permeable Sidewalk and Tree Trench

Stormwater BMP Project **Mill Creek Watershed**



Contact: Glen Abrams
215.685.6039
Glen.Abrams@phila.gov

Status: Concept Design

Partners:

Friends of Clark Park (FOCP)
University City District (UCD)
Philadelphia Water Department - OOW
University City Green (UCG)

Clark Park Permeable Sidewalk and Tree Trench...

The proposed project is located on the Farmer's Market side of Clark Park, along 43rd St. between Baltimore Ave. and Chester Ave., and is part of a master revitalization plan for PARC A of Clark Park. Stormwater runoff from adjacent streets and Clark Park will be captured by using a pervious pavement sidewalk with an infiltration bed which will water trees planted along the sidwalk. This design will capture rainfall from a one-inch storm and capture and estimate of 85% to 91% of the stormwater runoff in the project drainage area.

Benefits:

Improvements to the health of the Schuylkill Watershed caused by the prevention CSO release the from Mill Creek sewer into the Schuylkill River
Improvement to recreational use of Clark Park, which is impeded when flooding occurs, especially in the Farmers Market area.

Clean Water........ Green City
www.phillyriverinfo.org

Clemente Park Infiltration Tree Trenches

Stormwater BMP Project

Schuylkill Watershed

Contact: Lisa Beyer

Lisa.Beyer@phila.gov

Status: Design

Partners:

Department of Public Property

Clemente Park Infiltration Tree Trenches...

The Department of Public Property is redesigning parts of the interior of Clemente Park and PWD is developing designs to manage stormwater runoff from the street in new tree trenches proposed on the interior fenceline of the Park.

Benefits:

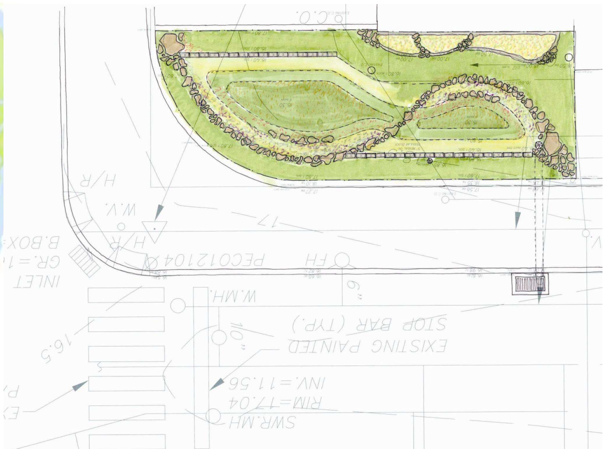
Reduce and slow the quantity of stormwater entering the combined stormsewer, particularly in large storm events.

Clean Water........ Green City
www.phillyriverinfo.org

Columbus Square Raingarden

Stormwater BMP Project

Delaware Watershed



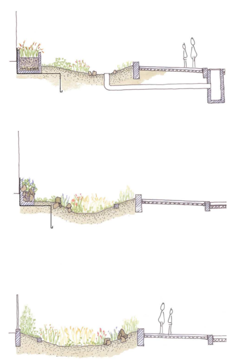
Contact: Jessica Brooks
215.685.6038
Jessica.K.Brooks@phila.gov

Status: Design

Partners:

Philadelphia Department of Recreation

Columbus Square Raingarden...



The intersection of 12th and Reed Streets at Columbus Square Recreation Center is currently covered by a large concrete pad. This stormwater demonstration project proposes to replace this concrete with a raingarden that would capture runoff and beautify the Center’s entrance. Inlets will be placed in the streets to capture and divert runoff into the raingarden. A control structure will be used to detain the stormwater within the raingarden and slowly release it back into the combined sewer. The system will be designed to reduce the flow rate during the small frequent storms that cause the majority of combined sewer overflows. The vegetated portion of the system will also provide some volume reduction through uptake and evapotranspiration.

Benefits:

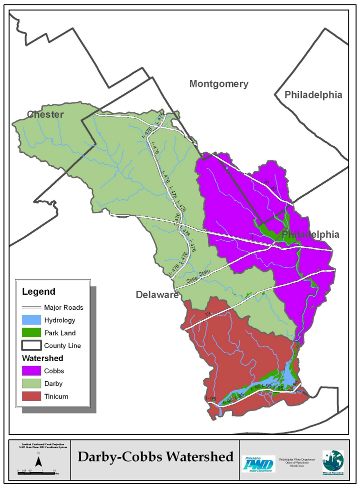
Combined sewer overflows are reduced through evapotranspiration and flow attenuation
Recreation Center entrance enhancements
Reduction in unneccessary impervious area

Clean Water....... Green City
www.phillyriverinfo.org

Darby Cobbs Stream Restoration

Restoration Project

Darby-Cobbs Watershed



Contact: Erik Haniman
215-685-4877
Erik.Haniman@phila.gov

Status: Concept Design

Partners:

Biohabitats, Inc
O'Brien & Gere Engineers
Fairmount Park Commission (FPC)
Philadelphia Water Dept. -Office of Watersheds

Darby Cobbs Stream Restoration...

Proposed restoration activities include streambank and streambed stabilization and/or realignment, planting of native vegetation, habitat restoration, trash removal, renovatations and protection for infrastructure, potential for constructed wetlands along the reach length, and the enhancements to park ammenities.

Benefits:

- Reduced erosion and sediment load
- Enhanced aquatic and riparian habitat
- Improved biological integrity
- Improved ecological stability
- Infrastructure improvement and protection
- Enhancement of the surrounding park

Clean Water....... Green City
www.phillyriverinfo.org

Dickinson Square Streetscaping

Project **Delaware Watershed**

Contact: Glen Abrams
215.685.6039
Glen.Abrams@phila.gov

Status: Concept Design

Partners:

Department of Recreation

Friends of Dickinson Square

Dickinson Square Streetscaping...

The Philadelphia Water Department is working with the Department of Public Property and the Department of Recreation on a streetscaping project around Dickinson Square Park. The streetscaping will utilize green infrastructure to manage stormwater while also improving and beautifying the area around the park. The streetscaping is likely to include tree trenches and stormwater planters. The green infrastructure will be designed to treat stormwater based on the management goals defined by PWD.

Benefits:

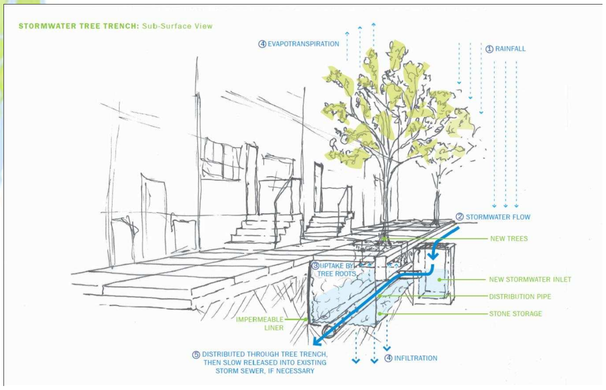
Improvements to the sidewalk around the park
Increased greening and shading though installation of green infrastructure
Reduce stormwater runoff to combined sewer

Clean Water........ Green City
www.phillyriverinfo.org

Epiphany of Our Lord School Green Streets

Stormwater BMP Project

Delaware Watershed



Contact: Chris Bergerson
215-685-6234
Chris.Bergerson@phila.gov

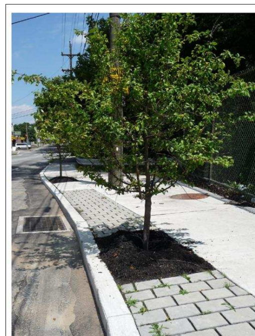
Status: Design

Partners:

Lower Moyamensing Civic Association

Epiphany of Our Lord School Green Streets...

Streets and sidewalks are by far the largest single category of impervious cover, accounting for roughly 38% of the impervious cover within the combined sewer system. To mitigate the impact of this impervious area, PWD has developed green street designs that use a combination of vegetated and engineered strategies to manage runoff at its source. Using a variety of green stormwater infrastructure tools, including stormwater tree trenches, stormwater planters, and stormwater bumpouts, a green street captures the first inch of runoff from streets and sidewalks, infiltrates it into the soil to recharge groundwater, and reduces the amount of stormwater runoff that would otherwise make its way into Philadelphia's combined sewer system.


Stormwater Tree Trench

Benefits:

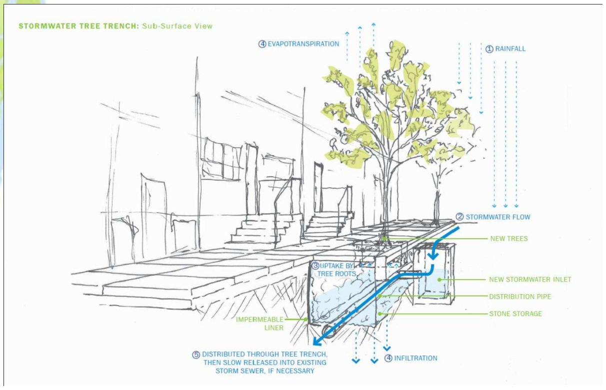
Reduce combined sewer overflows through infiltration, evapotranspiration, and extended detention of runoff from the right of way
Reduce urban heat island effect, improve air quality, and provide shade on streets
Beautify neighborhood
Provides opportunities to educate communities about water resources protection

Clean Water........ Green City
www.phillyriverinfo.org

Francis Scott Key School Green Streets

Stormwater BMP Project

Delaware Watershed



Contact: Chris Bergerson
215-685-6234
Chris.Bergerson@phila.gov

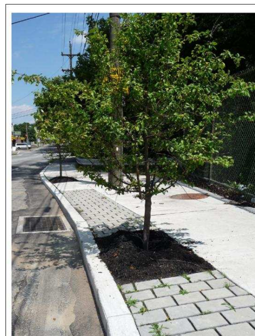
Status: Design

Partners:

Lower Moyamensing Civic Association

Francis Scott Key School Green Streets...

Streets and sidewalks are by far the largest single category of impervious cover, accounting for roughly 38% of the impervious cover within the combined sewer system. To mitigate the impact of this impervious area, PWD has developed green street designs that use a combination of vegetated and engineered strategies to manage runoff at its source. Using a variety of green stormwater infrastructure tools, including stormwater tree trenches, stormwater planters, and stormwater bumpouts, a green street captures the first inch of runoff from streets and sidewalks, infiltrates it into the soil to recharge groundwater, and reduces the amount of stormwater runoff that would otherwise make its way into Philadelphia's combined sewer system.


Stormwater Tree Trench

Benefits:

Reduce combined sewer overflows through infiltration, evapotranspiration, and extended detention of runoff from the right of way
Reduce urban heat island effect, improve air quality, and provide shade on streets
Beautify neighborhood
Provides opportunities to educate communities about water resources protection

Clean Water........ Green City
www.phillyriverinfo.org

Germantown Avenue Streetscaping

Project **Delaware Watershed**

Contact: Jessica Brooks
215.685.6038
Jessica.K.Brooks@phila.gov

Status: Concept Design

Germantown Avenue Streetscaping...

The Philadelphia Water Department is planning to construct a large storm flood relief sewer along Germantown Avenue and Laurel Street between Delaware Avenue and Wildey Street. The construction of this sewer will require that a large portion of the existing street and sidewalk be replace. During their replacement PWD will install systems that provide stormwater management for runoff from the streets and sidewalks. These systems may include tree trenches and stormwater planters. This project serves as an example of how green infrastructure may be included within the scope of future water and sewer construction projects.

Benefits:

Reduces stormwater runoff entering the combined sewer system
Reduces localized flooding
Green streetscaping reduces urban heat island effect, improves air quality, and increases evapotranspiration.
Illustrates a more cost effect method for construction of green infrastructure

Clean Water........ Green City
www.phillyriverinfo.org

John F. Kennedy Blvd from 30th St to 32nd St Green Streets

Stormwater BMP Project **Schuylkill Watershed**

Contact: Jessica Brooks
215.685.6038
Jessica.K.Brooks@phila.gov

Status: Design

Partners:

Drexel University (DU)
University of Pennsylvania (UPENN)
University City District (UCD)

John F. Kennedy Blvd from 30th St to 32nd St Green Streets...

Streets and sidewalks are by far the largest single category of impervious cover, accounting for roughly 38% of the impervious cover within the combined sewer system. To mitigate the impact of this impervious area, PWD has developed green street designs that use a combination of vegetated and engineered strategies to manage runoff at its source. Using a variety of green stormwater infrastructure tools, including stormwater tree trenches, stormwater planters, and stormwater bumpouts, a green street captures the first inch of runoff from streets and sidewalks, infiltrates it into the soil to recharge groundwater, and reduces the amount of stormwater runoff that would otherwise make its way into Philadelphia's combined sewer system.

Benefits:

Reduce combined sewer overflows through infiltration, evapotranspiration, and extended detention of runoff from the right of way
Reduce urban heat island effect, improve air quality, and provide shade on streets
Beautify neighborhood
Provides opportunities to educate communities about water resources protection

Clean Water........ Green City
www.phillyriverinfo.org

Mander Recreation Center

Project

Schuylkill Watershed

Contact: Lisa Beyer

Lisa.Beyer@phila.gov

Status: Concept Design

Partners:

Department of Recreation

Mural Arts Program

Mander Recreation Center...

Partnering with the Department of Parks and Recreation, and the Mural Arts Program, OOW is conceptualizing alternatives for managing stormwater runoff from the site and adjacent streets. The sytems will incorporate educational art and opportunities for interacting with the design.

Benefits:

Stormwater Management
Environmental Education

Clean Water........ Green City
www.phillyriverinfo.org

Stream Restoration of Redd Rambler Run

Restoration Project

Pennypack Watershed

Contact: Erik Haniman
215-685-4877
Erik.Haniman@phila.gov

Status: Design

Partners:

Philadelphia Water Department

Stream Restoration of Redd Rambler Run...

Redd Rambler Run sits within a narrow PWD easement that cuts through approximately 70 backyards in a Philadelphia subdivision. Its problems are typical for an urban stream including channel incision, bank erosion, and blockages to the movement of fish and other aquatic life. The project purpose is to recreate a stable, aesthetically pleasing stream with the potential to nurture habitat. The Redd Rambler Run project entails stream improvements on approximately 2,500 linear feet of stream channel. Urban stream restoration methods are intended to mimic nature and help the stream maintain itself, while improving water quality and reducing damage caused by fast, heavy flows of stormwater runoff.

Benefits:

- Creates a natural channel condition
- Creates a dynamically stable channel utilizing different stabilization techniques and materials
- Aims to improve water quality and aquatic habitat
- Creates a pleasing backyard stream which can be viewed by neighboring houses
- Creates the opportunity for public involvement which can empower the community to develop a stronger sense of stewardship for the creek

Clean Water........ Green City
www.phillyriverinfo.org

Thompson and Columbia Bumpouts

Stormwater BMP Project

Delaware Watershed

Contact: Jessica Brooks
215.685.6038
Jessica.K.Brooks@phila.gov

Status: Concept Design

Partners:

New Kensington Community Development Corporation

Philadelphia Water Department - OOW

Pennsylvania Horticultural Society (PHS)

Thompson and Columbia Bumpouts...

The New Kensington Community Development Corporation was awarded a Growing Greener grant for installation of vegetated bumpouts at the intersection of Thompson St and Columbia Ave. The bumpouts will be designed to manage the stormwater runoff from the surrounding streets and sidewalks. Stormwater enters the bumpout through curb cuts, filters through the soil, and it stored in a subsurface stone trench. The stored water is used by the vegetation in the bumpout and infiltrates into the surrounding soil. The size of the stone storage is designed to meet PWD stormwater management requirements. PWD is assisting the project by providing design services as well as additional construction funding and oversight.

Benefits:

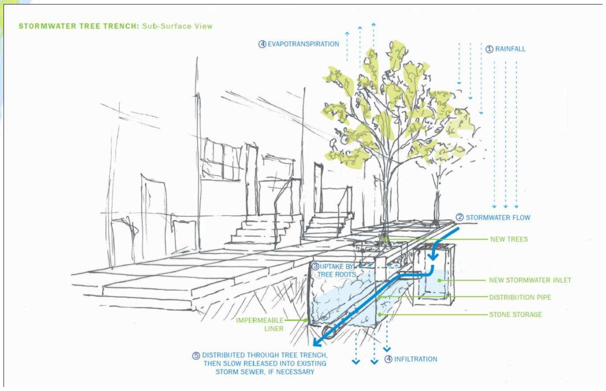
Improvements to the neighborhood through traffic calming and greening
Shorter, safer pedestrian crossing at intersections
Stormwater management reduces flooding and combined sewer overflows

Clean Water........ Green City
www.phillyriverinfo.org

Wakisha Charter School and Dendy Recreation Center Green Streets

Stormwater BMP Project

Delaware Watershed



Contact: Jillian Simmons
215.685.4961
Jillian.Simmons@phila.gov

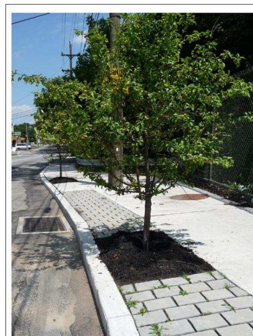
Status: Design

Partners:

Department of Recreation

Wakisha Charter School and Dendy Recreation Center Green Streets...

Streets and sidewalks are by far the largest single category of impervious cover, accounting for roughly 38% of the impervious cover within the combined sewer system. To mitigate the impact of this impervious area, PWD has developed green street designs that use a combination of vegetated and engineered strategies to manage runoff at its source. Using a variety of green stormwater infrastructure tools, including stormwater tree trenches, stormwater planters, and stormwater bumpouts, a green street captures the first inch of runoff from streets and sidewalks, infiltrates it into the soil to recharge groundwater, and reduces the amount of stormwater runoff that would otherwise make its way into Philadelphia's combined sewer system.



Stormwater Tree Trench

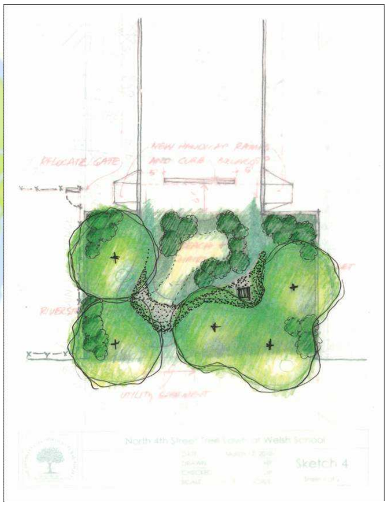
Benefits:

Reduce combined sewer overflows through infiltration, evapotranspiration, and extended detention of runoff from the right of way
Reduce urban heat island effect, improve air quality, and provide shade on streets
Beautify neighborhood
Provides opportunities to educate communities about water resources protection

Welsh School Green Streets

Stormwater BMP Project

Delaware Watershed



Contact: Jillian Simmons
215.685.4961
Jillian.Simmons@phila.gov

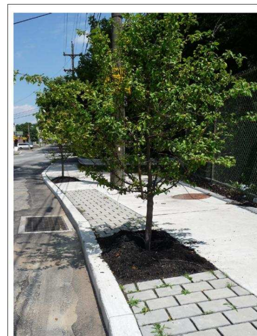
Status: Design

Partners:

Pennsylvania Horticultural Society (PHS)

Welsh School Green Streets...

Streets and sidewalks are by far the largest single category of impervious cover, accounting for roughly 38% of the impervious cover within the combined sewer system. To mitigate the impact of this impervious area, PWD has developed green street designs that use a combination of vegetated and engineered strategies to manage runoff at its source. Using a variety of green stormwater infrastructure tools, including stormwater tree trenches, stormwater planters, and stormwater bumpouts, a green street captures the first inch of runoff from streets and sidewalks, infiltrates it into the soil to recharge groundwater, and reduces the amount of stormwater runoff that would otherwise make its way into Philadelphia's combined sewer system.



Stormwater Tree Trench

Benefits:

Reduce combined sewer overflows through infiltration, evapotranspiration, and extended detention of runoff from the right of way
Reduce urban heat island effect, improve air quality, and provide shade on streets
Beautify neighborhood
Provides opportunities to educate communities about water resources protection

Clean Water........
Green City
www.phillyriverinfo.org

Spring Garden Greenway

Project **Delaware Watershed**

Contact: Lisa Beyer

Lisa.Beyer@phila.gov

Status: Concept Design

Partners:

Northern Liberties Neighborhood Association

Spring Garden Greenway...

The Northern Liberties Neighborhood Association plans to green Spring Garden between 3rd Street and Delaware Avenue, creating a pedestrian friendly path with trees and stormwater management techniques.

Benefits:

Stormwater management
Increased tree canopy

Clean Water........ Green City
www.phillyriverinfo.org

APPENDIX E –Wissahickon Creek Watershed: Sediment Total Maximum Daily Load (TMDL) - Addendum

Wissahickon Creek Watershed:
Total Maximum Daily Load (TMDL) Sediment Monitoring Report

ADDENDUM

Prepared By:

Philadelphia Water Department
Office of Watersheds
9/25/09

Addendum

During the week of August 10th, 2009, PWD revisited the 81 bank pin monitoring locations installed during 2005 and 2006 in the Monoshone, Kitchens Lane, Gorgas Lane, Cresheim, Valley Green, Hartwell, Wises Mill, Cathedral Run, Rex Ave, Thomas Mill, Bells Mill, and Hillcrest tributaries. At each location, bank profile measurements were taken, if possible, and a digital photo was taken. Updated bank profiles for each bank pin location are included in Appendix A1.

Of the 81 sites revisited by PWD, 30 sites were either damaged or lost. A damaged site was classified as a site in which the toe pin was removed from its initial location, thereby making any future measurement impossible. In most of these instances, the bank pins installed were still present. A lost site was classified as one in which no evidence of its profile was present. In these cases, both toe pins and banks pins were not able to be identified in the field. The longest monitoring interval measured at each bank pin location is listed in Appendix A2.

PWD believes that the majority of the damage at these sites was associated with a large rain event that took place on Sunday, August 2, 2009. This rain event produced 4.6 inches of rain in the northwestern portion of Philadelphia, which encompasses the monitoring area of this study. Flow measurement at USGS Gage 01474000 (Wissahickon Creek at Mouth, Philadelphia, PA) peaked at 6,900 cfs on August 2, 2009. This discharge represented a 9-Year storm based upon Bulletin 17B Guidelines. Visual observations and anecdotal evidence suggested extraordinary flood damage present throughout the Wissahickon Park system which would support the extensive damage observed at the bank pin monitoring locations.

The average monitoring period for a bank pin location was 31 months. The minimum monitoring period was 12 months and the maximum monitoring period was 45 months. For the 30 monitoring locations where re-measurement was not possible, the lateral erosion rate for the longest observation period at that location was used for further calculation.

The predicted stream bank erosion rates for these tributaries were calculated using the same methods detailed in this report, with one exception. In original report, the 81 remaining bank pin monitoring locations were divided into groups: Low, Moderate, and High. These groups were based on the BEHI field assessment. Further statistical analysis showed that the Low and Moderate groups were not statistically independent of one another. These groups were merged leaving two distinct groups, Low and High. In addition, statistical outliers were defined and removed for each group. In this addendum, the use of the Low and High groups has been modified. To establish a more comprehensive lateral erosion rate estimate for the study area, all monitoring locations have been classified as one group. The average lateral erosion rate of this group has been calculated using the most recent bank profile measurements of August, 2009 at all 81 monitoring locations. This decision was based on the subjective nature of the visual assessment and BEHI assessment protocols utilized in the prediction portion of this study. Additionally, this decision was supported by the lack of recent data at the 30 destroyed monitoring locations, making any correlation between BEHI rating and lateral erosion rate speculative, at best. In addition, because of the catastrophic damage observed in the latest round of monitoring, statistical outliers were not removed.

The sample (n=81) did not exhibit characteristics emblematic of a normally distributed population (Shapiro-Wilk: W=0.63, p=0.00000, Skewness = -4.02, Kurtosis = 30.81). The average lateral erosion rate was -0.0562 ft/yr (+/- 0.0809 ft/yr). The extrapolated lateral erosion rate produced an annual loading of 3.32 million pounds per year (+/- 4.42 million pounds per year) (Table A).

To assess the normalized erosion potential of each tributary, the erosion rate per acre of drainage area per year and the erosion rate per foot of stream length per year were calculated (Table B, Figure B, Figure C). This allowed direct comparison between each of the tributaries with respect to both watershed size and the length of the tributary. For example, in 2008, Cresheim Creek had the highest total erosion at 840,000 pounds of sediment per year simply because it was the longest tributary within Philadelphia. After the erosion rate per foot of stream length was calculated, Cresheim Creek ranked eighth out of the twelve tributaries.

Table A - 2008, 2009 Stream bank erosion estimate comparison

Tributary	Total Erosion (lb/yr)	
	2008	***2009***
Bell's Mill	150,000	420,000
Cathedral Road Run	160,000	150,000
Cresheim Creek	530,000	840,000
Gorgas Run	160,000	170,000
Hartwell Run	110,000	200,000
Hillcrest	28,000	90,000
Kitchen's Lane	170,000	200,000
Monoshone Creek	57,000	160,000
Rex Ave	100,000	150,000
Thomas Mill Run	170,000	320,000
Valley Green Run	100,000	140,000
Wise's Mill Run	400,000	490,000
Total	**2,100,000**	**3,300,000**

Table B – 2008, 2009 Erosion per drainage area and stream length

Tributary	Drainage Area (Acres)	Stream Length (feet)	***2008***			***2009***		
			Erosion Rate (lb/yr)	*Erosion Rate Per Acre*	*Erosion Rate Per Foot of Stream*	*Erosion Rate (lb/yr)*	*Erosion Rate Per Acre*	*Erosion Rate Per Foot of Stream*
Bell's Mill	323	6,722	150,000	464	22	420,000	1,307	63
Cathedral Run	160	2,790	160,000	1,000	57	150,000	913	52
Cresheim Creek	1,218	16,431	530,000	435	32	840,000	690	51
Gorgas Run	499	2,170	160,000	321	74	170,000	345	79
Hartwell Run	217	3,530	110,000	507	31	200,000	918	56
Hillcrest	144	5,272	28,000	194	5	90,000	597	16
Kitchen's Lane	234	7,753	170,000	726	22	200,000	850	26
Monoshone Creek	1,056	6,926	57,000	54	8	160,000	156	24
Rex Ave	137	1,903	100,000	730	53	150,000	1,131	81
Thomas Mill Run	104	4,008	170,000	1,635	42	320,000	3,058	79
Valley Green Run	128	2,874	100,000	781	35	140,000	1,086	48
Wise's Mill Run	446	7,056	400,000	897	57	490,000	1,090	69
Total / *Average*	**4,666**	**67,435**	**2,100,000**	***645***	***37***	**3,300,000**	***1,012***	***54***

Figure A - Average Annual Erosion Rate

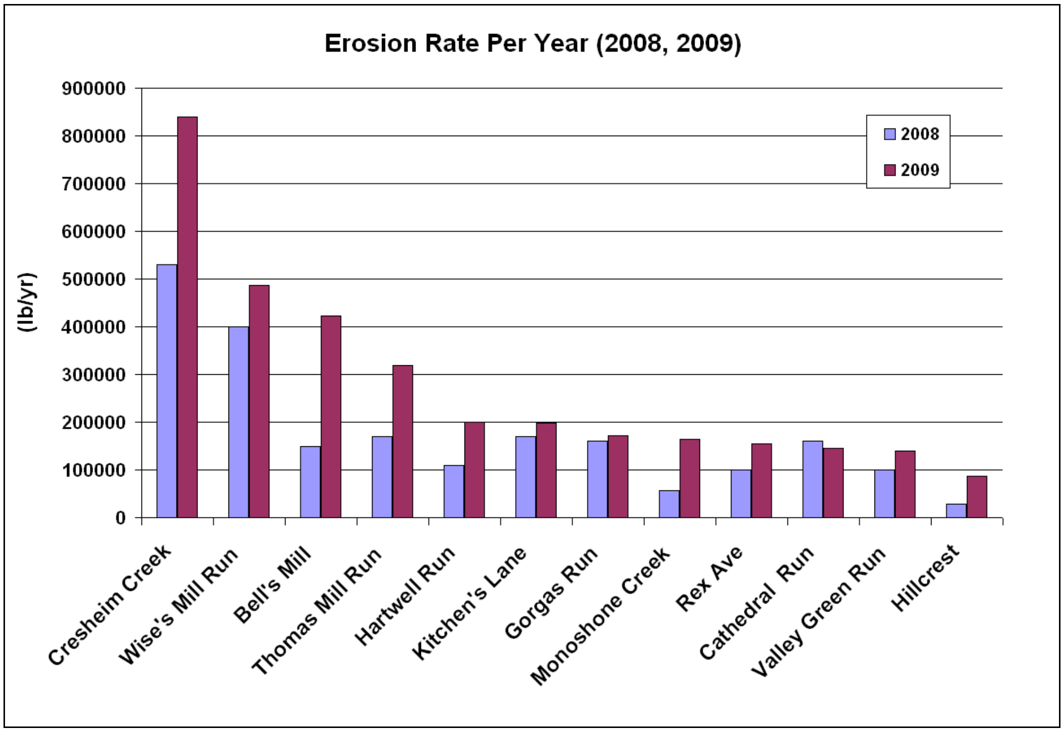


Figure B - Erosion Rate Per Acre of Drainage Area (2008, 2009)

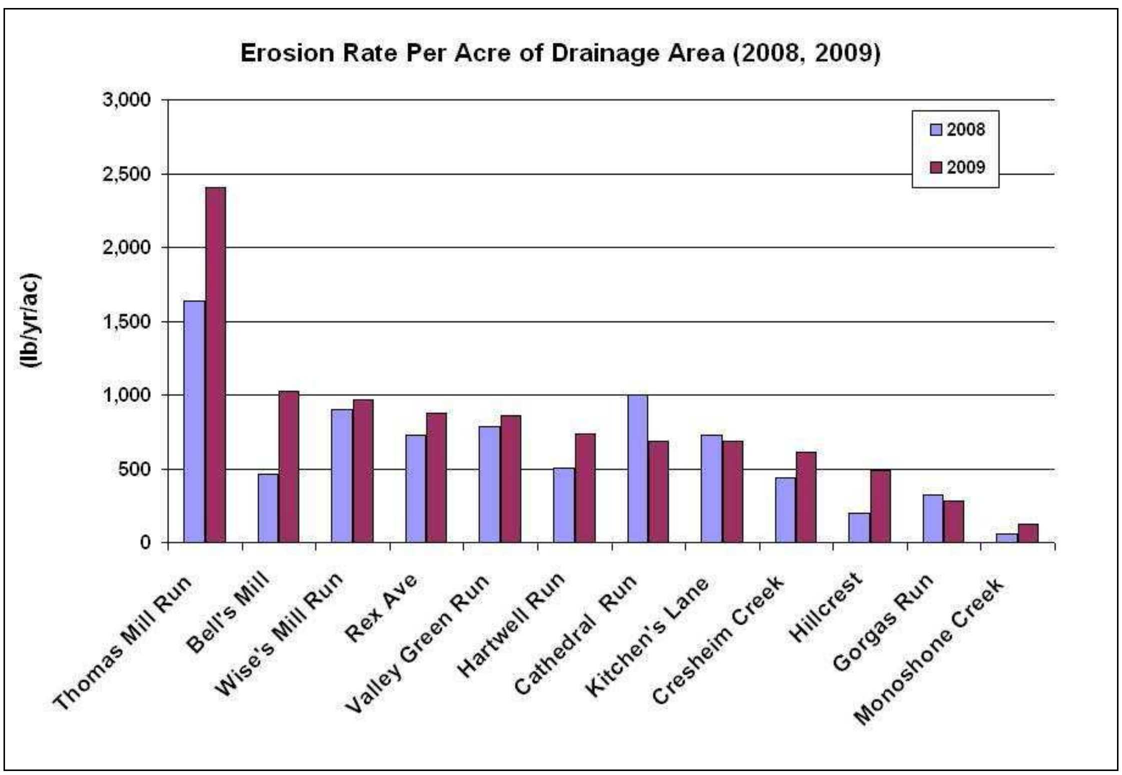
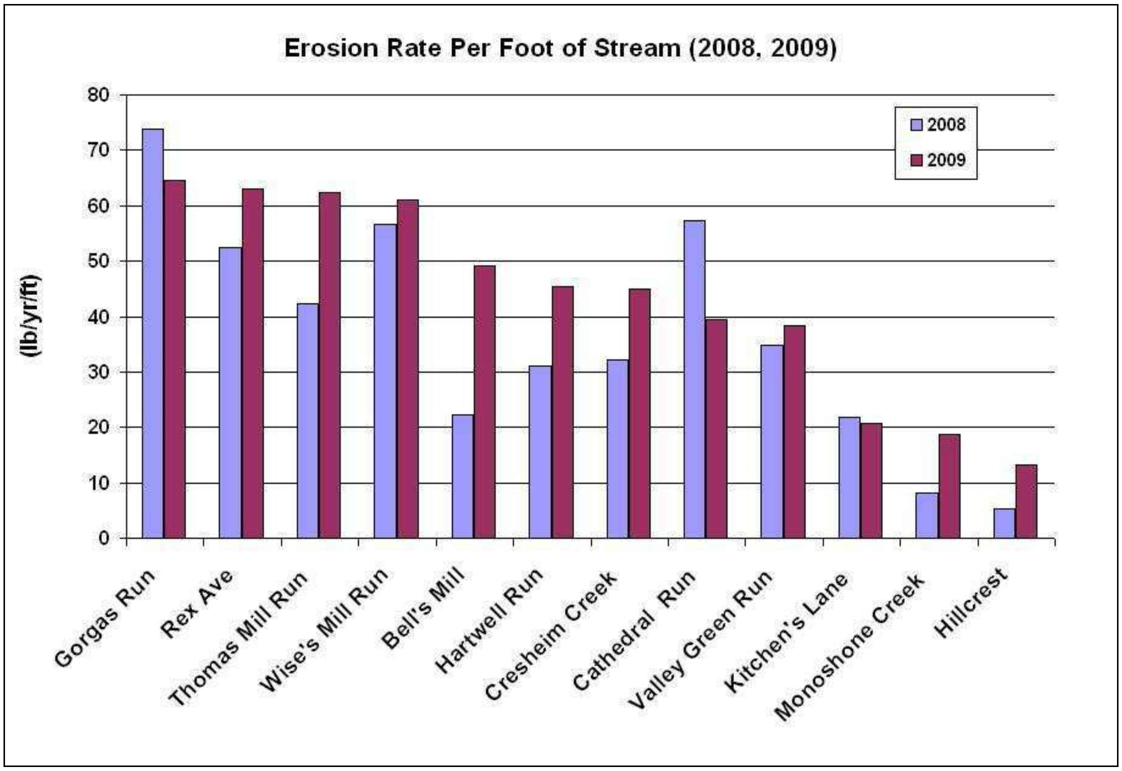


Figure C - Erosion Rate Per Foot Stream Length (2008, 2009)



Discussion

Over the last four years, PWD's effort to estimate sediment loading from the more than 24 miles of stream bank in the study area proved to be extremely enlightening. This effort produced data suggesting that roughly 3.3 million pounds of sediment are eroded from the study area annually. Given the relative consistency in this estimate over the last three years, PWD is confident that this estimate can be considered accurate at an order of magnitude level. At present, PWD does not plan to re-monitor the remaining 51 monitoring locations at any defined, regular interval.

However, the intensive field efforts completed by PWD over the last four years have also resulted in some recommendations for future efforts of this nature. Specifically, these recommendations relate to the use of bank pin monitoring locations. Bank pin monitoring locations, by their very nature, lack the permanence that is required for this sort of effort. Over one year, more than 38% (31 of 81) of the monitoring locations installed as part of this effort were lost. These sites were lost due to both degradation and aggradation. Down-cutting and erosion can cause toe pins and bank pins to be lost. In bedrock controlled settings, like those present in the Wissahickon watershed, the depth to which toe pins can installed is usually less than twelve inches. Aggradation can bury monitoring sites, leaving them unidentifiable by field personnel, and therefore useless. During the August 2009 field effort, multiple monitoring locations were buried by more than two feet of sediment.

To avoid similar monitoring problems in the future, PWD recommends the use of permanent cross-sections to monitoring channel adjustment. The use a permanent cross-section provides the following advantages:

Increased level of permanence

A monumented cross-section set back 5-10 feet from the streambank can be reoccupied year after year without worry. In contrast, bank pin monitoring sites are rendered worthless once the toe pin is lost or damaged.

Increased ability to collect geomorphic data

Monumented cross-sections are part of the standard operating procedure for understanding the geomorphic condition of a stream channel. Cross-sections allow for the geometry of the full stream to be ascertained, not just that of one bank.

Increased understanding of channel-wide sediment transport processes

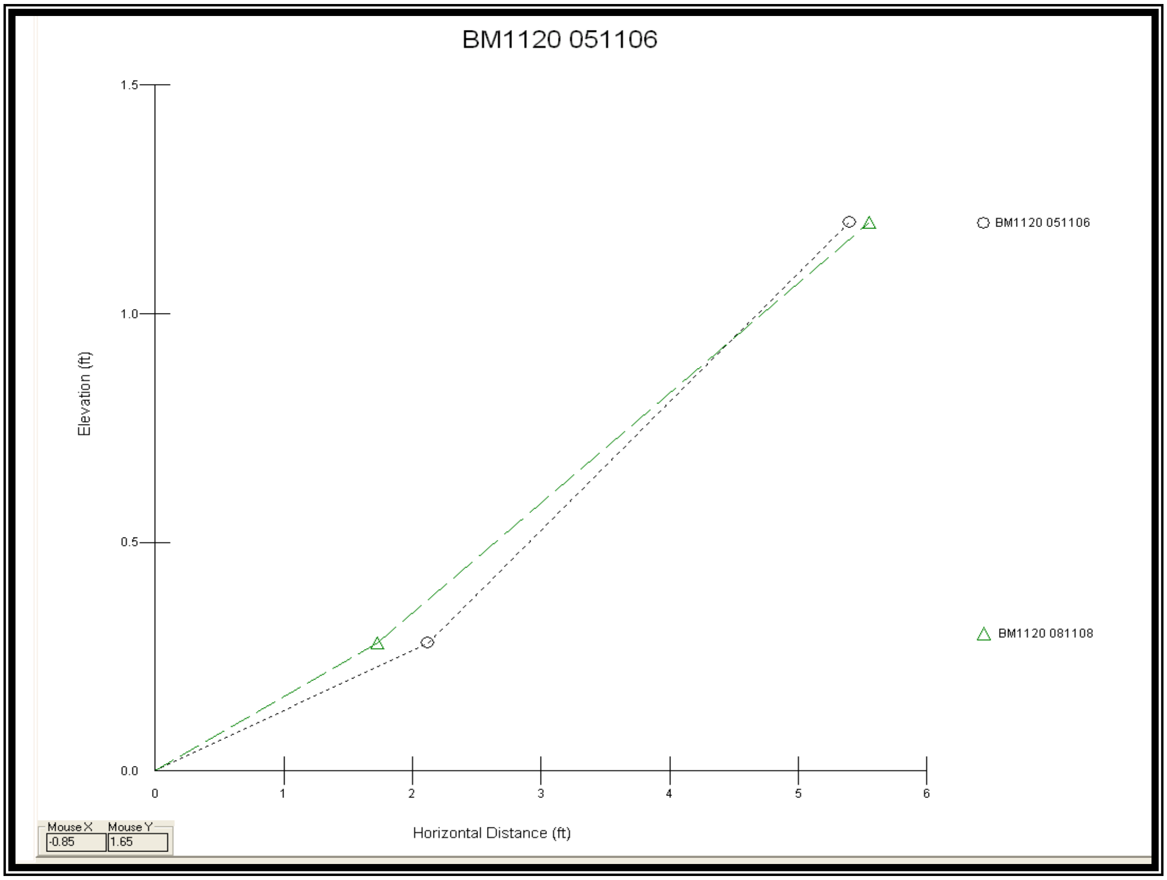
By providing a full cross-section, better data is available at aggrading areas in the channel, such as side bars and point bars. Bank pin monitoring locations buried by bed load, fail to provide any information about the rate at which this process occurs.

APPENDIX A1

BANK PIN PHOTOS AND UPDATED BANK PROFILES

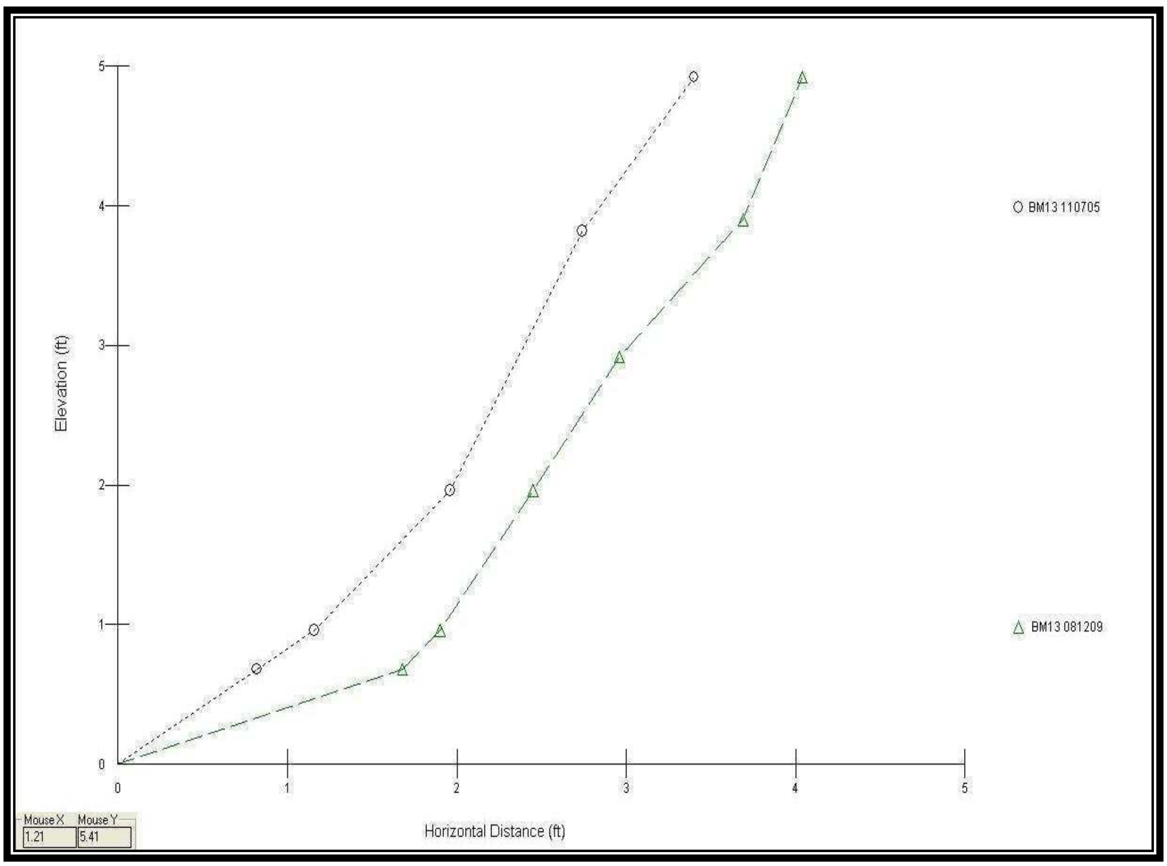
BM1120

BEHI = Moderate   Erosion Rate = 0.063 ft/yr



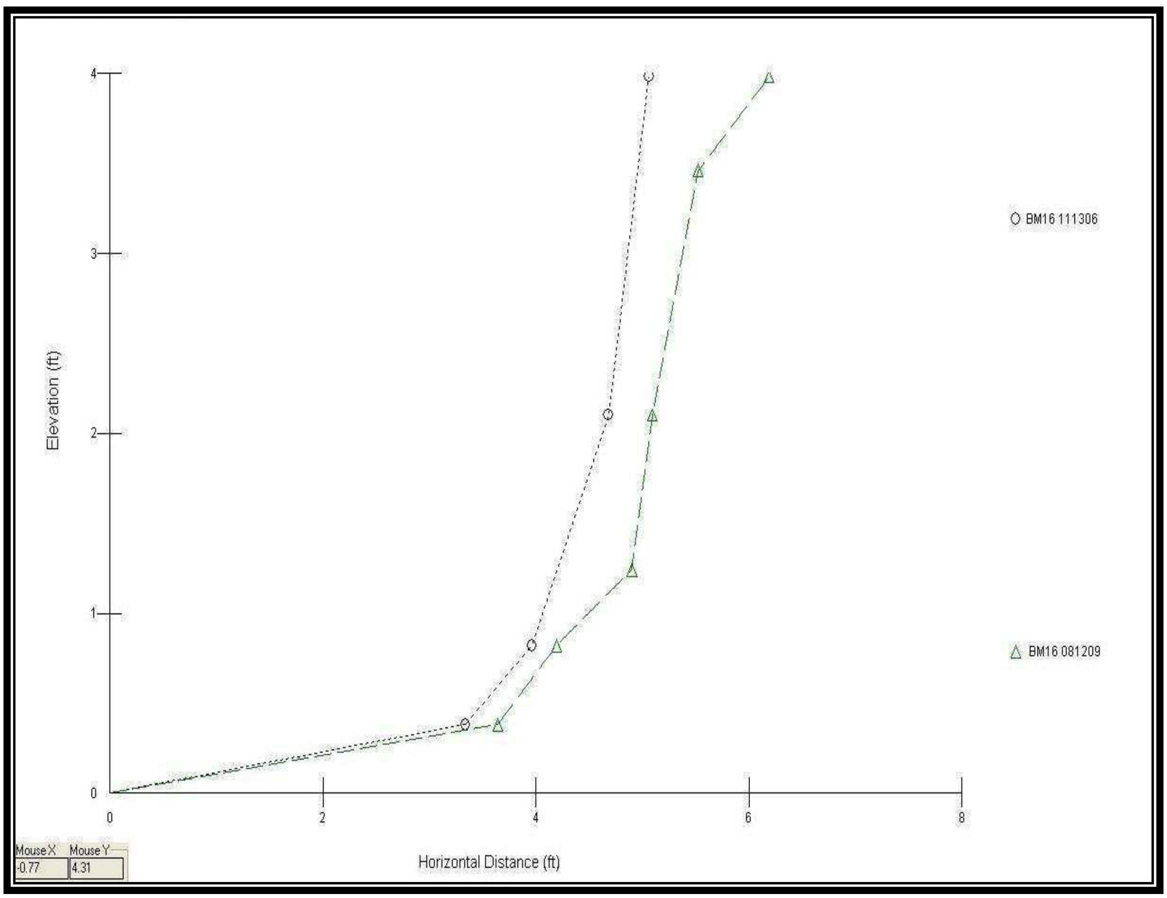
BM13

BEHI = High   Erosion Rate = -0.21 ft/yr



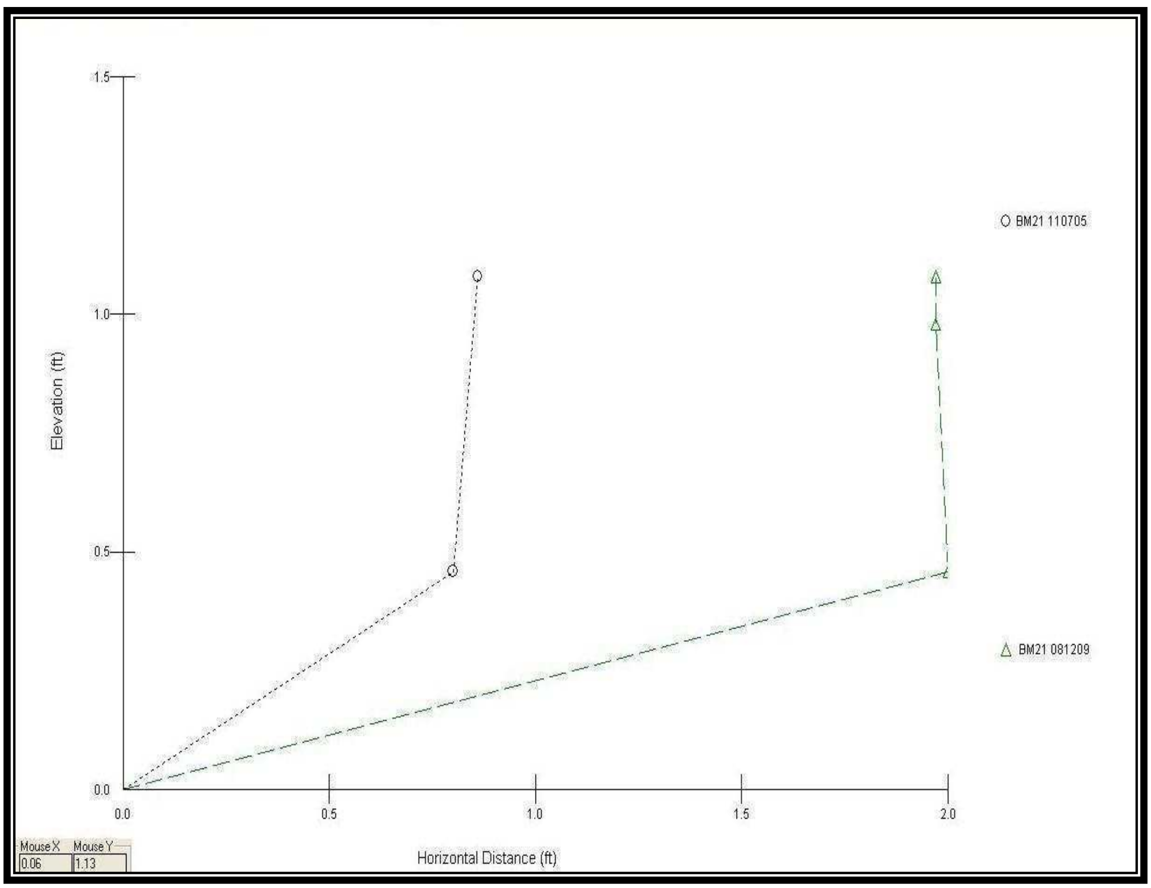
BM16

BEHI = High   Erosion Rate = -0.18 ft/yr



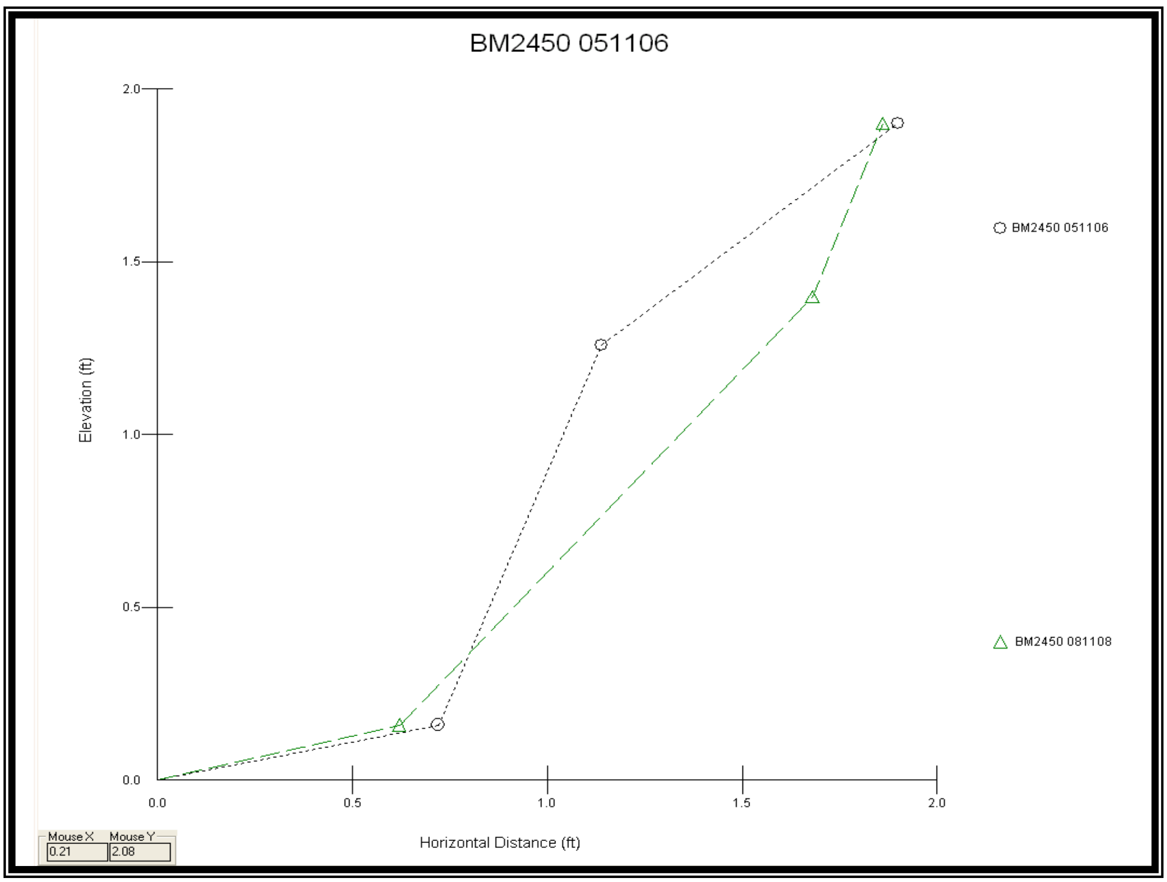
BM21

BEHI = Moderate   Erosion Rate = -0.24 ft/yr



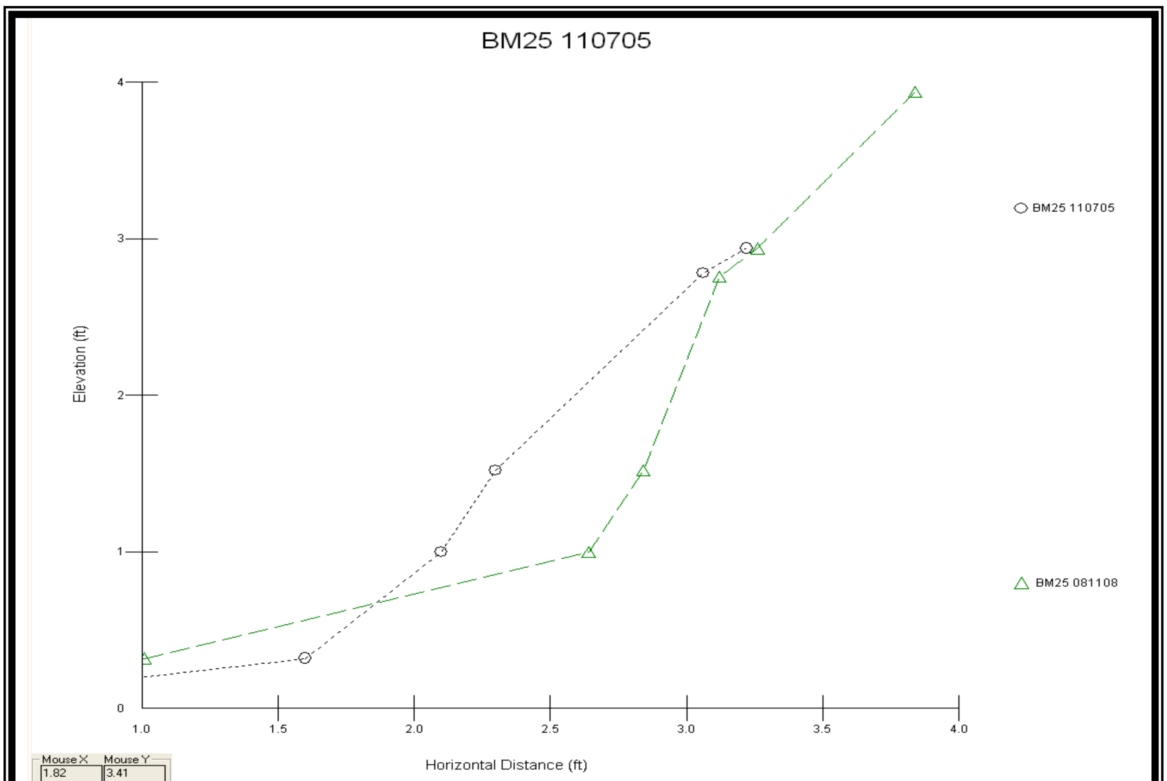
BM2450

BEHI = Moderate   Erosion Rate = -0.072 ft/yr



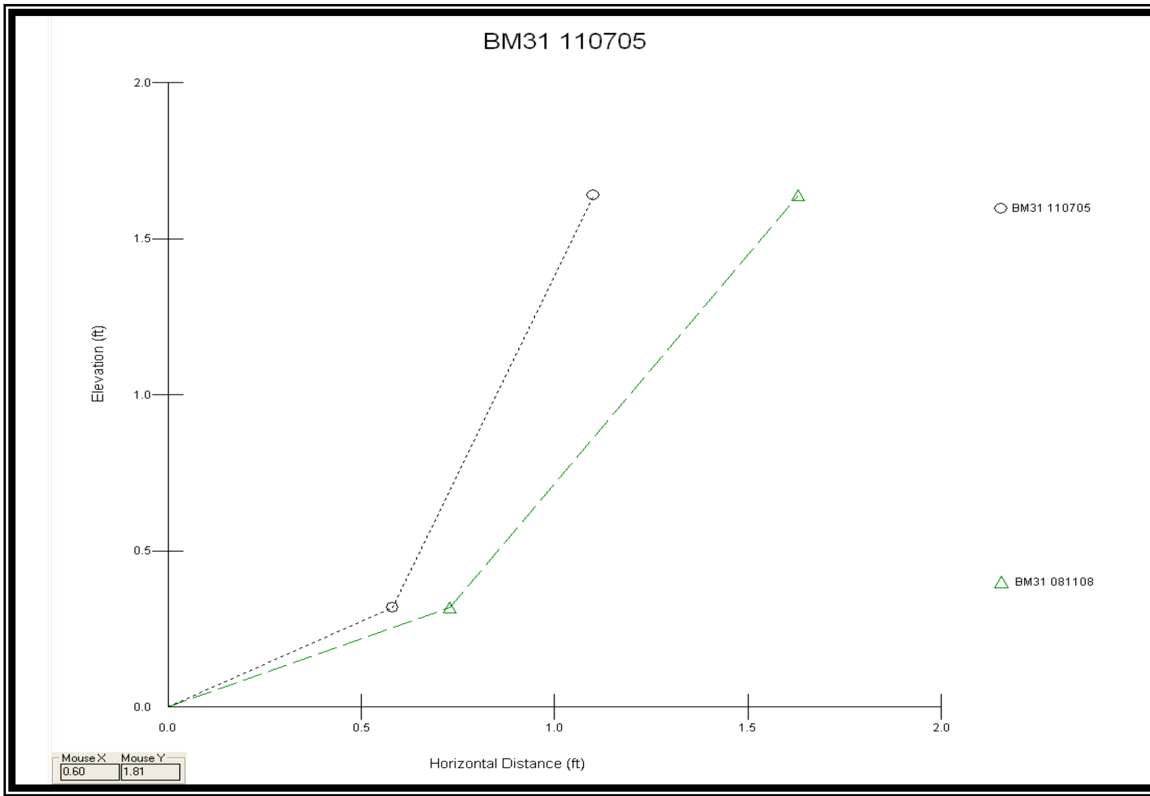
BM25

BEHI = Moderate   Erosion Rate = -0.38 ft/yr



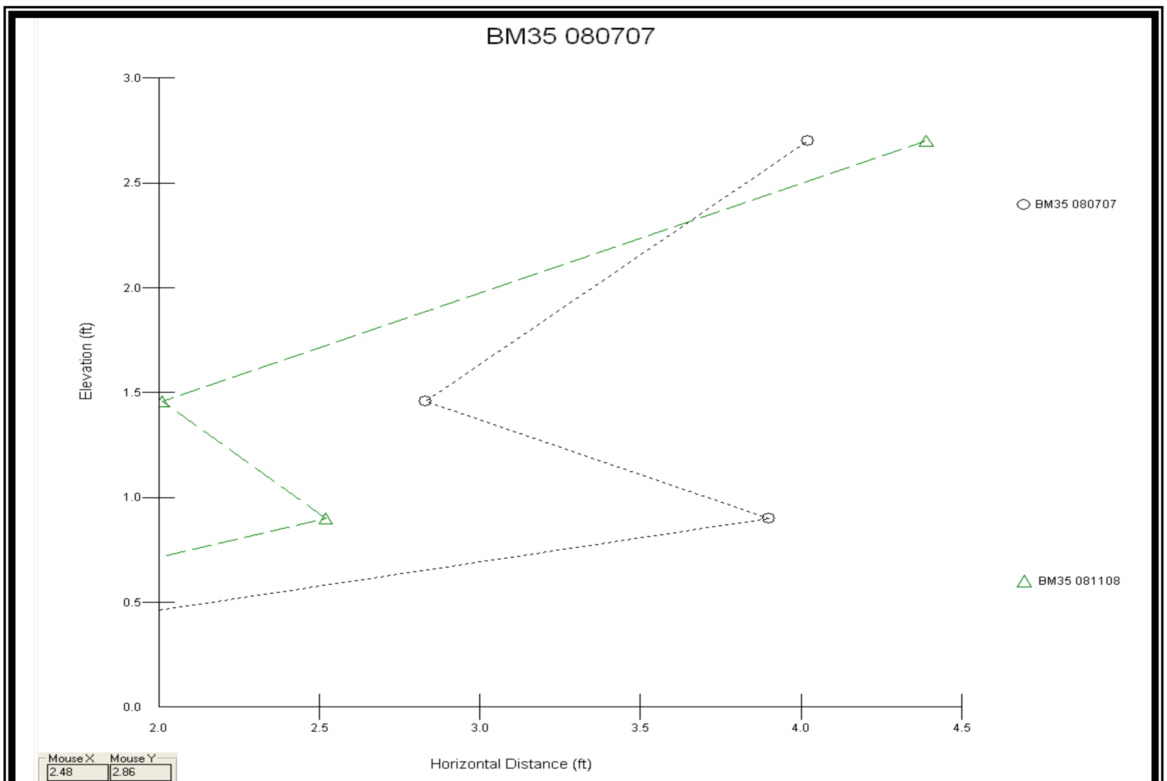
BM31

BEHI = High   Erosion Rate = -0.10 ft/yr



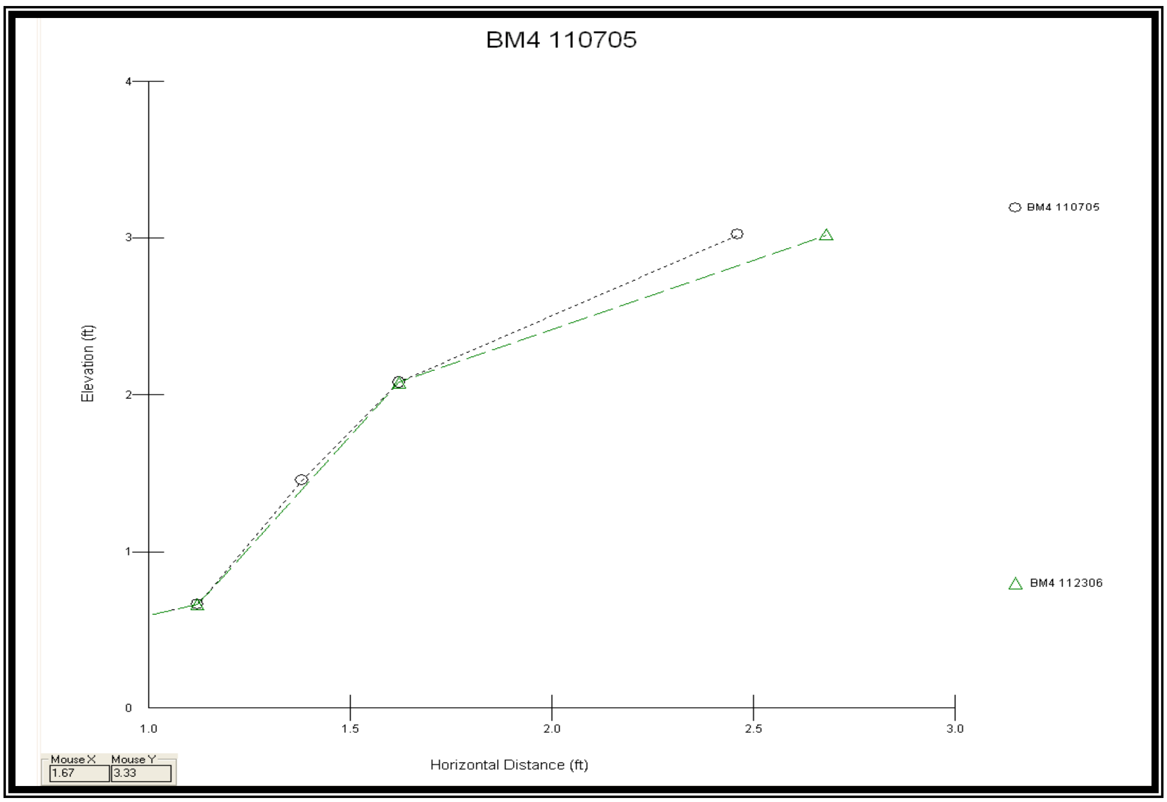
BM35

BEHI = High   Erosion Rate = 0.56 ft/yr



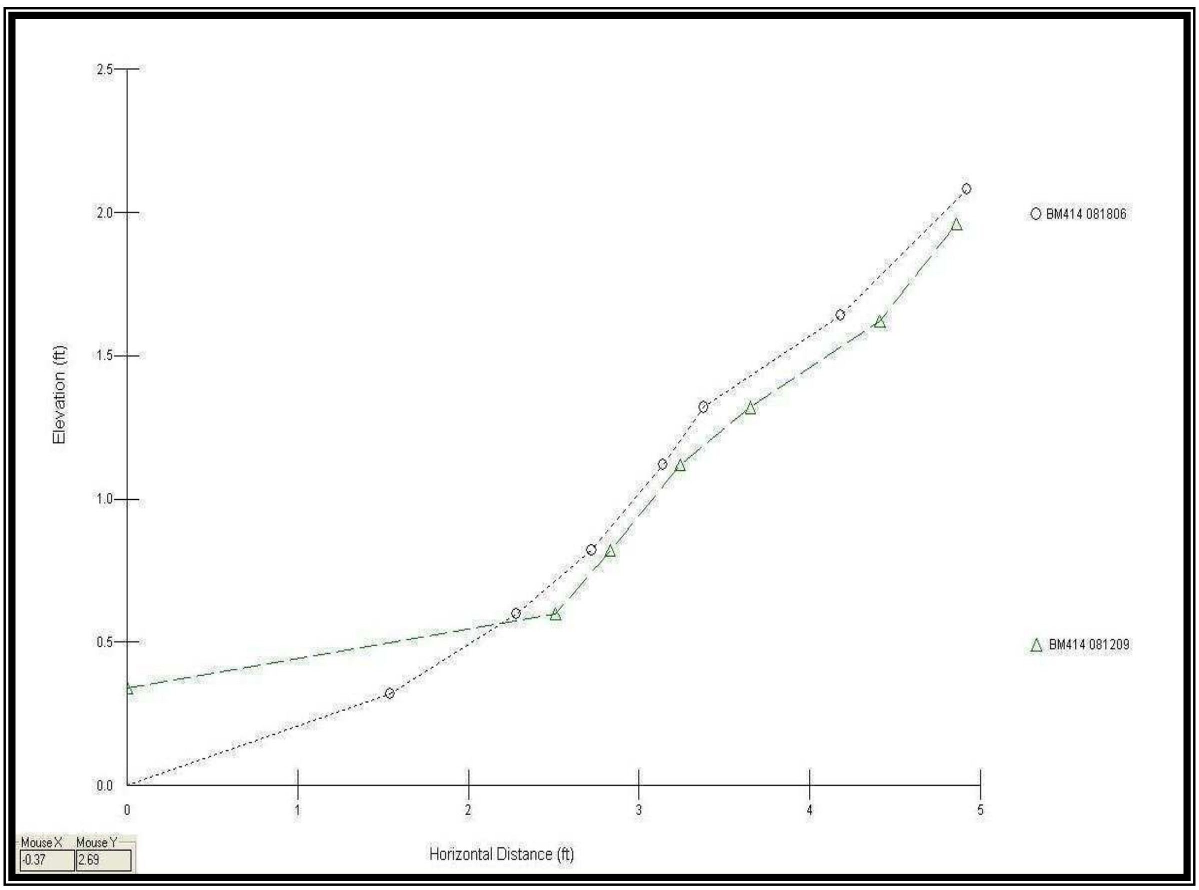
BM4

BEHI = Moderate Erosion Rate = -0.039 ft/yr



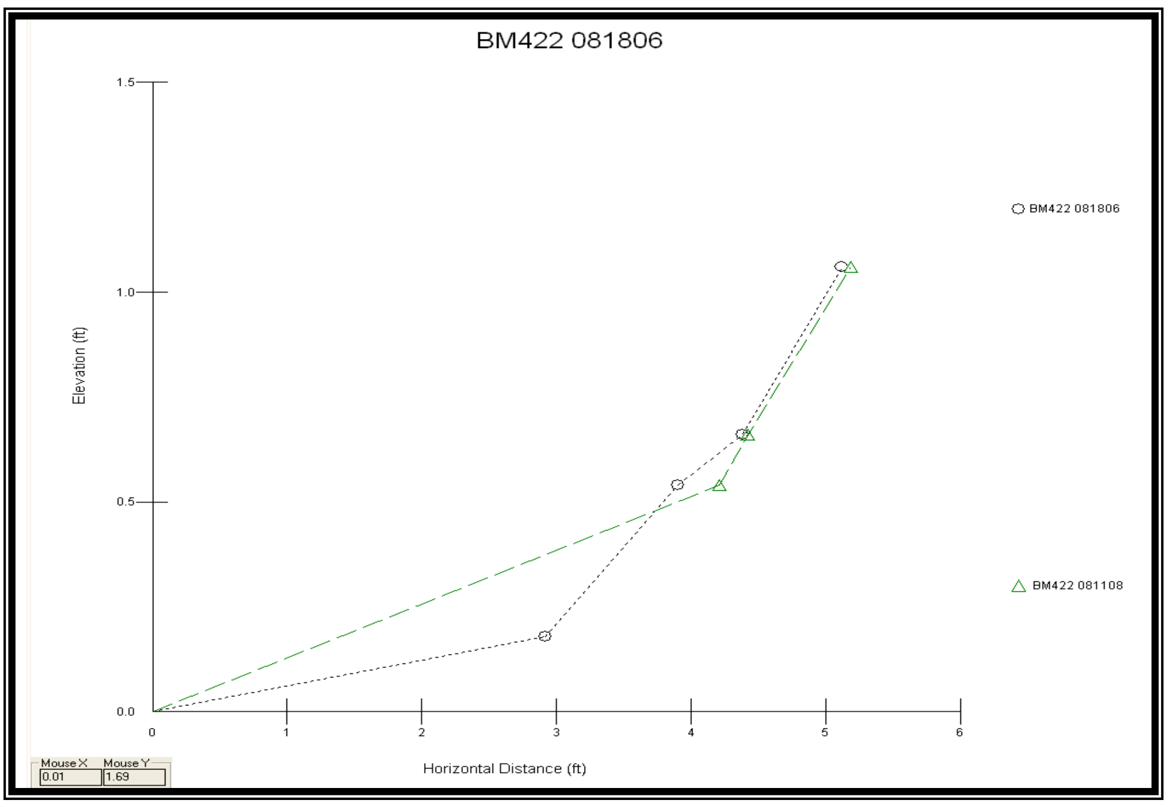
BM414

BEHI = Low   Erosion Rate = 0.12 ft/yr



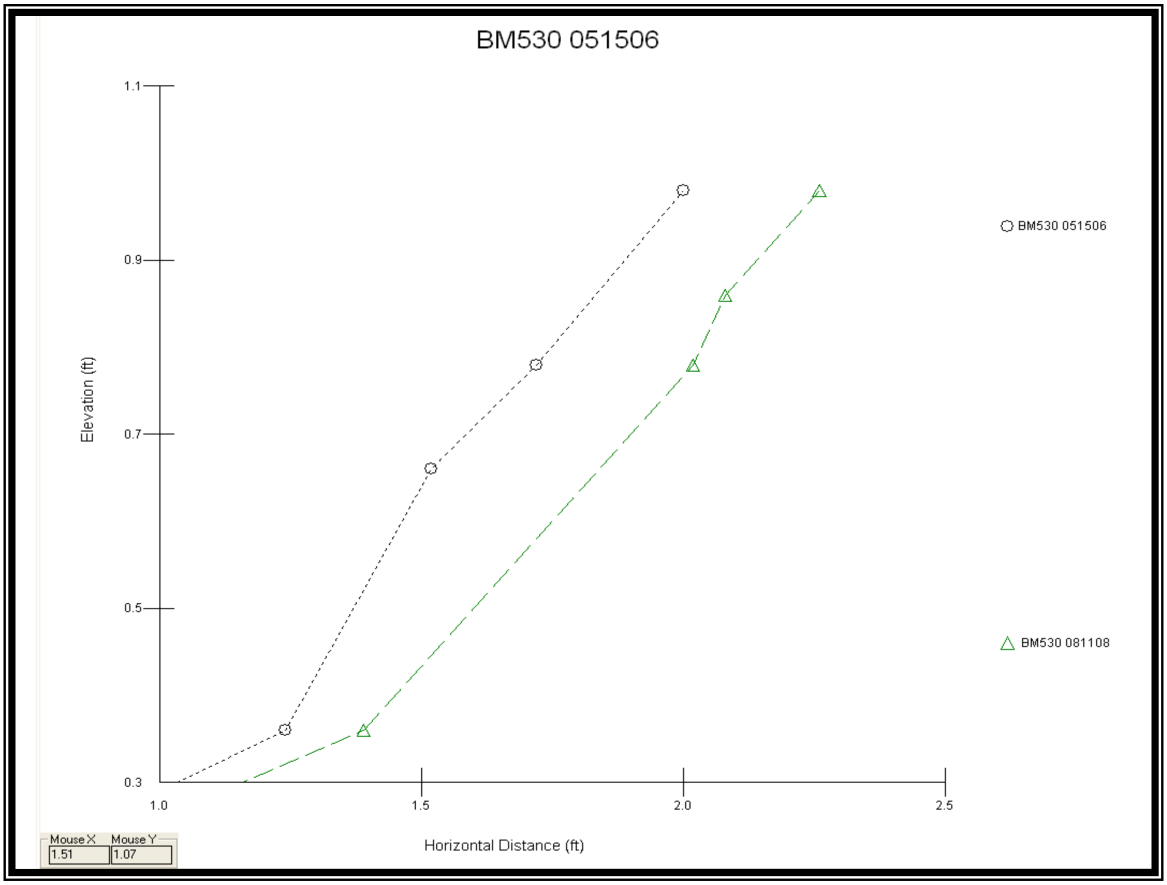
BM422

BEHI = Low   Erosion Rate = 0.15 ft/yr



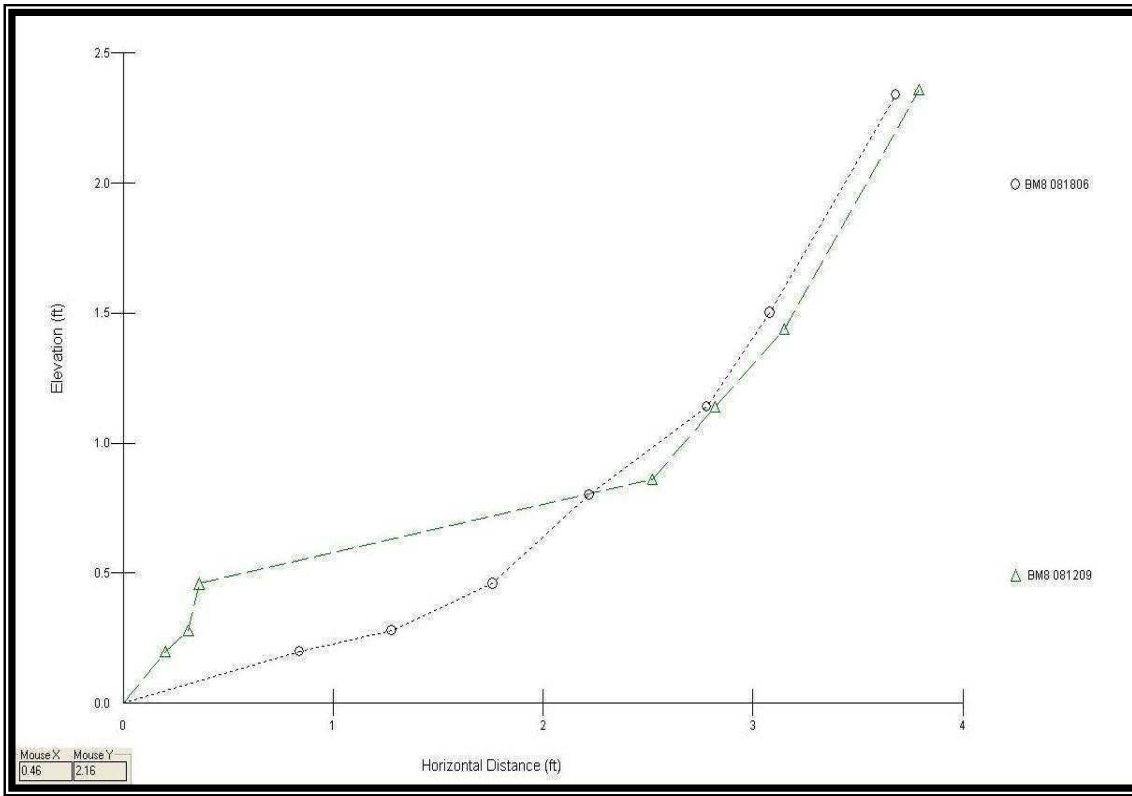
BM530

BEHI = Low   Erosion Rate = -0.086 ft/yr



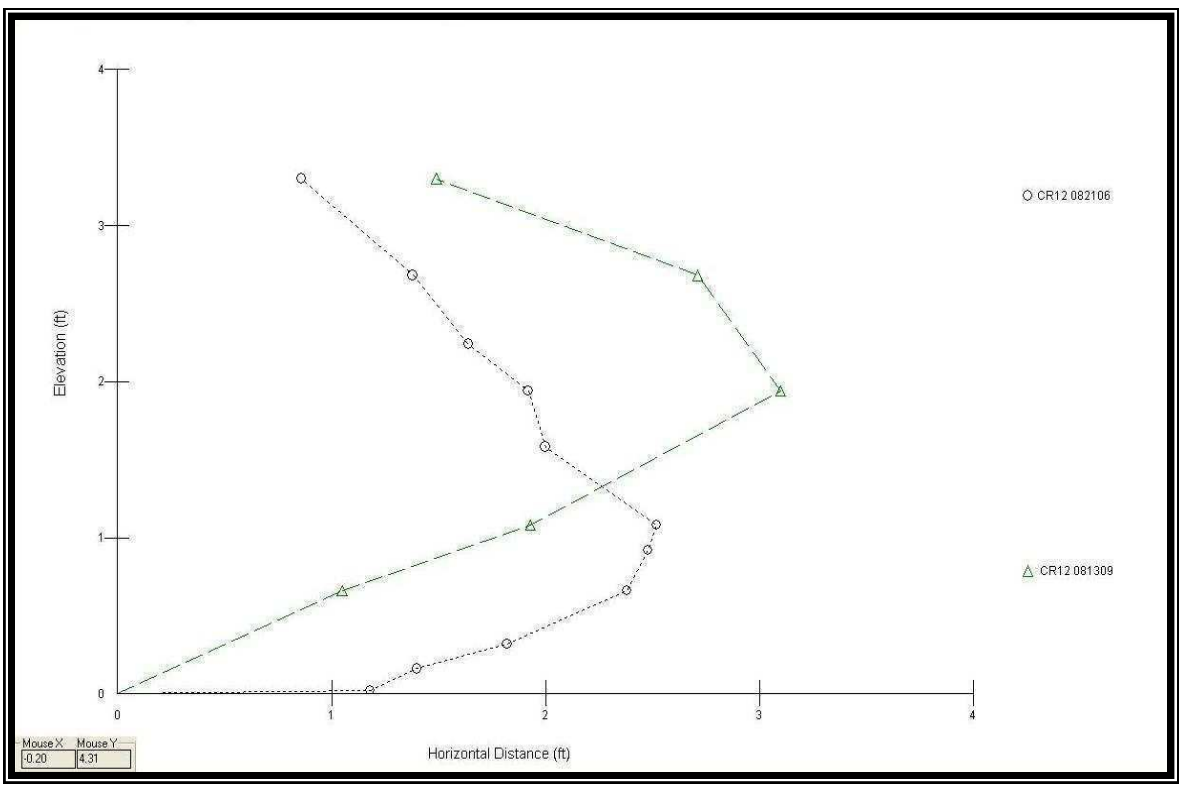
BM8

BEHI = High   Erosion Rate = -0.050 ft/yr



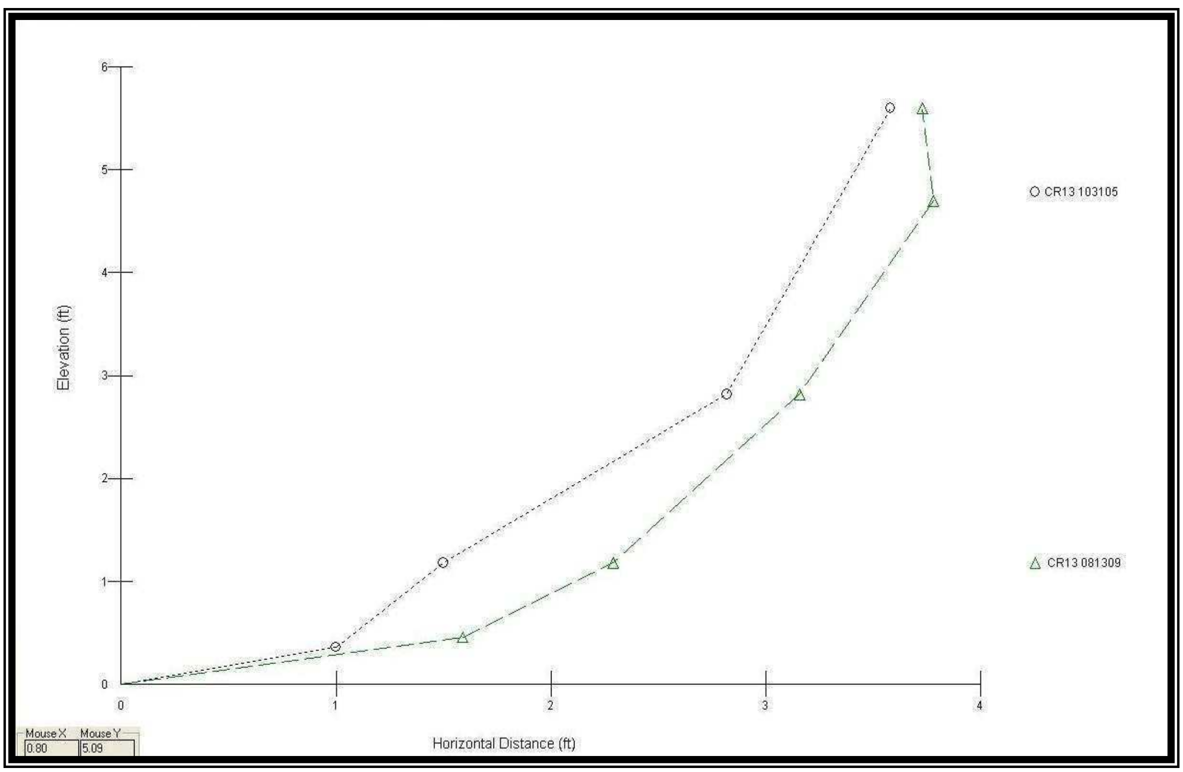
CR12

BEHI = Moderate   Erosion Rate = -0.068 ft/yr



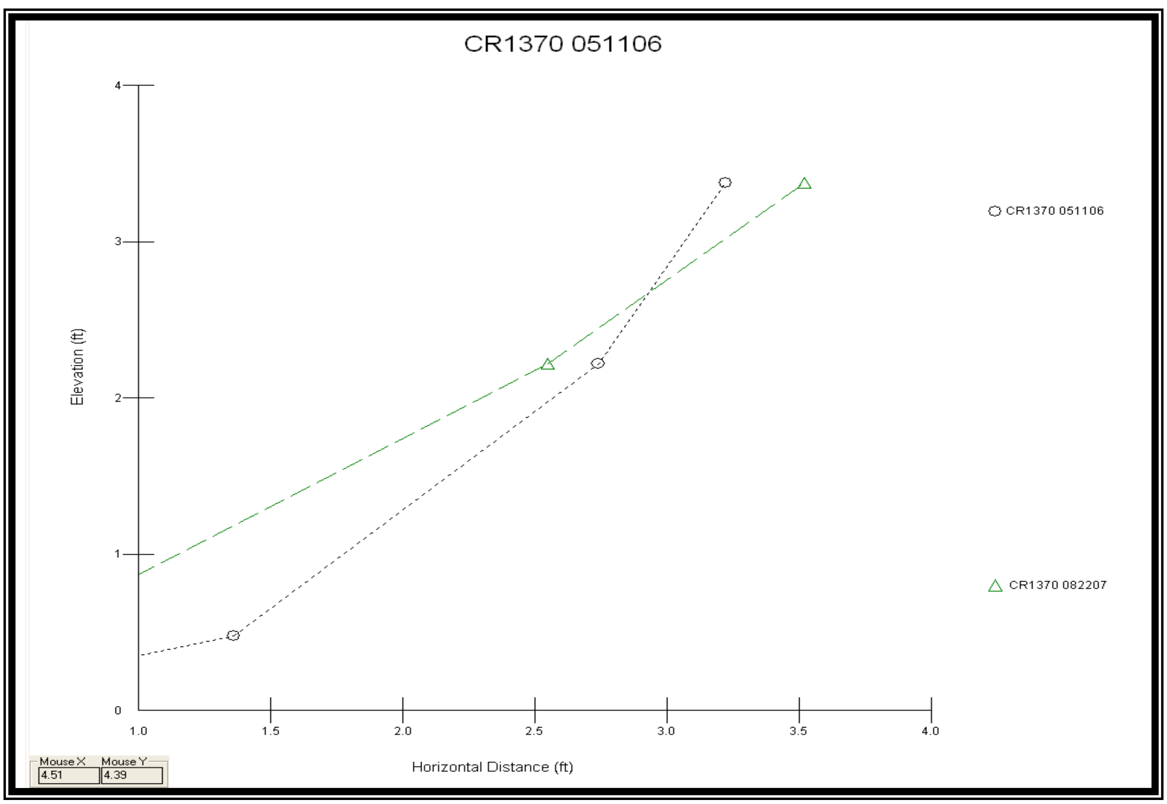
CR13

BEHI = High   Erosion Rate = -0.12 ft/yr



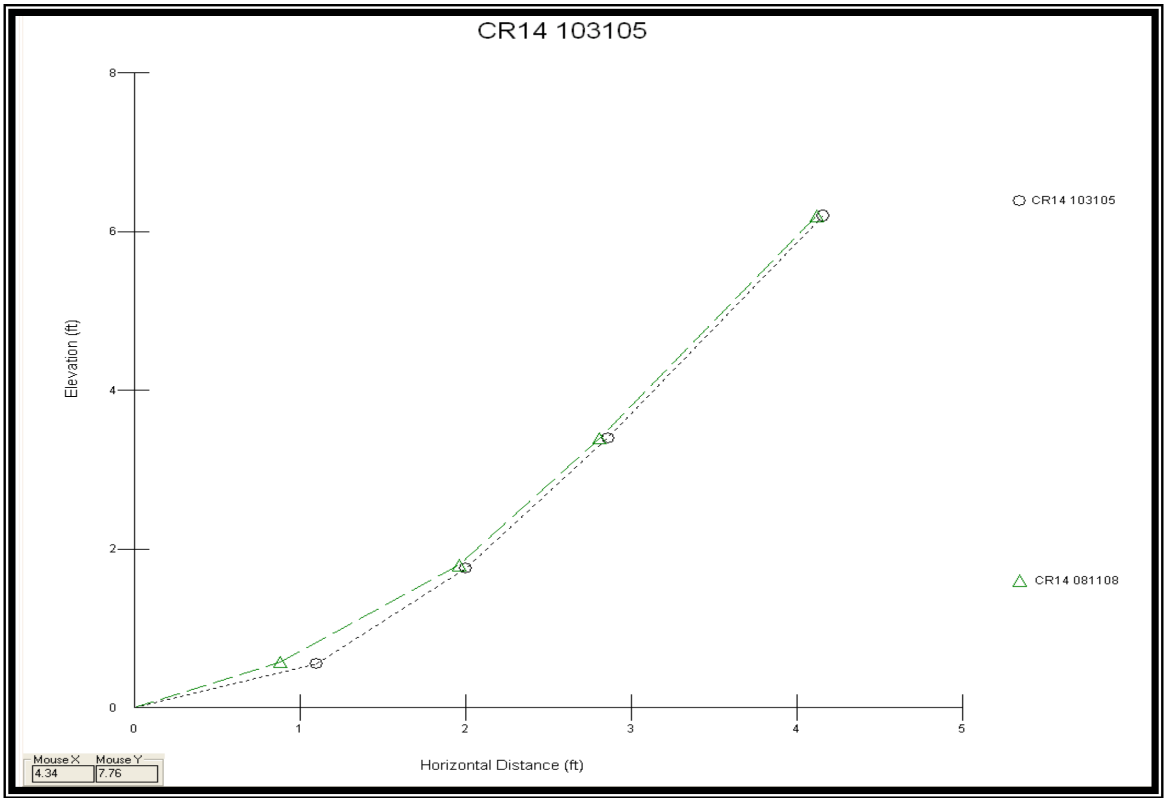
CR1370

BEHI = Moderate   Erosion Rate = 0.23 ft/yr



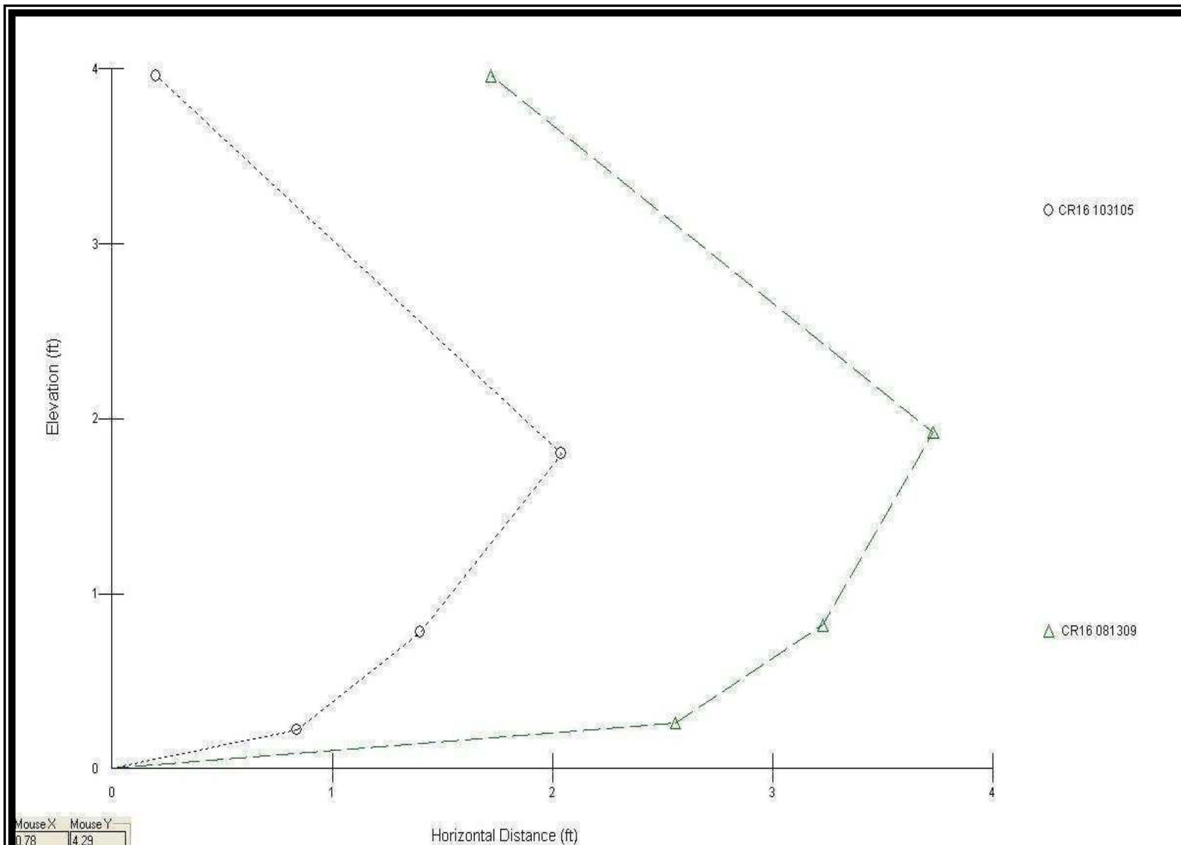
CR14

BEHI = Moderate   Erosion Rate = 0.027 ft/yr



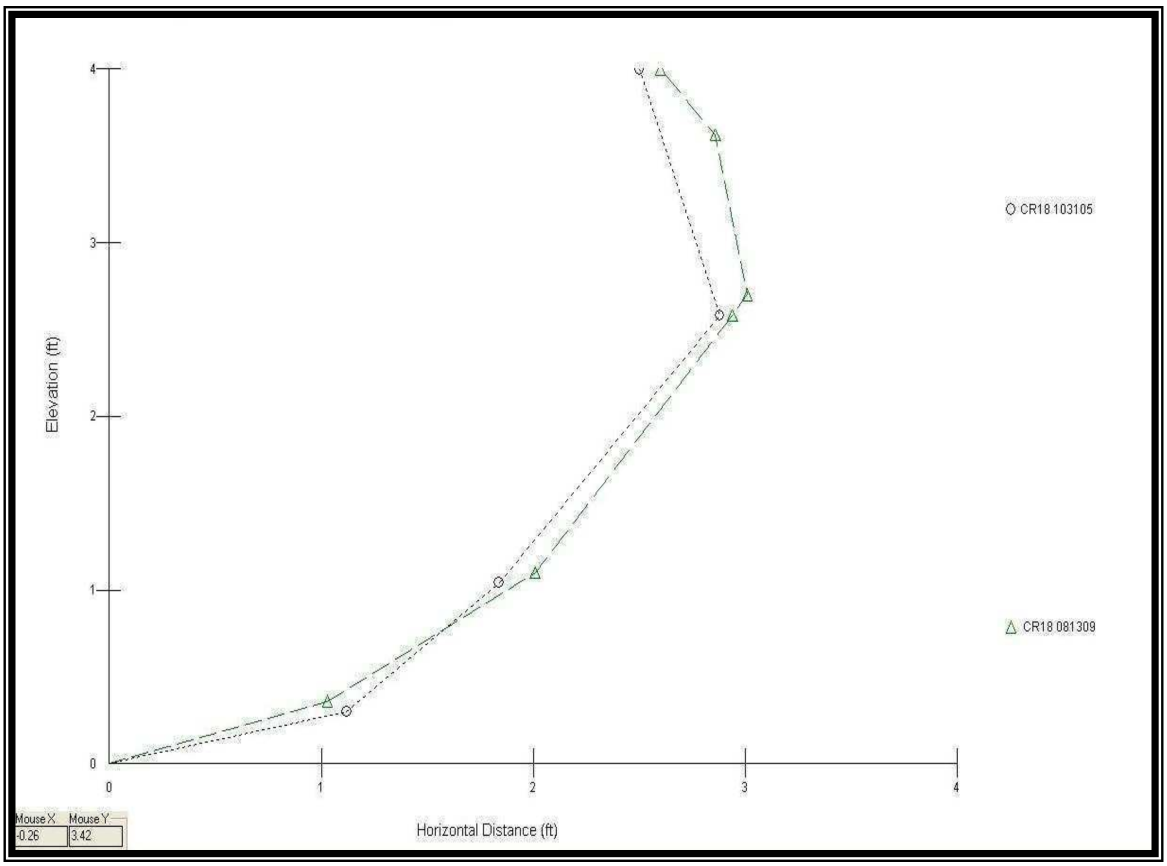
CR16

BEHI = Moderate   Erosion Rate = -0.43 ft/yr



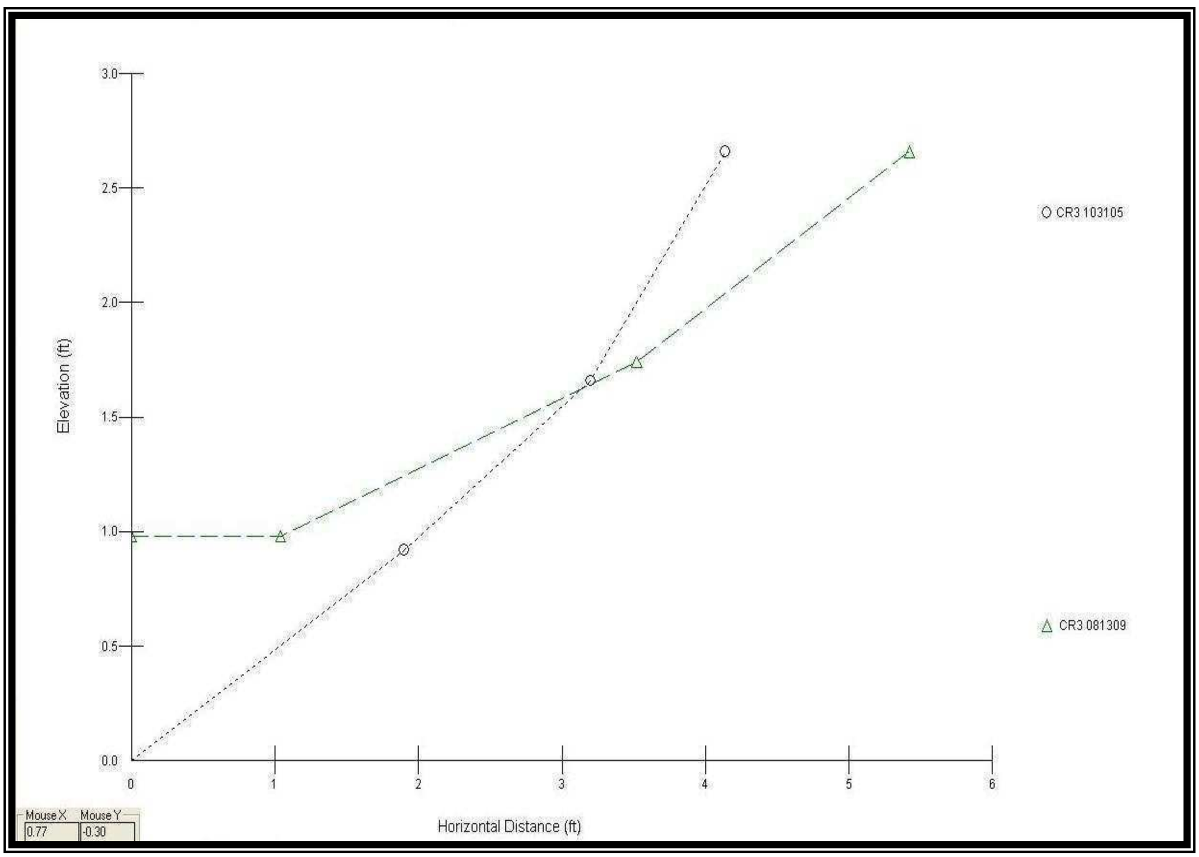
CR18

BEHI = Moderate   Erosion Rate = -0.023 ft/yr



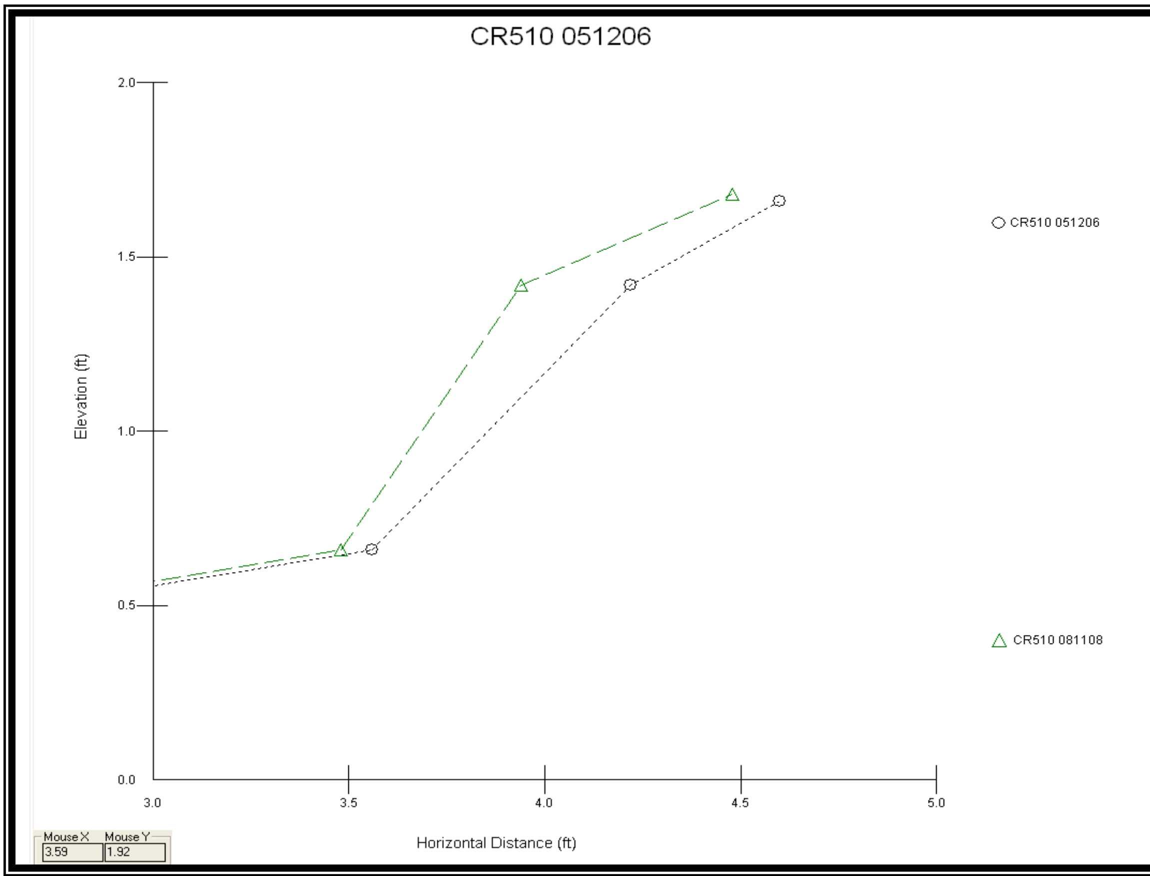
CR3

BEHI = High   Erosion Rate = 0.058 ft/yr



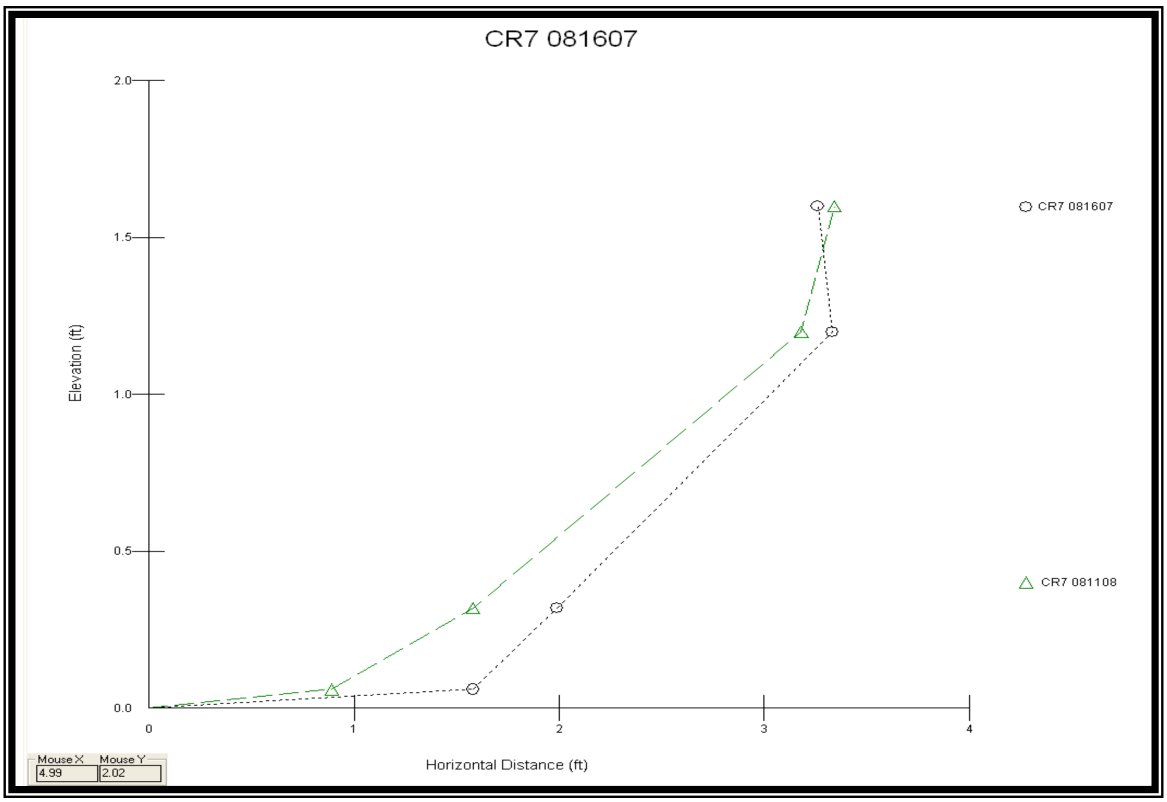
CR510

BEHI = Moderate   Erosion Rate = 0.035 ft/yr



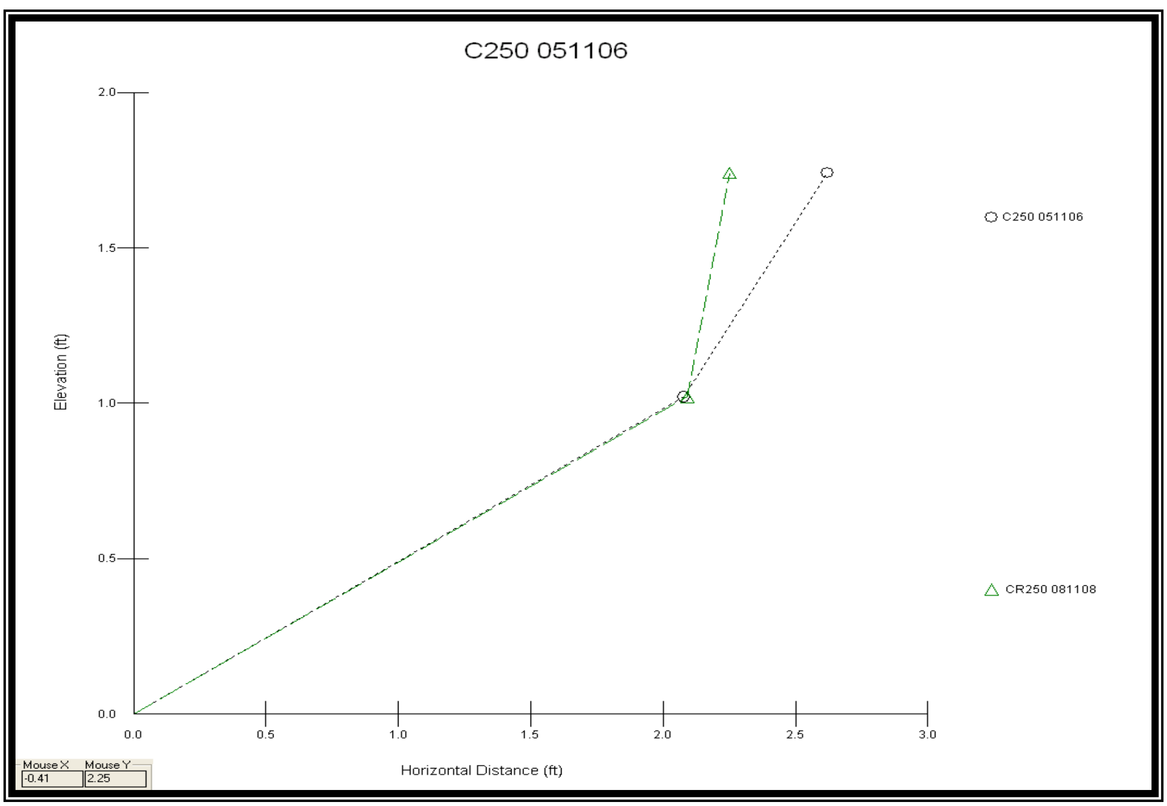
CR7

BEHI = High   Erosion Rate = 0.27 ft/yr



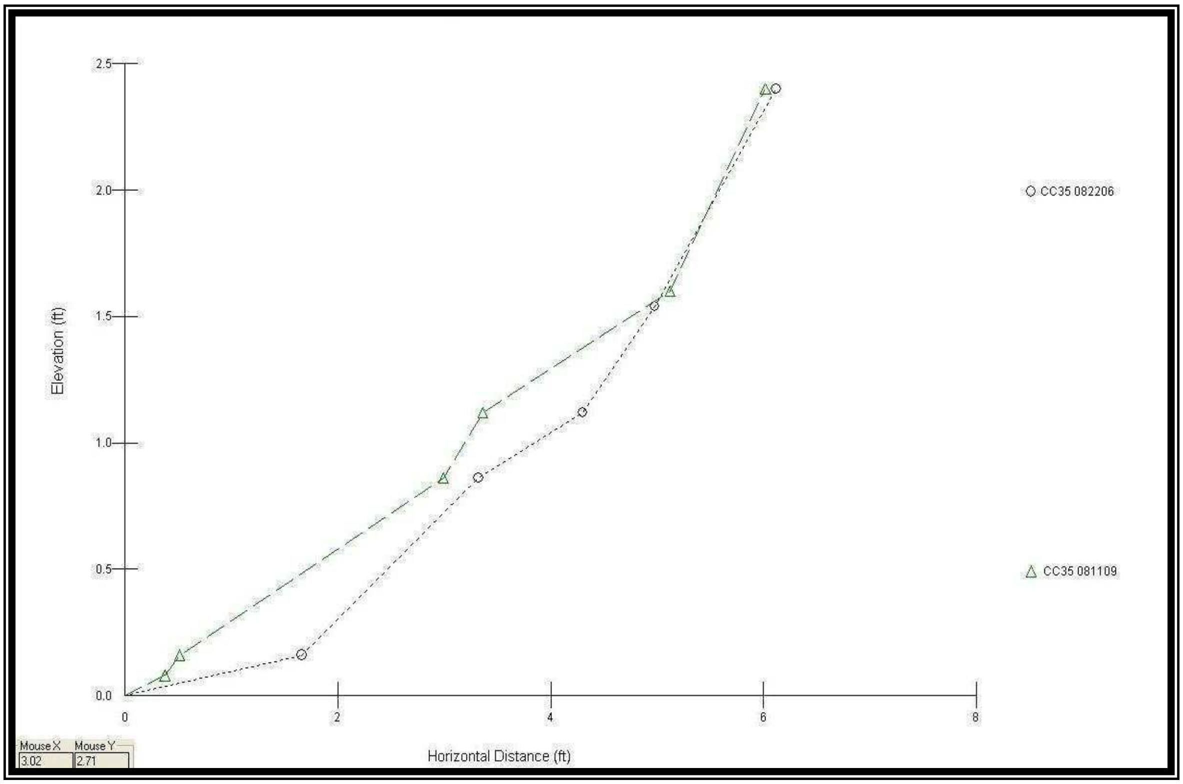
CR250

BEHI = Moderate   Erosion Rate = 0.031 ft/yr



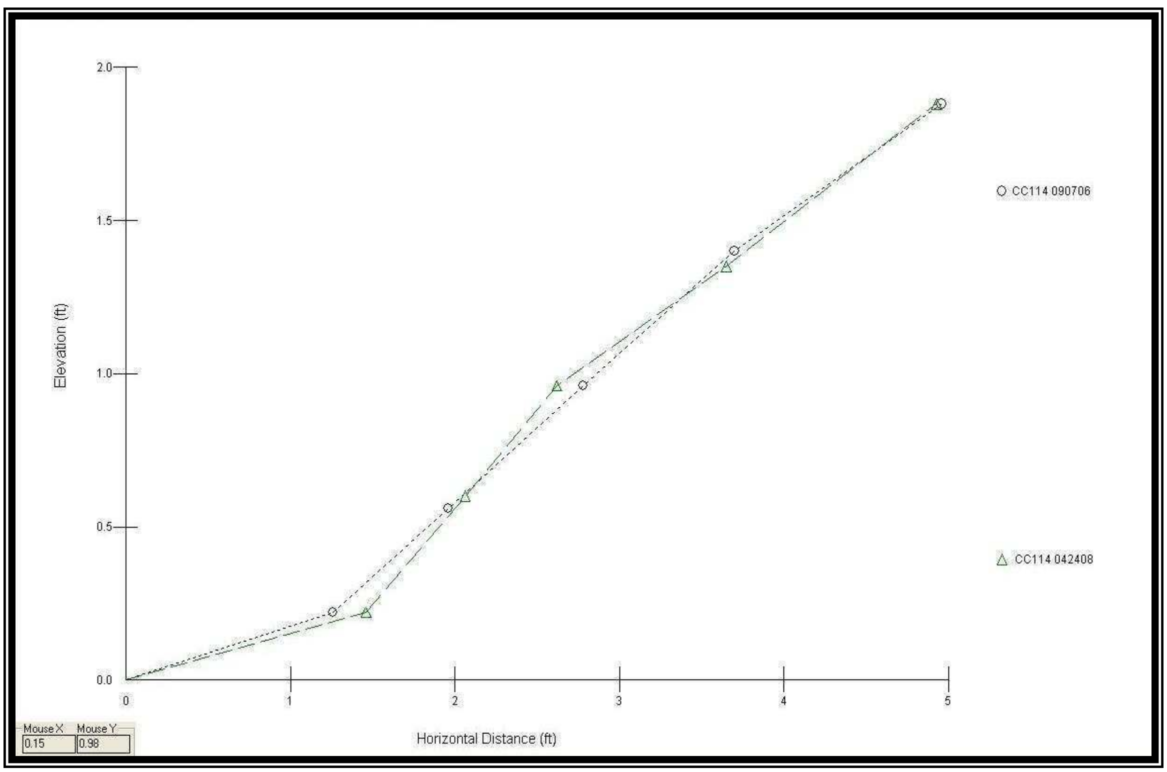
CC35

BEHI = Moderate   Erosion Rate = 0.14 ft/yr



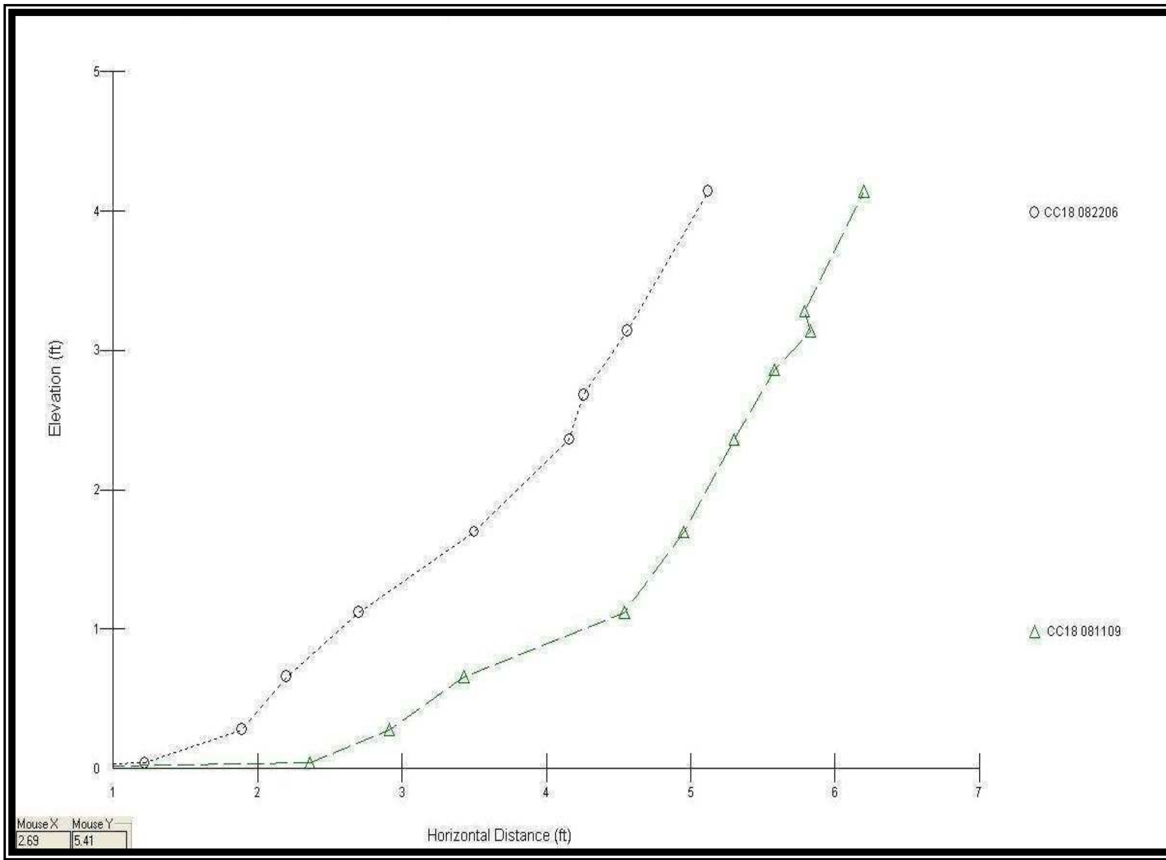
CC114

BEHI = Low   Erosion Rate = -0.062 ft/yr



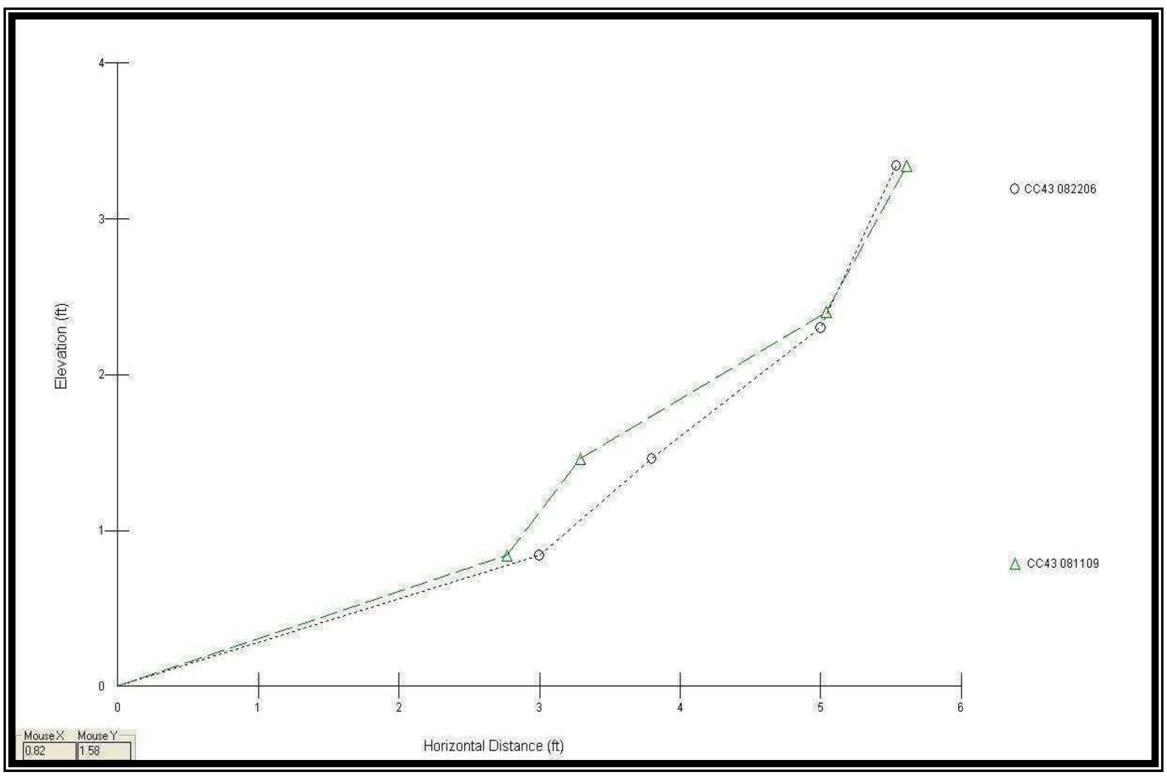
CC18

BEHI = High   Erosion Rate = -0.43 ft/yr



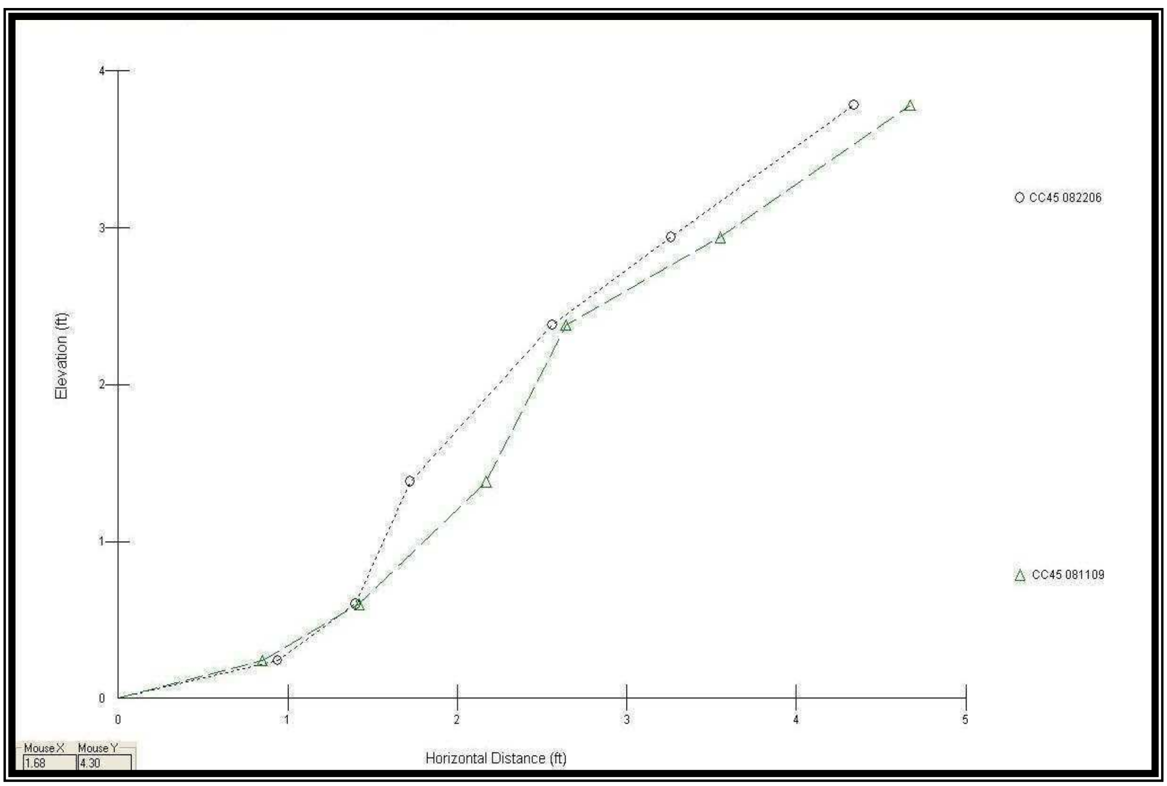
CC43

BEHI = High Erosion Rate = 0.058 ft/yr



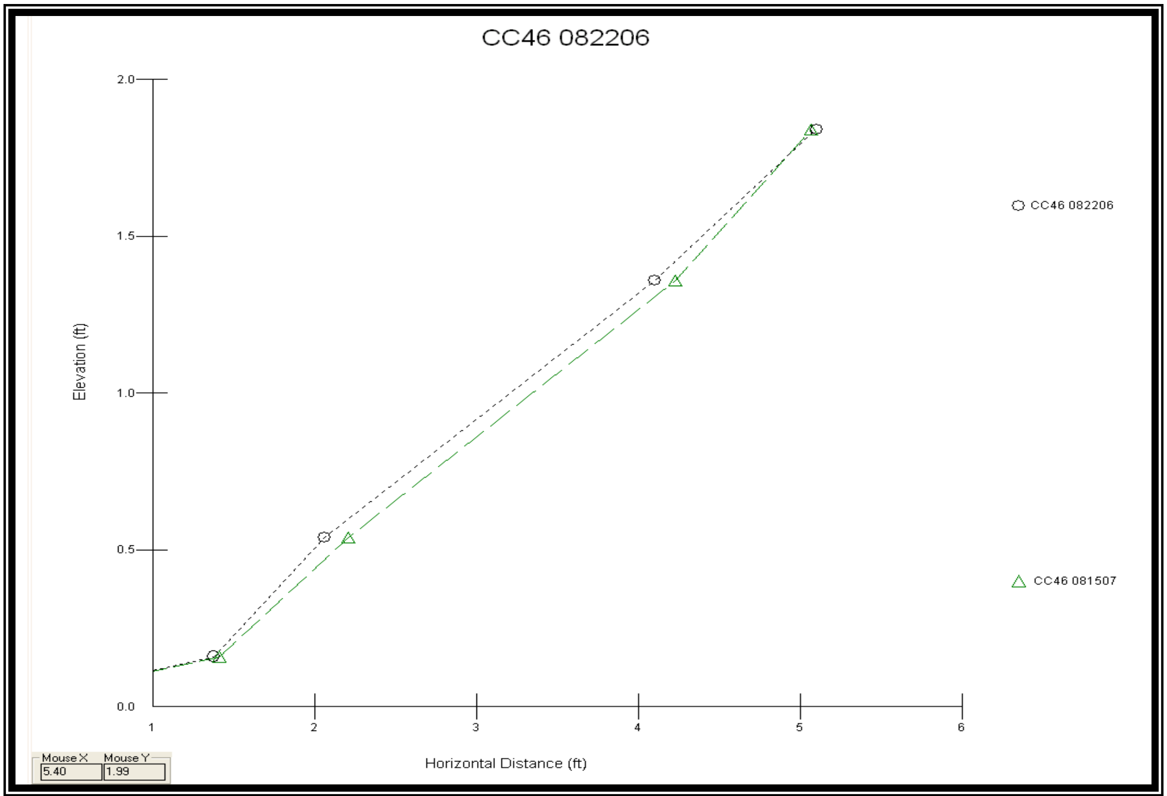
CC45

BEHI = High   Erosion Rate = -0.070 ft/yr



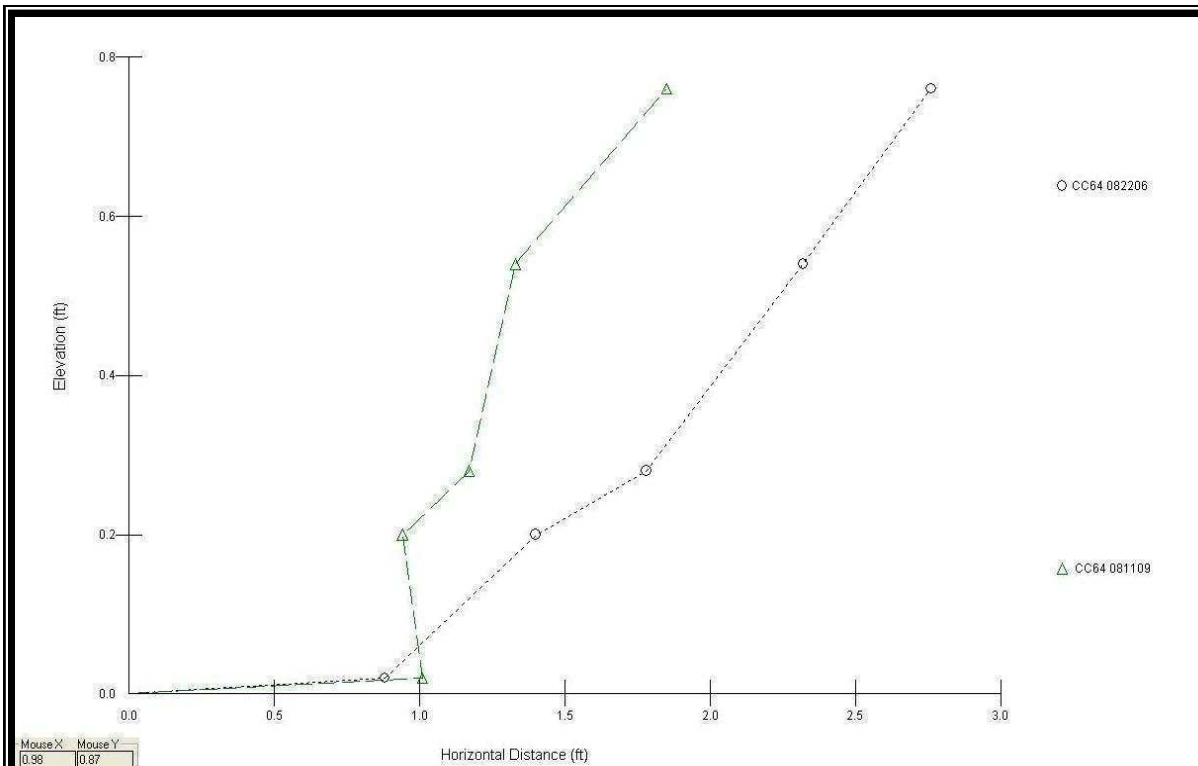
CC46

BEHI = High   Erosion Rate = -0.094 ft/yr



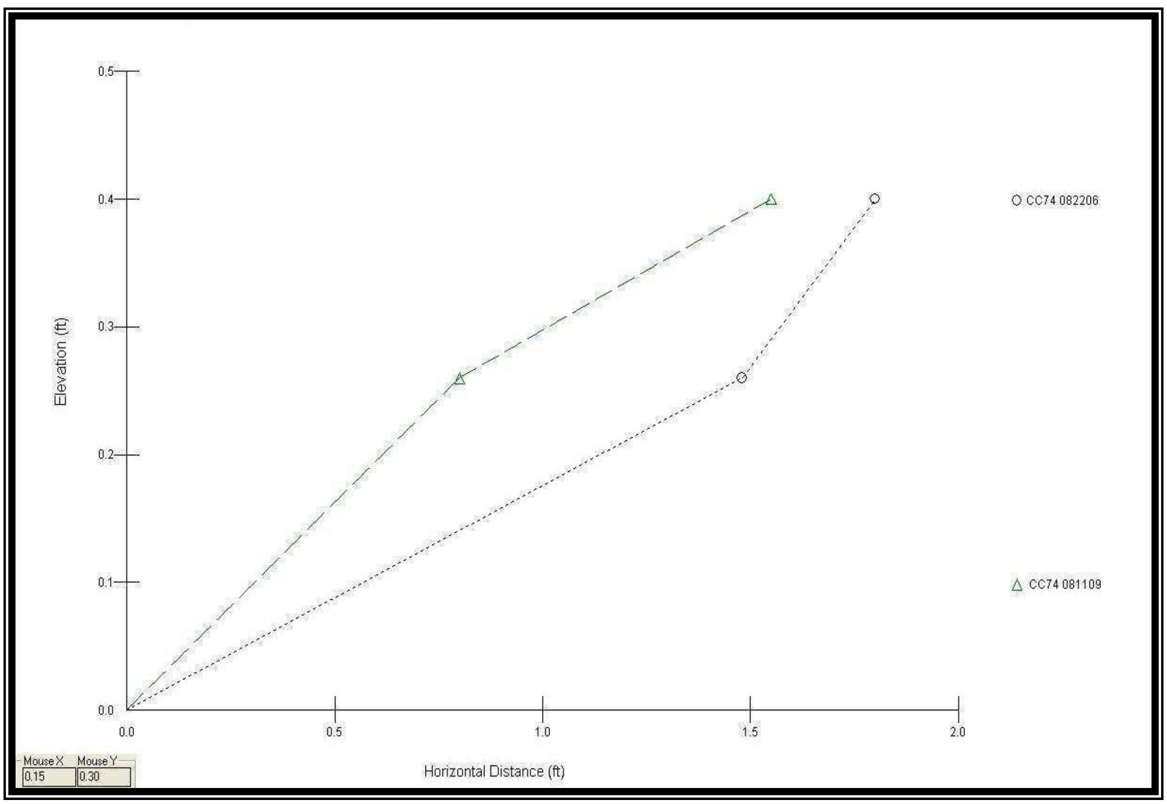
CC64

BEHI = Low   Erosion Rate = 0.22 ft/yr



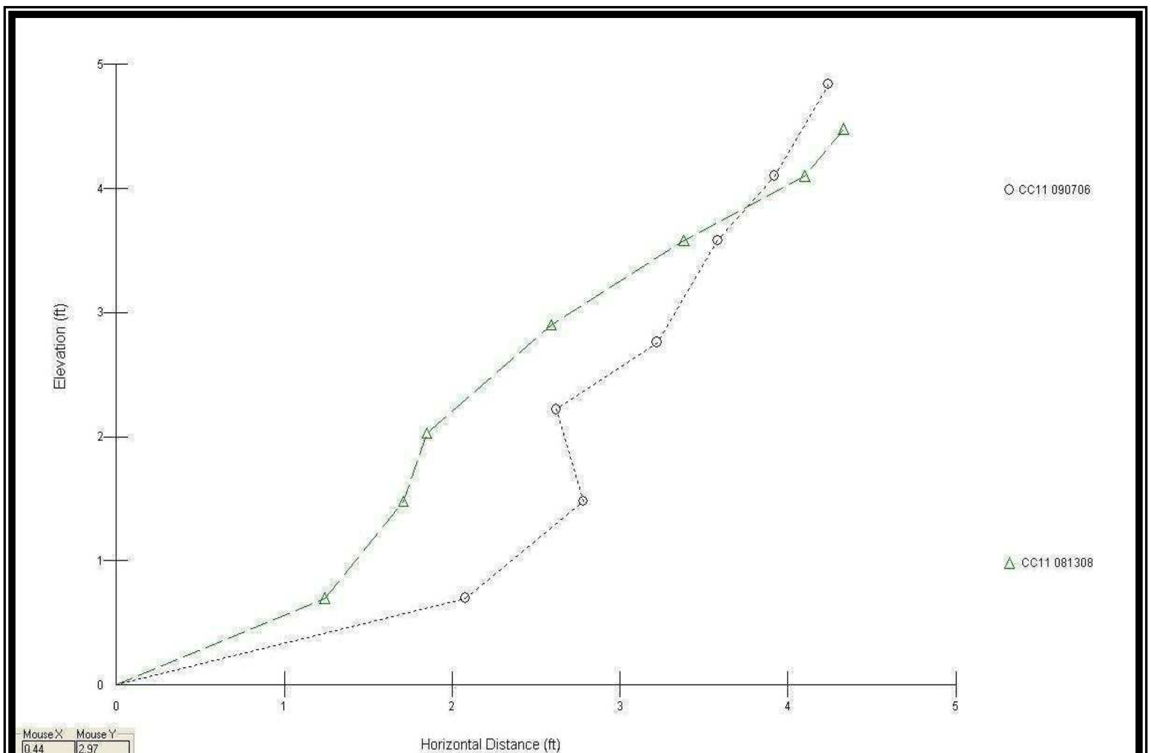
CC74

BEHI = Low   Erosion Rate = 0.13 ft/yr



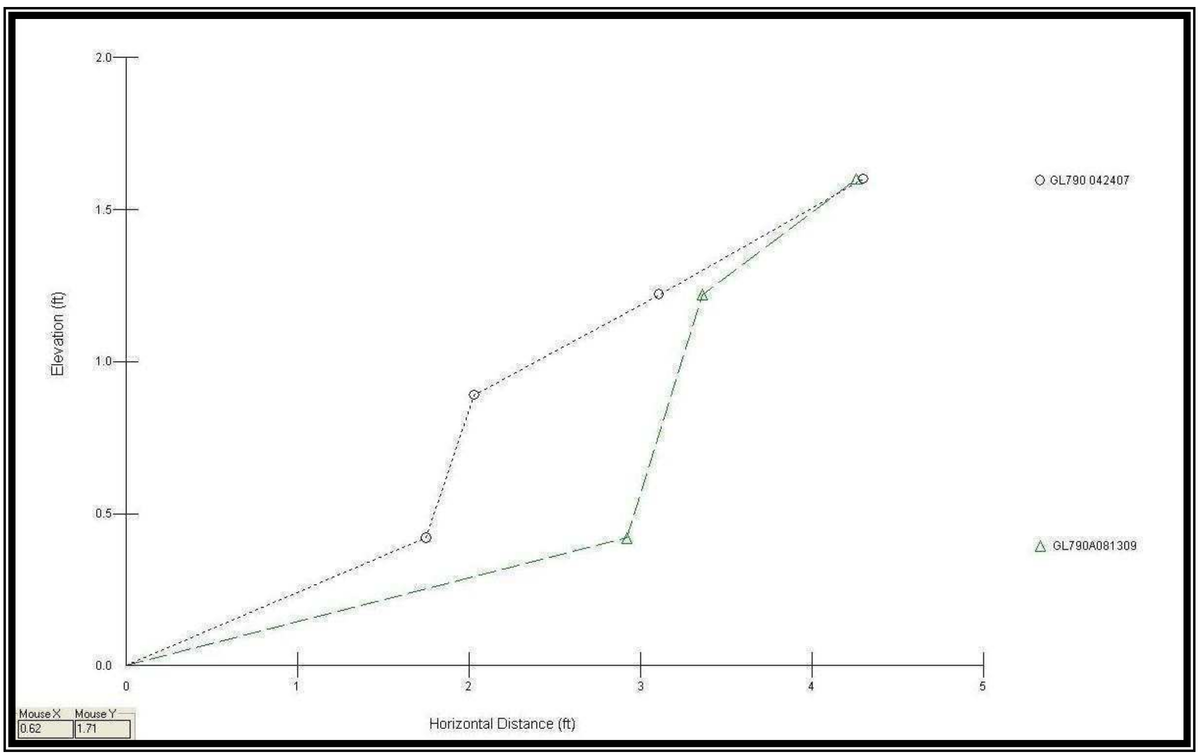
CC11

BEHI = High   Erosion Rate = 0.45 ft/yr



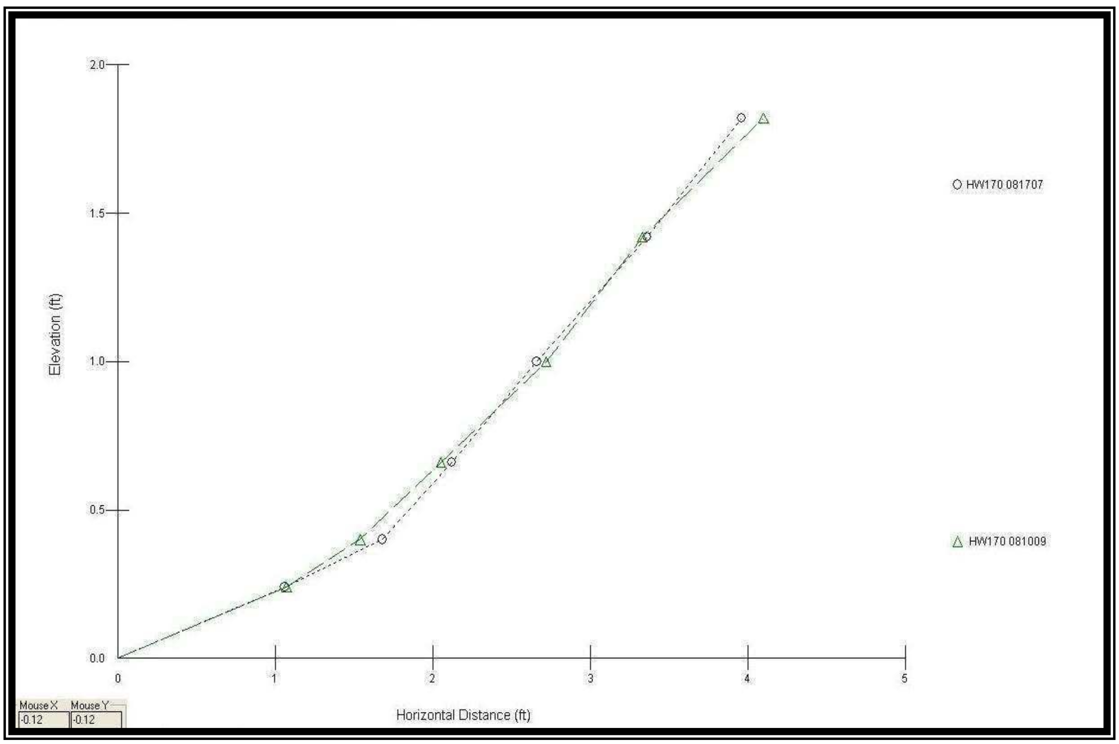
GL790

BEHI = Low   Erosion Rate = -0.29 ft/yr



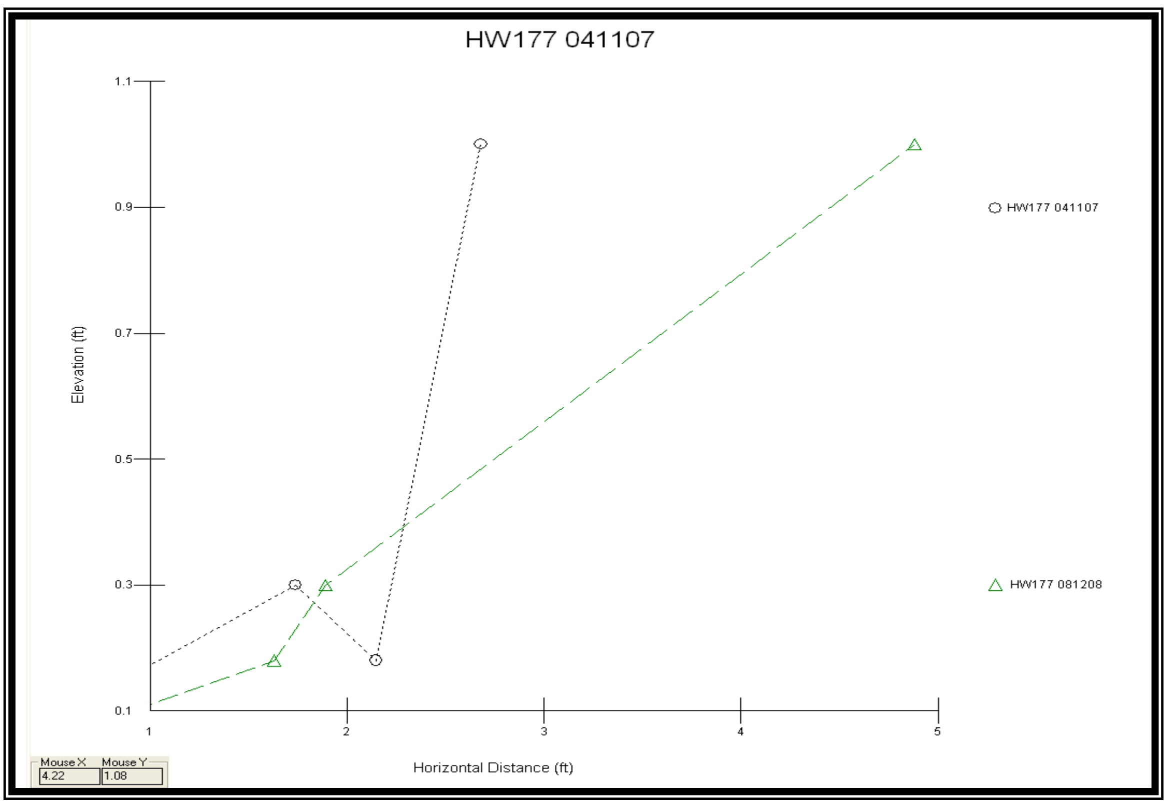
HW170

BEHI = Low   Erosion Rate = 0.0028 ft/yr



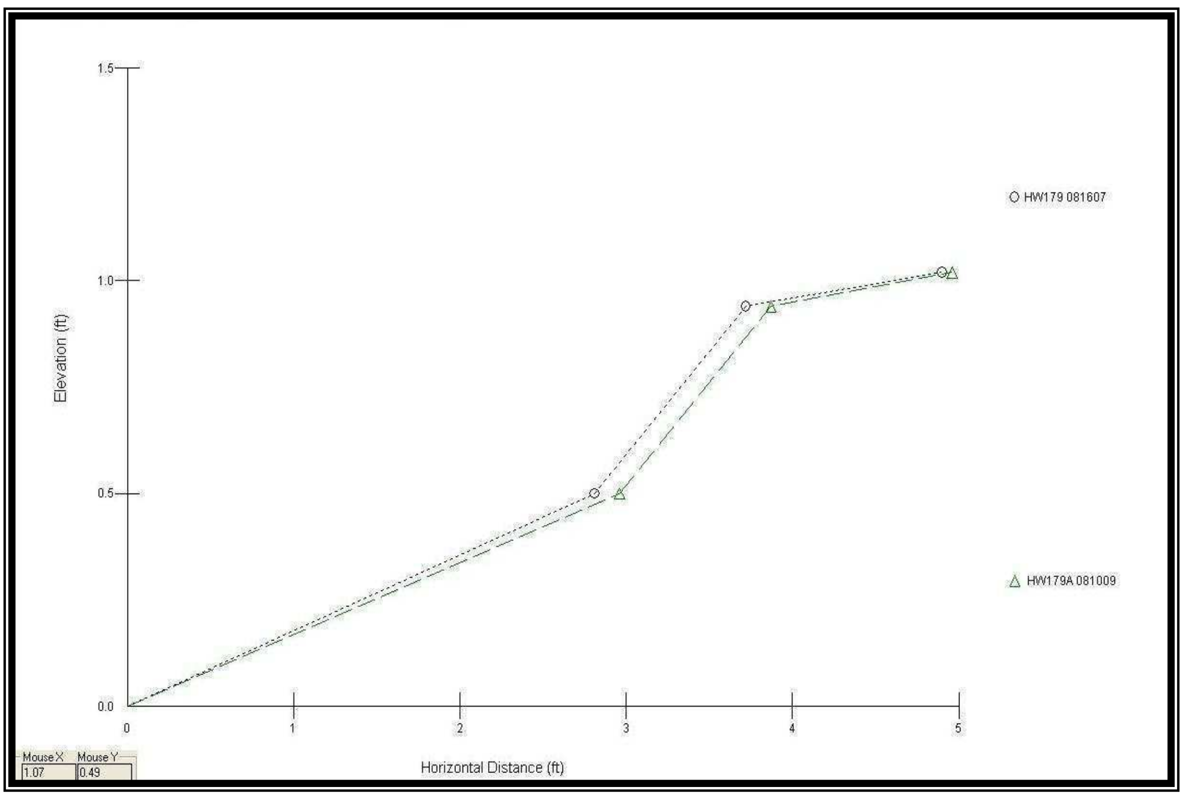
HW177

BEHI = Moderate   Erosion Rate = -0.54 ft/yr



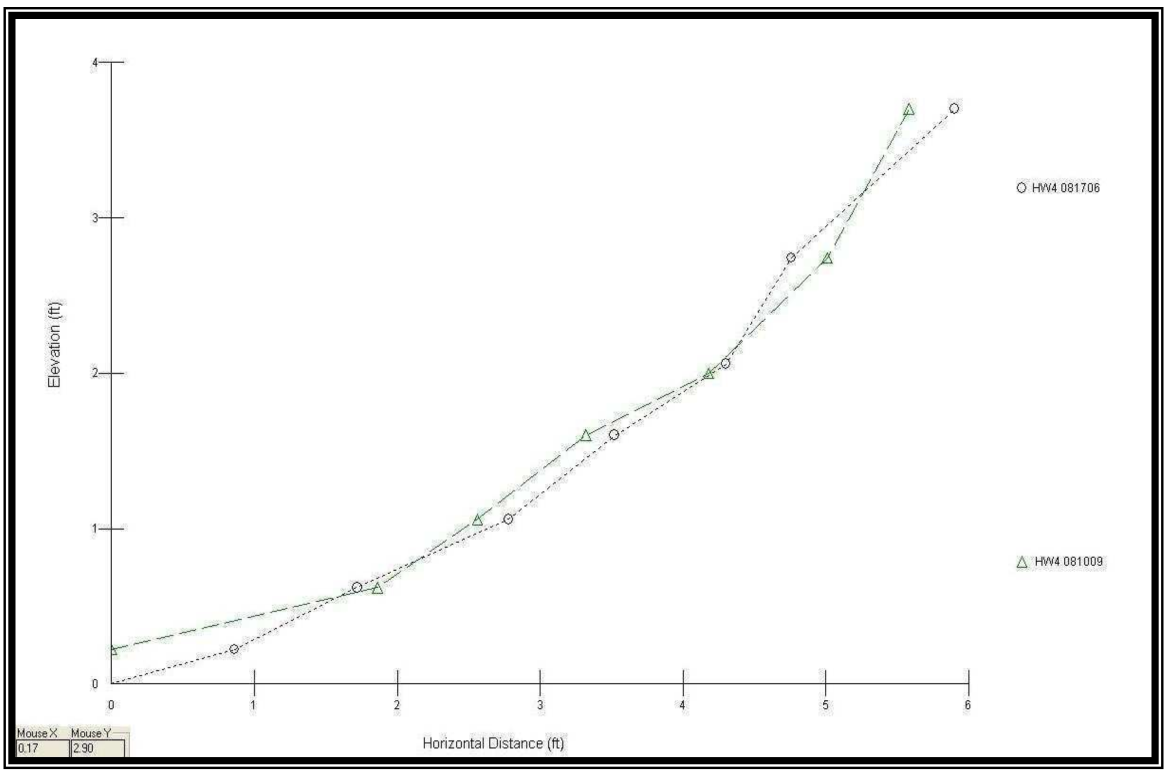
HW179

BEHI = Low   Erosion Rate = -0.059 ft/yr



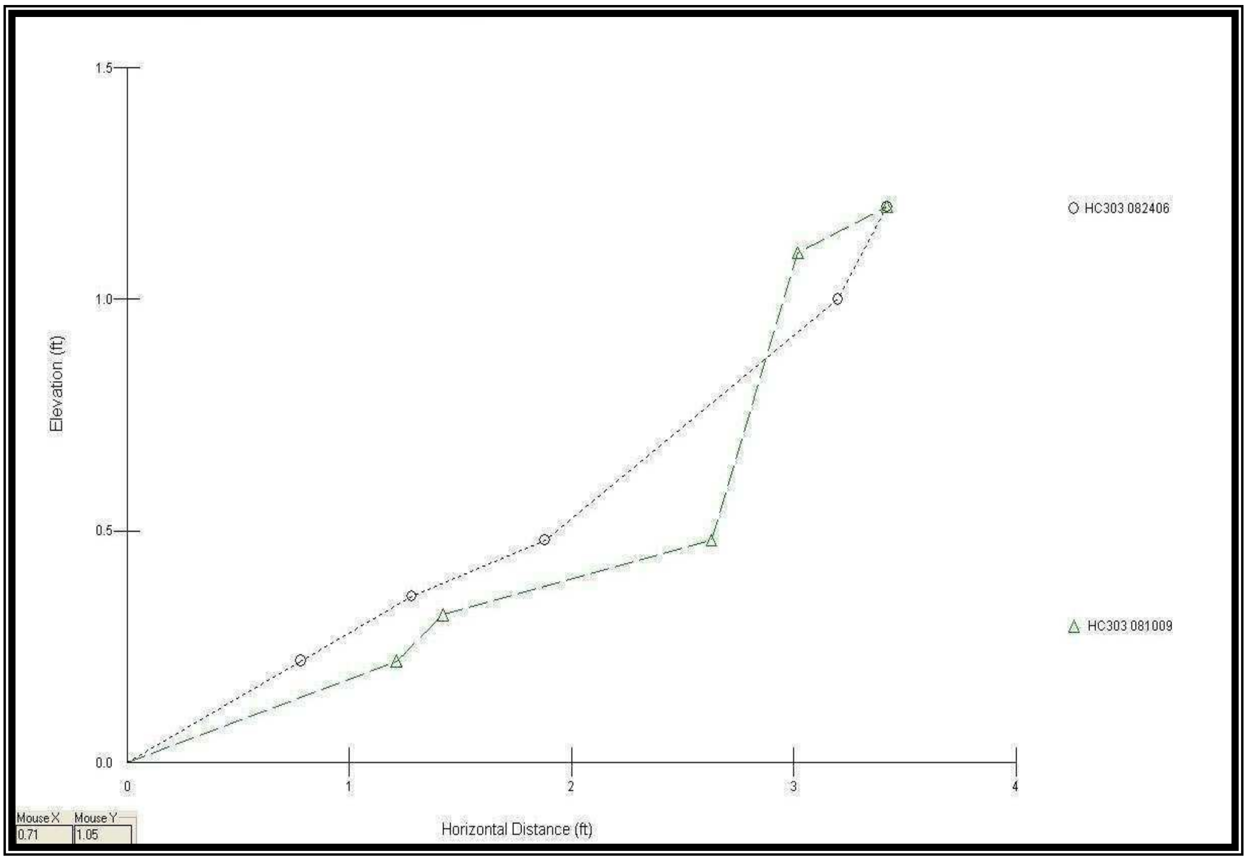
HW4

BEHI = Very High   Erosion Rate = 0.034 ft/yr



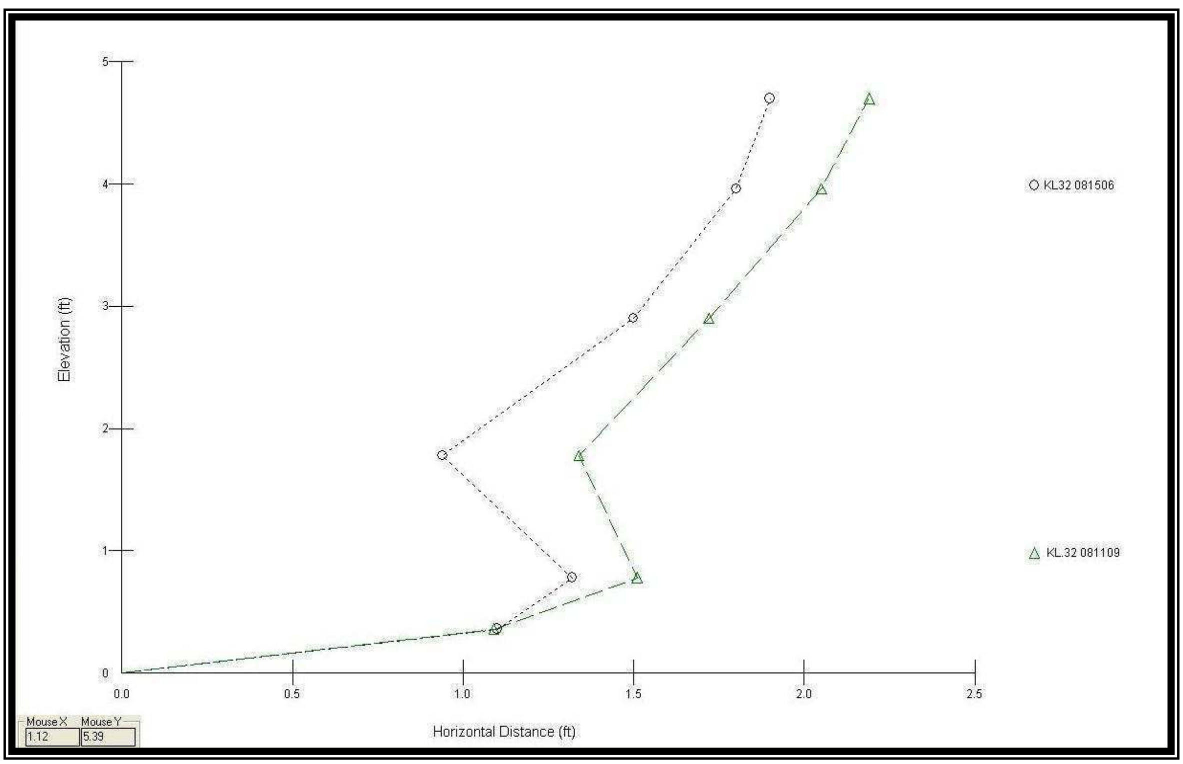
HC303

BEHI = Low   Erosion Rate = -0.073 ft/yr



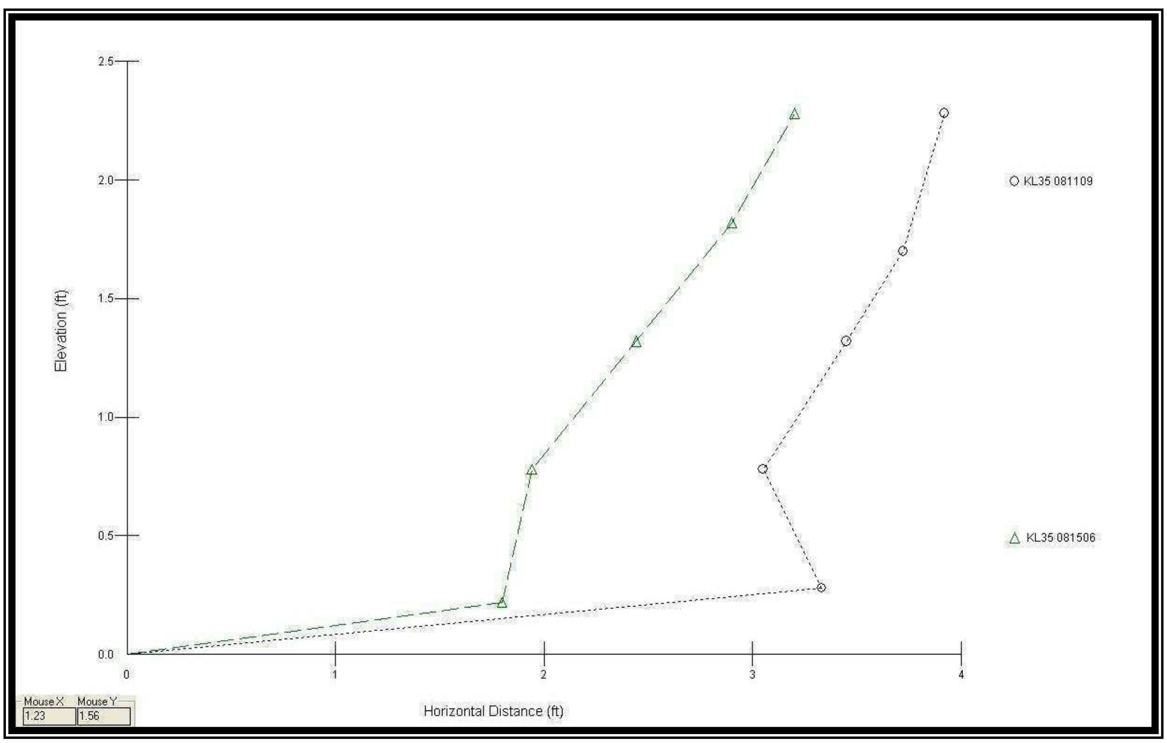
KL32

BEHI = High   Erosion Rate = -0.080 ft/yr



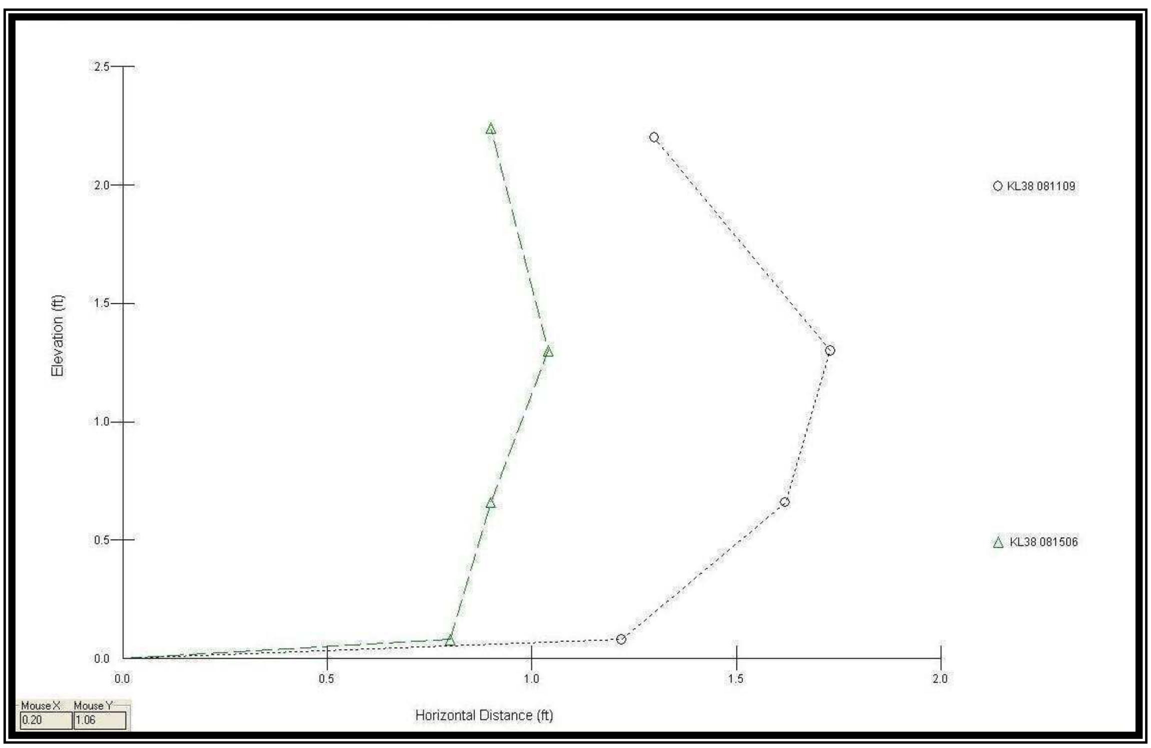
KL35

BEHI = Very High   Erosion Rate = -0.33 ft/yr



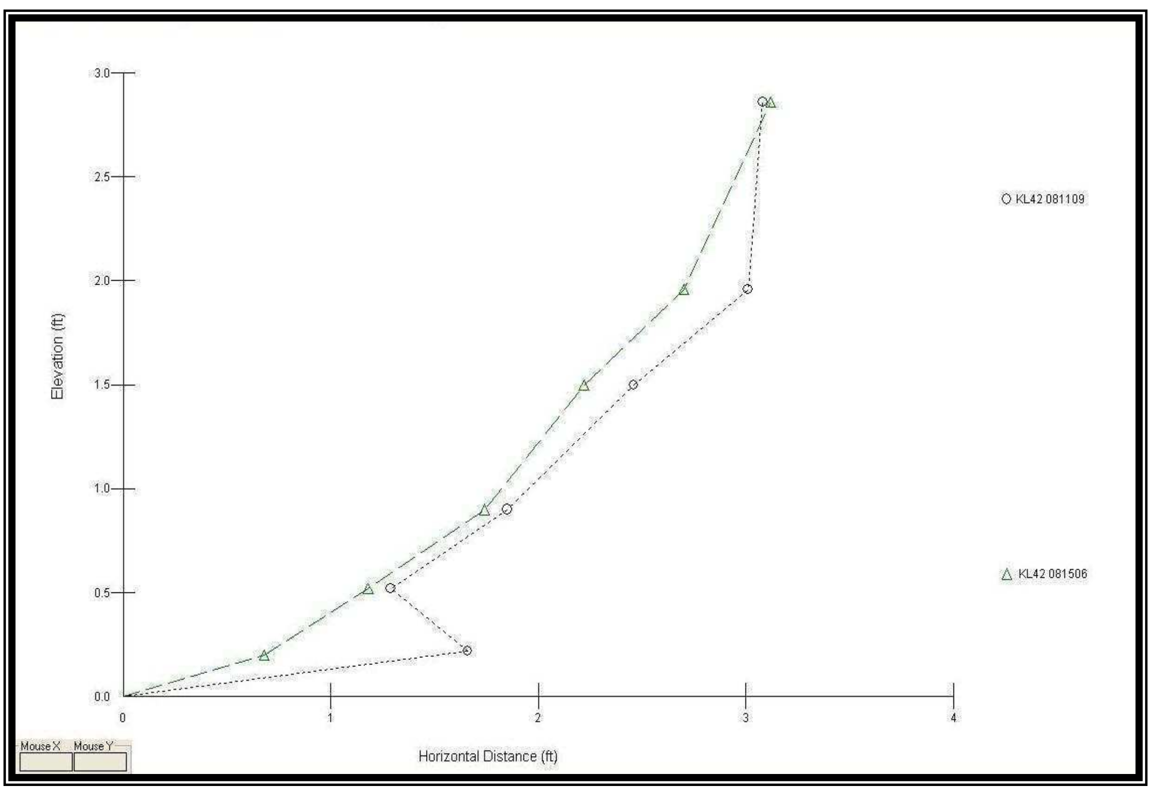
KL38

BEHI = High   Erosion Rate = -0.19 ft/yr



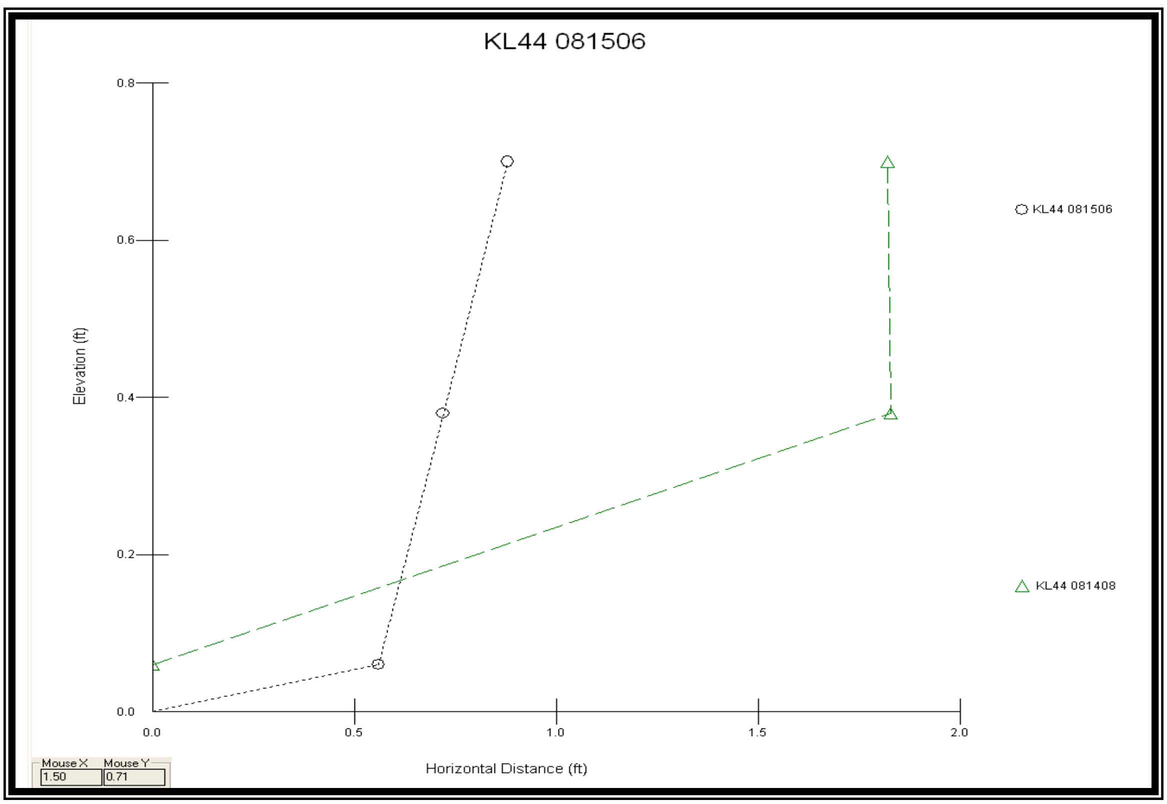
KL42

BEHI = Very High   Erosion Rate = -0.076 ft/yr



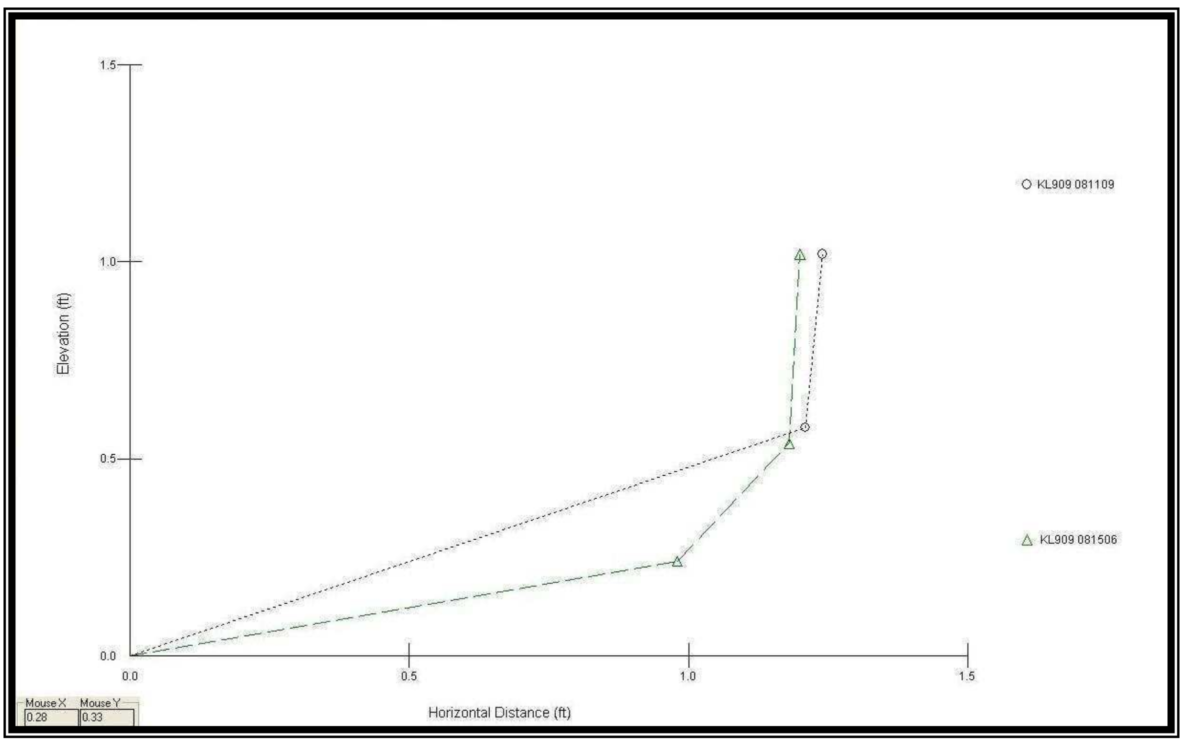
KL44

BEHI = High   Erosion Rate = -0.29 ft/yr



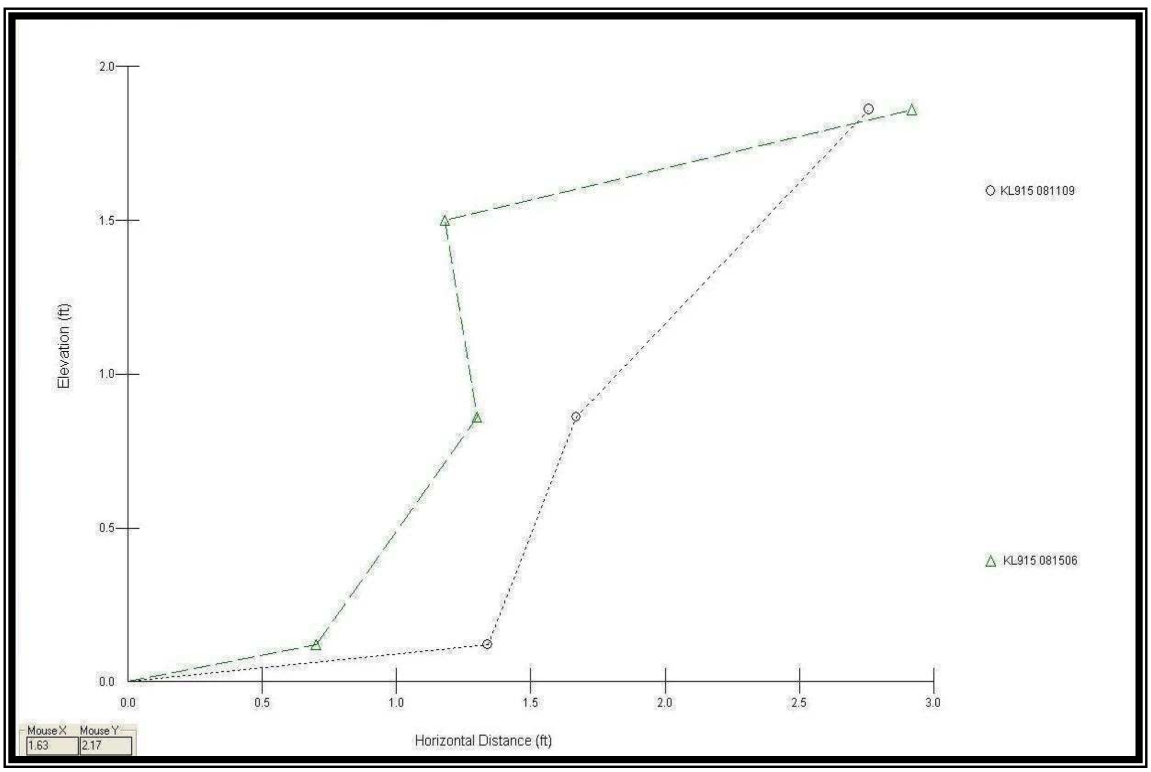
KL909

BEHI = Low   Erosion Rate = 0.039 ft/yr



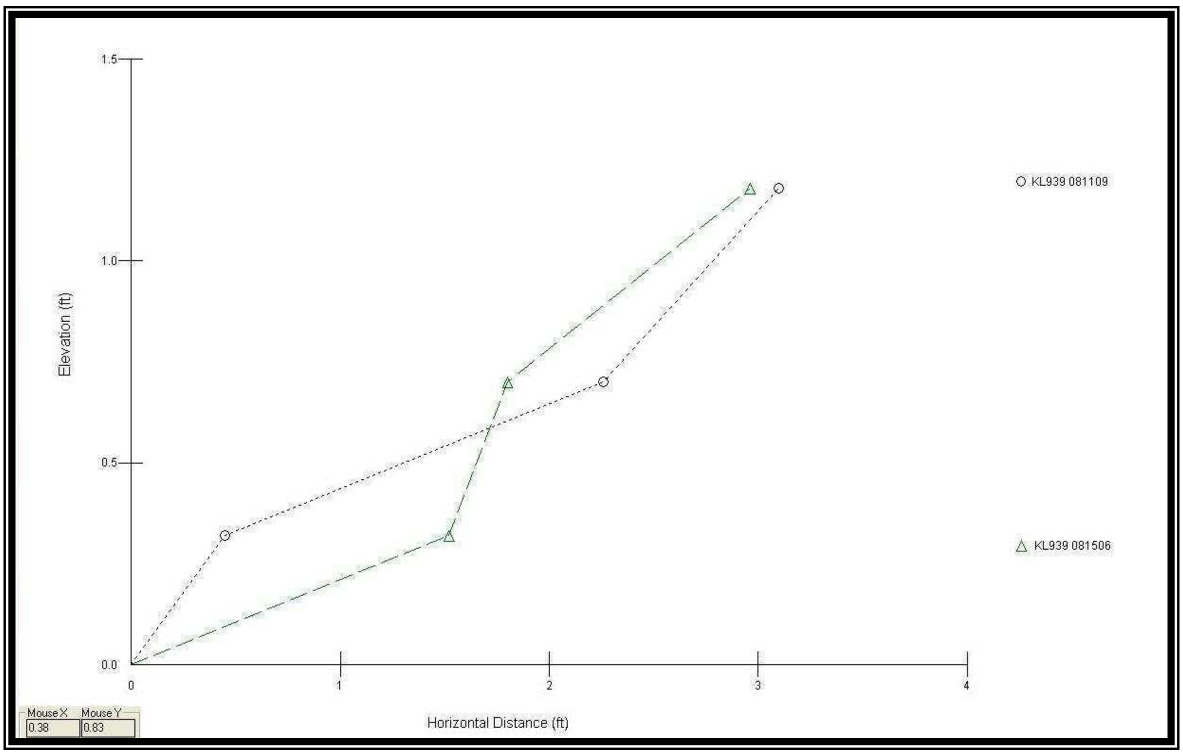
KL915

BEHI = Moderate   Erosion Rate = -0.12 ft/yr



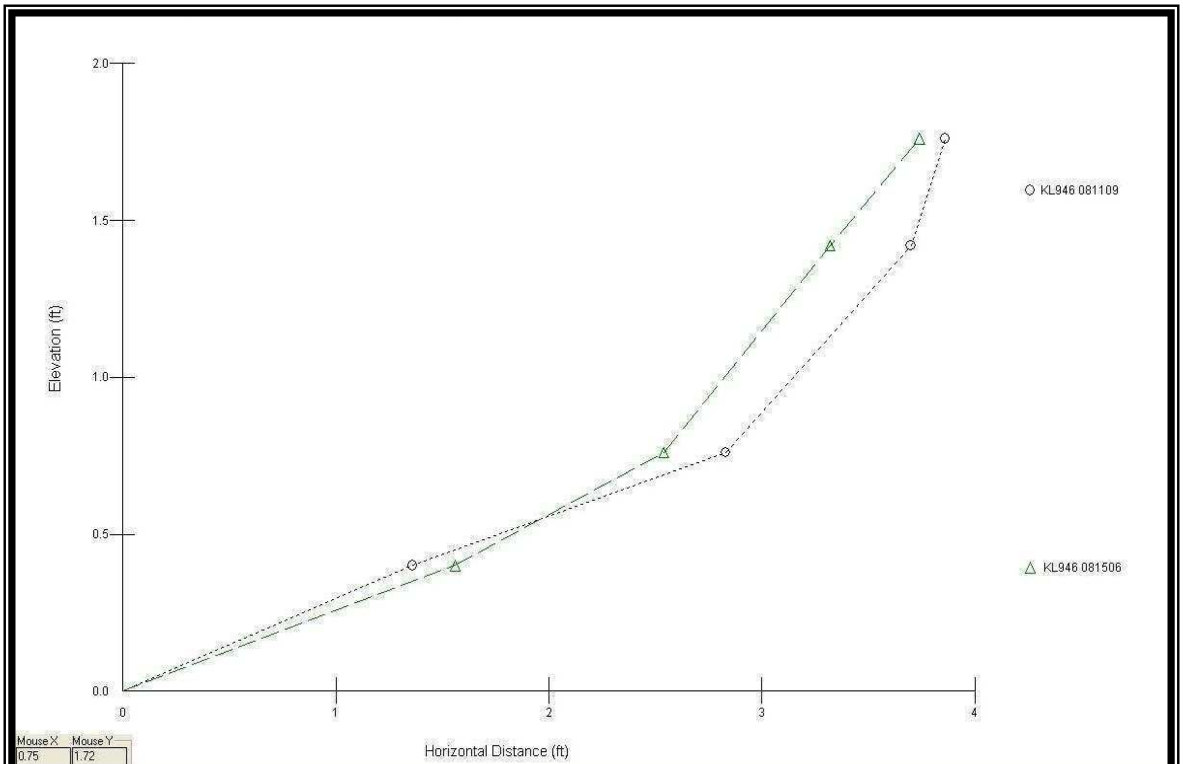
KL939

BEHI = Low Erosion Rate = 0.042 ft/yr



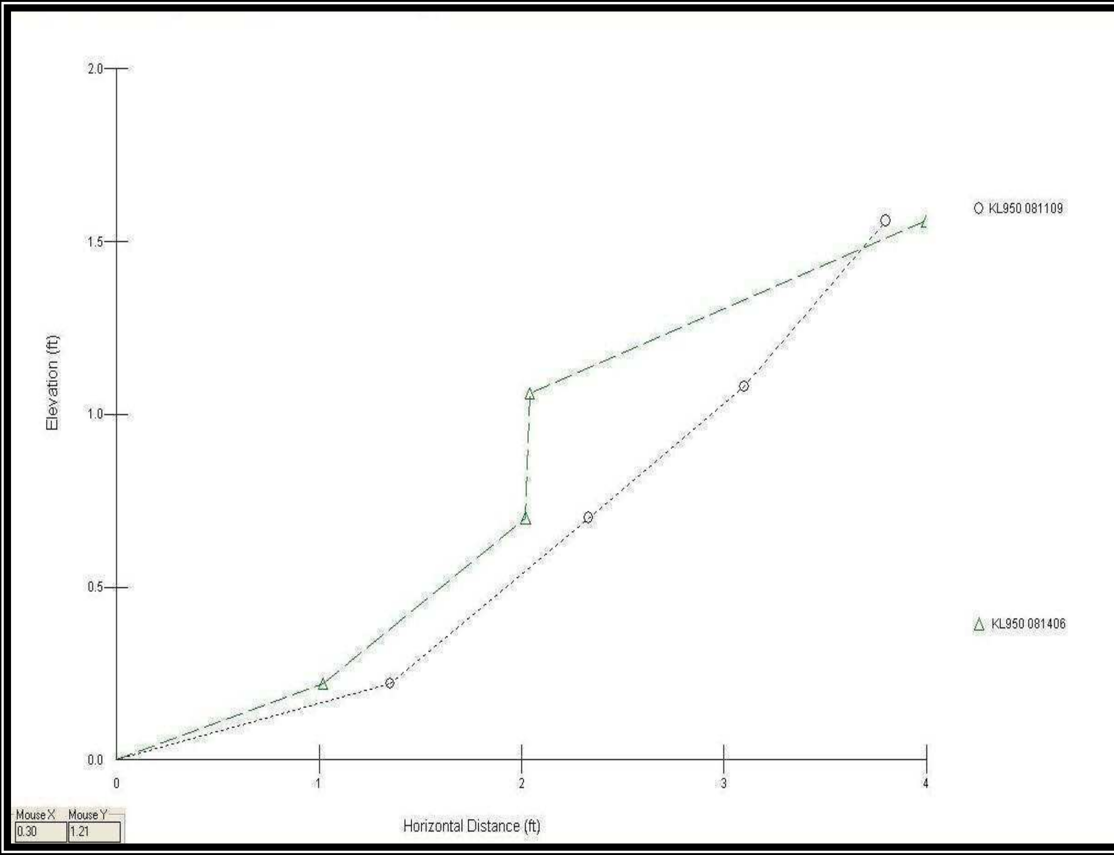
KL946

BEHI = Low   Erosion Rate = -0.055 ft/yr



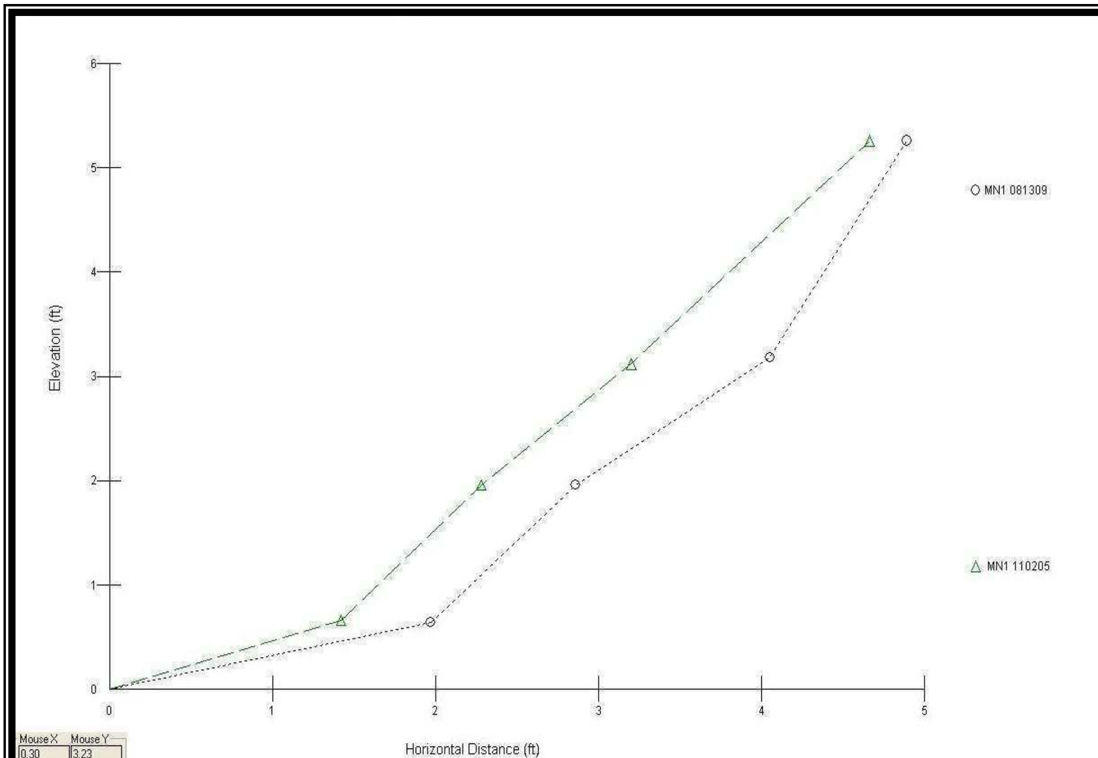
KL950

BEHI = Low   Erosion Rate = -0.14 ft/yr



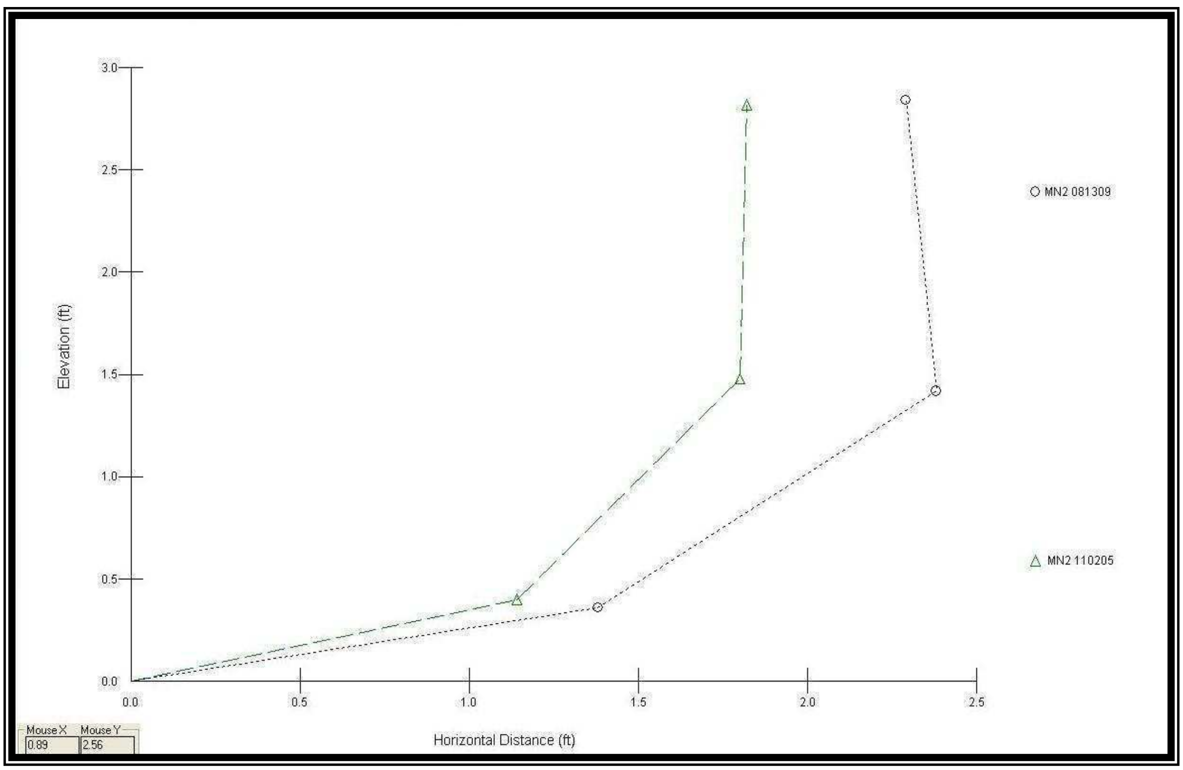
MN1

BEHI = Moderate   Erosion Rate = -0.14 ft/yr



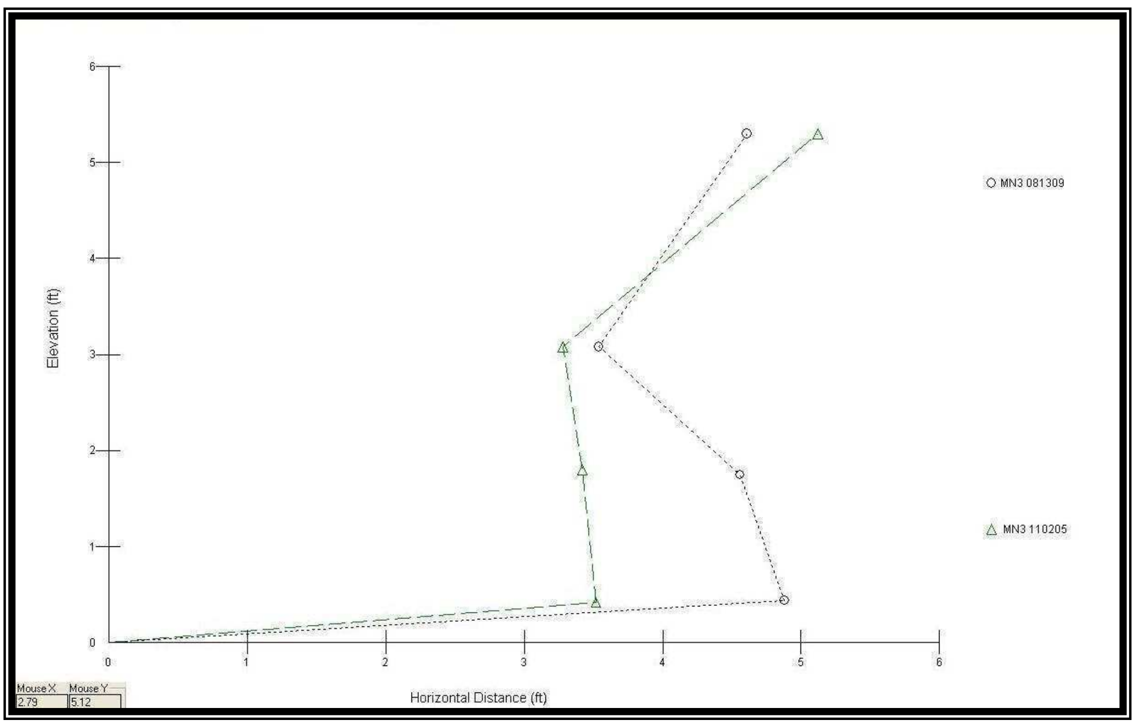
MN2

BEHI = Moderate   Erosion Rate = -0.12 ft/yr



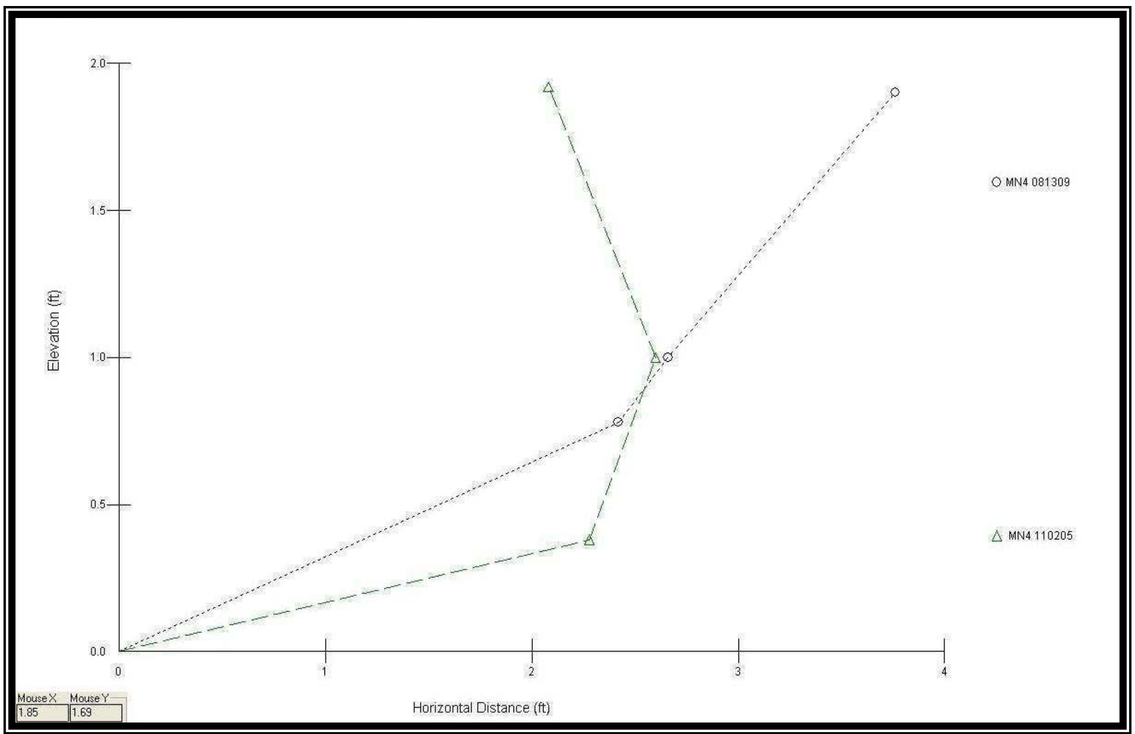
MN3

BEHI = High   Erosion Rate = -0.13 ft/yr



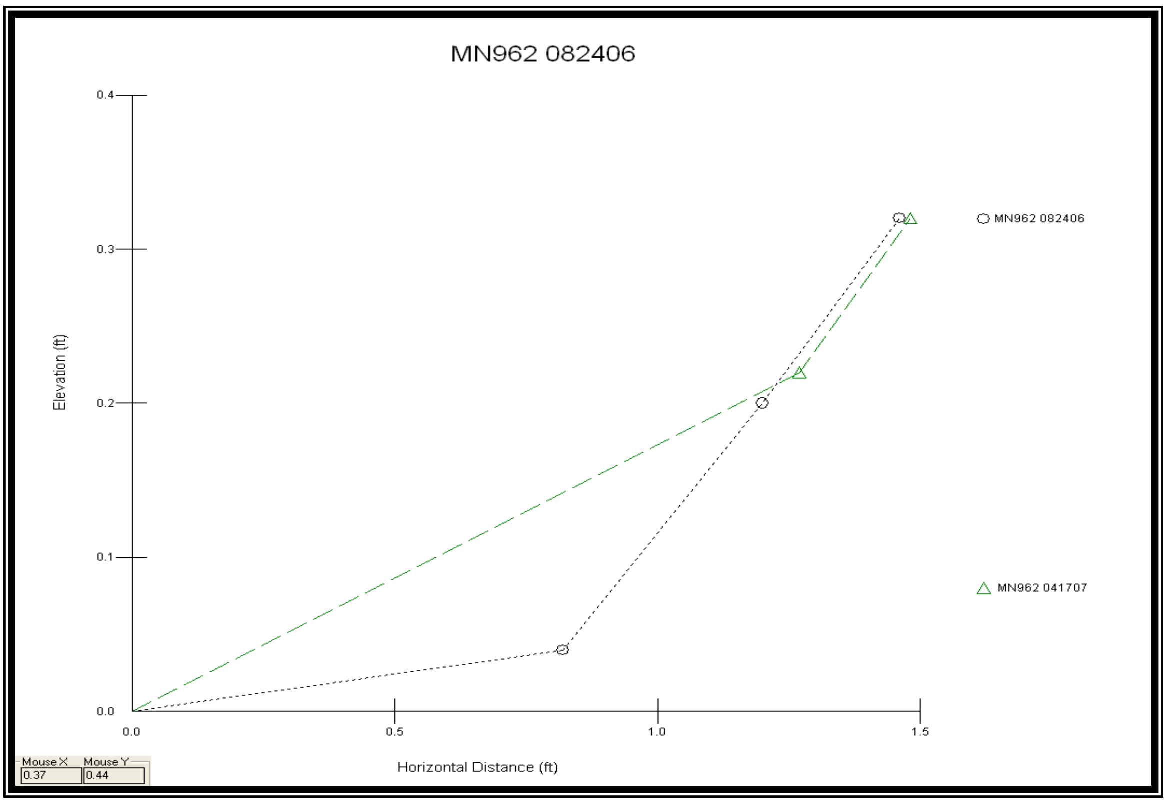
MN4

BEHI = Moderate   Erosion Rate = 0.040 ft/yr



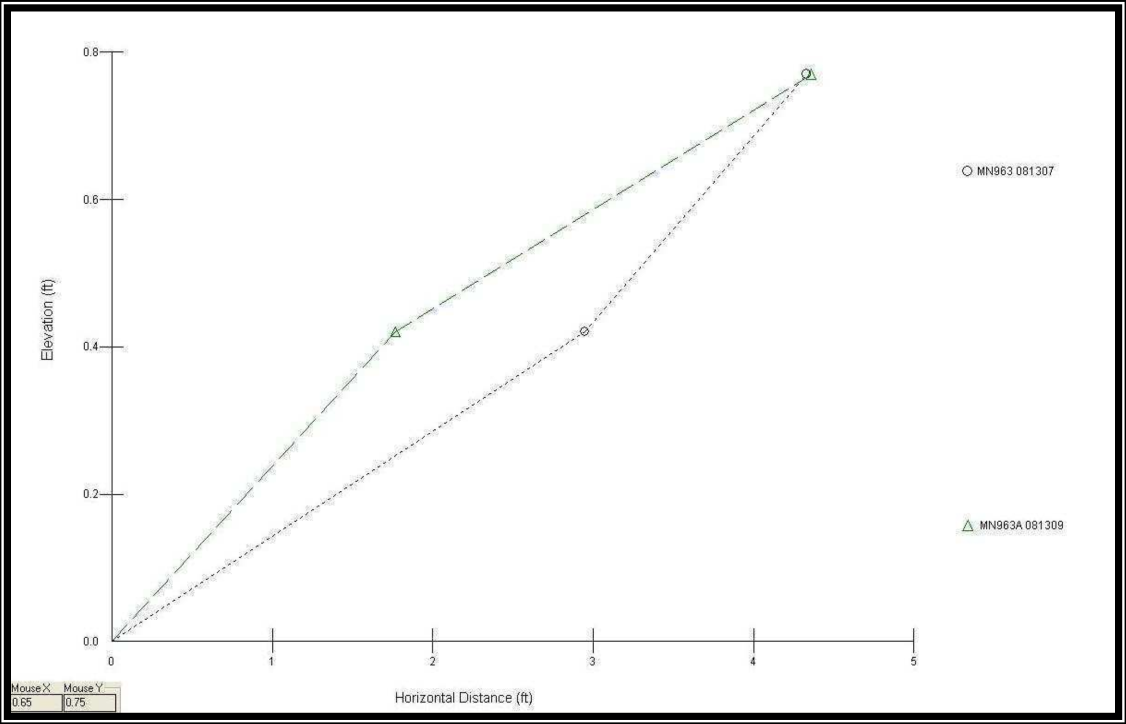
MN962

BEHI = Low   Erosion Rate = 0.095 ft/yr



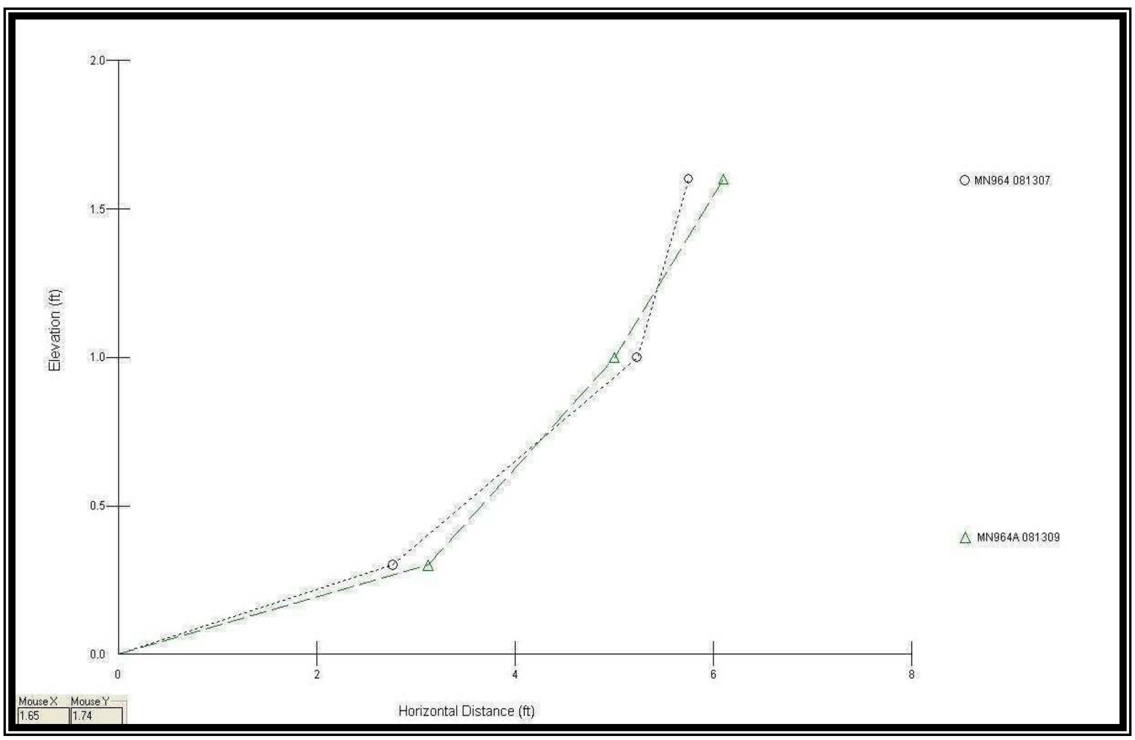
MN963

BEHI = Low   Erosion Rate = 0.29 ft/yr



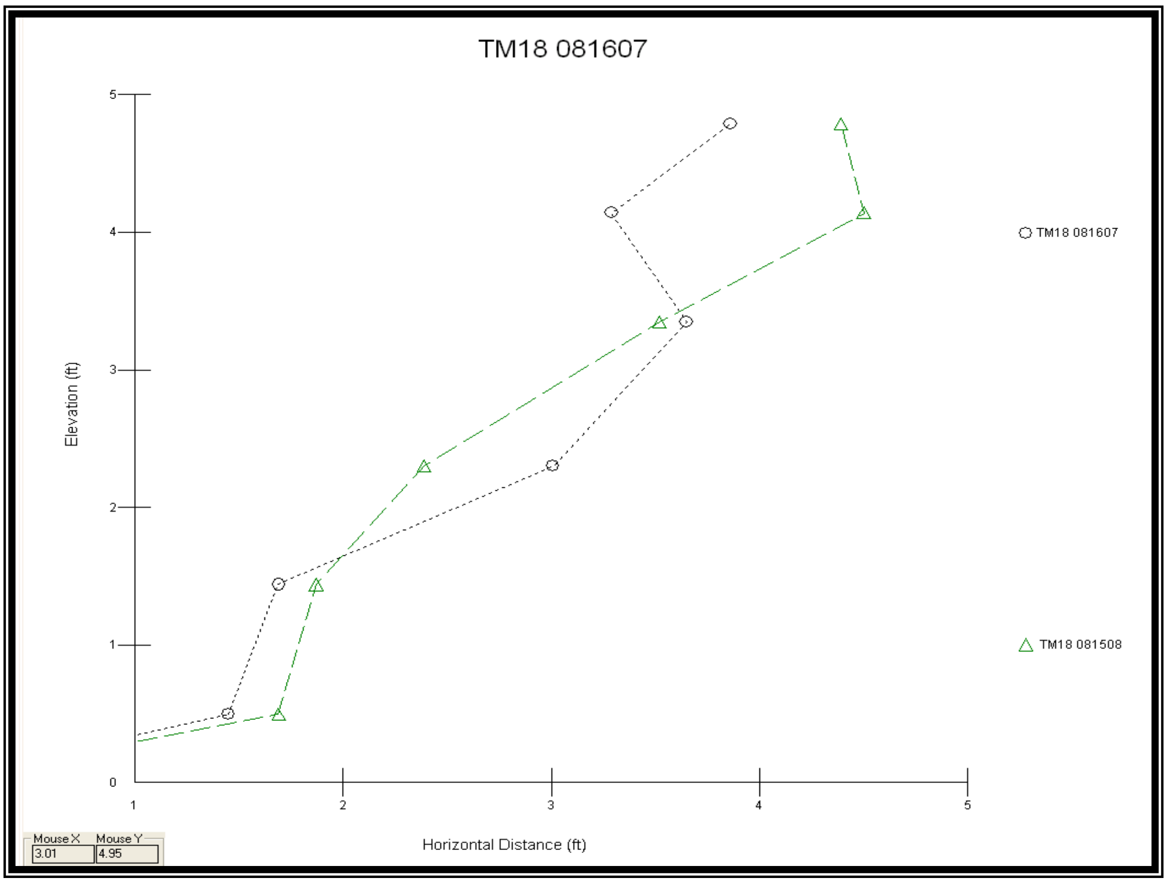
MN964

BEHI = Low   Erosion Rate = -0.041 ft/yr



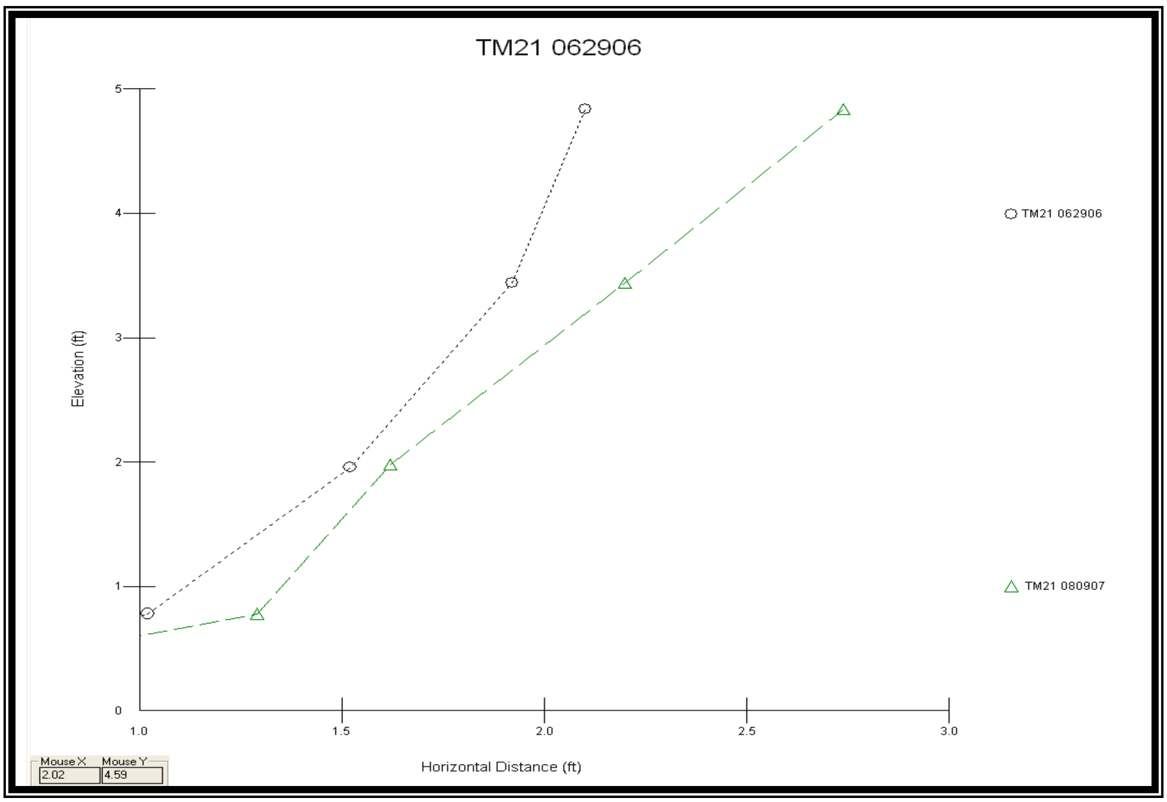
TM18

BEHI = Moderate   Erosion Rate = -0.14 ft/yr



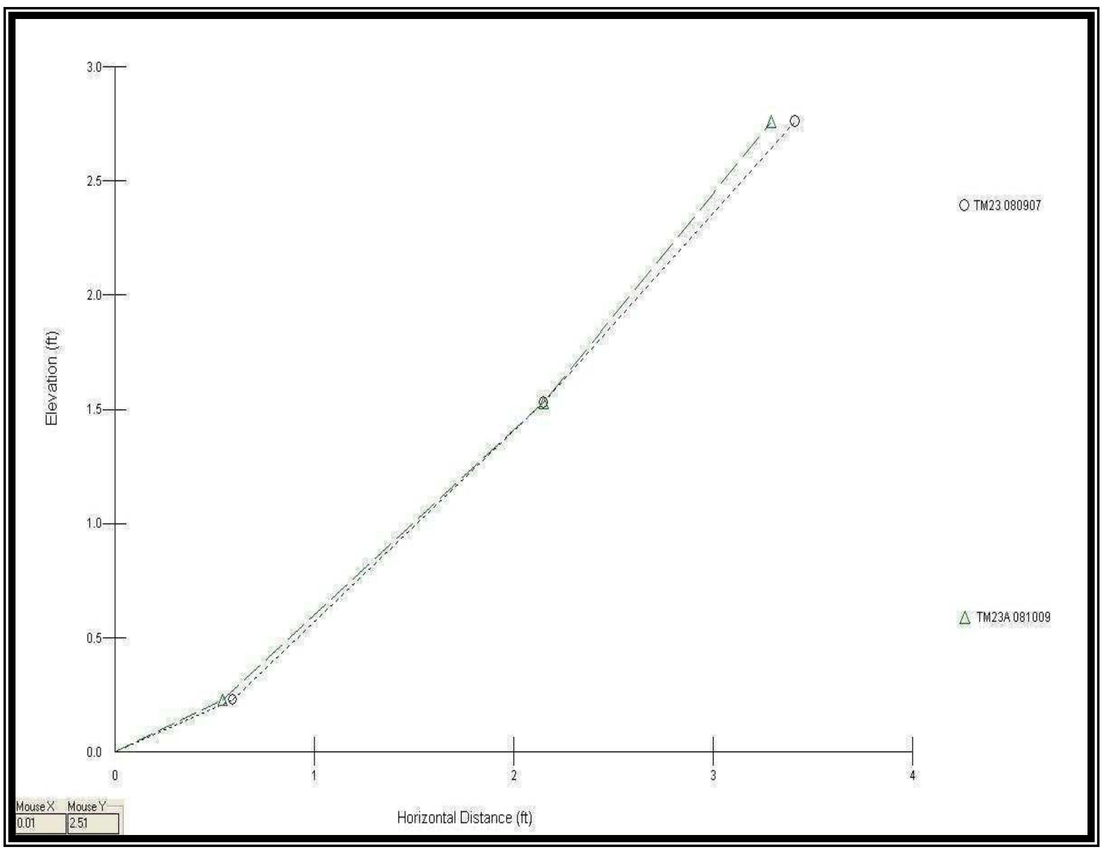
TM21

BEHI = Very High   Erosion Rate = -0.23 ft/yr



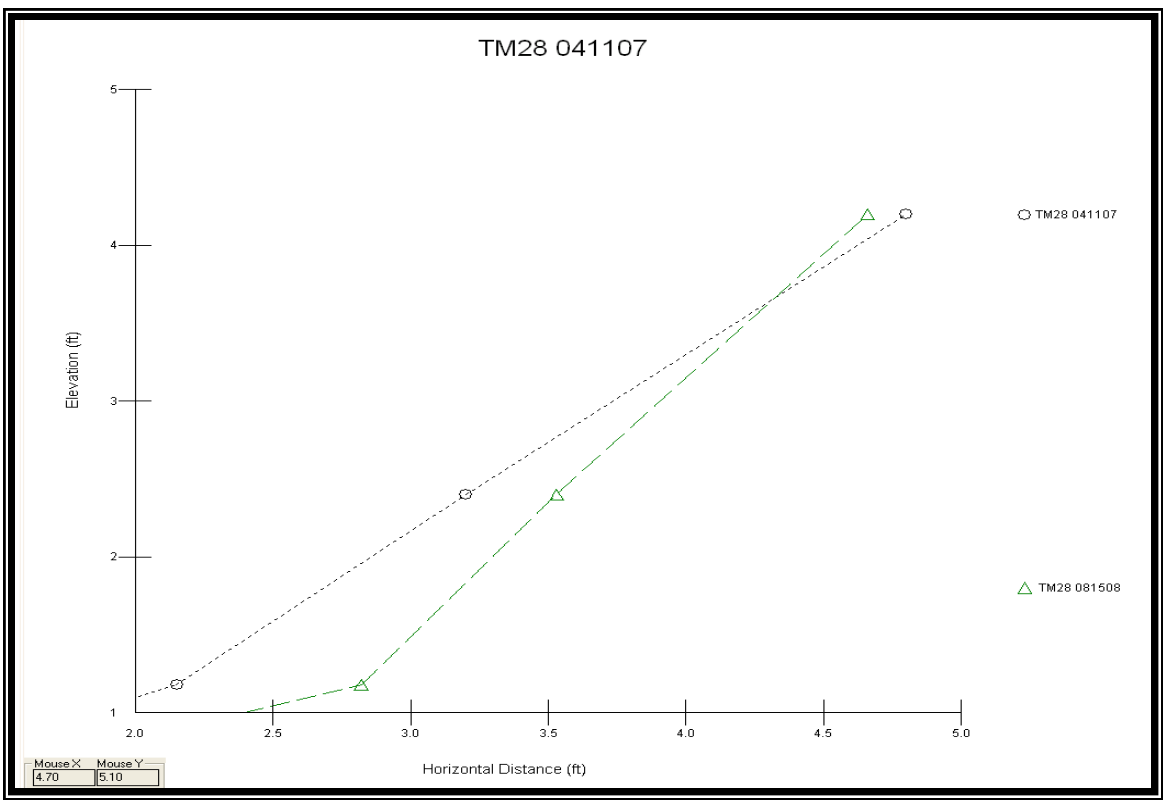
TM23

BEHI = Moderate   Erosion Rate = 0.020 ft/yr



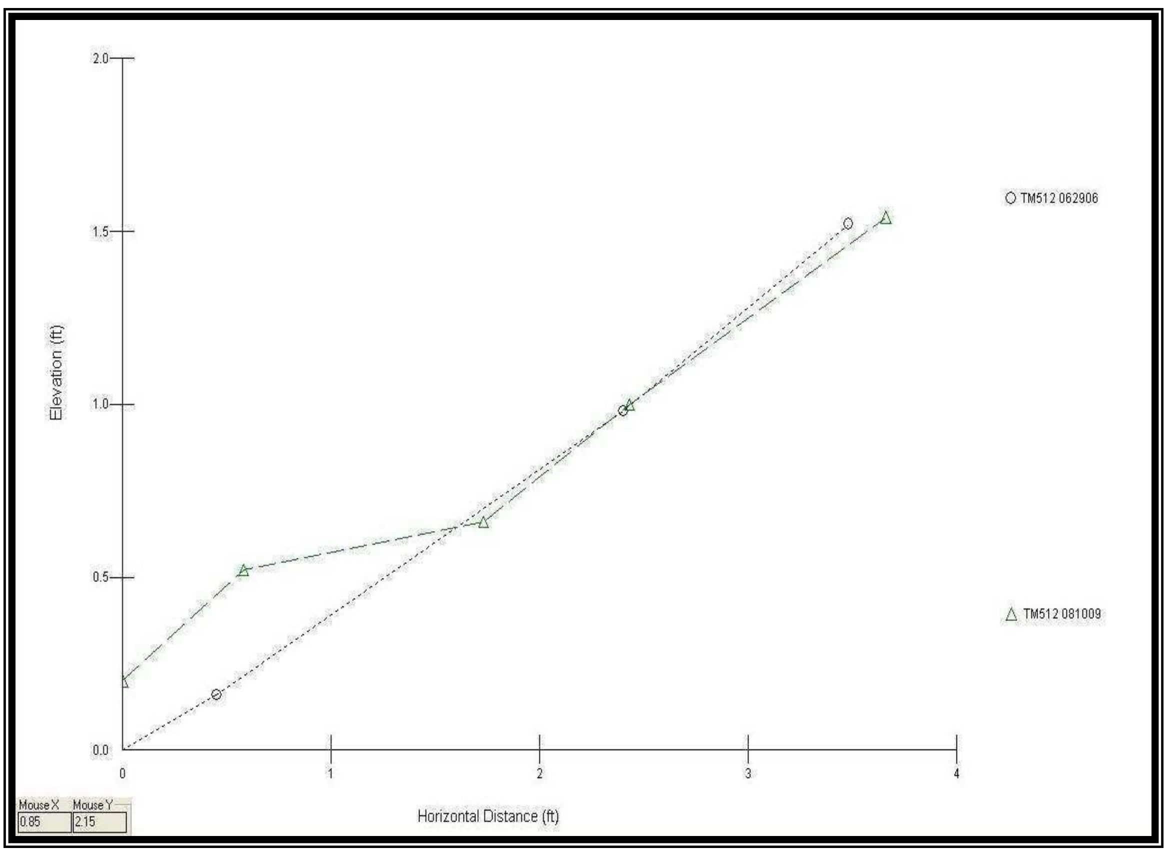
TM28

BEHI = Moderate   Erosion Rate = -0.21 ft/yr



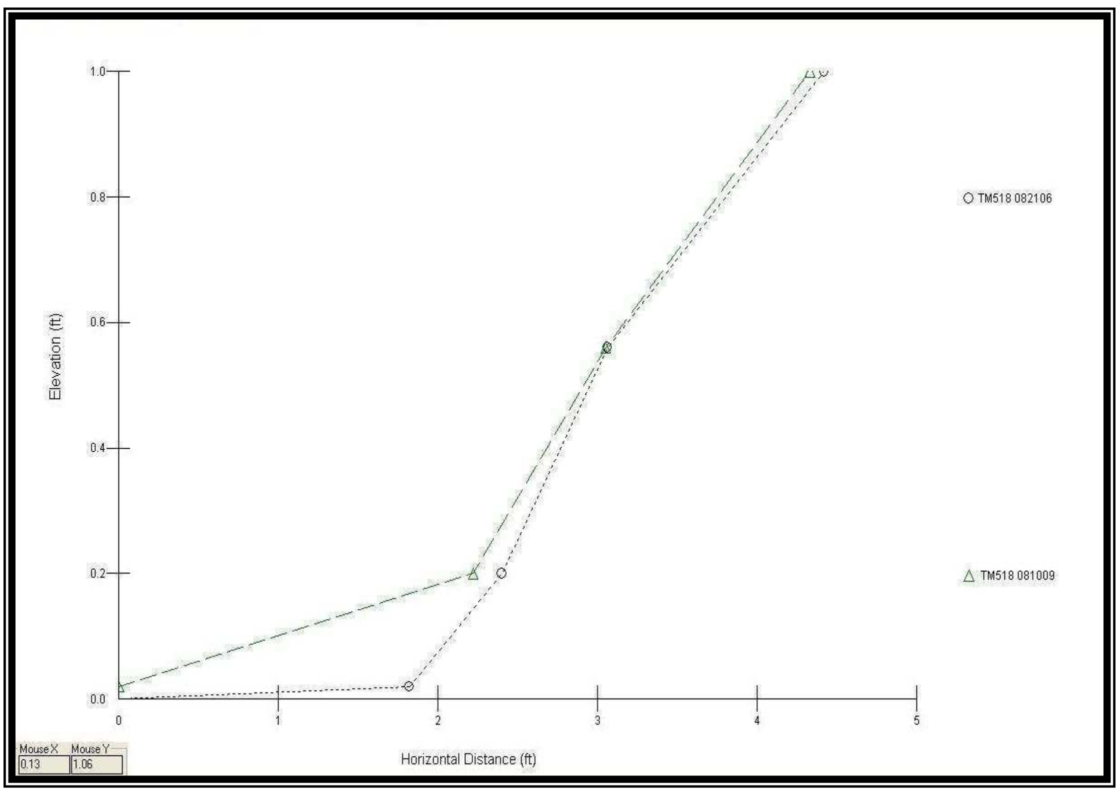
TM512

BEHI = Low Erosion Rate = 0.038 ft/yr



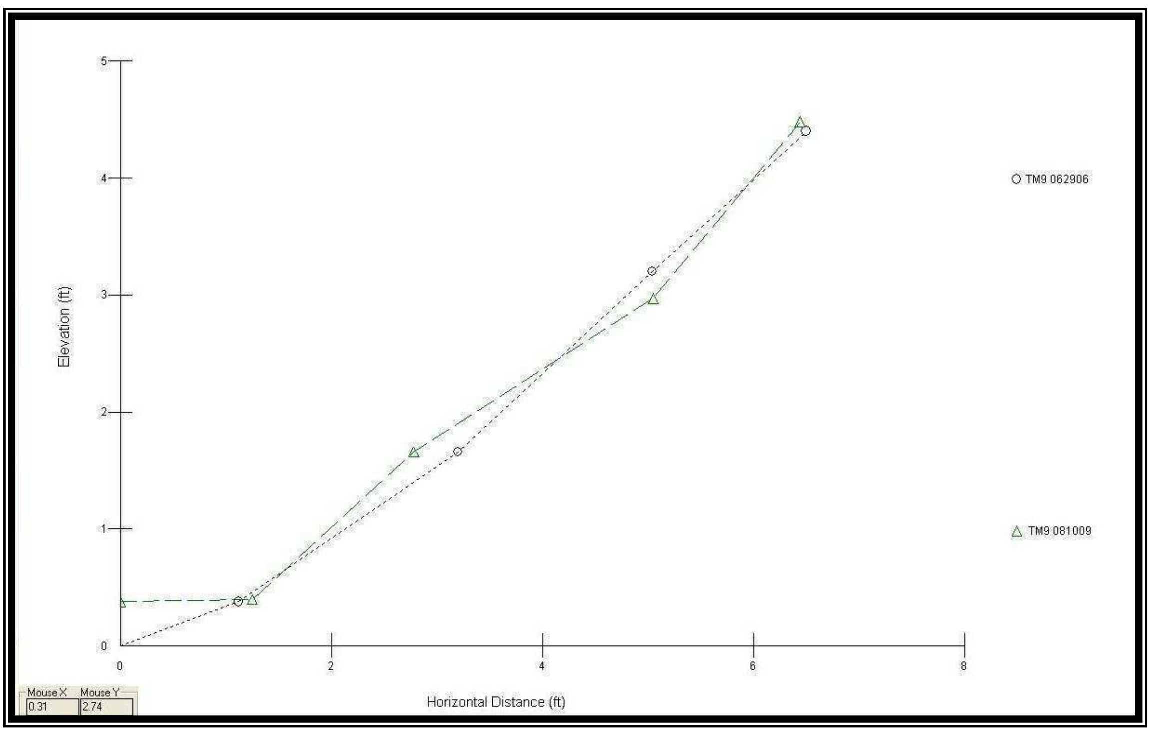
TM518

BEHI = Low   Erosion Rate = 0.087 ft/yr



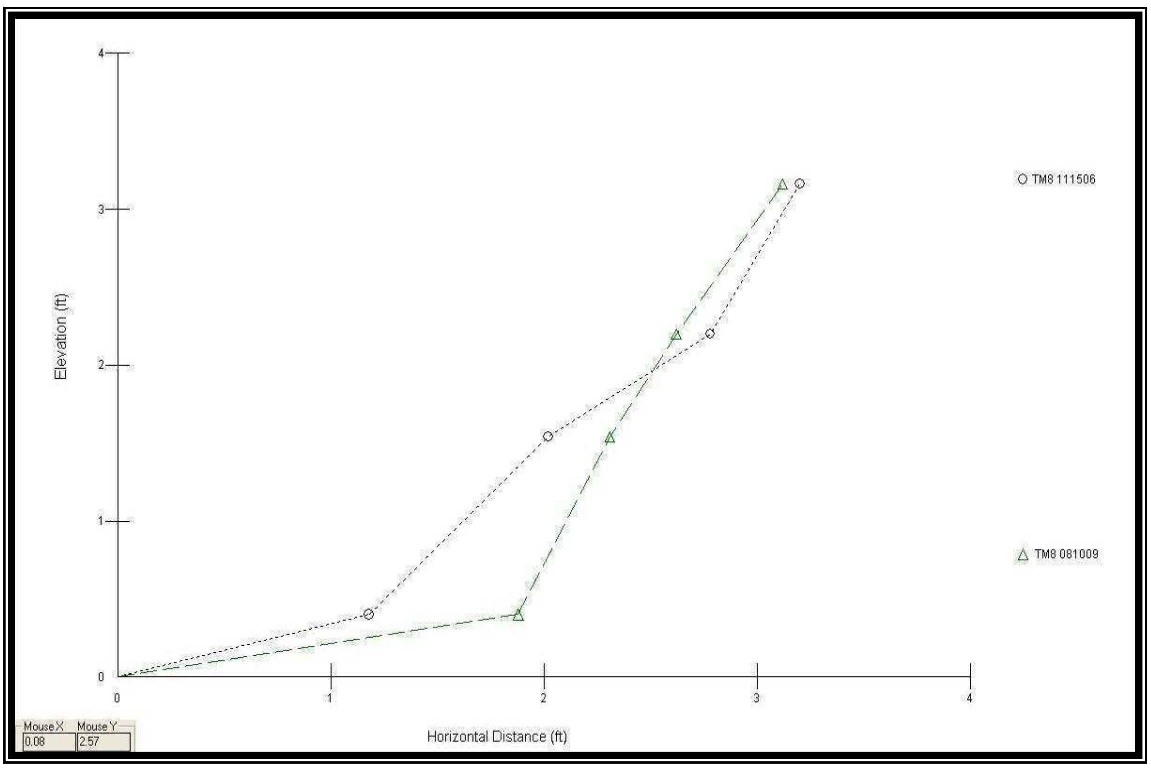
TM9

BEHI = Moderate Erosion Rate = -0.0080 ft/yr



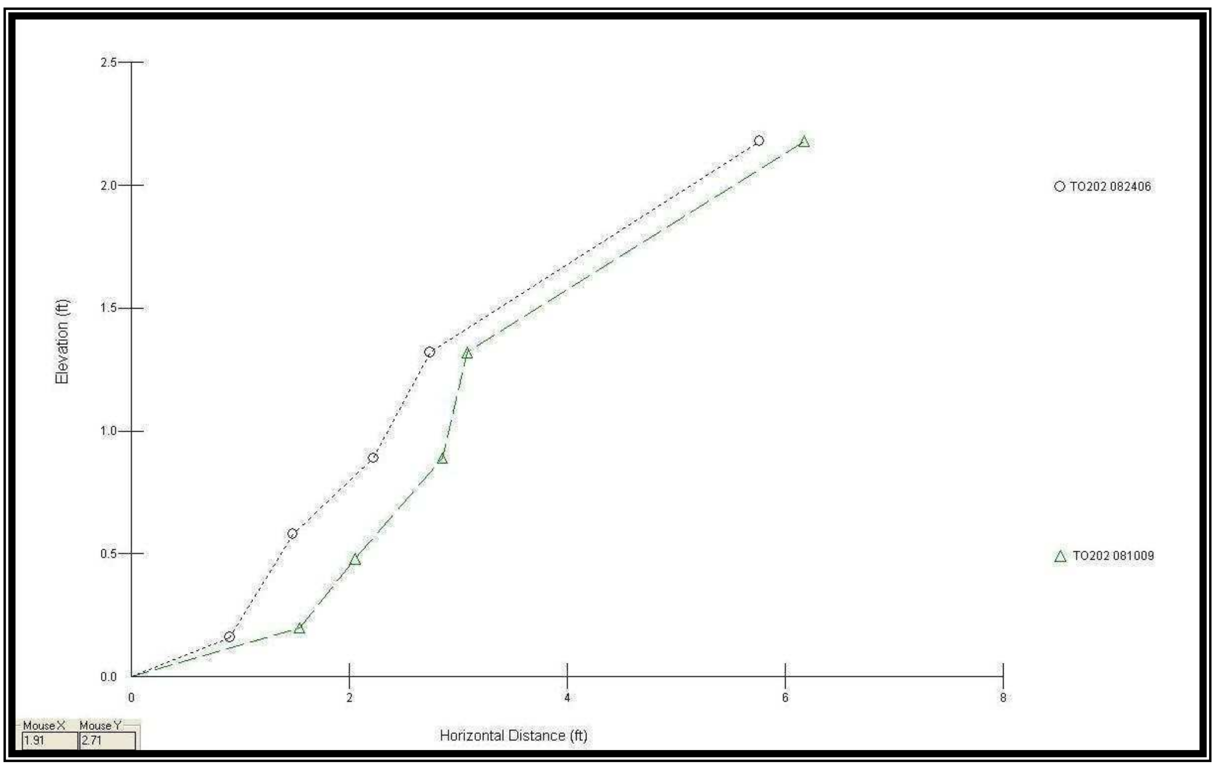
TM8

BEHI = Moderate   Erosion Rate = -0.074 ft/yr



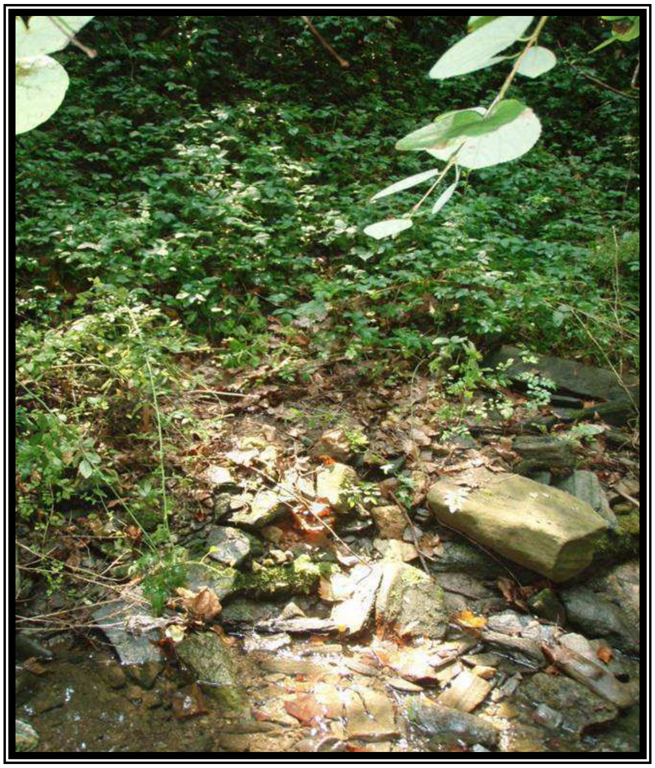
TO202

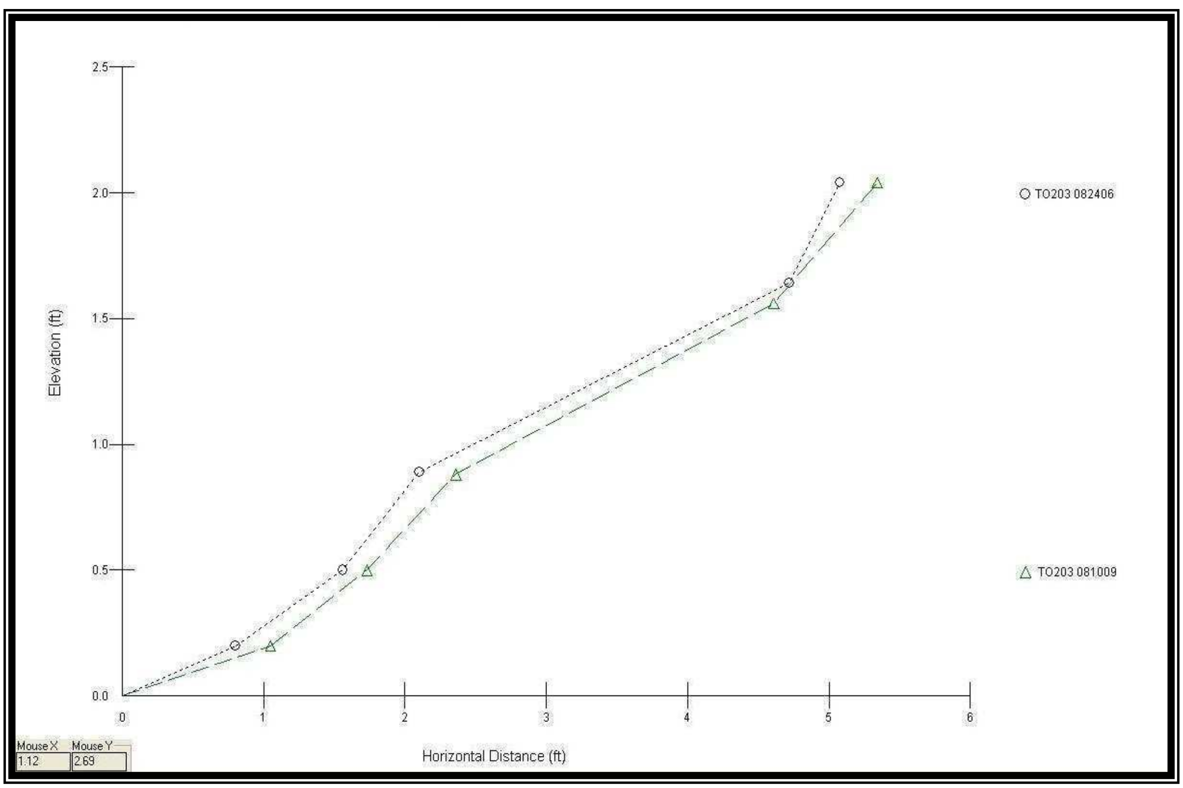
BEHI = Moderate   Erosion Rate = -0.16 ft/yr



TO203

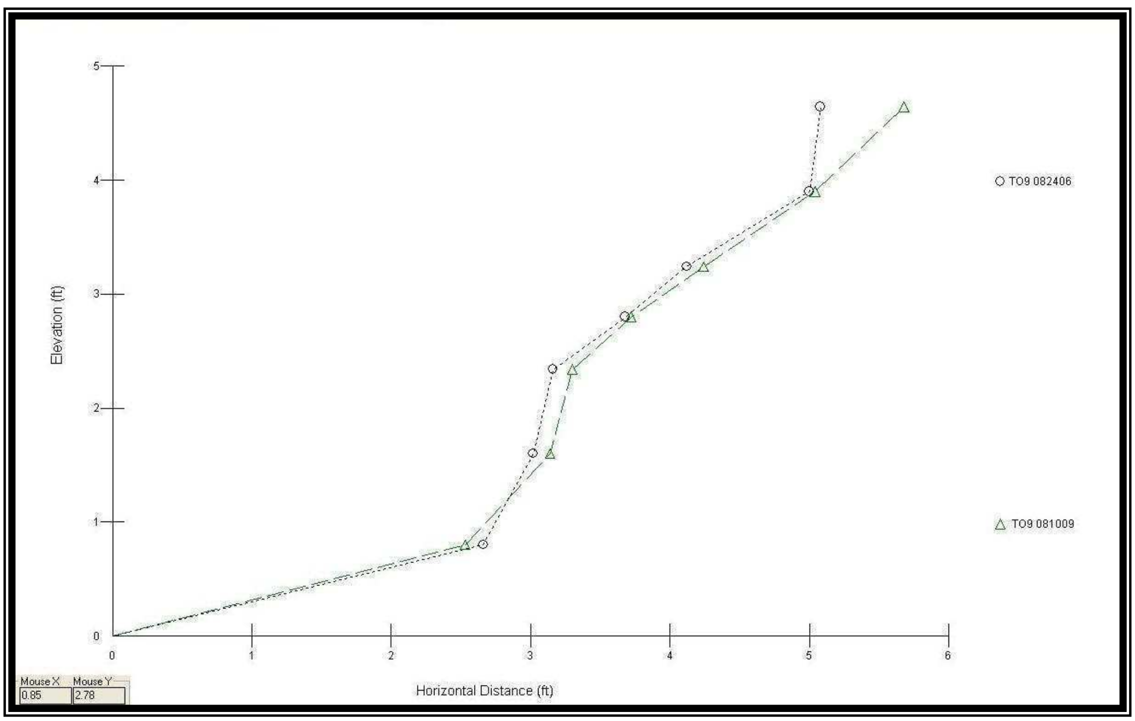
BEHI = Low   Erosion Rate = -0.064 ft/yr





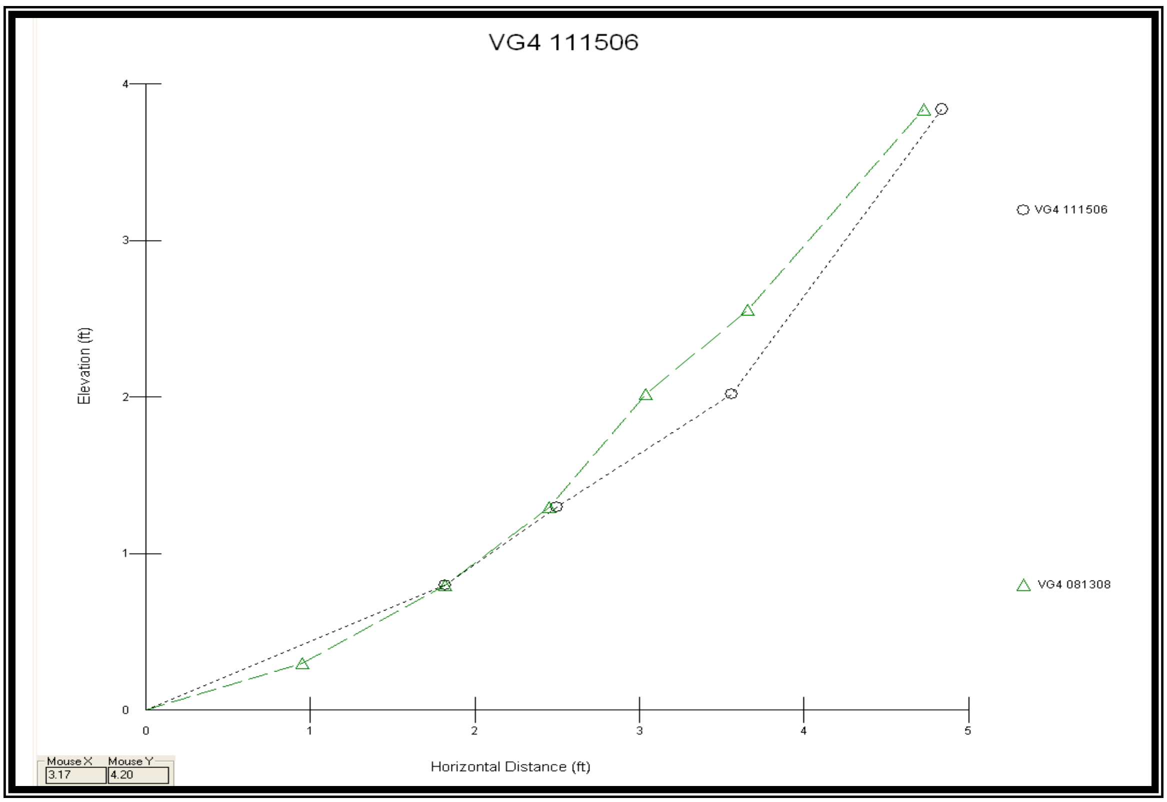
TO9

BEHI = High   Erosion Rate = -0.030 ft/yr



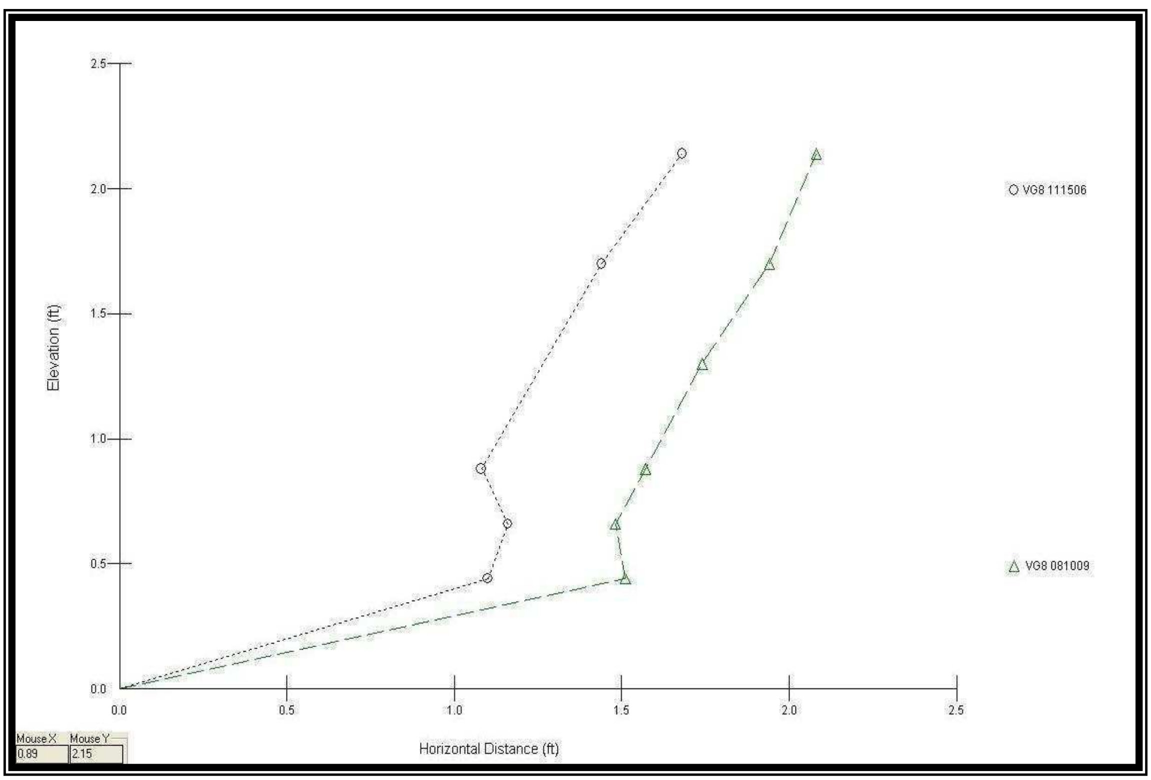
VG4

BEHI = High   Erosion Rate = 0.085 ft/yr



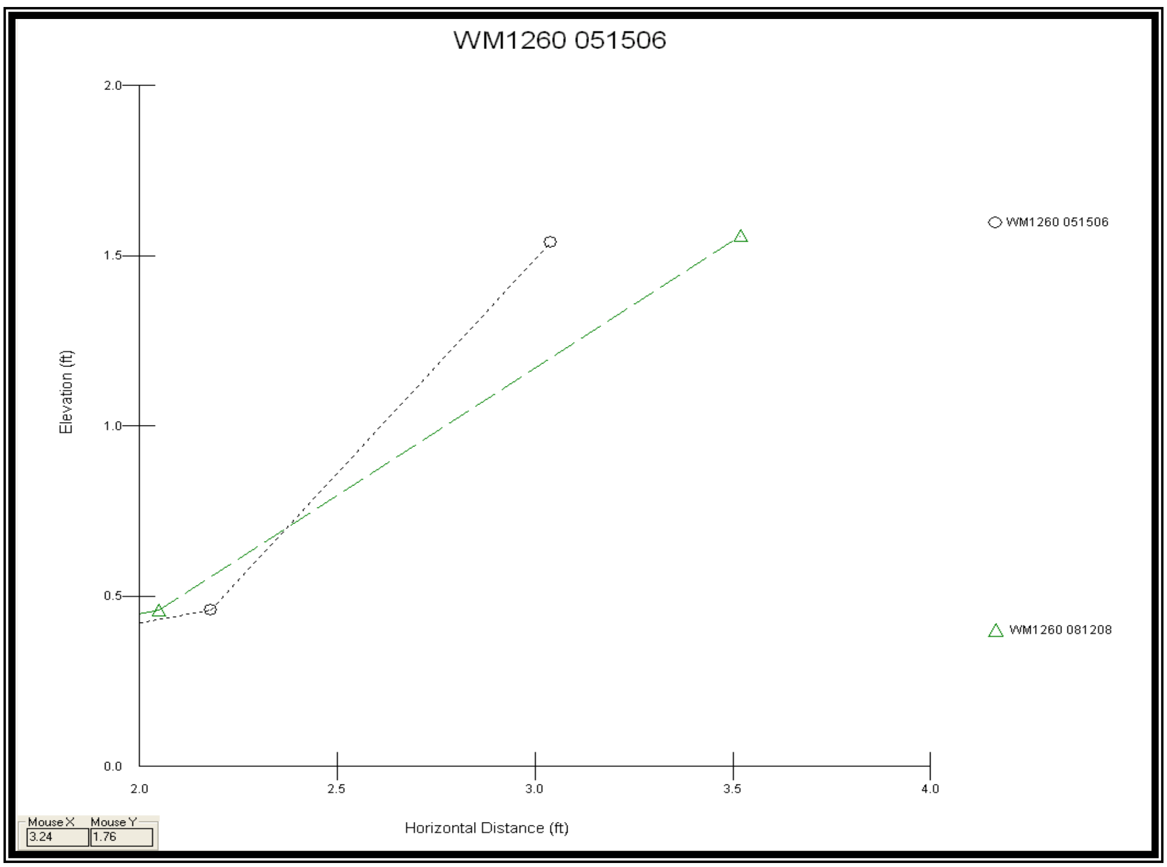
VG8

BEHI = High   Erosion Rate = -0.15 ft/yr



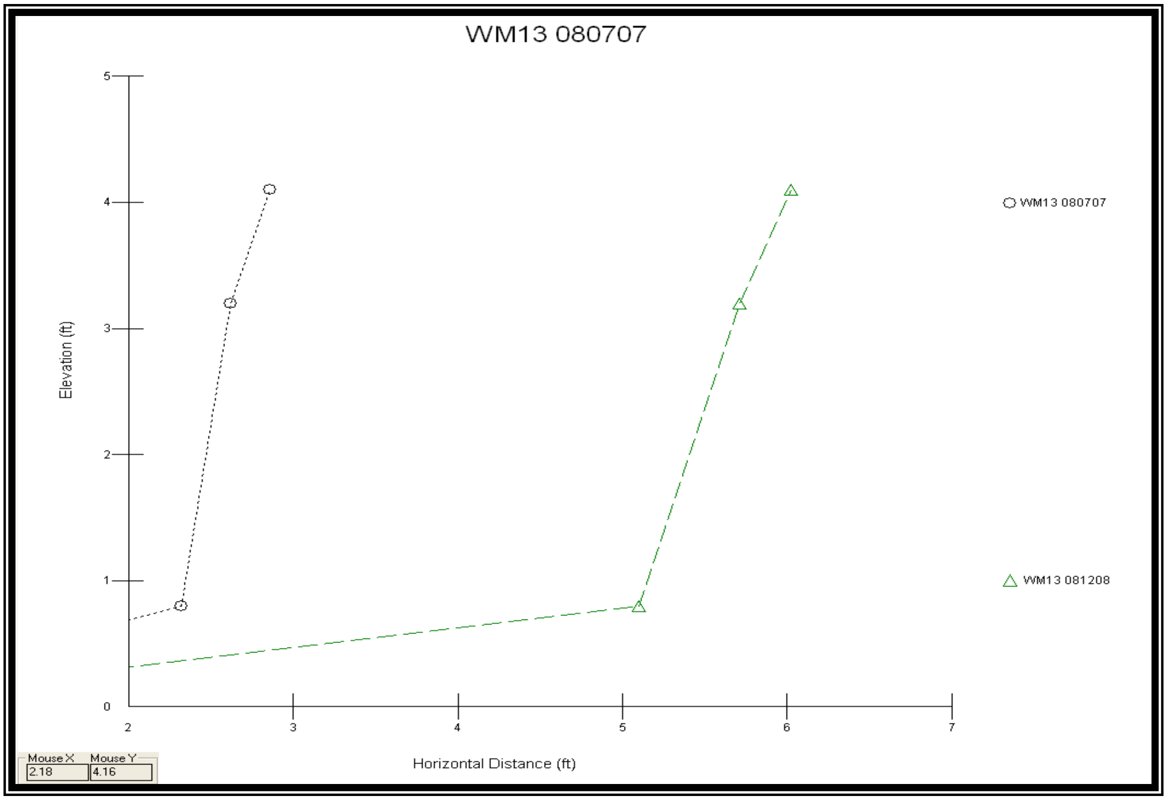
WM1260

BEHI = Moderate   Erosion Rate = -0.060 ft/yr



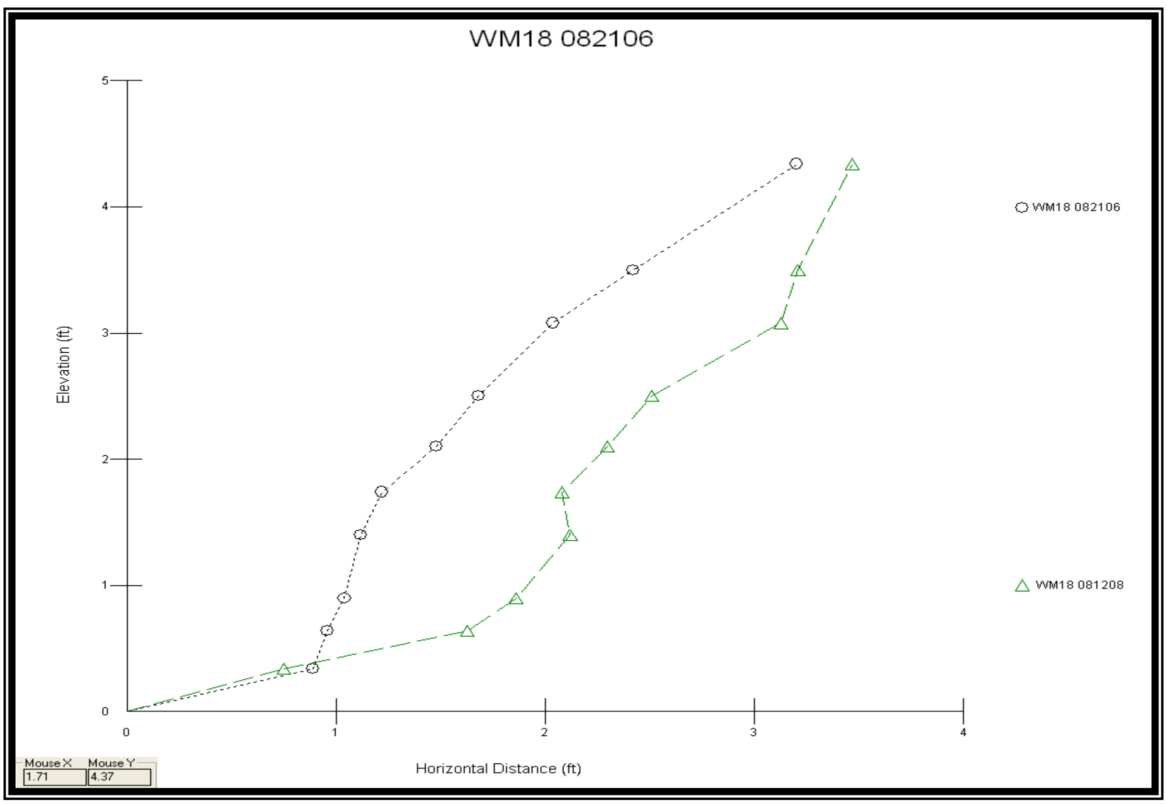
WM13

BEHI = High   Erosion Rate = -2.6 ft/yr



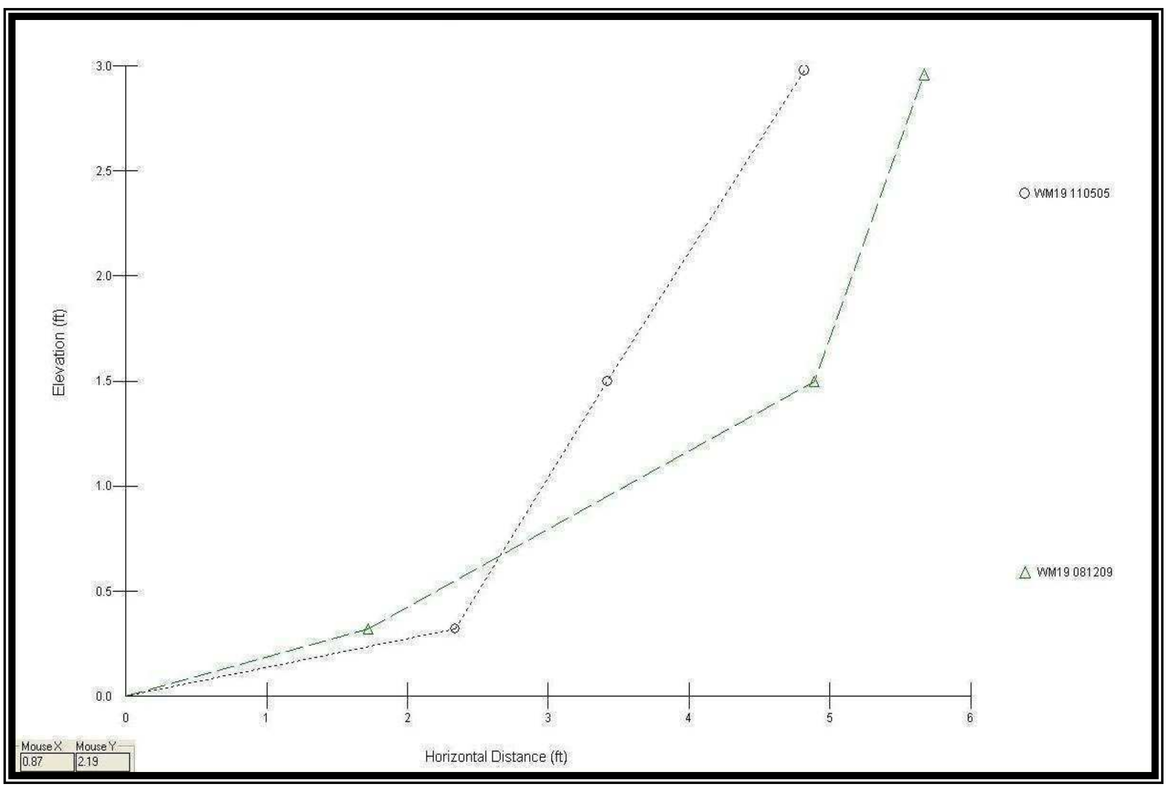
WM18

BEHI = High   Erosion Rate = -0.36 ft/yr



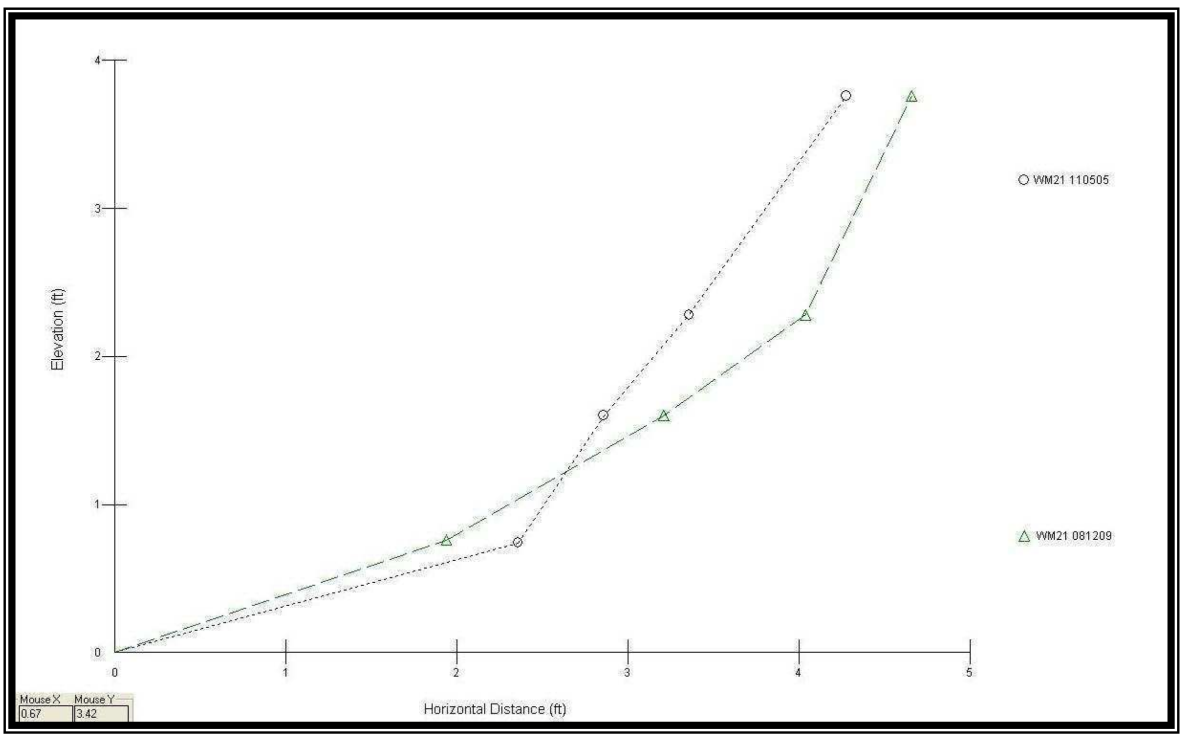
WM19

BEHI = High   Erosion Rate = -0.18 ft/yr



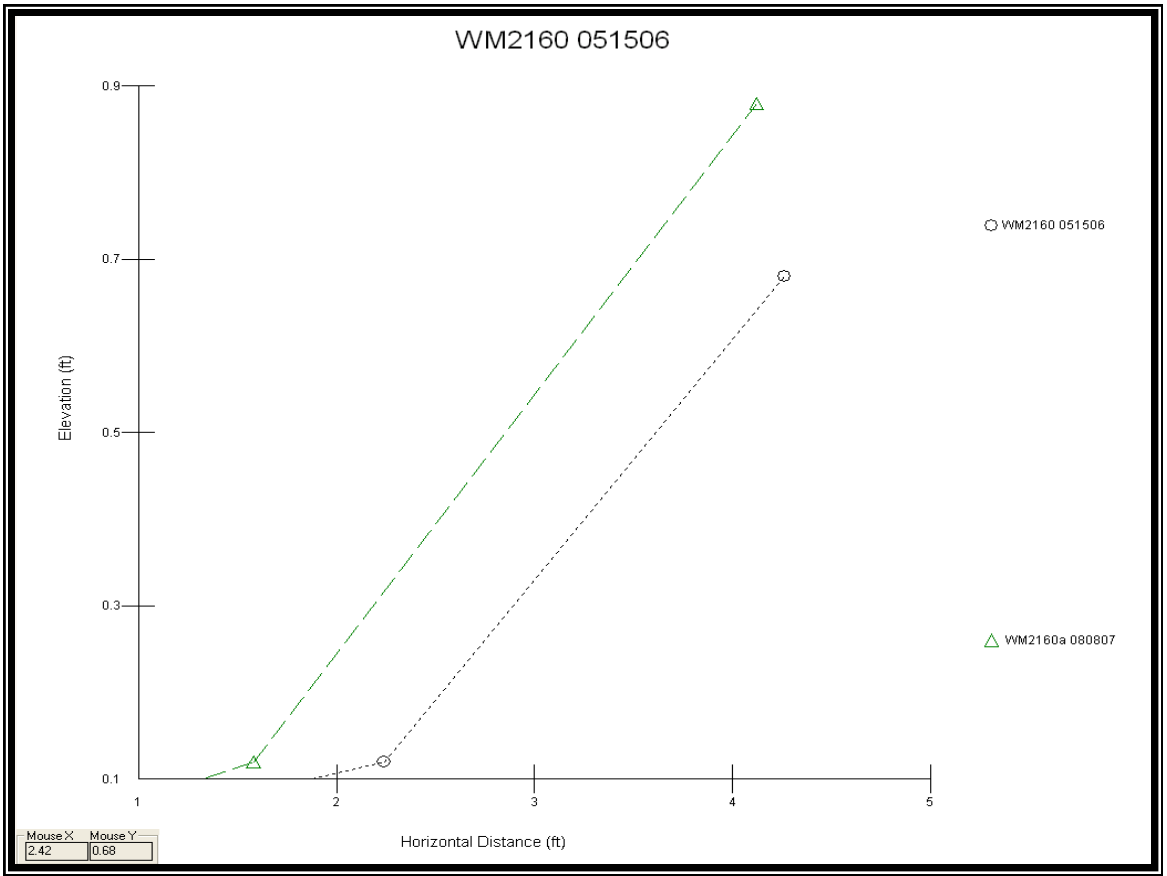
WM21

BEHI = Moderate   Erosion Rate = -0.064 ft/yr



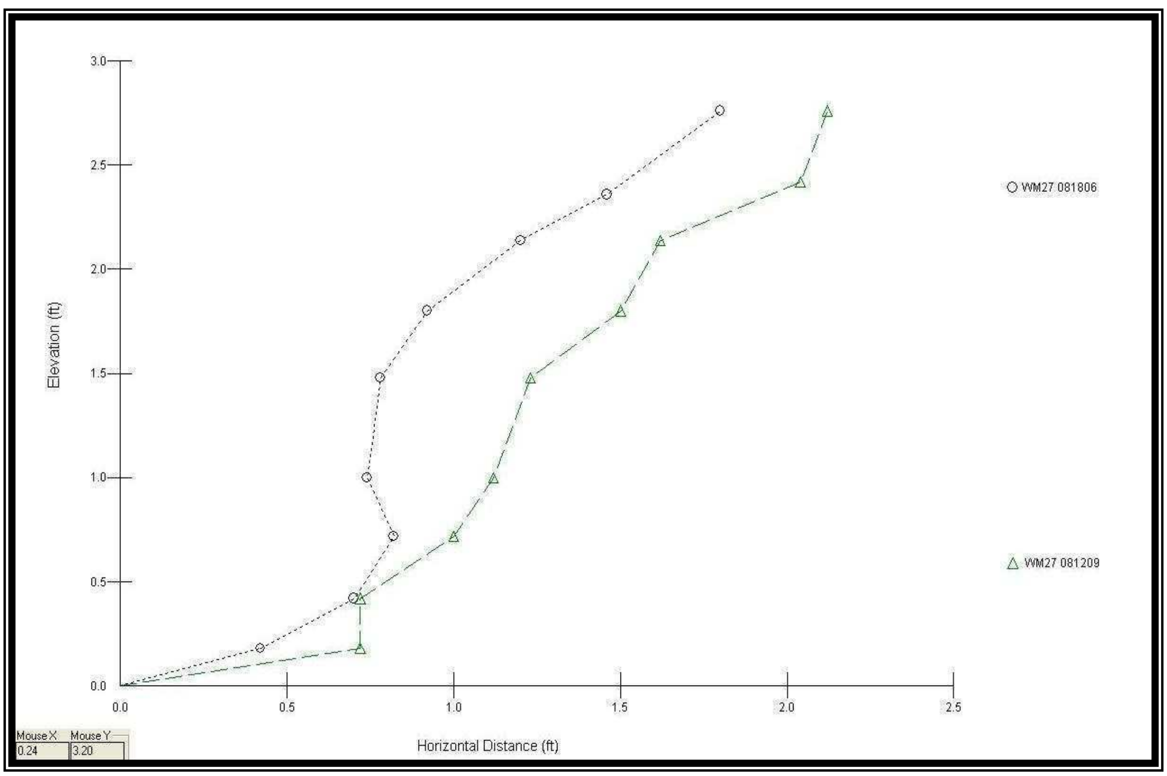
WM2160

BEHI = Low   Erosion Rate = 0.31 ft/yr



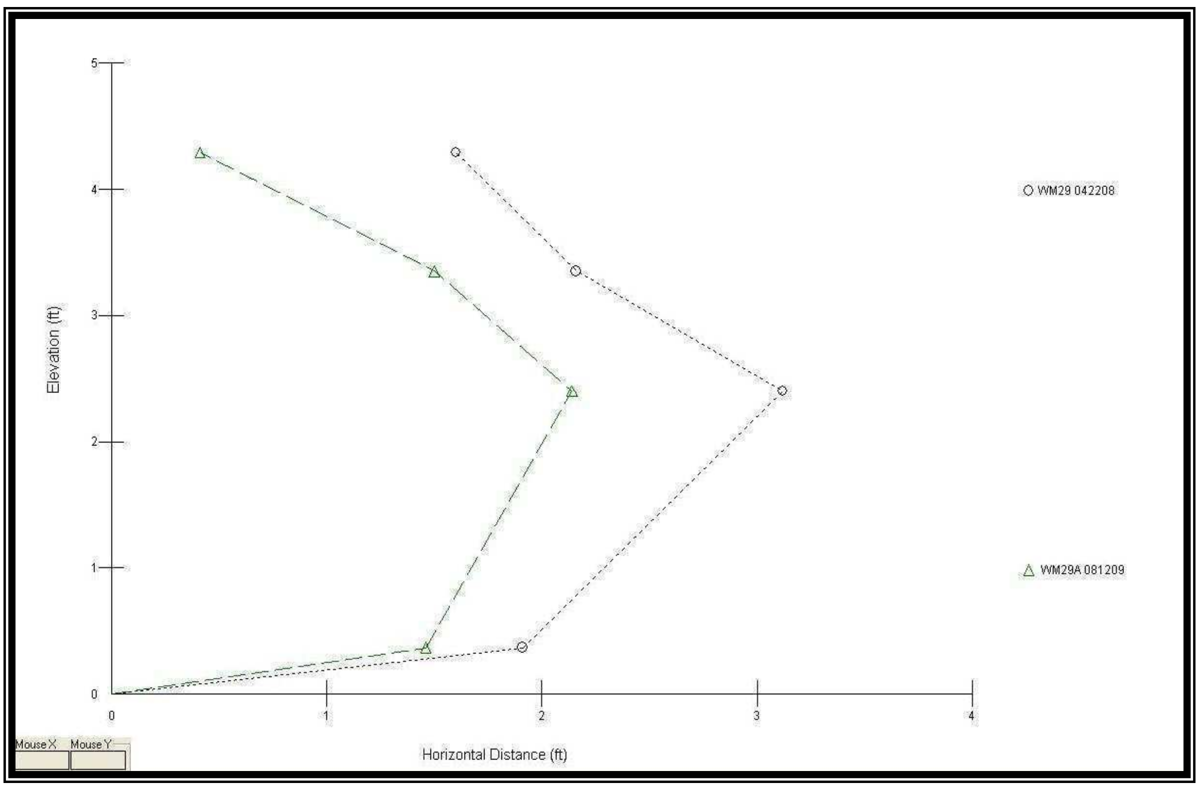
WM27

BEHI = Low   Erosion Rate = -0.12 ft/yr



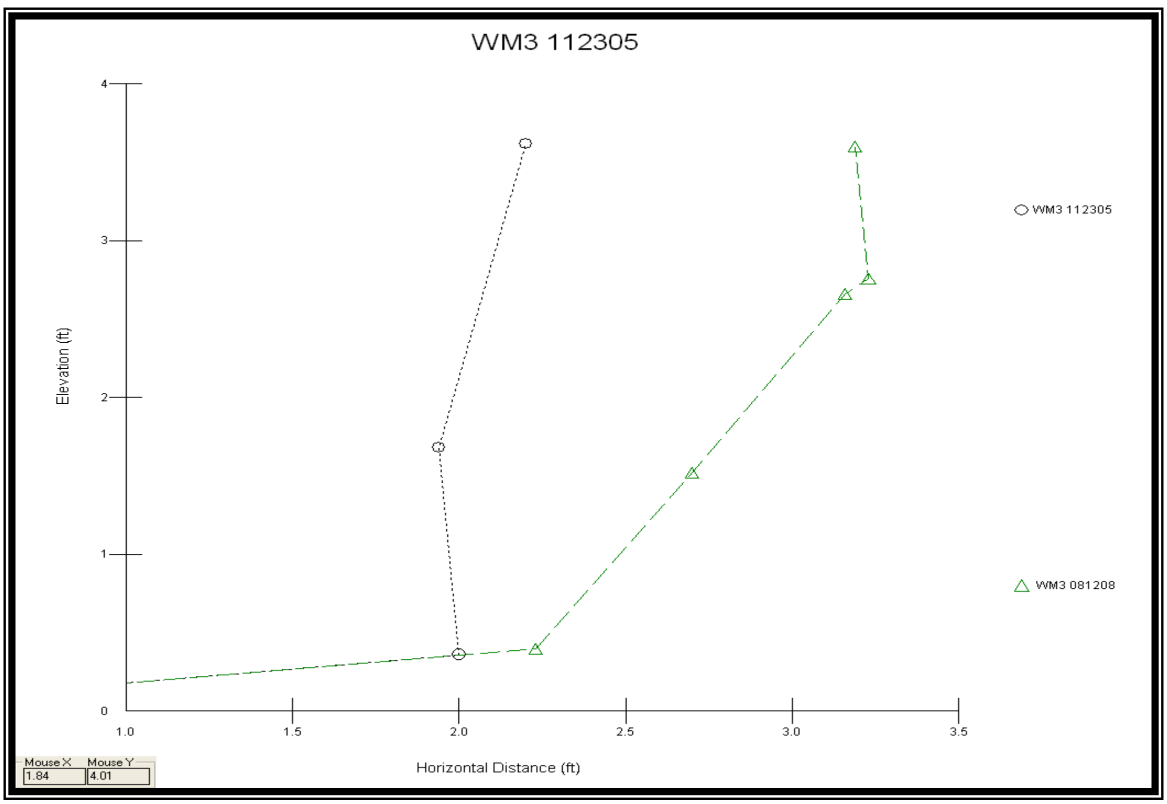
WM29

BEHI = Moderate   Erosion Rate = 0.57 ft/yr



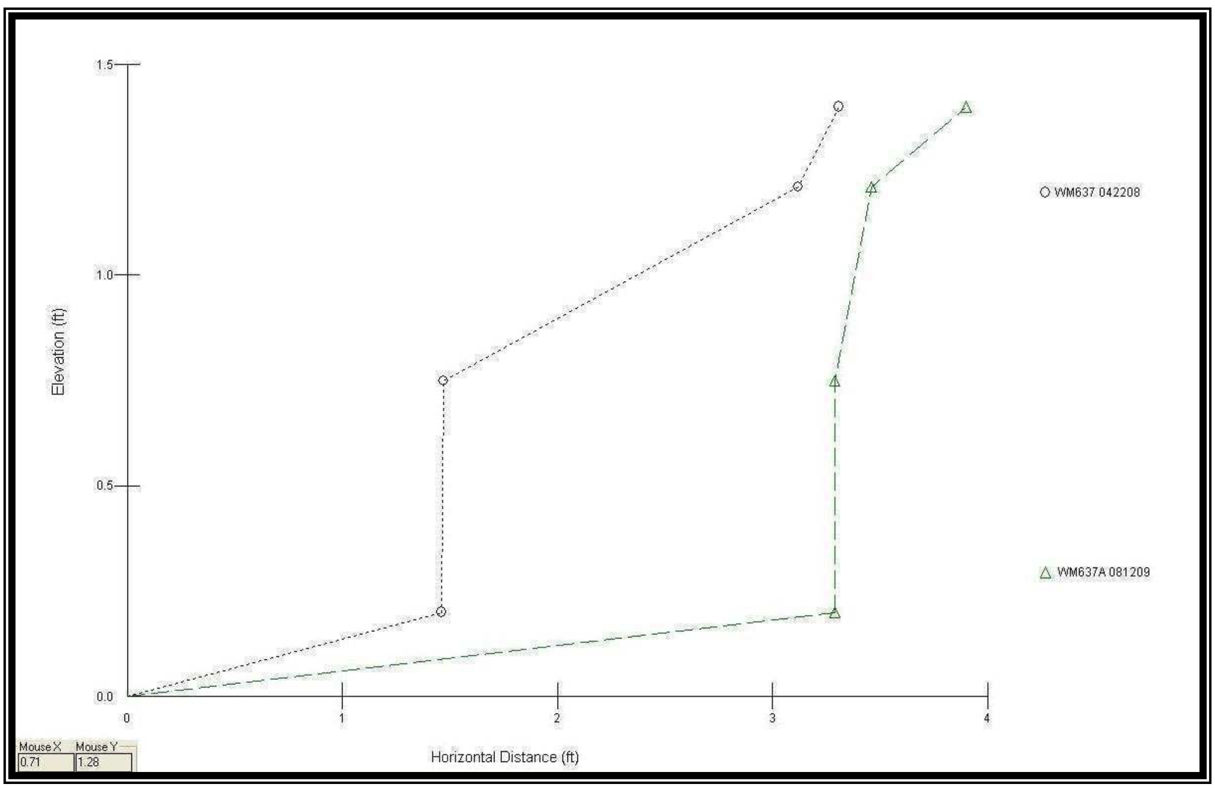
WM3

BEHI = High   Erosion Rate = -0.26 ft/yr



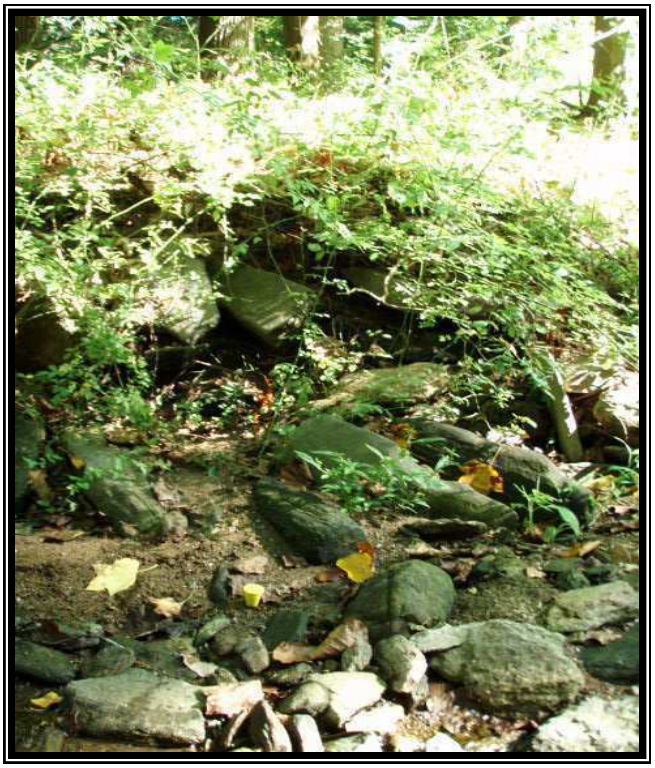
WM637

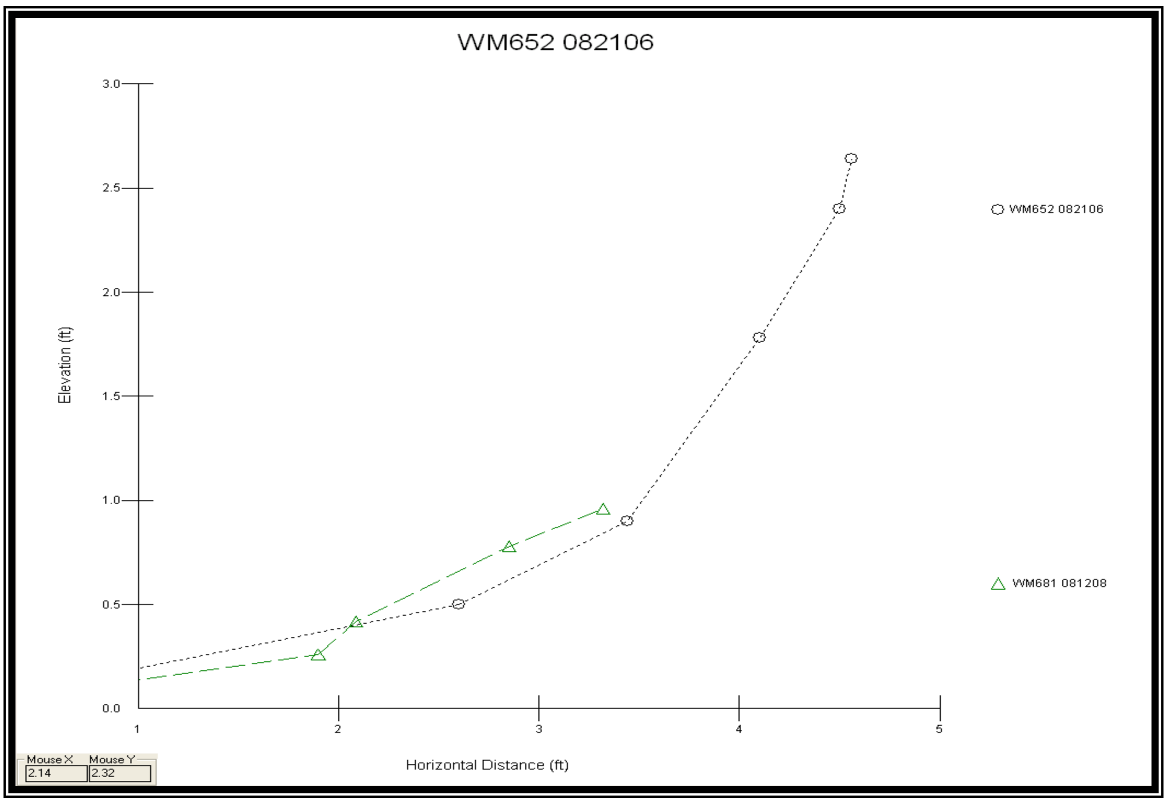
BEHI = Low   Erosion Rate = 0.97 ft/yr



WM652

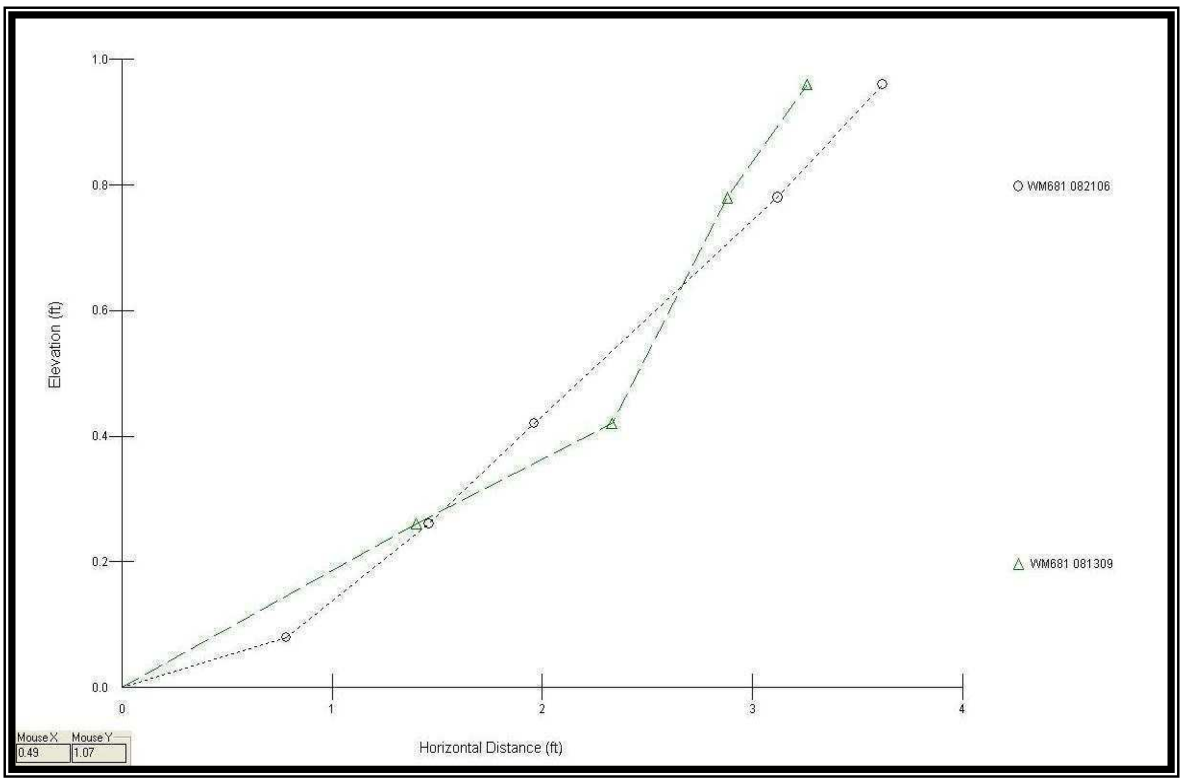
BEHI = Low   Erosion Rate = -0.042 ft/yr





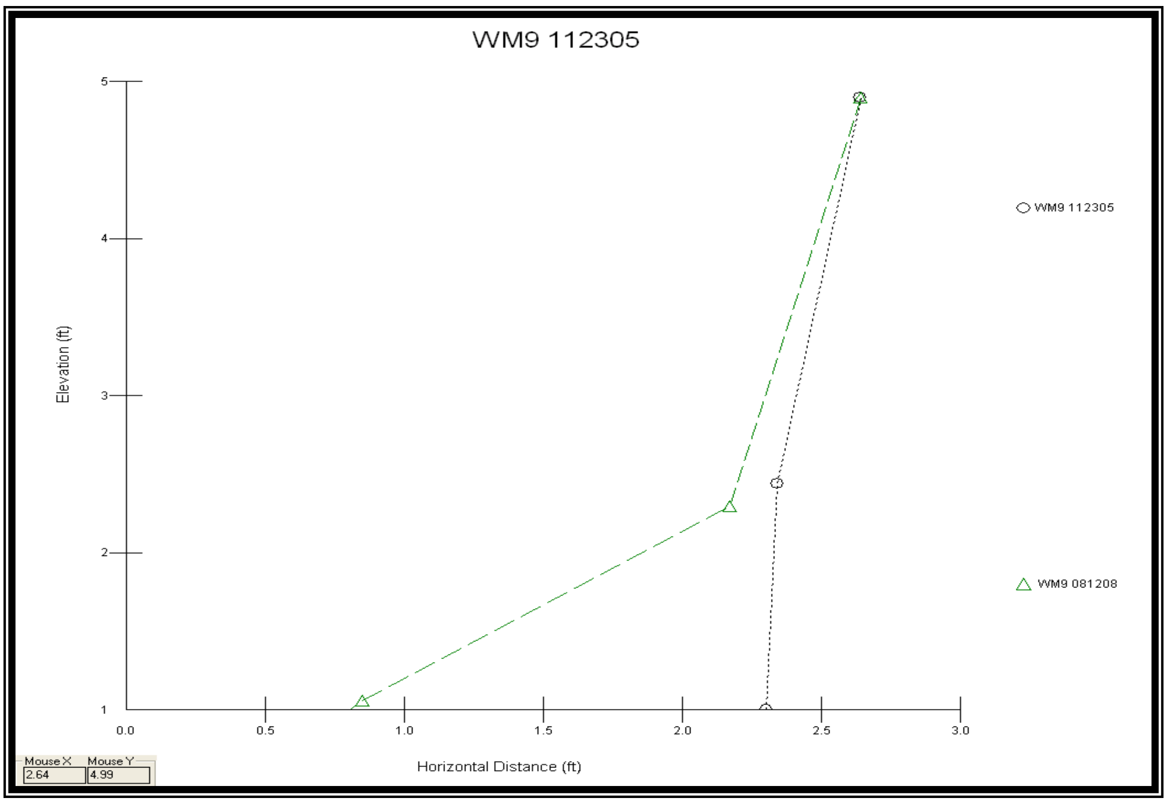
WM681

BEHI = Very Low   Erosion Rate = 0.021 ft/yr



WM9

BEHI = Moderate   Erosion Rate = 0.15 ft/yr



APPENDIX A2

2009 Bank Pin Monitoring Interval

Longest Monitoring Interval Measured at Each Bank Pin Location

	Baseline Reading	Most Recent Reading
Cresheim Creek		
CC35	8/22/2006	8/11/2009
CC114	9/7/2006	8/11/2009
CC18	8/22/2006	8/11/2009
CC43	8/22/2006	8/11/2009
CC45	8/22/2006	8/11/2009
CC46	8/22/2006	8/15/2007
CC64	8/22/2006	8/11/2009
CC74	8/22/2006	8/11/2009
CC11	9/7/2006	8/13/2008
Gorgas		
GO790	4/24/2007	8/15/2008
Hillcrest		
HC303	8/24/2006	8/10/2009
Hartwell Run		
HW170	8/17/2007	8/10/2009
HW177	4/11/2007	8/12/2008
HW179	8/16/2007	8/10/2009
HW4	8/17/2006	8/10/2009
Kitchens Lane		
KL32	8/15/2006	8/11/2009
KL35	8/15/2006	8/11/2009
KL38	8/15/2006	8/11/2009
KL42	8/15/2006	8/11/2009
KL44	8/15/2006	8/14/2008
KL909	8/15/2006	8/11/2009
KL915	8/15/2006	8/11/2009
KL939	8/15/2006	8/11/2009
KL946	8/15/2006	8/11/2009
KL950	8/14/2006	8/11/2009
Monoshone Creek		
MN1	11/2/2005	8/13/2009
MN2	11/2/2005	8/13/2009
MN3	11/2/2005	8/13/2009
MN4	11/2/2005	8/13/2009
MN962	8/24/2006	8/14/2008
MN963	8/13/2007	8/13/2009
MN964	8/13/2007	8/13/2009
Thomas Mill		
TM18	8/16/2007	8/15/2008
TM21	6/29/2006	8/9/2007
TM23	8/9/2007	8/10/2009
TM28	4/11/2007	8/15/2008
TM512	6/29/2006	8/10/2009
TM518	8/21/2006	8/10/2009
TM9	6/29/2006	8/10/2009
TM8	11/15/2006	8/10/2009
Rex Avenue Trib		
TO202	8/24/2006	8/10/2009
TO203	8/24/2006	8/10/2009
TO9	8/24/2006	8/10/2009

	Baseline Reading	Most Recent Reading
Valley Green Run		
VG4	11/15/2006	8/13/2008
VG8	11/15/2006	8/10/2009
Bells Mill		
BM1120	5/11/2006	8/11/2008
BM13	11/7/2005	8/12/2009
BM16	11/13/2006	8/12/2009
BM21	11/7/2005	8/12/2009
BM2450	5/11/2006	8/11/2008
BM25	11/7/2005	8/11/2008
BM31	11/7/2005	8/11/2008
BM35	8/7/2007	8/11/2008
BM4	11/7/2005	11/13/2006
BM414	8/18/2006	8/12/2009
BM422	8/18/2006	8/11/2008
BM530	5/15/2006	8/11/2008
BM8	8/18/2006	8/12/2009
Wise's Mill		
WM1260	5/15/2006	8/12/2008
WM13	8/7/2007	8/12/2008
WM18	8/21/2006	8/12/2008
WM19	11/5/2005	8/13/2009
WM21	11/5/2005	8/13/2009
WM2160	5/15/2006	8/8/2007
WM27	8/18/2006	8/13/2009
WM29	11/5/2005	8/13/2009
WM3	11/23/2005	8/12/2008
WM637	8/18/2006	8/13/2009
WM652	8/21/2006	8/12/2008
WM681	8/21/2006	8/13/2009
WM9	11/23/2005	8/12/2008
Cathedral Run		
CR12	8/21/2006	8/13/2009
CR13	10/31/2005	8/13/2009
CR1370	5/11/2006	8/22/2007
CR14	10/31/2005	8/11/2008
CR16	10/31/2005	8/13/2009
CR18	10/31/2005	8/13/2009
CR3	10/31/2005	8/13/2009
CR510	5/21/2006	8/11/2008
CR7	8/16/2007	8/11/2008
CR250	5/11/2006	8/11/2008

APPENDIX F – POTENTIAL PCB LOCATIONS & INSPECTIONS

Table 1 PCB Inspection Summary

	# sites NE	# sites SE	# sites SW		# sites Separate	# sites Combined	# sites Storm Only	# sites Non-Contributing	# sites Outside City (-)
All Records	171	73	160	404	100	253	10	16	17
Duplicate Records	16	2	12	30					
Blank Records	3	3	4	10					
Actual Records	152	68	144	364	99	239	10	16	9
City-wide Records	143	68	139	347					
Outside City Records	9	0	5	17					
Inspections Completed	127	62	131	284	73	171	10	12	10
Remaining inspections	25	14	41	80	27	82	-	-	7

Table 2 Potential PCB Sources Inspection List

PWD #	Referral Agency	Completed	Inspection Date	Company Name	Street	Type of PCB Equipment	# of PCB Devices	Status of PCB Equipment:			Status of Facility:			
								In use	Out of Service	Dis-connected	Off Site	Operating	Closed	Abandoned
NE-1	USEPA Megarule	2006-4	02/28/07	Arsenal Business Center	5301 Tacony St.	Transformer	86	X				X		
NE-2	USEPA Megarule	2006-4	Duplicate	Arsenal Associates	5301 Tacony St.		87				NA		NA	
NE-3	USEPA Megarule	2010-1	02/03/10	The School District of Philadelphia	7300 Glendale Avenue	Transformer	6	X				X		
NE-4	USEPA Megarule	2010-1	Duplicate	The School District of Philadelphia	7300 Glendale Avenue		6							
NE-5	USEPA Megarule	2007-1	03/28/07	Community Education Partners	4224 N. Front Street		2	X				X		
NE-6	USEPA Megarule	2007-1	Duplicate	Community Education Partners	4224 N. Front Street		2							
NE-7	USEPA Megarule			The School District of Philadelphia	1400 West Olney Avenue		4							
NE-8	USEPA Megarule	2010-1	02/03/10	The School District of Philadelphia	1400 West Olney Avenue	Transformer	4	X				X		
NE-9	USEPA Megarule	2006-3	Duplicate	Sunoco Chemicals Frankford Plant	Cooling Tower 4		2				NA		NA	
NE-10	USEPA Megarule	2006-3	10/23/06	Sunoco Chemicals Frankford Plant	Margeret and Bermuda Sts	Transformer	0				X	X		
NE-11	USEPA Megarule	2006-4	01/30/07	Posel Corporation	9381 Krewstown Road	Transformer	1	X				X		
NE-12	USEPA Megarule	2006-4	01/30/07	Posel Corporation	9381 Krewstown Road	Transformer	1	X				X		
NE-	USEPA	2010-1	02/03/10	The School	10159	Transform	2	X				X		

13	Megarule			District of Philadelphia	Bustleton Avenue	er								
NE-14	USEPA Megarule	2009-2	Duplicate	The School District of Philadelphia	10159 Bustleton Avenue		2							
NE-15	USEPA Megarule			Peco Energy Company	Walnut & Fourth Street		2							
NE-16	USEPA Megarule	2008-1	Duplicate	Peco Energy Company	Walnut & Fourth Street		2							
NE-17	USEPA Megarule	2009-4	10/06/09	SEPTA	1410 W. Loudon Street	Transformer	2	X				X		
NE-18	USEPA Megarule	2009-2	Duplicate	The School District of Philadelphia	5701 Oxford Street		3							
NE-19	USEPA Megarule			The School District of Philadelphia	5701 Oxford Street		3							
NE-20	USEPA Megarule	2006-3	10/23/06	Sunoco Chemicals Frankford Plant	Margeret and Bermuda Sts	(1 removed)	0				X	X		
NE-21	USEPA Megarule	2006-2	Duplicate	Sunoco Chemicals , Frankford Plant	Cooling Tower 3		~~1~~				**NA**		**NA**	
NE-22	USEPA Megarule	2006-2	06/23/06	General Electric International, Inc. (GEII)		Transformer	2		X		X	X		
NE-23	USEPA Megarule	2006-2	06/23/06	General Electric International, Inc. (GEII)		CAPACITORS	2		X		X	X		
NE-24	USEPA Megarule	2006-2	06/23/06	SEPTA-General Electric Service Shop		Undercars	26	****See Note****				X		
NE-25	USEPA Megarule	2006-2	06/23/06	SEPTA - General Electric Service Shop	1040 East Erie Avenue	Transformer	0	****See Note****				X		
NE-26	USEPA Megarule	2006-2	Duplicate	Sunoco Chemicals Frankford Plant	Cooling Tower 5		~~1~~				**NA**		**NA**	
NE-27	USEPA Megarule	2006-3	10/23/06	Sunoco Chemicals Frankford Plant	Margeret and Bermuda Sts		1				X	X		

NE-28	USEPA Megarule	2009-2	Duplicate Record	PECO Energy Co.	Legrande Avenue		1							
NE-29	USEPA Megarule	2009-2	Duplicate Record	PECO Energy Co.	Legrande Avenue		1							
NE-30	USEPA Megarule			Peco Energy Company	900 Big Oak Road		1							
NE-31	USEPA Megarule	2009-2	Duplicate Record	Peco Energy Company	900 Big Oak Road		1							
NE-32	USEPA Megarule			Peco Energy Company	2860 Trenton Avenue		1							
NE-33	USEPA Megarule	2009-2	Duplicate Record	Peco Energy Company	2860 Trenton Avenue		1							
NE-34	USEPA Megarule			Peco Energy Company	Betharyes Road & 2nd St Pike		1							
NE-35	USEPA Megarule	2009-2	Duplicate Record	Peco Energy Company	Betharyes Road & 2nd St Pike		1							
NE-36	Phila. Water Dept	2006-3	11/20/06	PHILA WATER DEPT	9001 STATE RD	CAPACITORS	6		X	X		X		
NE-37	USEPA Megarule			The Philadelphia District of Schools	3939 N. 5th Street		2							
NE-38	USEPA Megarule	2009-2	Duplicate Record	The Philadelphia District of Schools	3939 N. 5th Street		2							
NE-39	Phila. Fire Dept	2006-3	10/11/06	AFTER SIX INC	G & HUNTING PARK	Transformer	1				X		**Demolished**	
NE-40	Phila. Fire Dept	2007-2	10/01/07	Wymex Beauty	3621 B ST.	Transformer	1	X				X		
NE-41	Phila. Fire Dept	2007-1	06/08/07	BUDD CO	FOX & HUNTING PK	Transformer	1		X			X		
NE-42	Phila. Fire Dept	2007-2	07/23/07	DODGE FOUNDRY	6501 STATE RD	Transformer	1		X	X	X		X	Demolished
NE-43	Phila. Fire Dept	2007-2	07/23/07	DODGE FOUNDRY	6501 STATE RD	Transformer	1		X	X	X		X	Demolished
NE-44	Phila. Fire Dept			GEN ELECT CO	401 E HUNTING PK	Transformer	1							

NE-45	Phila. Fire Dept			MUTUAL INDUS.	707 W. GRANGE	Transformer	1							
NE-46	Phila. Fire Dept			NE SHOPPING CTR	9173 ROOSEVELT BLVD	Transformer	1							
NE-47	Phila. Fire Dept			NE SHOPPING CTR	9173 ROOSEVELT BLVD	Transformer	1							
NE-48	Phila. Fire Dept			NORTHERN ASSOCIATES	7777 STATE RD.	Transformer	1							
NE-49	Phila. Fire Dept	2007-1	04/27/07	PHILA PRISONS	8215 TORRESDALE	Transformer	1	X				X		
NE-50	Phila. Fire Dept			PHILA SCHOOL BOARD	5TH & LUZERNE	Transformer	1							
NE-51	Phila. Fire Dept			PHILA SCHOOL BOARD	B & WYOMING	Transformer	1							
NE-52	Phila. Fire Dept	2010-2	05/25/10	PHILA SCHOOL BOARD	HEDGE & UNITY (STEARNE)	Transformer	1		X	X	X	X		
NE-53	Phila. Fire Dept	2010-2	05/25/10	PHILA SCHOOL BOARD	KNIGHTS & CHALFONT	Transformer	1	X				X		
NE-54	Phila. Fire Dept	2010-2	05/25/10	PHILA SCHOOL BOARD	SHARON & ALICIA	Transformer	3	X				X		
NE-55	Phila. Fire Dept	2007-1	04/24/07	PHILA STATE HOSPITAL	14000 ROOSEVELT BLVD	Transformer	~~1~~				X	X		
NE-56	Phila. Fire Dept	2007-1	04/24/07	PHILA STATE HOSPITAL		Transformer	~~1~~				X			Demolished
NE-57	Phila. Fire Dept	2007-1	04/24/07	PHILA STATE HOSPITAL		Transformer	~~1~~				X			Demolished
NE-58	Phila. Fire Dept	2007-1	04/24/07	PHILA STATE HOSPITAL		Transformer	~~1~~				X			Demolished
NE-59	Phila. Fire Dept	2007-2	08/15/07	S.D. RICHMAN INC	2435 WHEATSHEAF	Transformer	1	X				X		
NE-60	Phila. Fire Dept	2007-1	09/04/07	Preit	4820 LANGDON ST	Transformer	1		X	X	X		X	
NE-	Phila. Fire	2009-1	03/07/09	SEPTA	4701	Transform	1		X	X	X			

61	Dept				GRISCOM ST	er								
NE-62	Phila. Fire Dept	2009-1	03/07/09	SEPTA	8365 CASTOR AVE	Transformer	1		X	X	X			
NE-63	Phila. Fire Dept	2007-2	10/01/07	Wymex Beauty (TL Tan LLC)	3621 B ST	Transformer	1	X				X		
NE-64		2006-4	Blank Record	-										
NE-65	Phila. Fire Dept	2007-2	07/19/07	Specialty Engine Rebuilding	5201 UNRUH	Transformer	1	X				X		
NE-66	Phila. Fire Dept	2006-3	10/23/06	THALHEIMER BROS	5550 WHITAKER AVE	Transformer	1	X				X		
NE-67	Phila. Fire Dept	2006-3	10/23/06	THALHEIMER BROS	700 E GODFREY AVE	Transformer	~~1~~ 2	X				X		
NE-68	Phila. Fire Dept	2006-1	05/17/06	Island Green Country Club,	1 RED LION RD	Transformer	0				X	X		
NE-69	Phila. Fire Dept	2006-1	05/17/06	Island Green Country Club	1 RED LION RD	Transformer	0				X	X		
NE-70	Phila. Fire Dept			Menasha	601-21 E ERIE	Transformer	1							
NE-71	Phila. Fire Dept			FAIRMOUNT PARK (BANDSTAND)	OLD YORK RD. & HUNTING PARK AVE	Transformer	1							
NE-72	Phila. Fire Dept	2009-1	04/27/09	SEPTA	WINDRIM & GERMANTOWN	Transformer	10		X	X	X	X		
NE-73	Phila. Fire Dept	2006-4	03/12/07	Delaware Ave. LLC	HEDLEY & DELAWARE RIVER - 4301 Delaware Ave.	CAPACITOR	2				X	X		
NE-74	Phila. Fire Dept	2006-4	03/12/07	Delaware Ave. LLC		CAPACITORS	2				X	X		
NE-75	Phila. Fire Dept	2006-4	03/12/07	Delaware Ave. LLC		CAPACITORS	2				X	X		
NE-76	Phila. Fire Dept	2006-4	03/12/07	Delaware Ave. LLC		CAPACITORS	2				X	X		
NE-77	Phila. Fire Dept			ANCHOR CONTAINER	4219 TORRESDALE	Transformer	2							
NE-	Phila. Fire			BARRIT CORP	CASTOR &	Transform	2							

78	Dept				SEDGELY	er								
NE-79	Phila. Fire Dept	2007-1	06/09/07	BUDD CO	2501 HUNTING PK	Transformer	2		X			X		
NE-80	Phila. Fire Dept	2006-1	05/17/06	Cardinal Health: Formerly DEVON APPAREL	3001 RED LION RD	Transformer	0				X	X		
NE-81	Phila. Fire Dept			FOX TRUST BLDG	3634 N BROAD	Transformer	2							
NE-82	Phila. Fire Dept			FRANKLIN SMELTING	CASTOR & RICHMOND	Transformer	2							
NE-83	Phila. Fire Dept			JOHN F. KENNEDY MEMORIAL HOSPITAL	5600 LANGDON ST.	Transformer	2							
NE-84	Phila. Fire Dept	2007-2	08/17/07	Wolf Investments	1771 TOMLINSON	Transformer	2		X	X	X	X		
NE-85	Phila. Fire Dept			SEARS & ROEBUCK	4640 ROOSEVELT BLVD	Transformer	2							
NE-86	Phila. Fire Dept	2009-1	03/07/09	SEPTA	1823 E. LETTERLY	Transformer	2		X	X	X	X		
NE-87	Phila. Fire Dept	2009-1	04/27/09	SEPTA	200 W WYOMING	Transformer	2		X	X	X		X	
NE-88	Phila. Fire Dept	2009-1	04/27/09	SEPTA	4000 N BROAD	Transformer	2		X	X	X		X	
NE-89	Phila. Fire Dept	2009-4	10/06/09	SEPTA	1823 E. LETTERLY	Transformer	2		X	X	X	X		
NE-90	Phila. Fire Dept	2007-2	07/24/07	STERNS	7300 BUSELTON AVE	Transformer	2		X	X	X	X		Demolished
NE-91	Phila. Fire Dept	2007-1	04/30/07	Sterling Paper	2155 E CASTOR	Transformer	2	X				X		
NE-92	Phila. Fire Dept	2006-1	05/17/06	Island Green Country Club, Formerly: TRANSIT AMERICA	1 RED LION RD	Transformer	0				X	X		
NE-93	Phila. Fire Dept	2006-1	05/18/06	Island Green Country Club,		Transformer	0				X	X		
NE-	Phila. Fire	2006-1	05/19/06	Island Green		Transform	0				X	X		

94	Dept			Country Club,		er								
NE-95	Phila. Fire Dept	2006-1	05/20/06	Island Green Country Club,		Transformer	0				X	X		
NE-96	Phila. Fire Dept	2006-1	05/21/06	Island Green Country Club,		Transformer	0				X	X		
NE-97	Phila. Fire Dept	2006-1	05/22/06	Island Green Country Club,		Transformer	0				X	X		
NE-98	Phila. Fire Dept	2006-1	05/23/06	Island Green Country Club,		Transformer	0				X	X		
NE-99	Phila. Fire Dept	2006-1	05/24/06	Island Green Country Club,		Transformer	0				X	X		
NE-100	Phila. Fire Dept	2006-1	05/25/06	Island Green Country Club,		Transformer	0				X	X		
NE-101	Phila. Fire Dept	2006-1	05/26/06	Island Green Country Club,		CAPACITORS	0				X	X		
NE-102	Phila. Fire Dept	2006-1	05/27/06	Island Green Country Club,		CAPACITORS	0				X	X		
NE-103	Phila. Fire Dept	2006-1	05/28/06	Island Green Country Club,		CAPACITORS	0				X	X		
NE-104	Phila. Fire Dept	2006-4	03/12/07	Delaware Ave. LLC	HEDLEY & DELAWARE RIVER - 4301 Delaware Ave.	CAPACITORS	26				X	X		
NE-105	Phila. Fire Dept	2007-1	05/29/07	SEARS & ROEBUCK	5540 ALGON STST	Transformer	3		X	X	X	X		
NE-106	Phila. Fire Dept	2006-4	03/12/07	Delaware Ave. LLC	HEDLEY & DELAWARE RIVER - 4301 Delaware Ave.	Transformer	3	X				X		
NE-107	Phila. Fire Dept	2007-1	06/07/07	BUDD CO	2501 HUNTING PK	Transformer	3	??				X		
NE-108	Phila. Fire Dept	2007-2	07/26/07	Northwest Human Services	2900 SOUTHHAMPTON	Transformer	3	X				X		
NE-109	Phila. Fire Dept			PHILA ELECTRIC CO	3300 N 10TH STREET	Transformer	3							
NE-110	Phila. Fire Dept	2007-1	04/27/07	PHILA PRISONS	8001 STATE RD.	Transformer	3	X				X		
NE-111	Phila. Fire Dept			PHILA SCHOOL BOARD	BROAD & OLNEY (WIDNER)	Transformer	3							

NE-112	Phila. Fire Dept			PHILA SCHOOL BOARD	FRONT & DUNCANNON (OLNEY)	Transformer	3							
NE-113	Phila. Fire Dept	2010-2	05/25/10	PHILA SCHOOL BOARD	OLD YORK RD. & ONTARIO (BETHUNE)	Transformer	3		X	X	X	X		
NE-114	Phila. Fire Dept	2007-2	08/17/07	Active Reality (Black red white furniture/ PBM	10175 NORTHEAST AVE	Transformer	3		X	X	X	X		
NE-115	Phila. Fire Dept	2007-1	09/04/07	Preit	4640 ROOSEVELT BLVD	Transformer	3		X	X	X		X	
NE-116	Phila. Fire Dept	2007-1	09/04/07	Preit	4640 ROOSEVELT BLVD	Transformer	3		X	X	X		X	
NE-117	Phila. Fire Dept	2009-1	04/27/09	SEPTA	BROAD & ALLGEHENY	Transformer	3		X	X	X	X		
NE-118	Phila. Fire Dept	2009-1	04/27/09	SEPTA	BROAD & WYOMING	Transformer	3		X	X	X	X	X	
NE-119	Phila. Fire Dept	2006-3	10/23/06	THALHEIMER BROS.	5601 TABOR AVE.	Transformer	3	X				X		
NE-120	Phila. Fire Dept	2006-1	05/17/06	Island Green Country Club, Formerly: TRANSIT AMERICA	1 RED LION RD	Transformer	0				X	X		
NE-121	Phila. Fire Dept	2006-3	10/26/06	ALLEGHENY SCRAP	ADAMS & TACONY	CAPACITORS	4	X				X		
NE-122	Phila. Fire Dept	2006-3	10/26/06	ALLEGHENY SCRAP	ADAMS & TACONY	CAPACITORS	4	X				X		
NE-123	Phila. Fire Dept	2010-2	05/25/10	PHILA SCHOOL BOARD	18 & HUNTING PARK (GRATZ)	Transformer	4		X	X	X	X		
NE-124	Phila. Fire Dept	2006-1	05/17/06	Island Green Country Club,	1 RED LION RD						X	X		
NE-125	Phila. Fire Dept	2006-1	05/17/06	Island Green Country Club,							X	X		
NE-126	Phila. Fire Dept	2006-1	05/17/06	Island Green Country Club,							X	X		

NE-127	Phila. Fire Dept	2006-1	05/17/06	Island Green Country Club,							X	X		
NE-128	Phila. Fire Dept	2006-1	05/17/06	Island Green Country Club,							X	X		
NE-129	Phila. Fire Dept	2006-1	05/17/06	Island Green Country Club,							X	X		
NE-130	Phila. Fire Dept	2006-1	05/17/06	Island Green Country Club,							X	X		
NE-131	Phila. Fire Dept	2006-1	05/17/06	Island Green Country Club,							X	X		
NE-132	Phila. Fire Dept	2006-1	05/17/06	Island Green Country Club,							X	X		
NE-133	Phila. Fire Dept	2006-1	05/17/06	Island Green Country Club,							X	X		
NE-134	Phila. Fire Dept	2006-3	10/26/06	ALLEGHENY SCRAP	ADAMS & TACONY	CAPACIT ORS	5	X				X		
NE-135	Phila. Fire Dept	2006-4	03/12/07	Delaware Ave. LLC	HEDLEY & DELAWARE RIVER - 4301 Delaware Ave.	CAPACIT ORS	5				X	X		
NE-136	Phila. Fire Dept	2006-3	11/16/06	ANZON	2545 ARAMINGO AVE.	Transform er	~~5~~				X		X	
NE-137	Phila. Fire Dept	2010-2	Duplicate	PHILA ELECTRIC CO	7735 GERMANTOW N AVE	Transform er	5							
NE-138	Phila. Fire Dept	2006-3	10/26/06	ALLEGHENY SCRAP	ADAMS & TACONY	CAPACIT ORS	6	X				X		
NE-139		2006-2	Blank record								NA		NA	
NE-140	Phila. Fire Dept			PHILA ELECTRIC CO	3901 N DELAWARE AVE	Transform er	6							
NE-141	Phila. Fire Dept			PHILA ELECTRIC CO	4125 LONGSHORE ST	Transform er	6							
NE-142	Phila. Fire Dept			PHILA ELECTRIC CO	7549 THOURON ST	Transform er	6							
NE-143	Phila. Fire Dept	2006-3	10/23/06	THALHEIMER BROS	700 E GODFREY AVE	Transform er	7 (5 retrofilled 2 dry)	X				X		

NE-144	Phila. Fire Dept	2006-3	10/26/06	ALLEGHENY SCRAP	ADAMS & TACONY	CAPACITORS	8	X				X		
NE-145	Phila. Fire Dept	2006-4	03/12/07	Delaware Ave. LLC	HEDLEY & DELAWARE RIVER - 4301 Delaware Ave.	CAPACITORS	8				X	X		
NE-146	Phila. Fire Dept	2009-1	02/28/09	SEPTA	BROAD & GRANGE	Transformer	8		X	X	X	X		
NE-147	Phila. Fire Dept	2006-1	05/17/06	Island Green Country Club,	1 RED LION RD	CAPACITORS	0				X	X		
NE-148	Phila. Fire Dept	2006-3	10/23/06	ALUMINIUM FINISHING	700 E GODFREY	Transformers	~~2~~ Replaced w/ dry (4/94)	X				X		
NE-149	Phila. Fire Dept	2007-3	07/18/07	PHILA STREETS	DELAWARE & WHEATSHEAF	RETROFILLED				X			X	
NE-150	Phila. Fire Dept	2006-3	10/13/06	Philly Self Service	335 E PRICE	RETROFILLED					X	X		
NE-151	Phila. Fire Dept			JOHN F. KENNEDY HOSPITAL	CHELTENHAM AVE. & LANGDON ST.	TRANSFORMERS	2							
NE-152	Phila. Fire Dept	2010-2	05/25/10	PHILA SCHOOL BOARD	D & ALLEGHENY (ELKIN)	TRANSFORMERS	1		X	X	X	X		
NE-153	Exelon			PECO Energy	6106 N 5th Street	Regulator								
NE-154	Exelon			PECO Energy	5031 Elbridge Street	PCB Capacitors								
NE-155	Exelon			PECO Energy	3440 Richmond Street	Light & Power								
NE-156	Exelon			PECO Energy	7735 Gremanton Avenue	Regulator								
NE-157	Exelon			PECO Energy		Regulator								
NE-158	Exelon			PECO Energy		Regulator								
NE-159	Exelon			PECO Energy		Regulator								
NE-	Exelon			PECO Energy		Regulator								

160														
NE-161	Exelon			PECO Energy		Regulator								
NE-162	Exelon			PECO Energy	Pennypack Street	Cable Compartment								
NE-163	Exelon			PECO Energy	1100 Ivy Hill Road	PCB Capacitors								
NE-164	Exelon			PECO Energy	651 Foulkrod Street	PCB Capacitors								
NE-165	Exelon			PECO Energy	7738 Tabor Road	PCB Capacitors								
NE-166	Exelon			PECO Energy	4601 Rhawn Street	PCB Capacitors								
NE-167	Exelon			PECO Energy	LeGrande Avenue	Light & Power								
NE-168	Phila. Fire Dept	2006-4	03/16/07	STONE CONTAINER	9820 BLUE GRASS RD	Transformer	~~1~~				X	X		
NE-169	Phila. Fire Dept	2006-4	03/12/07	Delaware Ave. LLC	HEDLEY & DELAWARE RIVER - 4301 Delaware Ave.	CAPACITOR	1				X	X		
NE-200	Phila. Fire Dept	2007-1	06/10/07	BUDD CO	2401 HUNTING PK	Transformers	1 REMOVED, NOW 4	??			X			
NE-201	Phila. Fire Dept	2007-1	04/25/07	Pioneer Leimel	2250 E ONTARIO ST	Transformer	1	X				X		
SE-1	USEPA Megarule	2009-4	10/6/2009	SEPTA	816 Sansom Street	Transformer	2	X				X		
SE-2	USEPA Megarule	2009-4	10/6/2009	SEPTA	1327 Mount Vernon Street	Transformer	3		X	X	X	X		
SE-3	USEPA Megarule			The School District of Philadelphia	1700 N. 11th Street		1							
SE-4	USEPA Megarule	2009-2	Duplicate Record	The School District of Philadelphia	1700 N. 11th Street		1							
SE-5	USEPA Megarule	2009-4	40096	Southeastern Pennsylvania Transportation Aut	Broad & Pattison Streets	Transformer	2	X				X		

SE-6	Phila. Fire Dept	2006-3	3/14/2007	SOUTHWARK PLAZA (PHA)	1024 S. 4TH. ST.	Transformer	1					X	X	
SE-7		2006-4	Blank record											
SE-8	Phila. Fire Dept	2006-4	3/14/2007	BROAD & LOCUST ASSOCIATES	230 S. BROAD ST.	Transformer	~~1~~				X	X		
SE-9	Phila. Fire Dept			FOUR FREEDOMS	6101 W MORRIS ST	Transformer	1							
SE-10	Phila. Fire Dept	2007-1	5/10/2007	PACKER MARINE TERMINAL	DELAWARE & PACKER	Transformer	1				X	X		
SE-11	Phila. Fire Dept			PHILA ELECT CO	2646 S 13TH ST	Transformer	1							
SE-12	Phila. Fire Dept			PHILA ELECTRIC CO	456 E INDIANNA AVE	Transformer	1							
SE-13	Phila. Fire Dept	2009-2	Duplicate Record	PHILA SCHOOL BOARD	11 & C. B. MOORE (WANAMAKER)	Transformer	1							
SE-14	Phila. Fire Dept	2010-2	4/26/2010	PHILA SCHOOL BOARD	8TH & MIFFLIN (BOK)	Transformer	1	X				X		
SE-15	Phila. Fire Dept	2010-2	5/25/2010	PHILA SCHOOL BOARD	B & ALLEGEHENT (STETSON)	Transformer	1	X				X		
SE-16	Phila. Fire Dept	2010-2	6/18/2010	PHILA SCHOOL BOARD	E.YORK & TRENTON (HACKETT)	Transformer	1		X	X	X	X		
SE-17	Phila. Fire Dept	2010-2	6/18/2010	PHILA SCHOOL BOARD	FKD & CLEMINTINE	Transformer	1		X	X	X	X		
SE-18		2007-1	Blank record											
SE-19	Phila. Fire Dept	2006-2	9/8/2006	SCHMIDTS INC	1097 GERMANTOWN	Transformer	~~1~~				X		**2002**	
SE-20	Phila. Fire Dept	2006-2	9/8/2006	SCHMIDTS INC	1097 GERMANTOWN	Transformer	~~1~~				X		**2002**	

SE-21	Phila. Fire Dept	2006-2	9/8/2006	SCHMIDTS INC	1135 N 2ND	Transformer	~~1~~				X		**2002**	
SE-22	Phila. Fire Dept	2006-2	9/8/2006	SCHMIDTS INC	128 W. VAN HORN	Transformer	~~1~~				X		**2002**	
SE-23	Phila. Fire Dept	2006-2	9/8/2006	SCHMIDTS INC	145 W. WILDEY	Transformer	~~1~~				X		**2002**	
SE-24	Phila. Fire Dept	2006-2	9/8/2006	SCHMIDTS INC	162 W. GIRARD	Transformer	~~1~~				X		**2002**	
SE-25	Phila. Fire Dept	2006-2	9/8/2006	SCHMIDTS INC	188 W. GIRARD	Transformer	~~1~~				X		**2002**	
SE-26	Phila. Fire Dept			SCHNEIDER BROS	1317 BROWN	Transformer	1							
SE-27	Phila. Fire Dept	2009-1	4/28/2009	SEPTA	BROAD & FAIRMOUNT	Transformer	1		X	X	X	X		
SE-28	Phila. Fire Dept	2009-1	4/28/2009	SEPTA	BROAD & FAIRMOUNT	Transformer	1		X	X	X	X		
SE-29	Phila. Fire Dept	2009-1	4/28/2009	SEPTA	BROAD & GIRARD	Transformer	1		X	X	X	X		
SE-30	Phila. Fire Dept	2009-1	4/28/2009	SEPTA	BROAD & GIRARD	Transformer	1		X	X	X	X		
SE-31	Phila. Fire Dept	2009-4	10/6/2009	SEPTA	MC KEAN & JUNIPER	Transformer	1		X	X	X	X		
SE-32	Phila. Fire Dept			ZEIGLER & SONS	6215 ARDLEIGH ST	Transformer	1							
SE-33	Phila. Fire Dept			PHILA ELECTRIC CO	267 E JOHNSON ST	Transformer	11							
SE-34	Phila. Fire Dept			PGW	1800 N. 9TH. ST.	Capacitors	2 (6 Transformers Removed)							
SE-35	Phila. Fire Dept			METRO HOSP	201 N 8TH ST	Transformer	2							
SE-36	Phila. Fire Dept	2007-1	5/10/2007	PACKER MARINE TERMINAL	DELAWARE & PACKER	Transformer	2				X	X		
SE-37	Phila. Fire Dept	2010-2	6/18/2010	PHILA SCHOOL BOARD	2400 N. 8TH (HARTRANFT REC. CENTER)	Transformer	2		X	X	X	X		
SE-38	Phila. Fire Dept	2007-2	8/29/2007	PSFS	7TH & WALNUT	Transformer	2		X			X		

SE-39	Phila. Fire Dept	2006-2	9/8/2006	SCHMIDTS INC	1147 N 2ND	Transformer	~~2~~				X		**2002**	
SE-40	Phila. Fire Dept	2006-2	9/8/2006	SCHMIDTS INC	1157 SOPHIA	Transformer	~~2~~				X		**2002**	
SE-41	Phila. Fire Dept	2006-2	9/8/2006	SCHMIDTS INC	119 EDWARD	Transformer	~~2~~				X		**2002**	
SE-42	Phila. Fire Dept	2006-2	9/8/2006	SCHMIDTS INC	121 EDWARD	Transformer	~~2~~				X		**2002**	
SE-43	Phila. Fire Dept	2010-1	1/6/2010	SEPTA	8TH & RIDGE	Transformer	2		X	X	X	X		
SE-44	Phila. Fire Dept	2009-1	4/28/2009	SEPTA	BROAD & SPRING GARDEN	Transformer	2		X	X	X	X		
SE-45	Phila. Fire Dept	2010-1	1/6/2010	SEPTA	MARKET & 13TH	Transformer	2		X	X	X	X		
SE-46	Phila. Fire Dept	2010-1	1/6/2010	SEPTA	MARKET & 5TH	Transformer	2		X	X	X	X		
SE-47	Phila. Fire Dept	2010-1	1/6/2010	SEPTA	MARKET & 8TH	Transformer	2		X	X	X	X		
SE-48	Phila. Fire Dept	2010-1	1/6/2010	SEPTA	MARKET & JUNIPER	Transformer	2		X	X	X	X		
SE-49	Phila. Fire Dept	2007-2	8/27/2007	SHOE CTR PHILA [Loft Condos]	436-54 N 4TH ST	Transformer	2				X	X		
SE-50	Phila. Fire Dept	2006-3	10/30/2006	Philadelphia Turf Club	700 PACKER AVE	Transformer	2				X		X	
SE-51	Phila. Fire Dept			JEFFERSON HOSPITAL	1020 LOCUST ST	CAPACITORS	3							
SE-52	Phila. Fire Dept			METRO HOSP	201 N 8TH ST	Transformer	3							
SE-53	Phila. Fire Dept			PHILA ELECTRIC CO	2726 W. GORDON ST	Transformer	3							
SE-54	Phila. Fire Dept	2010-2	6/18/2010	PHILA SCHOOL BOARD	8 & CUMBERLAND (HARTRANFT)	Transformer	3		X	X	X	X		
SE-55	Phila. Fire Dept	2009-1	Does not exist	SEPTA	1117 ARCH ST	Transformer	3							
SE-56	Phila. Fire Dept	2010-1	1/6/2010	SEPTA	BROAD & MANNING	Transformer	3		X	X	X	X		
SE-57	Phila. Fire	2009-1	4/29/2009	SEPTA	RIDGE &	Transform	3		X	X	X	X		

	Dept				CALLOWHILL	er								
SE-58	Phila. Fire Dept	2007-2	8/27/2007	US GOVT (GSA) [Social Security Admin. Bldg.)	300 SPRING GARDEN	Transformer	4				X	X		
SE-59	Phila. Fire Dept	2007-2	8/28/2007	US GOVT (GSA) [Social Security Admin. Bldg.)	300 SPRING GARDEN	Transformer	4				X	X		
SE-60	Phila. Fire Dept			QUAKER STORAGE	901 POPLAR ST	Transformer	5							
SE-61	Phila. Fire Dept			PENN MUTUAL	530 WALNUT ST.	Transformer	6							
SE-62	Phila. Fire Dept	2007-2	8/30/2007	US GOVT (GSA)	BROAD & WASHINGTON	Transformer	9				X	X		
SE-63	Phila. Fire Dept			1401 ARCH ST. BUILDING	1401 ARCH ST.	REMOVED/ REPLACED (5)								
SE-64	Phila. Fire Dept	2007-2	8/29/2007	CURTIS CTR	601 WALNUT ST	RETROFILLED	[2]		X			X		
SE-65	Phila. Fire Dept			KEYSTONE SHIPPING	313 CHESTNUT ST	RETROFILLED								
SE-66	Phila. Fire Dept			KEYSTONE SHIPPING	313 CHESTNUT ST	RETROFILLED								
SE-67				PHILA GIRARD SQ	21 S. 12TH ST	RETROFILLED								
SE-68	Phila. Fire Dept	2007-1	6/19/2007	PHILA STREETS (EAST CENTRAL INCINERATOR)	DELAWARE & SPRING GARDEN	RETROFILLED					X		X	
SE-69	Phila. Fire Dept	2007-1	6/19/2007	PHILA STREETS (EAST CENTRAL INCINERATOR)	DELAWARE & SPRING GARDEN	RETROFILLED					X		X	

SE-70	Phila. Fire Dept	2007-1	6/19/2007	PHILA STREETS (EAST CENTRAL INCINERATOR)	DELAWARE & SPRING GARDEN	RETROFILLED					X		X	
SE-71	Phila. Fire Dept	2007-2	8/31/2007	WANAMAKERS	1300 MARKET	RETROFILLED					X	X		
SE-72	Phila. Fire Dept	2010-2	5/25/2010	PHILA SCHOOL BOARD	2800 N. 6TH ST (FAIRHILL)	UNKNOWN					X	X	X	
SE-73	Exelon			PECO	1121 W. Callowhill St.	PCB Capacitors								
SW-1	USEPA Megarule	2009-4	40092	Southeastern Pennsylvania Transporting Autho	33rd & Market St; Subway Surface		3		X			X		
SW-2	USEPA Megarule	2010-2	40347	The School District of Philadelphia	1400 Green Street		2		X			X		
SW-3	USEPA Megarule	2010-2	Duplicate	The School District of Philadelphia	1400 Green Street		2							
SW-4	USEPA Megarule	2009-4	10/6/2009	Southeastern Pennsylvania Transporting Autho	2034 Ranstead Street		3		X			X		
SW-5	USEPA Megarule	2010-2	6/18/2010	The School District of Philadelphia	6450 Ridge Avenue		4		X			X		
SW-6	USEPA Megarule	2010-2	Duplicate	The School District of Philadelphia	6450 Ridge Avenue		4							
SW-7	USEPA Megarule			Peco Energy Company	West Chester Pike & Ashton Rd		1							
SW-8	USEPA Megarule	2010-2	Duplicate	Peco Energy Company	West Chester Pike & Ashton Rd		1							
SW-9	USEPA Megarule			PECO Energy Co.	E. Wynnewood Road, SW/O Lancaster Pike		1							

SW-10	USEPA Megarule	2008-1	Duplicate Record	PECO Energy Co.	E. Wynnewood Road, SW/O Lancaster Pike		1							
SW-11	USEPA Megarule	2010-2	Duplicate	The School District of Philadelphia	2200 N. 31st Street		2							
SW-12	USEPA Megarule	2009-2	Duplicate record	The School District of Philadelphia	2200 N. 31st Street		2							
SW-13	USEPA Megarule			Peco Energy Company	2800 Christian Street		2							
SW-14	USEPA Megarule	2009-2	Duplicate Record	Peco Energy Company	2800 Christian Street		2							
SW-15	USEPA Megarule	2006-4	2/22/2007	Sunoco, Inc. (R&M) Philadelphia Refinery	3144 PASSYUNK AVE	RETROFILLED	~~3~~ 2	X				X		
SW-16	USEPA Megarule	2006-4	2/22/2007	Sunoco, Inc. (R&M) Philadelphia Refinery	3144 PASSYUNK AVE	RETROFILLED	~~3~~ 2	X				X		
SW-17	USEPA Megarule			Peco Energy Company	2131 N 62nd Street		1							
SW-18	USEPA Megarule			Peco Energy Company	2131 N 62nd Street		1							
SW-19	USEPA Megarule			PECO Energy Co.	380 Long Lane		1							
SW-20	USEPA Megarule	2008-1	Duplicate Record	PECO Energy Co.	380 Long Lane		1							
SW-21	USEPA Megarule	2006-4	2/20/2007	Goebelwood Ind. Inc,	100 Sycamore Ave.	Transformers	3	X				X		
SW-22	USEPA Megarule	2006-4	Duplicate Record	Goebelwood Ind. Inc,	100 Sycamore Ave.		3							
SW-23	Phila. Water Dept	2006-2	10/4/2006	PHILA WATER DEPT	7000 Penrose Ave	CAPACITOR	2	X				X		
SW-24	Phila.Water Dept	2006-2	10/24/2006	PHILA WATER DEPT	NEIL DR & WINDING RD	Transformers	1		2004		X	X		
SW-25	Phila. Fire Dept	2007-4	1/25/2008	PASCHALL APARTMENTS (PHA)	7212 WOODLAND AVE		1			X		X		
SW-	Phila. Fire			1500 WALNUT	15TH	Transform	1							

26	Dept			BLDG	WALNUT ST	ers								
SW-27	Phila. Fire Dept	2006-3	10/11/2006	ADAMS MARK HOTEL	CITY & MONUMENT	Transformers	1		**2005**		**X**			Demolished
SW-28	Phila. Fire Dept	2006-3	10/11/2006	ADAMS MARK HOTEL	CITY & MONUMENT	Transformers	1		**2005**		**X**			Demolished
SW-29	Phila. Fire Dept	2006-3	10/11/2006	ADAMS MARK HOTEL	CITY & MONUMENT	Transformers	1		**2005**		**X**			Demolished
SW-30	Phila. Fire Dept	2006-3	10/11/2006	ADAMS MARK HOTEL	CITY & MONUMENT	Transformers	1		**2005**		**X**			Demolished
SW-31	Phila. Fire Dept	2006-4	2/22/2007			RETROFILLED	~~1~~ 2	**X**				**X**		
SW-32	Phila. Fire Dept	2006-4	2/22/2007			RETROFILLED	1	**X**				**X**		
SW-33	Phila. Fire Dept	2006-4	2/22/2007			RETROFILLED	1	**X**				**X**		
SW-34	Phila. Fire Dept	2006-4	2/22/2007			RETROFILLED	1	**X**				**X**		
SW-35	Phila. Fire Dept	2006-4	2/22/2007			RETROFILLED	~~1~~ 2	**X**				**X**		
SW-36	Phila. Fire Dept	2006-4	2/22/2007			RETROFILLED	1	**X**				**X**		
SW-37	Phila. Fire Dept	2006-4	2/22/2007	Sunoco, Inc. (R&M)	3144	RETROFILLED	1	**X**				**X**		
SW-38	Phila. Fire Dept	2006-4	2/22/2007	Philadelphia Refinery	PASSYUNK AVE	RETROFILLED	1	**X**				**X**		
SW-39	Phila. Fire Dept	2007-4	1/22/2008	CARBONATOR RENTAL	6500 EASTWICK	Transformers	1	**X**				**X**		
SW-40	Phila. Fire Dept			DREXEL UNIV	3330 MARKET ST	Transformers	1							
SW-41	Phila. Fire Dept			DREXEL UNIV	3330 MARKET ST	Transformers	1							
SW-42	Phila. Fire Dept			EASTERN PENNSYLVANIA PSYCHIATRIC HOSPITAL (EPPI)	3200 HENRY AVE.	Transformers	1							

SW-43	Phila. Fire Dept	2007-4	1/18/2008	~~HB HESS CO~~ Lane's Borough	1601 Locust St.	Transformers	1	X				X		
SW-44	Phila. Fire Dept			PHILA COMMERCE	PIA LONGTERM PKNG	Transformers	1							
SW-45	Phila. Fire Dept			PHILA COMMERCE	PIA SCOTT PAPER	Transformers	1							
SW-46	Phila. Fire Dept			PHILA COMMERCE	PIA UAL FLT KITCH	Transformers	1							
SW-47	Phila. Fire Dept			PHILA ELECT CO	523 N 18TH ST	Transformers	1							
SW-48	Phila. Fire Dept			PHILA ELECTRIC CO	2600 HUNTING PARK AVE	Transformers	1							
SW-49	Phila. Fire Dept	2010-2	6/18/2010	PHILA SCHOOL BOARD	22ND & SUSQUEHANNA	Transformers	1	X				X		
SW-50	Phila. Fire Dept	2010-2	4/26/2010	PHILA SCHOOL BOARD	23 & CHESTNUT (GREENFIELD)	Transformers	2		X	X	X	X		
SW-51	Phila. Fire Dept	2010-2	4/26/2010	PHILA SCHOOL BOARD	32 & LEHIGH (E. ALLEN)	Transformers	1		X	X	X	X		
SW-52	Phila. Fire Dept	2010-2	Duplicate	PHILA SCHOOL BOARD	32ND & RIDGE	Transformers	1							
SW-53	Phila. Fire Dept			PHILA SCHOOL BOARD	58TH & WALNUT (SAYRE)	Transformers	1							
SW-54	Phila. Fire Dept			PHILA SCHOOL BOARD	67TH & ELMWOOD	Transformers	1							
SW-55	Phila. Fire Dept			PHILA SCHOOL BOARD	734 SCHYKILL AVE	Transformers	1							
SW-56	Phila. Fire Dept			PHILA SCHOOL BOARD	734 SCHYKILL AVE	Transformers	1							
SW-57	Phila. Fire Dept			PHILA SCHOOL BOARD	734 SCHYKILL AVE	Transformers	1							

SW-58	Phila. Fire Dept	2010-2	6/18/2010	PHILA SCHOOL BOARD	HENRY & ROBERTS (RANDOLPH)	Transformers	1		X	X	X	X		
SW-59	Phila. Fire Dept			PHILA UNTD INS	4500 CITY AVE	Transformers	1							
SW-60		2006-2	Blank Record											
SW-61	Phila. Fire Dept			PHOENIX MUTUAL	1508 WALNUT	Transformers	1							
SW-62	Phila. Fire Dept	2006-4	3/14/2007	RICH. I. RUBIN CO	230 S BROAD ST	Transformers	1	X				X		
SW-63	Phila. Fire Dept			SEPTA	37TH & SANSOM	Transformers	1							
SW-64	Phila. Fire Dept	2007-2	7/30/2007	SPC CORP	26TH & PENROSE	Transformers	1				X	X		
SW-65	Phila. Fire Dept	2007-2	7/30/2007	SPC CORP	26TH & PENROSE	Transformers	1				X	X		
SW-66		2006-4	Blank Record											
SW-67	Phila. Fire Dept	2006-4	12/19/2006	SUN CHEMICAL	3301 HUNTING PARK	Dry TRANSFORMER	1	X				X		
SW-68	Phila. Fire Dept	2006-4	12/19/2006	SUN CHEMICAL	3301 HUNTING PARK	Dry TRANSFORMER	~~1~~ 2	X				X		
SW-69	Phila. Fire Dept	2006-3	3/14/2007	ATLANTIC BLDG	260 S BROAD ST	CAPACITORS	~~16~~				X	X		
SW-70	Phila. Fire Dept	2006-2	8/7/2006	MELLON BANK	Broad & Chestnut Streets	CAPACITORS	~~17~~				X		X	
SW-71	Phila. Fire Dept	2006-2	6/5/2006			CAPACITORS	2	X				X		
SW-72	Phila. Fire Dept	2006-2	6/5/2006			CAPACITORS	2	X				X		
SW-73	Phila. Fire Dept	2006-2	6/5/2006			CAPACITORS	2	X				X		
SW-74	Phila. Fire Dept	2006-2	6/5/2006			CAPACITORS	2	X				X		
SW-75	Phila. Fire Dept	2006-2	6/5/2006	MCP	3300 HENRY AVE.	CAPACITORS	2	X				X		
SW-	Phila. Fire			1500 WALNUT	15TH	Transform	2							

76	Dept			BLDG	WALNUT ST	ers								
SW-77	Phila. Fire Dept			HOLIDAY INN	1800 MARKET	Transformers	2							
SW-78	Phila. Fire Dept	2007-4	1/22/2008	Shoprite Store	2301 OREGON AVE	Transformers	2				X	X		
SW-79	Phila. Fire Dept			PHILA COMMERCE	PIA CTRL UTIL BLDG	Transformers	2							
SW-80	Phila. Fire Dept			PHILA COMMERCE	PIA S. APRON	Transformers	2							
SW-81	Phila. Fire Dept	2010-2	4/26/2010	PHILA SCHOOL BOARD	24 & MASTER (VAUX)	Transformers	2		X	X	X	X		
SW-82	Phila. Fire Dept	2010-1	2/3/2010	PHILA SCHOOL BOARD	32 & SUSQUEHANNA (STRAWBERRY MANSION)	Transformers	2	X				X		
SW-83	Phila. Fire Dept			PHILA SCHOOL BOARD	49 & CHESTNUT (MYA PARKWAY)	Transformers	2							
SW-84	Phila. Fire Dept	2010-1	1/6/2010	SEPTA	36TH & SANSOM	Transformers	2		X	X	X	X		
SW-85	Phila. Fire Dept	2010-1	1/6/2010	SEPTA	37TH & SANSOM	Transformers	2		X	X	X	X		
SW-86	Phila. Fire Dept	2010-1	1/6/2010	SEPTA	BROAD & CHANCELLOR	Transformers	2		X	X	X	X		
SW-87	Phila. Fire Dept	2010-1	1/6/2010	SEPTA	BROAD & DAUPHIN	Transformers	2		X	X	X	X		
SW-88	Phila. Fire Dept	2010-1	1/6/2010	SEPTA	BROAD & MARKET	Transformers	2		X	X	X	X		
SW-89	Phila. Fire Dept	2010-1	1/6/2010	SEPTA	BROAD & OREGON	Transformers	2		X	X	X	X		
SW-90	Phila. Fire Dept	2010-1	1/5/2010	SEPTA	BROAD & SNYDER	Transformers	2		X	X	X	X		
SW-91	Phila. Fire Dept			SEPTA	BROAD & TASKER	Transformers	2							
SW-92	Phila. Fire Dept	2010-1	1/5/2010	SEPTA	MARKET & 30TH	Transformers	2		X	X	X	X		
SW-	Phila. Fire			SEPTA	RIDGE &	Transform	2							

93	Dept				FAIRMOUNT	ers								
SW-94	Phila. Fire Dept			SEPTA	RIDGE & SPRING GARDEN	Transformers	2							
SW-95	Phila. Fire Dept	2007-4	1/24/2008	Leacoras Center & Shops	1724 N BROAD ST	Transformers	2				X		X	
SW-96	Phila. Fire Dept	2006-3	11/16/2006	112 N. BROAD ST.	112 N. BROAD ST.	Transformers DRY-TYPE	2	NA				X		
SW-97	Phila. Fire Dept	2006-2	8/7/2006	MELLON BANK	Broad & Chestnut Streets	CAPACITORS	~~20~~				X		X	
SW-98	Phila. Fire Dept	2006-2	8/7/2006	MELLON BANK	Broad & Chestnut Streets	CAPACITORS	~~22~~				X		X	
SW-99	Phila. Fire Dept	2006-2	6/5/2006	MCP	3300 HENRY AVE.	CAPACITORS	3	X				X		
SW-100	Phila. Fire Dept	2006-2	8/11/2006	St.Joes Dormitory	5320 CITY AVE	CAPACITORS	~~3~~				X		X	
SW-101	Phila. Fire Dept			EASTERN PENNSYLVANIA PSYCHIATRIC HOSPITAL (EPPI)	3200 HENRY AVE.	Transformers	3	X				X		
SW-102	Phila. Fire Dept	2007-4	1/24/2008	Devon Self Storage	19TH & ALLEGHENY	Transformers	3				X		X	
SW-103	Phila. Fire Dept	2009-1	Duplicate record	SEPTA	33RD. & MARKET	Transformers	3							
SW-104	Phila. Fire Dept			SEPTA	MARKET & 15TH	Transformers	3							
SW-105	Phila. Fire Dept			SEPTA	MARKET & 25TH	Transformers	3							
SW-106	Phila. Fire Dept			SEPTA	MARKET & 31ST	Transformers	3							
SW-107	Phila. Fire Dept			SEPTA	MARKET & 44TH	Transformers	3							
SW-108	Phila. Fire Dept	2007-2	8/8/2007	THE PHILADELPHIAN	2401 PENNSYLVANIA AVE.	Transformers	3			X		X		
SW-	Phila. Fire	2007-2	8/8/2007	THE	2401	Transform	3							

109	Dept			PHILADELPHIA N	PENNSYLVANIA AVE.	ers								
SW-110	Phila. Fire Dept			PHILA COMMERCE	PIA MAIN TERM	CAPACITORS	33							
SW-111	Phila. Fire Dept	2006-2	8/7/2006	Ritz Carlton	Broad & Chestnut Streets	CAPACITORS	4				X	X		
SW-112	Phila. Fire Dept	2007-4	1/22/2008	Shoprite Store	2301 OREGON AVE	CAPACITORS	4			X				X
SW-113	Phila. Fire Dept			1530 BLDG	1530 CHESTNUT	Transformers	4							
SW-114	Phila. Fire Dept	2007-3	11/23/2007	GOLDMAN PAPER	2201 E ALLEGHENY	Transformers	4				X		X	
SW-115	Phila. Fire Dept	2007-4	1/25/2008	METHODIST HOSP	2301 S BROAD	Transformers	4				X	X		
SW-116	Phila. Fire Dept	2007-4	1/25/2008	METHODIST HOSP	2301 S BROAD	Transformers	4				X	X		
SW-117	Phila. Fire Dept	2006-2	6/5/2006	MCP	3300 HENRY AVE.	CAPACITORS	5	X				X		
SW-118	Phila. Fire Dept			PHILA ELECTRIC CO	1835 OXFORD STA	Transformers	5							
SW-119	Phila. Fire Dept	2006-4	3/14/2007	ATLANTIC BLDG	260 S BROAD ST	Transformers(1 NOW NON-PCB)	5	X				X		
SW-120		2009-2	Blank Record											
SW-121	Phila. Fire Dept	2007-2	7/11/2007	EASTERN PENNSYLVANIA PSYCHIATRIC HOSPITAL (EPPI)	3200 HENRY AVE.	Transformers	6							
SW-122	Phila. Fire Dept	2007-2	7/11/2007	EASTERN PENNSYLVANIA PSYCHIATRIC HOSPITAL (EPPI)	3200 HENRY AVE.	Transformers	6							

SW-123	Phila. Fire Dept	2007-2	7/11/2007	EASTERN PENNSYLVANIA PSYCHIATRIC HOSPITAL (EPPI)	3200 HENRY AVE.	Transformers	6							
SW-124	Phila. Fire Dept	2007-2	7/11/2007	EASTERN PENNSYLVANIA PSYCHIATRIC HOSPITAL (EPPI)	3200 HENRY AVE.	Transformers	6							
SW-125	Phila. Fire Dept			FIRST PA BANK	3020 MARKET	Transformers	6							
SW-126	Phila. Fire Dept	2006-2	8/7/2006	~~MELLON BANK~~	Broad & Chestnut Streets	Transformers	~~6~~				X		X	
SW-127	Phila. Fire Dept	2010-2	6/18/2010	PHILA SCHOOL BOARD	17 & SPRING GARDEN (MASTERMAN)	Transformers	6	X				X		
SW-128	Phila. Fire Dept			PHILA SCHOOL BOARD	22ND & LEHIGH (DOBBINS)	Transformers	7							
SW-129	Phila. Fire Dept	2006-2	6/5/2006	MCP	3300 HENRY AVE.	CAPACITORS	8	X				X		
SW-130	Phila. Fire Dept	2007-2	8/18/2007	RITTENHOUSE PLAZA	19TH & WALNUT	RETROFILLED	[4]	X				X		
SW-131	Phila. Fire Dept	2006-3	11/16/2006	Commerce Bldg.	401 N BROAD ST	RETROFILLED	3	X				X		
SW-132	Phila. Fire Dept			CHILDRENS HOSPITAL	34TH & CIVIC CTR BLVD	RETROFILLED								
SW-133	Phila. Fire Dept			CHILDRENS HOSPITAL	34TH & CIVIC CTR BLVD	RETROFILLED								
SW-134	Phila. Fire Dept	2007-4	1/18/2008	KENNEDY HOUSE[Condos]	1901 JFK BLVD	RETROFILLED		X				X		
SW-136	Phila. Fire Dept	2006-4	3/14/2007	LAND TITLE BLDG	100 S BROAD ST	RETROFILLED	4	X				X		
SW-135	Phila. Fire Dept	2007-4	Duplicate Record	KENNEDY HOUSE	1901 JFK BLVD	RETROFILLED								

SW-137	Phila. Fire Dept	2007-2	7/11/2007	MELRATH GASKET	2901 HUNTING PK	RETROFILLED	0	X				X		
SW-138	Phila. Fire Dept	2007-4	1/18/2008	Suburban Station	1617 J.F. KENNEDY BLVD.	RETROFILLED	[3]	X				X		
SW-139	Phila. Fire Dept			PHILA COMMERCE	NEA ASPLUNDH HANGER	RETROFILLED								
SW-140	Phila. Fire Dept			PHILA COMMERCE	PIA ATLANTIC AVIATION	RETROFILLED								
SW-141	Phila. Fire Dept			PHILA COMMERCE	PIA BAGGAGE CLAIM	RETROFILLED								
SW-142	Phila. Fire Dept			PHILA PARKING AUTH.	PIA PARKING GARAGE C	RETROFILLED								
SW-143	Phila. Fire Dept			PHILA PARKING AUTH.	PIA PARKING GARAGE D	RETROFILLED								
SW-144	Phila. Fire Dept	2007-4	1/23/2008	PHILA STREETS (BARTRAM TRANSFER STATION)	51 & GRAYS	RETROFILLED				X			X	
SW-145		2006-2	Blank Record											
SW-146	Phila. Fire Dept	2007-1	5/11/2007	PHILADELPHIA AIRPORT HILTON	4509 ISLAND AVE	RETROFILLED			X			X		
SW-147	Phila. Fire Dept	2007-1	5/22/2007	STREETS (NORTHWEST INCINERATOR	DOMINO & UMBRIA	RETROFILLED					X	X		
SW-148	Phila. Fire Dept			PHILA COMMERCE	PIA TWA HANGER	RETROFILLED #30257 CERTIFICATION								
SW-149	Phila. Fire Dept			PHILA COMMERCE	PIA TERM E	RETROFILLED #30276 & 30277 CERTIFIC								

						ATION								
SW-150	Phila. Fire Dept			PHILA COMMERCE	PIA PAVILION E	RETROFILLED #30278 & 30279 CERTIFICATION								
SW-151	Phila. Fire Dept			PHILA COMMERCE	PIA TERM D	RETROFILLED #30281 & 30281 CERTIFICATION								
SW-152	Phila. Fire Dept			PHILA SCHOOL BOARD	54 & MASTER (HESTON)	UNKNOWN								
SW-153	Phila. Fire Dept			PHILA ELECT CO	1122 SEDGELY AVE	Transformers	1							
SW-154	Phila. Fire Dept			PHILA SCHOOL BOARD	8 & LEHIGH (BILINGUAL MIDDLE MAGNET)	Transformers	2							
SW-155	Exelon			PECO	24th & Washington Avenue	Transformer								
SW-156	Exelon			PECO	7515 Ridge Avenue	Transformer (Tap Changer)								
SW-156a	Exelon			PECO	1155 S. 57th Street	Regulator								
SW-157	Exelon			PECO	7200 N. Umbria Street	PCB Capacitors								
SW-157a	Exelon			PECO	2230 Township Line Road	Regulator								
SW-158	Phila. Fire Dept	2006-4	12/19/2006	SUN CHEMICAL	3301 HUNTING PARK	Dry TRANSFORMER	1	X				X		

APPENDIX G – PWD QUARTERLY DRY WEATHER WATER QUALITY MONITORING PROGRAM

Quarterly Dry Weather Water Quality Monitoring

Background

General

In 2009, the Philadelphia Water Department (PWD) initiated a dry weather water quality sampling program designed to work in tandem with the continuous data collection efforts of the PWD/USGS Cooperative Program. Grab samples are collected from ten sites covering all six of Philadelphia County's watersheds on a quarterly basis by the staff of PWD's Bureau of Laboratory Services (BLS). Data collected through this program are most pertinent to Target A (Dry Weather Water Quality & Aesthetics) of the PWD's Integrated Watershed Management Plan (IWMP) Strategy, as outlined in the following section.

PWD's IWMP "Target" Strategy

IWMPs are designed to meet the goals and objectives of numerous, water resources related regulations and programs. Each IWMP results in a series of implementation recommendations that utilize adaptive management approaches to achieve measurable benefits watershed-wide. Through PWD's experience in working with stakeholder groups in goal prioritization and option evaluation, they have learned that stakeholder priorities can at times differ from those identified by the data driven problem identification process. This could present a challenge in development and approval of a management alternative for watershed implementation. PWD has developed an approach that is able to address what often emerges as a set of high priority stakeholder concerns while simultaneously addressing the scientifically defined priorities.

By defining three distinct "targets" to meet the overall plan objectives, priorities identified by stakeholders could be addressed simultaneously with those identified through scientific data. Two of the targets were defined so that they could be fully met through implementation of a limited set of options, while the third target would be best addressed through an adaptive management approach. In addition to the three Targets – a fourth category has been developed to capture the more programmatic implementation options related to planning, outreach, reporting, and continuation of the Watershed Partnership.

Targets are defined here as groups of objectives that each focus on a different problem related to the urban stream system. They can be thought of as different parts of the overall goal of fishable and swimmable waters through improved water quality, more natural flow patterns, and restored aquatic and riparian habitat. Targets are specifically designed to help focus plan implementation. By defining these targets, and designing alternatives and an implementation plan to address the targets simultaneously, the plan will have a greater likelihood of success. It also will result in realizing some of the objectives within a relatively short time frame, providing positive incentives to the communities and agencies involved in the restoration, and more immediate benefits to the people living in the watershed. PWD's IWMP planning targets are defined below:

Program Support

A number of implementation options deemed appropriate for a given watershed are "programmatic" in nature. While these options may support achievement of Targets A, B, and/or C, implementation of these options alone would not result in achievement of a particular Target. These "Program Support" associated options include items such as monitoring, reporting, feasibility studies, outreach/education, and continuation of the Watershed Partnership.

Target A: Dry Weather Water Quality and Aesthetics

Streams should be aesthetically appealing (look and smell good), be accessible to the public, and be an amenity to the community. Target A was defined with a focus on eliminating sources of sewage discharge and other pollution during dry weather, along with trash removal and litter prevention. Access and interaction with the stream during dry weather has the highest priority, because dry weather flows occur about 60-65% of the time during the course of a year. These are also the times when the public is most likely to be near or in contact with the stream. In dry weather, stream water quality should be similar to background concentrations in groundwater, particularly with respect to bacteria.

Target B: Healthy Living Resources

Improvements to the number, health, and diversity of benthic macroinvertebrate and fish species need to focus on habitat improvement and the creation of refuges for organisms to avoid high velocities during storms. Fluvial geomorphological studies, wetland and streambank restoration/creation projects, and stream modeling should be combined with continued biological monitoring to ensure that correct procedures are implemented to increase habitat heterogeneity within the aquatic ecosystem.

Improving the ability of an urban stream to support viable habitat and fish populations focuses primarily on the elimination or remediation of the more obvious impacts of urbanization on the stream. These include loss of riparian habitat, eroding and undercut banks, scoured streambed or excessive sediment deposits, channelized and armored stream sections, trash buildup, and invasive species. Thus, the primary tool to accomplish Target B is stream restoration.

Target C: Wet Weather Water Quality and Quantity

The third target is to restore water quality to meet fishable and swimmable criteria during wet weather. Improving water quality and flow conditions during and after storms is the most difficult target to meet in the urban environment. During wet weather, extreme increases in streamflow are common, accompanied by short-term changes in water quality. Where water quality and quantity problems exist, options may be identified that address both. Any BMP that increases infiltration or detains flow will help decrease the frequency of damaging floods; however, the size of such structures may need to be increased in areas where flooding is a major concern. (Reductions in the frequency of erosive flows and velocities also will help protect the investment in stream restoration made as part of the Target B.)

Target C must be approached somewhat differently from Targets A and B. Full achievement of this target means meeting all water quality standards during wet weather, as well as elimination of flood related issues. Meeting these goals will be difficult. It will be expensive and will require a long-term effort. A rational approach to achieve this target includes stepped implementation with interim goals for reducing wet weather pollutant loads and stormwater flows, along with monitoring for the efficacy of control measures.

Monitoring Locations

Water quality samples are taken at ten USGS gage sites in the USGS/PWD Cooperative Monitoring Program (Figure 1). Site identification codes used by PWD's Bureau of Laboratory Services (BLS) are presented alongside USGS gage station numbers in Table 1. USGS stream gaging stations are ideal monitoring points as they allow discrete sample data to be coupled with continuous data being collected year-round at these sites for loading estimate purposes. Furthermore, grab sample results and field meter readings taken at the time of grab sampling may be invaluable when evaluating continuous water quality data from these USGS gages.

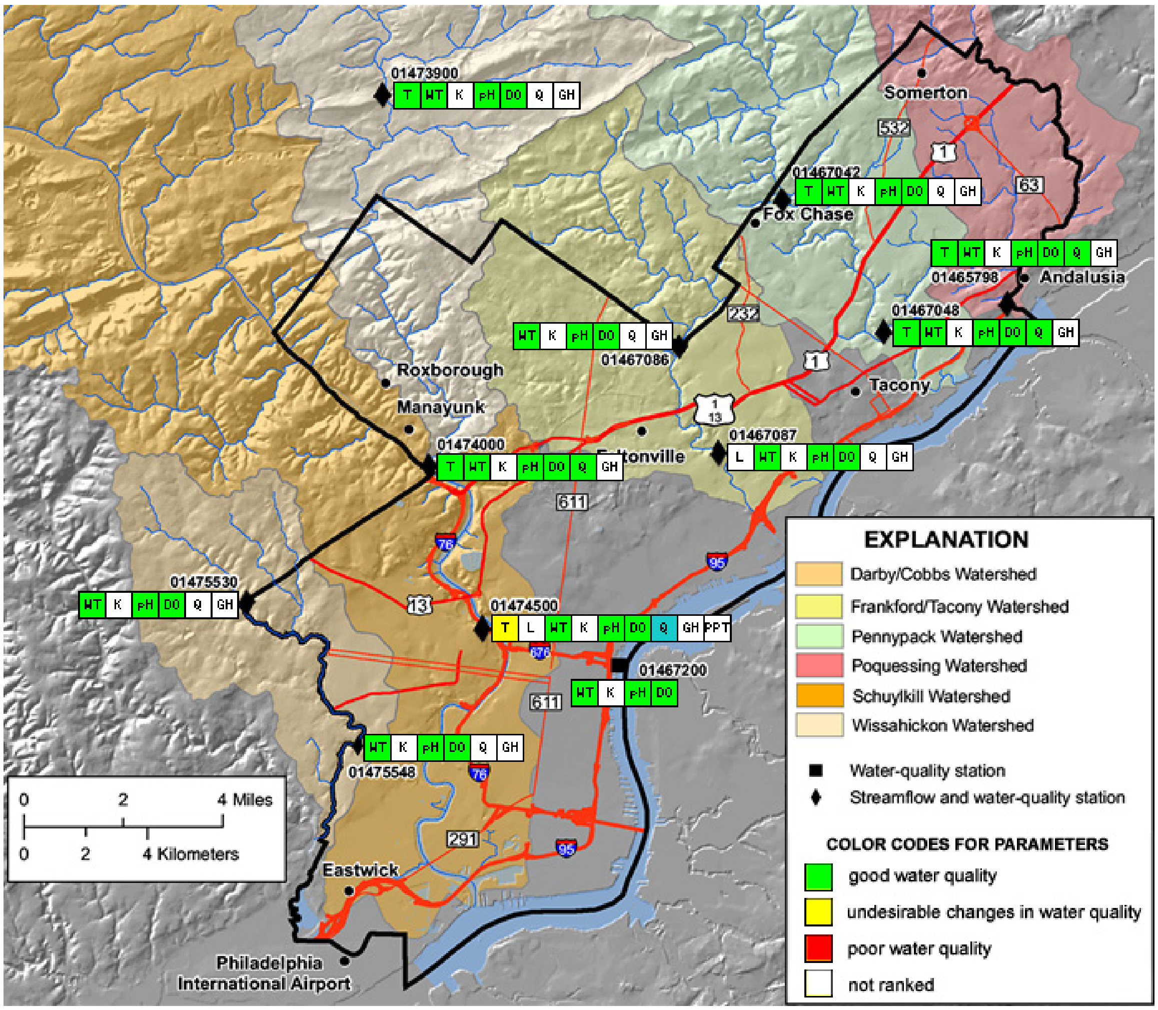


Figure 1. Philadelphia Water Quality Gage Stations as Viewed on Cooperative USGS-PWD Website (http://pa.water.usgs.gov/pwd/).

Table 1. Monitoring Locations in the PWD/USGS Cooperative Monitoring Program with location IDs used by PWD Bureau of Laboratory Services

Description	USGS Gage #	BLS Location ID
Cobbs Creek at US Rt. 1 (City Line Ave.)	01475530	COBB700
Cobbs Creek at Mt. Moriah cemetery	01475548	COBB355
Schuylkill River at Fairmount Dam	01474500	SCHU154
Wissahickon Creek at Ft Washington (Rt. 73)	01473900	WISS500
Wissahickon Creek at Ridge Ave.	01474000	WISS130
Tacony Creek at Castor Ave.	01467087	TACO250
Tacony Creek at Adams Ave.	01467086	TACO435
Pennypack Creek at Pine Rd.	01467042	PENN407
Pennypack Creek at Rhawn St.	01467048	PENN175
Poquessing Creek at Grant Ave.	01465798	POQU150

PWD is implementing a City-wide approach to dry weather water quality monitoring, rather than focusing on a single individual watershed. Currently a number of BMP projects are in their early stages of implementation across the city, water quality benefits of which will only be observable over a period of several years. This fact remains, regardless of whether water quality is monitored on a broad or focused scale. Gauging the success of such projects on a more immediate scale is best accomplished solely by hydrological analysis. Therefore, the strategic value of the widespread sampling approach is that as more BMP projects are completed over the coming years, the water quality data should gradually begin to reflect their positive environmental impacts.

Quarterly Monitoring - June 2009 – June 2010

Stream Conditions

This report summarizes results from a five sets of quarterly grab samples that were collected from June 2009 through June 2010. In subsequent years, four sets of samples per year will be presented in the annual summary, along with comparison to historical data from Comprehensive Characterization Reports (CCR). PWD is not aware of any spills, discharges or unusual conditions that would cause misleading results in the water quality data from any of these grab samples.

Nutrient Analysis

The macronutrients phosphorus and nitrogen are essential to the growth and overall survival of all plants. However, when occurring in surplus they can be extremely detrimental to aquatic ecosystems, and in turn to the human population that utilizes these water bodies for drinking water and recreational activities such as fishing, boating, and swimming. Elevated nutrient concentrations in rivers and streams can most often be attributed to anthropogenic pollution sources. In these situations, the most common sources of both nutrients are runoff from fertilized lawns/farmland and wastewater discharge.

The most immediate result of excessive nutrient concentrations in any natural water body is excessive plant growth, seen in a variety of growth forms from suspended algae to aquatic macrophytes. As the first step in the process of eutrophication, this unnatural acceleration of aquatic plant growth can start a chain reaction leading to highly adverse effects to that ecosystem. For example, in small shallow streams, unnaturally high densities of algal periphyton can cause pronounced fluctuations in dissolved oxygen and pH and also adversely affect aquatic habitat by forming thick mats of filamentous algae or algal scums on stream substrates. Moreover, alteration of the algal community structure can lead to the proliferation of nuisance taxa, taste and odor problems in the drinking water supply, increased water treatment costs, and in rare cases, production of toxins (*e.g.*, from cyanobacteria blooms). As a result of these direct and indirect responses, streams and rivers can suffer severe impacts in regard to both aquatic biodiversity and human recreational use.

It should be noted that several phosphorus-containing compounds, known as polyphosphates, can be found in the region's waterways, but they are naturally occurring and are present due to the geologic composition of the area. Furthermore, these polyphosphates pose little ecological threat as they are not present in a biologically available form. Only over long periods of time can these compounds be broken down into orthophosphates, which plants and algae can absorb and utilize for growth. Therefore, aside from the relatively minor contributions of the regions geology, the most significant source of orthophosphates in rivers and streams is human-generated pollution. It is for this reason that orthophosphates, along with nitrates, are included as components of this water quality monitoring program. These forms of N and P are readily available to stream producers.

Nutrient Results

Nutrient data collected in thus far at each of the sites are generally consistent with the data collected for Comprehensive Characterization Reports (CCRs) prepared for each of the respective watersheds. Five of 10 sites are not affected by treated wastewater and had orthophosphate concentration less than the reporting limit of 0.1 mg/L (Figure 3). Conversely, Pennypack and Wissahickon Creeks had multiple instances of elevated P concentration which is likely attributable to point source discharge of treated wastewater. Dilution effects were seen between upstream and downstream gages, particularly in the cases of Pennypack and Wissahickon Creeks. PWD recognizes that the 0.1mg/L reporting limit value is close to, or perhaps even within the recommended range of instream phosphorus concentration expected to result in nuisance densities of algal periphyton and is working to improve the low-scale performance of phosphorus laboratory analyses.

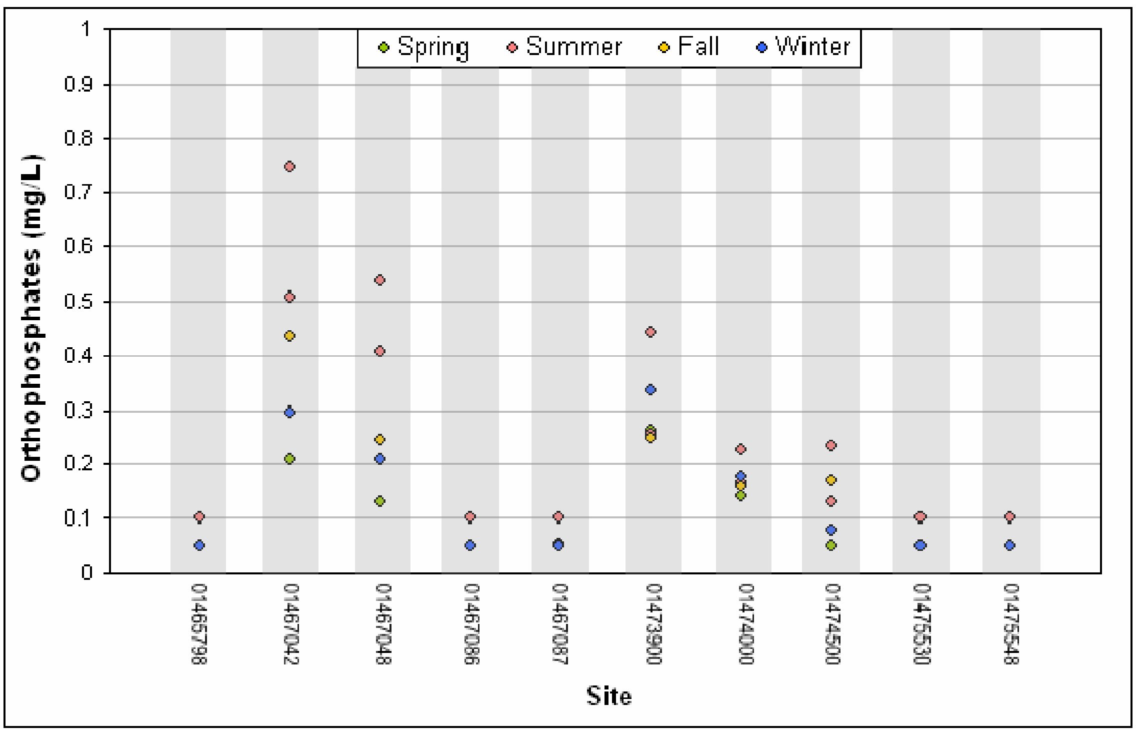


Figure 3. Orthophosphate concentration at 10 USGS gage stations, June 2009-June 2010

Similar examples of wastewater discharge impacts and upstream/downstream dilution have also begun to emerge with regards to the nitrate data that has been collected. The data seem to indicate a trend towards decreased nitrate concentrations during warmer months, which would correspond to the increased uptake of nutrients by plant life during those growing seasons (Figure 4). The only exceptions are the Pennypack and Wissahickon Creek gage sites, which as previously stated are directly impacted by treated wastewater discharge. It should be noted, however, that these statements and observations are in no way conclusive given that the dataset is still relatively limited in size. As this dataset grows over subsequent years, further statistical analysis can be carried out and any apparent patterns or phenomena can be explored.

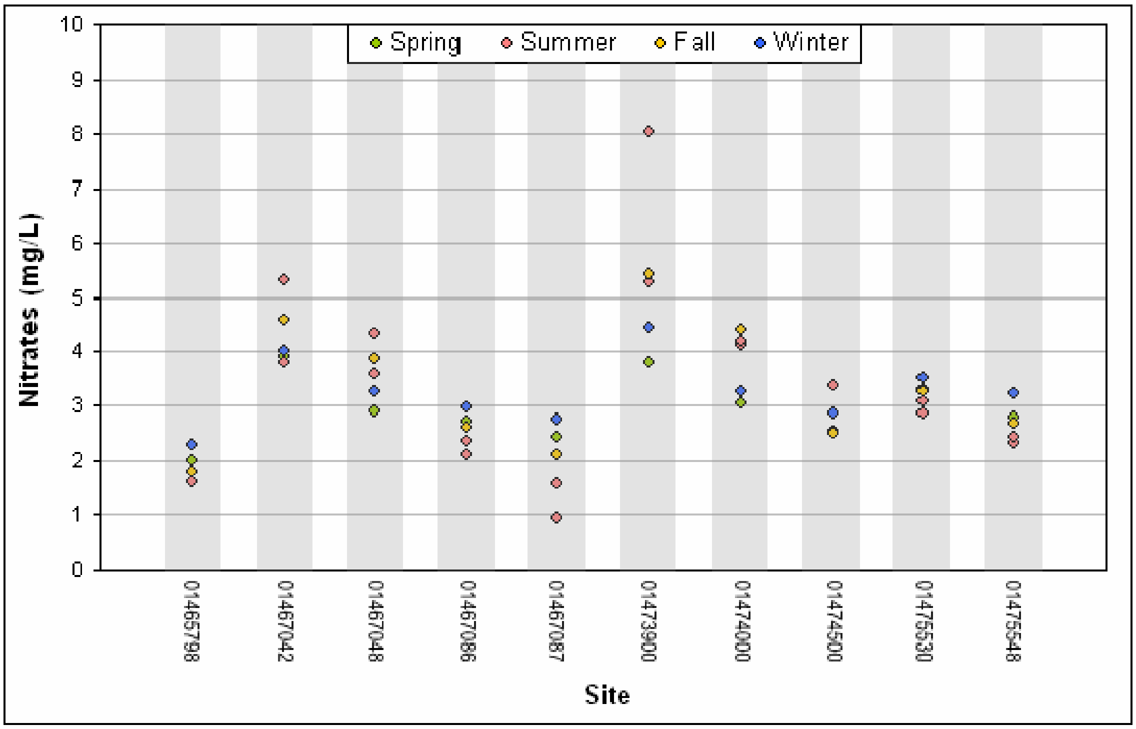


Figure 4. Nitrate concentration at 10 USGS gage stations, June 2009-June 2010

Microbial Analysis

Fecal indicator bacteria, found naturally in the gut of warm–blooded animals, can be used in detection of human or animal waste contamination in a body of water. While these bacteria themselves are generally harmless to humans, they are considered to be very reliable indicators of the presence of other more serious fecal-borne pathogens, such as viruses, protozoa, and other bacteria. The extent to which a water body is contaminated with fecal indicator bacteria can indicate the likelihood that the water has been contaminated by human or animal wastes. In urban environments, the most likely dry weather pollution sources are domestic animals, wildlife, and untreated sewage from improperly connected or leaking sanitary sewers.

PWD performs three fecal indicator bacteria tests, including fecal coliform, *Escherichia coli*, and enterococci. The fecal coliform test covers a relatively wide subgroup of fecal-specific bacteria, however it does include some species that are not necessarily fecal in origin. *E. coli*, on the other hand, is a single coliform species that is noteworthy due to the fact that it occurs only in the fecal matter of humans and other warm-blooded animals. This qualifies *E. coli* as an excellent indicator of human waste. The final coliform group tested, the enterococci, are significant in that they tend to mimic many enteric pathogens with their ability to thrive in saline conditions over a wide range of temperatures. This makes the enterococci test very useful in waterways that may have a marine influence, or any other river or stream that may have above normal salinity due to the geology of the area.

Microbial Analysis Results

PADEP has established seasonal bacteria water quality criteria which are more stringent in warmer months, or the "swimming season". For the period May 1st through September 30 water quality standards require that the geometric mean of a group of at least five samples collected on non-consecutive days over a thirty day period not exceed 200 fecal coliform CFU/100mL. During the non-swimming season this value increases to 2000 CFU/mL. Generally, results of microbial analyses from the five sampling quarters indicate fecal indicator bacteria levels greater than 200CFU/100mL, but within the "background" urban dry weather range at most locations. The only exceptions to this were the downstream Pennypack, upstream Tacony, and downstream Cobbs Creek gage sites, where both fecal coliform (Figure 3) and *E. coli* (Figure 4) were noticeably elevated, perhaps indicating some dry weather source of pollution. However, these data represent a single test from a single sample taken on a single day rather than a geometric mean of five samples. Fecal coliform counts can show a range of variation among samples collected on a given day, as well as variability within each given sample. While the sample size is very small, fecal coliform and *E. coli* counts were very closely correlated but there was no correlation between either fecal coliform or *E. coli* and enterococci. This lack of correlation has been observed in other data sets from the Philadelphia area as well. Lack of correlation may be related to differential survivability of the various fecal indicator bacteria. Furthermore, as the size dataset is still relatively limited, no conclusive statements pertaining to large-scale or long-term patterns can be made at this time.

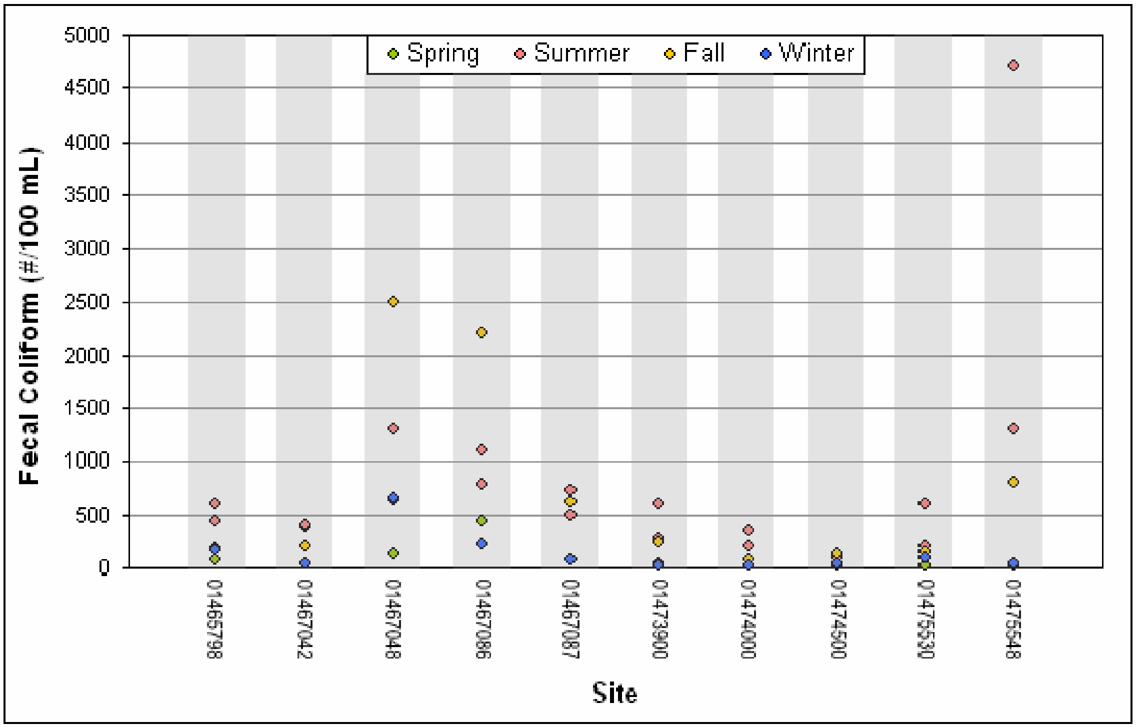


Figure 5. Fecal coliform results at 10 USGS gage stations, June 2009 – June 2010

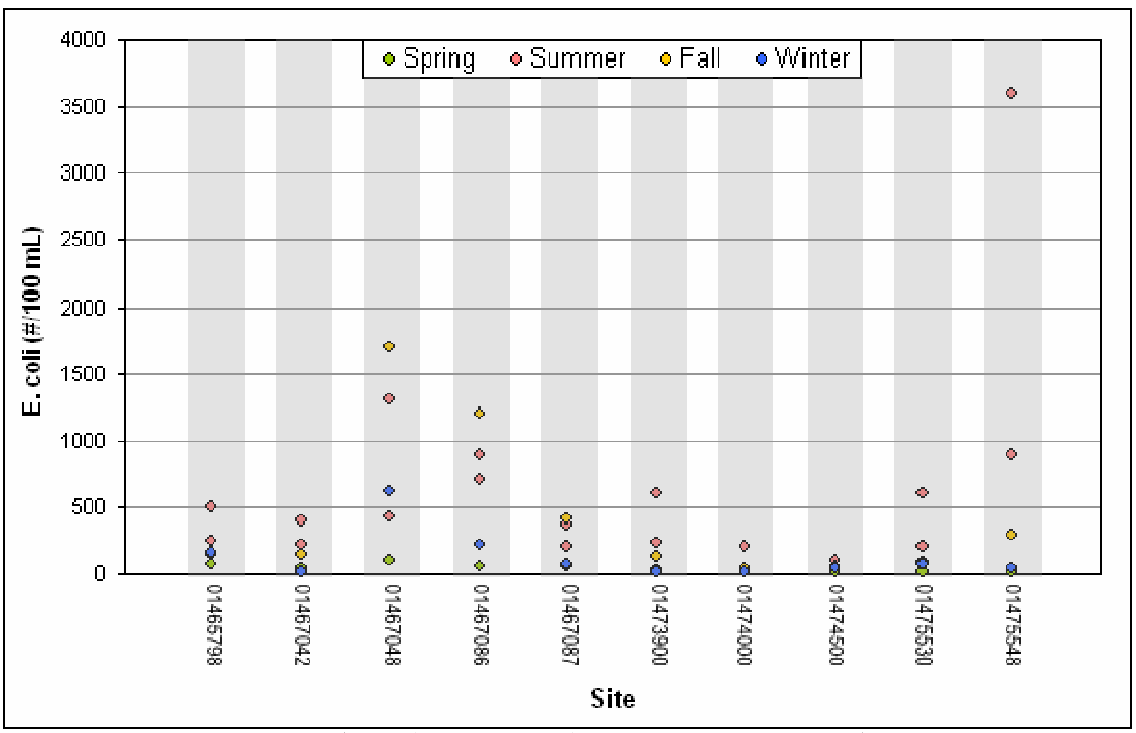


Figure 6. *E. coli* results at 10 USGS gage stations, June 2009 – June 2010

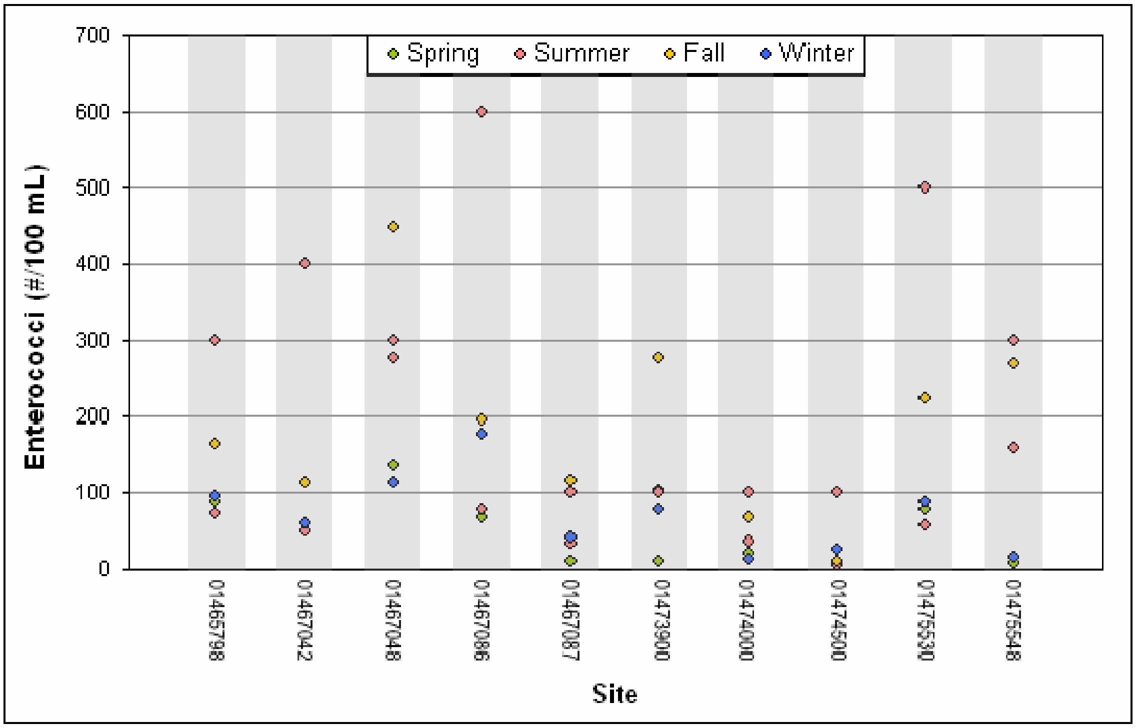


Figure 7. Enterococci results at 10 USGS gage stations, June 2009 – June 2010

Physicochemical Analysis

In addition to nutrient and microbial analyses, a basic set of physicochemical parameters were also monitored as part of the discrete quarterly sampling program. These parameters (dissolved oxygen, pH, temperature, and specific conductance) were specifically chosen to coincide with those being measured by the USGS continuous water quality monitoring gages. These data can then be utilized as valuable field checks when analyzing continuous water quality data from USGS gages.

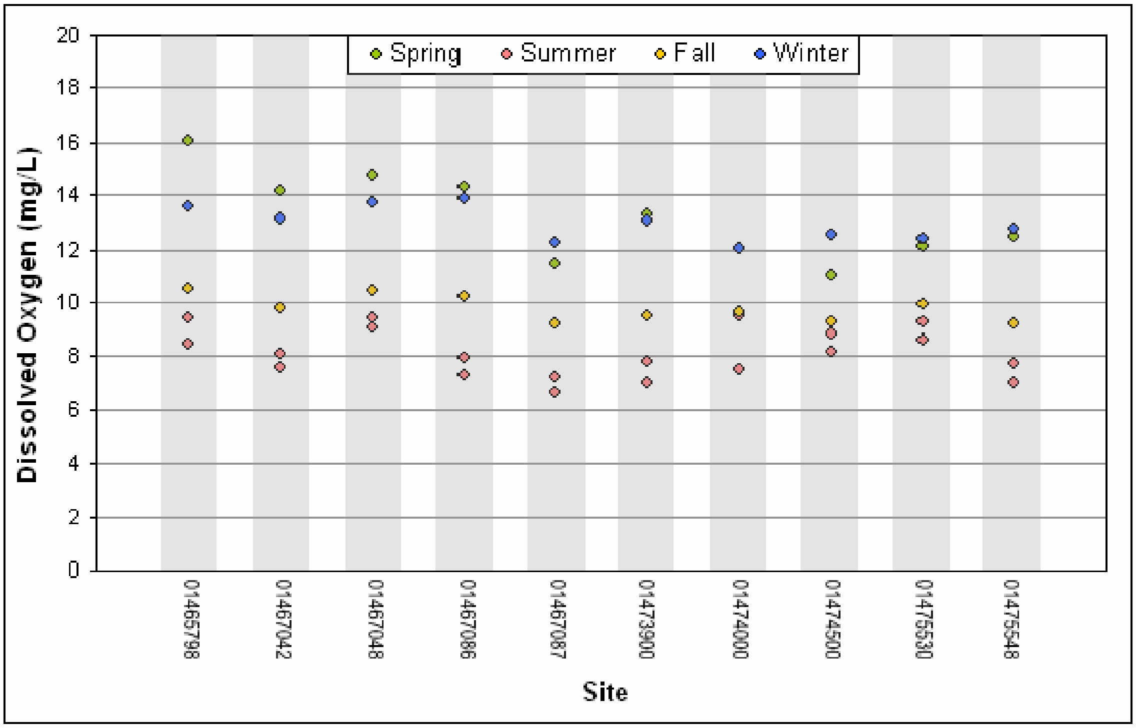


Figure 8. Dissolved oxygen results at 10 USGS gage stations, June 2009 – June 2010

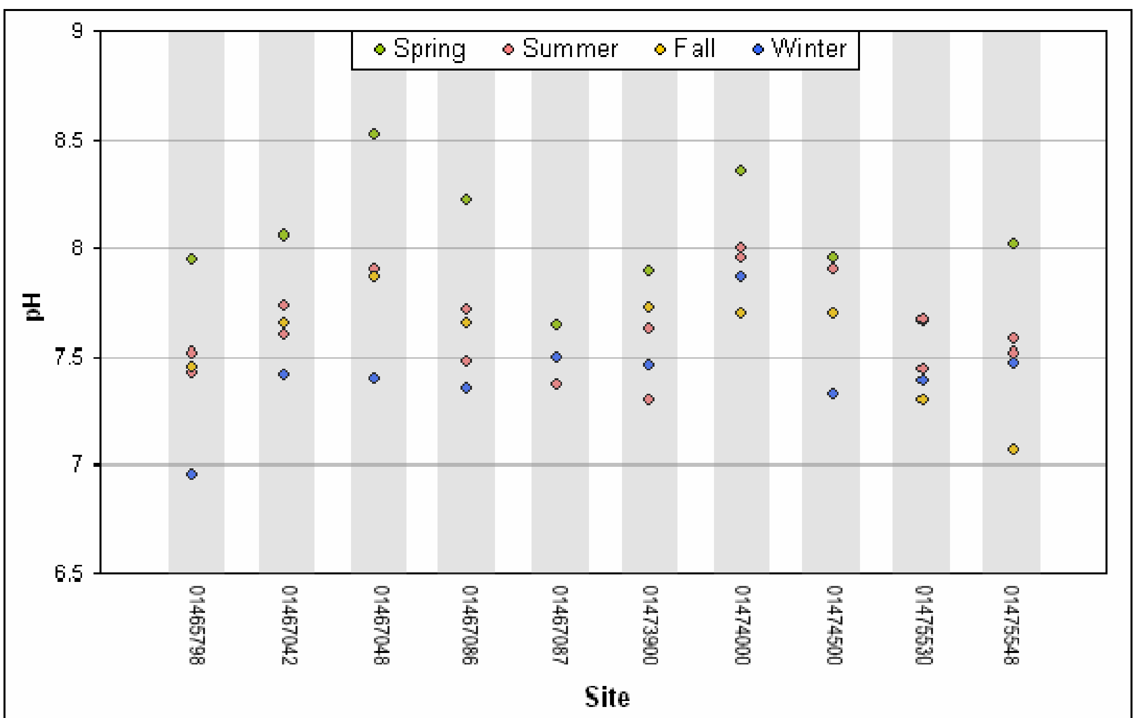


Figure 9. pH results at 10 USGS gage stations, June 2009 – June 2010

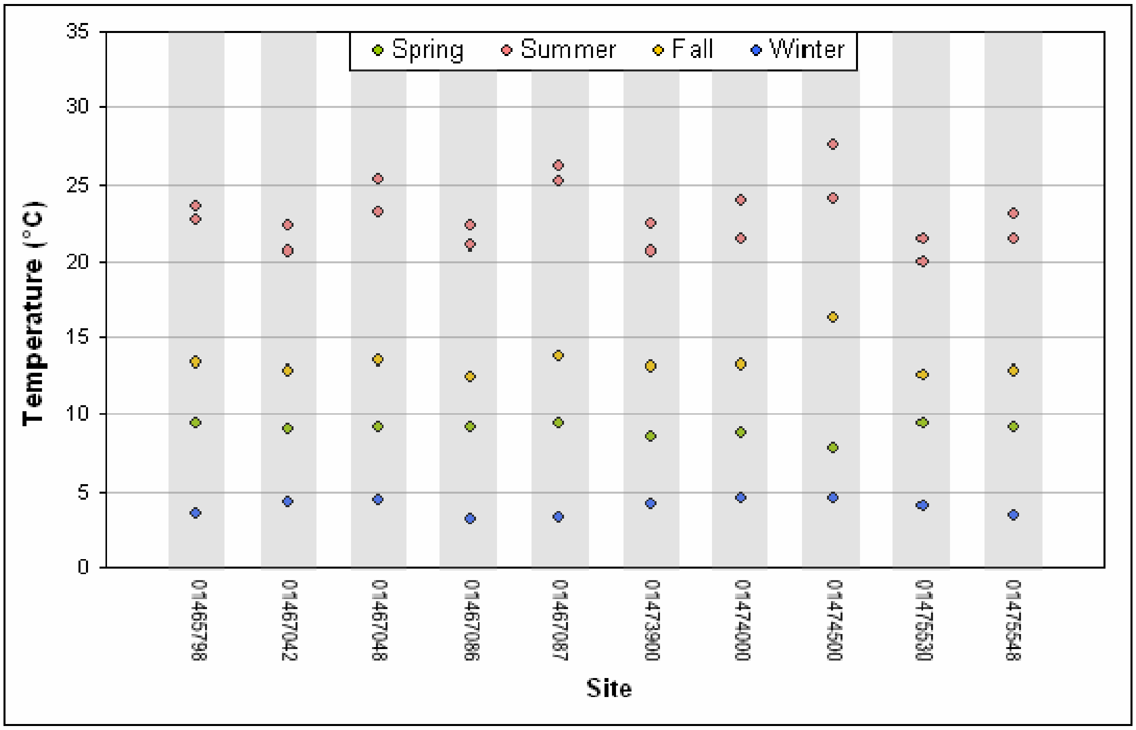


Figure 10. Temperature results at 10 USGS gage stations, June 2009 – Jun e2010

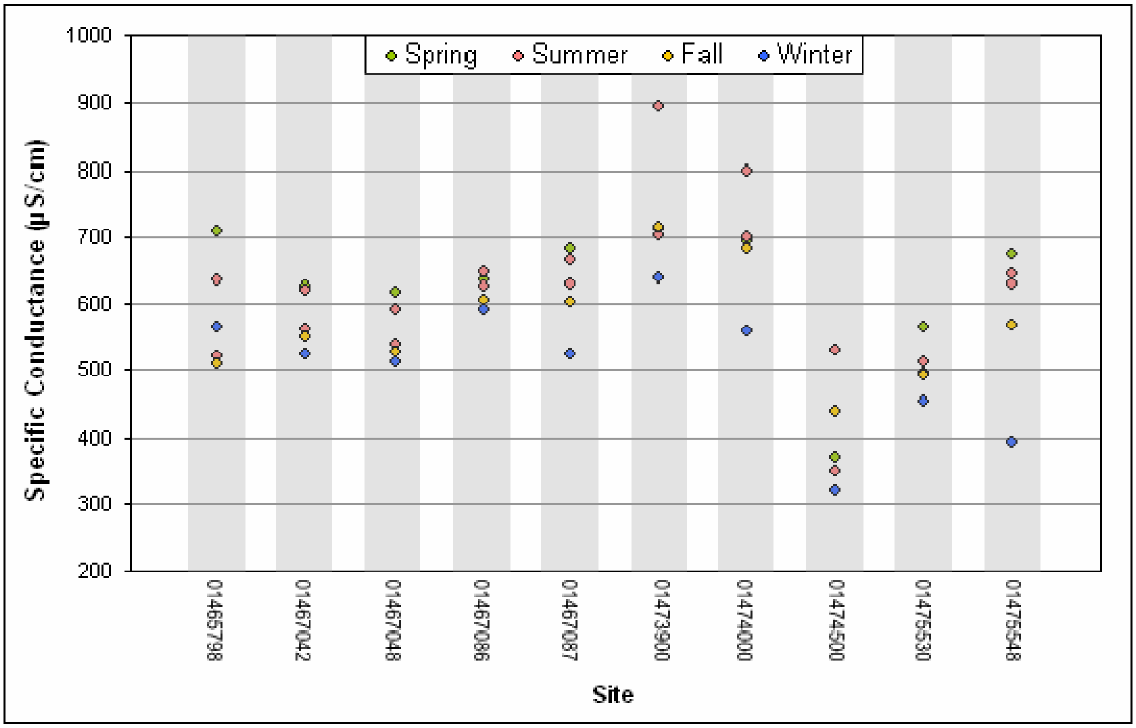


Figure 11. Specific conductance results at 10 USGS gage stations, June 2009 – June 2010

APPENDIX H – PWD-USGS COOPERATIVE WATER QUALITY MONITORING PROGRAM ANNUAL SUMMARY

PWD/USGS Cooperative Water Quality Monitoring Program Annual Summary

Background

PWD and the United States Geologic Survey (USGS) have constructed and/or refurbished gaging stations in ten locations throughout Philadelphia's watersheds. USGS staff are responsible for construction and maintenance of the gage structure, stream stage monitoring instruments, data communications, maintaining and verifying stage-discharge rating curves and pumping apparatus. PWD staff is responsible for installation and maintenance of continuous water quality instrumentation. Data collected through the PWD/USGS cooperative water quality monitoring program are disseminated through the USGS National Water Information System (NWIS) Web Interface (http://waterdata.usgs.gov/pa/nwis/nwis), as well as a website specifically dedicated to Philadelphia's watersheds (Figure 1).

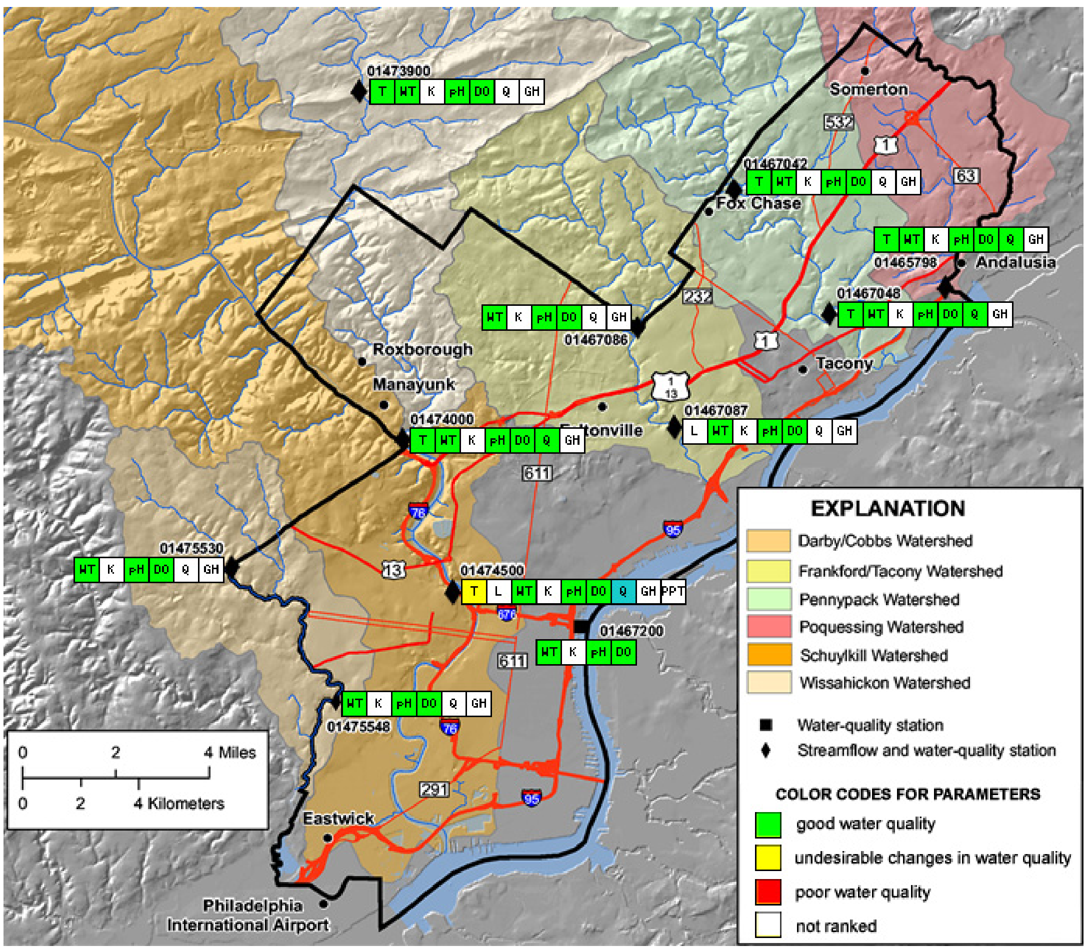


Figure 1. Philadelphia Water Quality Gauge Stations as Viewed on Cooperative USGS-PWD Website (http://pa.water.usgs.gov/pwd/).

Monitoring Locations

The PWD/USGS Cooperative Monitoring Program builds upon the widespread network of USGS gages that were formerly operated throughout Philadelphia. These gages are logically situated and/or have a continuous period of record making them ideal for water quality monitoring purposes. Within a given watershed, downstream-most historic stations were chosen to represent water quality as these streams flow through Philadelphia into the receiving waters (*i.e.*, the Schuylkill and Delaware Rivers).

Regarding upstream stations, three gages (Pennypack Creek at Pine Rd, Tacony Creek at Adams Ave, and Cobbs Creek at US Rt.1) are strategically located to monitor water quality of the streams as they enter Philadelphia (Figure 1). The upstream Wissahickon Creek monitoring station is located at Rte 73 in Fort Washington, which is approximately 3.7 river miles upstream of the City. This location was chosen due to its extensive period of record (Table 1). Upstream water quality is not measured in Poquessing-Byberry Creek Watershed. The Schuylkill River gage is in an ideal location to provide data related to the Schuylkill River Fairmount Dam Fish Ladder Renovation Project and was equipped with water quality monitoring instrumentation upon project completion in early 2009.

This annual report summarizes water quality data from July 1, 2008 – June 30, 2009, excluding the period of December 2008 through February 2009, during which time monitoring probes were not deployed in order to protect the equipment from cold temperatures. Per agreement with USGS, water quality data at the Delaware River gage 01467200 was not available for an additional month, from December 2008 through March 2009. Finally, Schuylkill River gage data collection did not begin until March 2009.

Table 1. PWD/USGS Cooperative Water Quality Monitoring Program Gages

Gage Number	Gage name	Flow Data Record
01465798	Poquessing Creek at Grant Avenue, Philadelphia, PA	July 1965 to Present
01467042	Pennypack Creek at Pine Road, Philadelphia, PA	August 1964 to September 1974; September 2007 to Present
01467048	Pennypack Creek at Lower Rhawn St Br., Philadelphia, PA	June 1965 to Present
01467086	Tacony Creek at County Line, Philadelphia, PA	October 1965 to September 1986; September 2005 to Present
01467087	Frankford Creek at Castor Ave, Philadelphia, PA	July 1982 to Present
01467200*	Delaware River at Ben Franklin Bridge, Philadelphia, PA	August 1949 to Present
01474000	Wissahickon Creek at Mouth, Philadelphia, PA	June 1897 to September 1903; January 1905 to July 1906; October 1965 to Present
01474500	Schuylkill River at Philadelphia, PA	October 1931 to Present
01475530	Cobbs Creek at U.S. Highway No. 1, Philadelphia, PA	October 1964 to September 1981; September 2004 to Present
01475548	Cobbs Creek at Mt. Moriah Cemetery, Philadelphia, PA	October 2005 to Present

*Funding for the operation of this gage is provided by USGS and the Delaware River Basin Commission (DRBC)

USGS Gage Data Processing & Analysis Procedures

With 10 USGS gages collecting data for multiple water quality parameters at half hour intervals, a large amount of data are produced. PWD Office of Watersheds (OOW) staff have developed procedures for the processing and analysis of these data using Microsoft Excel and Access software, as well as R, a free software environment for statistical computing and graphics. Most aspects of the data processing and analysis have been automated with custom Visual Basic and R code.

OOW independently maintains databases of water quality and streamflow via automated regular retrievals of these data from USGS NWIS. On a monthly basis, the databases are queried and results for each gage are imported into MS Excel workbooks. If available, any field data collected during that period (*e.g.*, hand meter readings from field maintenance checks, water quality grab samples, etc.) are also imported. Once all required data have been entered, separate plots are produced for each parameter (dissolved oxygen, turbidity, pH, specific conductance, and temperature) to enable a subjective review of data quality.

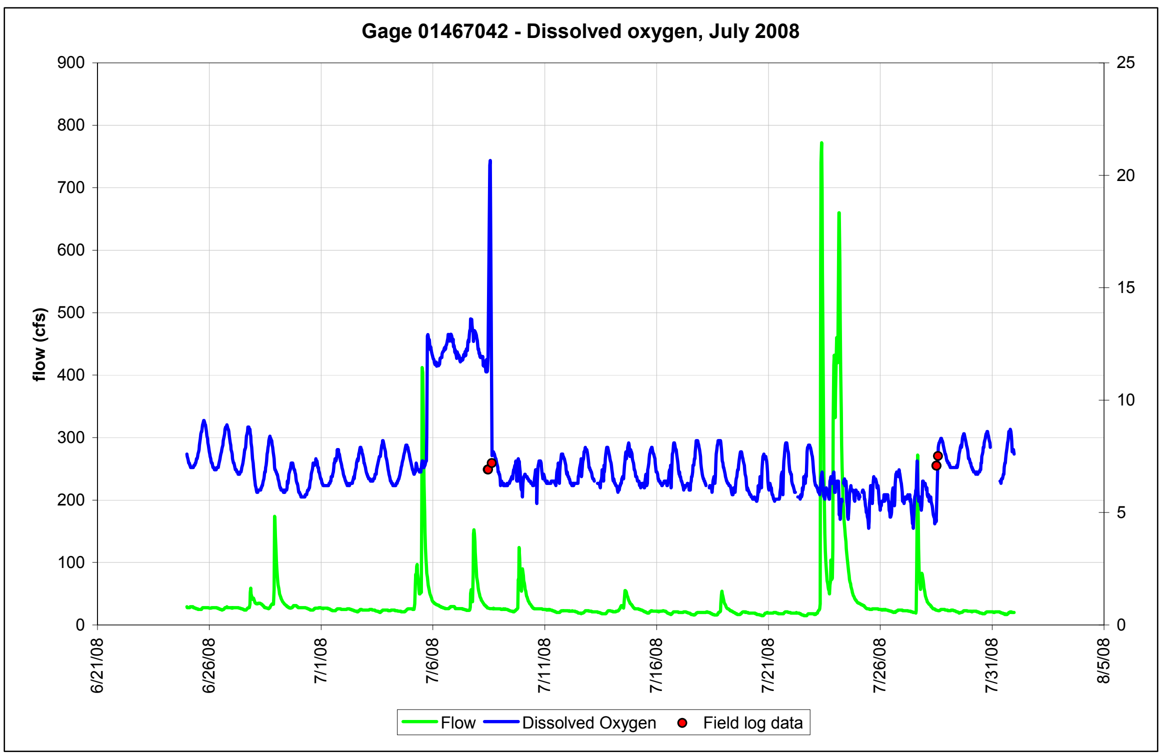


Figure 2. Example of an Excel-generated data processing/analysis plot; Gage 01467042, Dissolved Oxygen, July 2008.

These plots are examined and are the primary basis for the selection of good vs. questionable data for a given month. Intervals of questionable data are located, and added to a table of "flagged" data for that particular parameter, which is then used to update the water quality database.

The final step of the procedure utilizes R, a statistical programming language and software environment. The R software code developed by OOW staff analyzes all of the water quality data in a database, as well as the good and questionable flags, and generates statistical and graphic results in a variety of forms. These include monthly plots for all data parameters for each site, showing accepted and questionable data, water quality criteria, grab sample data, and stream flow (Figure 3); assorted statistics including accepted and questionable data comparisons, monthly exceedance percentages, and comparisons of wet and dry weather periods; additional plots, including average dissolved oxygen (DO), percent DO saturation, and pH/percent DO saturation.

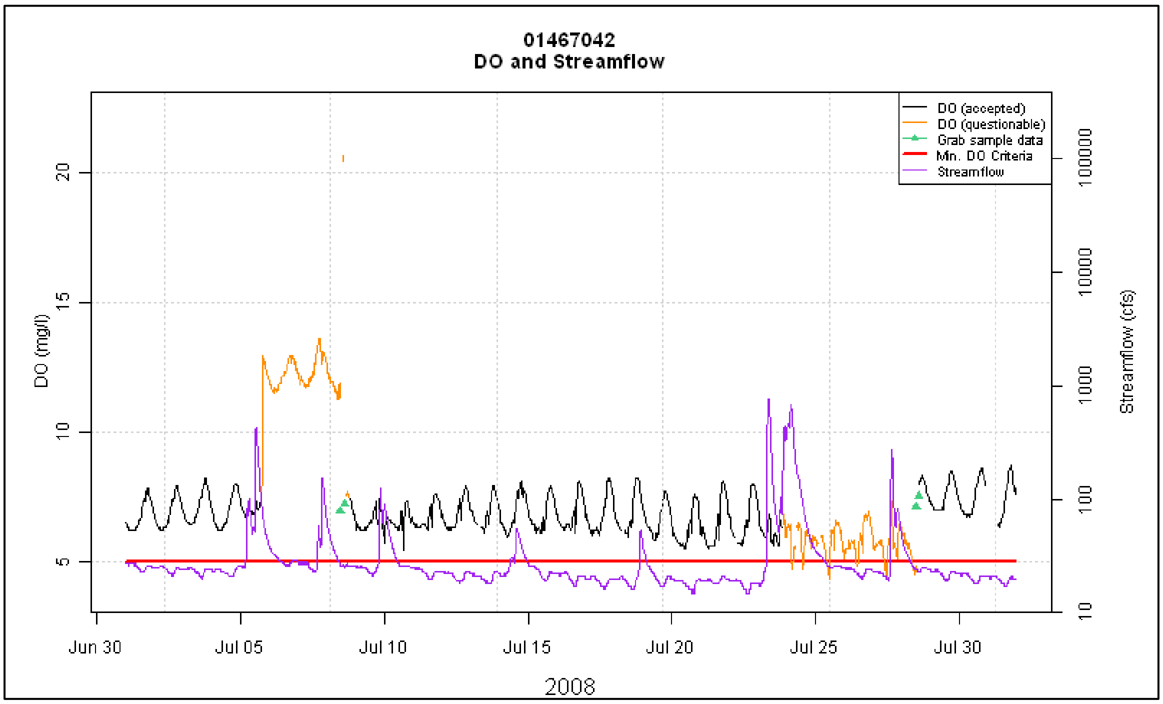


Figure 3. Example of an R-generated plot showing accepted and questionable data, and minimum water quality criteria; Gage 01467042, Dissolved Oxygen, July 2008.

Continuous Water Quality Monitoring Results

Annual Summary, July 2009 - June 2010

Dissolved Oxygen

Background

Dissolved oxygen concentrations are a concern in several of Philadelphia's watersheds. Dissolved oxygen concentration is suppressed by high temperatures, respiratory activity of stream organisms, and nitrification and other oxidation reactions. Streams generally develop problems with dissolved oxygen due to water column BOD, sediment oxygen demand (SOD) and eutrophication due to increased nutrient concentration. These processes are inter-related, and physical conditions can also affect dissolved oxygen concentrations.

Designated Uses

Streams in the Philadelphia region are affected by ambient temperatures, which can be quite warm in the spring and summer months. For this reason, these streams cannot support natural self-sustaining populations of cold water fish. Different water quality criteria for dissolved oxygen and temperature are applied to different stream segments. Of the sites that were instrumented for water quality, the Wissahickon and Pennypack Creek gages (*i.e*., 01473900, 01474000, 01467042, and 01467048) are each designated as a Trout Stocking Fishery (TSF) with conditions appropriate for maintenance of stocked trout over the period February 15 to July 31. Water quality criteria for dissolved oxygen are more stringent for these sites, with a daily instantaneous minimum criterion of 5 mg/L and daily mean criterion of 6 mg/L. Dissolved oxygen criteria for Warm Water Fisheries (WWF) are 4 mg/L and 5 mg/L, respectively. The Delaware River gage 01467200 dissolved oxygen criteria are defined by the Delaware River Basin Commission (DRBC) criteria for Zone 3 (DRBC, 2007) with a daily mean of 3.5 mg/L and a seasonal mean (April 1 to June 15, and September 16 to December 31) of 6.5 mg/L (Table 2).

Table 2. PADEP Dissolved Oxygen Water Quality Criteria

Gage number	Designated Use	DO Minimum Criterion	DO Daily Mean Criterion
01465798	WWF	4.0 mg/L	5.0 mg/L
01467042	TSF*	5.0 mg/L	6.0 mg/L
01467048	TSF*	5.0 mg/L	6.0 mg/L
01467086	WWF	4.0 mg/L	5.0 mg/L
01467087	WWF	4.0 mg/L	5.0 mg/L
01467200	DRBC**	None	3.5 mg/L
01473900	TSF*	5.0 mg/L	6.0 mg/L
01474000	TSF*	5.0 mg/L	6.0 mg/L
01474500	WWF	4.0 mg/L	5.0 mg/L
01475530	WWF	4.0 mg/L	5.0 mg/L
01475548	WWF	4.0 mg/L	5.0 mg/L

*TSF criteria for DO only apply from February 15 - July 31. WWF criteria are applicable from August 1 – January 31.
**A seasonal mean criterion of 6.5 mg/L also applies from April 1 - June 15, and September 16 - December 31.

Results

Results were processed as follows for Table 3. The "total hours accepted data" are the total hours of data that were not flagged; that quantity divided by 24 yields the "total days accepted data". The remainder of the table lists the percent of total hours of data that was flagged, and the percentages of accepted data that violated the standard and complied with the standard.

Results were processed as follows for Table 4. If a single day contained at least one flagged measurement, the entire day was considered flagged for calculating the daily mean. Thus the "percent days flagged data" corresponds to the percentage of total days of data that contained at least one flag in a single day. Conversely, if none of the measurements in a single day were flagged, that day was considered one day of accepted data, and the total amount of accepted days was calculated. Finally, the percentages of accepted data that violated the standard and complied with the standard were calculated.

DO minimum and daily mean criteria were most frequently violated at the downstream Tacony Creek site (gage 01467087). The percentage of flagged data was also highest at this site for both criteria. At all other sites, less than 1.5% violation of the DO minimum criterion, and less than 2.5% violation of the daily mean criterion were observed. A more in-depth discussion of potential causes of DO problems at gage 01467087 is contained in the Monthly Results section.

Table 3. USGS Gage July 2009 - June 2010 Dissolved Oxygen Minimum Criterion Summary Results

USGS Gage July 2009 - June 2010 Dissolved Oxygen Minimum Criteria Summary Information						
Gage number	Designated Use	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. violation	% hrs. compliance
01465798	WWF	6206.0	258.6	4.9	0.0	100.0
01467042	TSF	6294.5	262.3	2.5	0.0	100.0
01467048	TSF	5740.5	239.2	1.9	0.0	100.0
01467086	WWF	6436.0	268.2	1.4	0.0	100.0
01467087	WWF	4604.5	191.9	21.0	9.3	90.7
01467200*	DRBC	N/A	N/A	N/A	N/A	N/A
01473900	TSF	6128.5	255.4	5.5	0.4	99.6
01474000	TSF	5518.0	229.9	13.6	0.4	99.6
01474500	WWF	4271.5	178.0	16.8	0.0	100.0
01475530	WWF	6217.5	259.1	5.4	0.0	100.0
01475548	WWF	6240.5	260.0	4.7	1.4	98.6

*No minimum DO criterion applies at gage 01467200

Table 4. USGS Gage July 2009 - June 2010 Dissolved Oxygen Daily Mean Criterion Summary Results

USGS Gage July 2009 - June 2010 Dissolved Oxygen Daily Mean Criteria Summary Information					
Gage number	Designated Use	Total days accepted data	% days flagged data	% days violation	% days compliance
01465798	WWF	234.0	14.0	0.0	100.0
01467042	TSF	233.0	14.6	0.0	100.0
01467048	TSF	207.0	20.4	0.0	100.0
01467086	WWF	249.0	8.4	0.0	100.0
01467087	WWF	159.0	41.3	10.7	89.3
01467200	DRBC	213.0	12.7	0.0	100.0
01473900	TSF	228.0	16.2	0.4	99.6
01474000	TSF	213.0	21.4	0.5	99.5
01474500	WWF	155.0	27.6	0.0	100.0
01475530	WWF	237.0	13.5	0.0	100.0
01475548	WWF	245.0	10.2	2.4	97.6

Table 5. USGS Gage 01467200 Dissolved Oxygen Seasonal Mean Criterion Summary Result

Gage number	Designated Use	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	Seasonal mean	Attained Standard?
01467200	DRBC	1624.5	67.7	10.9	7.97	Yes

pH

Background

pH has been identified as a parameter of potential concern for some of Philadelphia's watersheds, primarily because of algal effects on the dissolved inorganic carbon (DIC) composition of stream water. Algae take up CO2 during photosynthesis and shift the composition of DIC toward the alkaline carbonates, resulting in occasional violations of daily maximum pH violations at some sites (Table 6). There were no observed violations of the daily minimum pH criterion in the report timeframe. pH fluctuations are typically observed concomitant with pronounced dissolved oxygen fluctuations, as detailed in the Monthly Results section.

At gage 01467200, pH criteria (regulated by DRBC) are bounded by 6.5 and 8.5. At all other gages, pH criteria are bounded by daily minima and maxima of 6.0 and 9.0, respectively, as defined by PADEP water quality standards.

Results

Results were processed as follows for Table 6. The "total hours accepted data" are the total hours of data that were not flagged; that quantity divided by 24 yields the "total days accepted data". The remainder of the table lists the percentage of total hours of data that was flagged, the percentages of accepted hours that violated or complied with criteria, and the percentages of daily minima and maxima that violated or complied with criteria.

There were no observed violations of the daily minimum pH criterion in the report timeframe. The daily maximum criterion was violated in 2.5% of observed days at the upstream Wissahickon Creek gage, and 1.6 % of observed days at the downstream Wissahickon Creek gage. Also, at the downstream gages of both the Pennypack and Tacony Creeks, maximum criterion violations took place in 0.2% and 0.7% of observed days, respectively.

Table 6. USGS Gage July 2009 - June 2010 pH Criteria Summary Results

USGS Gage July 2009 - June 2010 pH Criteria Summary Information									
Gage number	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. max. violation	% days max. violation	% hrs. min. violation	% days min. violation	% hrs. compliance	% days compliance
01465798	6182.5	6373.5	265.6	2.4	0.0	0.0	0.0	0.0	100.0
01467042	6279.0	6344.0	264.3	3.2	0.0	0.0	0.0	0.0	100.0
01467048	6210.0	4628.0	192.8	21.6	0.2	2.0	0.0	0.0	99.8
01467086	6152.0	6435.5	268.1	1.4	0.7	4.8	0.0	0.0	99.3
01467087	6210.0	5257.0	219.0	19.2	0.0	0.0	0.0	0.0	100.0
01467200	4642.5	5658.0	235.8	3.4	0.0	0.0	0.0	0.0	100.0
01473900	5801.5	6291.5	262.1	3.6	1.6	7.9	0.0	0.0	98.4
01474000	6225.5	6273.0	261.4	3.6	2.5	3.7	0.0	0.0	97.5
01474500	2598.5	4124.0	171.8	19.7	0.2	0.6	0.0	0.0	99.8
01475530	6332.0	6238.0	259.9	5.1	0.0	0.0	0.0	0.0	100.0
01475548	6299.0	6447.5	268.6	1.6	0.3	2.2	0.0	0.0	99.7

Turbidity

Background

Turbidity in Philadelphia's streams increases with increased flow as inorganic sediment and additional constituents of stormwater runoff are introduced to the stream or scoured/eroded from the stream channel. There are no numeric PADEP water quality criteria for Turbidity, so PWD Watershed management plans used a reference value for turbidity that was derived from EPA Guidance document EPA 822-B-00-023 (*i.e.*, 2.825 NTU). This value is surpassed more often in wet weather than in dry weather (Table 77). Turbidity data has also been used to help investigate sediment loading and transport in the Wissahickon Creek Watershed for the Wissahickon Creek Sediment TMDL.

Results

Results were processed as follows for Table 7. The "total hours accepted data" are the total hours of data that were not flagged; that quantity divided by 24 yields the "total days accepted data". The remainder of the table lists the percentage of total hours of data that was flagged, and the percentages of accepted hours that either surpassed or fell below the maximum guideline.

Among the tributary sites, the maximum guideline was most frequently surpassed at the downstream Wissahickon Creek gage, and least frequently surpassed at the upstream Wissahickon Creek gage.

Table 7. USGS Gage July 2009 - June 2010 Turbidity Summary Results

USGS Gage July 2009 - June 2010 Turbidity Summary Information					
Gage number	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. above max. guideline	% hrs. below max. guideline
01465798	5908.0	246.2	9.5	42.6	57.4
01467042	6241.5	260.1	4.7	33.0	67.0
01467048	4314.0	179.8	26.7	41.5	58.5
01467086*	N/A	N/A	N/A	N/A	N/A
01467087	258.0	10.8	98.0	89.1	10.9
01467200	3108.5	129.5	15.3	90.0	10.0
01473900	6037.5	251.6	7.5	63.2	36.8
01474000	6312.5	263.0	3.0	24.3	75.7
01474500	4233.5	176.4	17.6	78.1	21.9
01475530*	N/A	N/A	N/A	N/A	N/A
01475548*	N/A	N/A	N/A	N/A	N/A

*Turbidity is not continuously monitored at these locations

Specific Conductance

Background

Specific Conductance is a measure of the ability of water to conduct electricity over a given distance, expressed as microsiemens/cm (corrected to 25ºC). Dissolved ion content is useful in determining the start of wet weather events at ungaged water quality monitoring stations, but not applicable to the USGS gage network. Conductivity in Philadelphia streams is extremely sensitive to changes in flow, as stormwater (diluent) usually contains smaller concentrations of dissolved ions than stream baseflow. Data collected in the report timeframe were generally consistent with earlier observations. Stations receiving inputs of treated wastewater generally had greater conductivity.

Results

There is no water quality standard for specific conductance. Table 8 merely illustrates the total hours of data that was not flagged and considered "accepted", the equivalent quantity in day-units, and the percentage of total hours of data that was flagged. More detailed results at each site are described in the Monthly Results section.

Table 8. USGS Gage July 2009 - June 2010 Specific Conductance Summary Results

USGS Gage July 2009 - June 2010 Specific Conductance Summary Information			
Gage number	Total hrs. accepted data	Total days accepted data	% hrs. flagged data
01465798	6293.0	262.2	3.6
01467042	6491.0	270.5	0.9
01467048	5869.0	244.5	1.7
01467086	6461.5	269.2	1.0
01467087	6254.5	260.6	3.8
01467200	5658.0	235.8	3.4
01473900	6244.5	260.2	4.3
01474000	6353.5	264.7	2.4
01474500	4136.0	172.3	19.5
01475530	4847.0	202.0	26.3
01475548	6173.5	257.2	5.8

Temperature

Background

Streams in the Philadelphia region are designated Warm Water Fisheries (WWF) or Trout Stocking Fisheries (TSF), with separate corresponding temperature criteria (Table 9). These criteria are "stepped" (remaining constant for 15 or 30-day intervals), while streams tend to warm up and cool down more gradually due primarily to changes in ambient temperature. (Gage 01467200 is the exception and is subject to a DRBC criterion of 30°C maximum). Stream temperatures were observed to exceed these criteria, somewhat frequently in springtime. These exceedances are generally natural, as there are no major sources of heated wastes. It is possible that baseflow diminution is partially responsible for a lack of buffering against temperature increases.

Table 9. PADEP Temperature Water Quality Criteria

Date range start	Date range end	WWF maximum (°C)	WWF maximum (°F)	TSF maximum (°C)	TSF maximum (°F)
1/1	1/31	4	40	4	40
2/1	2/29	4	40	4	40
3/1	3/31	8	46	8	46
4/1	4/15	11	52	11	52
4/16	4/30	14	58	14	58
5/1	5/15	18	64	18	64
5/16	5/31	22	72	20	68
6/1	6/15	27	80	21	70
6/16	6/30	29	84	22	72
7/1	7/31	31	87	23	74
8/1	8/15	31	87	27	80
8/16	8/30	31	87	31	87
9/1	9/15	29	84	29	84
9/16	9/30	26	78	26	78
10/1	10/15	22	72	22	72
10/16	10/31	19	66	19	66
11/1	11/15	14	58	14	58
11/16	11/30	10	50	10	50
12/1	12/31	6	42	6	42

Results

Results were processed in the same manner as the parameters described above. The highest exceedance rate occurred at the downstream Pennypack Creek gage. Aside from the Delaware River gage, the lowest exceedance rates were observed at the Poquessing, both Cobbs, both Tacony Creek, and the Schuylkill River gage (Table 10). Those six gages are all designated as WWF and have less stringent criteria.

Table 10. USGS Gage July 2009 - June 2010 Temperature Maximum Criteria Summary Results

USGS Gage July 2009 - June 2010 Temperature Maximum Criteria Summary Information						
Gage number	Designated Use	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. exceedance	% hrs. compliance
01465798	WWF	6376.0	265.7	2.3	21.1	78.9
01467042	TSF	6492.0	270.5	0.9	31.3	68.7
01467048	TSF	5868.5	244.5	1.8	37.5	62.5
01467086	WWF	6461.0	269.2	1.0	21.6	78.4
01467087	WWF	6290.5	262.1	3.3	24.6	75.4
01467200	DRBC	5658.5	235.8	3.4	0.0	100.0
01473900	TSF	6282.5	261.8	3.7	32.6	67.4
01474000	TSF	6422.0	267.6	1.3	33.6	66.4
01474500	WWF	4264.5	177.7	17.0	24.7	75.3
01475530	WWF	6237.0	259.9	5.1	20.8	79.2
01475548	WWF	6519.0	271.6	0.5	22.6	77.4

Monthly Results, July 2009 - June 2010

This section summarizes results at the monthly time scale. Results were processed in the same manner as in the previous section. Gages are grouped according to the type of sewer system that impacts water quality at the site.

Gages in Combined Sewer System Watersheds

Tookany/Tacony-Frankford Creek (Gages 01467086 and 01467087)

Dissolved oxygen and pH

Dissolved oxygen concentrations were markedly worse between the upstream and downstream Tacony Creek gages. The monthly minima, percentage of hours the minimum criteria was violated, and percentage of days the daily mean criteria was violated were all much worse at the downstream gage (Tables 11-14). For example, DO was particularly poor at the downstream Tacony Creek gage in June 2010; the minimum DO criterion was violated throughout much of the month (Figure 4). Poor DO was also observed in the same month at the upstream gage, however the minimum criterion was almost never violated there (Figure 5). This difference likely reflects the additional stormwater runoff and sewage overflows that entered the creek between the two gages.

The lowest DO concentrations are typically seen in the period after storm events, reflecting both the immediate and lingering, oxygen-depleting effects of stormwater runoff and biochemical oxygen demand (BOD) entering the stream (Figure 6).

Diel DO fluctuations are suppressed for a few days following a storm event because the event either scours away algae or temporarily inhibits their growth. As dry weather continues, the algae recover and diel DO and pH fluctuations typically increase, sometimes resulting in pH maximum criterion violations, as observed at the upstream gage in March 2010 (Figure 7). Percent DO saturation extremes of 50% at night and over 150% in daylight were observed at gage 01467086 in March 2010, indicating high levels of algal activity (Figure 8). Diel DO fluctuations tended to increase with prolonged periods of sunlight, further indicating high levels of algal activity.

Interestingly, no pH maximum criterion violations were recorded at the downstream gage. A lower monthly mean pH was consistently observed at gage 01467087, along with generally less pronounced diel pH fluctuations, probably due to an increased buffering capacity at the downstream gage (Tables 15-16).

Table 11. Gage 01467086 Dissolved Oxygen Minimum Criterion Summary Results by Month

Gage 01467086 Dissolved Oxygen Min Criteria Summary Information by Month									
Month	Des. Use	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. violation	% hrs. compliance	Min	Max	Mean
Jul-09	WWF	739.5	30.8	0.6	0.0	100.0	4.6	10.9	7.04
Aug-09	WWF	707.5	29.5	4.9	0.0	100.0	5.3	11.2	7.39
Sep-09	WWF	716.0	29.8	0.6	0.0	100.0	6.1	12.3	8.24
Oct-09	WWF	732.0	30.5	1.6	0.0	100.0	6.7	13.7	9.62
Nov-09	WWF	717.5	29.9	0.3	0.0	100.0	7.2	14.4	9.98
Mar-10	WWF	645.5	26.9	5.2	0.0	100.0	8.4	17.3	11.48
Apr-10	WWF	719.0	30.0	0.1	0.0	100.0	6.2	14.8	9.51
May-10	WWF	743.0	31.0	0.1	0.0	100.0	4.2	12.2	7.58
Jun-10	WWF	716.0	29.8	0.6	0.3	99.7	3.7	10.2	6.54

Table 12. Gage 01467087 Dissolved Oxygen Minimum Criterion Summary Results by Month

Gage 01467087 Dissolved Oxygen Min Criteria Summary Information by Month									
Month	Des. Use	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. violation	% hrs. compliance	Min	Max	Mean
Jul-09	WWF	477.5	19.9	35.8	25.3	74.7	0.1	10.1	4.98
Aug-09	WWF	450.5	18.8	39.4	0.9	99.1	1.8	9.8	7.21
Sep-09	WWF	466.0	19.4	35.3	0.0	100.0	4.6	11.1	7.91
Oct-09	WWF	484.0	20.2	34.9	0.3	99.7	3.0	12.2	8.71
Nov-09	WWF	620.5	25.9	13.8	0.0	100.0	5.5	11.2	9.44
Mar-10	WWF	536.5	22.4	17.1	0.0	100.0	5.5	15.0	10.61
Apr-10	WWF	639.0	26.6	11.3	0.4	99.6	1.7	12.5	8.84
May-10	WWF	486.5	20.3	34.6	4.2	95.8	1.6	9.5	6.49
Jun-10	WWF	444.0	18.5	38.3	63.1	36.9	0.2	8.3	3.61

Table 13 . Gage 01467086 Dissolved Oxygen Daily Mean Criterion Summary Results by Month

Gage 01467086 Dissolved Oxygen Daily Mean Criteria Summary Information by Month								
Month	Des. Use	Total days accepted data	% days flagged data	% days violation	% days compliance	Min.	Max.	Mean
Jul-09	WWF	26.0	16.1	0.0	100.0	5.7	8.3	6.97
Aug-09	WWF	28.0	9.7	0.0	100.0	6.6	8.7	7.36
Sep-09	WWF	27.0	10.0	0.0	100.0	6.6	9.0	8.22
Oct-09	WWF	29.0	6.5	0.0	100.0	8.4	10.6	9.59
Nov-09	WWF	27.0	10.0	0.0	100.0	8.2	11.4	10.01
Mar-10	WWF	25.0	11.9	0.0	100.0	9.3	13.3	11.55
Apr-10	WWF	29.0	3.3	0.0	100.0	8.0	10.6	9.50
May-10	WWF	30.0	3.2	0.0	100.0	5.7	9.4	7.52
Jun-10	WWF	28.0	6.7	0.0	100.0	5.0	7.4	6.53

Table 14. Gage 01467087 Dissolved Oxygen Daily Mean Criterion Summary Results by Month

Gage 01467087 Dissolved Oxygen Daily Mean Criteria Summary Information by Month								
Month	Des. Use	Total days accepted data	% days flagged data	% days violation	% days compliance	Min.	Max.	Mean
Jul-09	WWF	12.0	61.3	41.7	58.3	3.4	6.8	5.22
Aug-09	WWF	14.0	54.8	0.0	100.0	6.4	8.3	7.26
Sep-09	WWF	17.0	43.3	0.0	100.0	7.2	8.6	7.89
Oct-09	WWF	17.0	45.2	0.0	100.0	7.9	10.2	8.65
Nov-09	WWF	24.0	20.0	0.0	100.0	8.3	10.5	9.45
Mar-10	WWF	20.0	25.8	0.0	100.0	7.8	12.8	10.65
Apr-10	WWF	25.0	16.7	0.0	100.0	6.2	10.4	8.86
May-10	WWF	17.0	45.2	5.9	94.1	4.6	8.7	6.44
Jun-10	WWF	13.0	56.7	84.6	15.4	1.3	5.3	3.63

Table 15. Gage 01467086 pH Criteria Summary Results by Month

Gage 01467086 pH Criteria Summary Information by Month												
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. max. violation	% days max. violation	% hrs. min. violation	% days min. violation	% hrs. compliance	% days compliance	Min.	Max.	Mean
Jul-09	741.0	30.9	0.4	0.0	0.0	0.0	0.0	100.0	100.0	6.9	8.3	7.55
Aug-09	707.5	29.5	4.9	0.0	0.0	0.0	0.0	100.0	100.0	6.9	8.7	7.72
Sep-09	716.0	29.8	0.6	0.0	0.0	0.0	0.0	100.0	100.0	7.0	8.9	7.75
Oct-09	732.0	30.5	1.6	0.0	0.0	0.0	0.0	100.0	100.0	7.0	8.6	7.61
Nov-09	717.5	29.9	0.3	0.0	0.0	0.0	0.0	100.0	100.0	7.1	8.6	7.66
Mar-10	645.5	26.9	5.2	4.4	33.3	0.0	0.0	95.6	66.7	7.1	9.3	7.85
Apr-10	717.5	29.9	0.3	2.0	13.3	0.0	0.0	98.0	86.7	7.1	9.2	7.88
May-10	742.5	30.9	0.2	0.0	0.0	0.0	0.0	100.0	100.0	7.0	8.6	7.53
Jun-10	716.0	29.8	0.6	0.0	0.0	0.0	0.0	100.0	100.0	7.1	8.2	7.52

Table 16. Gage 01467087 pH Criteria Summary Results by Month

Gage 01467087 pH Criteria Summary Information by Month												
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. max. violation	% days max. violation	% hrs. min. violation	% days min. violation	% hrs. compliance	% days compliance	Min.	Max.	Mean
Jul-09	668.0	27.8	10.2	0.0	0.0	0.0	0.0	100.0	100.0	6.2	8.2	7.09
Aug-09	529.5	22.1	28.8	0.0	0.0	0.0	0.0	100.0	100.0	6.3	8.5	7.44
Sep-09	665.5	27.7	7.6	0.0	0.0	0.0	0.0	100.0	100.0	6.8	8.9	7.75
Oct-09	239.5	10.0	67.8	0.0	0.0	0.0	0.0	100.0	100.0	6.7	7.7	7.35
Nov-09	718.5	29.9	0.2	0.0	0.0	0.0	0.0	100.0	100.0	7.1	8.1	7.80
Mar-10	600.5	25.0	7.2	0.0	0.0	0.0	0.0	100.0	100.0	7.0	8.9	7.73
Apr-10	640.5	26.7	11.0	0.0	0.0	0.0	0.0	100.0	100.0	6.9	8.7	7.51
May-10	485.5	20.2	34.7	0.0	0.0	0.0	0.0	100.0	100.0	6.9	7.6	7.24
Jun-10	709.5	29.6	1.5	0.0	0.0	0.0	0.0	100.0	100.0	6.6	7.6	6.96

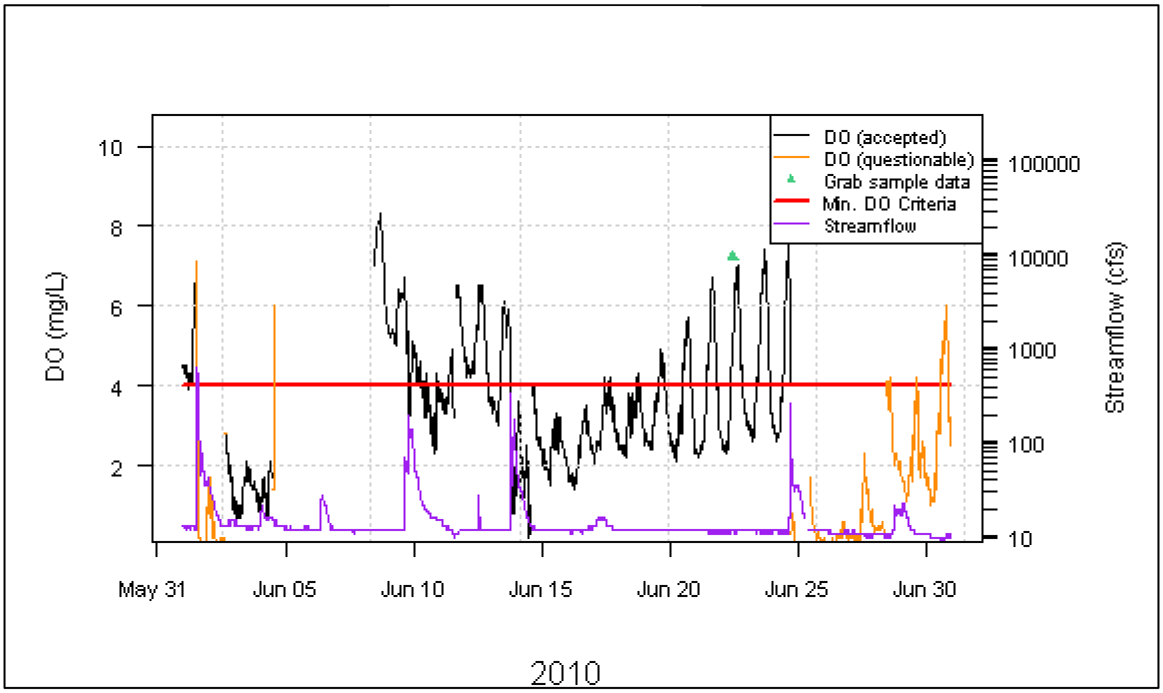


Figure 4. Gage 01467087, Dissolved Oxygen and Streamflow, June 2010.

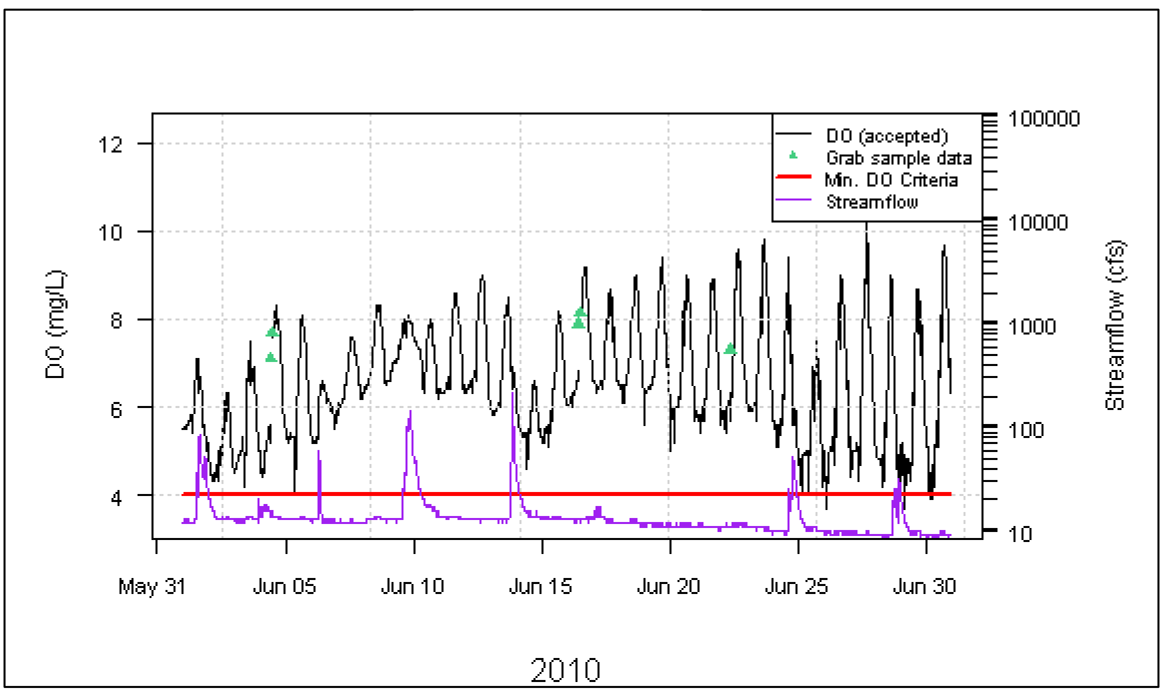


Figure 5. Gage 01467086, Dissolved Oxygen and Streamflow, June 2010.

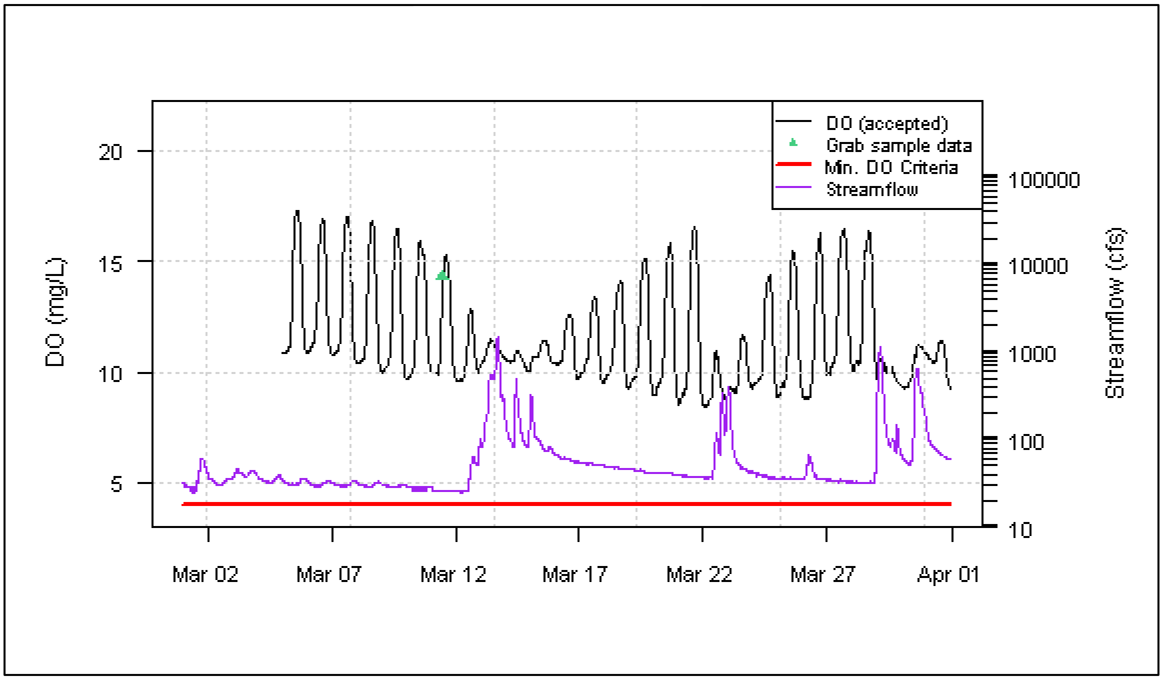


Figure 6. Gage 01467086, Dissolved Oxygen and Streamflow, March 2010.

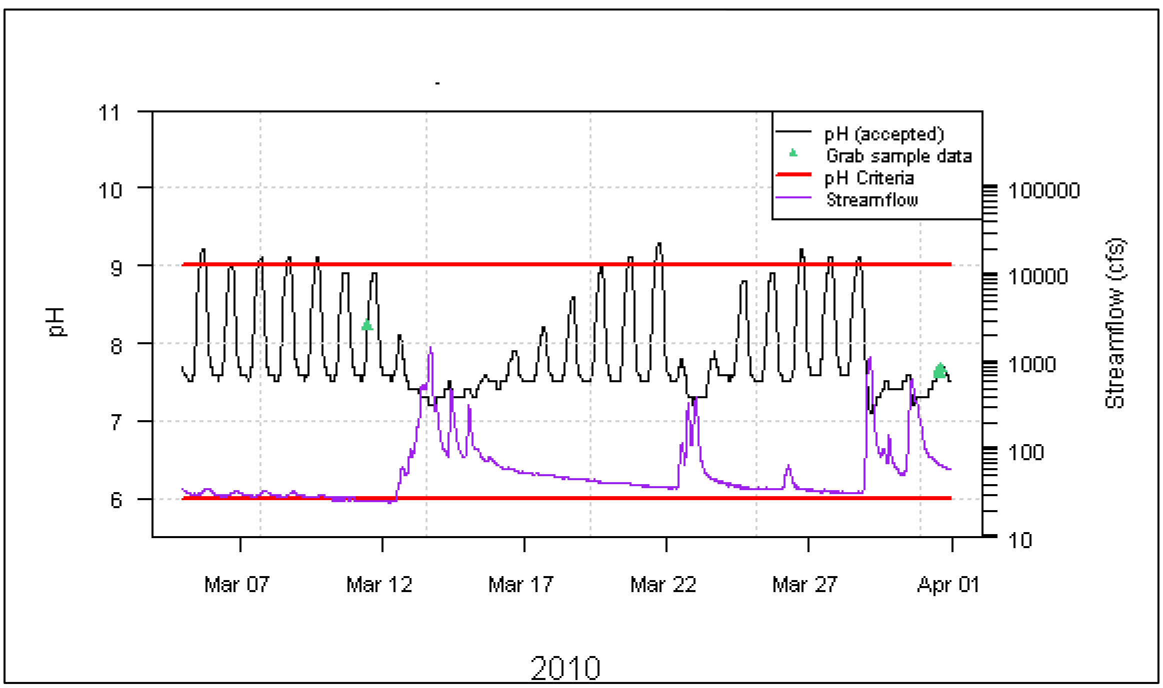


Figure 7. Gage 01467086, pH and Streamflow, March 2010.

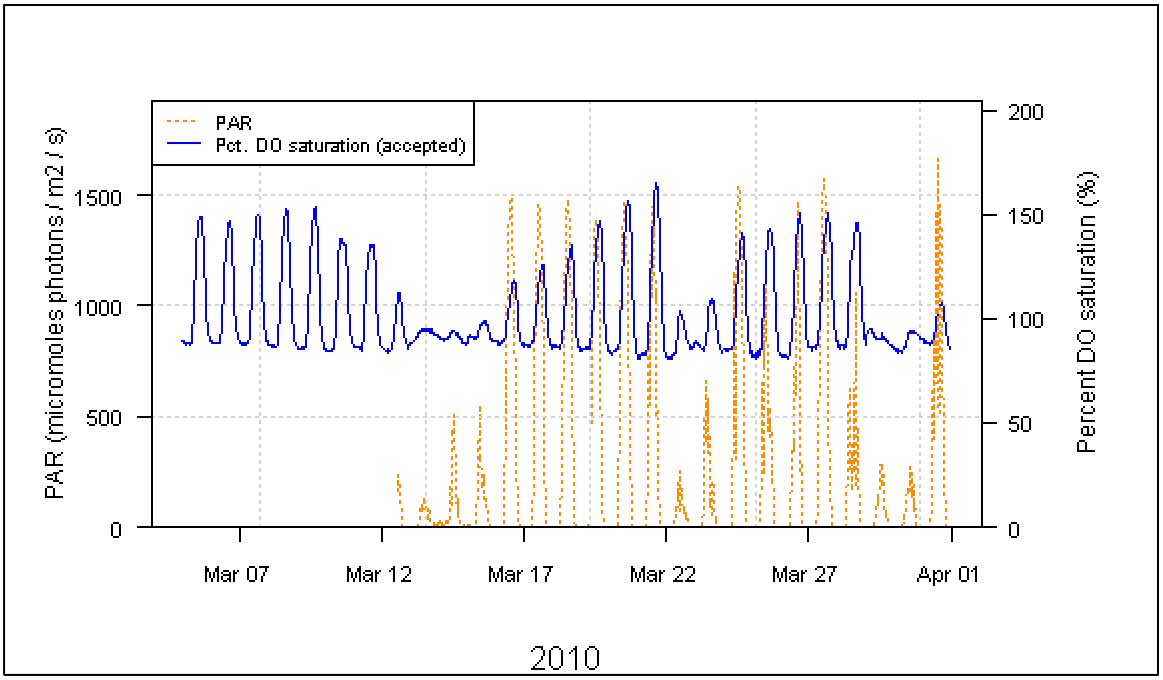


Figure 8. Gage 01467086, PAR and Percent Dissolved Oxygen Saturation, March 2010.

Specific Conductance

Table 17. Gage 01467086 Specific Conductance Summary Results by Month

Gage 01467086 Specific Conductance Summary Information by Month						
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	Min.	Max.	Mean
Jul-09	741.0	30.9	0.4	76.0	691.0	489.41
Aug-09	707.5	29.5	4.9	53.0	660.0	490.87
Sep-09	716.0	29.8	0.6	86.0	639.0	514.11
Oct-09	732.0	30.5	1.6	59.0	631.0	514.83
Nov-09	718.0	29.9	0.3	172.0	614.0	556.89
Mar-10	679.5	28.3	0.2	85.0	918.0	549.83
Apr-10	719.0	30.0	0.1	294.0	625.0	554.68
May-10	742.5	30.9	0.2	146.0	636.0	561.66
Jun-10	716.0	29.8	0.6	239.0	669.0	570.98

Table 18. Gage 01467087 Specific Conductance Summary Results by Month

Gage 01467087 Specific Conductance Summary Information by Month						
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	Min.	Max.	Mean
Jul-09	667.0	27.8	10.3	63.0	671.0	449.57
Aug-09	740.0	30.8	0.5	42.0	622.0	444.83
Sep-09	671.5	28.0	6.7	94.0	663.0	464.53
Oct-09	712.5	29.7	4.2	70.0	625.0	489.91
Nov-09	717.5	29.9	0.3	159.0	608.0	535.13
Mar-10	599.0	25.0	7.4	85.0	743.0	524.31
Apr-10	715.5	29.8	0.6	216.0	639.0	559.65
May-10	722.0	30.1	3.0	124.0	667.0	558.42
Jun-10	709.5	29.6	1.5	312.0	676.0	567.85

Temperature

Monthly mean temperatures observed at the downstream gage were consistently higher than at the upstream gage. Consequently a higher rate of temperature criteria violations was observed at the downstream gage in October, November, March, April, May and June. No violations were observed in the other months (Tables 19-20).

Table 19. Gage 01467086 Temperature Summary Results by Maximum Criteria Period

Gage 01467086 Temperature Summary Information by Max. Criteria Period										
Designated Use	Date range start	Date range end	% hrs. exceedance	% hrs. compliance	% hrs. flagged data	Total hrs. accepted data	Total days accepted data	Min.	Max.	Mean
WWF	1-Jul	31-Jul	0.0	100.0	0.4	741.0	30.9	18.3	25.9	21.77
WWF	1-Aug	15-Aug	0.0	100.0	10.1	323.5	13.5	19.2	25.4	22.57
WWF	16-Aug	31-Aug	0.0	100.0	0.0	384.0	16.0			
WWF	1-Sep	15-Sep	0.0	100.0	0.7	357.5	14.9	14.2	22.4	18.28
WWF	16-Sep	30-Sep	0.0	100.0	0.4	358.5	14.9			
WWF	1-Oct	15-Oct	0.0	100.0	0.0	360.0	15.0	7.9	18.6	13.07
WWF	16-Oct	31-Oct	0.0	100.0	3.1	372.0	15.5			
WWF	1-Nov	15-Nov	6.3	93.7	0.3	359.0	15.0	6.2	15.9	10.71
WWF	16-Nov	30-Nov	57.9	42.1	0.3	359.0	15.0			
WWF	1-Mar	31-Mar	77.7	22.3	2.4	679.5	28.3	4.5	15.3	9.76
WWF	1-Apr	15-Apr	90.4	9.6	0.0	360.0	15.0	9.4	20.6	13.87
WWF	16-Apr	30-Apr	34.4	65.6	0.3	359.0	15.0			
WWF	1-May	15-May	39.7	60.3	0.3	359.0	15.0	10.5	23.9	17.61
WWF	16-May	31-May	12.3	87.7	0.3	383.0	16.0			
WWF	1-Jun	15-Jun	0.0	100.0	0.4	358.5	14.9	16.9	28.6	22.85
WWF	16-Jun	30-Jun	0.0	100.0	0.7	357.5	14.9			

Table 20. Gage 01467087 Temperature Summary Results by Maximum Criteria Period

Gage 01467087 Temperature Summary Information by Max. Criteria Period										
Designated Use	Date range start	Date range end	% hrs. exceedance	% hrs. compliance	% hrs. flagged data	Total hrs. accepted data	Total days accepted data	Min.	Max.	Mean
WWF	1-Jul	31-Jul	0.0	100.0	10.8	663.5	27.6	20.1	27.0	23.01
WWF	1-Aug	15-Aug	0.0	100.0	0.6	358.0	14.9	20.8	27.2	23.62
WWF	16-Aug	31-Aug	0.0	100.0	0.4	382.5	15.9			
WWF	1-Sep	15-Sep	0.0	100.0	0.6	358.0	14.9	15.5	23.0	19.11
WWF	16-Sep	30-Sep	0.0	100.0	0.3	359.0	15.0			
WWF	1-Oct	15-Oct	0.0	100.0	1.9	353.0	14.7	8.8	19.1	13.51
WWF	16-Oct	31-Oct	0.3	99.7	7.0	357.0	14.9			
WWF	1-Nov	15-Nov	5.6	94.4	0.4	358.5	14.9	7.1	17.0	10.81
WWF	16-Nov	30-Nov	63.5	36.5	0.0	360.0	15.0			
WWF	1-Mar	31-Mar	84.2	15.8	7.3	600.5	25.0	5.7	14.6	10.18
WWF	1-Apr	15-Apr	97.8	2.2	0.0	360.0	15.0	10.7	19.7	14.48
WWF	16-Apr	30-Apr	49.6	50.4	1.8	353.5	14.7			
WWF	1-May	15-May	51.9	48.1	6.5	336.5	14.0	11.3	25.7	18.49
WWF	16-May	31-May	20.5	79.5	0.5	382.0	15.9			
WWF	1-Jun	15-Jun	1.3	98.7	1.1	356.0	14.8	17.2	30.0	24.27
WWF	16-Jun	30-Jun	1.3	98.7	2.1	352.5	14.7			

Cobbs Creek (Gages 01475530 and 01475548)

Dissolved oxygen and pH

Higher pH was generally observed at the downstream gage (Tables 25-26), the reverse of the trend seen in Tacony Creek. In Cobbs Creek, this is likely due to a greater difference in algal activity between the two gages, with more algal growth occurring downstream. This is supported by comparing the monthly DO minima and maxima at the two gages (Tables 21-22). In all key algal growing season months, minima are lower and maxima are higher at gage 01475548, indicating more pronounced diel DO fluctuations downstream (Figures 9-10).

Table 21. Gage 01475530 Dissolved Oxygen Minimum Criterion Summary Results by Month

Gage 01475530 Dissolved Oxygen Min Criteria Summary Information by Month									
Month	Des. Use	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. violation	% hrs. compliance	Min	Max	Mean
Jul-09	WWF	742.0	30.9	0.3	0.0	100.0	5.6	9.2	7.40
Aug-09	WWF	459.0	19.1	38.3	0.1	99.9	2.8	8.9	7.64
Sep-09	WWF	711.5	29.6	1.2	0.0	100.0	7.2	10.8	8.70
Oct-09	WWF	730.0	30.4	1.9	0.0	100.0	7.5	11.2	9.15
Nov-09	WWF	678.0	28.3	5.8	0.0	100.0	7.3	12.1	9.81
Mar-10	WWF	728.0	30.3	0.1	0.0	100.0	8.2	14.3	10.78
Apr-10	WWF	718.5	29.9	0.2	0.0	100.0	7.4	12.0	9.55
May-10	WWF	743.5	31.0	0.1	0.0	100.0	7.1	10.4	8.47
Jun-10	WWF	717.0	29.9	0.4	0.0	100.0	5.7	9.2	7.48

Table 22. Gage 01475548 Dissolved Oxygen Minimum Criterion Summary Results by Month

Gage 01475548 Dissolved Oxygen Min Criteria Summary Information by Month									
Month	Des. Use	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. violation	% hrs. compliance	Min	Max	Mean
Jul-09	WWF	742.5	30.9	0.2	5.4	94.6	3.0	10.1	6.31
Aug-09	WWF	641.5	26.7	13.8	2.1	97.9	3.6	10.5	6.62
Sep-09	WWF	719.0	30.0	0.1	0.0	100.0	5.5	13.4	8.47
Oct-09	WWF	662.0	27.6	11.0	0.0	100.0	7.0	13.0	9.35
Nov-09	WWF	606.0	25.3	15.8	0.0	100.0	6.4	13.5	9.91
Mar-10	WWF	711.5	29.6	0.4	0.0	100.0	7.6	17.4	11.29
Apr-10	WWF	717.5	29.9	0.3	0.0	100.0	4.5	14.6	9.61
May-10	WWF	742.5	30.9	0.2	0.0	100.0	5.6	10.8	8.11
Jun-10	WWF	717.0	29.9	0.4	5.0	95.0	3.0	10.8	6.28

Table 23. Gage 01475530 Dissolved Oxygen Daily Mean Criterion Summary Results by Month

Gage 01475530 Dissolved Oxygen Daily Mean Criteria Summary Information by Month								
Month	Des. Use	Total days accepted data	% days flagged data	% days violation	% days compliance	Min.	Max.	Mean
Jul-09	WWF	29.0	6.5	0.0	100.0	6.8	8.1	7.39
Aug-09	WWF	16.0	48.4	0.0	100.0	7.2	8.3	7.63
Sep-09	WWF	27.0	10.0	0.0	100.0	7.8	9.3	8.72
Oct-09	WWF	26.0	16.1	0.0	100.0	8.3	10.1	9.15
Nov-09	WWF	25.0	16.7	0.0	100.0	8.1	10.8	9.86
Mar-10	WWF	28.0	7.8	0.0	100.0	9.0	11.8	10.82
Apr-10	WWF	28.0	6.7	0.0	100.0	8.9	10.1	9.55
May-10	WWF	30.0	3.2	0.0	100.0	7.6	9.7	8.48
Jun-10	WWF	28.0	6.7	0.0	100.0	6.6	8.3	7.49

Table 24. Gage 01475548 Dissolved Oxygen Daily Mean Criterion Summary Results by Month

Gage 01475548 Dissolved Oxygen Daily Mean Criteria Summary Information by Month								
Month	Des. Use	Total days accepted data	% days flagged data	% days violation	% days compliance	Min.	Max.	Mean
Jul-09	WWF	29.0	6.5	3.4	96.6	4.2	7.8	6.27
Aug-09	WWF	25.0	19.4	4.0	96.0	4.9	8.4	6.58
Sep-09	WWF	29.0	3.3	0.0	100.0	7.5	9.8	8.43
Oct-09	WWF	25.0	19.4	0.0	100.0	7.8	10.4	9.36
Nov-09	WWF	24.0	20.0	0.0	100.0	8.6	11.2	9.90
Mar-10	WWF	27.0	9.2	0.0	100.0	8.2	13.3	11.35
Apr-10	WWF	28.0	6.7	0.0	100.0	7.8	10.7	9.60
May-10	WWF	30.0	3.2	0.0	100.0	6.8	9.7	8.11
Jun-10	WWF	28.0	6.7	14.3	85.7	4.3	8.0	6.24

Table 25. Gage 01475530 pH Criteria Summary Results by Month

Gage 01475530 pH Criteria Summary Information by Month												
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. max. violation	% days max. violation	% hrs. min. violation	% days min. violation	% hrs. compliance	% days compliance	Min.	Max.	Mean
Jul-09	742.0	30.9	0.3	0.0	0.0	0.0	0.0	100.0	100.0	6.8	7.7	7.31
Aug-09	479.5	20.0	35.6	0.0	0.0	0.0	0.0	100.0	100.0	6.7	7.6	7.33
Sep-09	711.5	29.6	1.2	0.0	0.0	0.0	0.0	100.0	100.0	7.1	8.0	7.48
Oct-09	730.0	30.4	1.9	0.0	0.0	0.0	0.0	100.0	100.0	7.0	7.7	7.37
Nov-09	678.0	28.3	5.8	0.0	0.0	0.0	0.0	100.0	100.0	7.0	7.7	7.37
Mar-10	728.0	30.3	0.1	0.0	0.0	0.0	0.0	100.0	100.0	7.0	8.8	7.60
Apr-10	718.5	29.9	0.2	0.0	0.0	0.0	0.0	100.0	100.0	7.2	8.3	7.47
May-10	743.5	31.0	0.1	0.0	0.0	0.0	0.0	100.0	100.0	6.9	7.5	7.21
Jun-10	717.0	29.9	0.4	0.0	0.0	0.0	0.0	100.0	100.0	6.8	7.7	7.23

Table 26. Gage 01475548 pH Criteria Summary Results by Month

Gage 01475548 pH Criteria Summary Information by Month												
Month	total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. max. violation	% days max. violation	% hrs. min. violation	% days min. violation	% hrs. compliance	% days compliance	Min.	Max.	Mean
Jul-09	742.0	30.9	0.3	0.0	0.0	0.0	0.0	100.0	100.0	6.2	8.2	7.28
Aug-09	671.0	28.0	9.8	0.0	0.0	0.0	0.0	100.0	100.0	6.1	8.0	7.01
Sep-09	719.0	30.0	0.1	0.0	0.0	0.0	0.0	100.0	100.0	6.4	8.8	7.51
Oct-09	729.5	30.4	1.9	0.0	0.0	0.0	0.0	100.0	100.0	6.5	8.4	7.49
Nov-09	717.0	29.9	0.4	0.0	0.0	0.0	0.0	100.0	100.0	6.6	8.2	7.29
Mar-10	711.5	29.6	0.4	3.1	20.0	0.0	0.0	96.9	80.0	7.1	9.2	7.85
Apr-10	716.5	29.9	0.5	0.0	0.0	0.0	0.0	100.0	100.0	7.1	8.9	7.76
May-10	743.0	31.0	0.1	0.0	0.0	0.0	0.0	100.0	100.0	7.0	8.0	7.56
Jun-10	717.0	29.9	0.4	0.0	0.0	0.0	0.0	100.0	100.0	6.8	8.7	7.41

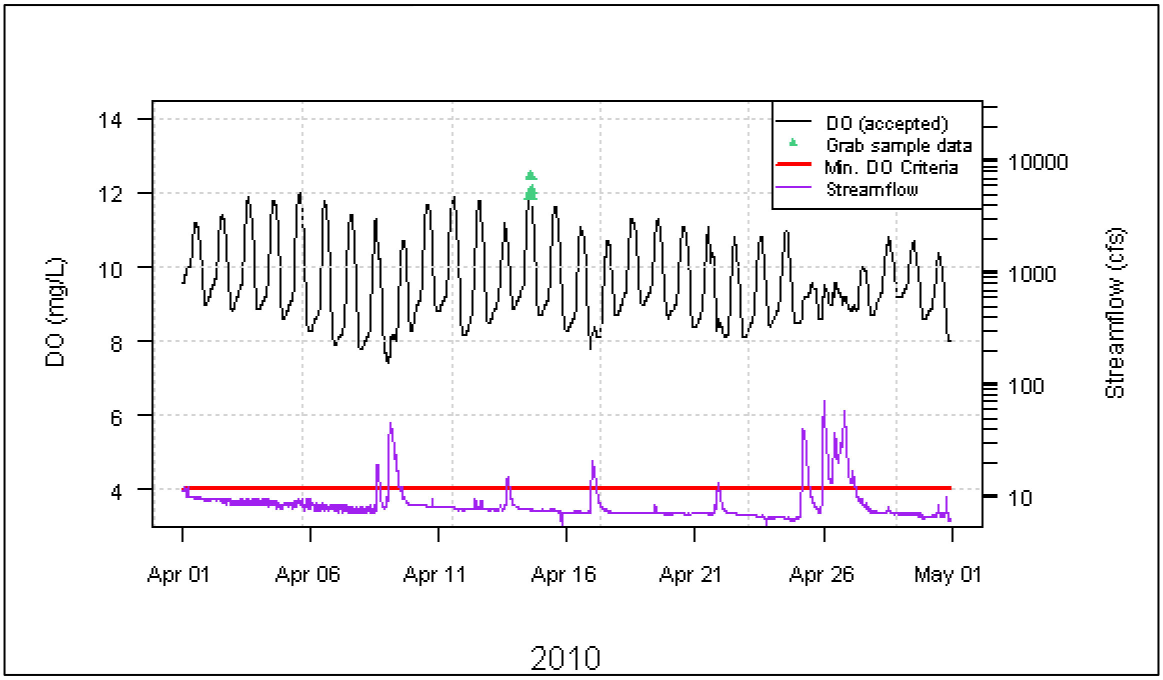


Figure 9. Gage 01475530, Dissolved Oxygen and Streamflow, April 2010.

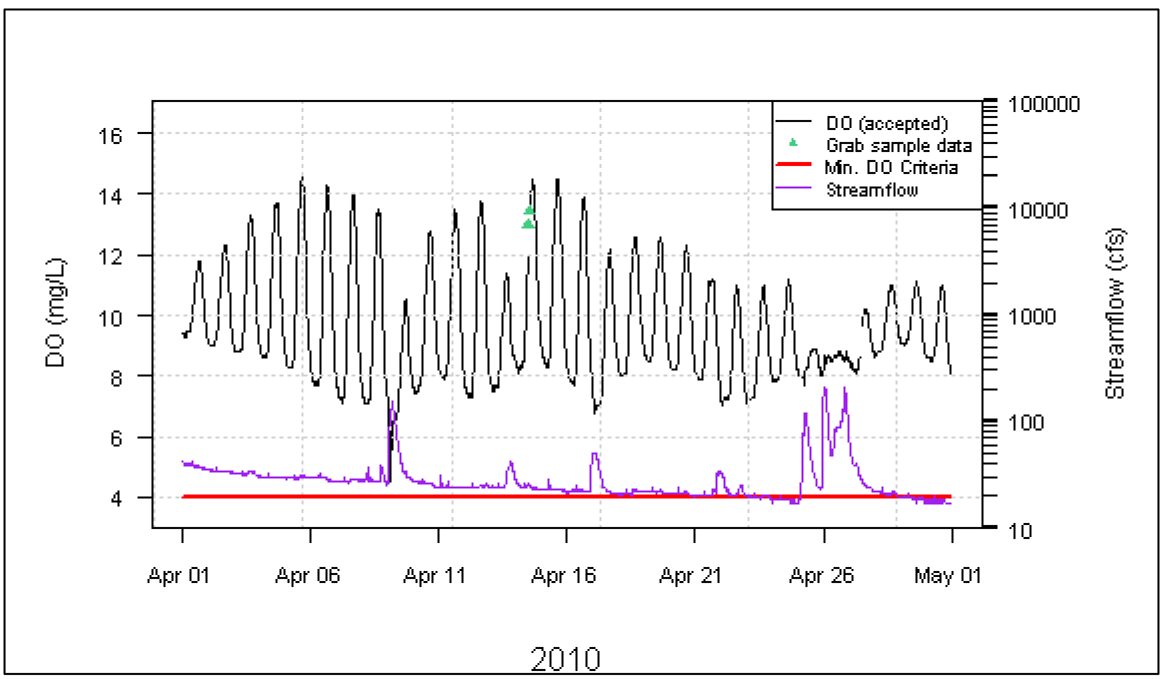


Figure 10. Gage 01475548, Dissolved Oxygen and Streamflow, April 2010.

Specific Conductance

Specific conductance observations were consistently higher at the downstream gage 01475548 (Tables 27-28). Since stormwater runoff typically lowers the specific conductance in the stream, this might indicate stormwater runoff having a less dilutive effect at the downstream gage. A comparison of September 2009 specific conductance plots at each gage indicates higher concentrations were observed at the downstream gage throughout the month. (Figures 11-12). The higher concentrations also indicate a higher buffering capacity downstream.

Table 27. Gage 01475530 Specific Conductance Summary Results by Month

Gage 01475530 Specific Conductance Summary Information by Month						
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	Min.	Max.	Mean
Jul-09	742.0	30.9	0.3	37.0	506.0	429.15
Aug-09	291.0	12.1	60.9	32.0	513.0	318.58
Sep-09	711.5	29.6	1.2	64.0	509.0	421.20
Oct-09	574.5	23.9	22.8	26.0	491.0	423.98
Nov-09	608.5	25.4	15.5	93.0	529.0	446.65
Mar-10	654.0	27.3	10.3	85.0	1040.0	524.26
Apr-10	391.5	16.3	45.6	171.0	499.0	436.61
May-10	307.5	12.8	58.7	55.0	486.0	455.92
Jun-10	576.5	24.0	19.9	73.0	493.0	289.15

Table 28. Gage 01475548 Specific Conductance Summary Results by Month

Gage 01475548 Specific Conductance Summary Information by Month						
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	Min.	Max.	Mean
Jul-09	728.5	30.4	2.1	93.0	631.0	470.11
Aug-09	664.5	27.7	10.7	67.0	618.0	415.90
Sep-09	719.0	30.0	0.1	126.0	647.0	513.42
Oct-09	729.5	30.4	1.9	66.0	629.0	484.53
Nov-09	624.0	26.0	13.3	149.0	597.0	512.41
Mar-10	712.5	29.7	0.2	77.0	1230.0	618.80
Apr-10	585.5	24.4	18.7	215.0	602.0	520.22
May-10	713.0	29.7	4.2	137.0	613.0	516.92
Jun-10	716.0	29.8	0.6	130.0	663.0	523.95

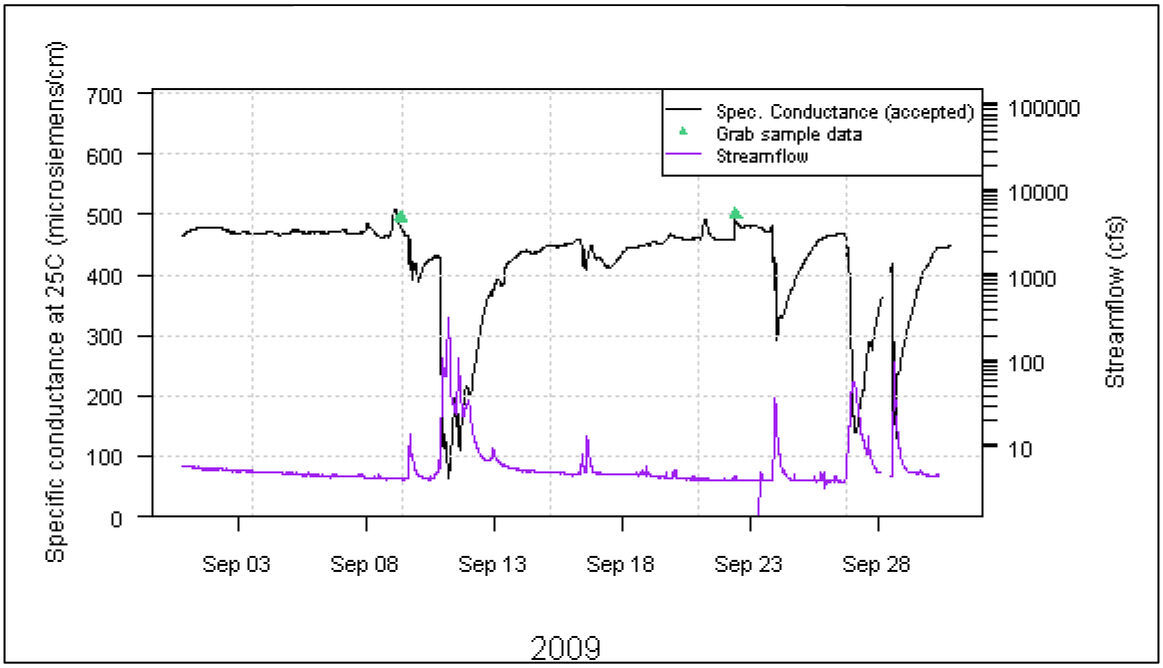


Figure 11. Gage 01475530, Specific Conductance and Streamflow, September 2009.

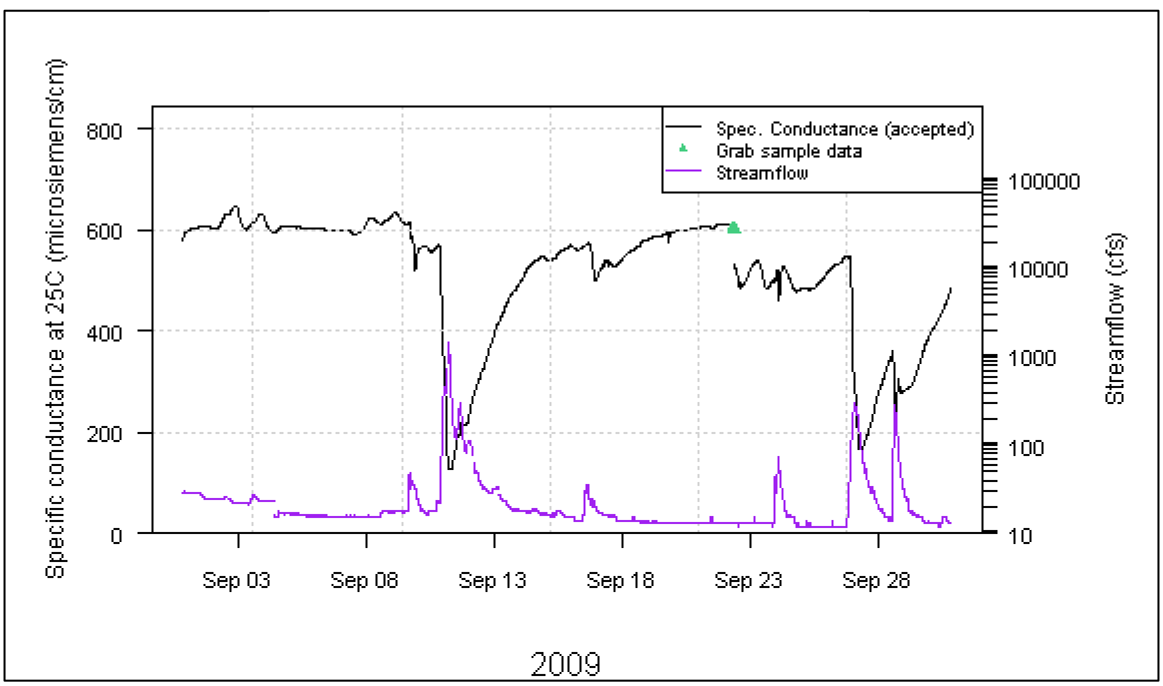


Figure 12. Gage 01475548, Specific Conductance and Streamflow, September 2009.

Temperature

As was also observed in Tacony Creek, slightly higher temperatures were recorded at the downstream gage in Cobbs Creek, resulting in more frequent violations downstream in November, March, April and May (Tables 29-30).

Table 29. Gage 01475530 Temperature Summary Results by Maximum Criteria Period

Gage 01475530 Temperature Summary Information by Max. Criteria Period										
Designated Use	Date range start	Date range end	% hrs. exceedance	% hrs. compliance	% hrs. flagged data	Total hrs. accepted data	Total days accepted data	Min.	Max.	Mean
WWF	1-Jul	31-Jul	0.0	100.0	0.3	741.5	30.9	17.4	25.3	20.52
WWF	1-Aug	15-Aug	0.0	100.0	15.8	303.0	12.6	18.4	24.6	21.51
WWF	16-Aug	31-Aug	0.0	100.0	54.0	176.5	7.4			
WWF	1-Sep	15-Sep	0.0	100.0	0.0	360.0	15.0	14.3	20.8	17.68
WWF	16-Sep	30-Sep	0.0	100.0	2.4	351.5	14.6			
WWF	1-Oct	15-Oct	0.0	100.0	0.6	358.0	14.9	8.0	18.6	13.09
WWF	16-Oct	31-Oct	0.0	100.0	3.3	371.5	15.5			
WWF	1-Nov	15-Nov	4.2	95.8	11.4	319.0	13.3	7.0	15.5	11.00
WWF	16-Nov	30-Nov	70.1	29.9	0.3	359.0	15.0			
WWF	1-Mar	31-Mar	71.8	28.2	2.2	728.0	30.3	4.5	15.1	9.52
WWF	1-Apr	15-Apr	90.9	9.1	0.3	359.0	15.0	9.6	19.9	13.68
WWF	16-Apr	30-Apr	27.8	72.2	0.1	359.5	15.0			
WWF	1-May	15-May	21.8	78.2	0.0	360.0	15.0	10.7	22.4	16.59
WWF	16-May	31-May	1.4	98.6	0.1	383.5	16.0			
WWF	1-Jun	15-Jun	0.0	100.0	0.6	358.0	14.9	16.4	26.8	21.26
WWF	16-Jun	30-Jun	0.0	100.0	0.3	359.0	15.0			

Table 30. Gage 01475548 Temperature Summary Results by Maximum Criteria Period

Gage 01475548 Temperature Summary Information by Max. Criteria Period										
Designated Use	Date range start	Date range end	% hrs. exceedance	% hrs. compliance	% hrs. flagged data	Total hrs. accepted data	Total days accepted data	Min.	Max.	Mean
WWF	1-Jul	31-Jul	0.0	100.0	0.3	742.0	30.9	19.3	26.6	22.26
WWF	1-Aug	15-Aug	0.0	100.0	0.1	359.5	15.0	20.0	26.6	23.26
WWF	16-Aug	31-Aug	0.0	100.0	0.1	383.5	16.0			
WWF	1-Sep	15-Sep	0.0	100.0	0.0	360.0	15.0	15.2	22.1	18.63
WWF	16-Sep	30-Sep	0.0	100.0	0.3	359.0	15.0			
WWF	1-Oct	15-Oct	0.0	100.0	0.6	358.0	14.9	8.6	18.7	13.38
WWF	16-Oct	31-Oct	0.0	100.0	3.3	371.5	15.5			
WWF	1-Nov	15-Nov	6.7	93.3	0.4	358.5	14.9	6.7	16.3	10.90
WWF	16-Nov	30-Nov	67.4	32.6	0.4	358.5	14.9			
WWF	1-Mar	31-Mar	74.2	25.8	0.3	712.0	29.7	4.9	15.0	9.64
WWF	1-Apr	15-Apr	96.7	3.3	0.4	358.5	14.9	10.4	20.4	14.33
WWF	16-Apr	30-Apr	40.5	59.5	0.6	358.0	14.9			
WWF	1-May	15-May	40.1	59.9	0.0	360.0	15.0	11.2	24.6	17.74
WWF	16-May	31-May	11.4	88.6	0.4	382.5	15.9			
WWF	1-Jun	15-Jun	0.0	100.0	0.6	358.0	14.9	17.3	27.9	23.01
WWF	16-Jun	30-Jun	0.0	100.0	0.4	358.5	14.9			

Gages in Separate Sewer System Watersheds

Pennypack Creek (Gages 01467042 and 01467048)

Dissolved oxygen and pH

Both the upstream (gage 01467042) and downstream (gage 01467048) gages of Pennypack Creek showed pronounced diel fluctuations in dissolved oxygen and pH as a result of algal activity. These patterns are most evident during dry weather periods, when algal growth is able to excel because of abundant sunshine and a lack of storm events which might otherwise scour the algal population.

At both upstream and downstream Pennypack Creek gages, extended periods of dry weather in warm months are conducive to excessive algal growth. During these periods, algal populations seemed to flourish, with daily DO fluctuations as high as 7 mg/L (Figure 13), and daily pH fluctuations of approximately 1.5 units (Figure 14). While major pH fluctuations did occur at this downstream gage, there were no pH maximum violations. However, during the same period, a number of violations were seen at gage 01467048 (Figure 15). Furthermore, it would be reasonable to conclude that if not for periodic interruptions of algal activity due to rainfall, those extreme fluctuations and subsequent criteria violations would likely occur on a constant basis through the entire season.

Algal populations in the area of gage 01467048 recover quickly after storm events, as seen in March 2010 (Figure 16). Prior to the first storm event in March 2010, both DO and pH showed the typical high fluctuations indicative of strong algal activity. This stopped abruptly with the each of the three storms that occurred during that month. During these storms, much of the algae was likely scoured away and overcast conditions likely inhibited further growth, as indicated by the PAR data for March 2010 (Figure 17). However, within 3-4 days of the conclusion of the rainfall and the return of sunny conditions, the signature fluctuations of DO and pH made a very dramatic return, and within a few days the algal activity returned to high levels. This not only demonstrates the resilience of the algal population in this ecosystem, but also a likely abundance of nutrients that allows such a resurgence to occur.

Table 31. Gage 01467042 Dissolved Oxygen Minimum Criterion Summary Results by Month

Gage 01467042 Dissolved Oxygen Min Criteria Summary Information by Month									
Month	Des. Use	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. violation	% hrs. compliance	Min	Max	Mean
Jul-09	TSF	667.0	27.8	10.3	0.0	100.0	6.5	9.3	7.63
Aug-09	TSF	712.0	29.7	4.3	0.0	100.0	6.2	9.0	7.53
Sep-09	TSF	714.5	29.8	0.8	0.0	100.0	7.0	10.2	8.15
Oct-09	TSF	705.5	29.4	5.2	0.0	100.0	7.5	11.2	9.29
Nov-09	TSF	717.0	29.9	0.4	0.0	100.0	4.9	12.3	9.29
Mar-10	TSF	702.5	29.3	0.4	0.0	100.0	8.1	16.7	11.56
Apr-10	TSF	718.0	29.9	0.3	0.0	100.0	7.6	13.2	9.81
May-10	TSF	665.5	27.7	10.6	0.0	100.0	5.6	10.3	8.18
Jun-10	TSF	702.5	29.3	2.4	0.0	100.0	5.2	9.5	7.37

Table 32. Gage 01467048 Dissolved Oxygen Minimum Criterion Summary Results by Month

Gage 01467048 Dissolved Oxygen Min Criteria Summary Information by Month									
Month	Des. Use	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. violation	% hrs. compliance	Min	Max	Mean
Jul-09	TSF	719.5	30.0	3.3	0.0	100.0	6.8	13.4	8.32
Aug-09	TSF	488.5	20.4	34.3	0.0	100.0	7.1	10.3	8.16
Sep-09	TSF	709.0	29.5	1.5	0.0	100.0	7.2	12.6	8.95
Oct-09	TSF	713.5	29.7	4.1	0.0	100.0	8.4	13.6	10.11
Nov-09	TSF	715.5	29.8	0.6	0.0	100.0	8.7	14.0	10.78
Mar-10	TSF	633.0	26.4	2.2	0.0	100.0	9.3	17.3	11.64
Apr-10	TSF	516.0	21.5	28.3	0.0	100.0	7.2	13.0	10.06
May-10	TSF	534.0	22.3	0.7	0.0	100.0	6.3	11.0	8.63
Jun-10	TSF	713.5	29.7	0.9	0.0	100.0	5.2	11.7	7.90

Table 33. Gage 01467042 Dissolved Oxygen Daily Mean Criterion Summary Results by Month

Gage 01467042 Dissolved Oxygen Daily Mean Criteria Summary Information by Month								
Month	Des. Use	Total days accepted data	% days flagged data	% days violation	% days compliance	Min.	Max.	Mean
Jul-09	TSF	741.5	30.9	0.3	0.0	0.0	0.0	0.0
Aug-09	TSF	611.0	25.5	17.9	0.0	0.0	0.0	0.0
Sep-09	TSF	719.0	30.0	0.1	0.0	0.0	0.0	0.0
Oct-09	TSF	705.5	29.4	5.2	0.0	0.0	0.0	0.0
Nov-09	TSF	717.0	29.9	0.4	0.0	0.0	0.0	0.0
Mar-10	TSF	702.5	29.3	0.4	0.0	0.0	0.0	0.0
Apr-10	TSF	718.0	29.9	0.3	0.0	0.0	0.0	0.0
May-10	TSF	742.0	30.9	0.3	0.0	0.0	0.0	0.0
Jun-10	TSF	697.5	29.1	3.1	0.0	0.0	0.0	0.0

Table 34. Gage 01467048 Dissolved Oxygen Daily Mean Criterion Summary Results by Month

Gage 01467048 Dissolved Oxygen Daily Mean Criteria Summary Information by Month								
Month	Des. Use	Total days accepted data	% days flagged data	% days violation	% days compliance	Min.	Max.	Mean
Jul-09	TSF	26.0	16.1	0.0	100.0	7.6	9.8	8.30
Aug-09	TSF	18.0	41.9	0.0	100.0	7.5	8.8	8.19
Sep-09	TSF	25.0	16.7	0.0	100.0	8.0	9.5	9.01
Oct-09	TSF	22.0	29.0	0.0	100.0	9.1	11.2	10.12
Nov-09	TSF	26.0	13.3	0.0	100.0	9.4	11.9	10.83
Mar-10	TSF	25.0	7.3	0.0	100.0	10.1	13.3	11.66
Apr-10	TSF	19.0	36.7	0.0	100.0	9.1	10.8	10.07
May-10	TSF	20.0	10.8	0.0	100.0	7.4	10.1	8.56
Jun-10	TSF	28.0	6.7	0.0	100.0	6.9	8.9	7.93

Table 35. Gage 01467042 pH Criteria Summary Results by Month

Gage 01467042 pH Criteria Summary Information by Month												
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hours max. violation	% days max. violation	% hrs. min. violation	% days min. violation	% hrs. compliance	% days compliance	Min.	Max.	Mean
Jul-09	741.5	30.9	0.3	0.0	0.0	0.0	0.0	100.0	100.0	7.0	7.9	7.53
Aug-09	611.0	25.5	17.9	0.0	0.0	0.0	0.0	100.0	100.0	6.8	7.9	7.54
Sep-09	719.0	30.0	0.1	0.0	0.0	0.0	0.0	100.0	100.0	7.1	8.2	7.62
Oct-09	705.5	29.4	5.2	0.0	0.0	0.0	0.0	100.0	100.0	7.0	7.9	7.59
Nov-09	717.0	29.9	0.4	0.0	0.0	0.0	0.0	100.0	100.0	7.1	7.8	7.47
Mar-10	702.5	29.3	0.4	0.0	0.0	0.0	0.0	100.0	100.0	7.0	8.8	7.48
Apr-10	718.0	29.9	0.3	0.0	0.0	0.0	0.0	100.0	100.0	7.2	8.6	7.52
May-10	742.0	30.9	0.3	0.0	0.0	0.0	0.0	100.0	100.0	7.1	7.7	7.39
Jun-10	697.5	29.1	3.1	0.0	0.0	0.0	0.0	100.0	100.0	7.2	8.1	7.52

Table 36. Gage 01467048 pH Criteria Summary Results by Month

Gage 01467048 pH Criteria Summary Information by Month												
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. max. violation	% days max. violation	% hrs. min. violation	% days min. violation	% hrs. compliance	% days compliance	Min.	Max.	Mean
Jul-09	728.5	30.4	2.1	0.0	0.0	0.0	0.0	100.0	100.0	6.8	8.7	7.56
Aug-09	488.5	20.4	34.3	0.0	0.0	0.0	0.0	100.0	100.0	6.7	8.2	7.54
Sep-09	340.0	14.2	52.8	0.0	0.0	0.0	0.0	100.0	100.0	7.3	8.7	7.80
Oct-09	11.0	0.5	98.5	0.0	0.0	0.0	0.0	100.0	100.0	7.3	7.7	7.58
Nov-09	550.0	22.9	23.6	0.0	0.0	0.0	0.0	100.0	100.0	7.4	8.6	7.80
Mar-10	646.0	26.9	0.2	1.7	14.8	0.0	0.0	98.3	85.2	7.1	9.2	7.79
Apr-10	619.5	25.8	14.0	0.0	0.0	0.0	0.0	100.0	100.0	6.2	8.6	7.59
May-10	533.5	22.2	0.8	0.0	0.0	0.0	0.0	100.0	100.0	7.2	8.0	7.52
Jun-10	713.0	29.7	1.0	0.0	0.0	0.0	0.0	100.0	100.0	7.0	8.8	7.64

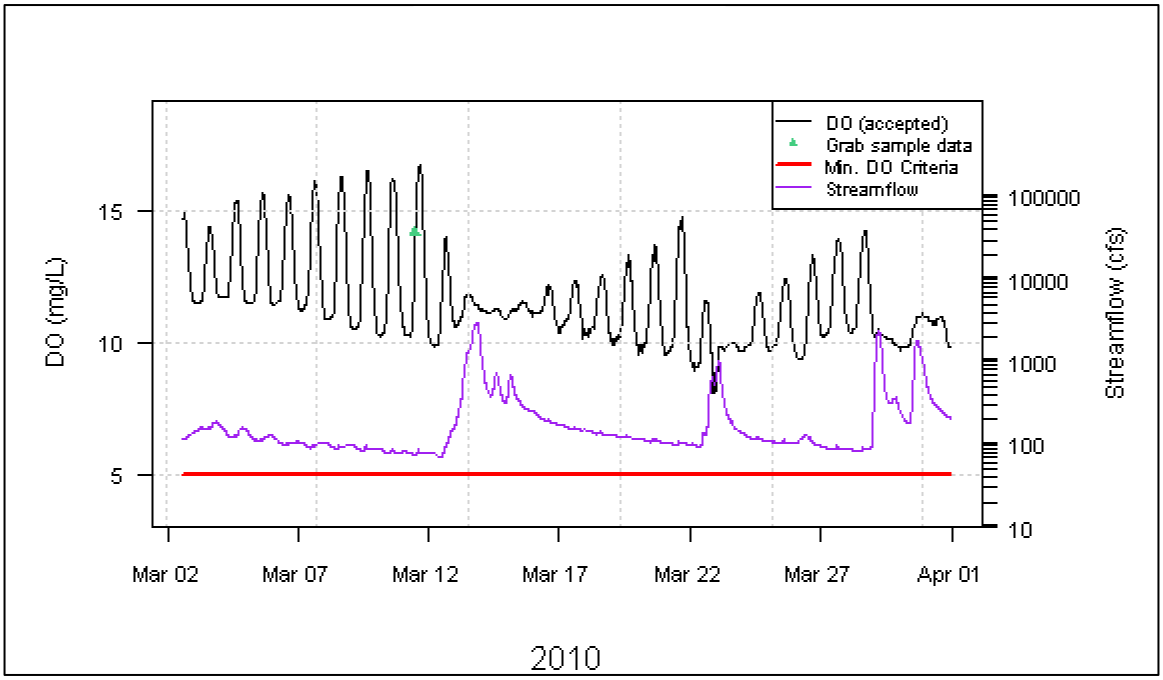


Figure 13. Gage 01467042, Dissolved Oxygen and Streamflow, March 2010.

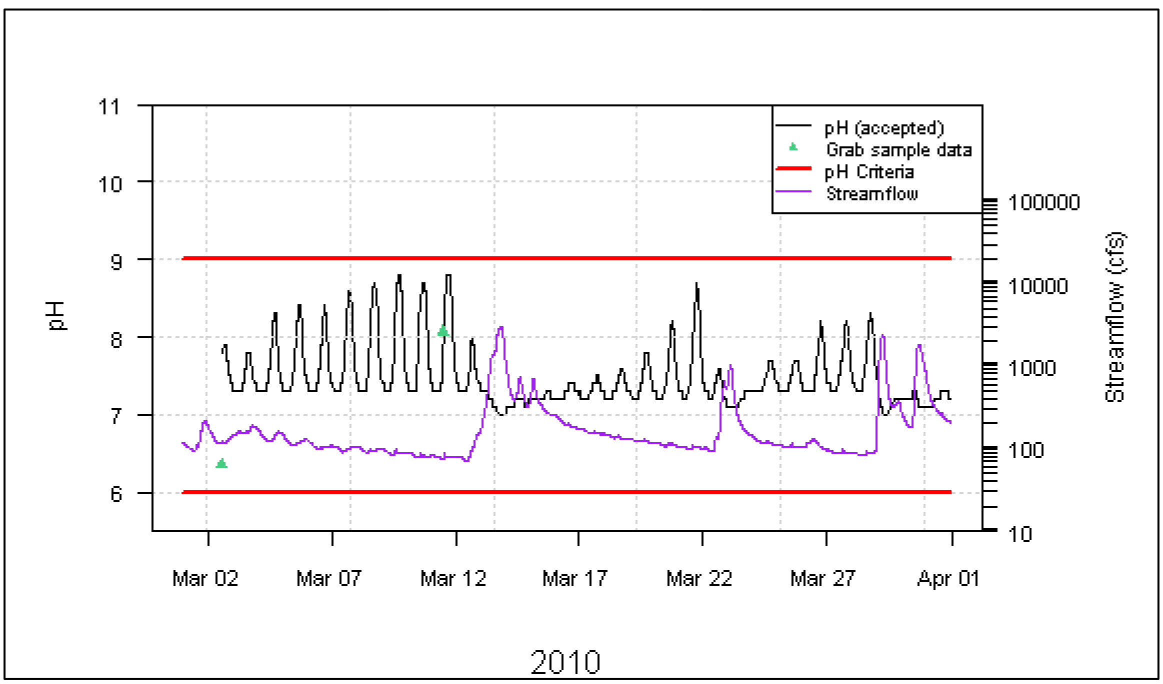


Figure 14. Gage 01467042, pH and Streamflow, March 2010.

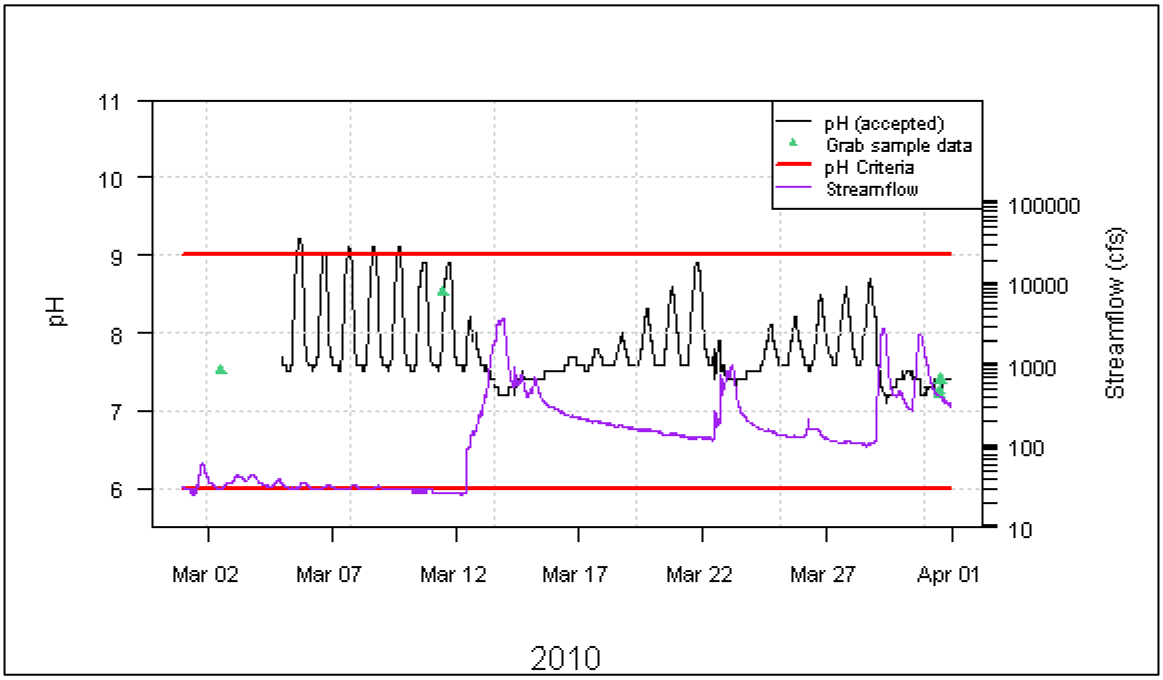


Figure 15. Gage 01467048, pH and Streamflow, March 2010.

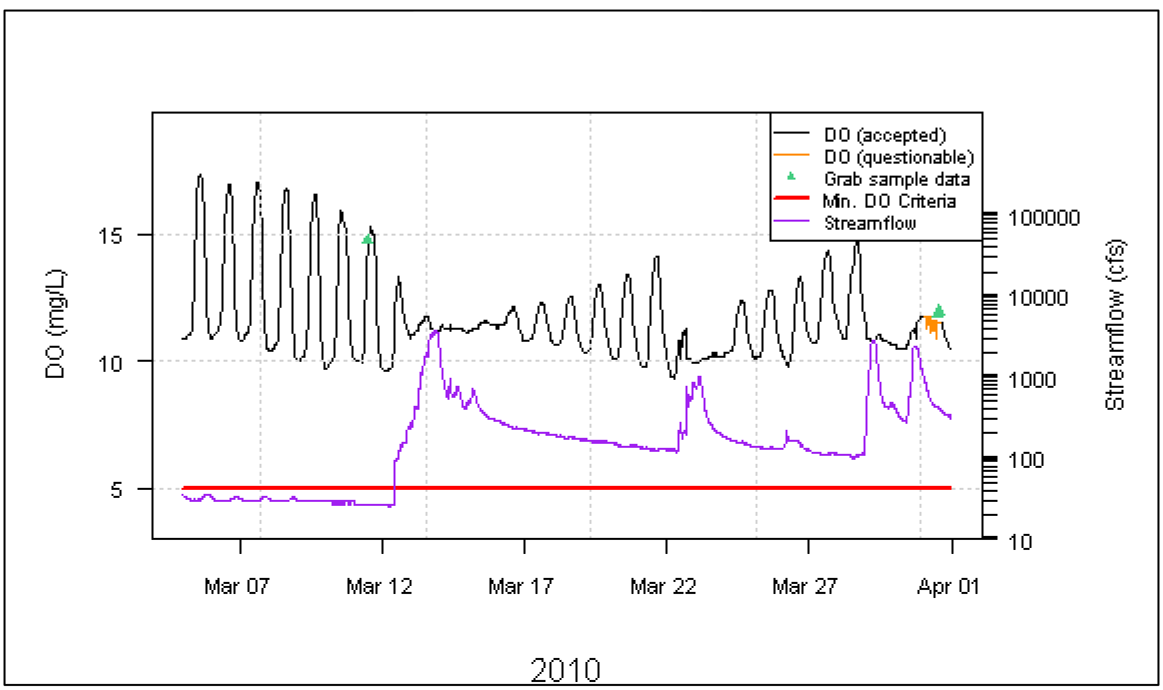


Figure 16. Gage 01467048, Dissolved Oxygen and Streamflow, March 2010.

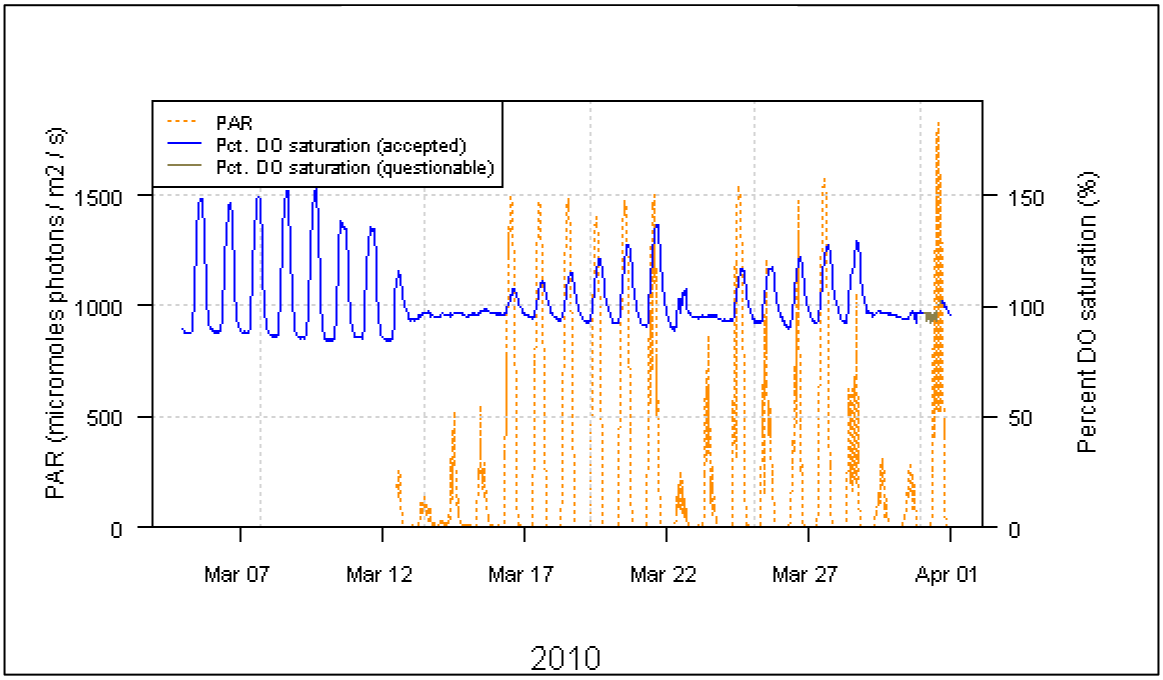


Figure 17. Gage 01467048, PAR and Percent Dissolved Oxygen Saturation, March 2010.

Turbidity

The most notable aspect of the turbidity data from the upstream site (gage 01467042) was an unusual pattern of regularly spaced and repeating spikes in turbidity. The pattern became most noticeable September through November 2009 (Figures 18-20). There seemed to be a clear correlation between the frequent increases in turbidity and a similar daily fluctuation in flow. Upon careful examination of the data, it appears that the daily timing for each rise and fall in flow (as well as each turbidity spike) took place almost always between 9:00 am-6:00 pm. Furthermore, the majority of these turbidity spikes do not correspond to rainfall events. Therefore it would seem that an anthropogenic phenomenon was taking place on a daily basis upstream of these gages. Possible causes might include a streamside construction site or the regular discharge from a wastewater treatment facility.

Table 37. Gage 01467042, Turbidity Summary Results by Month

Gage 01467042 Turbidity Summary Information by Month								
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. above max. guideline	% hrs. below max. guideline	Min.	Max.	Mean
Jul-09	740.0	30.8	0.5	44.7	55.3	0.1	320.0	13.51
Aug-09	710.5	29.6	4.5	50.5	49.5	0.2	700.0	15.08
Sep-09	701.0	29.2	2.6	32.8	67.2	0.1	230.0	7.31
Oct-09	685.5	28.6	7.9	39.5	60.5	0.1	330.0	8.34
Nov-09	712.0	29.7	1.1	21.1	78.9	0.1	310.0	3.75
Mar-10	673.0	28.0	4.5	52.5	47.5	0.1	390.0	16.93
Apr-10	682.0	28.4	5.3	12.3	87.7	0.1	15.0	1.31
May-10	671.0	28.0	9.8	25.8	74.2	0.5	54.0	3.46
Jun-10	676.5	28.2	6.0	16.3	83.7	0.1	300.0	3.23

Table 37. Gage 01467048, Turbidity Summary Results by Month

Gage 01467048 Turbidity Summary Information by Month								
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. above max. guideline	% hrs. below max. guideline	Min.	Max.	Mean
Jul-09	721.5	30.1	3.0	59.7	40.3	1.2	690.0	19.44
Aug-09	474.0	19.8	36.3	54.1	45.9	0.6	670.0	23.28
Sep-09	645.0	26.9	10.4	34.0	66.0	0.0	490.0	9.92
Oct-09	644.0	26.8	13.4	31.7	68.3	-0.2	360.0	8.92
Nov-09	715.0	29.8	0.7	12.0	88.0	0.6	870.0	2.81
Mar-10	453.0	18.9	30.0	98.6	1.4	0.5	920.0	39.34
Apr-10	601.5	25.1	16.5	22.2	77.8	-1.1	42.0	2.28
May-10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Jun-10	59.5	2.5	91.7	25.2	74.8	-0.7	15.0	2.27

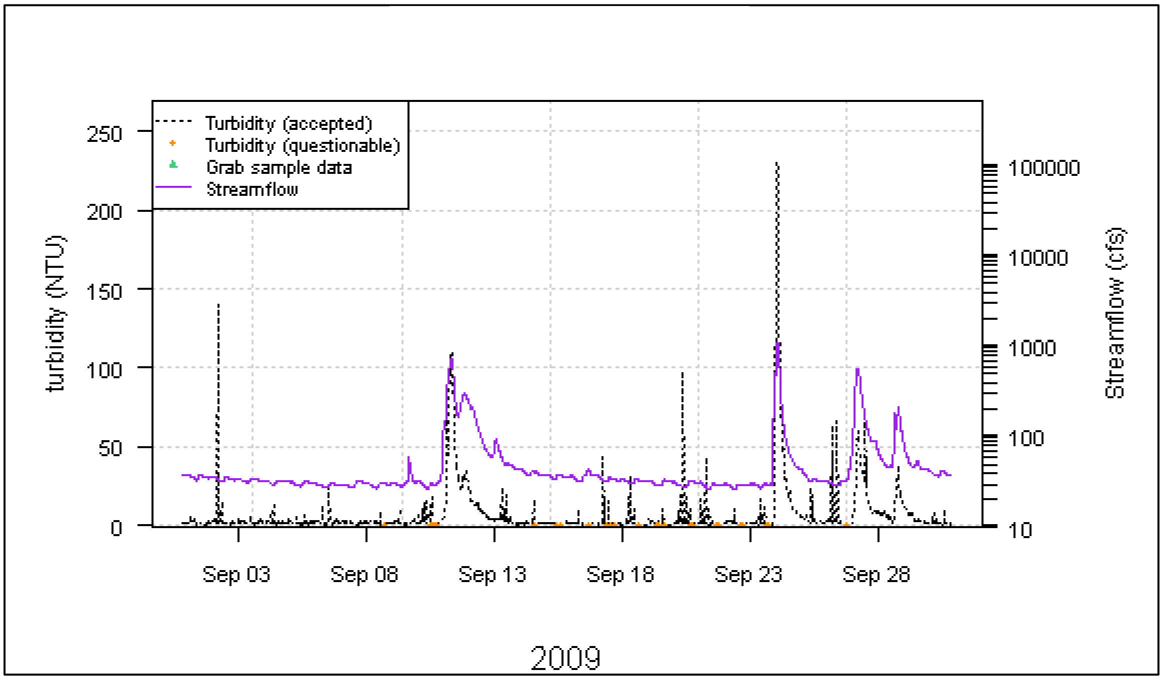


Figure 18. Gage 01467042, Turbidity and Streamflow, September 2009.

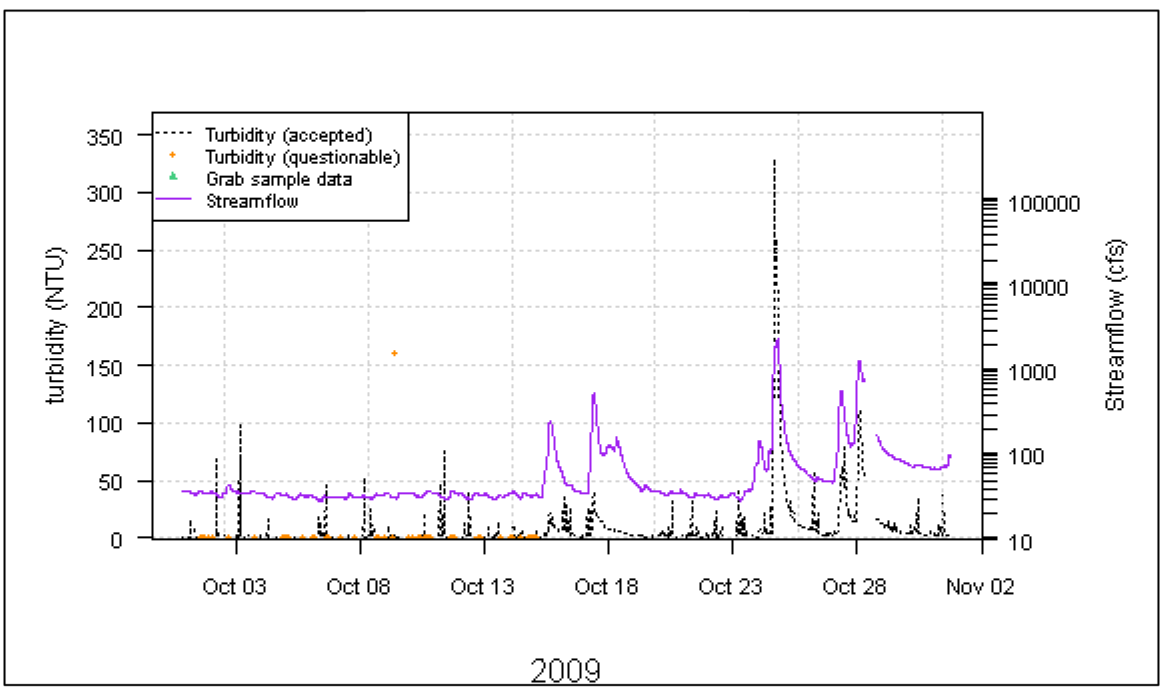


Figure 19. Gage 01467042, Turbidity and Streamflow, October 2009.

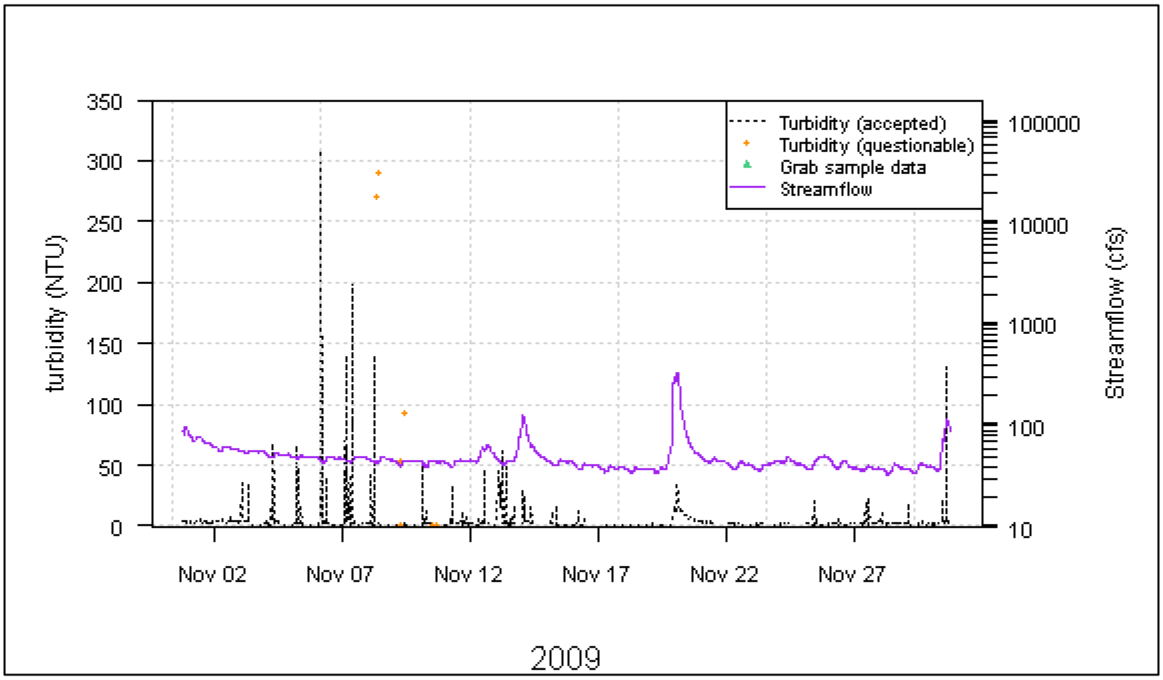


Figure 20. Gage 01467042, Turbidity and Streamflow, November 2009.

Specific Conductance

As discussed in the previous section, a potentially anthropogenic turbidity/flow phenomenon was noted at gage 01467042. A notable pattern can also be seen in the specific conductance data gathered at this site in April 2010 (Figure 21). During what would normally be the more stable periods of conductance, regular fluctuations were observed that may be directly related to the unusual flow pattern of suspected anthropogenic origin noted above.

Table 38. Gage 01467042 Specific Conductance Summary Results by Month

Gage 01467042 Specific Conductance Summary Information by Month						
Month	Total hours accepted data	Total days accepted data	Percent hours flagged data	Min.	Max.	Mean
Jul-09	741.5	30.9	0.3	138.0	633.0	463.20
Aug-09	715.5	29.8	3.8	70.0	569.0	448.67
Sep-09	719.0	30.0	0.1	163.0	592.0	479.77
Oct-09	729.5	30.4	1.9	82.0	614.0	484.15
Nov-09	717.0	29.9	0.4	293.0	555.0	508.62
Mar-10	702.5	29.3	0.4	121.0	895.0	536.63
Apr-10	718.0	29.9	0.3	367.0	559.0	506.25
May-10	742.0	30.9	0.3	325.0	628.0	521.06
Jun-10	716.0	29.8	0.6	132.0	677.0	553.48

Table 39. Gage 01467048 Specific Conductance Summary Results by Month

Gage 01467048 Specific Conductance Summary Information by Month						
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	Min.	Max.	Mean
Jul-09	734.0	30.6	1.3	62.0	621.0	406.77
Aug-09	488.5	20.4	34.3	63.0	556.0	427.78
Sep-09	709.0	29.5	1.5	158.0	621.0	461.85
Oct-09	713.0	29.7	4.2	95.0	605.0	465.30
Nov-09	715.5	29.8	0.6	215.0	582.0	505.53
Mar-10	646.0	26.9	0.2	120.0	801.0	509.15
Apr-10	619.5	25.8	14.0	8.2	568.0	493.74
May-10	533.0	22.2	0.9	320.0	594.0	509.26
Jun-10	713.0	29.7	1.0	131.1	676.2	531.87

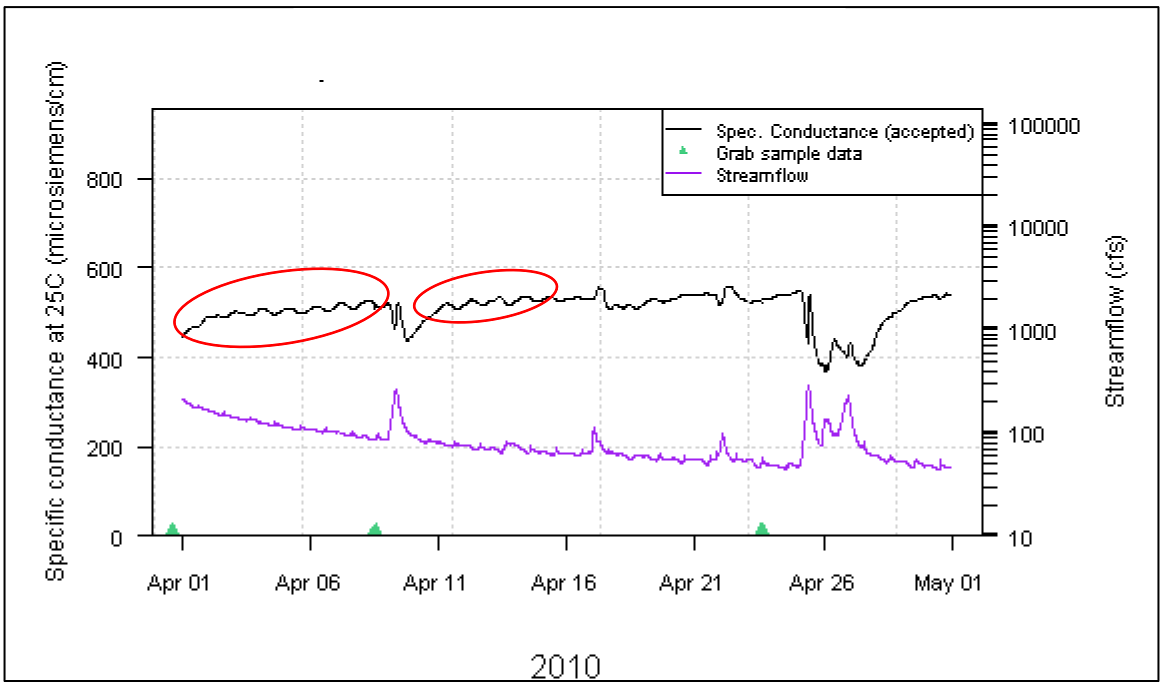


Figure 21. Gage 01467042, Specific Conductance and Streamflow, April 2010. Unusual fluctuations in conductance are circled in red.

Temperature

Temperature data collected were mostly in compliance with maximum temperature criteria (Tables 40-41). The only periods that did exceed maximum criteria were July and November 2009, and March-June 2010. Late fall and early spring months are always subject to major air temperature fluctuations, and reliably predicting average stream temperatures during these periods of time is difficult at best. In June 2010, exceedances occurred during an early summer month which is prone to periods of above normal temperatures (*i.e.*, heat waves). However, the maximum criteria for this stream vary over the course of the month (21-22°C), and therefore do not take into account natural summer temperature peaks, as occurred during the entire month (Figures 22-23). These periods of above normal air temperatures likely caused the high stream temperature exceedance rates in June. Similar exceedance rates and air temperature phenomena were also observed in March and early April, 2010.

Table 40. Gage 01467042 Temperature Summary Results by Maximum Criteria Period.

Gage 01467042 Temperature Summary Information by Max. Criteria Period										
Des. Use	Date range start	Date range end	Percent hours exceedance	Percent hours compliance	Percent hours flagged data	Total hours accepted data	Total days accepted data	Min.	Max.	Mean
TSF	1-Jul	31-Jul	10.5	89.5	0.3	742.0	30.9	18.1	25.3	21.26
TSF	1-Aug	15-Aug	0.0	100.0	0.6	358.0	14.9	19.1	25.1	22.13
TSF	16-Aug	31-Aug	0.0	100.0	6.8	358.0	14.9			
TSF	1-Sep	15-Sep	0.0	100.0	0.3	359.0	15.0	14.5	22.2	18.25
TSF	16-Sep	30-Sep	0.0	100.0	0.0	360.0	15.0			
TSF	1-Oct	15-Oct	0.0	100.0	0.4	358.5	14.9	8.6	17.8	13.35
TSF	16-Oct	31-Oct	0.0	100.0	3.4	371.0	15.5			
TSF	1-Nov	15-Nov	7.1	92.9	0.3	359.0	15.0	7.0	15.6	10.98
TSF	16-Nov	30-Nov	65.9	34.1	0.6	358.0	14.9			
TSF	1-Mar	31-Mar	71.9	28.1	0.8	702.5	29.3	5.1	14.7	9.37
TSF	1-Apr	15-Apr	91.6	8.4	0.3	359.0	15.0	9.5	19.8	13.71
TSF	16-Apr	30-Apr	32.3	67.7	0.3	359.0	15.0			
TSF	1-May	15-May	37.7	62.3	0.6	358.0	14.9	10.7	23.8	17.44
TSF	16-May	31-May	27.2	72.8	0.0	384.0	16.0			
TSF	1-Jun	15-Jun	62.0	38.0	0.7	357.5	14.9	16.8	27.0	22.45
TSF	16-Jun	30-Jun	78.1	21.9	0.4	358.5	14.9			

Table 41. Gage 01467048, Temperature Summary Results by Maximum Criteria Period.

Gage 01467048 Temperature Summary Information by Max. Criteria Period										
Designated Use	Date range start	Date range end	% hrs. exceedance	% hrs. compliance	% hrs. flagged data	Total hrs. accepted data	Total days accepted data	Min.	Max.	Mean
TSF	1-Jul	31-Jul	26.6	73.4	1.3	734.0	30.6	19.6	25.6	22.20
TSF	1-Aug	15-Aug	0.0	100.0	14.3	308.5	12.9	20.0	25.9	22.54
TSF	16-Aug	31-Aug	0.0	100.0	53.1	180.0	7.5			
TSF	1-Sep	15-Sep	0.0	100.0	2.8	350.0	14.6	15.2	22.5	18.69
TSF	16-Sep	30-Sep	0.0	100.0	0.4	358.5	14.9			
TSF	1-Oct	15-Oct	0.0	100.0	1.9	353.0	14.7	8.4	18.5	13.25
TSF	16-Oct	31-Oct	0.0	100.0	6.1	360.5	15.0			
TSF	1-Nov	15-Nov	6.0	94.0	1.3	355.5	14.8	6.8	15.4	10.75
TSF	16-Nov	30-Nov	61.4	38.6	0.0	360.0	15.0			
TSF	1-Mar	31-Mar	83.7	16.3	0.3	646.0	26.9	4.5	14.2	9.82
TSF	1-Apr	15-Apr	96.5	3.5	8.5	329.5	13.7	9.4	19.9	14.41
TSF	16-Apr	30-Apr	44.8	55.2	19.4	290.0	12.1			
TSF	1-May	15-May	17.2	82.8	3.2	151.0	6.3	11.1	24.6	19.97
TSF	16-May	31-May	41.0	59.0	0.9	380.5	15.9			
TSF	1-Jun	15-Jun	74.2	25.8	1.5	354.5	14.8	17.0	29.5	23.69
TSF	16-Jun	30-Jun	93.2	6.8	0.3	359.0	15.0			

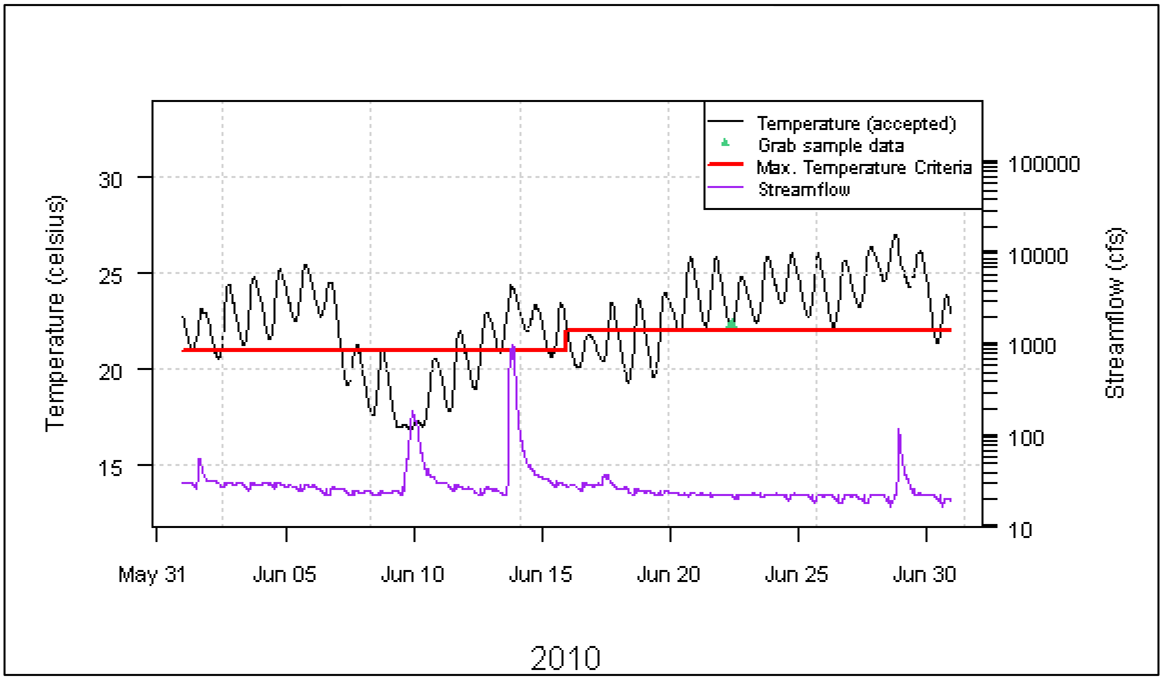


Figure 22. Gage 01467042, Temperature and Streamflow, June 2010.

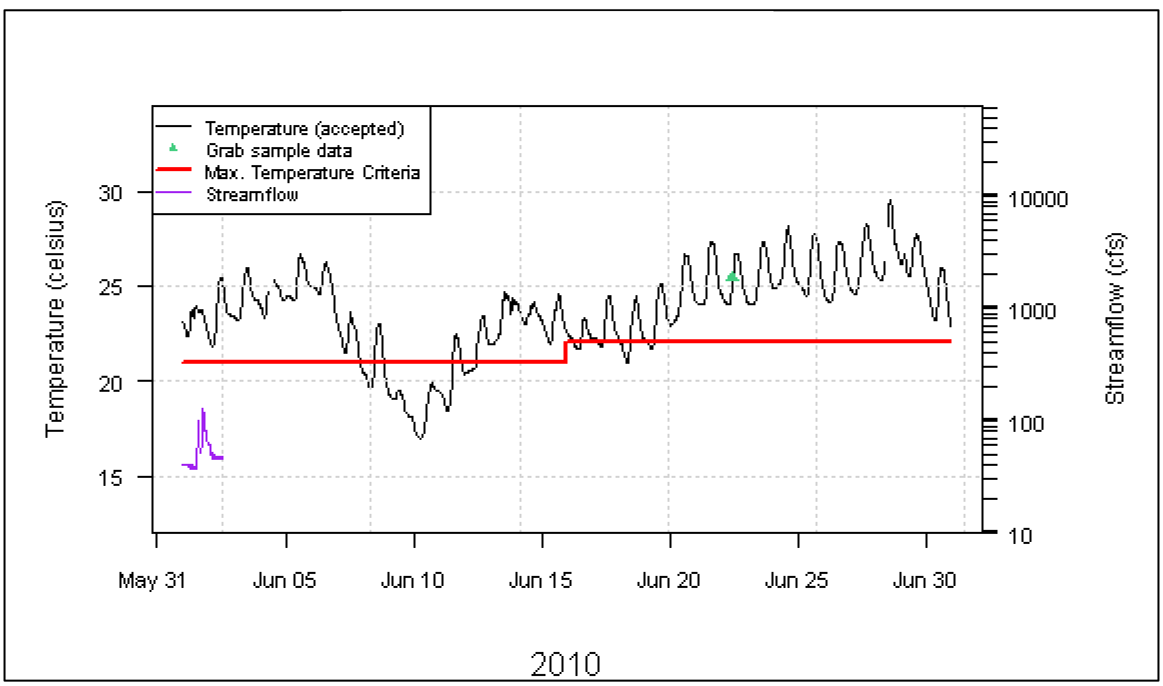


Figure 23. Gage 01467048, Temperature and Streamflow, June 2010.

Wissahickon Creek (Gages 01473900 and 01474000)

Dissolved oxygen and pH

Dissolved oxygen and pH data collected from the Wissahickon Creek gages also show signs of strong algal activity in the form of diel fluctuations. The upper gage (01473900) exhibits some of the most dramatic diel fluctuations of any of the Philadelphia USGS gage sites. In April 2010, dissolved oxygen is seen fluctuating from 18 to 6.9 mg/L in a single day/night period (Figure 24), with pH ranging from approximately 7.8 to 9.4 at the same time (Figure 25). Frequent pH maxima exceedances also occurred during that month on an almost daily basis, a direct result of algal activity. A contributing factor for the number of exceedances is the fact that April 2010 was a particularly dry month, and therefore provided a very long period for algal growth, uninterrupted by cloudy weather and scouring storm events.

Table 42. Gage 01473900 Dissolved Oxygen Minimum Criterion Summary Results by Month

Gage 01473900 Dissolved Oxygen Min Criteria Summary Information by Month									
Month	Des. Use	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. violation	% hrs. compliance	Min	Max	Mean
Jul-09	TSF	740.5	30.9	0.5	0.0	100.0	5.9	9.5	7.31
Aug-09	TSF	681.0	28.4	8.5	0.0	100.0	6.1	9.5	7.35
Sep-09	TSF	715.5	29.8	0.6	0.0	100.0	6.5	11.3	8.25
Oct-09	TSF	726.0	30.3	2.4	0.0	100.0	7.3	12.8	9.32
Nov-09	TSF	682.5	28.4	5.2	0.0	100.0	7.4	14.5	9.88
Mar-10	TSF	581.5	24.2	17.5	0.0	100.0	7.2	18.8	11.12
Apr-10	TSF	621.5	25.9	13.7	0.0	100.0	5.9	18.1	9.94
May-10	TSF	716.5	29.9	3.7	0.5	99.5	4.7	12.8	7.58
Jun-10	TSF	697.0	29.0	3.2	3.0	97.0	4.2	11.3	6.98

Table 43. Gage 01474000 Dissolved Oxygen Minimum Criterion Summary Results by Month

Gage 01474000 Dissolved Oxygen Min Criteria Summary Information by Month									
Month	Des. Use	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. violation	% hrs. compliance	Min	Max	Mean
Jul-09	TSF	742.0	30.9	0.3	0.1	99.9	4.9	10.7	7.51
Aug-09	TSF	690.0	28.8	7.3	2.2	97.8	2.8	11.9	7.52
Sep-09	TSF	618.0	25.8	14.2	0.0	100.0	5.3	10.7	8.19
Oct-09	TSF	682.5	28.4	8.3	0.0	100.0	8.1	11.2	9.72
Nov-09	TSF	719.0	30.0	0.1	0.0	100.0	8.2	12.7	10.01
Mar-10	TSF	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Apr-10	TSF	706.5	29.4	1.9	0.8	99.2	4.2	14.2	9.00
May-10	TSF	641.0	26.7	13.8	0.3	99.7	3.6	11.3	8.22
Jun-10	TSF	719.0	30.0	0.1	0.0	100.0	5.2	13.6	8.20

Table 44. Gage 01473900 Dissolved Oxygen Daily Mean Criterion Summary Results by Month

Gage 01473900 Dissolved Oxygen Daily Mean Criteria Summary Information by Month								
Month	Des. Use	Total days accepted data	% days flagged data	% days violation	% days compliance	Min.	Max.	Mean
Jul-09	TSF	28.0	9.7	0.0	100.0	6.9	7.7	7.32
Aug-09	TSF	26.0	16.1	0.0	100.0	6.8	7.9	7.36
Sep-09	TSF	27.0	10.0	0.0	100.0	7.6	9.0	8.24
Oct-09	TSF	27.0	12.9	0.0	100.0	8.1	10.9	9.30
Nov-09	TSF	24.0	20.0	0.0	100.0	8.7	10.9	9.84
Mar-10	TSF	21.0	28.5	0.0	100.0	9.3	12.8	11.13
Apr-10	TSF	23.0	23.3	0.0	100.0	8.4	11.6	10.06
May-10	TSF	26.0	16.1	0.0	100.0	6.3	9.3	7.63
Jun-10	TSF	27.0	10.0	3.7	96.3	5.7	8.0	6.99

Table 45. Gage 01474000 Dissolved Oxygen Daily Mean Criterion Summary Results by Month

Gage 01474000 Dissolved Oxygen Daily Mean Criteria Summary Information by Month								
Month	Des. Use	Total days accepted data	% days flagged data	% days violation	% days compliance	Min.	Max.	Mean
Jul-09	TSF	29.0	6.5	0.0	100.0	6.3	8.6	7.48
Aug-09	TSF	27.0	12.9	0.0	100.0	5.3	8.8	7.47
Sep-09	TSF	22.0	26.7	0.0	100.0	6.8	9.5	8.14
Oct-09	TSF	25.0	19.4	0.0	100.0	8.9	10.6	9.73
Nov-09	TSF	29.0	3.3	0.0	100.0	8.7	11.2	10.01
Mar-10	TSF	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Apr-10	TSF	28.0	6.7	3.6	96.4	5.8	10.3	8.95
May-10	TSF	25.0	19.4	0.0	100.0	6.5	9.4	8.25
Jun-10	TSF	28.0	6.7	0.0	100.0	7.0	9.0	8.23

Table 46. Gage 01473900 pH Criteria Summary Results by Month

Gage 01473900 pH Criteria Summary Information by Month													
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. max. violation	% days max. violation	% hrs. min. violation	% days min. violation	% hrs. compliance	% days compliance	Min.	Max.	Mean
Jul-09	740.5	30.9	0.5	0.0	0.0	0.0	0.0	100.0	100.0	7.1	7.8	7.58
Aug-09	681.0	28.4	8.5	0.0	0.0	0.0	0.0	100.0	100.0	6.9	7.9	7.55
Sep-09	715.5	29.8	0.6	0.0	0.0	0.0	0.0	100.0	100.0	6.8	8.0	7.54
Oct-09	730.0	30.4	1.9	0.0	0.0	0.0	0.0	100.0	100.0	6.3	8.1	7.51
Nov-09	682.5	28.4	5.2	0.0	0.0	0.0	0.0	100.0	100.0	7.0	8.2	7.45
Mar-10	701.5	29.2	0.4	6.2	30.0	0.0	0.0	93.8	70.0	7.4	9.5	7.99
Apr-10	621.5	25.9	13.7	8.8	44.4	0.0	0.0	91.2	55.6	7.5	9.4	8.14
May-10	739.5	30.8	0.6	0.0	0.0	0.0	0.0	100.0	100.0	7.3	8.2	7.63
Jun-10	713.0	29.7	1.0	0.0	0.0	0.0	0.0	100.0	100.0	7.3	8.6	7.81

Table 47. Gage 01474000 pH Criteria Summary Results by Month

Gage 01474000 pH Criteria Summary Information by Month												
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. max. violation	% days max. violation	% hrs. min. violation	% days min. violation	% hrs. compliance	% days compliance	Min.	Max.	Mean
Jul-09	740.5	742.0	30.9	0.3	0.0	0.0	0.0	0.0	100.0	100.0	7.3	8.3
Aug-09	718.0	693.5	28.9	6.8	0.0	0.0	0.0	0.0	100.0	100.0	7.3	8.7
Sep-09	694.5	673.0	28.0	6.5	0.0	0.0	0.0	0.0	100.0	100.0	7.3	8.4
Oct-09	731.0	671.5	28.0	9.7	0.0	0.0	0.0	0.0	100.0	100.0	7.4	8.3
Nov-09	716.5	719.0	30.0	0.1	0.0	0.0	0.0	0.0	100.0	100.0	7.6	8.4
Mar-10	541.5	597.0	24.9	8.6	26.0	38.5	0.0	0.0	74.0	61.5	7.3	9.9
Apr-10	657.5	718.5	29.9	0.2	0.0	0.0	0.0	0.0	100.0	100.0	7.1	9.0
May-10	634.0	739.5	30.8	0.6	0.0	0.0	0.0	0.0	100.0	100.0	6.6	8.3
Jun-10	717.5	719.0	30.0	0.1	0.0	0.0	0.0	0.0	100.0	100.0	7.4	8.7

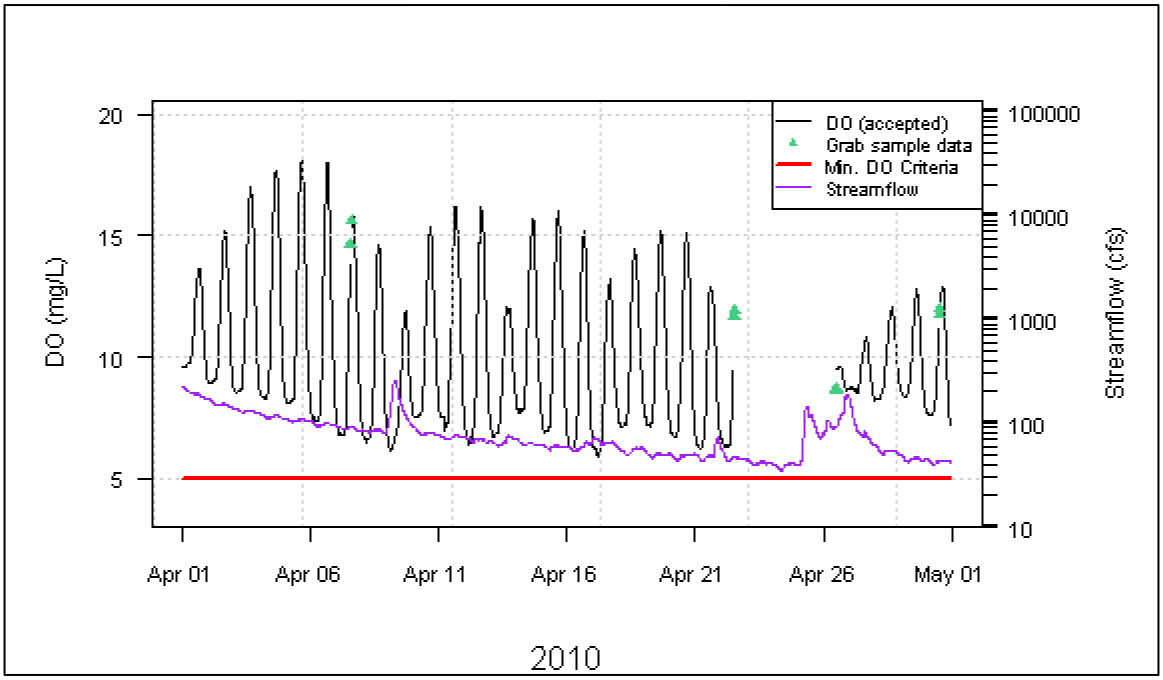


Figure 24. Gage 01473900, Dissolved Oxygen and Streamflow, April 2010.

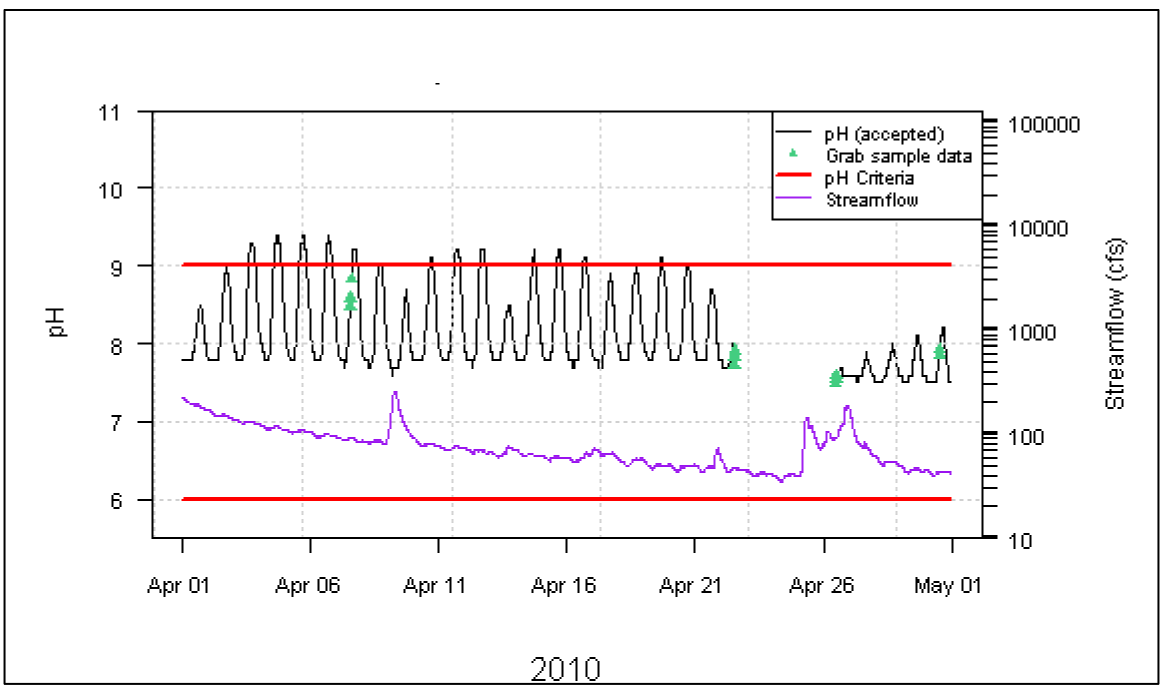


Figure 25. Gage 01473900, pH and Streamflow, April 2010.

Turbidity

Turbidity at this site, as with most of Philadelphia's streams, increases drastically with increased flow from rainfall. During the wet month August 2009, turbidity averaged well above the guideline (Tables 48-49). However, during dry periods between storm events, turbidity quickly decreased. A number of sizeable storm events during that month (Figure 26) resulted in sharp increases in stream turbidity, however those levels decreased rapidly afterwards as stream flow returned to normal. Such is the case with nearly all storm-related high turbidity events in Philadelphia's streams.

Table 48. Gage 01473900 Turbidity Summary Results by Month

Gage 01473900 Turbidity Summary Information by Month								
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. above max. guideline	% hrs. below max. guideline	Min.	Max.	Mean
Jul-09	740.0	30.8	0.5	93.2	6.8	1.8	390.0	16.27
Aug-09	681.0	28.4	8.5	80.7	19.3	0.9	380.0	24.36
Sep-09	703.0	29.3	2.4	48.9	51.1	0.7	180.0	7.54
Oct-09	687.5	28.6	7.6	51.4	48.6	0.5	340.0	11.68
Nov-09	682.5	28.4	5.2	36.1	63.9	0.5	50.0	3.28
Mar-10	576.0	24.0	18.2	57.9	42.1	1.3	590.0	12.51
Apr-10	575.0	24.0	20.1	84.1	15.9	1.1	42.0	4.82
May-10	708.5	29.5	4.8	52.2	47.8	0.6	140.0	8.24
Jun-10	713.0	29.7	1.0	66.7	33.3	0.4	660.0	17.63

Table 49. Gage 01474000 Turbidity Summary Results by Month

Gage 01474000 Turbidity Summary Information by Month								
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. above max. guideline	% hrs. below max. guideline	Min.	Max.	Mean
Jul-09	713.0	29.7	4.2	41.3	58.7	0.0	200.0	10.03
Aug-09	694.5	28.9	6.7	44.6	55.4	0.0	610.0	17.35
Sep-09	692.5	28.9	3.8	36.2	63.8	0.0	80.0	5.51
Oct-09	724.0	30.2	2.7	36.5	63.5	0.2	200.0	6.73
Nov-09	717.0	29.9	0.4	10.9	89.1	0.2	110.0	1.35
Mar-10	603.0	25.1	7.7	37.8	62.2	0.3	180.0	11.94
Apr-10	549.0	22.9	23.8	5.0	95.0	0.1	11.0	1.29
May-10	732.5	30.5	1.5	5.4	94.6	0.0	32.0	0.67
Jun-10	412.0	17.2	42.8	10.2	89.8	0.1	20.0	1.36

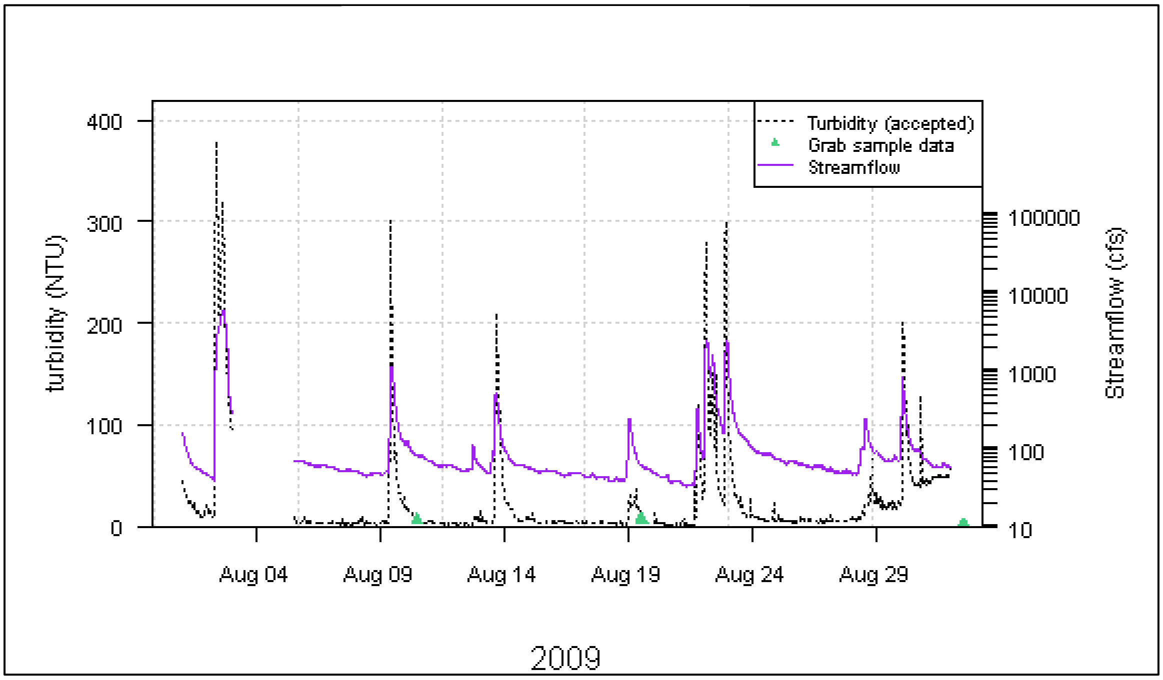


Figure 26. Gage 01473900, Turbidity and Streamflow, August 2009.

Specific Conductance

Table 50. Gage 01473900 Specific Conductance Summary Results by Month

Gage 01473900 Specific Conductance Summary Information by Month						
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	Min.	Max.	Mean
Jul-09	740.5	30.9	0.5	243.0	827.0	657.11
Aug-09	681.0	28.4	8.5	116.0	777.0	563.98
Sep-09	715.5	29.8	0.6	214.0	799.0	645.17
Oct-09	729.5	30.4	1.9	106.0	834.0	647.10
Nov-09	683.0	28.5	5.1	431.0	746.0	674.22
Mar-10	701.0	29.2	0.5	139.0	937.0	624.43
Apr-10	574.5	23.9	20.2	493.0	772.0	637.46
May-10	740.0	30.8	0.5	429.0	846.0	728.15
Jun-10	713.0	29.7	1.0	294.0	1000.0	806.54

Table 51. Gage 01474000 Specific Conductance Summary Results by Month

Gage 01474000 Specific Conductance Summary Information by Month						
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	Min.	Max.	Mean
Jul-09	741.5	30.9	0.3	229.0	773.0	570.48
Aug-09	741.0	30.9	0.4	109.0	748.0	488.98
Sep-09	686.5	28.6	4.7	246.0	749.0	591.18
Oct-09	727.5	30.3	2.2	178.0	761.0	587.85
Nov-09	718.5	29.9	0.2	479.0	708.0	642.42
Mar-10	599.0	25.0	8.3	158.0	720.0	550.07
Apr-10	717.5	29.9	0.3	401.0	691.0	619.27
May-10	704.5	29.4	5.3	463.0	764.0	687.47
Jun-10	717.5	29.9	0.3	428.0	827.0	715.96

Temperature

Temperature trends and exceedance rates in Wissahickon Creek Watershed were similar to those observed in Pennypack Creek (Tables 52-53, Figures 27-28).

Table 52. Gage 01473900 Temperature Summary Results by Month by Maximum Criteria Period

Gage 01473900 Temperature Summary Information by Max. Criteria Period										
Designated Use	Date range start	Date range end	% hrs. exceedance	% hrs. compliance	% hrs. flagged data	Total hrs. accepted data	Total days accepted data	Min.	Max.	Mean
TSF	1-Jul	31-Jul	8.7	91.3	0.6	739.5	30.8	18.4	24.6	21.25
TSF	1-Aug	15-Aug	0.0	100.0	16.9	299.0	12.5	19.1	25.1	22.08
TSF	16-Aug	31-Aug	0.0	100.0	0.5	382.0	15.9			
TSF	1-Sep	15-Sep	0.0	100.0	0.4	358.5	14.9	14.9	21.9	18.40
TSF	16-Sep	30-Sep	0.0	100.0	0.8	357.0	14.9			
TSF	1-Oct	15-Oct	0.0	100.0	0.0	360.0	15.0	8.8	17.7	13.64
TSF	16-Oct	31-Oct	0.0	100.0	3.9	369.0	15.4			
TSF	1-Nov	15-Nov	8.4	91.6	9.3	326.5	13.6	7.3	15.8	11.29
TSF	16-Nov	30-Nov	70.8	29.2	0.6	358.0	14.9			
TSF	1-Jul	31-Jul	69.2	30.8	1.4	698.0	29.1	4.5	14.6	9.25
TSF	1-Apr	15-Apr	94.3	5.7	0.6	358.0	14.9	9.5	19.9	13.95
TSF	16-Apr	30-Apr	33.3	66.7	26.9	263.0	11.0			
TSF	1-May	15-May	43.6	56.4	1.0	356.5	14.9	11.4	23.8	17.75
TSF	16-May	31-May	30.4	69.6	1.0	380.0	15.8			
TSF	1-Jun	15-Jun	66.0	34.0	1.3	355.5	14.8	17.1	27.3	22.54
TSF	16-Jun	30-Jun	80.9	19.1	1.3	355.5	14.8			

Table 53. Gage 01474000 Temperature Summary Results by Month by Maximum Criteria Period

Gage 01474000 Temperature Summary Information by Max. Criteria Period										
Designated Use	Date range start	Date range end	% hrs. exceedance	% hrs. compliance	% hrs. flagged data	Total hrs. accepted data	Total days accepted data	Min.	Max.	Mean
TSF	1-Jul	31-Jul	18.5	81.5	0.3	742.0	30.9	19.4	25.2	21.94
TSF	1-Aug	15-Aug	0.0	100.0	0.1	359.5	15.0	19.7	25.1	22.44
TSF	16-Aug	31-Aug	0.0	100.0	0.4	382.5	15.9			
TSF	1-Sep	15-Sep	0.0	100.0	0.4	358.5	14.9	15.2	21.4	18.27
TSF	16-Sep	30-Sep	0.0	100.0	0.3	359.0	15.0			
TSF	1-Oct	15-Oct	0.0	100.0	0.0	360.0	15.0	8.7	17.4	13.19
TSF	16-Oct	31-Oct	0.0	100.0	5.2	364.0	15.2			
TSF	1-Nov	15-Nov	5.7	94.3	0.0	360.0	15.0	7.5	14.8	10.80
TSF	16-Nov	30-Nov	63.9	36.1	0.3	359.0	15.0			
TSF	1-Mar	31-Mar	76.0	24.0	6.9	603.0	25.1	5.8	13.9	9.48
TSF	1-Apr	15-Apr	96.8	3.2	0.3	359.0	15.0	10.3	19.6	14.03
TSF	16-Apr	30-Apr	34.1	65.9	0.3	359.0	15.0			
TSF	1-May	15-May	39.6	60.4	1.8	353.5	14.7	11.4	23.2	17.72
TSF	16-May	31-May	32.0	68.0	0.0	384.0	16.0			
TSF	1-Jun	15-Jun	73.0	27.0	0.1	359.5	15.0	17.3	27.0	23.00
TSF	16-Jun	30-Jun	89.0	11.0	0.1	359.5	15.0			

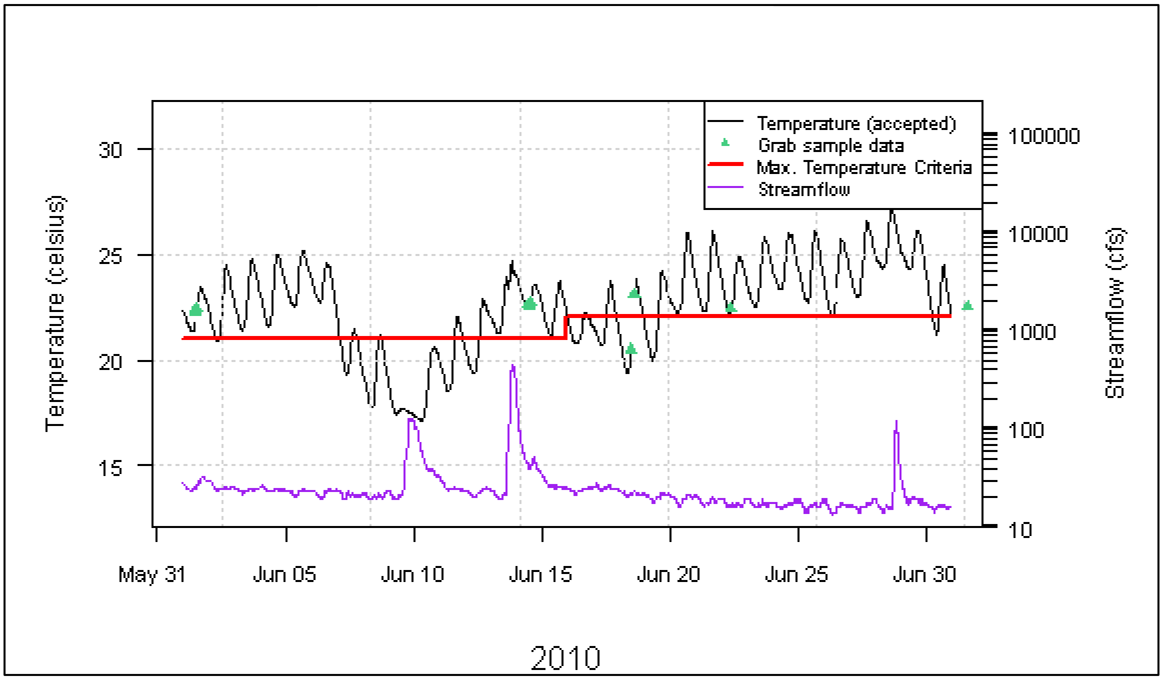


Figure 27. Gage 01473900, Temperature and Streamflow, June 2010.

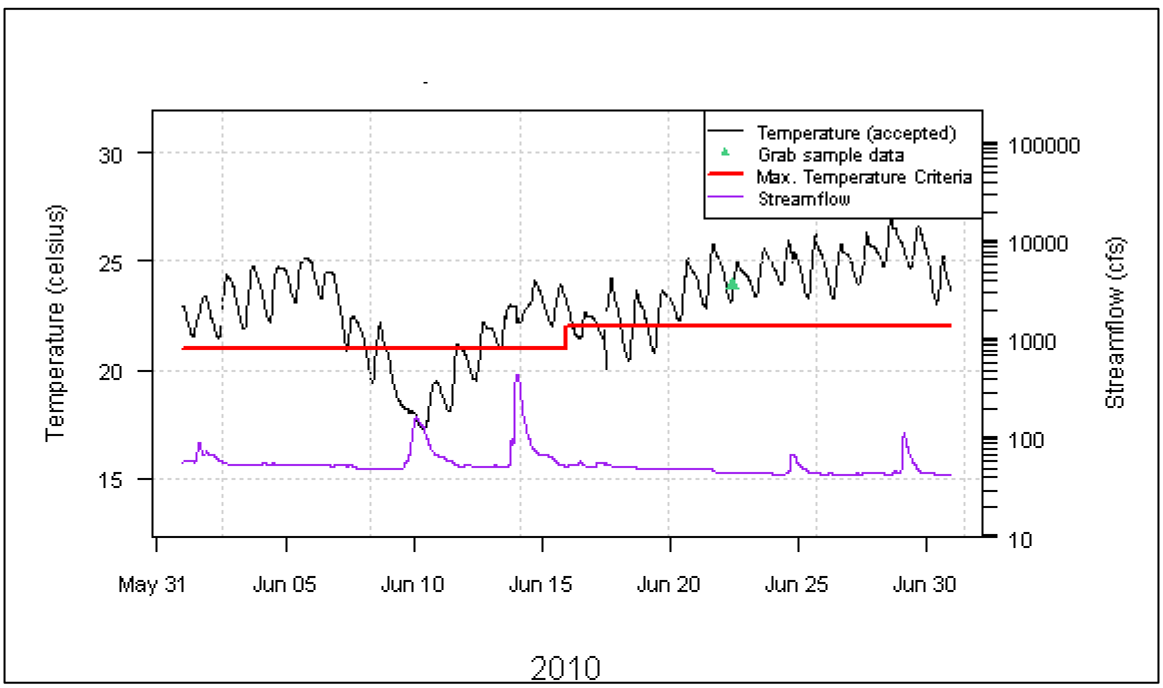


Figure 28. Gage 01474000, Temperature and Streamflow, June 2010.

Poquesssing Creek (Gage 01465798)

Dissolved oxygen and pH

Dissolved oxygen and pH at this gage site were well within acceptable ranges and almost never fell below the minimum criterion (Tables 54-59). Data collected from Poquessing Creek did exhibit classic signs of algal activity, as indicated by diel fluctuations in both DO and pH (Figures 29-30).

As seen with previous sites, the algal activity and related diel fluctuations in DO and pH are only suppressed by storm events. These suppressions, however, are only very temporary. Given an adequate period of uninterrupted algal growth, such as June 15-28 (Figures 29-30), one can expect steadily increasing DO & pH fluctuations. While there were no maximum pH violations at these particular sites, it is clear that lengthy periods of dry weather and algal growth raise diel pH peaks close to 9.0, as seen on June 27 (Figure 30).

Table 54. Gage 01465798 Dissolved Oxygen Min. Criteria Summary Results by Month

Gage 01465798 Dissolved Oxygen Min. Criteria Summary Information by Month									
Month	Des. Use	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. violation	% hrs. compliance	Min	Max	Mean
Jul-09	WWF	738.0	30.8	0.8	0.0	100.0	4.5	12.0	7.46
Aug-09	WWF	481.0	20.0	35.3	0.0	100.0	5.9	10.3	7.48
Sep-09	WWF	718.5	29.9	0.2	0.0	100.0	6.5	12.5	8.31
Oct-09	WWF	738.0	30.8	0.8	0.0	100.0	5.6	12.6	8.99
Nov-09	WWF	718.5	29.9	0.2	0.0	100.0	5.2	11.5	8.35
Mar-10	WWF	668.0	27.8	0.4	0.0	100.0	8.5	17.0	11.19
Apr-10	WWF	685.0	28.5	4.9	0.0	100.0	6.9	14.1	9.58
May-10	WWF	743.0	31.0	0.1	0.0	100.0	5.7	10.9	7.96
Jun-10	WWF	716.0	29.8	0.6	0.0	100.0	4.6	12.3	7.24

Table 55. Gage 01465798 Dissolved Oxygen Mean Criteria Summary Results by Month

Gage 01465798 Dissolved Oxygen Daily Mean Criteria Summary Information by Month								
Month	Des. Use	Total days accepted data	% days flagged data	% days violation	% days compliance	Min.	Max.	Mean
Jul-09	WWF	29.0	6.5	0.0	100.0	6.5	8.9	7.48
Aug-09	WWF	18.0	41.9	0.0	100.0	6.8	8.2	7.48
Sep-09	WWF	28.0	6.7	0.0	100.0	7.2	9.1	8.32
Oct-09	WWF	29.0	6.5	0.0	100.0	7.7	9.9	8.99
Nov-09	WWF	29.0	3.3	0.0	100.0	7.4	9.3	8.37
Mar-10	WWF	24.0	14.2	0.0	100.0	9.1	13.0	11.35
Apr-10	WWF	21.0	30.0	0.0	100.0	8.0	10.5	9.50
May-10	WWF	29.0	6.5	0.0	100.0	6.7	9.2	7.96
Jun-10	WWF	27.0	10.0	0.0	100.0	5.9	8.2	7.29

Table 56. Gage 01465798 pH Criteria Summary Results by Month

Gage 01465798 pH Criteria Summary Information by Month												
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. max. violation	% days max. violation	% hrs. min. violation	% days min. violation	% hrs. compliance	% days compliance	Min.	Max.	Mean
Jul-09	741.5	30.9	0.3	0.0	0.0	0.0	0.0	100.0	100.0	6.5	8.2	7.22
Aug-09	643.5	26.8	13.5	0.0	0.0	0.0	0.0	100.0	100.0	6.5	7.9	7.22
Sep-09	718.5	29.9	0.2	0.0	0.0	0.0	0.0	100.0	100.0	6.5	8.4	7.27
Oct-09	739.5	30.8	0.6	0.0	0.0	0.0	0.0	100.0	100.0	6.4	7.4	6.95
Nov-09	718.5	29.9	0.2	0.0	0.0	0.0	0.0	100.0	100.0	6.6	7.1	6.89
Mar-10	668.0	27.8	0.4	0.0	0.0	0.0	0.0	100.0	100.0	6.8	8.9	7.51
Apr-10	685.0	28.5	4.9	0.0	0.0	0.0	0.0	100.0	100.0	6.6	8.1	7.16
May-10	31.0	0.1	0.0	0.0	0.0	0.0	0.0	100.0	100.0	6.5	7.5	7.11
Jun-10	716.0	29.8	0.6	0.0	0.0	0.0	0.0	100.0	100.0	6.7	8.8	7.27

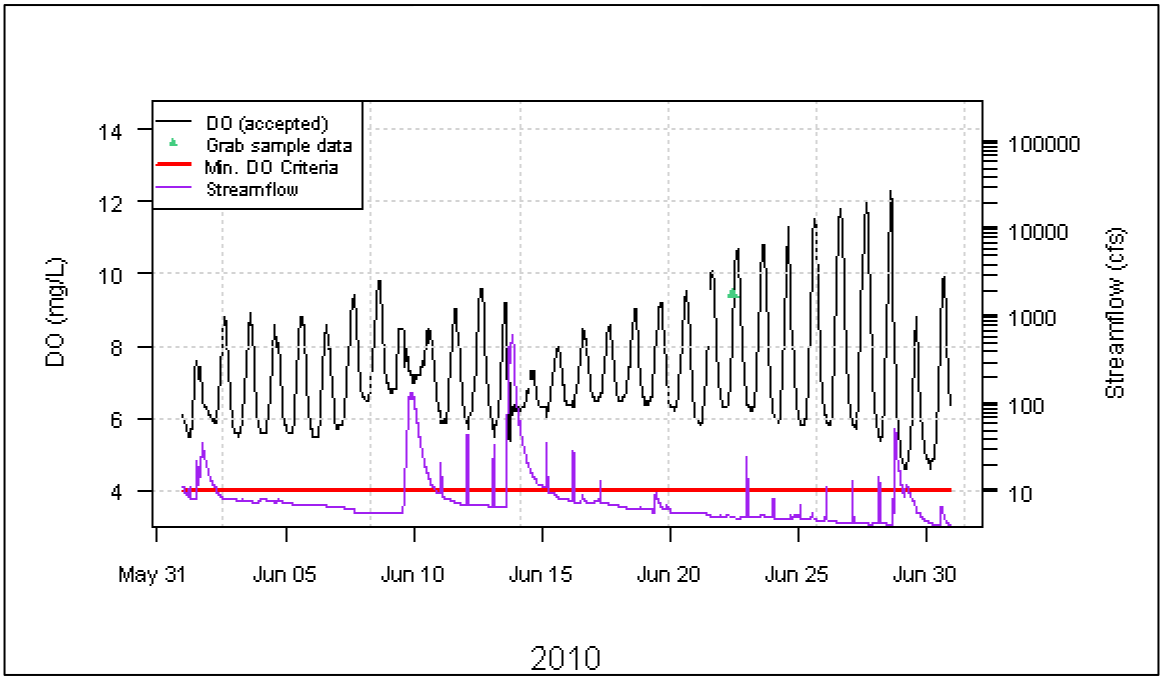


Figure 29. Gage 01465798, Dissolved Oxygen and Streamflow, June 2010.

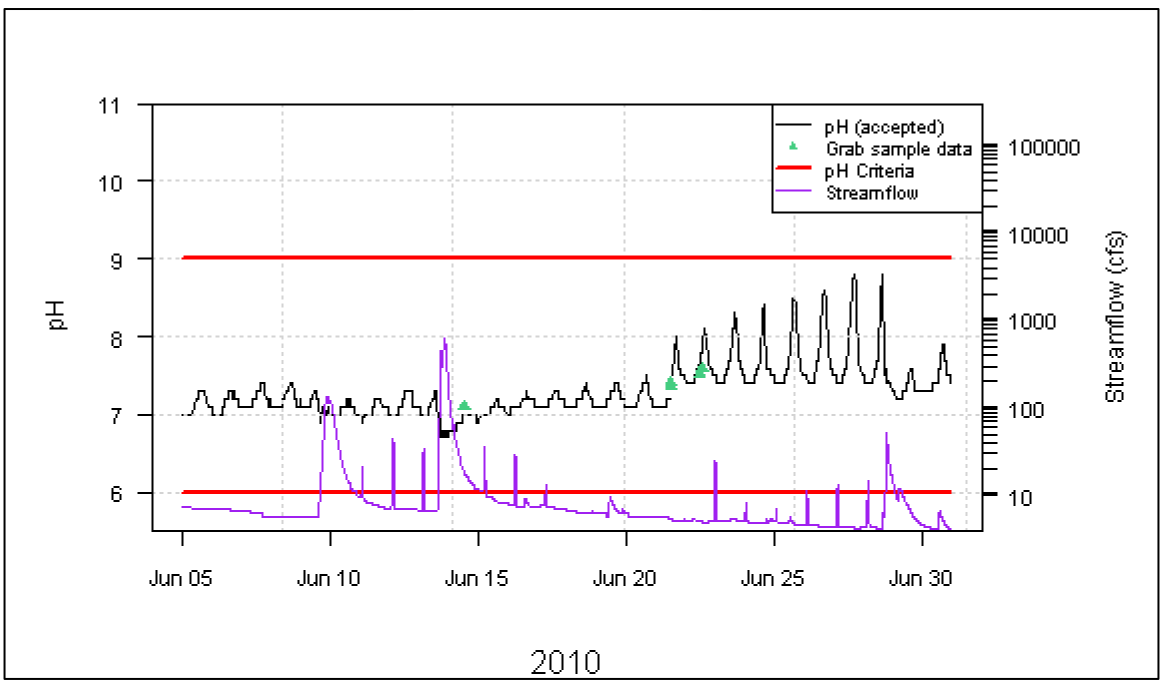


Figure 30. Gage 01465798, pH and Streamflow, June 2010.

Turbidity

Table 57. Gage 01465798 Turbidity Summary Results by Month

Gage 01465798 Turbidity Summary Information by Month								
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. above max. guideline	% hrs. below max. guideline	Min.	Max.	Mean
Jul-09	735.5	30.6	1.1	50.0	50.0	0.7	360.0	12.80
Aug-09	640.0	26.7	14.0	55.9	44.1	0.4	1100.0	26.25
Sep-09	663.0	27.6	7.9	34.9	65.1	0.1	670.0	8.53
Oct-09	742.0	30.9	0.3	37.1	62.9	0.0	1070.0	12.21
Nov-09	651.5	27.1	9.5	33.5	66.5	0.0	380.0	6.26
Mar-10	656.0	27.3	2.2	58.8	41.2	1.1	890.0	33.06
Apr-10	504.5	21.0	29.9	35.1	64.9	0.1	180.0	5.45
May-10	610.5	25.4	17.9	38.2	61.8	0.1	500.0	37.72
Jun-10	628.0	26.2	12.8	42.6	57.4	0.1	570.0	10.12

Specific Conductance

Table 58. Gage 01465798 Specific Conductance Summary Results by Month

Gage 01465798 Specific Conductance Summary Information by Month						
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	Min.	Max.	Mean
Jul-09	711.5	29.6	4.4	68.0	586.0	384.71
Aug-09	630.0	26.3	15.3	70.0	577.0	364.21
Sep-09	718.5	29.9	0.2	110.0	618.0	448.75
Oct-09	703.5	29.3	5.4	65.0	835.0	458.73
Nov-09	718.5	29.9	0.2	171.0	604.0	477.83
Mar-10	668.0	27.8	0.4	116.0	1100.0	599.18
Apr-10	684.0	28.5	5.0	192.0	625.0	541.79
May-10	743.0	31.0	0.1	115.0	698.0	518.58
Jun-10	716.0	29.8	0.6	132.0	674.0	538.9197

Temperature

Temperature exceedance rates observed in Poquessing Creek were similar to those in other WWF designated use creeks (*e.g.*, Tacony and Cobbs Creeks).

Table 59. Gage 01465798 Temperature Summary Results by Maximum Criteria Period

Gage 01465798 Temperature Summary Information by Max. Criteria Period										
Designated Use	Date range start	Date range end	% hrs. exceedance	% hrs. compliance	% hrs. flagged data	Total hrs. accepted data	Total days accepted data	Min.	Max.	Mean
WWF	1-Jul	31-Jul	0.0	100.0	0.3	742.0	30.9	18.6	26.2	21.92
WWF	1-Aug	15-Aug	0.0	100.0	10.0	324.0	13.5	19.6	27.1	23.01
WWF	16-Aug	31-Aug	0.0	100.0	16.8	319.5	13.3			
WWF	1-Sep	15-Sep	0.0	100.0	0.1	359.5	15.0	14.7	23.1	18.58
WWF	16-Sep	30-Sep	0.0	100.0	0.3	359.0	15.0			
WWF	1-Oct	15-Oct	0.0	100.0	0.1	359.5	15.0	8.3	19.1	13.30
WWF	16-Oct	31-Oct	0.1	99.9	0.1	383.5	16.0			
WWF	1-Nov	15-Nov	6.7	93.3	0.4	358.5	14.9	6.6	16.6	10.75
WWF	16-Nov	30-Nov	60.8	39.2	0.0	360.0	15.0			
WWF	1-Mar	31-Mar	72.8	27.2	0.6	668.0	27.8	4.4	15.5	9.59
WWF	1-Apr	15-Apr	92.9	7.1	9.9	324.5	13.5	9.6	21.6	14.04
WWF	16-Apr	30-Apr	34.8	65.2	0.3	359.0	15.0			
WWF	1-May	15-May	40.3	59.7	0.1	359.5	15.0	10.8	24.6	17.63
WWF	16-May	31-May	11.7	88.3	0.1	383.5	16.0			
WWF	1-Jun	15-Jun	0.0	100.0	0.6	358.0	14.9	17.1	28.8	22.87
WWF	16-Jun	30-Jun	0.0	100.0	0.6	358.0	14.9			

Gages in Large Watersheds

Schuylkill River (Gage 01474500)

Dissolved oxygen and pH

DO criteria were never violated at this location (Tables 60-61). pH criteria were exceeded in June due to an apparent algal bloom (Table 62). Supersaturated DO conditions were observed concomitant with pH above 8.0 for most of June (Figure 31), indicating high algal activity.

Table 60. Gage 01474500 Dissolved Oxygen Minimum Criterion Summary Results by Month

Gage 01474500 Dissolved Oxygen Min Criteria Summary Information by Month									
Month	Des. Use	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. violation	% hrs. compliance	Min	Max	Mean
Jul-09	WWF	710.5	29.6	4.5	0.0	100.0	6.4	10.0	7.69
Aug-09	WWF	66.0	2.8	91.1	0.0	100.0	6.7	8.8	7.42
Sep-09	WWF	716.0	29.8	0.6	0.0	100.0	7.8	9.7	8.63
Oct-10	WWF	614.5	25.6	17.4	0.0	100.0	8.7	11.7	9.79
Apr-10	WWF	711.5	29.6	1.2	0.0	100.0	8.3	11.3	9.82
May-10	WWF	737.5	30.7	0.9	0.0	100.0	7.3	10.4	8.80
Jun-10	WWF	715.5	29.8	0.6	0.0	100.0	6.5	10.5	7.93

Table 61. Gage 01474500 Dissolved Oxygen Daily Mean Criterion Summary Results by Month

Gage 01474500 Dissolved Oxygen Daily Mean Criteria Summary Information by Month								
Month	Des. Use	Total days accepted data	% days flagged data	% days violation	% days compliance	Min.	Max.	Mean
Jul-09	WWF	28.0	9.7	0.0	100.0	6.8	8.8	7.66
Aug-09	WWF	2.0	93.5	0.0	100.0	7.0	7.3	7.13
Sep-09	WWF	26.0	13.3	0.0	100.0	8.1	9.6	8.63
Oct-10	WWF	23.0	25.8	0.0	100.0	8.9	11.1	9.71
Apr-10	WWF	25.0	16.7	0.0	100.0	8.7	10.9	9.76
May-10	WWF	25.0	19.4	0.0	100.0	7.6	10.1	8.77
Jun-10	WWF	26.0	13.3	0.0	100.0	7.4	8.6	7.93

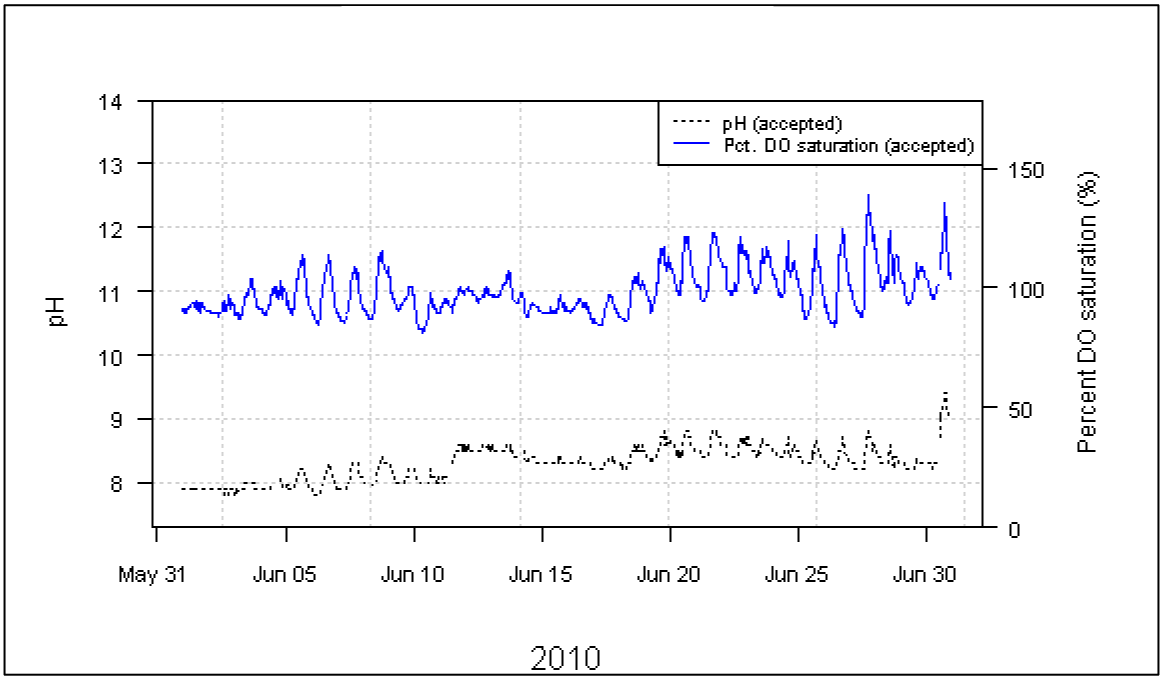


Figure 31. Gage 01474500, pH and Percent Dissolved Oxygen Saturation, June 2010.

Table 62. Gage 01474500 pH Criteria Summary Results by Month

Gage 01474500 pH Criteria Summary Information by Month													
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. max. violation	% days max. violation	% hrs. min. violation	% days min. violation	% hrs. compliance	% days compliance	Min.	Max.	Mean
Jul-09	710.0	29.6	4.6	0.0	0.0	0.0	0.0	100.0	100.0	7.4	8.3	7.66
Aug-09	66.0	2.8	91.1	0.0	0.0	0.0	0.0	100.0	100.0	7.2	7.8	7.48
Sep-09	683.0	28.5	5.1	0.0	0.0	0.0	0.0	100.0	100.0	7.6	8.0	7.78
Oct-10	614.5	25.6	17.4	0.0	0.0	0.0	0.0	100.0	100.0	7.3	8.0	7.85
Apr-10	709.5	29.6	1.5	0.0	0.0	0.0	0.0	100.0	100.0	7.7	8.1	7.89
May-10	626.5	26.1	15.8	0.0	0.0	0.0	0.0	100.0	100.0	7.5	8.0	7.82
Jun-10	714.5	29.8	0.8	1.0	3.3	0.0	0.0	99.0	96.7	7.8	9.4	8.29

Temperature

Table 63. Gage 01474500 Temperature Summary Results by Maximum Criteria Period

Gage 01474500 Temperature Summary Information by Max. Criteria Period										
Designated Use	Date range start	Date range end	% hrs. exceedance	% hrs. compliance	% hrs. flagged data	Total hrs. accepted data	Total days accepted data	Min.	Max.	Mean
WWF	1-Jul	31-Jul	0.0	100.0	4.7	709.0	29.5	23.2	27.5	24.88
WWF	1-Aug	15-Aug	0.0	100.0	84.2	57.0	2.4	22.1	26.9	24.97
WWF	16-Aug	31-Aug	0.0	100.0	97.7	9.0	0.4			
WWF	1-Sep	15-Sep	0.0	100.0	0.3	359.0	15.0	17.3	23.0	20.47
WWF	16-Sep	30-Sep	0.0	100.0	0.7	357.5	14.9			
WWF	1-Oct	15-Oct	0.0	100.0	0.1	359.5	15.0	9.2	17.7	14.42
WWF	16-Oct	31-Oct	0.0	100.0	33.6	255.0	10.6			
WWF	1-Apr	15-Apr	92.7	7.3	1.4	355.0	14.8	8.8	19.4	14.99
WWF	16-Apr	30-Apr	75.2	24.8	0.8	357.0	14.9			
WWF	1-May	15-May	47.9	52.1	1.8	353.5	14.7	13.3	25.4	19.31
WWF	16-May	31-May	39.3	60.7	1.3	379.0	15.8			
WWF	1-Jun	15-Jun	17.1	82.9	0.8	357.0	14.9	22.1	30.2	26.47
WWF	16-Jun	30-Jun	21.7	78.3	0.8	357.0	14.9			

Turbidity

Table 64. Gage 01474500 Turbidity Summary Results by Month

Gage 01474500 Turbidity Summary Information by Month								
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. above max. guideline	% hrs. below max. guideline	Min.	Max.	Mean
Jul-09	707.0	29.5	5.0	98.5	1.5	2.5	38.0	6.81
Aug-09	57.0	2.4	92.3	100.0	0.0	6.6	350.0	72.28
Sep-09	697.5	29.1	3.1	99.5	0.5	0.0	30.0	7.87
Oct-10	613.5	25.6	17.5	91.4	8.6	0.0	150.0	6.31
Apr-10	711.5	29.6	1.2	86.4	13.6	0.0	50.0	5.66
May-10	733.0	30.5	1.5	70.9	29.1	0.3	27.0	4.83
Jun-10	714.0	29.8	0.8	22.7	77.3	-0.1	9.2	2.15

Specific Conductance

Table 65. Gage 01474500 Specific Conductance Summary Results by Month

Gage 01474500 Specific Conductance Summary Information by Month						
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	Min.	Max.	Mean
Jul-09	619.5	25.8	16.7	294.0	490.0	400.87
Aug-09	65.5	2.7	91.2	169.0	426.0	320.92
Sep-09	711.5	29.6	1.2	277.0	490.0	400.28
Oct-10	583.0	24.3	21.6	115.0	529.0	456.48
Apr-10	709.0	29.5	1.5	248.0	431.0	365.94
May-10	733.5	30.6	1.4	240.0	468.0	392.16
Jun-10	714.0	29.8	0.8	395.0	568.0	489.80

Delaware River (Gage 01467200)

Dissolved oxygen and pH

The DRBC DO daily mean criterion of 3.5mg/L was met July 2009-June 2010 (Table 66).

The pH criteria were never exceeded (Table 67).

Table 66. Gage 01467200 Dissolved Oxygen Daily Mean Criterion Summary Results by Month

Gage 01467200 Dissolved Oxygen Daily Mean Criteria Summary Information by Month										
Month	Des. Use	Total days accepted data	% days flagged data	% days violation	% days compliance	Daily Avg. Min.	Daily Avg. Max.	Daily Avg. Mean	Min.	Max
Jul-09	DRBC	31.0	0.0	0.0	100.0	4.0	7.4	6.0	3.2	8.1
Aug-09	DRBC	30.0	3.2	0.0	100.0	5.0	6.4	5.6	4.0	7
Sep-09	DRBC	29.0	3.3	0.0	100.0	5.5	7.5	6.6	4.6	8.2
Oct-09	DRBC	30.0	3.2	0.0	100.0	5.8	8.5	6.9	5.4	9
Nov-09	DRBC	30.0	0.0	0.0	100.0	7.9	9.1	8.5	7.3	9.4
Apr-10	DRBC	30.0	0.0	0.0	100.0	7.9	11.3	9.0	7.3	11.5
May-10	DRBC	24.0	22.6	0.0	100.0	7.2	9.7	8.0	5.9	10.3
Jun-10	DRBC	9.0	70.0	0.0	100.0	3.9	6.8	5.5	2.7	7.5

Table 67. Gage 01467200 pH Criteria Summary Results by Month

Gage 01467200 pH Criteria Summary Information by Month												
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. max. violation	% days max. violation	% hrs. min. violation	% days min. violation	% hrs. compliance	% days compliance	Min.	Max.	Mean
Jul-09	744.0	31.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	7.2	7.7	7.39
Aug-09	743.5	31.0	0.1	0.0	0.0	0.0	0.0	100.0	100.0	7.0	7.5	7.21
Sep-09	719.5	30.0	0.1	0.0	0.0	0.0	0.0	100.0	100.0	7.1	7.6	7.38
Oct-09	732.5	30.5	1.5	0.0	0.0	0.0	0.0	100.0	100.0	7.1	7.5	7.35
Nov-09	720.0	30.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	7.0	7.5	7.29
Apr-10	720.0	30.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	6.6	7.1	6.79
May-10	642.0	26.8	13.7	0.0	0.0	0.0	0.0	100.0	100.0	6.7	7.1	6.87
Jun-10	636.5	26.5	11.6	0.0	0.0	0.0	0.0	100.0	100.0	6.6	6.9	6.72

Temperature

Table 68. Gage 01467200 Temperature Summary Results by Maximum Criteria Period

Gage 01467200 Temperature Summary Information by Max. Criteria Period										
Designated Use	Date range start	Date range end	% hrs. exceedance	% hrs. compliance	% hrs. flagged data	Total hrs. accepted data	Total days accepted data	Min.	Max.	Mean
DRBC	1-Jul	31-Jul	0.0	100.0	0.0	744.0	31.0	22.3	26.1	24.33
DRBC	1-Aug	31-Aug	0.0	100.0	0.1	743.5	31.0	23.5	26.8	25.17
DRBC	1-Sep	30-Sep	0.0	100.0	0.1	719.5	30.0	19.9	24.6	21.75
DRBC	1-Oct	31-Oct	0.0	100.0	1.5	732.5	30.5	12.9	19.9	16.23
DRBC	1-Nov	30-Nov	0.0	100.0	0.0	720.0	30.0	9.9	13.2	11.32
DRBC	1-Apr	30-Apr	0.0	100.0	0.0	720.0	30.0	7.8	15.7	13.85
DRBC	1-May	31-May	0.0	100.0	13.6	642.5	26.8	14.1	22.2	18.12
DRBC	1-Jun	30-Jun	0.0	100.0	11.6	636.5	26.5	22.0	27.3	24.95

Specific Conductance

Monthly mean concentrations observed at this gage were lower than those observed in all other gages described in the report.

Table 69. Gage 01467200 Specific Conductance Summary Results by Month

Gage 01467200 Specific Conductance Summary Information by Month						
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	Min.	Max.	Mean
Jul-09	1488.0	31.0	0.0	162.0	260.0	214.81
Aug-09	1487.0	31.0	0.1	129.0	249.0	172.69
Sep-09	1439.0	30.0	0.1	173.0	271.0	224.47
Oct-09	1465.0	30.5	1.5	168.0	317.0	271.87
Nov-09	1440.0	30.0	0.0	154.0	232.0	195.93
Apr-10	1440.0	30.0	0.0	142.0	249.0	202.37
May-10	1284.0	26.8	13.7	196.0	262.0	236.62
Jun-10	1273.0	26.5	11.6	249.0	308.0	279.00

Turbidity

Table 70. Gage 01467200 Turbidity Summary Results by Month

Gage 0147200 Turbidity Summary Information by Month								
Month	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. above max. guideline	% hrs. below max. guideline	Min.	Max.	Mean
Jul-09	744.0	31.0	0.0	98.1	1.9	1.6	98.0	6.90
Aug-09	744.0	31.0	0.0	99.3	0.7	1.9	96.0	9.35
Sep-09	708.5	29.5	1.6	83.2	16.8	0.1	23.0	5.36
Oct-09	731.5	30.5	1.7	78.3	21.7	0.1	59.0	5.09
Nov-09	180.5	7.5	74.9	92.5	7.5	1.7	18.0	5.80
Apr-10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
May-10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Jun-10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Wet Weather and Dry Weather Results

Annual Summary, July 2009 - June 2010

Water quality data was also categorized as wet or dry for the purpose of evaluating weather effects on water quality, and specifically the incidence of violations of water quality criteria. A wet weather condition was defined as rainfall greater than 0.05 inches in the preceding 72 hours, as measured at the nearest PWD rain gage.

In general, more frequent violations of DO criteria were observed in wet weather due to the tendency of storm events to decrease DO via the introduction of stormwater runoff and BOD (Tables 71-74). The pH maximum criterion was more frequently violated in dry weather due to the effect of algal growth (Tables 75-76). The turbidity maximum guideline was more frequently surpassed in wet weather (Tables 77-78). Temperature criteria violation frequencies were generally similar in dry and wet weather conditions (Tables 81-82).

Table 71. USGS Gage July 2009 - June 2010 Dissolved Oxygen Minimum Criterion Summary Results During Wet Weather

USGS Gage July 2009 - June 2010 Dissolved Oxygen Minimum Criteria Summary - Wet Weather						
Gage number	Designated Use	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. violation	% hrs. compliance
01465798	WWF	4288.0	178.7	3.9	0.0	100.0
01467042	TSF	4265.5	177.7	4.6	0.0	100.0
01467048	TSF	3955.5	164.8	4.8	0.0	100.0
01467086	WWF	4250.5	177.1	0.4	0.0	100.0
01467087	WWF	2638.0	109.9	37.7	9.0	91.0
01467200	DRBC	N/A	N/A	N/A	N/A	N/A
01473900	TSF	4186.5	174.4	6.3	0.1	99.9
01474000	TSF	3698.5	154.1	16.5	0.3	99.7
01474500	WWF	2624.5	109.4	4.0	0.0	100.0
01475530	WWF	4116.0	171.5	0.7	0.0	100.0
01475548	WWF	4013.5	167.2	5.7	1.9	98.1

*No minimum DO criterion applies at this location.

Table 72. USGS Gage July 2009 - June 2010 Dissolved Oxygen Minimum Criterion Summary Results During Dry Weather

USGS Gage July 2009 - June 2010 Dissolved Oxygen Minimum Criteria Summary - Dry Weather						
Gage number	Designated Use	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. violation	% hrs. compliance
01465798	WWF	1918.0	79.9	0.6	0.0	100.0
01467042	TSF	2029.0	84.5	0.7	0.0	100.0
01467048	TSF	1785.0	74.4	0.9	0.0	100.0
01467086	WWF	2185.5	91.1	0.2	0.0	100.0
01467087	WWF	1966.5	81.9	7.4	9.8	90.2
01467200	DRBC	N/A	N/A	N/A	N/A	N/A
01473900	TSF	1966.0	81.9	1.0	1.1	98.9
01474000	TSF	1819.5	75.8	11.8	0.6	99.4
01474500	WWF	1647.0	68.6	0.3	0.0	100.0
01475530	WWF	2101.5	87.6	0.3	0.0	100.0
01475548	WWF	2227.0	92.8	2.5	0.6	99.4

*No minimum DO criterion applies at this location.

Table 73. USGS Gage July 2009 - June 2010 Dissolved Oxygen Daily Mean Criterion Summary Results During Wet Weather

USGS Gage July 2009 - June 2010 Diss. Oxygen Daily Mean Criteria Summary - Wet Weather					
Gage number	Designated Use	Total days accepted data	% days flagged data	% days violation	% days compliance
01465798	WWF	165.0	4.1	0.0	100.0
01467042	TSF	163.0	5.2	0.0	100.0
01467048	TSF	152.0	5.0	0.0	100.0
01467086	WWF	162.0	0.6	0.0	100.0
01467087	WWF	92.0	42.9	13.0	87.0
01467200	DRBC	140.0	0.0	0.0	100.0
01473900	TSF	160.0	7.5	0.0	100.0
01474000	TSF	137.0	19.9	0.0	100.0
01474500	WWF	99.0	4.8	0.0	100.0
01475530	WWF	156.0	0.6	0.0	100.0
01475548	WWF	155.0	5.5	3.2	96.8

Table 74. USGS Gage July 2009 - June 2010 Dissolved Oxygen Daily Mean Criterion Summary Results During Dry Weather

USGS Gage July 2009 - June 2010 Dissolved Oxygen Daily Mean Criteria Summary - Dry Weather					
Gage number	Designated Use	Total days accepted data	% days flagged data	% days violation	% days compliance
01465798	WWF	65.0	0.0	0.0	100.0
01467042	TSF	74.0	1.3	0.0	100.0
01467048	TSF	62.0	1.6	0.0	100.0
01467086	WWF	77.0	1.3	0.0	100.0
01467087	WWF	67.0	9.5	16.4	83.6
01467200	DRBC	71.0	0.0	0.0	100.0
01473900	TSF	71.0	1.4	0.0	100.0
01474000	TSF	62.0	12.7	0.0	100.0
01474500	WWF	63.0	0.0	0.0	100.0
01475530	WWF	75.0	0.0	0.0	100.0
01475548	WWF	81.0	1.2	1.2	98.8

Table 75. USGS Gage July 2009 - June 2010 pH Criteria Summary Results During Wet Weather

USGS Gage July 2009 - June 2010 pH Criteria Summary Information During Wet Weather									
Gage number	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. max. violation	% days max. violation	% hrs. min. violation	% days min. violation	% hrs. compliance	% days compliance
01465798	4448.5	185.4	0.3	0.0	0.0	0.0	0.0	100.0	100.0
01467042	4324.0	180.2	3.3	0.0	0.0	0.0	0.0	100.0	100.0
01467048	3172.5	132.2	23.6	0.1	0.6	0.0	0.0	99.9	99.4
01467086	4250.0	177.1	0.4	0.3	1.9	0.0	0.0	99.7	98.1
01467087	3271.0	136.3	22.7	0.0	0.0	0.0	0.0	100.0	100.0
01467200	3693.0	153.9	0.0	0.0	0.0	0.0	0.0	100.0	100.0
01473900	4349.5	181.2	2.6	1.1	6.2	0.0	0.0	98.9	93.8
01474000	4212.5	175.5	4.9	1.0	1.4	0.0	0.0	99.0	98.6
01474500	2599.0	108.3	4.9	0.0	0.0	0.0	0.0	100.0	100.0
01475530	4136.5	172.4	0.2	0.0	0.0	0.0	0.0	100.0	100.0
01475548	4189.5	174.6	1.6	0.2	1.0	0.0	0.0	99.8	99.0

Table 76. USGS Gage July 2009 - June 2010 pH Criteria Summary Results During Dry Weather

USGS Gage July 2009 - June 2010 pH Criteria Summary Information During Dry Weather									
Gage number	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. max. violation	% days max. violation	% hrs. min. violation	% days min. violation	% hrs. compliance	% days compliance
01465798	1925.0	80.2	0.3	0.0	0.0	0.0	0.0	100.0	100.0
01467042	2020.0	84.2	1.1	0.0	0.0	0.0	0.0	100.0	100.0
01467048	1455.5	60.6	19.2	0.5	3.5	0.0	0.0	99.5	96.5
01467086	2185.5	91.1	0.2	1.3	7.4	0.0	0.0	98.7	92.6
01467087	1986.0	82.8	6.5	0.0	0.0	0.0	0.0	100.0	100.0
01467200	1965.0	81.9	0.0	0.0	0.0	0.0	0.0	100.0	100.0
01473900	1966.0	81.9	1.0	2.5	7.2	0.0	0.0	97.5	92.8
01474000	2054.5	85.6	0.4	5.6	6.7	0.0	0.0	94.4	93.3
01474500	1525.0	63.5	7.7	0.5	1.2	0.0	0.0	99.5	98.8
01475530	2101.5	87.6	0.3	0.0	0.0	0.0	0.0	100.0	100.0
01475548	2258.0	94.1	1.1	0.6	3.3	0.0	0.0	99.4	96.7

Table 77. USGS Gage July 2009 - June 2010 Turbidity Summary Results During Wet Weather

USGS Gage July 2009 - June 2010 Turbidity Summary Information During Wet Weather					
Gage number	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. above max. guideline	% hrs. below max. guideline
01465798	4183.5	174.3	6.3	50.9	49.1
01467042	4307.0	179.5	3.6	41.9	58.1
01467048	3120.5	130.0	24.9	52.4	47.6
01467086	N/A	N/A	N/A	N/A	N/A
01467087	N/A	N/A	N/A	N/A	N/A
01467200	3289.5	137.1	10.4	87.6	12.4
01473900	4101.5	170.9	8.2	71.4	28.6
01474000	4297.0	179.0	3.0	33.9	66.1
01474500	2596.0	108.2	5.0	81.2	18.8
01475530	N/A	N/A	N/A	N/A	N/A
01475548	N/A	N/A	N/A	N/A	N/A

*Turbidity not continuously monitored at this location

Table 78. USGS Gage July 2009 - June 2010 Turbidity Summary Results During Dry Weather

USGS Gage July 2009 - June 2010 Turbidity Summary Information During Dry Weather					
Gage number	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. above max. guideline	% hrs. below max. guideline
01465798	1724.5	71.9	10.6	22.3	77.7
01467042	1934.5	80.6	5.3	13.2	86.8
01467048	1193.5	49.7	33.7	13.2	86.8
01467086	N/A	N/A	N/A	N/A	N/A
01467087	N/A	N/A	N/A	N/A	N/A
01467200	3503.0	146.0	4.6	95.2	4.8
01473900	1960.0	81.7	1.3	46.5	53.5
01474000	2009.5	83.7	2.6	3.7	96.3
01474500	1637.5	68.2	0.9	73.1	26.9
01475530	N/A	N/A	N/A	N/A	N/A
01475548	N/A	N/A	N/A	N/A	N/A

*Turbidity not continuously monitored at this location

Table 79. USGS Gage July 2009 - June 2010 Specific Conductance Summary Results During Wet Weather

USGS Gage July 2009 - June 2010 Specific Conductance Summary - Wet Weather			
Gage number	Total hrs. accepted data	Total days accepted data	% hrs. flagged data
01465798	4369.0	182.0	2.1
01467042	4455.5	185.6	0.3
01467048	4075.0	169.8	1.9
01467086	4251.0	177.1	0.4
01467087	4146.0	172.8	2.0
01467200	3693.0	153.9	0.0
01473900	4307.5	179.5	3.6
01474000	4287.5	178.6	3.2
01474500	2583.5	107.6	5.5
01475530	3083.5	128.5	25.6
01475548	3981.5	165.9	6.4

Table 80. USGS Gage July 2009 - June 2010 Specific Conductance Summary Results During Dry Weather

USGS Gage July 2009 - June 2010 Specific Conductance Summary - Dry Weather			
Gage number	Total hrs. accepted data	Total days accepted data	% hrs. flagged data
01465798	1924.0	80.2	0.3
01467042	2035.5	84.8	0.3
01467048	1794.0	74.8	0.4
01467086	2186.5	91.1	0.2
01467087	2108.5	87.9	0.7
01467200	1965.0	81.9	0.0
01473900	1961.0	81.7	1.3
01474000	2060.0	85.8	0.1
01474500	1552.5	64.7	6.1
01475530	1763.5	73.5	16.3
01475548	2192.0	91.3	4.0

Table 81. USGS Gage July 2009 - June 2010 Temperature Maximum Criteria Summary Results During Wet Weather

USGS Gage July 2009 - June 2010 Temperature Maximum Criteria Summary - Wet Weather						
Gage number	Designated Use	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. exceedance	% hrs. compliance
01465798	WWF	4452.5	185.5	0.2	20.2	79.8
01467042	TSF	4456.5	185.7	0.3	30.1	69.9
01467048	TSF	4072.5	169.7	1.9	36.6	63.4
01467086	WWF	4250.5	177.1	0.4	20.9	79.1
01467087	WWF	4176.5	174.0	1.3	24.2	75.8
01467200	DRBC	3693.5	153.9	0.0	0.0	100.0
01473900	TSF	4341.5	180.9	2.8	30.9	69.1
01474000	TSF	4355.0	181.5	1.7	31.7	68.3
01474500	WWF	2620.0	109.2	4.2	23.1	76.9
01475530	WWF	4135.5	172.3	0.2	20.2	79.8
01475548	WWF	4243.5	176.8	0.3	22.7	77.3

Table 82. USGS Gage July 2009 - June 2010 Temperature Maximum Criteria Summary Results During Dry Weather

USGS Gage July 2009 - June 2010 Temperature Maximum Criteria Summary - Dry Weather						
Gage number	Designated Use	Total hrs. accepted data	Total days accepted data	% hrs. flagged data	% hrs. exceedance	% hrs. compliance
01465798	WWF	1923.5	80.1	0.3	23.3	76.7
01467042	TSF	2035.5	84.8	0.3	33.8	66.2
01467048	TSF	1796.0	74.8	0.3	39.7	60.3
01467086	WWF	2186.5	91.1	0.2	23.2	76.8
01467087	WWF	2114.0	88.1	0.4	25.3	74.7
01467200	DRBC	1965.0	81.9	0.0	0.0	100.0
01473900	TSF	1965.0	81.9	1.1	35.9	64.1
01474000	TSF	2061.0	85.9	0.1	37.7	62.3
01474500	WWF	1644.5	68.5	0.5	27.3	72.7
01475530	WWF	2101.5	87.6	0.3	21.9	78.1
01475548	WWF	2275.5	94.8	0.4	22.5	77.5

References

Delaware River Basin Commission, 2007. Delaware River Basin Water Code: 18 CFR Part 410 (With Amendments Through September 27, 2006). West Trenton, NJ.

APPENDIX I – NPDES Permitted Dischargers

Table 1

	NPDES ID	FACILITY NAME	ADDRESS	COUNTY	PERMIT ISSUED DATE	PERMIT EXPIRED DATE	SIC CODE	SIC DESC	CSO/SW area	Receiving Waterbody *
1	PA0010855	DU PONT MARSHALL LAB	3401 GRAYS FERRY AVENUE, PHILADELPHIA, PA 19146	PHILADELPHIA	OCT-28-2004	OCT-31-2009	2851	PAINTS, VARNISHES, LACQUERS, ENAMELS, AND ALLIED PRODUCTS	CSO	Schuylkill
2	PA0011088	PLAINS PRODUCTS TERMINALS LLC	6850 ESSINGTON AVE., PHILADELPHIA, PA 19153	PHILADELPHIA	OCT-21-2005	OCT-31-2010	5171	PETROLEUM BULK STATIONS AND TERMINALS	SW Only	Schuylkill
3	PA0011428	AMERADA HESS - PHILADELPHIA TERMINAL	1630 SOUTH 51ST STREET, PHILADELPHIA, PA 19143	PHILADELPHIA	JUN-03-2004	JUN-30-2009	5171	PETROLEUM BULK STATIONS AND TERMINALS	CSO	Schuylkill
4	PA0011533	SUNOCO POINT BREEZE PROCESSING AREA	3144 PASSYUNK AVENUE, PHILADELPHIA, PA 19145	PHILADELPHIA	FEB-07-2006	FEB-28-2011	2911	PETROLEUM REFINING	CSO	Schuylkill
5	PA0011622	EXELON GENERATION CO DELAWARE STA	1325 NORTH BEACH STREET, PHILADELPHIA, PA 19125	PHILADELPHIA	JAN-16-2003	JAN-31-2008	4911	ELECTRIC SERVICES	Non-contributing	Delaware
6	PA0011649	EXELON RICHMOND GENERATING STA	3901 NORTH DELAWARE AVENUE, PHILADELPHIA, PA 19137	PHILADELPHIA	SEP-12-2002	SEP-30-2007	4911	ELECTRIC SERVICES	Non-contributing	Delaware
7	PA0011657	PECO ENERGY SCHUYLKILL GEN STA	2800 CHRISTIAN STREET, PHILADELPHIA, PA 19146	PHILADELPHIA	OCT-07-1999	OCT-07-2004	4911	ELECTRIC SERVICES	CSO	Schuylkill
8	PA0012572	PAPERWORKS INDUSTRIES INC	5000 FLAT ROCK ROAD, PHILADELPHIA, PA 19127	PHILADELPHIA	JUN-18-2004	JUN-30-2009	2631	PAPERBOARD MILLS	Non-contributing	Schuylkill
9	PA0012777	ROHM & HAAS CHEMICAL RICHMOND ST PLT	5000 RICHMOND STREET, PHILADELPHIA, PA 19137	PHILADELPHIA	FEB-28-2003	FEB-28-2008	2869	INDUSTRIAL ORGANIC CHEMICALS, NOT ELSEWHERE CLASSIFIED	Non-contributing	Delaware
10	PA0012882	PHILA GAS WORKS RICHMOND PLT	3100 EAST VENANGO STREET, PHILADELPHIA, PA 191346192	PHILADELPHIA	MAR-29-2005	MAR-31-2010	4925	MIXED, MANUFACTURED, OR LIQUEFIED PETROLEUM GAS PRODUCTION AND/OR DISTRIBUTION	CSO	Delaware
11	PA0024252	SUNOCO TRANSP	1801 MARKET STREET, 26TH FLOOR, PHILADELPHIA, PA 19126	PHILADELPHIA	JUL-25-1995	JUL-25-2000	5171	PETROLEUM BULK STATIONS AND TERMINALS	CSO	Schuylkill
12	PA0026662	PHILA SOUTHEAST POTW	25 PATTISON AVENUE, PHILADELPHIA, PA 19148	PHILADELPHIA	JUL-07-2000	JUL-07-2005	4952	SEWERAGE SYSTEMS	CSO	Delaware
13	PA0026671	SOUTHWEST WATER POLLUTION CONTROL PLANT	8200 ENTERPRISE AVENUE, PHILADELPHIA, PA 19153	PHILADELPHIA	JUL-07-2000	JUL-07-2005	4952	SEWERAGE SYSTEMS	Non-contributing	Schuylkill

14	PA0026689	NORTHEAST WPCP	3900 RICHMOND STREET, PHILADELPHIA, PA 19137	PHILADELPHIA	JUL-07-2000	JUL-07-2005	4952	SEWERAGE SYSTEMS	MS4	Tacony
15	PA0036447	PHILADELPHIA NAVAL BUSINESS CENTER	4500 SOUTH BROAD STREET, PHILADELPHIA, PA 19112-1403	PHILADELPHIA	MAR-03-2006	MAR-31-2011	8731	COMMERCIAL PHYSICAL AND BIOLOGICAL RESEARCH	Non-contributing	Delaware
16	PA0040991	PHILA TERM	4210 G STREET, PHILADELPHIA, PA 19124-4821	PHILADELPHIA	SEP-23-2004	SEP-30-2009	5171	PETROLEUM BULK STATIONS AND TERMINALS	CSO	Tacony
17	PA0046876	PHILA GAS WORKS PASSYUNK AVE PLT	3100 PASSYUNK AVE, PHILADELPHIA, PA 19145	PHILADELPHIA	OCT-26-1999	OCT-26-2004	4925	MIXED, MANUFACTURED, OR LIQUEFIED PETROLEUM GAS PRODUCTION AND/OR DISTRIBUTION	CSO	Schuylkill
18	PA0050202	NATIONAL RAILROAD PASSENGER CO	AMTRAK RACE ST/PENN COACH YARD, PHILADELPHIA, PA 191042898	PHILADELPHIA	FEB-11-2003	FEB-28-2008	4011	RAILROADS, LINE-HAUL OPERATING	CSO	Schuylkill
19	PA0054241	AMOCO OIL COMPANY	63RD & PASSYUNK AVENUE, PHILADELPHIA, PA 19142	PHILADELPHIA	JUL-03-2006	JUL-31-2011	5171	PETROLEUM BULK STATIONS AND TERMINALS	MS4	Schuylkill
20	PA0054712	PHILADELPHIA MS4	1101 MARKET STREET, PHILADELPHIA, PA 19107	PHILADELPHIA	SEP-30-2005	SEP-30-2010	4952	SEWERAGE SYSTEMS	CSO	Delaware
21	PA0056090	AIRCRAFT SVC INTL GROUP TINICUM TWP FAC	3 HOG ISLAND RD, PHILADELPHIA, PA 19153	PHILADELPHIA	APR-12-2000	APR-12-2005	5171	PETROLEUM BULK STATIONS AND TERMINALS	Non-contributing	Schuylkill
22	PA0057479	METRO MACHINE CORP	5120 SOUTH 17TH STREET, PHILADELPHIA, PA 19112	PHILADELPHIA	JUN-26-2006	JUN-20-2011	3731	SHIP BUILDING AND REPAIRING	Non-contributing	Delaware
23	PA0057690	AKER PHILA SHIPYARD	PORTER AVENUE AND BRIDGE STREET, PHILADELPHIA, PA 19112	PHILADELPHIA	JUL-06-2000	JUL-06-2005	3731	SHIP BUILDING AND REPAIRING	CSO	Delaware
24	PA0058947	JDM MATERIALS	2750 GRANT AVE, PHILADELPHIA, PA 19114	PHILADELPHIA	JUN-20-2006	JUN-30-2011	3273	READY-MIXED CONCRETE	Non-contributing	Pennypack
25	PA0058955	JDM MATERIALS CO	BARTRAM BATCH PLANT, PHILADELPHIA, PA 19153	PHILADELPHIA	JUN-20-2006	JUN-30-2011	3273	READY-MIXED CONCRETE	Non-contributing	Schuylkill
26	PAG100012	SUN PIPELINE CO	FORT MIFFLIN TERMINAL, PHILADELPHIA, PA 19153	PHILADELPHIA	MAR-04-2002	MAR-03-2007	2911	PETROLEUM REFINING	Non-contributing	Schuylkill
27	PAG100021	PHILA INTL AIRPORT PIPELINE RELOCATIOIN PROJ	8000 ESSINGTON AVE, PHILADELPHIA, PA 19153	PHILADELPHIA					MS4	Schuylkill

28	PAR110007	MARTIN MARIETTA ASTRO SPACE	BUILDING 100, PHILADELPHIA, PA 19101	PHILADELPHIA	FEB-08-1996	FEB-08-2001	3769	GUIDED MISSILE AND SPACE VEHICLE PARTS AND AUXILIARY EQUIPMENT, NOT ELSEWHERE CLASSIFIED	CSO	Schuylkill
29	PAR110015	MELCO AUTO PARTS	5112 UMBRIA ST, PHILADELPHIA, PA 19128	PHILADELPHIA	APR-24-1996	APR-24-2001	3533	OIL AND GAS FIELD MACHINERY AND EQUIPMENT	MS4	Schuylkill
30	PAR110036	CROWN CORK & SEAL	9300 ASHTON ROAD, PHILADELPHIA, PA 191143464	PHILADELPHIA	AUG-15-1996	AUG-15-2001	3559	SPECIAL INDUSTRY MACHINERY, NOT ELSEWHERE CLASSIFIED	MS4	Pennypack
31	PAR110040	LAVELLE AIRCRAFT COMP	275 GEIGER RD, PHILADELPHIA, PA 19115	PHILADELPHIA	SEP-20-1996	SEP-20-2001	3724	AIRCRAFT ENGINES AND ENGINE PARTS	MS4	Pennypack
32	PAR110042	L3 COMMUNICATIONS ROOSEVELT BLVD FAC	13500 ROOSEVELT BOULEVARD, PHILADELPHIA, PA 191164299	PHILADELPHIA	MAY-22-2001	MAY-22-2006	3613	SWITCHGEAR AND SWITCHBOARD APPARATUS	MS4	Poquessing
33	PAR110047	HOWARD MCCRAY REFRIG CO INC	GRANT AVE & BLUE GRASS RD, PHILADELPHIA, PA 19114	PHILADELPHIA	MAY-02-1997	MAY-02-2002	3585	AIR-CONDITIONING AND WARM AIR HEATING EQUIPMENT AND COMMERCIAL AND INDUSTRIAL REFRIGERATION EQUIPMENT	MS4	Pennypack
34	PAR110048	KURZ HASTINGS INCORPORATED	10901 DUTTON ROAD, PHILADELPHIA, PA 19154	PHILADELPHIA	DEC-09-1998	DEC-09-2003	3999	MANUFACTURING INDUSTRIES, NOT ELSEWHERE CLASSIFIED	MS4	Poquessing
35	PAR120002	DIETZ & WATSON INCORPORATED	5701 TACONY ST., PHILADELPHIA, PA 19135	PHILADELPHIA	MAY-17-1996	MAY-17-2001	2013	SAUSAGES AND OTHER PREPARED MEAT PRODUCTS	Non-contributing	Delaware
36	PAR120003	PEPSI COLA	11701 ROOSEVELT BLVD., PHILADELPHIA, PA 19154	PHILADELPHIA	AUG-22-1996	AUG-22-2001	2086	BOTTLED AND CANNED SOFT DRINKS AND CARBONATED WATERS	MS4	Poquessing
37	PAR120008	DEGUSSA FLAVORS & FRUIT SYS	1741 TOMLINSON RD, PHILADELPHIA, PA 19116	PHILADELPHIA	SEP-06-2001	SEP-06-2006	2033	CANNED FRUITS, VEGETABLES, PRESERVES, JAMS, AND JELLIES	MS4	Poquessing
38	PAR120011	HYGRADE FOOD PROD	8400 EXECUTIVE AVE, PHILADELPHIA, PA 19153	PHILADELPHIA	MAY-02-2001	MAY-02-2006	2013	SAUSAGES AND OTHER PREPARED MEAT PRODUCTS	MS4	Schuylkill
39	PAR120018	PHILADELPHIA BAKING CO	GRANT AVE & ROOSEVELT AVE, PHILADELPHIA, PA 19115	PHILADELPHIA	APR-23-1996	APR-23-2001	2051	BREAD AND OTHER BAKERY PRODUCTS, EXCEPT COOKIES AND CRACKERS	MS4	Pennypack

40	PAR120025	NABISCO	12000 EAST ROOSEVELT BOULEVARD, PHILADELPHIA, PA 19116	PHILADELPHIA	JUL-11-2002	JUL-10-2007	2052	COOKIES AND CRACKERS	MS4	Poquessing
41	PAR130004	IMPERIAL METAL & CHEM	2050 BYBERRY ROAD, PHILADELPHIA, PA 19116	PHILADELPHIA	JUL-16-1996	JUL-16-2001	2796	PLATEMAKING AND RELATED SERVICES	MS4	Poquessing
42	PAR140005	INTL PAPER	2100 EAST BYBERRY ROAD, PHILADELPHIA, PA 19116	PHILADELPHIA	AUG-21-1996	AUG-21-2001	2656	SANITARY FOOD CONTAINERS, EXCEPT FOLDING	MS4	Poquessing
43	PAR140020	FIBREFLEX PACKING & MANUF CO	INC, PHILADELPHIA, PA 19127	PHILADELPHIA	JUL-06-2000	JUL-06-2005	2675	DIE-CUT PAPER AND PAPERBOARD AND CARDBOARD	MS4	Schuylkill
44	PAR140021	PERFECSEAL BUSTLETON AVE FAC	9800 BUSTLETON AVENUE, PHILADELPHIA, PA 19115	PHILADELPHIA	JAN-01-2006	DEC-31-2010	2671	PACKAGING PAPER AND PLASTICS FILM, COATED AND LAMINATED	MS4	Pennypack
45	PAR140023	SMURFIT STONE CONTAINER ENTER	BLUE GRASS RD PLT, PHILADELPHIA, PA 19114	PHILADELPHIA	JUN-01-2005	MAY-31-2010	2653	CORRUGATED AND SOLID FIBER BOXES	MS4	Pennypack
46	PAR150006	LAWRENCE MCFADDEN	7430 STATE RD., PHILADELPHIA, PA 191364299	PHILADELPHIA	AUG-15-1996	AUG-15-2001	2851	PAINTS, VARNISHES, LACQUERS, ENAMELS, AND ALLIED PRODUCTS	CSO	Delaware
47	PAR200002	ALLIED TUBE & CONDUIT NORCOM RD PLT	11350 NORCOM ROAD, PHILADELPHIA, PA 19154	PHILADELPHIA	AUG-29-2005	AUG-31-2010	3317	STEEL PIPE AND TUBES	MS4	Poquessing
48	PAR200007	HENSHELL CORP	2955 NORTH 20TH STREET, PHILADELPHIA, PA 19132	PHILADELPHIA	FEB-26-1997	FEB-26-2002	3479	COATING, ENGRAVING, AND ALLIED SERVICES, NOT ELSEWHERE CLASSIFIED	CSO	Delaware
49	PAR200010	NESBITT DIV OF MESTEK INC	TULIP & RHAWN STS, PHILADELPHIA, PA 19136	PHILADELPHIA	AUG-13-1996	AUG-13-2001	3499	FABRICATED METAL PRODUCTS, NOT ELSEWHERE CLASSIFIED	CSO	Pennypack
50	PAR200011	GROSS METALS	221 WEST GLENWOOD AVENUE, PHILADELPHIA, PA 19135	PHILADELPHIA	MAY-07-1997	MAY-07-2002	3479	COATING, ENGRAVING, AND ALLIED SERVICES, NOT ELSEWHERE CLASSIFIED	CSO	Delaware
51	PAR200016	JOWITT & RODGERS STATE RD FAC	9400 STATE RD, PHILADELPHIA, PA 19114	PHILADELPHIA	OCT-02-2001	OCT-02-2006	3291	ABRASIVE PRODUCTS	MS4	Delaware
52	PAR200036	BUDD COMP	PHILADELPHIA PLANT, PHILADELPHIA, PA 19129	PHILADELPHIA	MAY-09-2000	MAY-09-2005	3465	AUTOMOTIVE STAMPINGS	MS4	Schuylkill
53	PAR200038	TJ COPE NORCOM RD FAC	11500 NORCOM RD, PHILADELPHIA, PA 19154	PHILADELPHIA	OCT-01-2003	OCT-31-2008	3443	FABRICATED PLATE WORK (BOILER SHOPS)	MS4	Poquessing
54	PAR200041	ABINGTON METALS REFIN & MFG IN	4924 WELLINGTON ST, PHILADELPHIA, PA 19135	PHILADELPHIA	AUG-17-2004	AUG-31-2009	3339	PRIMARY SMELTING AND REFINING OF NONFERROUS METALS, EXCEPT COPPER AND ALUMINUM	CSO	Delaware

55	PAR230043	DICKLER CHEMICAL LABORATORIES INCORPORATED	4201 TORRESDALE AVENUE, PHILADELPHIA, PA 191241001	PHILADELPHIA	MAR-05-1996	MAR-05-2001	2842	SPECIALTY CLEANING, POLISHING, AND SANITATION PREPARATIONS	CSO	Tacony
56	PAR230044	ASHLAND CHEM	2801 CHRISTOPHER COLUMBUS BOULEVARD, PHILADELPHIA, PA 19148	PHILADELPHIA	MAR-29-1996	MAR-29-2001	2821	PLASTICS MATERIALS, SYNTHETIC RESINS, AND NONVULCANIZABLE ELASTOMERS	CSO	Delaware
57	PAR230045	SUNOCO CHEMICAL & FRANKFORD PLANT	MARGARET & BERMUDA STREETS, PHILADELPHIA, PA 191371193	PHILADELPHIA	APR-28-2003	APR-30-2008	2869	INDUSTRIAL ORGANIC CHEMICALS, NOT ELSEWHERE CLASSIFIED	CSO	Delaware
58	PAR230060	RICHARDSAPEX INC	4202-10 MAIN STREET, PHILADELPHIA, PA 19127	PHILADELPHIA	SEP-17-2001	SEP-17-2006	2899	CHEMICALS AND CHEMICAL PREPARATIONS, NOT ELSEWHERE CLASSIFIED	Non-contributing	Schuylkill
59	PAR230088	SUN CHEM HUNTING PARK AVE PLT	3301 HUNTING PARK AVE., PHILADELPHIA, PA 19129	PHILADELPHIA	APR-01-2005	MAR-31-2010	2893	PRINTING INK	CSO	Schuylkill
60	PAR230089	UNITED COLOR MANUF INC	EAST TIOGA ST PLANT, PHILADELPHIA, PA 19134	PHILADELPHIA	NOV-01-2005	OCT-31-2010	2869	INDUSTRIAL ORGANIC CHEMICALS, NOT ELSEWHERE CLASSIFIED	CSO	Delaware
61	PAR600015	WASTE MGMT OF PA	PHILLY TRANS STATION, PHILADELPHIA, PA 19146	PHILADELPHIA	DEC-13-2001	DEC-13-2006	5093	SCRAP AND WASTE MATERIALS	CSO	Schuylkill
62	PAR600024	S D RICHMAN SONS WHEATSHEAF LN FAC	2435 E WHEATSHEAF LANE, PHILADELPHIA, PA 19137	PHILADELPHIA	OCT-31-2001	OCT-31-2006	5093	SCRAP AND WASTE MATERIALS	MS4	Tacony
63	PAR600025	SPC PENROSE AVE FAC	26TH STREET AND PENROSE AVENUE, PHILADELPHIA, PA 19145	PHILADELPHIA	JAN-28-2002	JAN-28-2007	5023	HOMEFURNISHINGS	CSO	Schuylkill
64	PAR600026	ALLEGHENY IRON & METAL TACONY ST FAC	TACONY STREET AND ADAMS AVENUE, PHILADELPHIA, PA 19124	PHILADELPHIA	OCT-23-2001	OCT-26-2006	5093	SCRAP AND WASTE MATERIALS	CSO	Tacony
65	PAR600028	CIMCO TERMINAL INC	C/O CAMDEN IRON & METAL INC, PHILADELPHIA, PA 19125	PHILADELPHIA	NOV-01-1998	NOV-01-2001	5093	SCRAP AND WASTE MATERIALS	CSO	Schuylkill
66	PAR600030	ORTHODOX AUTO UNRUH AVE FAC	5247 UNRUH AVE, PHILADELPHIA, PA 19135	PHILADELPHIA	JUN-01-2006	MAY-31-2011	5015	MOTOR VEHICLE PARTS, USED	Non-contributing	Delaware
67	PAR600034	ACER ENGINEERS INC	JIMMIES AUTO PARTS, PHILADELPHIA, PA 19137	PHILADELPHIA	FEB-26-1998	FEB-26-2001	5015	MOTOR VEHICLE PARTS, USED	CSO	Delaware
68	PAR600039	MORRIS IRON & STEEL CO INC	7345 MILNOR ST, PHILADELPHIA, PA 19136	PHILADELPHIA	AUG-28-1996	AUG-28-2001	5093	SCRAP AND WASTE MATERIALS	Non-contributing	Delaware
69	PAR600042	PHILADELPHIA CITY POLICE DEPT	POLICE & AUTO IMPOUNDMENT LOT, PHILADELPHIA, PA 19153	PHILADELPHIA	SEP-20-1996	SEP-20-2001	5015	MOTOR VEHICLE PARTS, USED	Non-contributing	Delaware

70	PAR600054	AMERICAN AUTO PARTS & SALV CO	3501 S 61ST ST, PHILADELPHIA, PA 191533522	PHILADELPHIA	JUN-12-2000	JUN-12-2005	5015	MOTOR VEHICLE PARTS, USED	Non-contributing	Schuylkill
71	PAR600055	FIORES AUTO PARTS	3300 S 61ST ST, PHILADELPHIA, PA 19153	PHILADELPHIA	JUN-12-2000	JUN-12-2005	5015	MOTOR VEHICLE PARTS, USED	MS4	Schuylkill
72	PAR600056	B & L AUTO PARTS 61ST STREET FAC	3404 S 61ST ST, PHILADELPHIA, PA 19153	PHILADELPHIA	JUL-25-2000	JUL-25-2005	5015	MOTOR VEHICLE PARTS, USED	MS4	Schuylkill
73	PAR600057	MICHAEL MACHINO DBA	OSCARS AUTO PARTS/PASSYUNK AVE, PHILADELPHIA, PA 19153	PHILADELPHIA	APR-01-2005	MAR-31-2010	5015	MOTOR VEHICLE PARTS, USED	MS4	Schuylkill
74	PAR600065	JT S USED AUTO PARTS S 61ST ST FAC	3505 SOUTH 61ST STREET, PHILADELPHIA, PA 19153	PHILADELPHIA	NOV-01-2005	OCT-31-2010	5015	MOTOR VEHICLE PARTS, USED	MS4	Schuylkill
75	PAR600066	DRIVE TRAIN EXCHANGE	DBA VENICE AUTO PARTS, PHILADELPHIA, PA 19153	PHILADELPHIA	OCT-01-2005	SEP-30-2010	5015	MOTOR VEHICLE PARTS, USED	MS4	Schuylkill
76	PAR600070	PASCO INC	PASCO PASCHALL AVE FACILITY, PHILADELPHIA, PA 19142	PHILADELPHIA	MAY-04-2004	MAY-31-2009	5093	SCRAP AND WASTE MATERIALS	CSO	Darby-Cobbs
77	PAR600071	ESSINGTON AVE AUTO PARTS	6746 ESSINGTON AVE, PHILADELPHIA, PA 19153	PHILADELPHIA	SEP-01-2004	AUG-31-2009	5015	MOTOR VEHICLE PARTS, USED	CSO	Schuylkill
78	PAR600072	HAROLDS USED AUTO PARTS	WHITBY AVE FAC, PHILADEPHIA, PA 19143	PHILADELPHIA	OCT-01-2004	SEP-30-2009	5015	MOTOR VEHICLE PARTS, USED	CSO	Darby-Cobbs
79	PAR600073	BRUCE PAUL AUTO PARTS	LEHIGH AVE FAC, PHILADELPHIA, PA 19125	PHILADELPHIA	OCT-01-2004	SEP-30-2009	5015	MOTOR VEHICLE PARTS, USED	CSO	Delaware
80	PAR600074	FREDDIES AUTO PARTS	CARTEL AUTO PARTS W PASSYUNK, PHILADELPHIA, PA 19153	PHILADELPHIA	NOV-01-2004	OCT-31-2009	5015	MOTOR VEHICLE PARTS, USED	Non-contributing	Schuylkill
81	PAR600075	POOR BOYS USED AUTO PARTS W ANNSBURY ST FAC	532 W ANNSBURY ST, PHILADELPHIA, PA 19140	PHILADELPHIA	DEC-01-2004	NOV-30-2009	5015	MOTOR VEHICLE PARTS, USED	CSO	Tacony
82	PAR600076	JACKS AUTO PARTS SALES	61ST ST FAC, PHILADELPHIA, PA 19153	PHILADELPHIA	DEC-01-2004	NOV-30-2009	5015	MOTOR VEHICLE PARTS, USED	CSO	Darby-Cobbs
83	PAR600078	KNOCK OUT AUTO PARTS E TIOGA ST FAC	3201 E TIOGA ST, PHILADELPHIA, PA 19134	PHILADELPHIA	APR-01-2005	MAR-31-2010	5015	MOTOR VEHICLE PARTS, USED	CSO	Delaware
84	PAR600079	K & A AUTO SALVAGE	EAST SOMERSET ST FAC, PHILADELPHIA, PA 19134	PHILADELPHIA	APR-01-2005	MAR-31-2010	5015	MOTOR VEHICLE PARTS, USED	CSO	Delaware
85	PAR600080	ATLANTIC USED AUTO PARTS W PASSYUNK AVE FAC	6030 W PASSYUNK AVE, PHILA, PA 19153	PHILADELPHIA	APR-01-2005	MAR-31-2010	5015	MOTOR VEHICLE PARTS, USED	Non-contributing	Schuylkill
86	PAR600081	BUTCHS AUTO PARTS	SOUTH 61ST ST FAC, PHILADELPHIA, PA 19142	PHILADELPHIA	APR-01-2005	MAR-31-2010	5015	MOTOR VEHICLE PARTS, USED	Non-contributing	Schuylkill

87	PAR600082	SAMMY'S AUTO PARTS	3405 SOUTH 61ST ST, PHILADELPHIA, PA 19153	PHILADELPHIA	APR-01-2006	MAR-31-2011	5015	MOTOR VEHICLE PARTS, USED	Non-contributing	Schuylkill
88	PAR600083	ROBERT VOLIO	DBA NICE GUYS AUTO PARTS, PHILADELPHIA, PA 19153	PHILADELPHIA	MAY-01-2005	APR-30-2010	5015	MOTOR VEHICLE PARTS, USED	MS4	Schuylkill
89	PAR600084	JIMS AUTO RECYCLING INC	W PASSYUNK FAC, PHILADELPHIA, PA 19153	PHILADELPHIA	JUN-01-2005	MAY-31-2010	5015	MOTOR VEHICLE PARTS, USED	MS4	Schuylkill
90	PAR600085	STEVEN NGO	DBA STEVES AUTO PARTS II, PHILADELPHIA, PA 19153	PHILADELPHIA	JUL-01-2005	JUN-30-2010	5015	MOTOR VEHICLE PARTS, USED	Non-contributing	Schuylkill
91	PAR600086	T&E AUTO PARTS W PASSYUNK AVE FAC	6219 W PASSYUNK AVE, PHILADELPHIA, PA 19153	PHILADELPHIA	SEP-01-2005	AUG-31-2010	5015	MOTOR VEHICLE PARTS, USED	MS4	Schuylkill
92	PAR600088	WILLIAM DORTONE DBA BILLS AUTO	PASSYUNK AVE FAC, PHILADELPHIA, PA 19153	PHILADELPHIA	NOV-01-2005	OCT-31-2010	5015	MOTOR VEHICLE PARTS, USED	MS4	Schuylkill
93	PAR600089	DRIVE LINE AUTO PARTS	WEST PASSYUNK AVE FAC, PHILADELPHIA, PA 19153	PHILADELPHIA	JAN-01-2006	DEC-31-2010	5015	MOTOR VEHICLE PARTS, USED	MS4	Schuylkill
94	PAR600090	JKL'S AUTO SALES & PARTS	ESSINGTON AVE FAC, PHILADELPHIA, PA 19153	PHILADELPHIA	JAN-01-2006	DEC-31-2010	5015	MOTOR VEHICLE PARTS, USED	MS4	Schuylkill
95	PAR600091	A&H AUTO PARTS PASSYUNK AVE FAC	6255 W. PASSYUNK AVE, PHILADELPHIA, PA 19153	PHILADELPHIA	JUN-01-2006	MAY-31-2011	5015	MOTOR VEHICLE PARTS, USED	MS4	Schuylkill
96	PAR600092	DAVE S DELAWARE VALLEY TOWING PASSYUNK AVE FAC	6159 PASSYUNK AVE, PHILADELPHIA, PA 19153	PHILADELPHIA					MS4	Schuylkill
97	PAR800019	CROWLEY AMERICAN TRANS	TIOGA MARINE TERMINAL, PHILADELPHIA, PA 19134	PHILADELPHIA	SEP-11-1996	SEP-11-2001	4212	LOCAL TRUCKING WITHOUT STORAGE	CSO	Delaware
98	PAR800027	CSX TRANSPORTATION	PHILADELPHIA RIP TRACK, PHILADELPHIA, PA 19145	PHILADELPHIA	JUN-01-2006	MAY-31-2011	4011	RAILROADS, LINE-HAUL OPERATING	CSO	Schuylkill
99	PAR800029	ABF FREIGHT SYSTEM INC	4000 RICHMOND ST, PHILADELPHIA, PA 19137	PHILADELPHIA	MAR-05-1996	MAR-05-2001	4213	TRUCKING, EXCEPT LOCAL	MS4	Tacony
100	PAR800033	SEPTA	ALLEGHENY GARAGE, PHILADELPHIA, PA 19129	PHILADELPHIA	AUG-22-1996	AUG-22-2001	4111	LOCAL AND SUBURBAN TRANSIT	MS4	Schuylkill
101	PAR800035	SEPTA	ROBERTS AVE FAC, PHILADELPHIA, PA 19129	PHILADELPHIA	FEB-01-2005	JAN-31-2010	4111	LOCAL AND SUBURBAN TRANSIT	MS4	Schuylkill
102	PAR800041	BFI TRANSF SYS OF PA CHRISTOPHER COLUMBUS BLVD FAC	2904 S CHRISTOPHER COLUMBUS BLVD, PHILADELPHIA, PA 19148	PHILADELPHIA	OCT-16-2001	OCT-16-2006	4212	LOCAL TRUCKING WITHOUT STORAGE	CSO	Delaware
103	PAR800052	TDSI PHILADELPHIA BIDS TERM	36TH & MOORE STS, PHILADELPHIA, PA 19145	PHILADELPHIA	JUN-04-1996	JUN-04-2001	4011	RAILROADS, LINE-HAUL OPERATING	CSO	Schuylkill

104	PAR800055	CF MOTOR FREIGHT PHL	2625 E CASTOR AVE, PHILADELPHIA, PA 19134	PHILADELPHIA	AUG-08-1996	AUG-08-2001	4213	TRUCKING, EXCEPT LOCAL	CSO	Delaware
105	PAR800060	DEGUSSA CORP	DEGUSSA CSX/BIDS FACILITY, PHILADELPHIA, PA 19145	PHILADELPHIA	OCT-09-2002	OCT-31-2007	4226	SPECIAL WAREHOUSING AND STORAGE, NOT ELSEWHERE CLASSIFIED	CSO	Delaware
106	PAR800062	US POSTAL SERV	BYBERRY RD FAC, PHILADELPHIA, PA 19116	PHILADELPHIA	NOV-01-2005	OCT-31-2010	4311	UNITED STATES POSTAL SERVICE THIS INDUSTRY INCLUDES ALL ESTABLISHMENTS OF THE UNITED STATES POSTAL SERVICE.	MS4	Poquessing
107	PAR800064	BFI WASTE SVC OF PA	3000 E HEDLEY STREET, PHILADELPHIA, PA 19137	PHILADELPHIA	SEP-28-2001	SEP-28-2006	4212	LOCAL TRUCKING WITHOUT STORAGE	Non-contributing	Delaware
108	PAR800067	WASTE MGMT OF PA INC	FORGE RECYCLING & RES REC CENT, PHILADELPHIA, PA 19036	PHILADELPHIA	SEP-12-2002	SEP-30-2007	5621	WOMEN'S CLOTHING STORES	MS4	Delaware
109	PAR800085	ROADWAY EXPRESS	CHURCH & PEARCE STREETS, PHILADELPHIA, PA 19124	PHILADELPHIA	AUG-29-2002	AUG-31-2007	4231	TERMINAL AND JOINT TERMINAL MAINTENANCE FACILITIES FOR MOTOR FREIGHT TRANSPORTATION	MS4	Tacony
110	PAR800088	CSX INTERMODAL	GREENWICH YARD, PHILADELEPHIA, PA 19148	PHILADELPHIA	JUL-14-1998	JUL-14-2003	4011	RAILROADS, LINE-HAUL OPERATING	CSO	Delaware
111	PAR800112	NORTHEAST PHILADELPHIA AIRPORT (PNE)	NORTHEAST PHILADELPHIA AIRPORT, PHILADELPHIA, PA 19114	PHILADELPHIA	FEB-12-2002	FEB-12-2007	4581	AIRPORTS, FLYING FIELDS, AND AIRPORT TERMINAL SERVICES	MS4	Pennypack
112	PAR800113	FEDERAL EXPRESS CORP	3600 GRAYS FERRY AVENUE, PHILADELPHIA, PA 19146	PHILADELPHIA	JUN-10-2002	JUN-09-2007	4513	AIR COURIER SERVICES	CSO	Schuylkill
113	PAR800118	ACAD RECYCLING TORRESDALE FAC	8901 TORRESDALE AVENUE, PHILADELPHIA, PA 19154	PHILADELPHIA	DEC-04-2002	DEC-31-2007	4953	REFUSE SYSTEMS	MS4	Pennypack
114	PAR800131	FEDEX GROUND	TOWNSEND RD FAC, PHILADELPHIA, PA 19154	PHILADELPHIA	MAR-01-2005	FEB-28-2010	4215	COURIER SERVICES, EXCEPT BY AIR	MS4	Poquessing
115	PAR800138	DHL EXPRESS USA INC	HOLSTEIN AVE FAC, PHILADELPHIA, PA 19153	PHILADELPHIA	APR-01-2006	MAR-31-2011	4215	COURIER SERVICES, EXCEPT BY AIR	MS4	Schuylkill
116	PAR802212	SUN COMPANY INC	EXETER TERMINAL, PHILADELPHIA, PA 19103	PHILADELPHIA	NOV-07-1992	NOV-06-1997	5171	PETROLEUM BULK STATIONS AND TERMINALS	CSO	Schuylkill
117	PAR900005	DELAWARE VALLEY RECYCLING	3107 SOUTH 61ST STREET, PHILADELPHIA, PA 19153	PHILADELPHIA	JAN-26-1996	JAN-26-2001	4953	REFUSE SYSTEMS	Non-contributing	Schuylkill

118	PAR900013	PHILADELPHIA CITY WATER DEPT	NE/WPCP, PHILADELPHIA, PA 19137	PHILADELPHIA	OCT-07-2002	OCT-31-2007	4952	SEWERAGE SYSTEMS	CSO	Delaware
119	PAR900017	CLEAN EARTH OF PHILA FAC	3201 SOUTH 61ST STREET, PHILADELPHIA, PA 19153	PHILADELPHIA	JUN-01-2006	MAY-31-2011	4953	REFUSE SYSTEMS	Non-contributing	Schuylkill
120	PAR900020	PHILADEPHIA WATER DEPT	SE WPCP, PHILADELPHIA, PA 19148	PHILADELPHIA	OCT-07-2002	OCT-31-2007	4952	SEWERAGE SYSTEMS	CSO	Delaware
121	PAR900024	PGW PASSYUNK PLANT	3100 W PASSYUNK AVE, PHILADELPHIA, PA 191455208	PHILADELPHIA	JUN-01-2006	MAY-31-2011	4925	MIXED, MANUFACTURED, OR LIQUEFIED PETROLEUM GAS PRODUCTION AND/OR DISTRIBUTION	CSO	Schuylkill
122	PAU123244	BILL'S AUTOGLASS	3402 S. 61ST ST, PHILADELPHIA, PA 19153	PHILADELPHIA			5015	MOTOR VEHICLE PARTS, USED	MS4	Schuylkill
123	PAU123245	JT'S AUTOMOBILE PARTS	PHILADELPHIA COUNTY, PA, EAST SOMERSET ST FAC	PHILADELPHIA			5015	MOTOR VEHICLE PARTS, USED	CSO	Delaware
124	PAU123248	JOHN'S USED AUTO PARTS	PHILADELPHIA COUNTY, PA, 9400 STATE RD	PHILADELPHIA			5015	MOTOR VEHICLE PARTS, USED	MS4	Delaware
125	PAU123459	CJ ASHLAND	4001 ASHLAND AVE, PHILADELPHIA, PA 19124	PHILADELPHIA			5015	MOTOR VEHICLE PARTS, USED	MS4	Tacony
126	PAU123460	LEGEND AUTO SALES	3990 FRANKFORD AVE, PHILADELPHIA, PA 19124	PHILADELPHIA			5015	MOTOR VEHICLE PARTS, USED	CSO	Tacony
127	PAU123461	UKNOWN AUTO SCRAP YARD	3970 FRANKFORD AVE, PHILADELPHIA, PA 19124	PHILADELPHIA			5015	MOTOR VEHICLE PARTS, USED	CSO	Tacony

APPENDIX J – MONITORING LOCATIONS

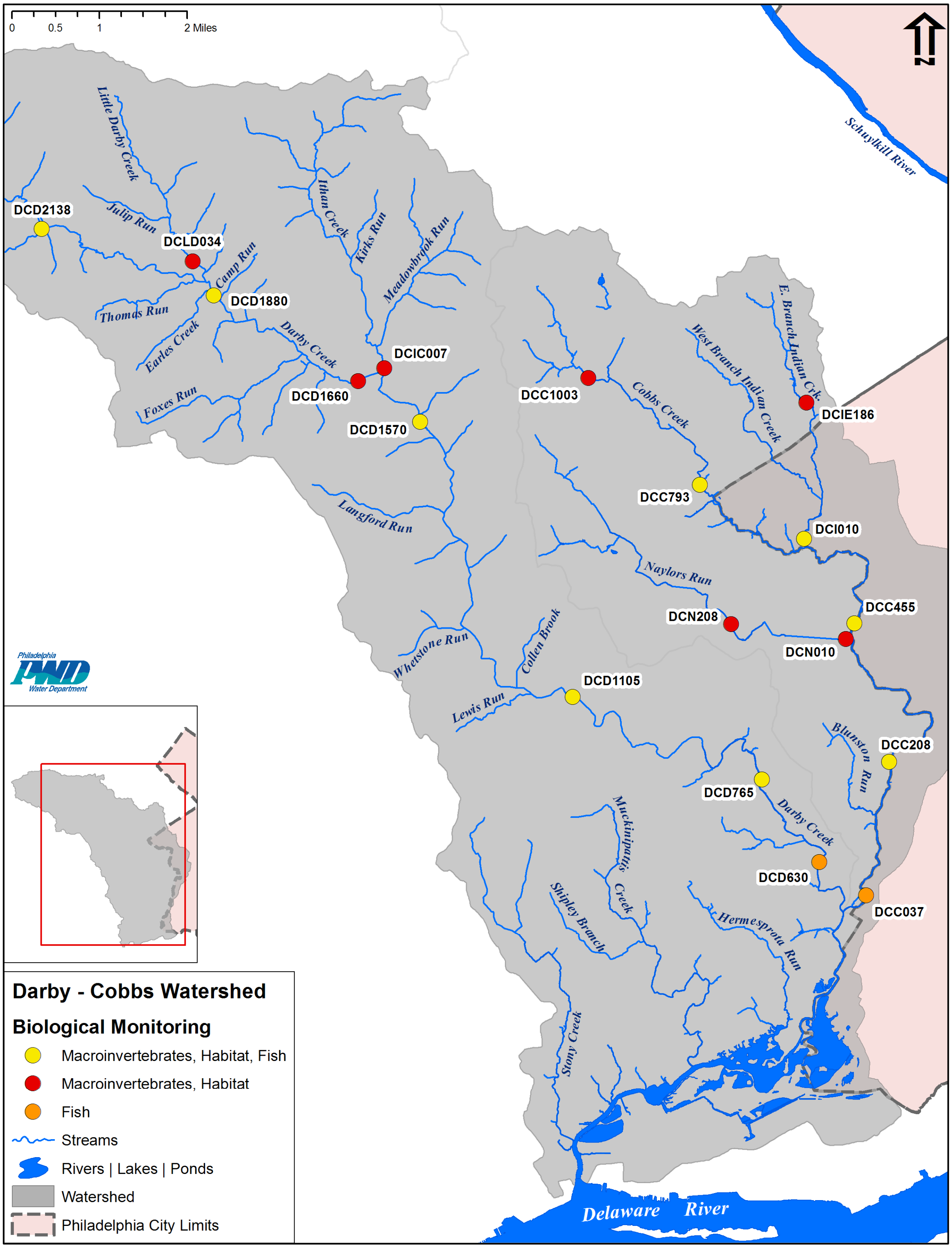


Figure J-1 Biological and Physical assessment locations in Darby-Cobbs Watershed

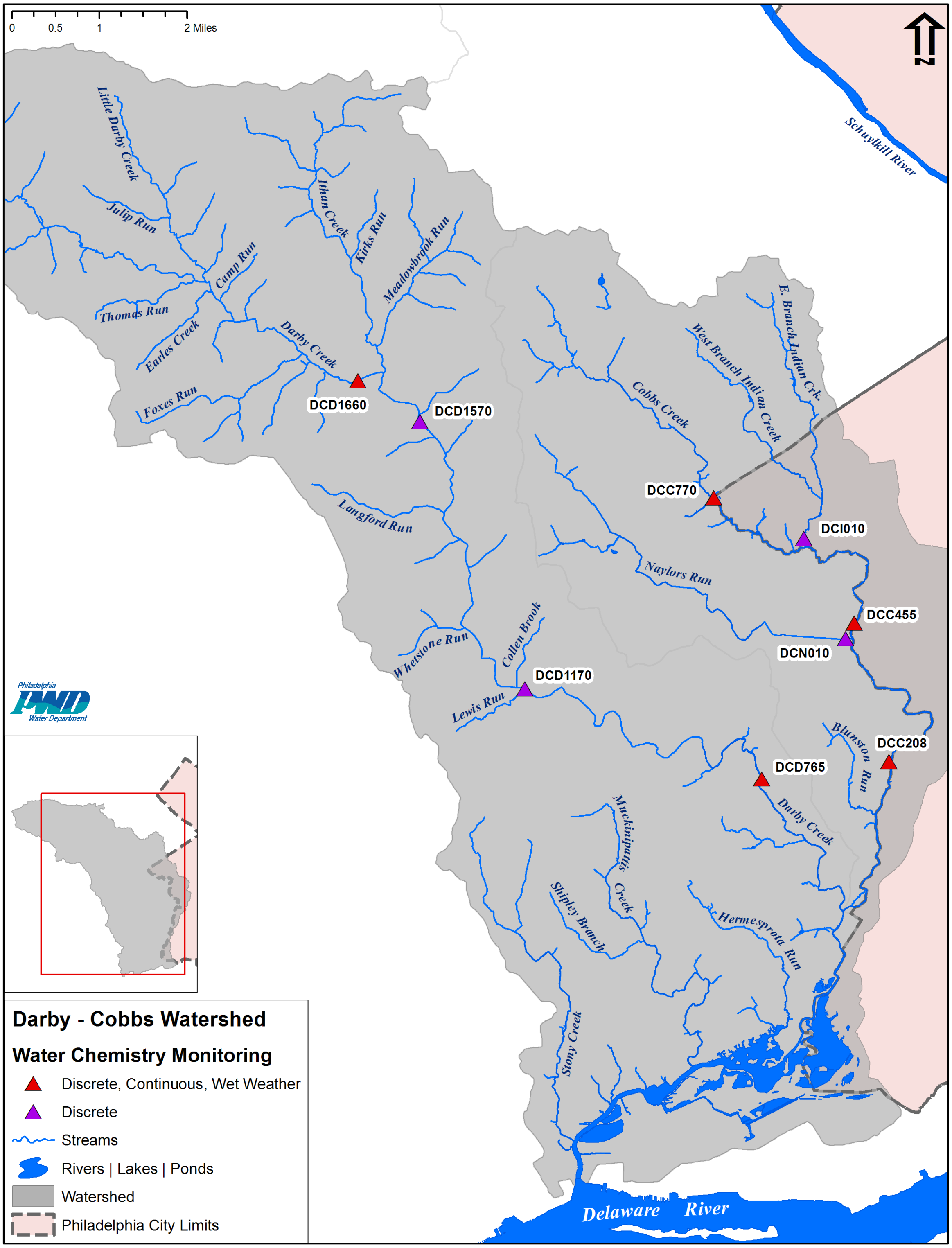


Figure J-2 Chemical monitoring locations in Darby-Cobbs Watershed

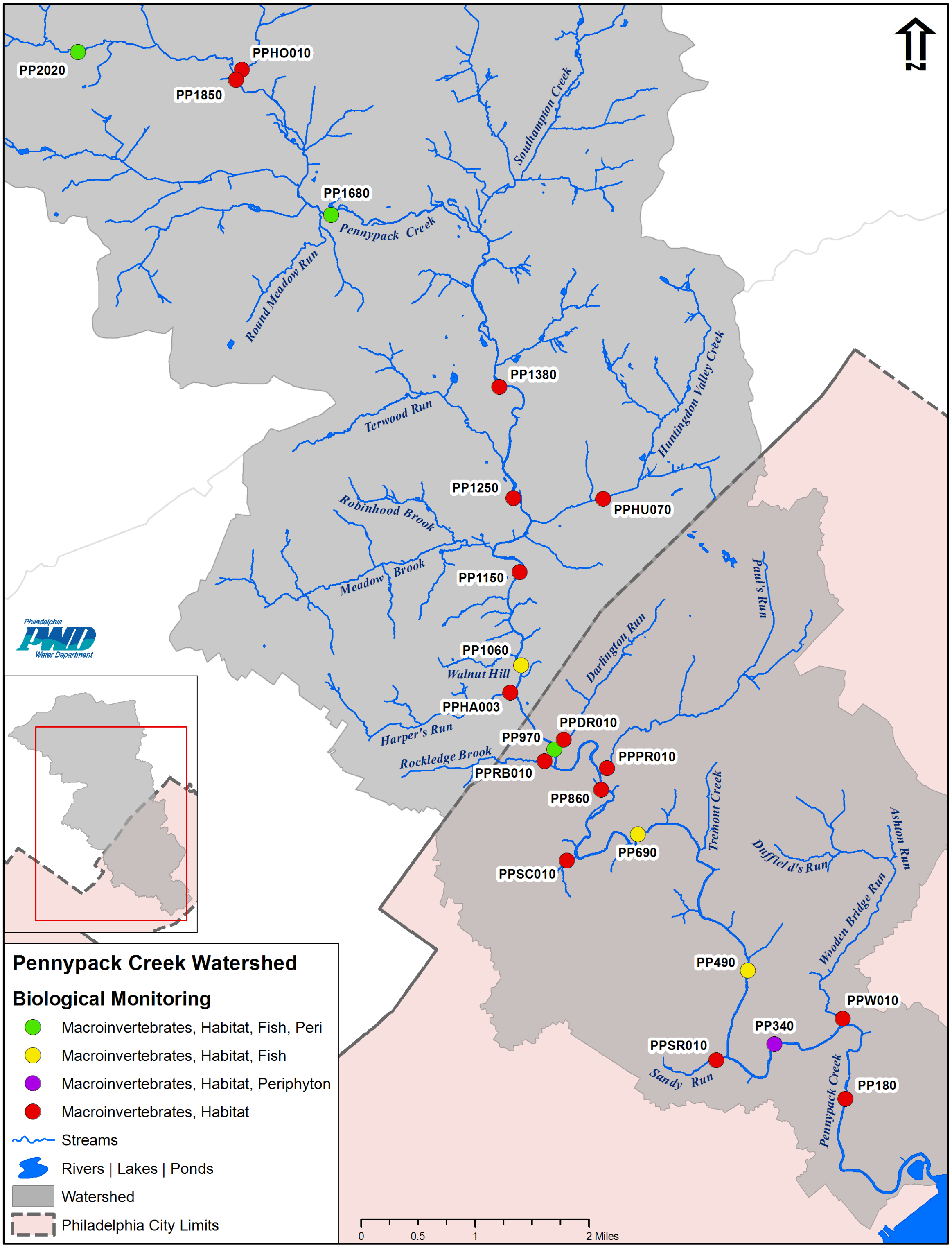


Figure J-3 Biological and Physical assessment locations in Pennypack Watershed

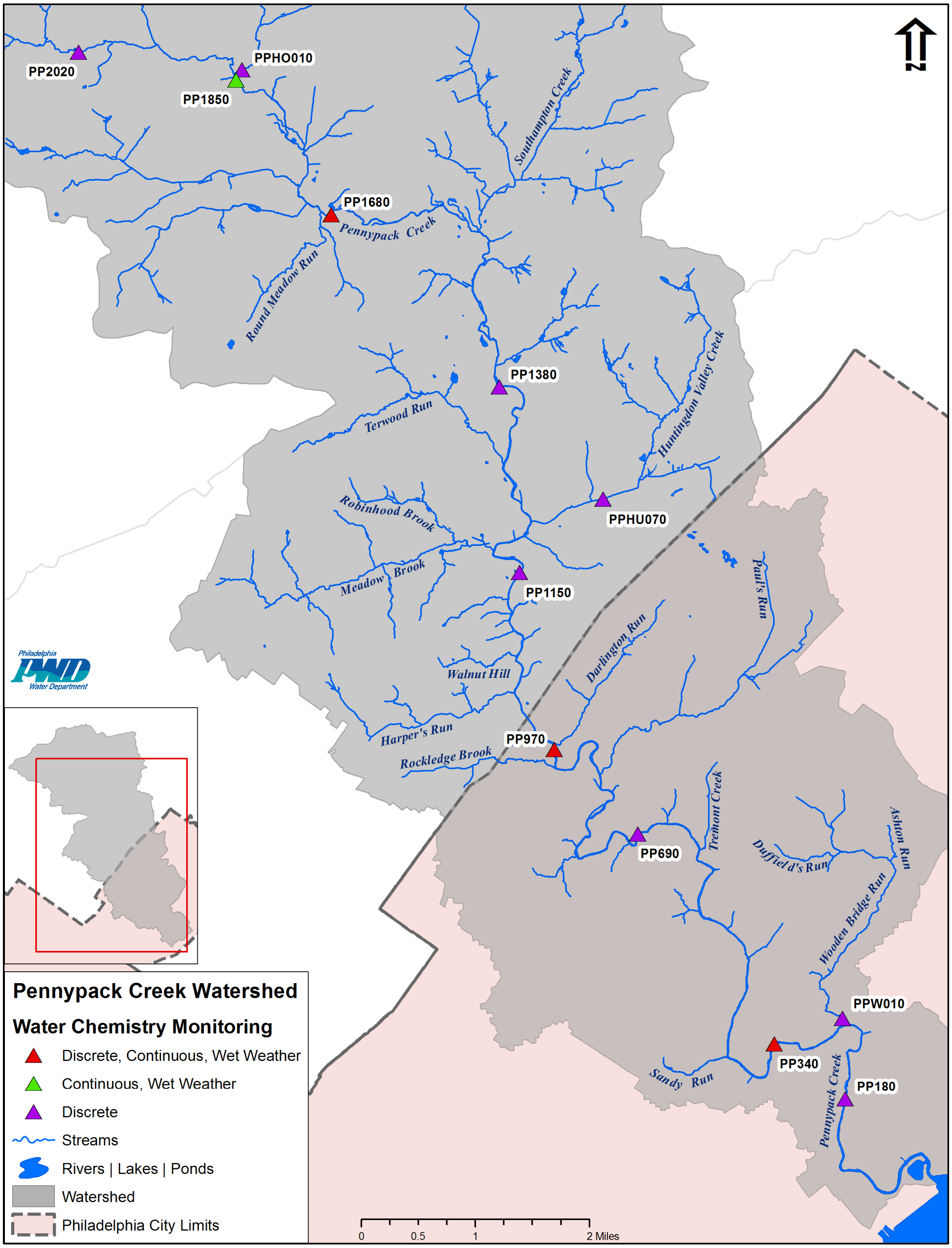


Figure J-4 Chemical monitoring locations in Pennypack Watershed

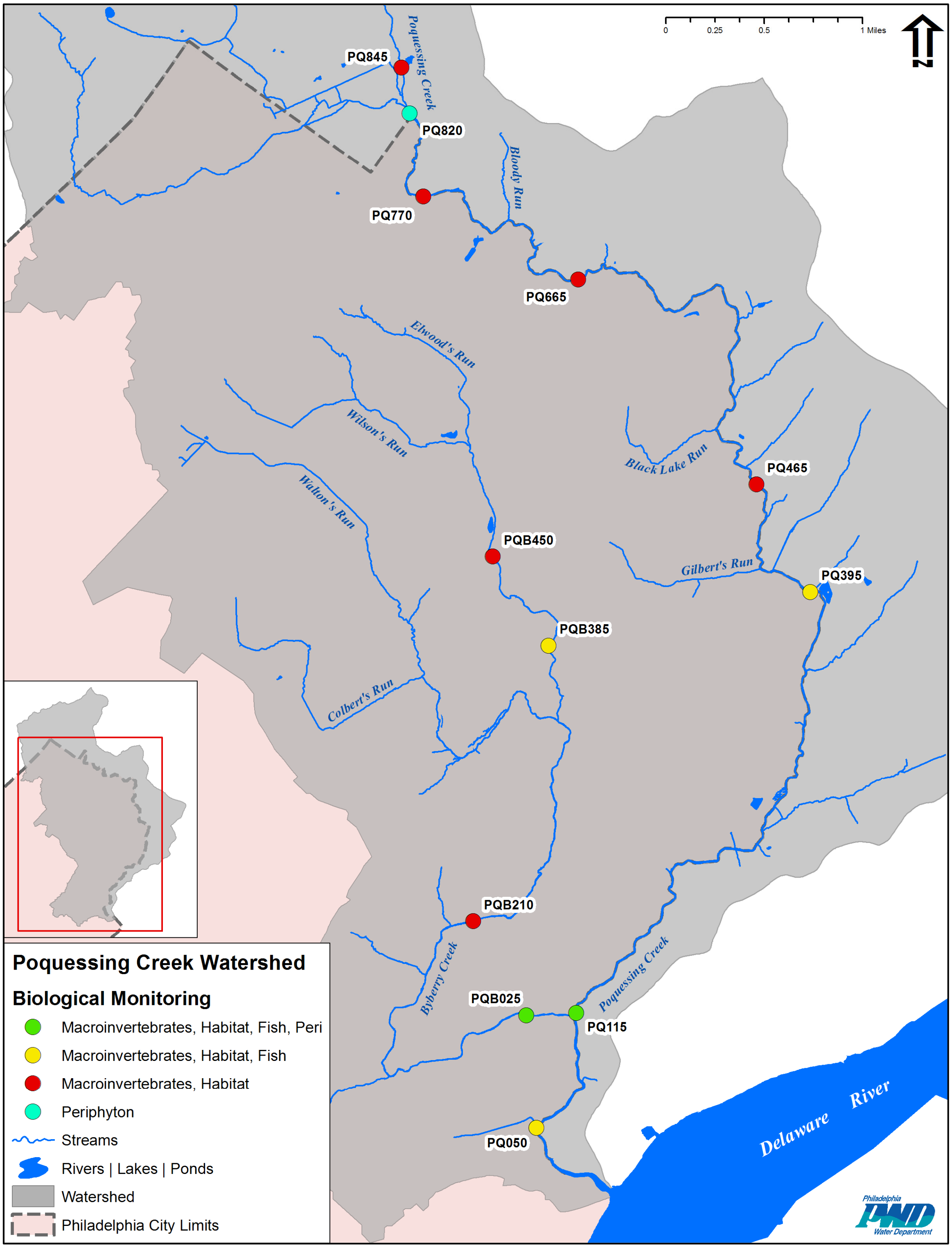


Figure J-5 Biological and Physical assessment locations in Poquessing-Byberry Watershed

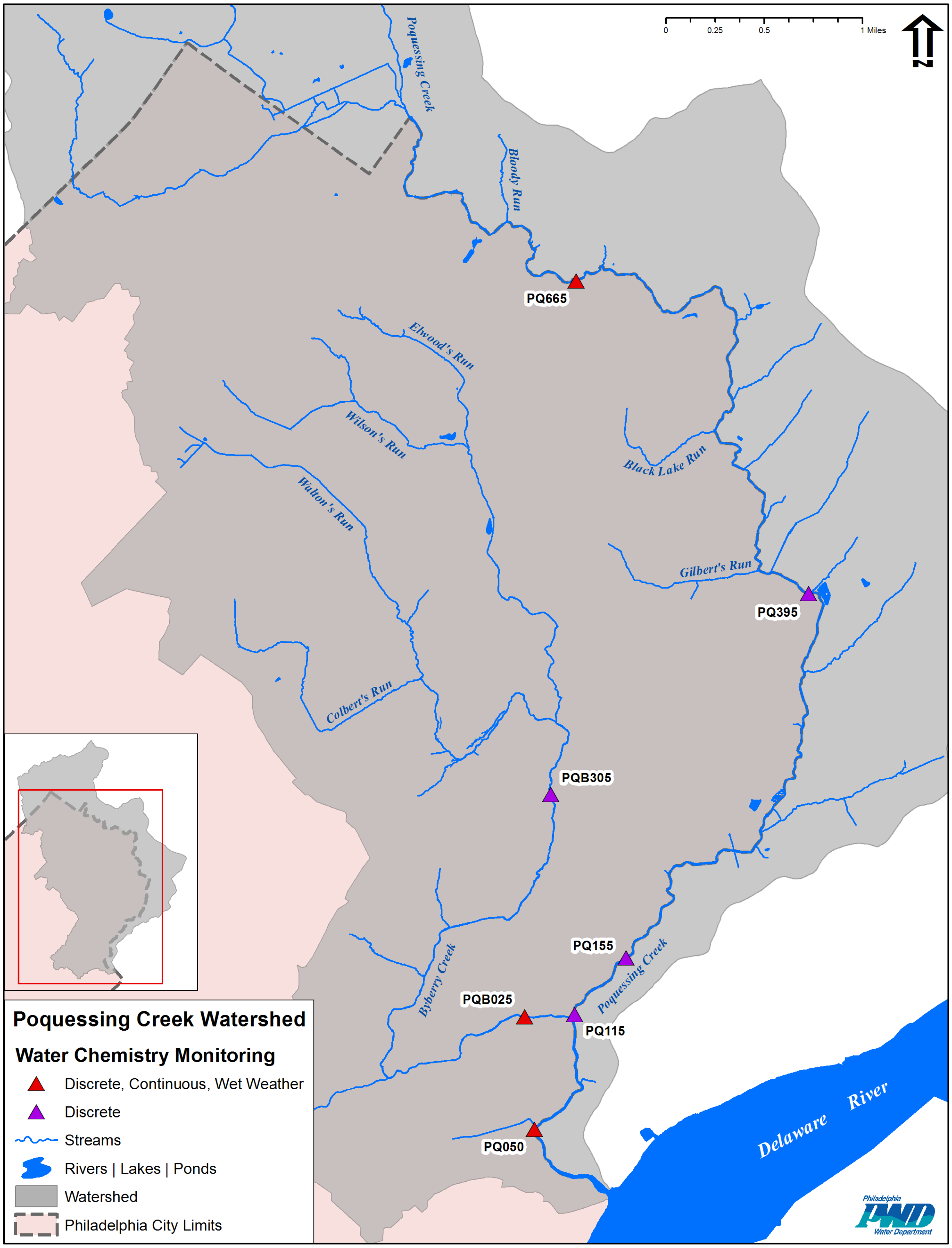


Figure J-6 Chemical monitoring locations in Poquessing-Byberry Watershed

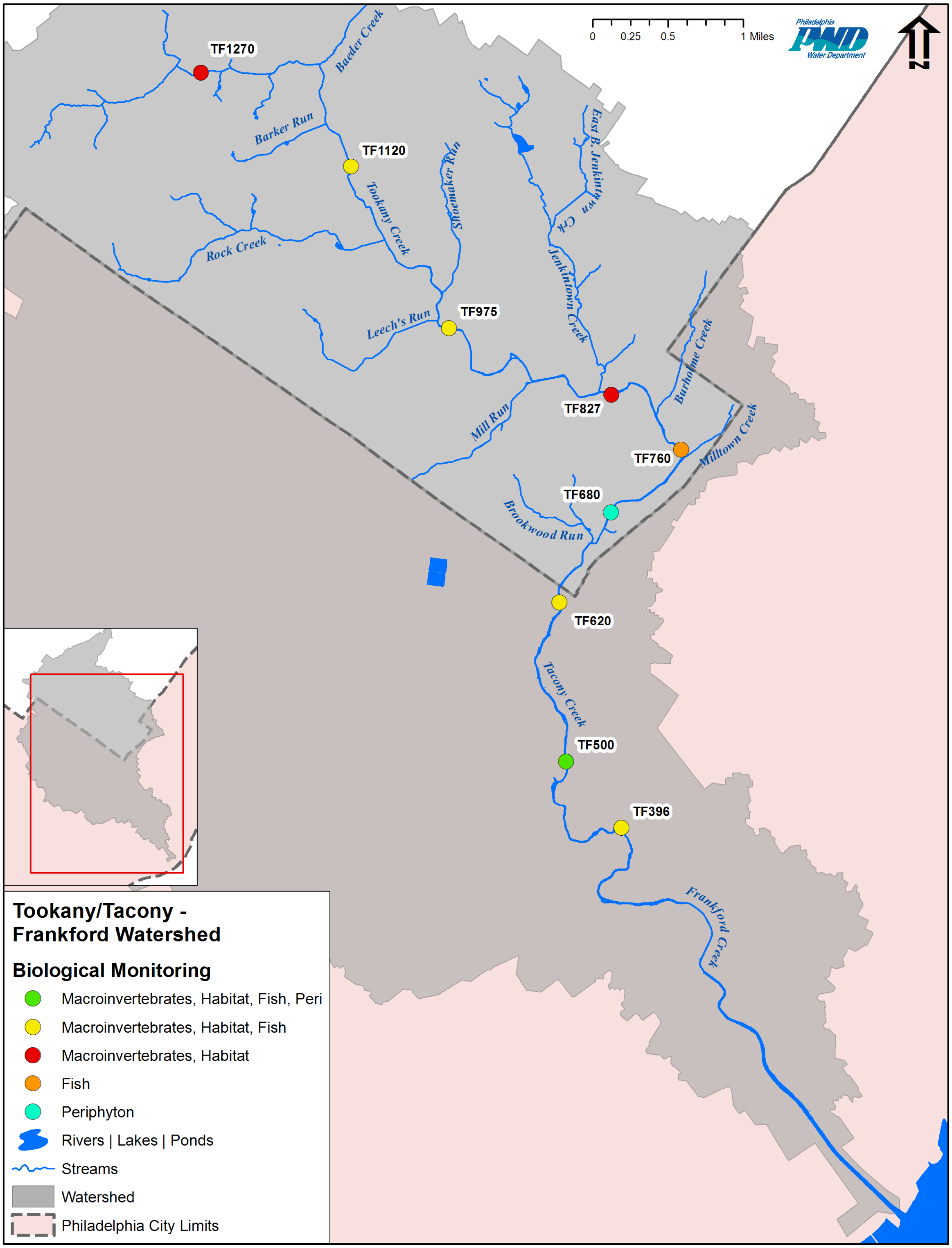


Figure J-7 Biological and Physical assessment locations in Tacony-Frankford Watershed

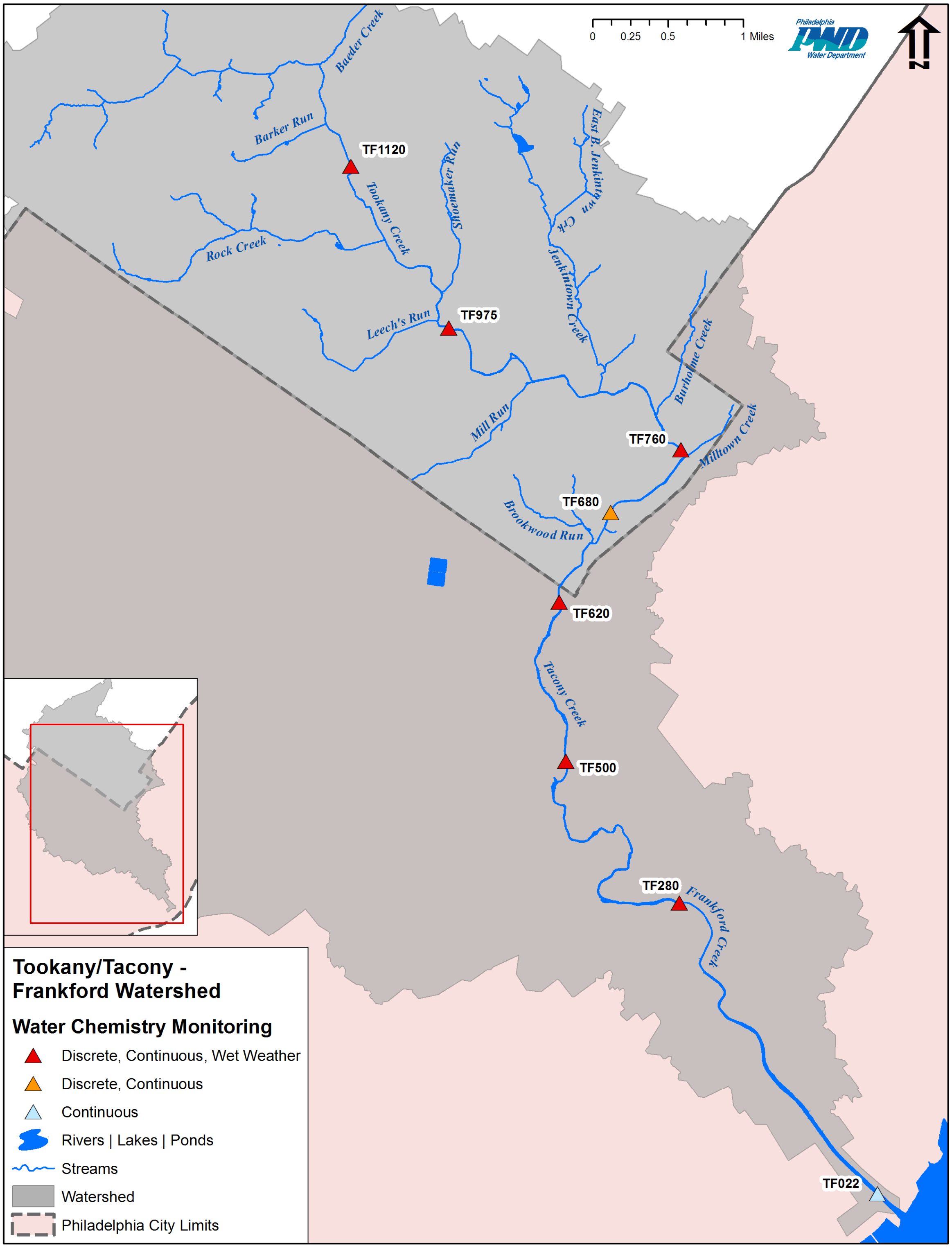


Figure J-8 Chemical monitoring locations in Tacony-Frankford Watershed

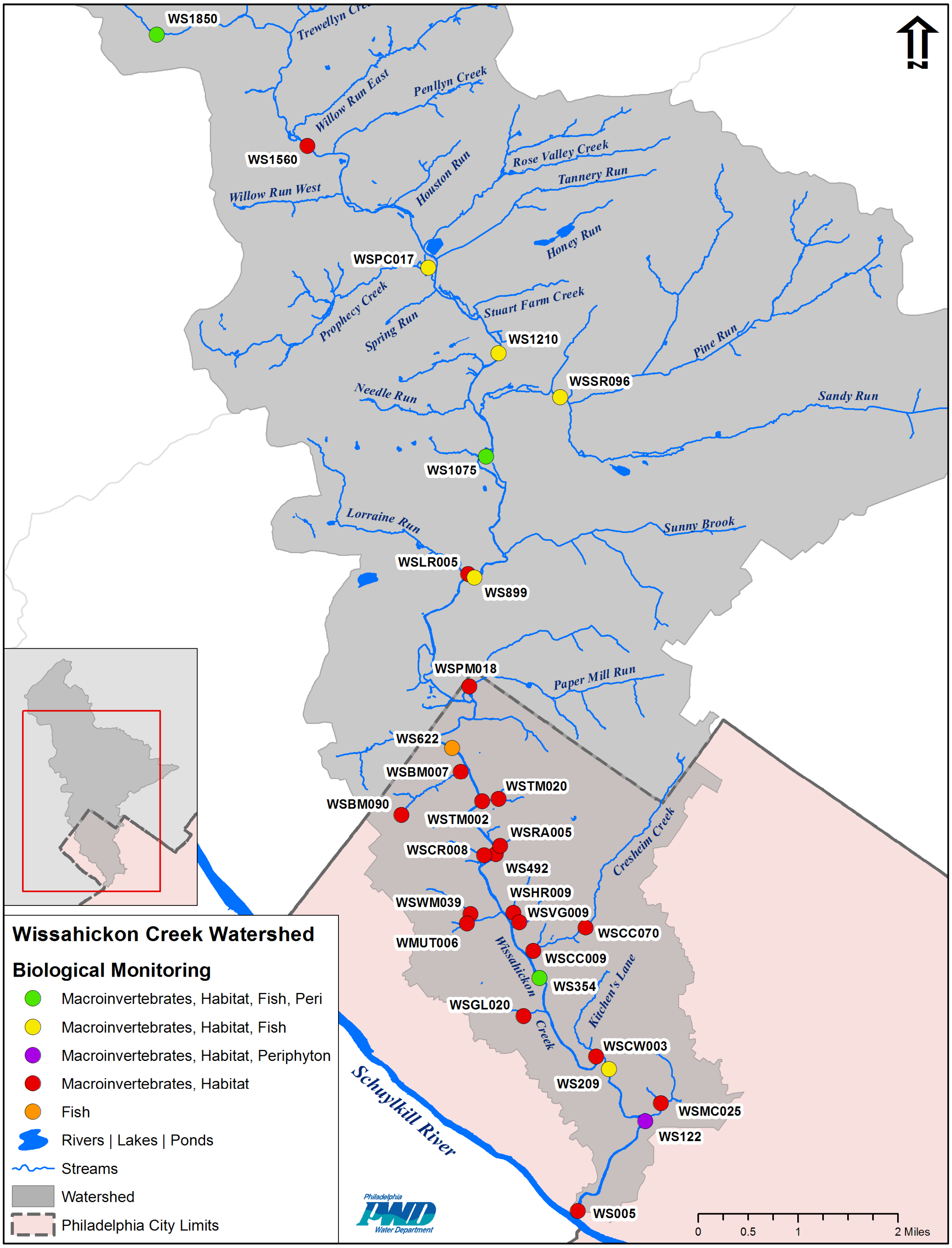


Figure J-9 Biological and Physical assessment locations in Wissahickon Watershed

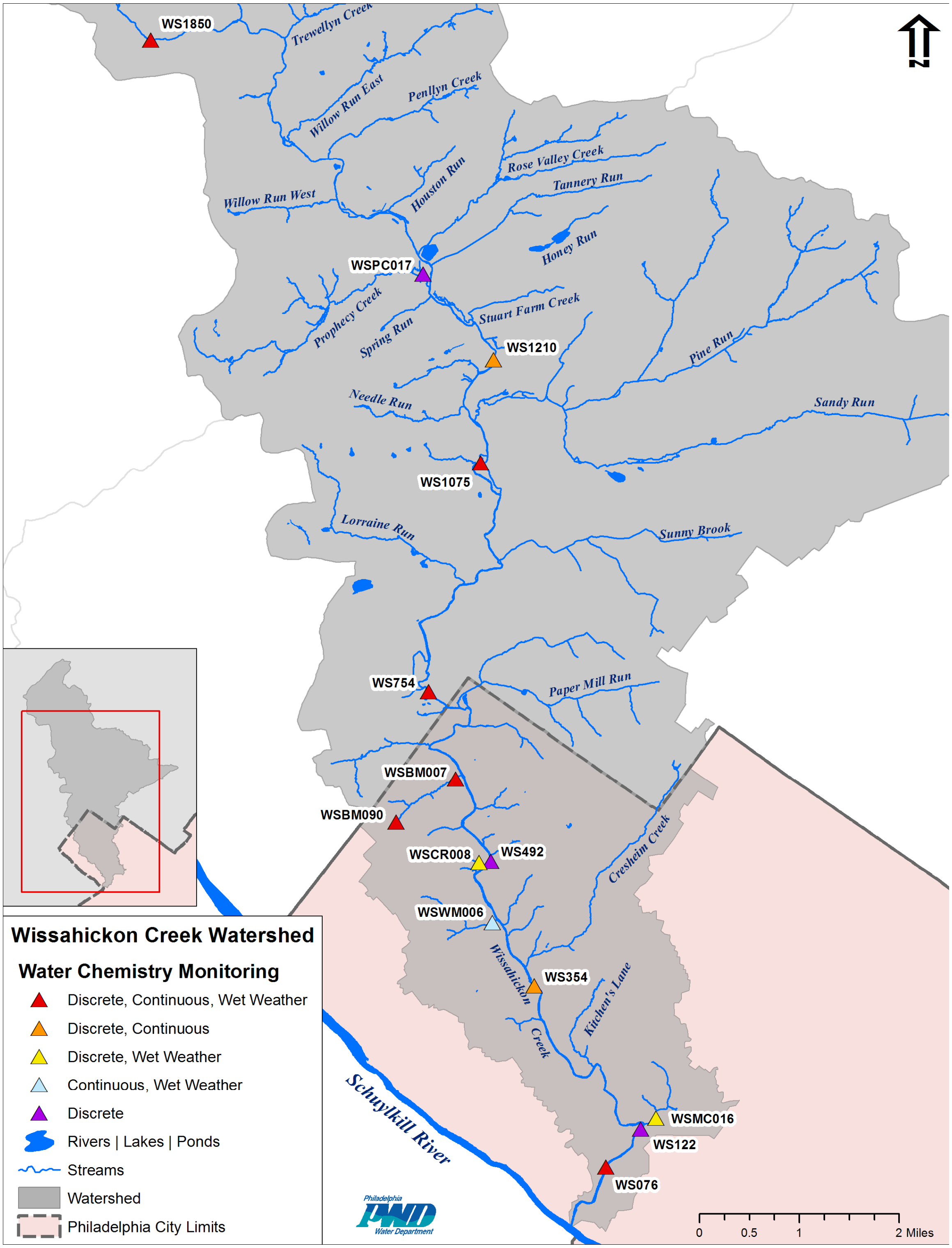


Figure J-10 Chemical monitoring locations in Wissahickon Watershed

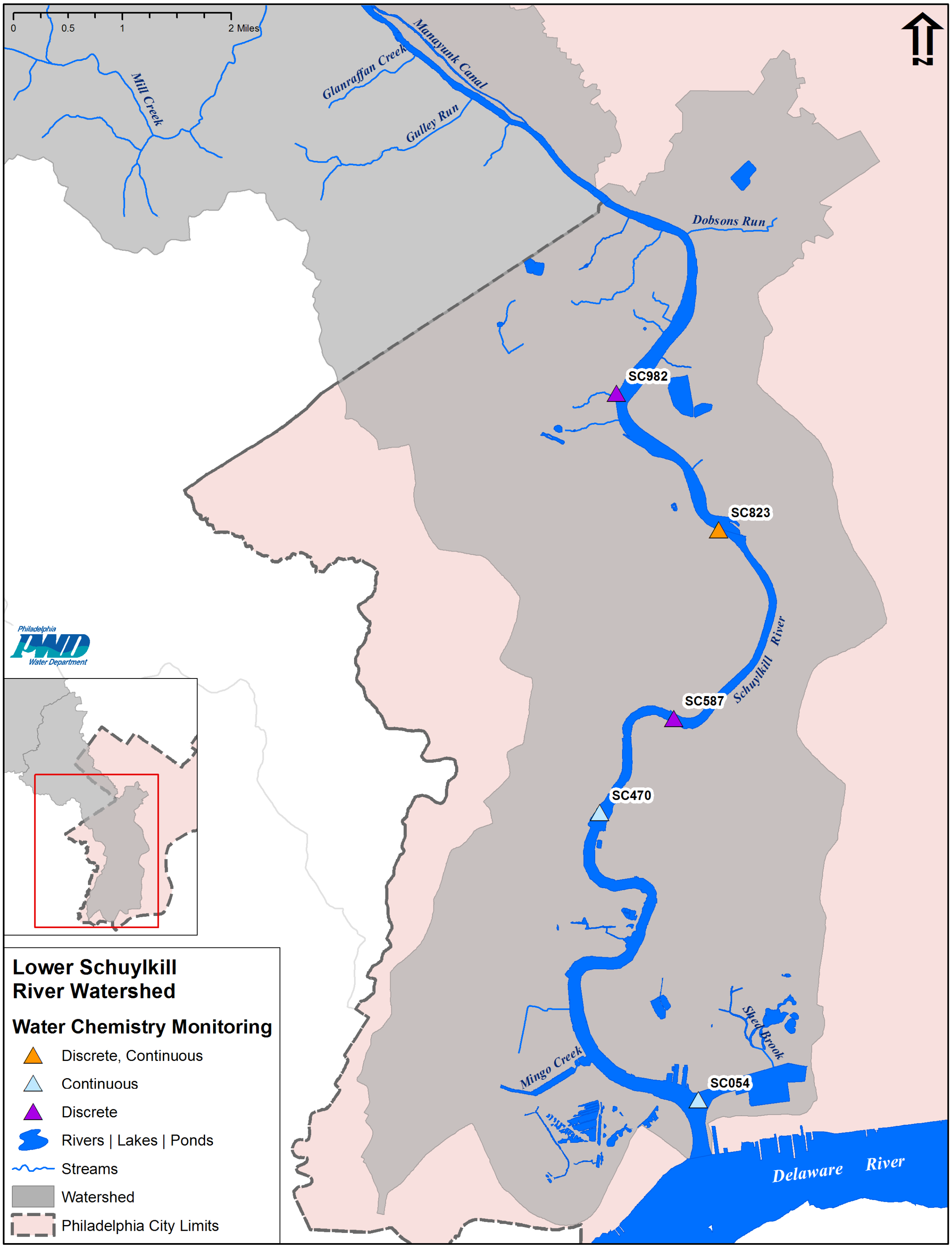


Figure J-11 Chemical monitoring locations in Lower Schuylkill River Watershed

APPENDIX K –Wissahickon Creek Stream Assessment Study Lower Wissahickon

WISSAHICKON CREEK STREAM ASSESSMENT STUDY
LOWER WISSAHICKON WATERSHED

Philadelphia Water Department Office of Watersheds 2010

Wissahickon Creek Watershed Stream Assessment Report
Lower Wissahickon Watershed

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

List of Appendices

1 INTRODUCTION

1.1 PROJECT PURPOSE

The purpose of the Wissahickon Creek Watershed Stream Assessment Report was to provide the Philadelphia Water Department (PWD), local watershed partnership groups, and other interested parties with an analysis and summary of the existing physical conditions within the watersheds of Wissahickon Creek Watershed inclusive of both stream networks and riparian corridors. Specifically, the goals of this assessment were to provide:

+ a characterization and documentation of existing conditions
+ a reference point for evaluating changes over time
+ a tool for prioritizing stream and habitat restoration sites
+ insight into appropriate restoration strategies
+ a land use planning and redevelopment tool
+ an aid in determining the effects of urbanization

With the insight gained from this assessment, it will be possible to strategically plan and coordinate restoration activities throughout the watershed as well as within individual watersheds. The ultimate goals of these restoration efforts will include: improving water quality, managing or replanting riparian vegetation, enhancing in-stream habitat, providing increased fish passage and finally, facilitating stream bank stabilization.

1.1.1 REPORT STRUCTURE

Each watershed section has been written to be a stand alone document. The methodologies described in the beginning of the report apply to all the data collection and processing techniques mentioned in each of the watershed assessments.

1.2 PROJECT DESCRIPTION

The Wissahickon Creek Watershed Stream Assessment consisted of an evaluation of approximately 115 miles of stream channel within the 64 square mile watershed by members of the Philadelphia Water Department's Office of Watersheds (PWDOOW) in 2005. The assessment involved walking the entire length of main stem Wissahickon Creek and 26 of its tributaries (Figure 1-1), to record specific information about the channel, surrounding habitat, and infrastructure located in or near the creeks. The Lower Wissahickon Creek Watershed from henceforth is defined as the portion of the watershed south of Northwestern Avenue, which forms the border between Mountgomery and Philadelphia counties.

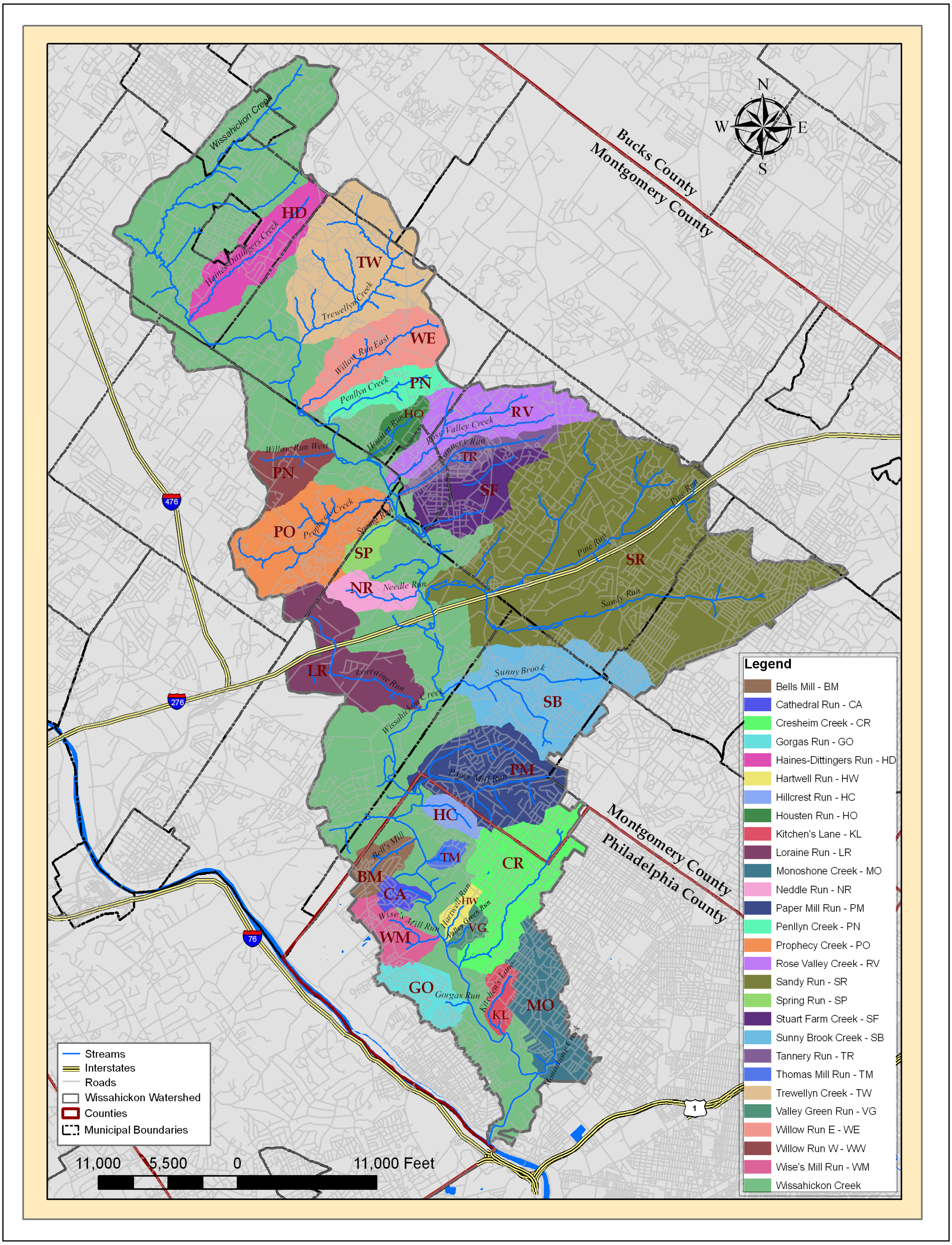


Figure 1-1: Wissahickon Creek Watershed

PWD completed a suite of field surveys and desktop analyses to summarize existing stream and riparian conditions in the Wissahickon Creek Watershed. Field surveys were focused on the characterization of channel morphology and in-stream hydraulics through the use of surveyed cross-section data and substrate particle size distribution. The physical processes that determine channel morphology, instream hydraulics, channel slope and sediment load are dependant on the physical conditions within the respective sub-catchments that drain into the Wissahickon Creek stream network. Factors that influence these conditions include valley slope, land-use and local geology as well as the potential impacts of infrastructure. Thus, to thoroughly characterize instream conditions, it was necessary to examine the physical conditions within respective watershed stream corridors as well (Figure 1-2).

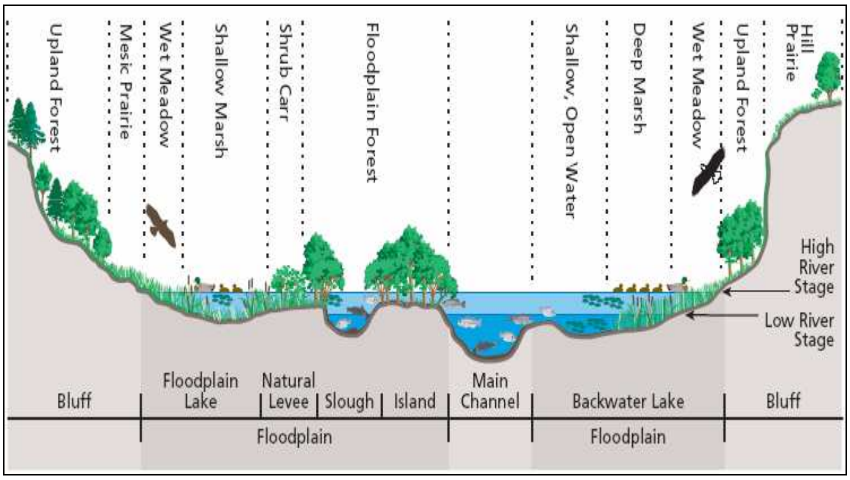


Figure 1-2: Generalized Cross Section of a Stream Corridor

*adapted from Bioscience, vol. 45, p. 170, March 1995.

Conceptually, stream corridors are extended watershed cross-sections consisting of three main components, which are the stream channel, flood plain and an upland transitional zone or terrace. The stream channel lies at the lowest elevation of this system and conveys water at least part of the year. The floodplain exists on one or both sides of the channel and is inundated by floodwaters at an interval determined by the regional hydrologic regime. The transitional upland portion of the river corridor exists on one or both sides of the floodplain and serves as the transition between the floodplain and the surrounding landscape (FISRWG 1998).

These three components are dynamically linked through the transport and storage of water, nutrients and sediment, such that alterations to one component will over time influence another component. An example of this process is evident in the change in hydraulic, hydrologic and sediment regimes of watersheds that undergo urbanization or have changes in land use.

Land cover is intrinsically linked to a watershed's hydrologic regime through the conversion of precipitation and throughfall to runoff. As a watershed is converted from a natural, forested land cover to a more impervious and urbanized land cover, runoff increases and concomitantly increases the volume of water transported or stored by the stream channel and floodplain (Figure 1-3).

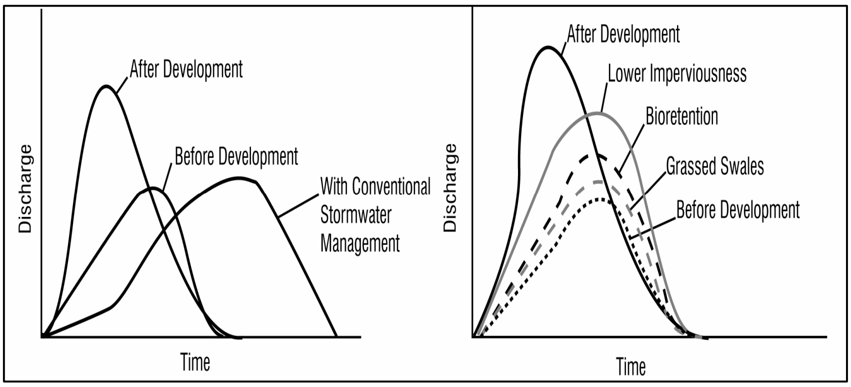


Figure 1-3: Comparison of Volume and Duration of Stormwater Runoff Before and After Land Development, and Reductions in Runoff from BMPs.

*Source: Prince George's County Department of Environmental Resources et. al. (undated)

1.3 WATERSHED DESCRIPTION

Wissahickon Creek is located in southeastern Pennsylvania, flowing from the suburbs of Montgomery County through the northwestern portion of the City of Philadelphia. The headwaters of the Wissahickon Creek originate in a parking lot at the Montgomeryville Mall complex in Montgomery Township and the main stem of the creek continues for approximately 27 miles through nine municipalities before reaching its confluence with the Schuylkill River. Wissahickon Creek Watershed has a total drainage area of approximately 64 square miles and drains portions of fifteen municipalities as well as the City of Philadelphia (Table 1-1). Numerous tributaries converge into main stem Wissahickon Creek as the total number of stream miles contributing to the Wissahickon Creek stream network is roughly 115 miles (Table 1-2).

Table 1-1: Municipalities with Contributing Drainage Area to the Wissahickon Creek Watershed

Municipality	% of Wissahickon Drainage in each Municipality
Upper Dublin Township	18.9%
City of Philadelphia	16.8%
Lower Gwynedd Township	13.0%
Whitemarsh Township	12.9%
Springfield Township	10.1%
Whitpain Township	8.3%
Upper Gwynedd Township	7.9%
Abington Township	5.6%
Montgomery Township	2.4%
Ambler Borough	1.3%
Lansdale Borough	1.1%
North Wales Borough	0.9%
Cheltenham Township	0.4%
Horsham Township	0.2%
Worcester Township	0.1%
Upper Moreland Township	0.1%

Table 1-2: Stream Lengths for Wissahickon Creek Main stem and Tributaries

Hydrologic Feature	Length (mi)
Bell's Mill	1.2
Cathedral Run	0.1
Cresheim Creek	3.1
Gorgas Run	0.3
Haines-Dittingers	3.3
Hartwell Run	0.7
Hillcrest Run	0.8
Honey Run	1.0
Housten Run	1.3
Kitchen's Lane	1.5
Lorraine Run	3.2
Monoshone Creek	1.3
Paper Mill Run	5.8
Pennlyn Creek	2.3
Pine Run	8.5
Prophecy Creek	5.0
Rose Valley Creek	5.7
Sandy Run	8.1
Spring Run	0.7
Stuart Farm Creek	1.2
Sunny Brook Run	3.8
Tannery Run	2.6
Thomas Run	0.8
Trewellyn Creek	7.3
Valley Green Run	0.5
Willow Run East	3.9
Wise's Mill	1.3
* Wissahickon Creek Main Stem	39.4
Total	**115**

* Wissahickon Creek stream length additionally includes small unnamed tributaries with direct drainage to the main stem**.**

1.4 LAND USE

Land use information for the Wissahickon Creek Watershed (Figure 1-4) was obtained from the Delaware Valley Regional Planning Commission (DVRPC). Over time, the Wissahickon Creek watershed has experienced continual and extensive urban and suburban development. The drainage area is characterized by a mixture of various land uses, but single family detached homes cover more than half of the watershed. During the initial stages of development within the Wissahickon Valley, agricultural and industrial (e.g. grist mills) land-use dominated the rugged landscape; however, the dominant land-use in the watershed is now residential at approximately 52 percent (Table 1-3).

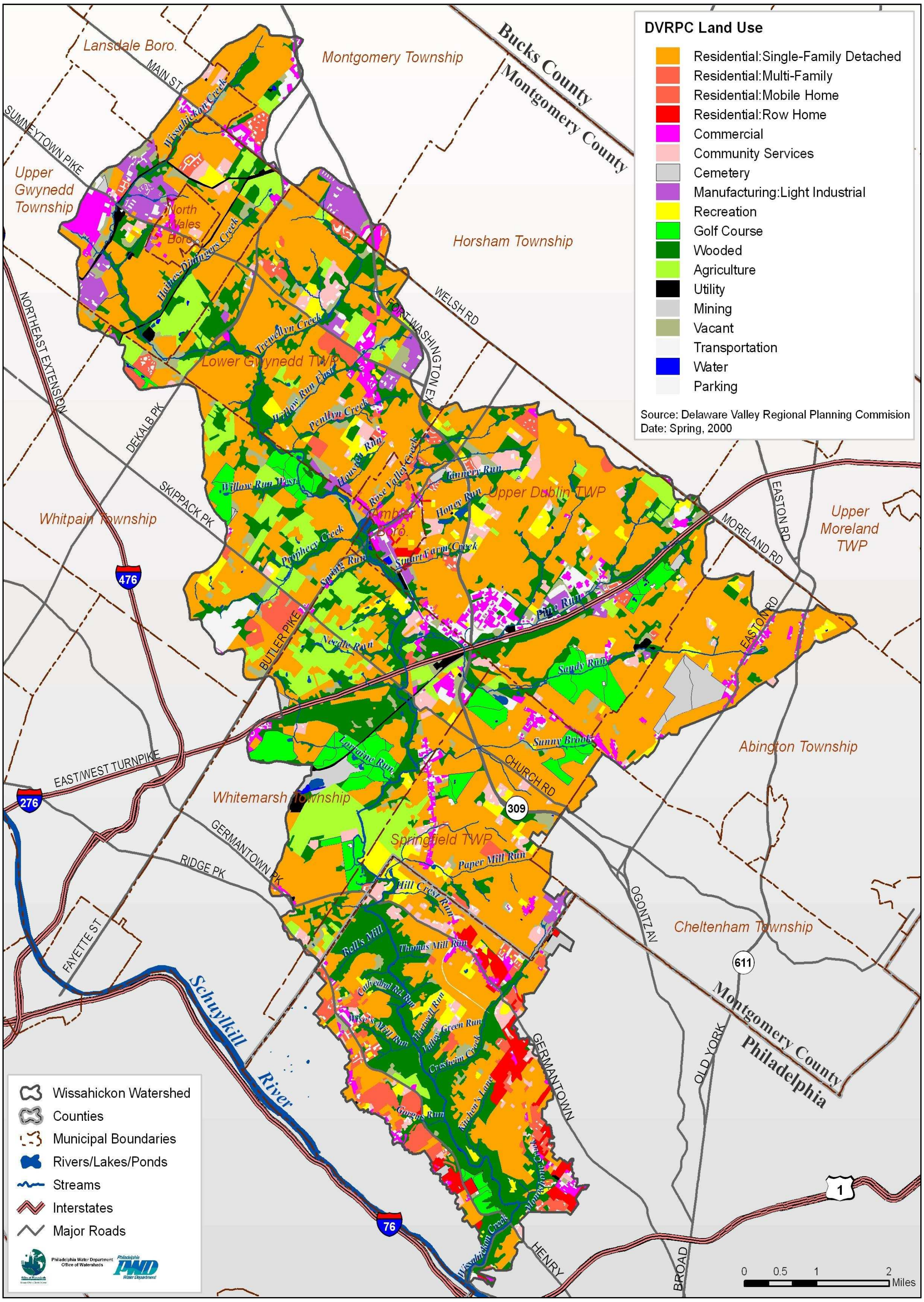


Figure 1-4: Wissahickon Creek Watershed Land Use

Source: DVRPC 2000 Land Use Data

Table 1-3: Land Use within the Wissahickon Watershed

Land Use Category	Percentage
Agriculture	6.2%
Cemetery	0.9%
Commercial	3.3%
Community Services	2.9%
Golf Course	4.0%
Manufacturing: Light Industrial	2.0%
Mining	0.2%
Parking	2.7%
Recreation	2.9%
Residential: Mobile Home	0.0%
Residential: Multi-Family	3.6%
Residential: Row Home	1.2%
Residential: Single-Family Detached	47.2%
Transportation	1.3%
Utility	0.7%
Vacant	3.3%
Water	0.8%
Wooded	16.8%

Source: DVRPC 2000 Land Use Data

1.5 GEOLOGY AND SOILS

1.5.1 WISSAHICKON CREEK GEOLOGY

Geology and soils play a significant role in the hydrology, water quality, and ecology of a watershed. The northern portion of the Wissahickon Creek Watershed is located within the Gettysburg-Newark Lowlands and Piedmont Lowlands (Figure 1-5), underlain by various clastic sedimentary rocks. The southern portion of the watershed is within the Piedmont Upland physiographic region, which is underlain by a variety of sedimentary, metamorphic and igneous rocks (Fairmount Park Commission, Montgomery County Planning Commission and Pennsylvania Department of Conservation and Natural Resources, 2000). As one moves from the northern most point in the watershed through each of the physiographic regions, the topography changes to reflect the differences in the underlying geology. Most notable are the steep slopes and large rock formations along the Wissahickon main stem as observed along Forbidden Drive in the Philadelphia portion of the watershed. A description of the geologic formations present throughout the Wissahickon Creek Watershed is presented in Table 1-4.

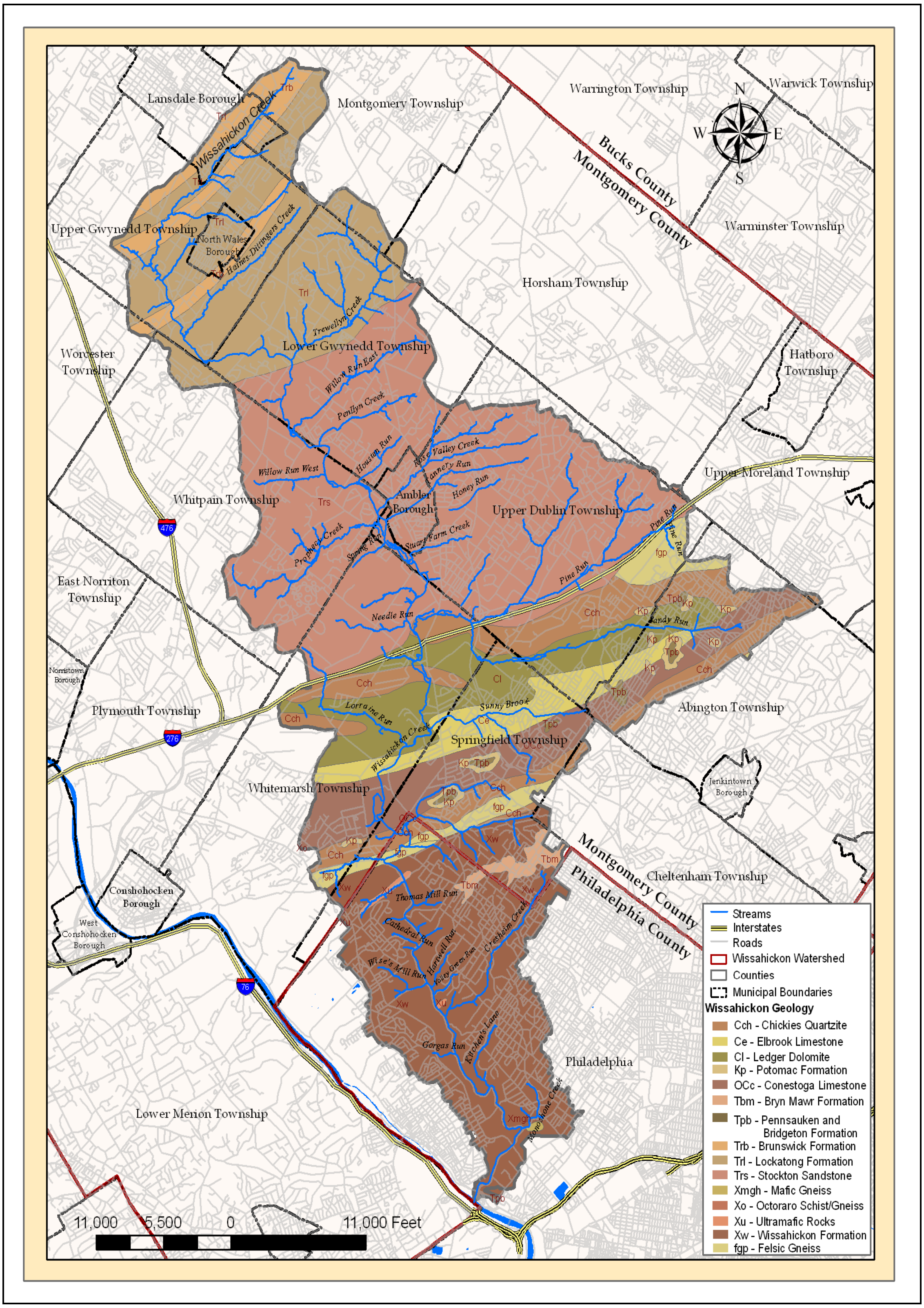


Figure 1-5: Wissahickon Creek Watershed Geology

Table 1-4: Generalized Descriptions of Geologic Formations within the Wissahickon Creek Watershed

Source: U.S. Department of Agriculture, Natural Resource Conservation Service, 2005, Montgomery County Open Space Plan, 2005, and Wissahickon Creek River Conservation Plan, 2001

Formation	Description
Brunswick Formation	This formation underlies much of the northwestern half of Montgomery County and is characterized by reddish brown shale, mudstone, and siltstone. The topography of the formation is characterized by rolling hills.
Bryn Mawr Formation	This formation consists of white, yellow, and brown gravel and sand. This is a deeply weathered formation.
Chickies Formation	This formation is created when sandstone is exposed to extreme heat and pressure. Composed of quartzite and quartz schist. This hard, dense rock weathers slowly. This formation has good surface drainage. A narrow band of quartzite extends westward across Bucks County from Morrisville.
Conestoga Formation	Conestoga Limestone is a blue-gray, thin-bedded, argillaceous limestone with intervals of a purer, granular limestone. Some of the basal beds are a coarse limestone conglomerate containing large pebbles and irregular masses of coarse white marble in a gray limestone This formation consists of Ordovician micaceous, medium-gray, impure, shaly limestone, which extends in the relatively wide belt across the county.
Elbrook Formation	The formation consists of blue dolomite and dolomitic limestone, some siliceous and shaly beds that weather to a well drained yellowish-red loam. This formation is moderately resistant to weathering. Solution channels provide a secondary porosity of moderate magnitude; moderate to high permeability. Solution openings which may be found in the substrata create certain structural problems for heavy buildings.
Felsic Gneiss, Pyroxene Bearing	This formation consists of metamorphic rock units that yield small quantities of water due to the smallness of the cracks, joints, and other openings within the rock. This fine - grained granitic gneiss is resistant to weathering but shows good surface drainage.

Ledger Dolomite	Ledger Dolomite is a white to light gray, massive to thick-bedded, granular, rather pure dolomite with high magnesium content. The dolomite is interbedded with some siliceous beds and laminated limestone. The Ledger contains a few beds of marble with high calcium content. Limestone and dolomite formations yield good trap rock and calcium rich rock which has been quarried for various industrial and construction uses. (Coorson's Quarry is found in this formation.)
Lockatong Formation	This formation is composed of dark gray to black argillite with occasional zones of limestone and black shale. This formation is part of a larger band, several miles wide, which runs from the Mont Clare area to the Montgomery/Horsham Township border. Resistant to weathering, these rocks form the prominent ridge that runs through central Montgomery County.
Mafic Gneiss	This formation consists of medium to fine grained, dark colored calcic plagioclase, hyperthene, augite, and quartz. It is highly resistant to weathering, but shows good surface drainage.
Pennsauken Formation	This formation consists of sand and gravel yellow to dark reddish brown, mostly comprised of quartz, quartzite, and chert. It is a deeply weathered floodplain formation.
Serpentine	This formation forms barren, rocky outcrops on low hills and ridges. Only small quantities of water are contained in the fractures. The water is hard and mineralized (magnesium bicarbonate).
Stockton Formation	This formation consists of interbedded arkose, arkosic conglomerate, feldspathic sandstone, and red shale and siltstone. It is a primarily coarse sandstone formation, which tends to form ridges resistant to weathering. This rock is a good source of brick, floor tile, and sintered aggregate material.
Wissahickon Schist	This formation is composed of mica schist, gneiss and quartzite. The schists are softer rock and are highly weathered near the surface. This formation consists mostly of metamorphosed sedimentary rocks, but also includes rocks of igneous origin.

1.5.2 WISSAHICKON CREEK WATERSHED SOILS

Soils in the United States have been assigned to Hydrologic Soil Groups (HSG). The assigned groups are listed in Natural Resources Conservation Service (NRCS) Field Office Technical Guides, published soil surveys, and local, state, and national soil databases. The Hydrologic Soil Groups, as defined by NRCS engineers, are A, B, C, D, and dual groups A/D, B/D, and C/D. The HSG rating can be useful in assessing the ability of the soils in an area to recharge stormwater or to accept recharge of treated wastewater or to allow for effective use of septic systems. Figure 1-6 shows the hydrologic soil groups in the study area. The map indicates that most of the study area contains soil in the hydrologic category B, with some areas at the upstream shown as category C. This has implications for the design of stormwater infiltration systems, and also affects the amount of water that needs to be infiltrated in newly developed areas to maintain predevelopment or natural infiltration rates.

Table 1-5: NRCS Soil Group Characteristics

Source: United States Department of Agriculture, Natural Resources Conservation Service. 2006. Field Indicators of Hydric Soils in the United States, Version 6.0

Hydrologic Soil Group	Average Infiltration Rates (in/hr)
A	1.00 - 8.3
B	0.50 -1.00
C	0.17 - 0.27
D	0.02 - 0.10

Soils in hydrologic group A have low runoff potential. These soils have a high rate of infiltration (Table 1-5) when saturated. The depth to any restrictive layer is greater than 100 cm (40 inches) and to a permanent water table is deeper than 150 cm (5 feet).

Soils that have a moderate rate of infiltration (Table 1-5) when saturated are in hydrologic group B. Water movement through these soils is moderately rapid. The depth to any restrictive layer is greater than 50 cm (20 inches) and to a permanent water table is deeper than 60 cm (2 feet).

Hydrologic group C soils have a slow rate of infiltration (Table 1-5) when saturated. Water movement through these soils is moderate or moderately slow; they generally have a restrictive layer that impedes the downward movement of water. The depth to the restrictive layer is greater than 50 cm (20 inches) and to a permanent water table is deeper than 60 cm (2 feet).

Soils in hydrologic group D have a high runoff potential. These soils have a very slow infiltration rate (Table 1-5) when saturated. Water movement through the soil is slow or very slow. A restrictive layer of nearly impervious material may be within 50 cm (20 inches) of the soil surface and the depth to the permanent water table is shallower than 60 cm (2 feet). Dual Hydrologic Soil Groups (A/D, B/D, and C/D) are given for certain wet soils that could be adequately drained. The first letter applies to the drained and the second to the saturated condition. Soils are assigned to dual groups if the depth to a permanent water table is the sole criteria for assigning a soil to hydrologic group D.

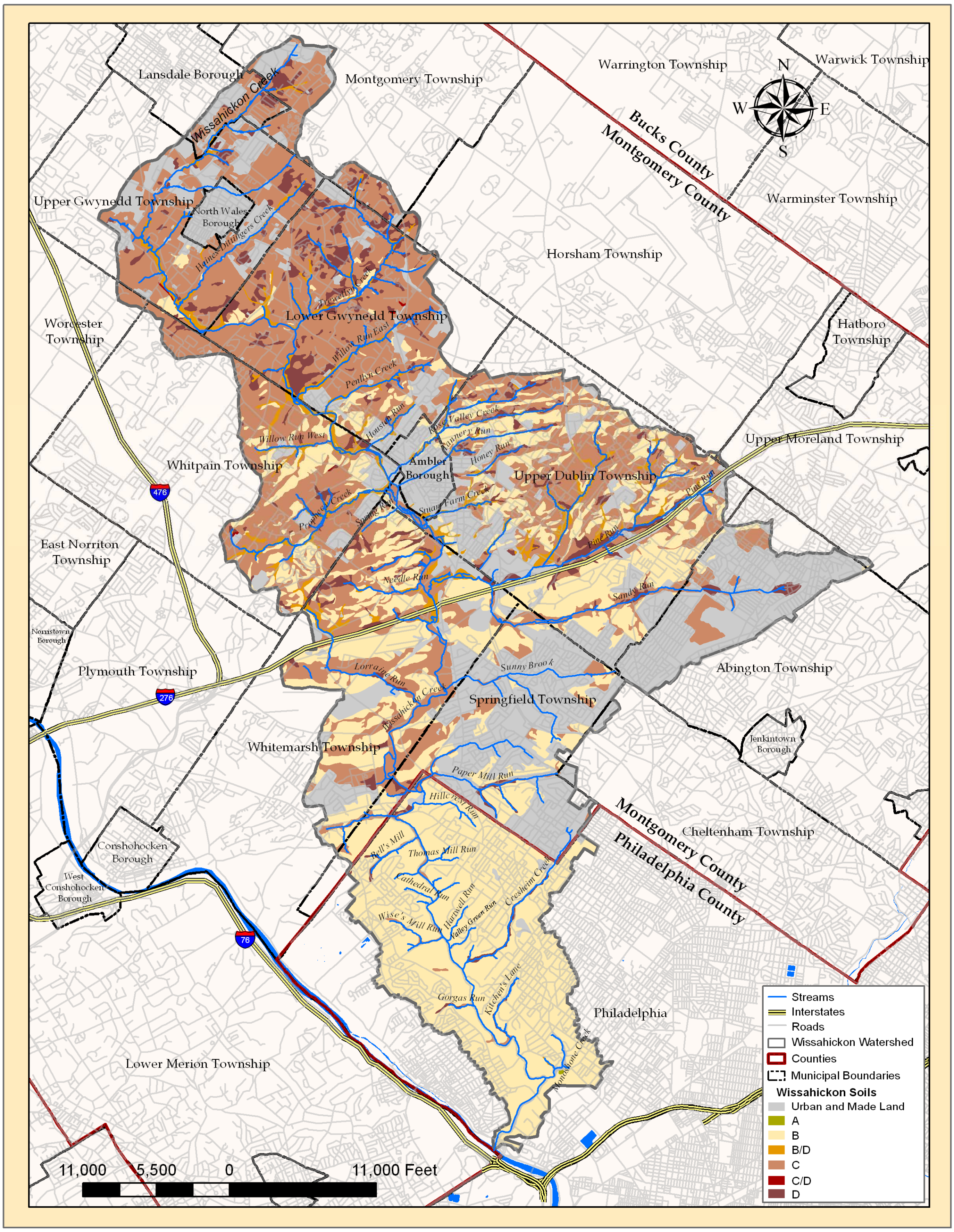


Figure 1-6: Wissahickon Creek Watershed (NRCS) Soil Types

2 METHODS

2.1 METHODS OVERVIEW

The individual stream networks assessed in this study were divided into one or several representative reaches, depending on the size and complexity of the stream network. One representative stream channel cross section, including local slope, was measured per reach. Measured field data was compiled to determine stream channel types for each reach and to help evaluate channel stability. Qualitative habitat data was compiled and used to determine habitat types adjacent to the stream channel. In addition, a full infrastructure assessment was conducted to survey all manholes, pipes, outfalls, culverts, channels, and bridges that were within the stream corridor. Both quantatative and qualitative datasets were evaluated for correlations between the natural and urbanized watersheds.

All of this data aided in the calculation of a reach-scale ranking metric which allowed for comparison between reaches and watersheds. Besides being used to make comparisons between reaches, the ranking scheme could also be used to prioritize restoration efforts and provide recommendations for each watershed.

2.2 CROSS SECTION LOCATION

Cross section locations were chosen according to multiple channel stability and geometry parameters that were representative of the entire reach. The appropriate location of a cross section in a channel exhibiting riffle/pool sequences is at the cross over reach (Rosgen, 1996). A cross over reach is a straight riffle section of channel between two meander bends. This riffle is used since it is a hydraulic control. Cross sections were placed in this location when the following criteria were satisfied:

+ Presence of bankfull indicators, or active floodplain
+ Representative of reach
+ No debris or obstructions such as rock, logs, outfalls, or in-stream structures

Debris or obstructions such as rocks, logs, outfalls, or in-stream structures were avoided because they would influence bankfull indicators and yield a false bankfull width. In some cases, reaches were so strongly influenced, degraded and/or altered such that there were no crossover reaches or riffle sections. Criteria used to determine the cross section location in these situations consisted of:

+ Representative of reach
+ Presence of best bankfull indicators
+ Least amount of debris, obstructions, and alterations
+ Safe wading water levels

Cross section locations were demarcated on the downstream right and downstream left banks with 2’ long, 1/2”-5/8” diameter rebar that was installed flush with the ground, when possible. At some sites where substrate consisted of large rocks, or tree roots or at sites where concrete debris was encountered, rebar could not be installed flush with the ground. After ensuring that the rebar could not be pulled out of the ground, the length of exposed rebar was noted on the data sheet. One inch yellow survey caps imprinted with the letters “PWD” were placed on each rebar as well as orange and black flagging. Flagging was also placed on the tree branch closest to the rebar to ensure that the rebar could be easily located upon subsequent field visits. The location (Northing, Easting, Elevation) of each rebar was then survey using a Total Station (Topcon GT235) in Pennsylvania South State Plane Coordinates and City of Philadelphia Datum.

2.3 REACH SELECTION

The reaches within each watershed were defined after all of the cross sections had been completed. The distance between two cross sections was then split in half and the distance upstream and downstream of a single cross section was combined to form one single reach (Figure 2-1). There was minimal geomorphic significance for the reach delineation. Reach lengths averaged 2500 feet with average cross section spacing of 1400 feet. Collecting channel cross section data at this increment ensured that all possible Rosgen channel types would be measured and that hydraulic and hydrologic models would be more reliable. The longest reach assessed was 7,695 feet (WSMS136) and the shortest was 361 feet (WSMSH04).

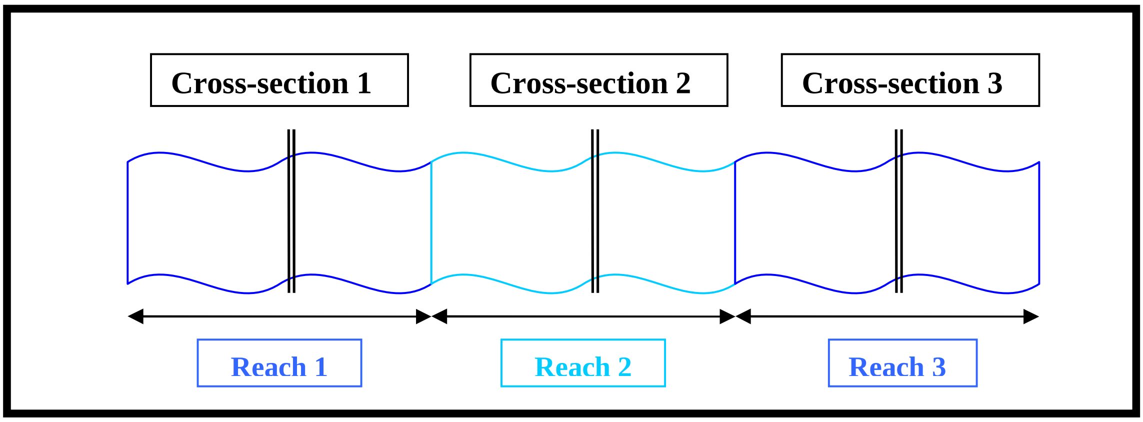


Figure 2-1: Diagram of Reach Delineation Procedure

2.4 STREAM SURVEY

The stream assessment consisted of PWD field crews performing a field reconnaissance of the Wissahickon Creek Watershed under protocols established by the Unified Stream Assessment Method (USAM) (Center for Watershed Protection, 2004). The Unified Stream Assessment is a tool used to quickly and systematically evaluate the physical conditions within stream corridors in urbanized streams and watersheds. These conditions include habitat quality, riparian condition, floodplain function as well as the potential for man-made structures and other anthropogenic factors to adversely impact stream corridor quality. Reach assessments were performed to get an overall picture of stream corridor conditions over defined reaches and to compare reach quality across the watershed. The Overall Stream Condition (Figure 2-2) form was used to characterize the average conditions present within a reach, such as bank stability and vegetative protection, instream and riparian habitat availability, and flood plain connectivity. Using this form, sites were given a standardized metric score (0-160) which allowed for comparison of total scores and individual component scores between assessed reaches.

Approximately 115 miles of stream channel were assessed on the main stem of Wissahickon Creek, and the majority of its contributing tributaries. The field reconnaissance included walking the entire length of stream, choosing and marking cross section locations, while also making general observations of the surrounding watershed. All initial field observations and cross section locations were noted on datasheets and large scale field maps respectively. Field data was later transferred to Mecklenburg sheets in order to calculate stream channel morphology and hydraulic parameters. The field reconnaissance was completed throughout the year of 2005.

2.5 MEASURED STREAM SURVEY AND CROSS SECTION PARAMETERS

Based on results of the stream assessment/field reconnaissance and following additional planning and base map preparation, the measured reach portion of the stream survey was completed. Measured reach stream surveys consisted of collecting data for channel morphology, disturbance, stability, and habitat parameters. Data for this analysis was based on results of stream surveys and field reconnaissance which were used to prepared watershed-scale base maps. Specific channel and habitat parameters included:

Channel Habitat
+ Riparian Width
+ Riparian Composition
+ Canopy Cover
+ Bed Materials
+ Sediment Supply
+ Sinuosity
+ Woody Debris
+ Substrate Attachment Sites

Channel Morphology
+ Stream Bed Materials
+ Sinuosity
+ Water Surface Slope
+ Bankfull Width
+ Floodprone Area Width
+ Entrenchment Ratio
+ Bankfull Cross-sectional Area
+ Rosgen Stream Classification Type

Channel Disturbance
+ Anthropogenic Channels
+ Culverts
+ Utilities (Manholes and Sewers)
+ Fish Blockages
+ Road, Railroad, Mass Transit Crossings

The measured reach stream survey also consisted of surveying channel cross sections at each location previously chosen during the field reconnaissance. Appendix A contains a summary of the results of the surveyed cross sections and local longitudinal profiles. Digital photographs were taken at every cross section location as a means of verification for field identified parameters. The photos consisted of an upstream view, a downstream view, and a view from left bank to right bank and/or right bank to left bank (Appendix A). Cross section locations are shown in Figure 2-3.

OVERALL STREAM CONDITION				
	Optimal	**Suboptimal**	**Marginal**	**Poor**
IN-STREAM HABITAT *(May modify criteria based on appropriate habitat regime)*	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
VEGETATIVE PROTECTION *(score each bank, determine sides by facing downstream)*	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0
BANK EROSION **(**facing downstream)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.	Past downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0
FLOODPLAIN CONNECTION	High flows (greater than bankfull) able to enter floodplain. Stream not deeply entrenched.	High flows (greater than bankfull) able to enter floodplain. Stream not deeply entrenched.	High flows (greater than bankfull) **not** able to enter floodplain. Stream deeply entrenched.	High flows (greater than bankfull) **not** able to enter floodplain. Stream deeply entrenched.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
OVERALL BUFFER AND FLOODPLAIN CONDITION				
	Optimal	**Suboptimal**	**Marginal**	**Poor**
VEGETATED BUFFER WIDTH	Width of buffer zone >50 feet; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, crops) have not impacted zone.	Width of buffer zone 25-50 feet; human activities have impacted zone only minimally.	Width of buffer zone 10-25 feet; human activities have impacted zone a great deal.	Width of buffer zone <10 feet: little or no riparian vegetation due to human activities.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0
FLOODPLAIN VEGETATION	Predominant floodplain vegetation type is mature forest	Predominant floodplain vegetation type is young forest	Predominant floodplain vegetation type is shrub or old field	Predominant floodplain vegetation type is turf or crop land
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
FLOODPLAIN HABITAT	Even mix of wetland and non-wetland habitats, evidence of standing/ponded water	Even mix of wetland and non-wetland habitats, no evidence of standing/ponded water	Either all wetland or all non-wetland habitat, evidence of standing/ponded water	Either all wetland or all non-wetland habitat, no evidence of standing/ponded water
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
FLOODPLAIN ENCROACH-MENT	No evidence of floodplain encroachment in the form of fill material, land development, or manmade structures	Minor floodplain encroachment in the form of fill material, land development, or manmade structures, but not effecting floodplain function	Moderate floodplain encroachment in the form of filling, land development, or manmade structures, some effect on floodplain function	Significant floodplain encroachment (i.e. fill material, land development, or man-made structures). Significant effect on floodplain function
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Sub Total In-stream: _____ **/80** + Buffer/Floodplain: _____ **/80** = **Total** Survey Reach ______ **/160**

Figure 2-2: Overall Stream Condition Field Sheet

Source: Center for Watershed Protection, 2004

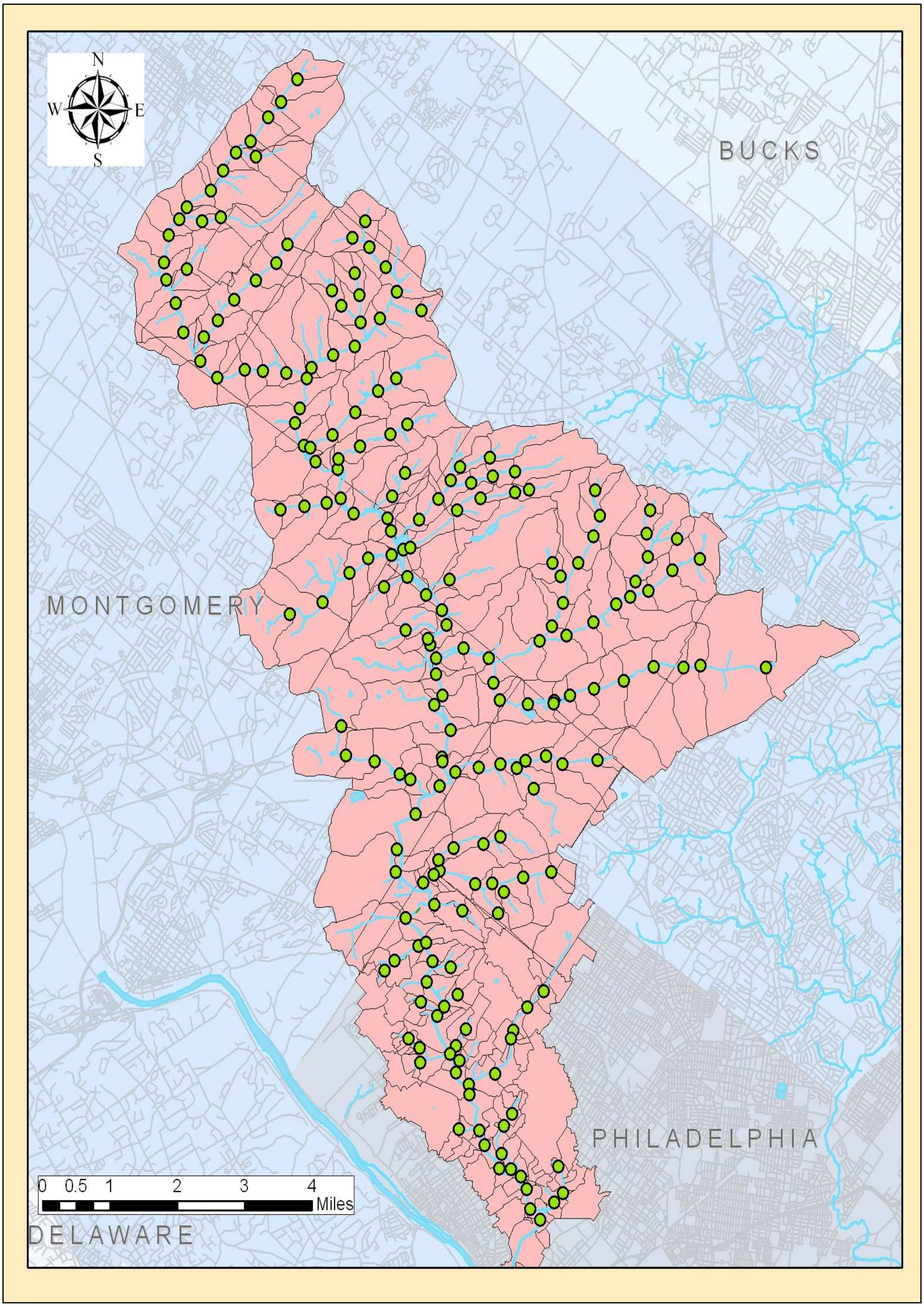


Figure 2-3: Wissahickon Creek Watershed Cross Section Locations

Figure 2-4: Lower Wissahickon Reach Breaks (Small Tributary reach breaks at confluences)

2.6 CROSS SECTION SURVEY PROTOCOL

Each stream cross section was measured by extending a 100 foot measuring tape across the channel. Where possible, a measuring tape was extended a minimum of twice the bankfull width for each cross section and a maximum of the entire valley width according to the estimated flood prone width. A transit level was used to record survey rod readings from the downstream left bank across the channel to the end of the measuring tape on the downstream right bank. Rod readings were taken at all significant channel features, or changes in channel features, such as the thalweg, bed materials, vegetation, slope, and flow lines including field identified bankfull. From the survey data, field data, and topographic base map, the following items were calculated:

+ Bankfull Area
+ Width to Depth Ratio
+ Entrenchment ratio
+ Shear Stress
+ Velocity
+ Water Surface/Channel slope
+ Sinuosity
+ Median particle size (D_{50})
+ Bankfull Discharge

2.6.1 EXTENDED CROSS SECTION PROCEDURE

PWD-surveyed cross sections were positioned at the center of the stream corridor and cross sections were then extended by hand beyond the flood prone width to the valley wall, where the flood prone width was defined as the width flooded at a stage equal to twice the maximum channel depth. Extended cross sections allowed for the estimation of entrenchment ratio (Equation 1). Lines were drawn from the last surveyed point on each side of the cross section perpendicular to 2-foot topographic contour line coverage (City of Philadelphia, Mayor's Office of Information Services, 2004). The extended cross sections were then plotted in excel and corrected if any obvious elevation discontinuities existed between the two data sets (Figure 2-5). Upstream cross sections are assumed to be representative of the stream channel geometry until the next downstream surveyed cross section.

$$\text{Entrenchment Ratio} = \frac{\text{Flood Prone Width}}{\text{Bankfull Width}} \qquad \text{(Equation1)}$$

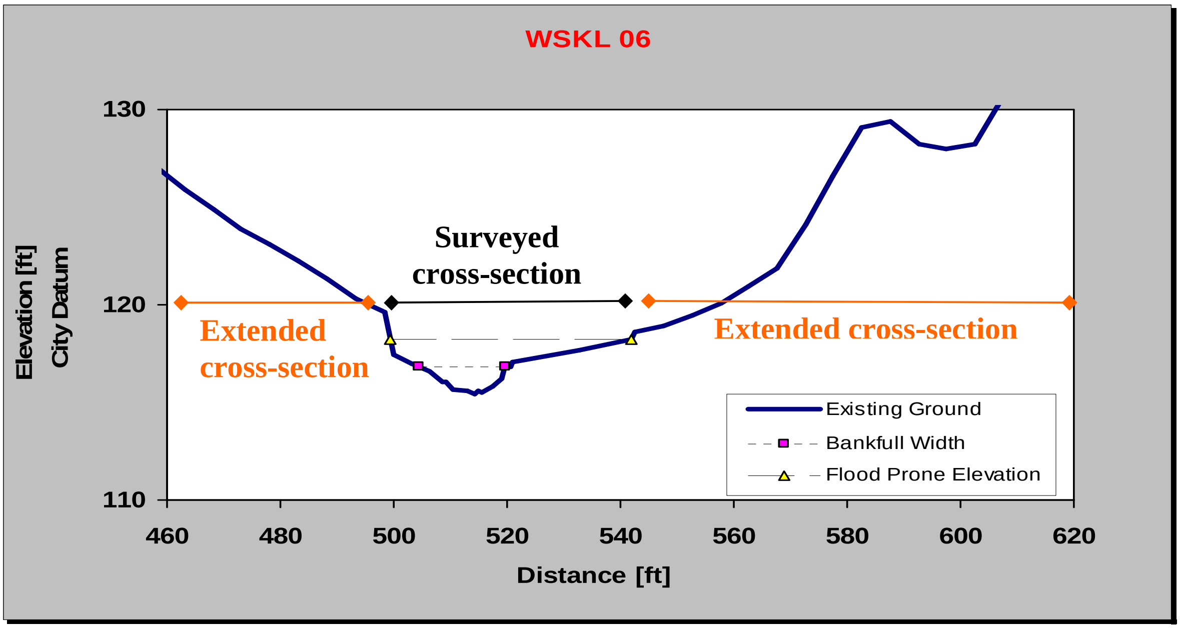


Figure 2-5: Sample Extended Cross Section surveyed on Kitchen's Lane Creek

2.7 LONGITUDINAL PROFILE SURVEY PROCEDURE

To estimate the local water surface slope at each cross section, the difference between the water surface elevation at the thalweg at the cross section immediately upstream and the water surface elevation at the thalweg at the cross section immediately downstream was divided by the stream distance measured between those two points as shown in Equation 2.

$Slope_{MS16}$ = (Water Surface Elevation at $Thalweg_{MS18}$ – Water Surface Elevation at $Thalweg_{MS14}$)/Creek $Distance_{MS14\to MS18}$ (Equation 2)

In instances where there was no cross section present either upstream or downstream from the reach of interest, Equation 3 was utilized.

$Slope_{B10}$ = (Water Surface Elevation at $Thalweg_{B10}$ – Water Surface Elevation at $Thalweg_{B8}$)/Creek $Distance_{B10\to B8}$ (Equation 3)

In instances where there was no cross section present both upstream and downstream from the reach of interest, an alternate procedure was implemented. A short channel profile was completed at these cross section locations, extending through the reach from the nearest upstream and downstream rifle. A 300 foot measuring tape was extended, upstream to downstream, in the channel thalweg. When there were no channel or line-of-sight obstructions, the profile was extended the full length of the measuring tape to 300 feet, or to the next riffle. Rod readings were taken at the top of riffles within the thalweg, except at degraded reaches where no riffles were present. These profile measurements were used as an estimate of bankfull slope and also for the calculation of a local slope for each cross section (Appendix A).

2.8 BANKFULL ELEVATION AND DISCHARGE CALIBRATION

In an ideal channel, bankfull elevation is at the top of the bank and is the point where the stream begins to overflow onto the floodplain. The bankfull discharge, defined by Manning's Equation (Equation 4), has the ability to transport sediment, alter a channel's morphology and eventually change the planform of the channel. The bankfull stage has been defined in many ways, but the commonly accepted definition provided here (Dunne and Leopold, 1978) was used for this study:

"The bankfull stage corresponds to the discharge at which channel maintenance is the most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphologic characteristics of channels."

$$Q = \frac{1.49}{n} * R_h^{2/3} * S^{1/2} * A \qquad \text{(Equation 4)}$$

where:
R_h = hydraulic radius (cross sectional area (A)/ wetted perimeter)
S= slope
n= Manning's Roughness coefficient

2.8.1 QUALITY OF BANKFULL INDICATORS

Bankfull indicators are often more difficult to identify, or not present at all, in impacted or disturbed urban streams such as the Wissahickon Creek Watershed, but are still essential to determining a bankfull elevation and discharge. Bankfull elevations at individual cross-sections were derived from all available indicators including depositional features such as the tops of point bars, scour and storm debris lines or changes in bank slope, vegetation or the grain size of bank material. During stream surveys, the quality of assessed bankfull indicators was determined based on the criterion set for five indicator quality classes: excellent, good, moderate, fair and poor. Analysis of the bankfull indicator quality was important because it provided a reference from which to determine the legitimacy of bankfull flow estimates as well as an explanation for some estimates that deviated substantially from anticipated flows.

- Excellent - characterized by a large, flat terrace with significant sandy deposition on the streambank's natural levee and no evidence of active adjustment of the channel.
- Good - characterized by isolated depositional features that were similar to features observed in upstream and downstream reaches. Such an observation would be indicative of minimal rates of active channel adjustment.
- Moderate - characterized by a change in bank slope adjacent to a terrace, but with little to no deposition. Within this category some signs of active channel adjustment were observed.

- Fair - characterized by consistent change in bank slope or vegetation with evidence of past incision. In these channels evidence reflecting some level of active adjustment was present.
- Poor - characterized by no observable bankfull indicators due to channel incision and/or vertical banks, which is indicative of active channel adjustment.

2.8.2 CALIBRATION OF BANKFULL DISCHARGE

Most regional curve studies to date have been conducted on streams in non-urban environments where bankfull indicators, such as the existence of terraces, fine sediment deposition, bank slope, and vegetation, are fairly easy to determine. The recurrence interval of a bankfull event is between every 1 to 2 years; however, these events occur more frequently in urbanized streams due to altered (i.e. impervious) land cover patterns. As such, these non-urban regional curves may not be directly applicable to urban systems. Several studies have been successful in creating regional curves that are fairly applicable to this region (e.g. Chaplin, 2005), although the predominance of impervious surfaces often precludes the use of regional curves in watersheds with grater than 20% imperviousness. As such, alternate methods must be used in urban, ungaged streams.

The bankfull discharge was calibrated using multiple methods: field cross section calculations, gauge station data, regional drainage area to peak discharge curves, and bankfull regression equations. Regression equations were fit to drainage area versus peak discharge curves and those equations with the highest coefficients of determination (i.e. R^2) were generally considered the most reliable bankfull calibration estimate. All preliminary bankfull discharge values for respective calibration methods were compared and evaluated based on factors such as the reliability of bankfull indicators and strength of coefficients of determination in order to determine the most appropriate discharge.

PWD personnel identified bankfull elevations in the field at varied locations as part of the Wissahickon Creek Watershed FGM study. As a result of channel disequilibrium, bankfull indicators were not easily identified. Depositional features were the primary indicator used in the final determination of bankfull elevation. Bankfull discharge was estimated by solving Manning's equation for discharge given the estimated bankfull elevation and measurements of the local channel geometry, slope, and roughness. Channel roughness, represented by Manning's "n," was approximated using the results of the Limerinos equation (Equation 5)

$$n = \frac{1.49 * R_h^{2/3} * (S/100)^{1/2}}{F * u_*} \qquad \text{(Equation 5)}$$

where:
F^1= Friction factor
u_*= shear velocity

[1]where:
$$F = 2.83 + 5.7*\log(d/D_{84}) \qquad \text{(Equation 6)}$$
d= mean depth
D_{84} = measured particle size where 84% of the particles are this size or smaller

2.9 PEBBLE COUNT PROCEDURE

Pebble counts were conducted at every other cross section within a reach using the Wolman Pebble Count procedure (Wolman, 1954). Intermediate axis lengths were then entered into Mecklenburg sheets to plot particle size frequency distributions used to extract D_{50} and D_{84} parameters for use in channel hydraulic calculations. For cross sections without pebble counts, the pebble count was interpolated based on pebble counts actually performed upstream, downstream, or both.

2.10 BANK PROFILE MEASUREMENTS

PWD employed the Bank Assessment for Non-point source Consequences of Sediment (BANCS) Model as defined by Rosgen (1996) to predict erosion rates and classify the erosion potential of the tributaries. The BANCS method utilizes two bank erosion estimation tools: the Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS). The BEHI is an assessment tool that allows the erosion potential of a stream bank to be quantified. The NBS method evaluates the amount of shear stress along the stream bank. BEHI and NBS methods were used to assess 368 stream segments in 12 tributaries to the Wissahickon Creek. The twelve tributaries were: Monoshone, Kitchen’s Lane, Gorgas Lane, Cresheim, Valley Green, Hartwell, Wise’s Mill, Cathedral Run, Rex Avenue, Thomas Mill, Bell’s Mill, and Hillcrest Creeks.

To field verify predictions made by the BANCS model, bank pins (18” lengths of ½” or 5/8” iron rebar) were driven horizontally into the stream bank normal to the curve of the bank at the location where radius of curvature was minimized (most severe bend). At least one bank pin was installed below field-estimated bankfull elevation. Depending on bank height, one or two additional pins were installed, spaced no closer than 1 foot apart, such that the total number of bank pins at a site ranged from one to three (Figure 2-6). In order to enable measurement of lateral erosion, toe pins (12” lengths of 5/8” rebar) were also installed at each site. Toe pins were driven vertically into the stream bed at the toe of slope inline with the bank pins along a line normal to the curve in the bank. Toe pin locations were captured using GPS (Xplore technologies model iX140C2 tablet PC with GPS module) and yellow plastic survey caps were installed. To further assist field teams in re-locating bank pin sites, orange spray paint was applied to bank pins and survey flagging was hung from nearby vegetation.

A total of 81 bank pin sites were chosen to reflect varying BEHI and NBS scores in order to validate and calibrate an erosion rate prediction model. 21 bank pin sites were installed during the fall of 2005, and 60 bank pin sites were installed during the summer of 2006 (Figure 2-7).

Figure 2-6: Example of Toe Pin (left) and Bank Pin (right) Setup along stream bank

Measurements were made using a survey rod (CRAIN, SFR Series Leveling Rod), a flexible "pocket rod" (Keson, Inc.) and two small cylindrical spirit levels (Figure 2-8). The survey rod was placed on the edge of the toe pin and held vertical using a level. The pocket rod was placed over the bank pin up against the bank and leveled with the second level. The distance from the bank to the edge of the survey rod closest to the bank was recorded on the field data sheet. Lateral erosion or aggradation of the stream bank was determined by measuring changes in bank pin distance from a line extending vertically from the toe pin. In order to obtain a better measurement of bank profile, a series of vertical reference points were measured in addition to the bank pins for several of the bank pin sites. These vertical reference points were measured at predetermined vertical points on the survey rod.

The measurement frequency for the bank pins varied throughout the duration of the study. Originally, the bank pins were measured quarterly to capture any seasonal effects. The frequency of measurements was then reduced to twice a year.

The most recent round of bank measurements occurred during the week of August 10th, 2009. During this week, PWD revisited the 81 bank pin monitoring locations installed during 2005 and 2006 in the Monoshone, Kitchen's Lane, Gorgas Lane, Cresheim, Valley Green, Hartwell, Wise's Mill, Cathedral Run, Rex Ave, Thomas Mill, Bell's Mill, and Hillcrest tributaries. A total of 30 monitoring locations were unable to be re-measured during the August 2009 monitoring event.

The average monitoring period for a bank pin location was 31 months. The minimum monitoring period was 12 months and the maximum monitoring period was 45 months. For the 30 monitoring locations where re-measurement was not possible, the lateral erosion rate for the longest observation period at that location was used for further calculation.

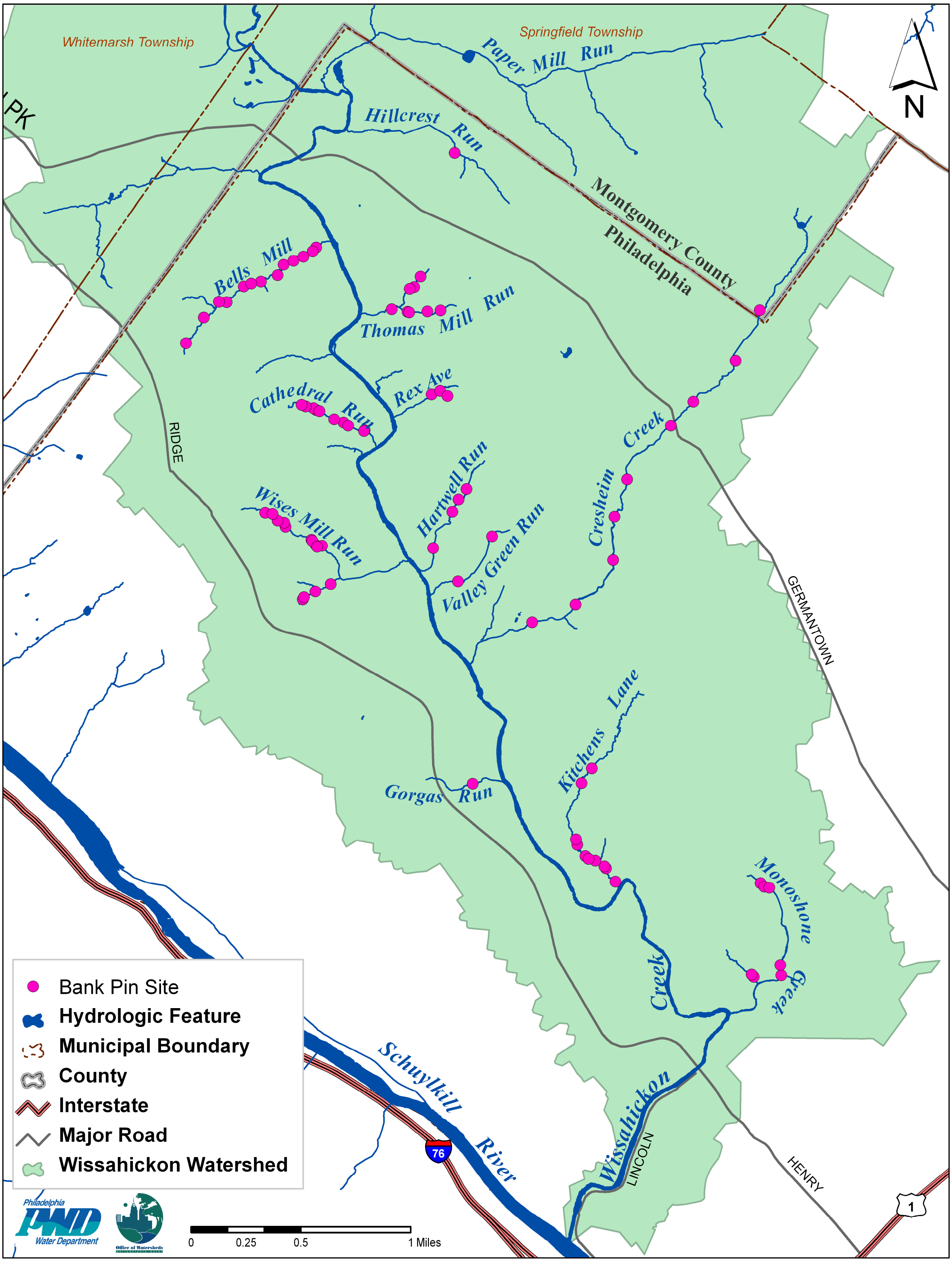


Figure 2-7: Wissahickon Creek Watershed Bank Pin Locations

Figure 2-8: Example of bank pin installation (left) and bank pin measurement (right) by PWD staff

2.11 INFRASTRUCTURE TRACKDOWN

The infrastructure trackdown was conducted by walking the entire length of the stream and taking note of the infrastructure encountered along the way. Data was collected on outfalls, bridges, manholes, culverts, pipes, dams, and channels. The amount and type of information collected for each point of infrastructure varied depending on type. Basic information included the date in which the data was collected, the names of crew members, and the weather conditions.

For each infrastructure point identified and mapped, photos were taken and documented, along with important notes which included the GPS point number, approximate dimensions, location, and any other miscellaneous characteristics. Photographs of each infrastructure point can be found in Appendix B. Maps with the location of Lower Wissahickon Creek Watershed infrastructure locations can be found in Appendix C. The naming convention used to describe infrastructure elements used the following format: WS to denote "Wissahickon"; a three letter descriptor indicting the type of infrastructure element being described (i.e. "out" for outfall, "bri" for bridge' or "cha" for a channelized segment); and a unique numerical identifier. For example, outfall 507 (Thomas Mill Run) would be called "WSout507."

2.11.1 OUTFALLS

An outfall was defined as the end of a pipe which releases either stormwater, combined sewage, or an encapsulated creek into the waterway (Figure 2-9). Data was collected on outfalls larger than 12 inches. The data collected for each outfall included the pipe diameter, height and width of the outfall including the presence of an apron, the construction material (i.e. metal, concrete, terra cotta, etc.), structural condition (i.e. good, fair, or poor), presence of, and quality of dry weather flow, bank location (right or left), and submergence depth.

Figure 2-9: Example of an outfall point assessed in infrastructure trackdown

2.11.2 BRIDGES

A bridge was defined as a structure that spanned a stream over which a road or walkway passes (Figure 2-10). Bridges mapped in this report are shown as one point at the center of the bridge along the creek. The data collected for each bridge included the approximate height, width and depth of the bridge opening, the construction material (i.e. metal, concrete, wood, stone, etc.), and structural condition (i.e. good, fair, or poor).

Figure 2-10: Examples of bridges assessed in infrastructure trackdown

2.11.3 MANHOLES

A manhole was defined as the covered opening that allows access to an existing utility (Figure 2-11). Data was collected for manholes either located within the creek or in close proximity to the stream banks. The data collected for each manhole included the approximate diameter of the manhole, the construction material (i.e. concrete or terra cotta), the height of the portion of manhole exposed above the ground or water surface, structural condition (good, fair, or poor), bank location (left or right) and the presence and description of any odor.

Figure 2-11: Examples of manholes assessed in infrastructure trackdown.

2.11.4 CULVERTS

A culvert was defined as a conduit which carried the stream under a roadway, sidewalk, building, or miscellaneous structure (Figure 2-12). Culverts were mapped by taking GPS coordinates at the start and end of the culvert with photos taken at each point. The data collected for each culvert included the approximate dimensions, construction material (e.g. stone, concrete, brick, etc.), structural condition (i.e. good, fair, or poor), presence and quality of dry weather flow, and bank location (left or right).

Figure 2-12: Examples of culverts assessed in infrastructure trackdown.

2.11.5 DAMS

A dam was defined as an obstruction that impounded stream flow (Figure 2-13). Data was only collected for manmade dams and did not include natural debris jams caused by coarse woody debris (CWD). The data collected for each dam included the approximate dimensions, construction material, structural condition (good, fair, or poor) and bank location (left, right, or across the creek).

Figure 2-13: Examples of dams assessed in infrastructure trackdown.

2.11.6 CHANNELS

A channel was defined as a straightening and reinforcement of stream bed and/or banks with manmade materials such as concrete (Figure 2-14). Channels were located on one or both banks, as well as on the bottom of the stream bed. Each channel was mapped by taking GPS coordinates at the start and end of the channel with photos taken at each point. The data collected for each channel included approximate dimensions, structural condition (good, fair, or poor), the portion of stream that was channelized (i.e. left bank, right bank or bottom), and construction material (stone or concrete).

Figure 2-14: Examples of channels assessed in infrastructure trackdown.

2.11.7 CONFLUENCES

A confluence was defined as the junction where two streams meet (Figure 2-15). The data collected for each confluence included the GPS coordinates of the larger stem bank location looking downstream (left or right) and width of the stream entering the larger stem.

Figure 2-15: Examples of confluences assessed in infrastructure trackdown.

2.11.8 PIPES

A pipe was defined as a conduit for carrying a utility across the stream (Figure 2-16). The data collected for each pipe included the approximate diameter, construction material (i.e. concrete, metal, terra cotta, etc.), the length and height above the water or ground surface of the exposed portion, structural condition (i.e. good, fair, or poor), presence and quality of dry weather flow, bank location (i.e. left, right or across the creek), and submergence depth.

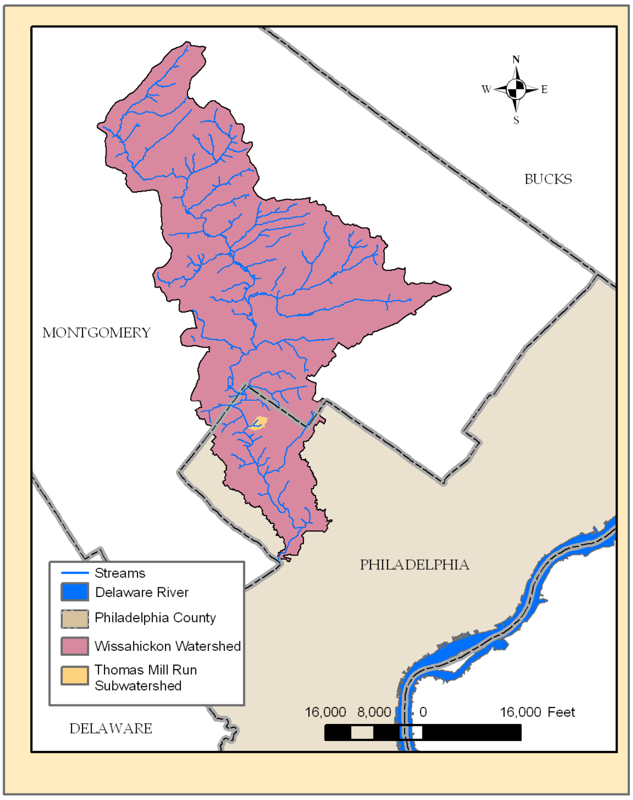
Figure 2-16: Example of a pipe assessed in infrastructure trackdown.

3 WATERSHED ASSESSMENTS

3.1 SMALL TRIBUTARY WATERSHED AND REACH CHARACTERISTICS

The Small Tributaries to the Wissahickon Creek were defined as those having only one cross section and representative reach. In the subsequent sections, "Small Tributary Average" refers to the average USAM score of the respective metric.

3.1.1 THOMAS MILL RUN WATERSHED AND REACH CHARACTERISTICS



Thomas Mill Run is a tributary to the main stem of the Wissahickon Creek. Thomas Mill Run originates from a privately-owned stormwater outfall. Thomas Mill Run is a first-order tributary for approximately 0.3 miles until a smaller 0.25 mile tributary enters Thomas Mill Run approximately 0.2 miles from the confluence with the Wissahickon main stem. The dominant substrate varies from course gravel to medium cobble material. Both the valley floor and channel have been substantially impacted by past and current land use.

The entire Thomas Mill Run watershed is 104 acres. Major land use types within the watershed include: wooded (59%) and residential – single family detached (32%). Thomas Mill Run is surrounded by Fairmount Park on both sides for the entire length. The Park buffer ranges from about 20 feet to about 2,000 feet.

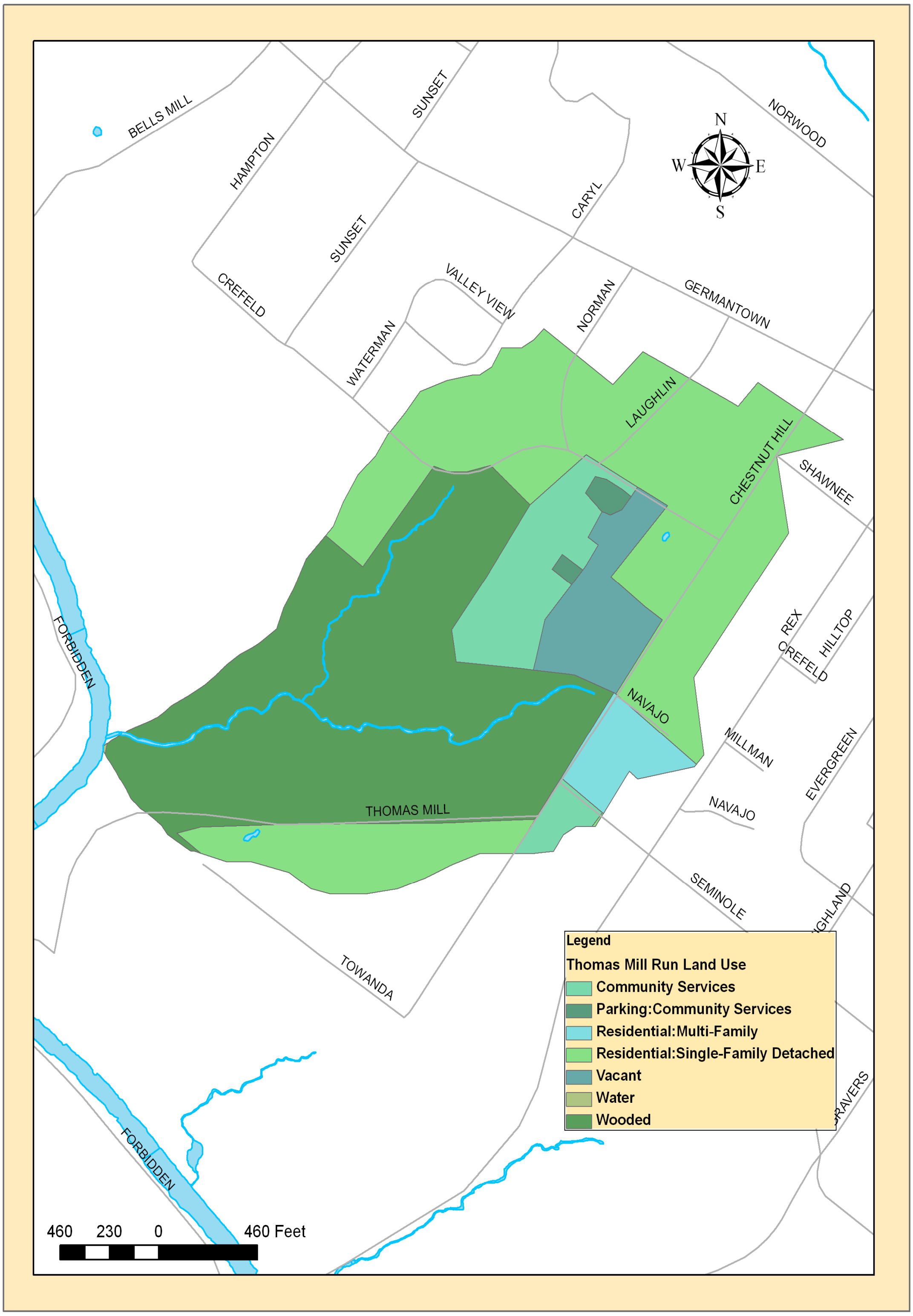


Figure 3-1: Thomas Mill Run Watershed Land Use

3.1.1.1 GEOLOGY

The majority of the Thomas Mill Run watershed is underlain by the Wissahickon Formation. The Wissahickon Formation consists of mica schist, gneiss and quartzite. The exposed schist near the surface is highly weathered. The Wissahickon Formation is also comprised of metamorphosed sedimentary rocks.

There is one small section within the Thomas Mill Run watershed that is underlain by the Bryn Mawr Formation. The Bryn Mawr Formation consists of white, yellow and brown gravel and sand. The Bryn Mawr Formation is considered a deeply weathered formation.

3.1.1.2 SOILS

According to the National Resource and Conservation Service Soil Survey, the soils for the entire Thomas Mill Run watershed are classified as hydrologic group B. These soils have a moderate rate of infiltration when the soils are wet (0.50-1.00 in/hr). Water movement through these soils is considered moderately rapid.

Table 3-1: Distribution of NRCS Soil Types in Thomas Mill Run Watershed

Group	Area (ft^2)	Percent of Total Area
B	4,530,240	100%
Total Area	**4,530,240**	**100%**

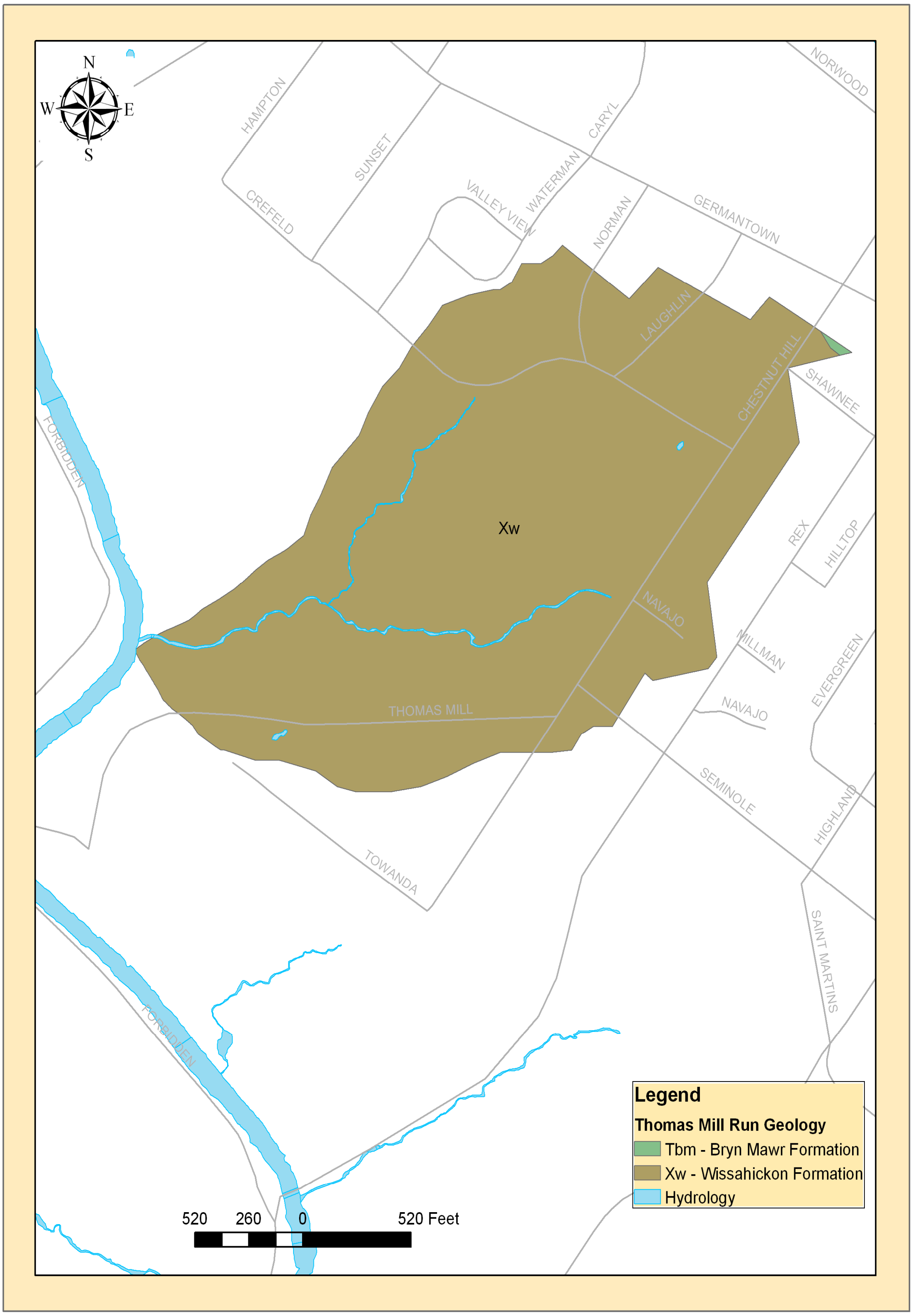


Figure 3-2: Geology of Thomas Mill Run Watershed

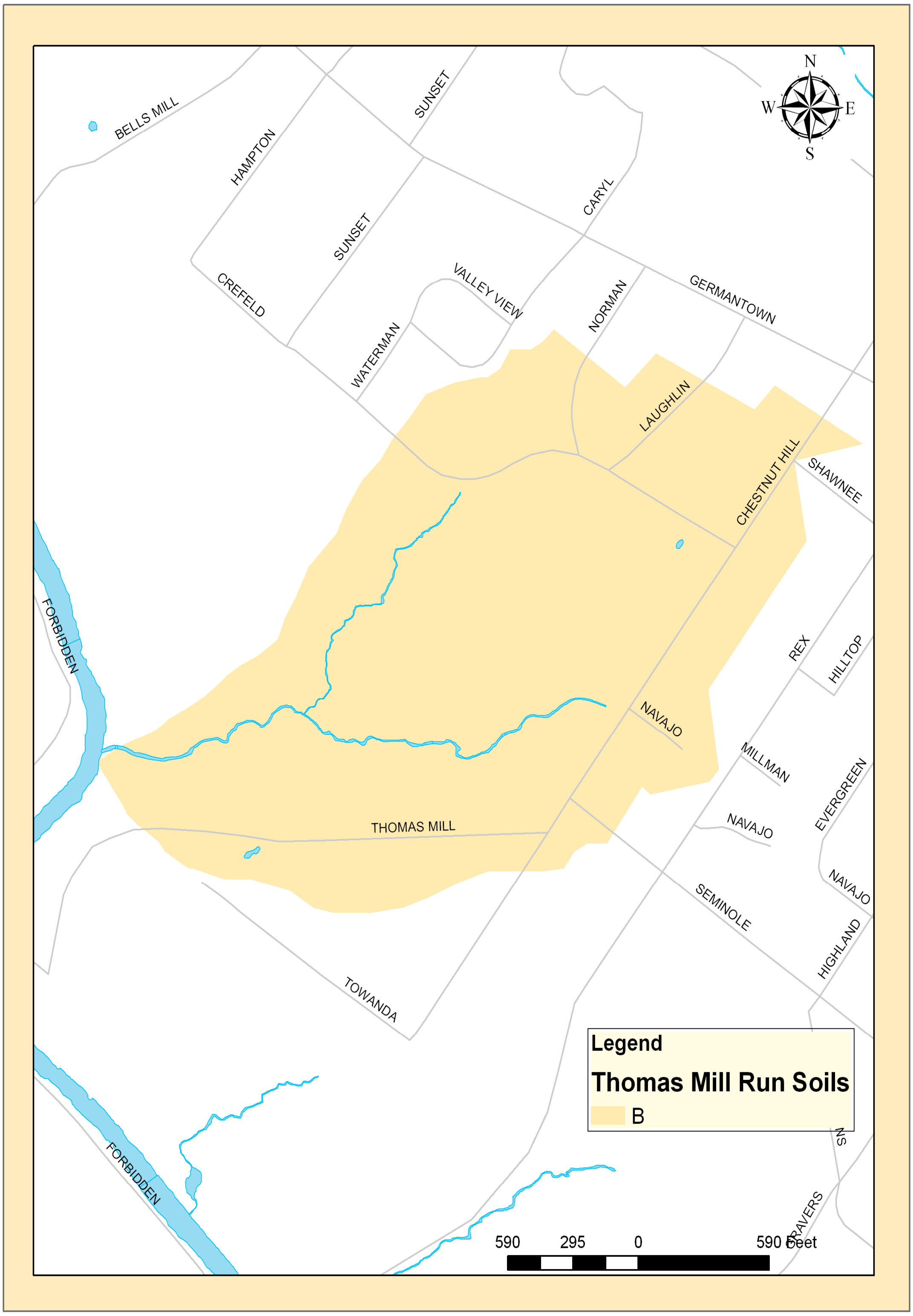


Figure 3-3: Distribution of NRCS Soil Types in Thomas Mill Watershed

3.1.1.3 BANK EROSION

There were nine bank pin locations along Thomas Mill Run (Figure 3-4). The calculated erosion rates are included in Table 3-2. The spatial distribution of BEHI assessment results were represented graphically (Figure 3-4) for each of the segments assessed on Thomas Mill Run. Each bank within a respective segment was assessed and rated separately; however, channelized and culverted segments were not assessed as they confer a high degree of protection from bank erosion.

Table 3-2: Thomas Mill Run Bank Pin Locations

	BEHI	NBS	Baseline Reading	Most Recent Reading	Erosion Rate (ft)	Erosion Rate (ft/yr)	Eroding (-) or Aggrading (+)
Thomas Mill							
TM18	Moderate	Low	8/16/2007	8/15/2008	-0.14	-0.14	E
TM21	Very High	Low	6/29/2006	8/9/2007	-0.26	-0.23	E
TM23	Moderate	Low	8/9/2007	8/10/2009	0.040	0.020	A
TM28	Moderate	Low	4/11/2007	8/15/2008	-0.28	-0.21	E
TM512	Low	Very Low	6/29/2006	8/10/2009	0.12	0.038	A
TM518	Low	Low	8/21/2006	8/10/2009	0.26	0.087	A
TM9	Moderate	Low	6/29/2006	8/10/2009	-0.025	-0.008	E
TM8	Moderate	Low	11/15/2006	8/10/2009	-0.20	-0.074	E

Total erosion rates were also calculated for the entire length of each tributary within the lower Wissahickon (Table 3-3). To assess the normalized erosion potential of each tributary, the erosion rate per acre of drainage area per year and the erosion rate per foot of stream length per year were calculated. This allowed direct comparison between each of the tributaries with respect to both watershed size and the length of the tributary. Thomas Mill Run was ranked second out of the twelve tributaries within the lower Wissahickon for erosion rate per foot of stream length. The rankings were based on a scale of one being the highest erosion rate and twelve being the lowest erosion rate.

Table 3-3: Erosion Rates for Lower Wissahickon Tributaries

Tributary	Drainage Area (Acres)	Stream Length (feet)	*2009*		
			Erosion Rate (lb/yr)	*Erosion Rate Per Acre*	*Erosion Rate Per Foot of Stream*
Bell's Mill	323	6,722	420,000	1,307	63
Cathedral Run	160	2,790	150,000	913	52
Cresheim Creek	1,218	16,431	840,000	690	51
Gorgas Run	499	2,170	170,000	345	79
Hartwell Run	217	3,530	200,000	918	56
Hillcrest	144	5,272	90,000	597	16
Kitchen's Lane	234	7,753	200,000	850	26
Monoshone Creek	1,056	6,926	160,000	156	24
Rex Ave	137	1,903	150,000	1,131	81
Thomas Mill Run	104	4,008	320,000	3,058	79
Valley Green Run	128	2,874	140,000	1,086	48
Wise's Mill Run	446	7,056	490,000	1,090	69
Total/*Average*	**4,666**	**67,435**	**3,300,000**	***1,012***	***54***

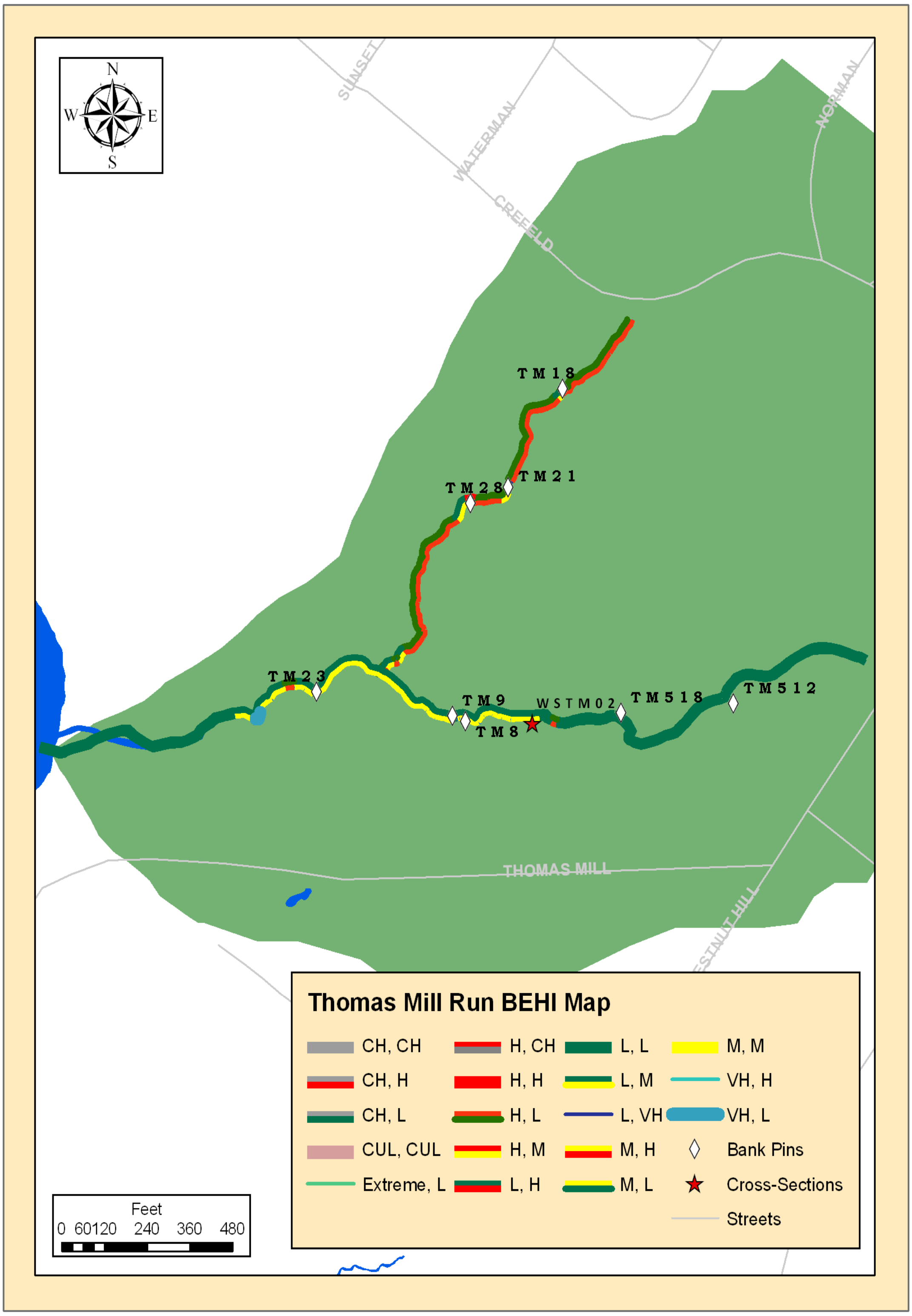


Figure 3-4: Thomas Mill Run Watershed BEHI Ratings and Bank Pin Locations

3.1.1.4 INFRASTRUCTURE TRACKDOWN SUMMARY

Thomas Mill Run is a small tributary to the Wissahickon Creek that flows almost entirely within Fairmount Park. This stream has only a few infrastructure elements which is a direct result of the tributary's location within the Park. Despite the benefit of its location, Thomas Mill Run exhibits some of the impairments associated with urban streams given its proximity to development in the form of residential neighborhoods that surround the stream channel. The most predominant infrastructure elements in the watershed were stormwater outfalls. The number of headwater outfalls (Table 3-4) on this stream indicates that it is heavily influenced by stormwater discharges in the upstream-most segments of WSTM02 (Figure 3-5).

WSout505 had an area of five square feet and conveyed no dry weather flow. This outfall was the headwaters for a tributary (unnamed tributary A) to the main stem of Thomas Mill Run. The tributary channel was observed to be intermittently dry, as there was only flow in the channel during wet weather events. These unfavorable flow conditions can cause channel instability and degrade instream habitat from frequent erosion and sedimentation. The channel did however convey the stormwater flows away from Crefeld Avenue effectively.

Similarly, the main stem of Thomas Mill Run is impacted by stormwater runoff discharged from outfalls (WSout506, WSout507 and WSout508). There was a small amount of steady dry weather flow observed at the headwaters of the main stem. The headwaters emanated from WSout508, a four foot diameter outfall, which conveyed drainage from Chestnut Hill Avenue. The size of this outfall indicates that during wet weather events the discharge from this outfall has the potential to be substantially larger. The other two outfalls, WSout507 and WSout506, had no dry weather flow but were in degraded condition. WSout506 was partially blocked by a build-up of sediment and debris. The three bridges on Thomas Mill Run (WSbri221, WSbri222 and WSbri223) were small although they constricted flow within the channel. The bridges were built along the stream to connect the Fairmount Park trails parallel to the channel. WSout507 was the only piece of infrastructure identified as being in poor condition. The bank that once supported the pipe eroded which exposed the pipe leading to the outfall; subsequently, the pipe collapsed due to the lack of proper support.

Table 3-4: Summary of Thomas Mill Run Infrastructure Points

Section ID	Bridge Count	Outfall Count	Confluence Count	Infra Point Count	Combined Outfall Area (ft^2)
WSTM02	3	4	1	7	22.33

Table 3-5: Summary Thomas Mill Run Infrastructure Linear Features

Section ID	Segment Length (ft)	Culvert Length (ft)	Percent Culverted	Channel Length (ft)	Percent Channelized
WSTM02	3648	0	0	0	0

Figure 3-5: Thomas Mill Run Infrastructure Locations

Figure 3-6: Thomas Mill Run Infrastructure in Poor Condition

3.1.1.5 UNIFIED STREAM ASSESSMENT RESULTS FOR THE THOMAS MILL RUN WATERSHED

In total, there were approximately 3,648 feet of stream channel within the Thomas Mill Run watershed. There was one associated tributary, unnamed tributary A, which began as flow from WSout505 which drains the neighborhood delimited by Germantown Avenue to the north and Crefeld Avenue to the south. The Center for Watershed Protection's (CWP) Unified Stream Assessment Methodology (USAM) was used to score and rate the instream, riparian buffer and floodplain conditions of the stream corridor to allow for comparison to other reaches and watersheds within the Lower Wissahickon Basin.

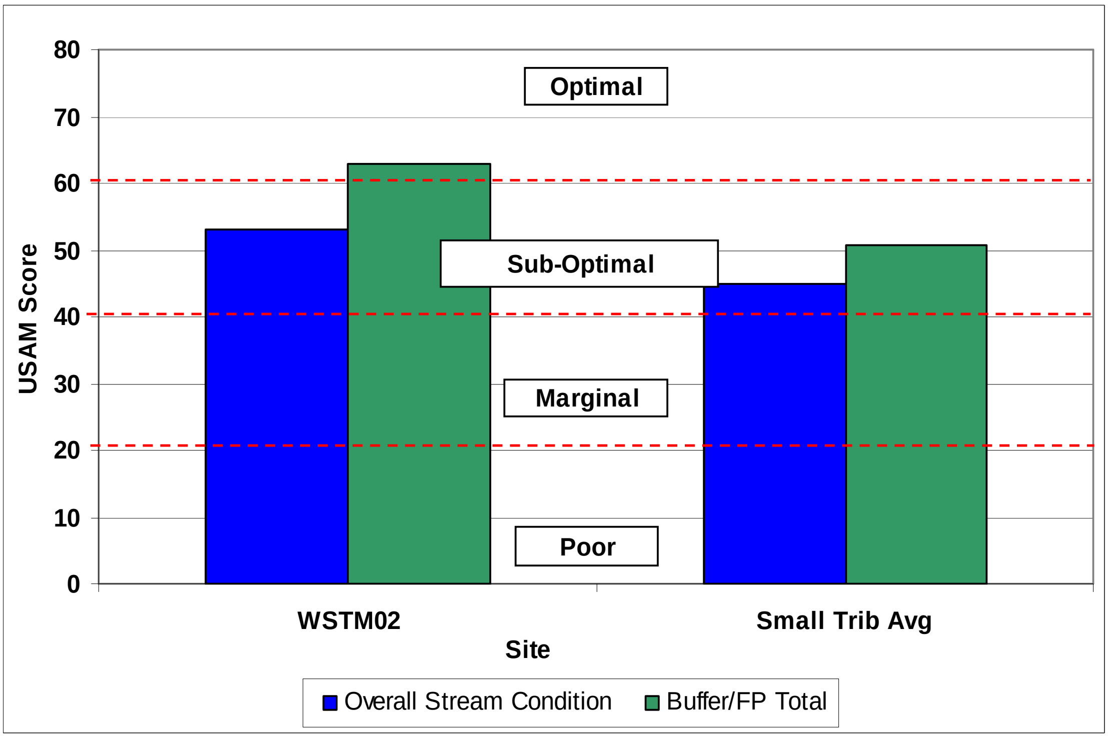


Figure 3-7: Results for Thomas Mill Run USAM Components

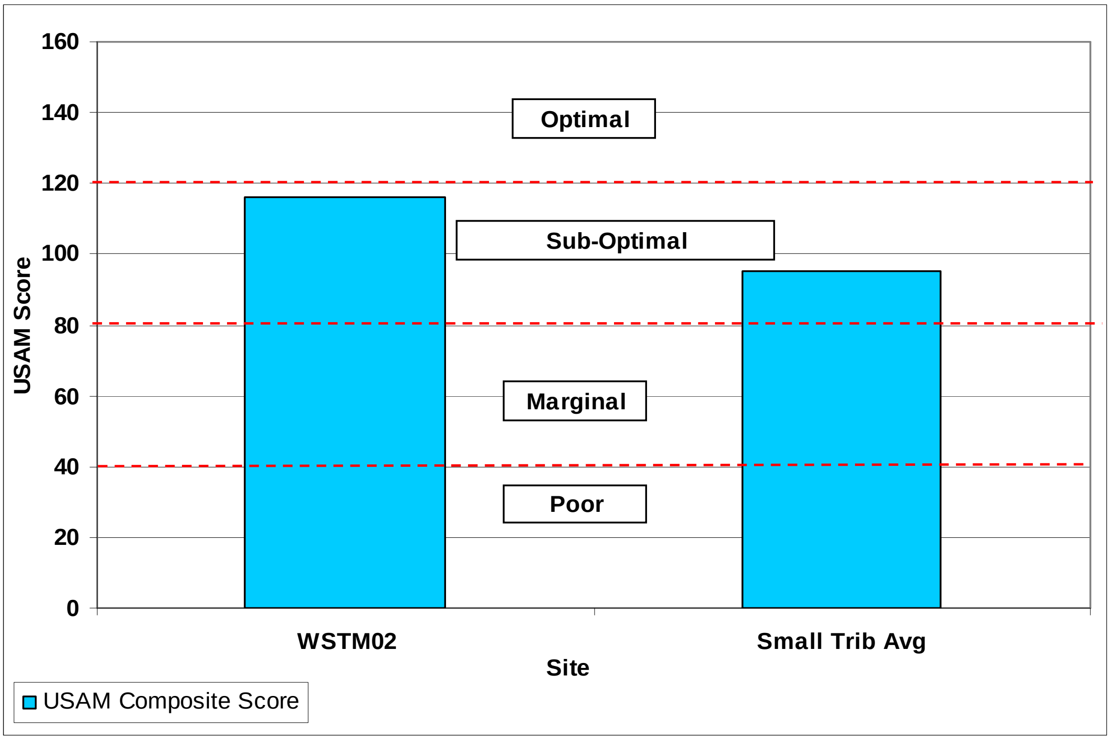


Figure 3-8: Thomas Mill Run USAM Results

3.1.1.5.1 WSTM02

Reach WSTM02 was characterized by a second order main stem channel (approximately 2,653 feet) with headwaters beginning at WSout508, which is due west of Chestnut Hill Road. The stream channel substrate distribution was dominated by gravel (2-64 mm) which comprised 53% of the substrate however there were boulder and cobble deposits as well as isolated areas in the watershed that were bedrock controlled. With a low width to depth ratio and relatively steep slope, the reach was classified as an A4 channel.

Most of reach WSTM02 is located entirely within Fairmount Park. About 485 feet of the main stem channel, upstream of outfall WSout506 and up to the headwaters, was outside of Fairmount Park. The watershed was completely forested; however, the surrounding land use was residential. As such, Thomas Mill Run receives large volumes of runoff from its very small drainage area (0.07 mi^2), which is notable given the relatively small bankfull channel in WSTM02 (10.4 ft^2). The WSTM02 reach received a USAM composite score of 116/160 (Figure 3-8).

3.1.1.6 Summary of Unified Stream Assessment Results

The mean scores for both the *Overall Stream Condition* USAM component as well as the *Overall* USAM score were all classified as “suboptimal” (Table 3-6). Conditions within the Thomas Mill Run watershed’s buffers and floodplains were considerably better than conditions observed within the stream channels as the *Overall Buffer and Floodplain Condition* was rated as “optimal”. The watershed scores for the both USAM components as well as the composite USAM score compared well against the respective Small

Tributary averages, especially the *Overall Buffer and Floodplain* score, which was considerably higher then the Small Tributary average.

Table 3-6: USAM Results for Thomas Mill Run Watershed

Reach ID	Sub-watershed	Overall Stream Condition	Overall Buffer/FP Condition	USAM Score
WSTM02	Thomas Mill	53	63	116
Small Tributary Average	**----**	**44.8**	**50.6**	**95.4**

3.1.1.6.1 SUMMARY OF OVERALL STREAM CONDITION SCORES IN THE THOMAS MILL RUN WATERSHED

The *Overall Stream Condition* score in the Thomas Mill Run watershed (53/80) was rated as "suboptimal" and was considerably higher than the Small Tributary average (44.8/80). Thomas Mill Run was observed to be among the best small tributaries in the Lower Wissahickon, as only Valley Green Run had a higher *Overall Stream Condition* Score (66/80). The habitat features that contributed most to the "suboptimal" rating were the abundance of CWD, stable bed substrate and channel morphology conducive to floodplain inundation. High rates of bank erosion observed on the unnamed tributary to Thomas Mill Run contribute an excessive amount of sediment to the main channel and ultimately Wissahickon Creek; however, most of Thomas Mill Run was observed to have relatively stable banks.

Table 3-7: USAM Overall Stream Condition Scoring for Thomas Mill Run Watershed

OVERALL STREAM CONDITION								
Reach ID	Sub-watershed	Instream Habitat	Vegetative Protection		Bank Erosion		Floodplain Connection	Overall Stream Condition
			Left	Right	Left	Right		
WSTM02	Thomas Mill	16	6	5	6	5	15	53
Small Tributary Average	**----**	**15.8**	**4.4**	**4.2**	**5.6**	**5.8**	**9**	**44.8**

3.1.1.6.1.1 INSTREAM HABITAT

The *Instream Habitat* parameter in Thomas Mill Run was rated as "optimal" with a score of 16/20. The habitat template in the creek was characterized by stable bed substrate, undercut banks and an abundance of coarse woody debris (CWD). The dominant substrate particle class was gravel (53%) although the majority of these particles were coarse (16-32 mm) or very coarse (32-64 mm) gravel which offers a much higher degree of stability than small gravel particles. Cobble (23%) and boulder (1%) particles were also present throughout riffle segments. The abundance of CWD throughout the reach was also an advantageous habitat feature as the small debris jams they caused throughout the reach serve as optimal habitat for macroinvertebrates and fish and are excellent at retaining organic matter (e.g. leaf packs).

3.1.1.6.1.2 VEGETATIVE PROTECTION

Scores for the *Vegetative Protection* parameter were rated as "marginal" for both the left (6/10) and right (5/10) banks. The scores for both banks of the Thomas Mill Run watershed were higher than the Small Tributary averages of 4.4/10 and 4.2/10 for the left and right banks respectively. The reduced scores were attributed to the observation of bare patches of soil throughout the watershed as shrubs and ground cover vegetation were sparsely distributed.

3.1.1.6.1.3 BANK EROSION

Bank erosion was observed to be most prevalent in the small tributary to Thomas Mill Run on which the entire DSL bank had high rates of erosion (Figure 3-4) - the main channel however, was observed to have limited erosion. The scores for both the left and the right banks were rated as "marginal" although both banks compared favorably to the Small Tributary averages which were also rated as "marginal." The erosion observed on the unnamed tributary to Thomas Mill Run was significant in that Thomas Mill Run was ranked among the most-erosion prone tributaries in the Lower Wissahickon. The erosion rate (normalized to stream length) was the second highest in the Lower Wissahickon at (79 lb/ft) after Gorgas Run where an erosion rate of (81 lb/ft) was estimated.

3.1.1.6.1.4 FLOODPLAIN CONNECTION

The score for the *Floodplain Connection* parameter (15/20) was rated as "suboptimal" and was the second highest score observed among the small Lower Wissahickon tributaries after Valley Green Run, which scored 17/20. The high entrenchment ratio (2.5) of the Thomas Mill Run main channel permits most flows in excess of bankfull discharge (estimated at 96.2 cfs) to enter the floodplain, which is a characteristic absent from many of the other small Lower Wissahickon tributaries.

3.1.1.6.2 SUMMARY OF OVERALL BUFFER AND FLOODPLAIN CONDITION SCORES IN THE THOMAS MILL RUN WATERSHED

The *Overall Buffer and Floodplain* score (63/80) for the Thomas Mill Run watershed was rated as "optimal" and was considerably higher than the Small Tributary average score (50.6/80) which was rated as "suboptimal". The vegetated buffers and riparian areas within the watershed were relatively undisturbed and as such were characterized by a well structured canopy and understory hierarchy. The steep valley walls precluded the formation of floodplain habitat features such as backwaters, vernal pools and wetlands; however the abundance of mature trees throughout the watershed offered additional bank stability and supplied adequate amounts of CWD (and "root wad" habitat) to the main channel.

Table 3-8: USAM Buffer and Floodplain Condition Scoring for Thomas Mill Run Watershed

OVERALL BUFFER AND FLOODPLAIN CONDITION							
Reach ID	Sub-watershed	Vegetated Buffer Width		Floodplain Vegetation	Floodplain Habitat	Floodplain Encroachment	Overall Buffer/FP Condition
		Left	Right				
WSTM02	Thomas Mill	10	10	18	7	18	63
Small Tributary Average	**----**	**9**	**8.8**	**16.2**	**5.6**	**11**	**50.6**

3.1.1.6.2.1 VEGETATED BUFFER WIDTH

The vegetated buffers throughout Thomas Mill Run were extensive and relatively uninterrupted on both sides of the corridor. The scores for both banks were rated as “optimal” and were higher then the Small Tributary averages for both the left (9/10) and right (8.8/10) banks which were rated as “suboptimal” (Table 3-8).

3.1.1.6.2.2 FLOODPLAIN VEGETATION

The score for the *Floodplain Vegetation* parameter (18/20) was the highest recorded amongst the small tributaries and was the second highest score observed throughout the Lower Wissahickon (following WSMO02 and WSBM02 which both had scores of 19/20). The dominant floodplain vegetation type was mature forest, although there was a well established understory throughout the watershed. Large, mature trees often abutted the stream which provided increased bank stability and a source of CWD.

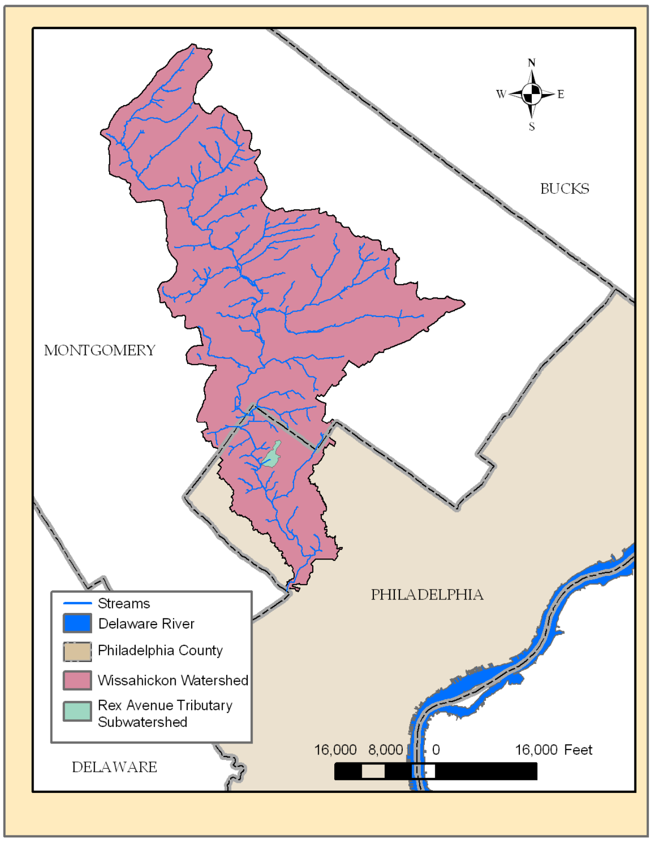
3.1.1.6.2.3 FLOODPLAIN HABITAT

Floodplain habitat was limited throughout the reach even though the main channel had a relatively high entrenchment ratio. The dominant floodplain habitat features were fallen logs and snags. The steep valley walls of the watershed and the lack of floodplain “benches” precluded the formation of many valuable habitat features that require periodically saturated conditions. The score for this parameter (7/20) was rated as “marginal”, which was considerably higher than the Small Tributary average of 5.6/20.

3.1.1.6.2.4 FLOODPLAIN ENCROACHMENT

There were very few instances of floodplain encroachment observed throughout the watershed, most of which were attributed to infrastructure. The score of 18/20 was rated as “optimal” and was the highest score recorded throughout the Lower Wissahickon.

3.1.2 Main stem Tributary I (Rex Avenue Run) Watershed



WSMSI – Tributary 1, also know as Rex Avenue, is a tributary to the main stem of the Wissahickon Creek. The tributary originates from a privately owned outfall located in a residential neighborhood. WSMSI – Tributary 1 is a first-order tributary that travels for approximately 1,900 feet before entering the Wissahickon Creek. The dominant substrate varies from medium gravel to medium cobble at different sections along the tributary. Both the valley floor and channel have been substantially impacted by past and current land use.

The entire WSMSI – Tributary 1 watershed is 137 acres. Major land use types within the watershed include: wooded (52%), residential – single family detached (36%), and recreation (3%). Approximately 375 feet of the northern portion of the tributary are located on private property. The rest of the tributary is surrounded by Fairmount Park on both sides. The Park buffer ranges from about 30 feet to about 2,000 feet.

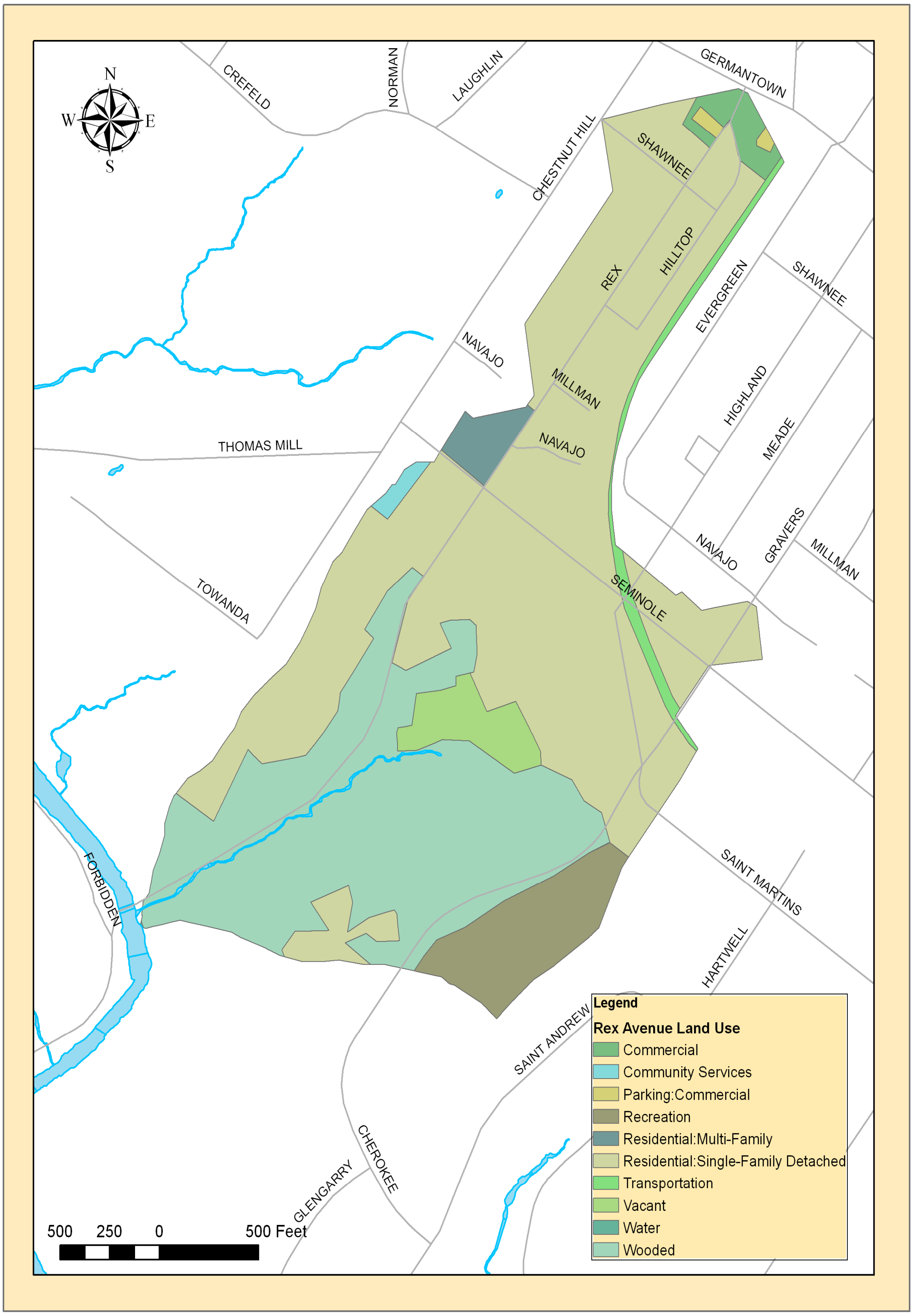


Figure 3-9: Tributary I - Rex Avenue Watershed Land Use

3.1.2.1 GEOLOGY

The majority of the Rex Avenue watershed is underlain by the Wissahickon Formation. The Wissahickon Formation consists of mica schist, gneiss and quartzite. The exposed schist near the surface is highly weathered. The Wissahickon Formation is also comprised of metamorphosed sedimentary rocks.

The northern portion of the Rex Avenue watershed is underlain by the Bryn Mawr Formation. The Bryn Mawr Formation consists of white, yellow and brown gravel and sand. The Bryn Mawr Formation is considered a deeply weathered formation.

3.1.2.2 SOILS

According to the National Resource and Conservation Service Soil Survey, the soils for the entire Rex Avenue watershed are classified as hydrologic group B. These soils have a moderate rate of infiltration when the soils are wet (0.50-1.00 in/hr). Water movement through these soils is considered moderately rapid.

Table 3-9: Distribution of NRCS Soil Types in Tributary I - Rex Avenue Watershed

Group	Area (ft^2)	Percent of Total Area
B	5,967,720	100%
Total Area	**5,967,720**	**100%**

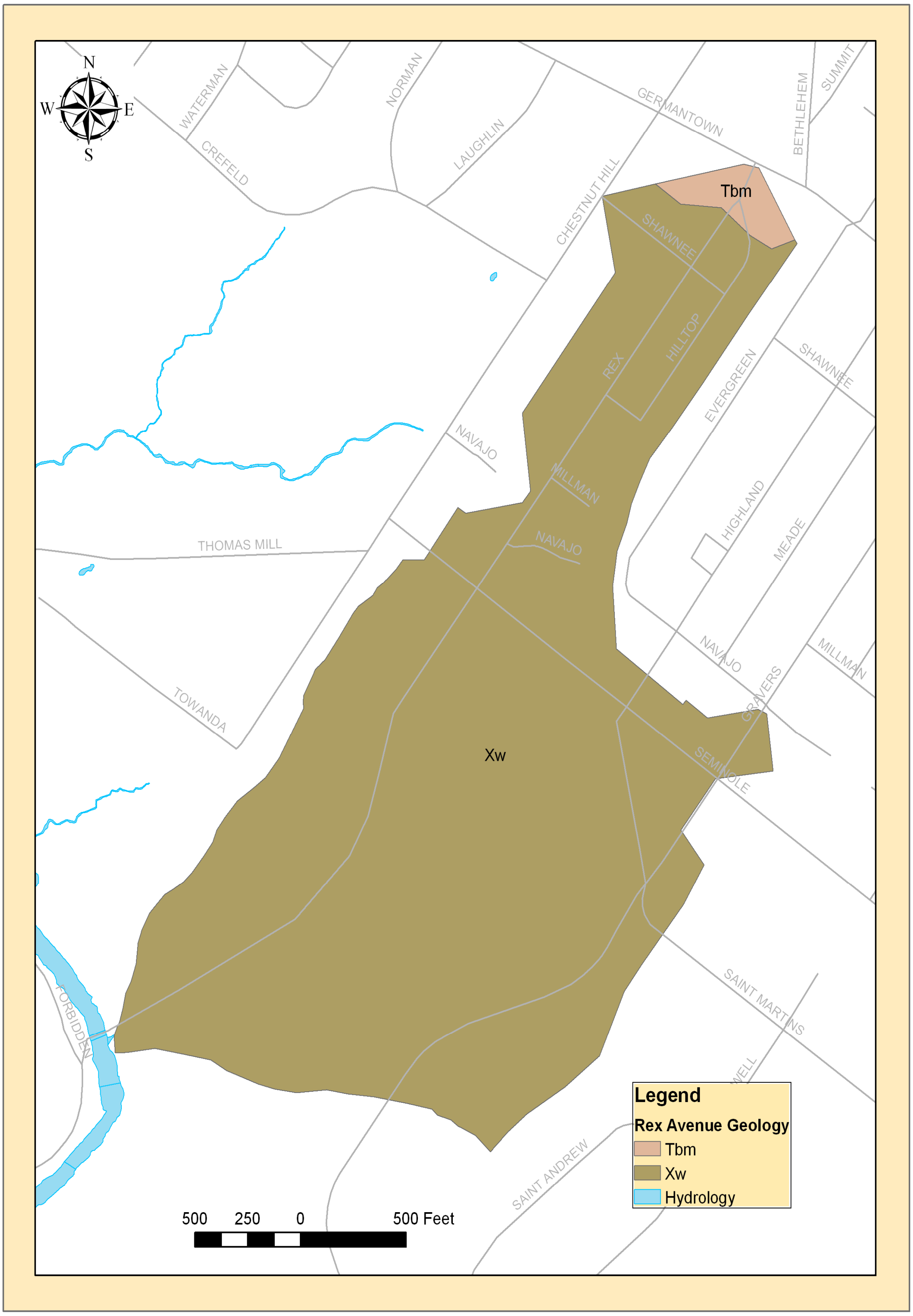


Figure 3-10: Geology of Tributary I - Rex Avenue Watershed

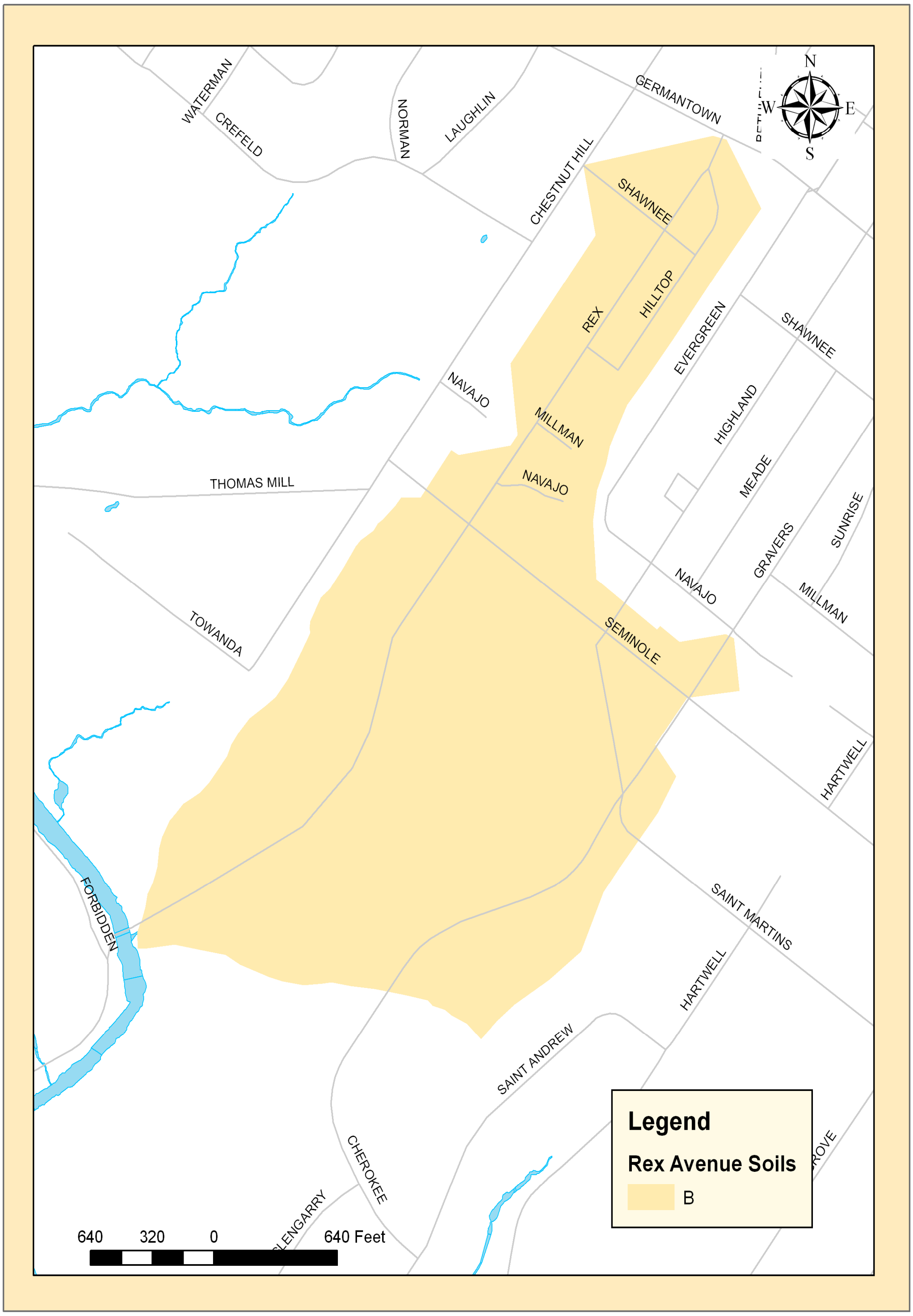


Figure 3-11: Distribution of NRCS Soil Types in Tributary I - Rex Avenue Watershed

3.1.2.3 BANK EROSION

There were three bank pin locations along WSMSI – Tributary 1 (Figure 3-12). The calculated erosion rates are included in Table 3-10. The spatial distribution of BEHI assessment results were represented graphically (Figure 3-12) for each of the segments assessed on WSMSI – Tributary I. Each bank within a respective segment was assessed and rated separately; however, channelized and culverted segments were not assessed as they confer a high degree of protection from bank erosion.

Table 3-10: Rex Avenue Bank Pin Locations

	BEHI	NBS	Baseline Reading	Most Recent Reading	Erosion Rate (ft)	Erosion Rate (ft/yr)	Eroding (-) or Aggrading (+)
Rex Avenue Tributary							
TO202	Moderate	Low	8/24/2006	8/10/2009	-0.48	-0.16	E
TO203	Low	Low	8/24/2006	8/10/2009	-0.19	-0.064	E
TO9	High	Low	8/24/2006	8/10/2009	-0.088	-0.030	E

Total erosion rates were also calculated for the entire length of each tributary within the lower Wissahickon (Table 3-11). To assess the normalized erosion potential of each tributary, the erosion rate per acre of drainage area per year and the erosion rate per foot of stream length per year were calculated. This allowed direct comparison between each of the tributaries with respect to both watershed size and the length of the tributary. WSMSI - Tributary 1 was ranked first out of the twelve tributaries within the lower Wissahickon for erosion rate per foot of stream length. The rankings were based on a scale of one being the highest erosion rate and twelve being the lowest erosion rate.

Table 3-11: Erosion Rates for Lower Wissahickon Tributaries

Tributary	Drainage Area (Acres)	Stream Length (feet)	*2009*		
			Erosion Rate (lb/yr)	*Erosion Rate Per Acre*	*Erosion Rate Per Foot of Stream*
Bell's Mill	323	6,722	420,000	1,307	63
Cathedral Run	160	2,790	150,000	913	52
Cresheim Creek	1,218	16,431	840,000	690	51
Gorgas Run	499	2,170	170,000	345	79
Hartwell Run	217	3,530	200,000	918	56
Hillcrest	144	5,272	90,000	597	16
Kitchen's Lane	234	7,753	200,000	850	26
Monoshone Creek	1,056	6,926	160,000	156	24
Rex Ave	137	1,903	150,000	1,131	81
Thomas Mill Run	104	4,008	320,000	3,058	79
Valley Green Run	128	2,874	140,000	1,086	48
Wise's Mill Run	446	7,056	490,000	1,090	69
Total/*Average*	**4,666**	**67,435**	**3,300,000**	***1,012***	***54***

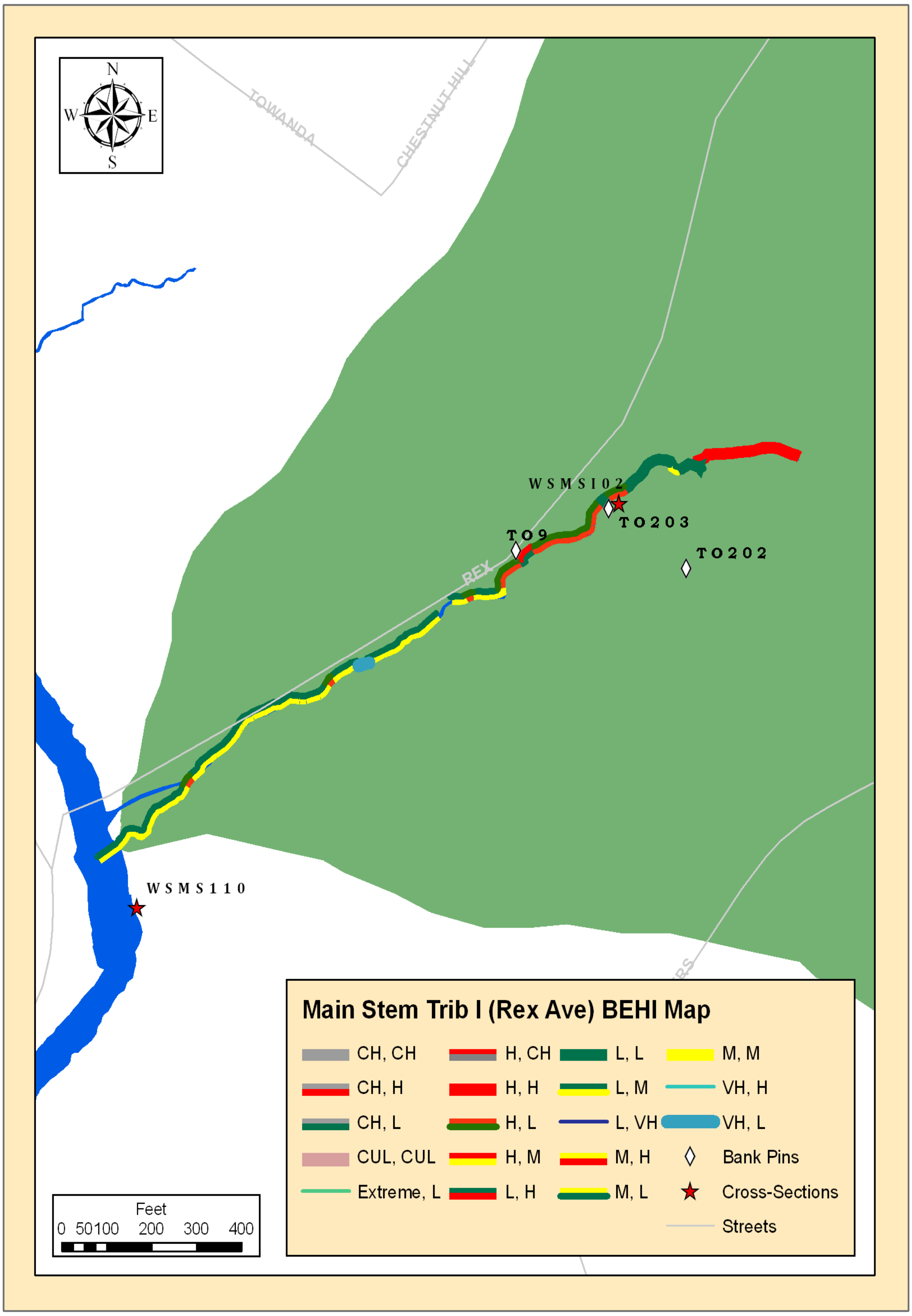


Figure 3-12: Tributary I - Rex Avenue Watershed BEHI Ratings and Bank Pin Locations

3.1.2.4 INFRASTRUCTURE TRACKDOWN SUMMARY

Wissahickon Tributary I is located within Fairmount Park adjacent to Rex Avenue and north of Gravers Lane. The most prominent piece of infrastructure on this stream is WSout509 (W-085-02), which is the largest outfall (4.5 foot diameter) on the tributary. It conveys stormwater drainage from Germantown Avenue and the nearby streets through a 54-inch diameter pipe directly to Tributary I. This outfall was observed to have a dry weather baseflow, which was a major contributing factor to the impairment of this tributary.

The high flows from WSout509 and to lesser extent outfalls WSout725 and WSout510 have impacted many aspects of the stream's physical and biological health. The eroding banks and "flashy" flow regime have spawned emergency repair and bank restoration projects to improve the condition of the stream. WScha115 was most likely a temporary structure constructed to provide immediate protection to the eroding bank in the vicinity of the channel; to prevent Rex Avenue from collapsing into the stream, and possibly to keep the stream from exposing the water main sewer and sanitary interceptor that run parallel to Rex Avenue. Just downstream of this channelized portion, the 15-inch Wissahickon High Level Interceptor crosses underneath the stream. There were no infrastructure elements found to be in poor condition. WScha115 was in fairly poor condition; however, it appeared to be a temporary structure.

Table 3-12: Summary of Main stem Tributary I Infrastructure Points

Section ID	Bridge Count	Outfall Count	Channel Count	Infra Point Count	Combined Outfall Area (ft^2)
WSMSI02	2	3	1	5	17.48

Table 3-13: Summary Main stem Tributary I Infrastructure Linear Features

Section ID	Segment Length (ft)	Culvert Length (ft)	Percent Culverted	Channel Length (ft)	Percent Channelized
WSMSI02	1865	0	0	45	0.8

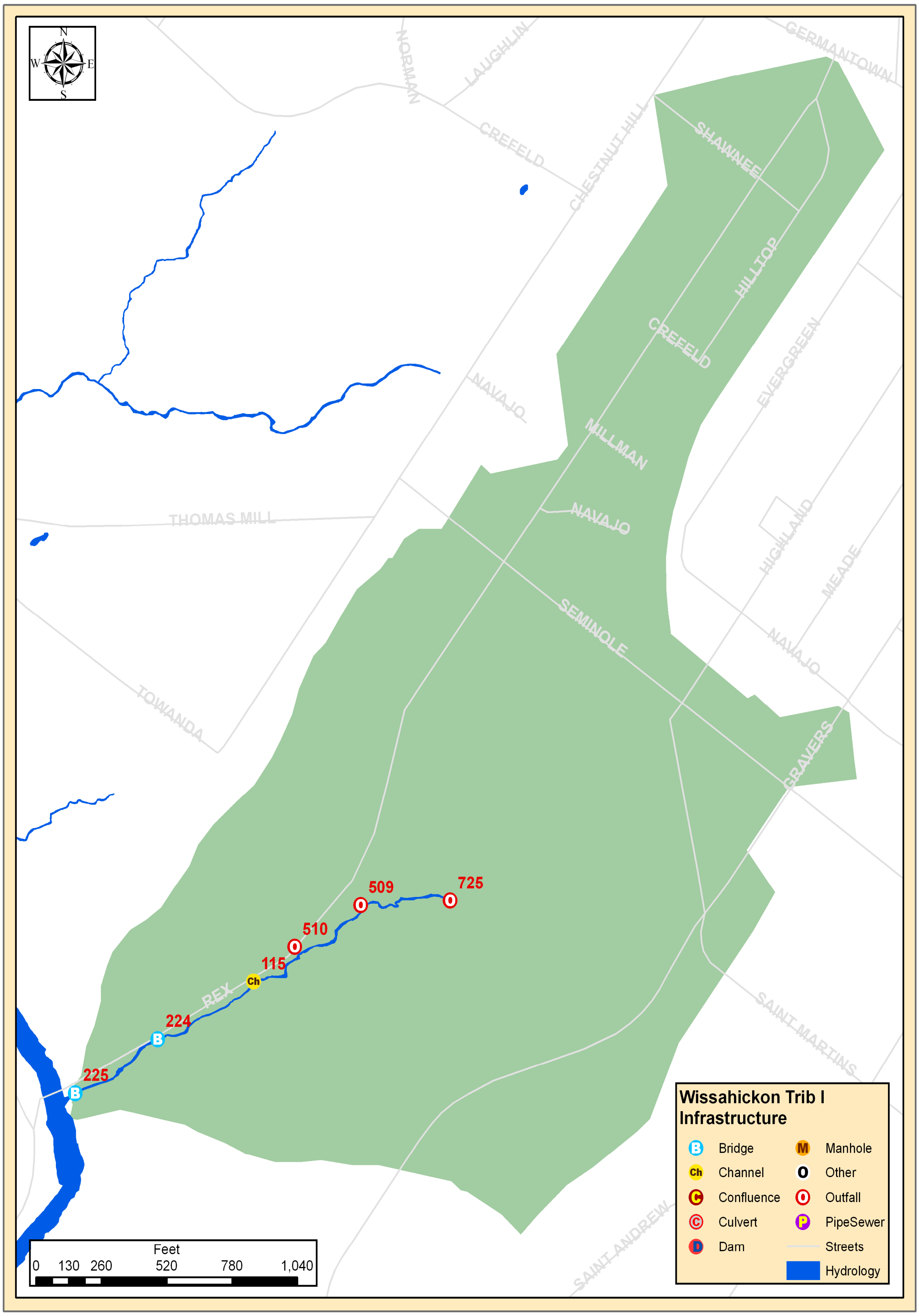


Figure 3-13: Tributary I Infrastructure

3.1.2.5 Unified Stream Assessment Results for the Main Stem Tributary I Watershed

The Main Stem Tributary I watershed had a single channel (approximately 1,865 feet) with no tributaries. Main Stem Tributary I was the only tributary of the Wissahickon Creek direct drainage that was entirely within the Lower Wissahickon Basin. The majority of the channel was located within Fairmount Park although the channel migrated outside of Park boundaries in several locations. The Center for Watershed Protection's (CWP) Unified Stream Assessment Methodology (USAM) was used to score and rate the instream, riparian buffer and floodplain conditions of the stream corridor to allow for comparison to other reaches and watersheds within the Lower Wissahickon Basin.

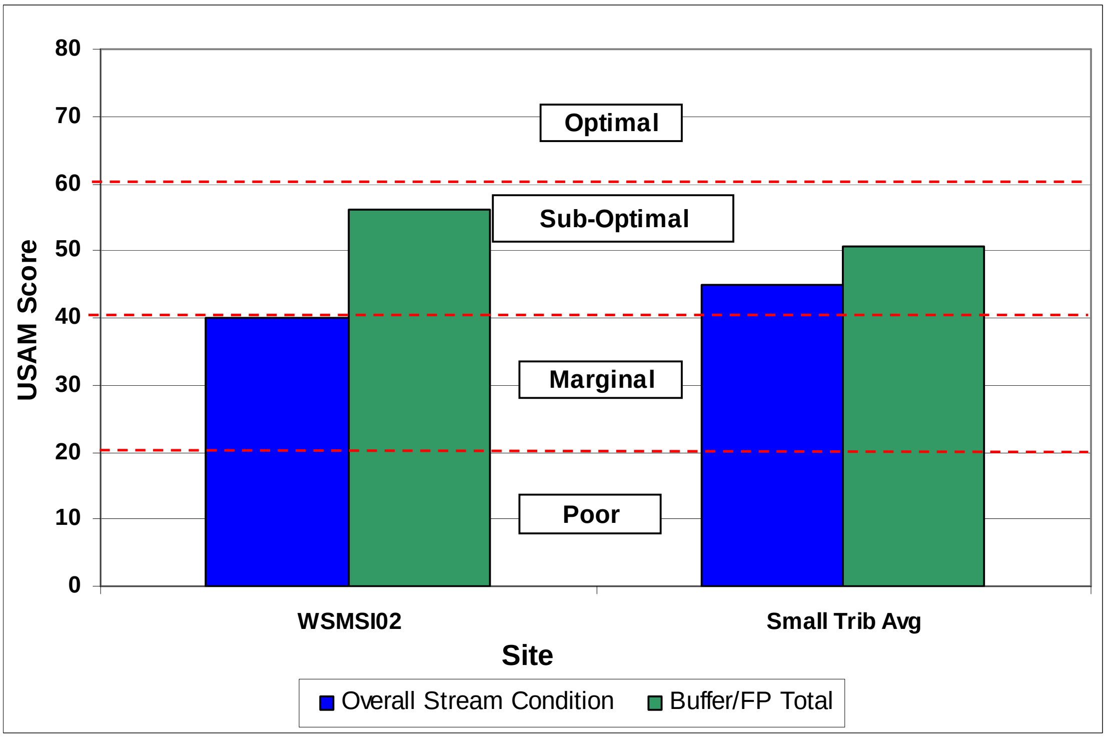


Figure 3-14: Results for Main Stem Tributary I – Rex Avenue USAM Components

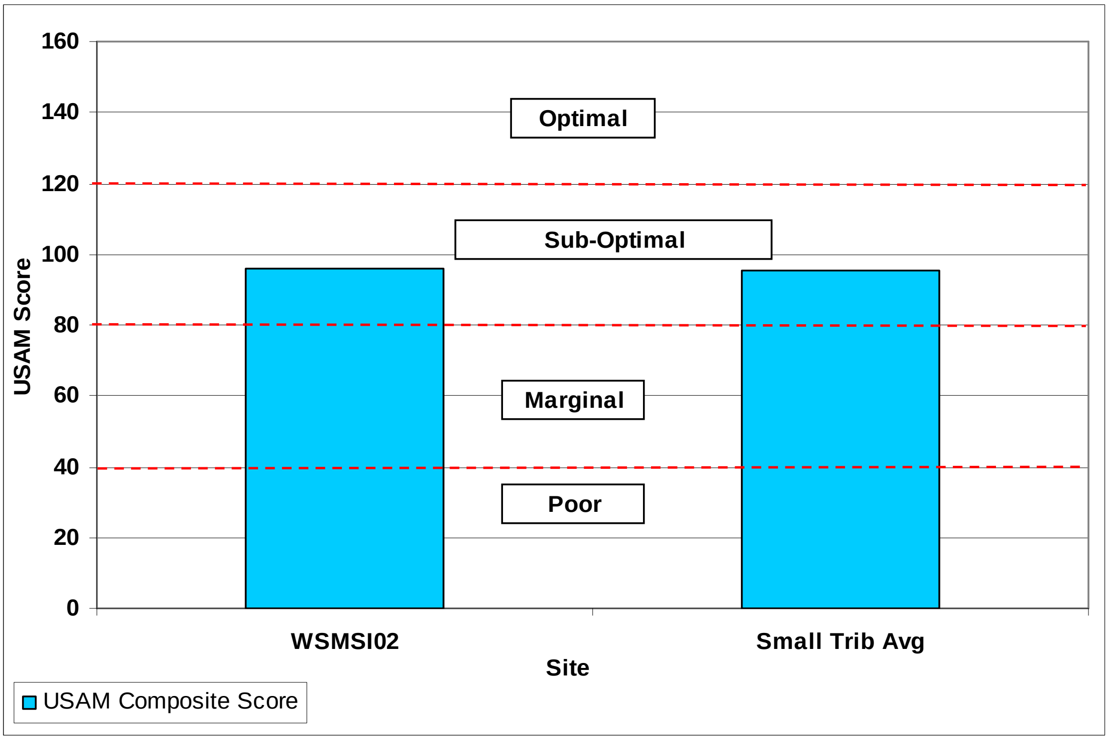


Figure 3-15: Tributary I - Rex Avenue USAM Results

3.1.2.5.1 WSMSI02

The headwaters of reach WSMSI02 began as flow from a privately owned outfall, WSout725, which was located within Fairmount Park. The channel was relatively small with a bankfull cross-sectional area of only 11.4 ft². The substrate distribution was dominated by gravel (61%) although cobble and a limited amount of boulders were also observed. The channel was characterized by a moderate width to depth ratio (13.8) and moderate degree of entrenchment (ER=1.4). As such, reach WSMSI02 was classified as a B4 type channel. The USAM composite score for the reach was 96/180 (Figure 3-15).

3.1.2.6 Summary of Unified Stream Assessment Results

The mean scores for both the *Overall Buffer and Floodplain Condition* USAM component as well as the overall USAM score were all classified as “suboptimal” (Table 3-14). Conditions within the Tributary I watershed’s buffers and floodplains were considerably greater than conditions observed within the stream channels. The watershed score for the *Overall Stream Condition* component did not compare well against the respective Small Tributary averages, though the *Overall Buffer and Floodplain* score was considerably higher than the Small Tributary average.

Table 3-14: USAM Results for Tributary I - Rex Avenue Watershed

Reach ID	Sub-watershed	Overall Stream Condition	Overall Buffer/FP Condition	USAM Score
WSMSI02	Main Stem Tributary I	40	56	96
Small Tributary Average	**----**	**44.8**	**50.6**	**95.4**

3.1.2.6.1 SUMMARY OF OVERALL STREAM CONDITION SCORES IN THE MAIN STEM TRIBUTARY I WATERSHED

In general, the *Overall Stream Condition* score for WSMSI02 was not very high (40/80) and was rated as "marginal." The score at WSMSI02 was observed to be the median condition among the small Lower Wissahickon tributaries. Valley Green Run and Thomas Mill Run were considerably better than Rex Avenue Run and the other two tributaries, Cathedral Run and Gorgas Run, were considerably worse. The individual scores for each of the *Overall Stream Condition* parameters were low to moderate for all parameters except for the *Instream Habitat* parameter, which had the highest score among the small Lower Wissahickon tributaries.

Table 3-15: Overall Stream Condition USAM Results for Tributary I - Rex Avenue Watershed

OVERALL STREAM CONDITION								
Reach ID	Sub-watershed	Instream Habitat	Vegetative Protection		Bank Erosion		Floodplain Connection	Overall Stream Condition
			Left	Right	Left	Right		
WSMSI02	Main Stem Tributary I	19	3	3	5	6	4	40
Small Tributary Average	**----**	**15.8**	**4.4**	**4.2**	**5.6**	**5.8**	**9**	**44.8**

3.1.2.6.1.1 INSTREAM HABITAT

Instream Habitat was rated as "optimal" in reach WSMSI02 with a score of 19/20, which was considerably higher than the Small Tributary average score of 15.8/20 which was rated as "suboptimal." The dominant substrate class was gravel as medium to coarse gravel (8-64 mm) comprised 52% of the bed substrate. There was also an abundance of cobble (64-256 mm) substrate of various size classes. Boulders were present throughout the reach, however, a large proportion of the boulders present throughout the reach were positioned along the margins of the stream. The combination of stable substrate and CWD positioned WSMSI02 as the highest scoring small tributary for this parameter.

3.1.2.6.1.2 VEGETATIVE PROTECTION

Scores for the left and right banks of reach WSMSI02 were very low and ranked among the worst scores recorded among the small Lower Wissahickon tributaries. Both the left and right banks of the reach had scores of 3/10 and were rated as “poor.” In comparison, the Small Tributary averages for the left (4.4/10) and right (4.2/10) banks were rated as “marginal.”

3.1.2.6.1.3 BANK EROSION

There was a moderate amount of bank erosion observed in WSMSI02, mostly in the upper half of the reach. The most severe erosion occurred at the top of the reach and was attributed to the impacts of WSout725 which functioned as the headwaters of the reach. Scores for both the left (5/10) and the right (6/10) banks of WSMSI02 were considerably lower than the Small Tributary average scores of 5.6/10 and 5.8/10 for the left and right banks respectively.

3.1.2.6.1.4 FLOODPLAIN CONNECTION

The *Floodplain Connection* parameter is a measure of the degree channel entrenchment observed throughout a reach. WSMSI02 had a score of 4/20 and was rated as “poor” compared to the Small Tributary average which was rated as “marginal” with a score of 9/20. The only small tributary with a similar degree of floodplain disconnection was WSGO02 which had a score of 2/20.

3.1.2.6.2 SUMMARY OF OVERALL BUFFER AND FLOODPLAIN CONDITION SCORES IN THE MAIN STEM TRIBUTARY I WATERSHED

The conditions within the floodplains and vegetated buffer zones of Main Stem Tributary I were among the best observed among the small Lower Wissahickon tributaries. The WSMSI02 score was higher than the Small Tributary average for each parameter except for the *Floodplain Habitat* parameter; however, low scores were recorded for this parameter throughout the Lower Wissahickon. The *Overall Buffer and Floodplain* score for WSMSI02 (56/80) was rated as “suboptimal” and greatly exceeded the Small Tributary average score (50.6/80). The only watershed to have a higher score was Thomas Mill Run (63/80) which was rated as “optimal”.

Table 3-16: USAM Buffer and Floodplain Condition Scoring for Tributary I - Rex Avenue Watershed

OVERALL BUFFER AND FLOODPLAIN CONDITION							
Reach ID	Sub-watershed	Vegetated Buffer Width		Floodplain Vegetation	Floodplain Habitat	Floodplain Encroachment	Overall Buffer/FP Condition
		Left	Right				
WSMSI02	Main Stem Tributary I	10	10	17	5	14	56
Small Tributary Average	----	**9**	**8.8**	**16.2**	**5.6**	**11**	**50.6**

3.1.2.6.2.1 VEGETATED BUFFER WIDTH

Scores for the right and left vegetated buffer zones were rated as “optimal” as both had a score of 10/10. Main Stem Tributary I was one of only three small tributaries to have optimal ratings for both the left and right side of the corridor. Scores recorded for the left and right vegetated buffers of reach WSMSI02 were above the respective Small Tributary averages of 9/10 and 8.8/10 for the left and right corridors respectively.

3.1.2.6.2.2 FLOODPLAIN VEGETATION

The floodplain vegetation within the Main Stem Tributary I watershed was mature forest, although shrubs and understory trees were also present, especially near the stream channel where there is increased light availability. The score for this parameter (17/20) was rated as "optimal" and was slightly higher than the Small Tributary average (16.2/20) which was also rated as "optimal." Aside from Rex Avenue, there has been limited development and associated tree clearing within the stream corridor allowing for the establishment of a relatively dense distribution of large, mixed hardwood species.

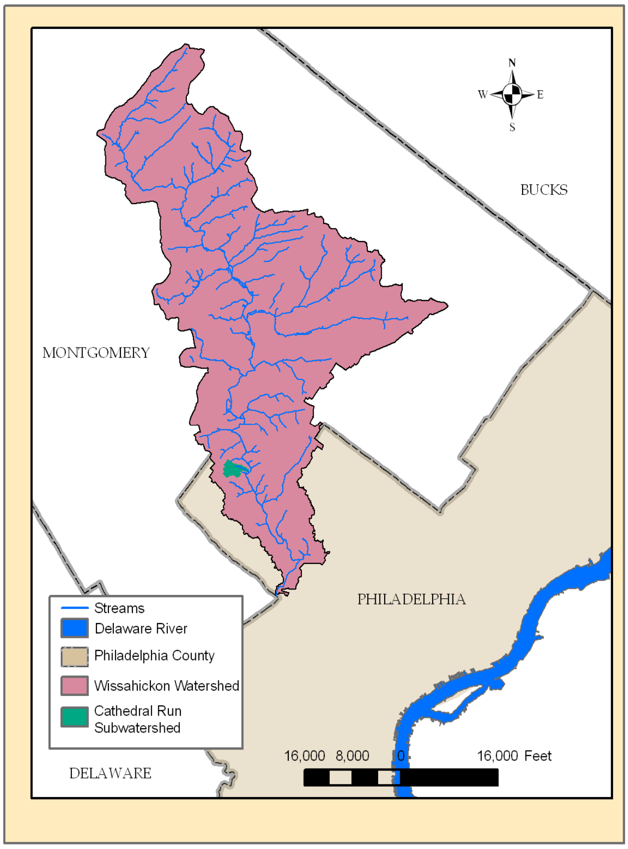
3.1.2.6.2.3 FLOODPLAIN HABITAT

Floodplain habitat other than fallen trees and snags was limited in reach WSMSI02. The score for this parameter was only 5/20 and was rated as "poor." The Small Tributary average (5.6/20) was only slightly higher and was rated towards the lower end of the marginal range. The deeply entrenched channel of reach WSMSI02 rarely accessed the floodplain which precludes the formation and maintenance of many types of floodplain and wetland habitat.

3.1.2.6.2.4 FLOODPLAIN ENCROACHMENT

The score for the *Floodplain Encroachment* parameter (14/20) was rated as "suboptimal" due to the close proximity of Rex Avenue to most of the DSR side of the stream channel. Along the DSL side of the corridor, the floodplain was extensive with no development within 500 feet of the channel. The score for reach WSMSI02 was considerably higher than the Small Tributary average (11/20) which was rated as "marginal."

3.1.3 Cathedral Run Watershed and Reach Characteristics



Cathedral Run is a small first-order tributary to Wissahickon Creek. The stream originates from springs downstream of Courtesy Stables near the intersection of Cathedral and Glen Campbell roads. Cathedral Run then travels approximately 2,500 feet through a wooded section of Fairmount Park before entering Wissahickon Creek. The stream is relatively steep with an average gradient of 8.5%; however, the downstream half of the tributary is steeper than the upstream reach.

The watershed is highly developed with 31% impervious cover and 361 homes. The natural drainage area is 116 acres; however two outfalls collect stormwater from an additional 40 acres. Baseflow is low and was measured to be 0.06 cfs during August 2005. One outfall (WSout760) located at the headwaters of the tributary drains approximately 91 acres of residential and commercial property. A second 36-inch outfall (WSout511), located at the intersection of Cathedral and Glenroy roads, drains approximately 38 acres of mostly residential property.

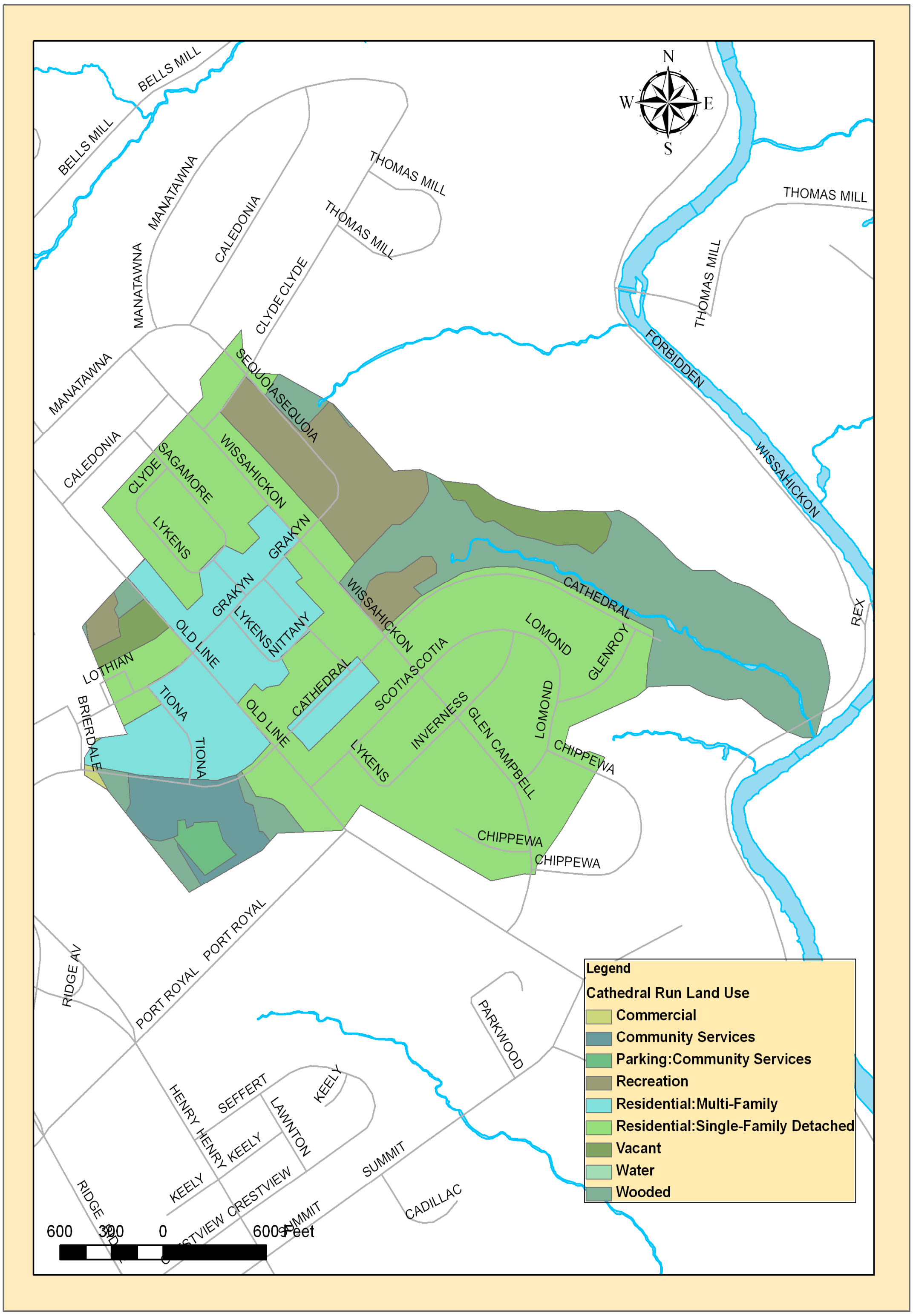


Figure 3-16: Cathedral Run Watershed Land Use

3.1.3.1 GEOLOGY

The Cathedral Run watershed is completely underlain by the Wissahickon Formation. The Wissahickon Formation consists of mica schist, gneiss and quartzite. The exposed schist near the surface is highly weathered. The Wissahickon Formation is also comprised of metamorphosed sedimentary rocks.

3.1.3.2 SOILS

According to the National Resource and Conservation Service Soil Survey, all soils for the Cathedral Run watershed are classified as hydrologic group B. These soils have a moderate rate of infiltration when the soils are wet. Water movement through these soils is considered moderately rapid.

Table 3-17: Distribution of NRCS Soil Types in Cathedral Run Watershed

Group	Area (ft^2)	Percent of Total Area
B	5,052,960	100%
Total Area	**5,052,960**	**100%**

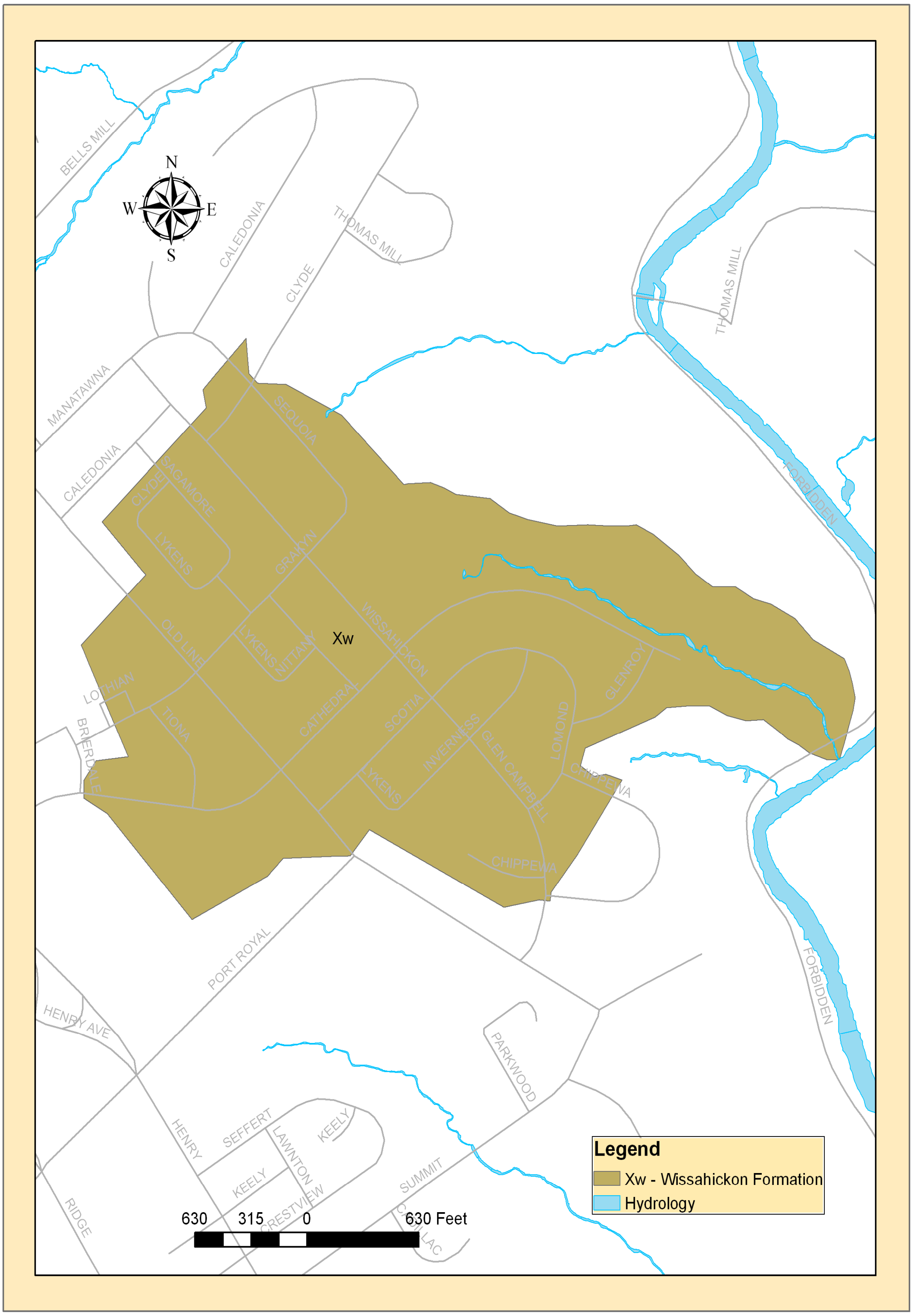


Figure 3-17: Geology of Cathedral Run Watershed

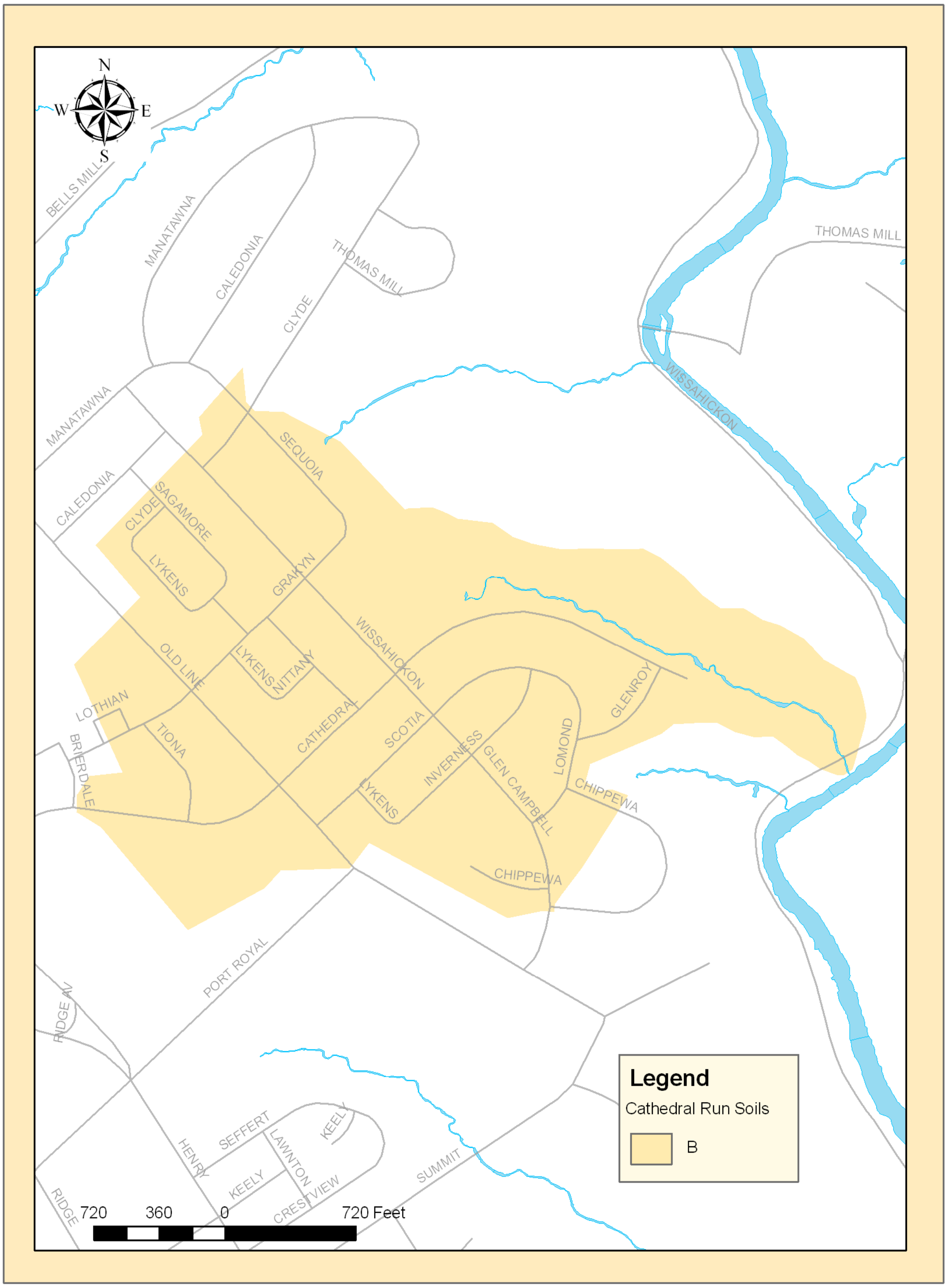


Figure 3-18: Distribution of NRCS Soil Types in Cathedral Run Watershed

3.1.3.3 BANK EROSION

There were 10 bank pin locations along Cathedral Run (Figure 3-19). The calculated erosion rates at each bank pin location are included in Table 3-18. The spatial distribution of BEHI assessment results were represented graphically (Figure 3-19) for each of the segments assessed on Cathedral Run. Each bank within a respective segment was assessed and rated separately; however, channelized and culverted segments were not assessed as they confer a high degree of protection from bank erosion.

Table 3-18: Cathedral Run Bank Pin Locations

	BEHI	NBS	Baseline Reading	Most Recent Reading	Erosion Rate (ft)	Erosion Rate (ft/yr)	Eroding (-) or Aggrading (+)
Cathedral Run							
CR12	Moderate	Very High	8/21/2006	8/13/2009	-0.20	-0.068	E
CR13	High	Low	10/31/2005	8/13/2009	-0.44	-0.12	E
CR1370	Moderate	Low	5/11/2006	8/22/2007	0.30	0.23	A
CR14	Moderate	Low	10/31/2005	8/11/2008	0.076	0.027	A
CR16	Moderate	High	10/31/2005	8/13/2009	-1.63	-0.43	E
CR18	Moderate	Very Low	10/31/2005	8/13/2009	-0.088	-0.023	E
CR3	High	Low	10/31/2005	8/13/2009	0.22	0.058	A
CR510	Moderate	Low	5/21/2006	8/11/2008	0.077	0.035	A
CR7	High	High	8/16/2007	8/11/2008	0.26	0.27	A
CR250	Moderate	Very Low	5/11/2006	8/11/2008	0.069	0.031	A

Total erosion rates were also calculated for the entire length of each tributary within the lower Wissahickon (Table 3-19). To assess the normalized erosion potential of each tributary, the erosion rate per acre of drainage area per year and the erosion rate per foot of stream length per year were calculated. This allowed direct comparison between each of the tributaries with respect to both watershed size and the length of the tributary. Cathedral Run was ranked seventh out of the twelve tributaries within the lower Wissahickon for erosion rate per foot of stream length. The rankings were based on a scale of one being the highest erosion rate and twelve being the lowest erosion rate.

Table 3-19: Erosion Rates for Lower Wissahickon Tributaries

Tributary	Drainage Area (Acres)	Stream Length (feet)	*2009*		
			Erosion Rate (lb/yr)	*Erosion Rate Per Acre*	*Erosion Rate Per Foot of Stream*
Bell's Mill	323	6,722	420,000	1,307	63
Cathedral Run	160	2,790	150,000	913	52
Cresheim Creek	1,218	16,431	840,000	690	51
Gorgas Run	499	2,170	170,000	345	79
Hartwell Run	217	3,530	200,000	918	56
Hillcrest	144	5,272	90,000	597	16
Kitchen's Lane	234	7,753	200,000	850	26
Monoshone Creek	1,056	6,926	160,000	156	24
Rex Ave	137	1,903	150,000	1,131	81
Thomas Mill Run	104	4,008	320,000	3,058	79
Valley Green Run	128	2,874	140,000	1,086	48
Wise's Mill Run	446	7,056	490,000	1,090	69
Total/*Average*	**4,666**	**67,435**	**3,300,000**	***1,012***	***54***

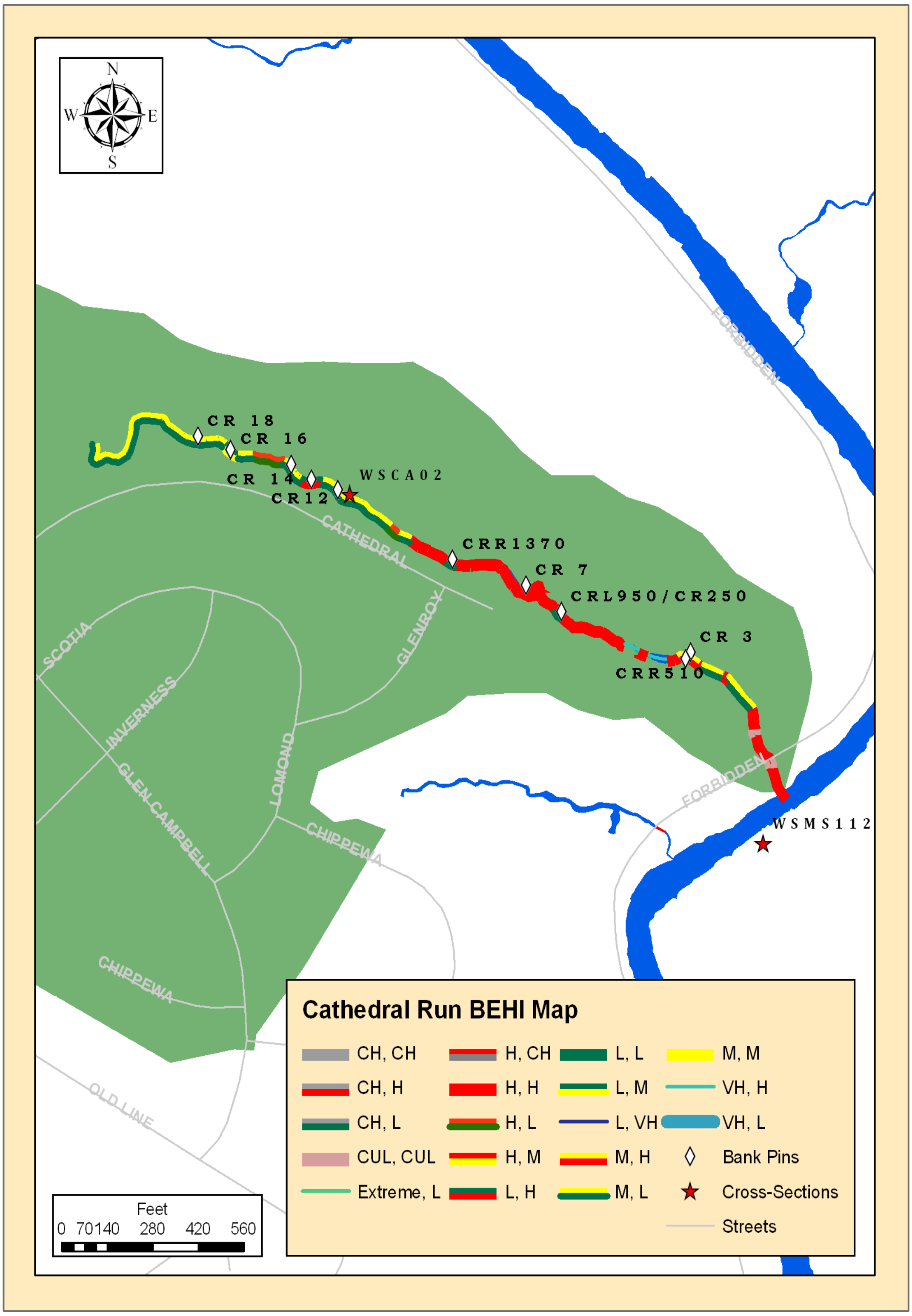


Figure 3-19: Cathedral Run Watershed BEHI Ratings and Bank Pin Locations

3.1.3.4 INFRASTRUCTURE TRACKDOWN SUMMARY

The Cathedral Run stream channel was located entirely within Fairmount Park. The tributary runs adjacent to Cathedral Road and as such was impacted by stormwater runoff from the adjacent neighborhood. There were five infrastructure points (Table 3-20) on the Cathedral Run tributary which included two culverts (WScul93 and WScul95) and three outfalls (WSout511, WSout726 and WSout760). Similar to some of the other tributaries along the Wissahickon corridor, Cathedral Run had culverts directly upstream of the confluence with the main stem of Wissahickon Creek due to Forbidden Drive and the Park trail system.

The two culverts account for only 2% of the entire stream length; however, they have the potential to dramatically alter the conveyance of water and sediment from the tributary to the main stem. Similar to the other tributaries, Cathedral Run has also been impacted dramatically by stormwater runoff, which is conveyed by the two outfalls discharging runoff from Cathedral Road as well as the residential neighborhood stretching out past Wissahickon Avenue. WSout760 (W-076-01) discharges stormwater from a 48-inch diameter pipe and WSout511 (W-076-02) discharges from a 36-inch diameter pipe. The flow from these two outfalls was likely a contributing factor to the impaired state of the stream. Streambank erosion, poor water quality, and a “flashy” hydraulic regime can all be attributed to the extreme flows caused by wet weather conditions. None of the infrastructure on Cathedral Run was found to be in poor condition. The infrastructure may be influenced significantly in the future by the Cathedral Run Stormwater Treatment Facility that will create a headwater wetland complex to absorb the energy of stormwater flows and retain some of the stormwater volume.

Table 3-20: Summary of Cathedral Run Infrastructure Points

Section ID	Culvert Count	Outfall Count	Infra Point Count	Combined Outfall Area (ft^2)
WSCA02	2	3	5	26.71

Table 3-21: Summary of Cathedral Run Infrastructure Linear Features

Section ID	Segment Length (ft)	Culvert Length (ft)	Percent Culverted	Channel Length (ft)	Percent Channelized
WSCA02	3123	50	1.60	0	0

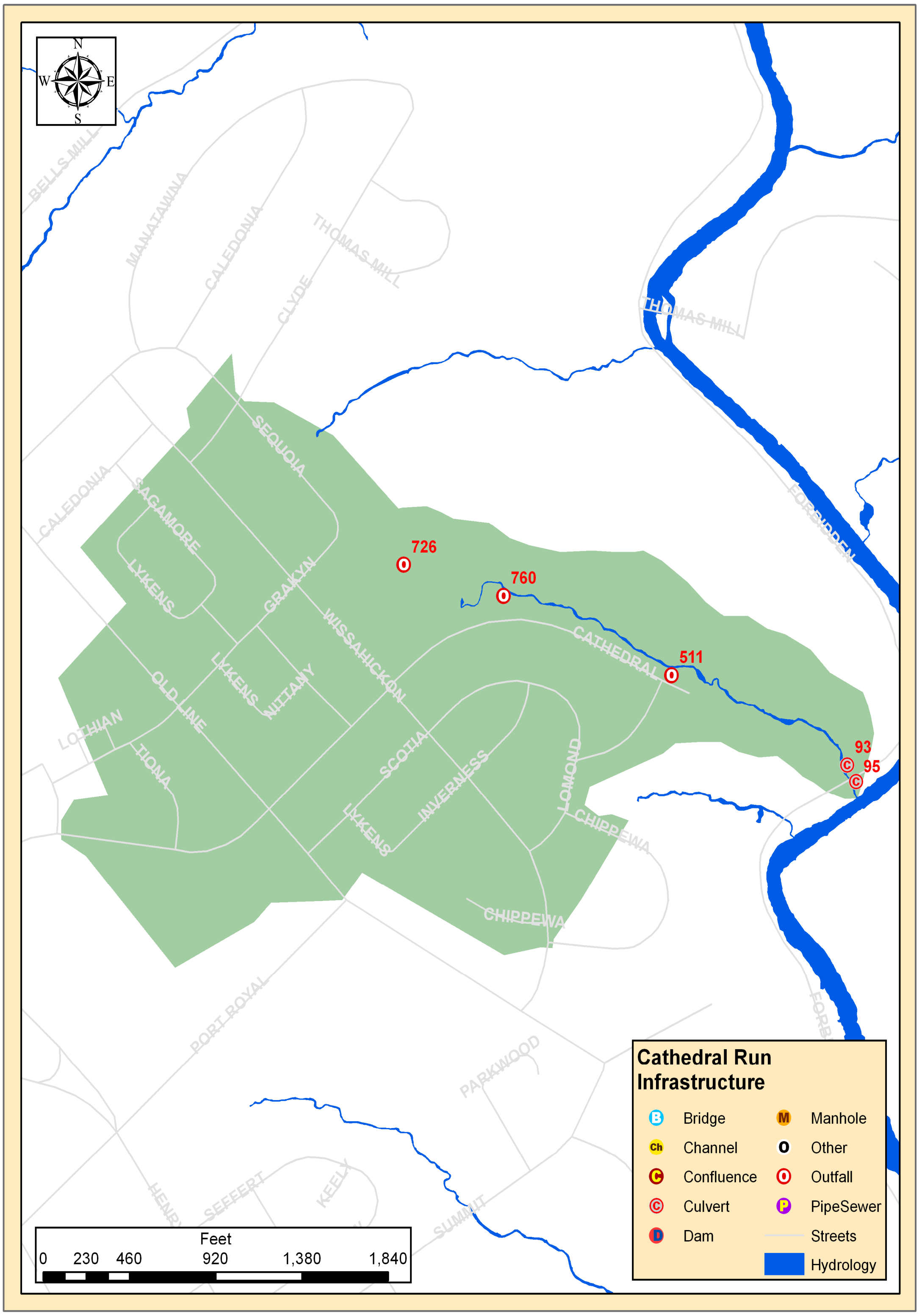


Figure 3-20: Cathedral Run Infrastructure Locations

3.1.3.5 Unified Stream Assessment Results for the Cathedral Run Watershed

The Cathedral Run watershed had a single first-order channel that was located almost entirely within Fairmount Park. There was a short segment of the channel upstream of WSout511 located outside of the Park, although the land cover in this segment was forest. The upstream half of the channel was abutted by residential land-use however the downstream half of the channel was abutted by an extensive forested corridor on both sides of the channel. The Center for Watershed Protection's (CWP) Unified Stream Assessment Methodology (USAM) was used to score and rate the instream, riparian buffer and floodplain conditions of the stream corridor to allow for comparison to other reaches and watersheds within the Lower Wissahickon Basin.

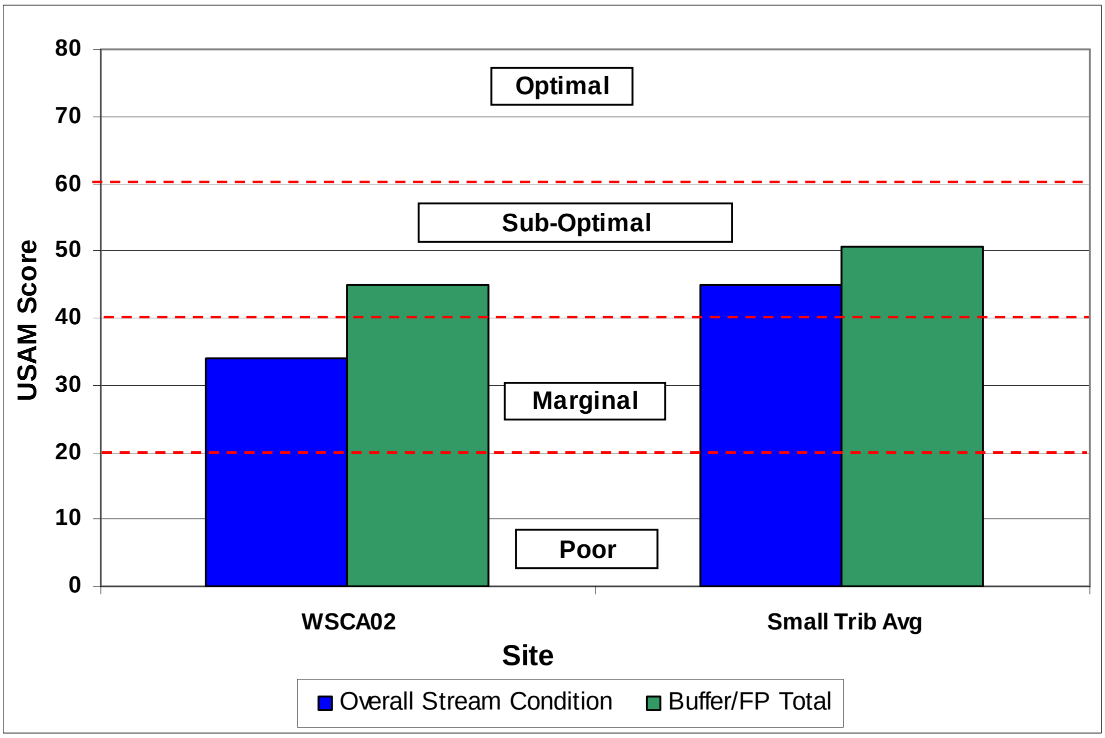


Figure 3-21: Results for Cathedral Run USAM Components

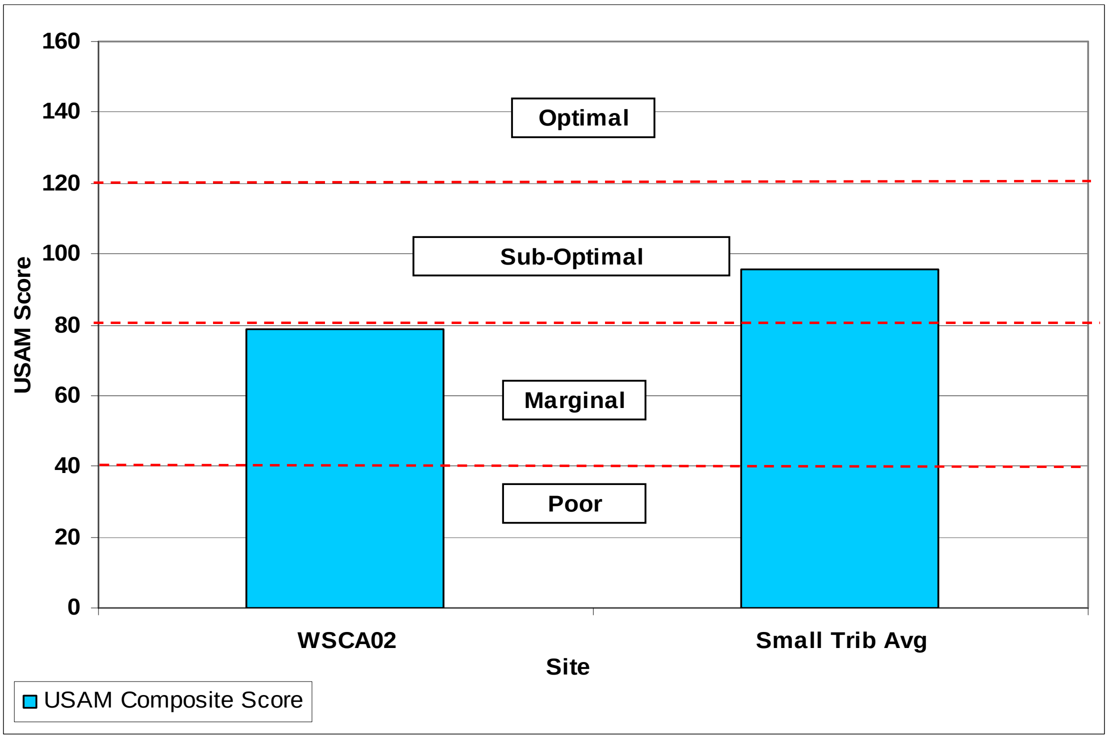


Figure 3-22: Cathedral Run USAM Results

3.1.3.5.1 WSCA02

The headwaters of reach WSCA02, located about 75 feet north of Cathedral Road, began as a zero order stream at the base of a steep swale that receives runoff from Courtesy Stables as well as WSout726. The WSCA02 channel was rather small with a bankfull cross sectional area of 6.9 ft^2, although the drainage area for the reach (0.19 mi^2) was relatively small as well. WSCA02 was dominated by gravel (55%) with cobble and boulders observed in much smaller proportions. A relatively high width to depth ratio was observed for WSCA02 as well as a moderately entrenched channel (ER=1.7). The reach was classified as a B4 type channel. The USAM composite score for the reach was 79/160 (Figure 3-22).

3.1.3.6 Summary of Unified Stream Assessment Results

The mean watershed scores for both the individual USAM components as well as the overall USAM score ranged from marginal to sub-optimal (Table 3-22). Observed conditions for the Cathedral Run *Buffer and Floodplain Condition* parameters were slightly better than the observed *Overall Stream Condition* parameters. For the *Overall Stream Condition* component, Cathedral Run scores were lower than the Small Tributary average for all four parameters. Similarly, the Small Tributary average was higher than Cathedral Run scores for all the *Overall Buffer and Floodplain Condition* parameters except for the *Vegetated Buffer Width* parameter, in which the left bank on reach WSCA02 had a higher score than the Small Tributary average and the *Floodplain Encroachment* parameter in which the WSA02 score and the Small Tributary Average were equal. As such, the USAM composite score for Cathedral Run (79/160) was considerably lower then the mean Small Tributary USAM score of 95.4/160 which was classified as "suboptimal."

Table 3-22: USAM Results for Cathedral Run Watershed

Reach ID	Sub-watershed	Overall Stream Condition	Overall Buffer/FP Condition	USAM Score
WSCA02	Cathedral	34	45	79
Small Tributary Average	**----**	**44.8**	**50.6**	**95.4**

3.1.3.6.1 SUMMARY OF OVERALL STREAM CONDITION SCORES IN THE CATHEDRAL RUN WATERSHED

The *Overall Stream Condition* scores for Cathedral Run were lower than the mean scores of the other "Small Tributaries" in the Lower Wissahickon for each parameter within this component of the USAM assessment (Table 3-23). Scores ranged from poor to sub-optimal in the watershed, and no parameter was rated as optimal. The largest discrepancy between the WSCA02 reach and the Small Tributary average was observed for the *Vegetative Protection* parameter. Both banks of reach WSCA02 were rated as poor (2/10) and were among the worst stream banks assessed in the Lower Wissahickon behind WSBM02 (both banks scored 1/10) and WSWM06 (both banks scored 2/10). The parameter that was rated the highest in the reach was the *Instream Habitat* parameter (13/20), which was a result of the relatively stable substrate in the reach which was comprised of 38% cobble (64-256mm).

Table 3-23: USAM Overall Stream Condition Scoring for Cathedral Run Watershed

OVERALL STREAM CONDITION								
Reach ID	Sub-watershed	Instream Habitat	Vegetative Protection		Bank Erosion		Floodplain Connection	Overall Stream Condition
			Left	Right	Left	Right		
WSCA02	Cathedral	13	2	2	5	5	7	34
Small Tributary Average	**----**	**15.8**	**4.4**	**4.2**	**5.6**	**5.8**	**9**	**44.8**

3.1.3.6.1.1 INSTREAM HABITAT

The *Instream Habitat* parameter was rated as "suboptimal" for WSCA02. Habitat scores in this reach were heavily influenced by the high proportion of stable substrate (i.e. cobble and boulders) observed within the reach as well as the presence of cover in the form of coarse woody debris (CWD) and undercut banks. Cobble and boulder substrate comprised 40% of the substrate observed in the reach, whereas the majority of the substrate was gravel of various size classes (55%). Coarser gravels (16-64 mm) may offer habitat value although the stability of these particles is questionable during high flows. Moderate amounts of CWD were observed in the channel although the narrow, deeply incised channel prevented many large fallen snags and CWD from being inundated. WSCA02 had a lower score (Table 3-23) than the Small Tributary average (15.8/20) which was classified as "optimal."

3.1.3.6.1.2 VEGETATIVE PROTECTION

Reach WSCA02 had very low scores for both the left and right bank for this parameter. Both banks had scores of (2/10) which classified them as poor. Under the USAM framework, poor vegetative protection is characterized by patchy distributions of vegetation, streambanks with less than 50% of their surface area covered with vegetation as well as the predominance of bare soil. The Small Tributary averages for the left (4.4/10) and right (4.2/10) banks were both higher than the WSCA02 scores, however the marginal rating of the Small Tributary average may be an indication of a larger issue. Smaller channels have less buffering capacity against flashy storm flows compared to larger systems which can more easily attenuate high volume, flashy flows. Many of the smaller tributaries in the Wissahickon may thus be predisposed to less than favorable conditions for the establishment of near-bank vegetation. Both the high rates of erosion observed among the small tributaries and frequent disturbance are the most likely factors contributing to the lack of adequate vegetative protection in the small Lower Wissahickon tributaries.

3.1.3.6.1.3 BANK EROSION

Bank erosion was moderate on reach WSCA02, with a score of 5/10 for both the right and left banks. The Small Tributary average was slightly higher at 5.6/10 and 5.8/10 respectively, although WSCA02 and the Small Tributary average were both rated as "marginal." The marginal rating for WSCA02 was attributed to the large proportion of the middle and lower segments of the reach that had high BEHI designations. The occurrences of high BEHI scores in the middle and lower reaches can be attributed to the stormwater outfall at the intersection of Cathedral Road and Glenroy Avenue and the culvert beneath Forbidden Drive respectively. Most of the upper portion of the reach had a medium BEHI score on the DSL bank and a low BEHI score on the DSR bank; however, there were sections of the upper reach that had high BEHI scores as a result of localized scour.

3.1.3.6.1.4 FLOODPLAIN CONNECTION

The *Floodplain Connection* parameter evaluates a stream channel's entrenchment ratio (ER), which is a geomorphic property that governs the frequency and occurrence of floodplain inundation during bankfull events. The entrenchment ratio calculated at cross section WSCA02 was (1.7), which was rated as marginal with a USAM score of 7/20. The Small Tributary average entrenchment ratio was 1.9 which was also rated as marginal (9/20). The entrenchment ratio at cross section WSCA02 was indicative of a deeply entrenched channel (a result of "downcutting") such that flows in excess of the estimated bankfull discharge (22.6 cfs) are fully contained within the channel and do not inundate the floodplain.

3.1.3.6.2 SUMMARY OF OVERALL BUFFER AND FLOODPLAIN CONDITION SCORES IN THE CATHEDRAL RUN WATERSHED

The *Overall Buffer/Floodplain Condition* score (Table 3-24) for Cathedral Run (45/80) was considerably lower than the Small Tributary average (50.6/80); however WSCA02 was still rated as "sub-optimal." Scores for the various parameters ranged from "poor" to "optimal" on reach WSCA02. The Small Tributary average scores were higher than Cathedral Run's scores for every parameter except for the left bank *Vegetated Buffer Width*. The close proximity of Cathedral Road to reach WSCA02 had a direct, adverse impact on both the *Vegetated Buffer Width* (right bank only) and the *Floodplain Encroachment* parameters.

Table 3-24: USAM Buffer and Floodplain Condition Scoring for Cathedral Run Watershed

OVERALL BUFFER AND FLOODPLAIN CONDITION							
Reach ID	Sub-watershed	Vegetated Buffer Width		Floodplain Vegetation	Floodplain Habitat	Floodplain Encroachment	Buffer/FP Condition
		Left	Right				
WSCA02	Cathedral	10	5	14	5	11	45
Small Tributary Average	**----**	**9**	**8.8**	**16.2**	**5.6**	**11**	**50.6**

3.1.3.6.2.1 VEGETATED BUFFER WIDTH

The riparian corridor of Cathedral Run was heavily influenced by Cathedral Road on the downstream right side of the valley in the upper half of Cathedral Run. The scores for the left (10/10) and right (5/10) bank of the corridor were rated as "optimal" and "marginal" respectively (Table 3-24). The left bank compared favorably to the Small Tributary average (9/10) however the condition of the right bank of WSCA02 was considerably worse than the Small Tributary average for the right bank (8.8/10). Comparisons to Small Tributary averages for this parameter may have a spatial bias in that some of the riparian corridors on the smaller tributary reaches are limited by residential development on one side and the location of developed lands with respect to each stream valley varies between watersheds.

3.1.3.6.2.2 FLOODPLAIN VEGETATION

The *Floodplain Vegetation* parameter assesses the predominant vegetation type observed within each reach (e.g. shrub, mature forest or mowed turf) with higher scores for floodplains dominated by mature forests. WSCA02 was rated as "suboptimal" due to the predominance of secondary forest vegetation and saplings (Table 3-24). The Small Tributary average was rated as optimal, with a score of 16.2/20.

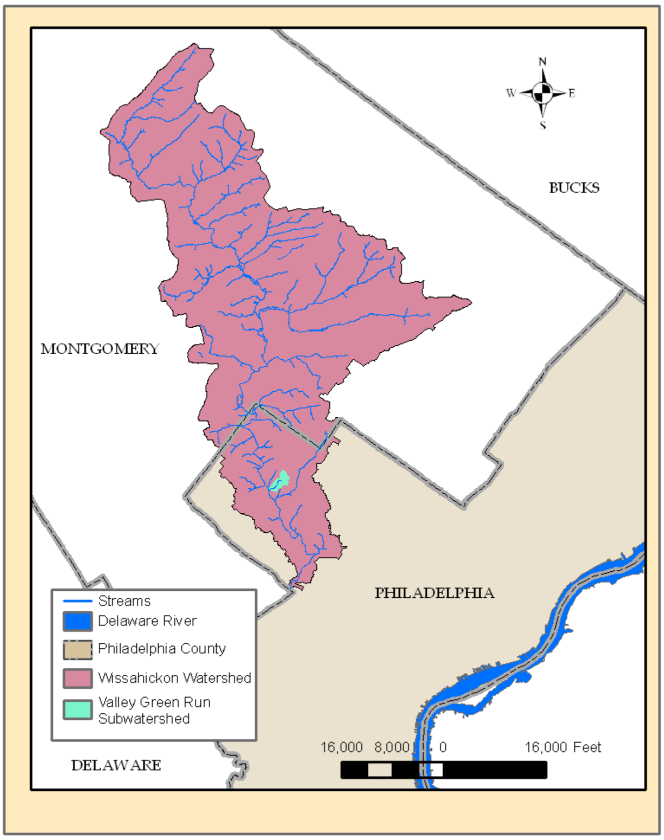
3.1.3.6.2.3 FLOODPLAIN HABITAT

The *Floodplain Habitat* parameter was rated as "poor" in reach WSCA02, due to the fact that the channel's geomorphic properties (low entrenchment ratio) do not permit flood flows to inundate the floodplain except under extreme flow conditions. Similarly, the Small Tributary average was rather low (5.6/10) and was rated as "marginal" (Table 3-24).

3.1.3.6.2.4 FLOODPLAIN ENCROACHMENT

The *Floodplain Encroachment* parameter evaluates the degree of anthropogenic influence on the function of floodplains throughout a reach. The floodplain function in reach WSCA02 was slightly impinged upon by development in the form of Cathedral Road and associated infrastructure on the upper half of the reach (Figure 3-19). The score of 11/20 for WSCA02 was rated as "marginal" (Table 3-24). The Small Tributary average was also 11/20 and rated as "marginal."

3.1.4 VALLEY GREEN RUN WATERSHED AND REACH CHARACTERISTICS



Valley Green Run is a tributary to the main stem of the Wissahickon Creek. Valley Green Run originates from a privately-owned stormwater outfall located within a wooded area. Valley Green Run is a first-order tributary for approximately one half mile before entering into the Wissahickon Creek. The dominant substrate varies from medium gravel to medium cobble material. Both the valley floor and channel have been substantially impacted by past and current land use.

The entire Valley Green Run watershed is 128 acres. Major land use types within the watershed include: wooded (59%), residential – single family detached (33%), and recreation (4%). The lower two-thirds of the tributary are surrounded by Fairmount Park on both sides. The Park buffer ranges from about 20 feet to about 2,000 feet.

The Philadelphia Water Department (PWD) owns and operates one stormwater outfall that releases into Valley Green Run. The entire watershed is drained by a separate storm sewer system that is directly connected to all impervious surfaces. There are an additional three outfalls owned by an entity other than PWD that release into Valley Green Run.

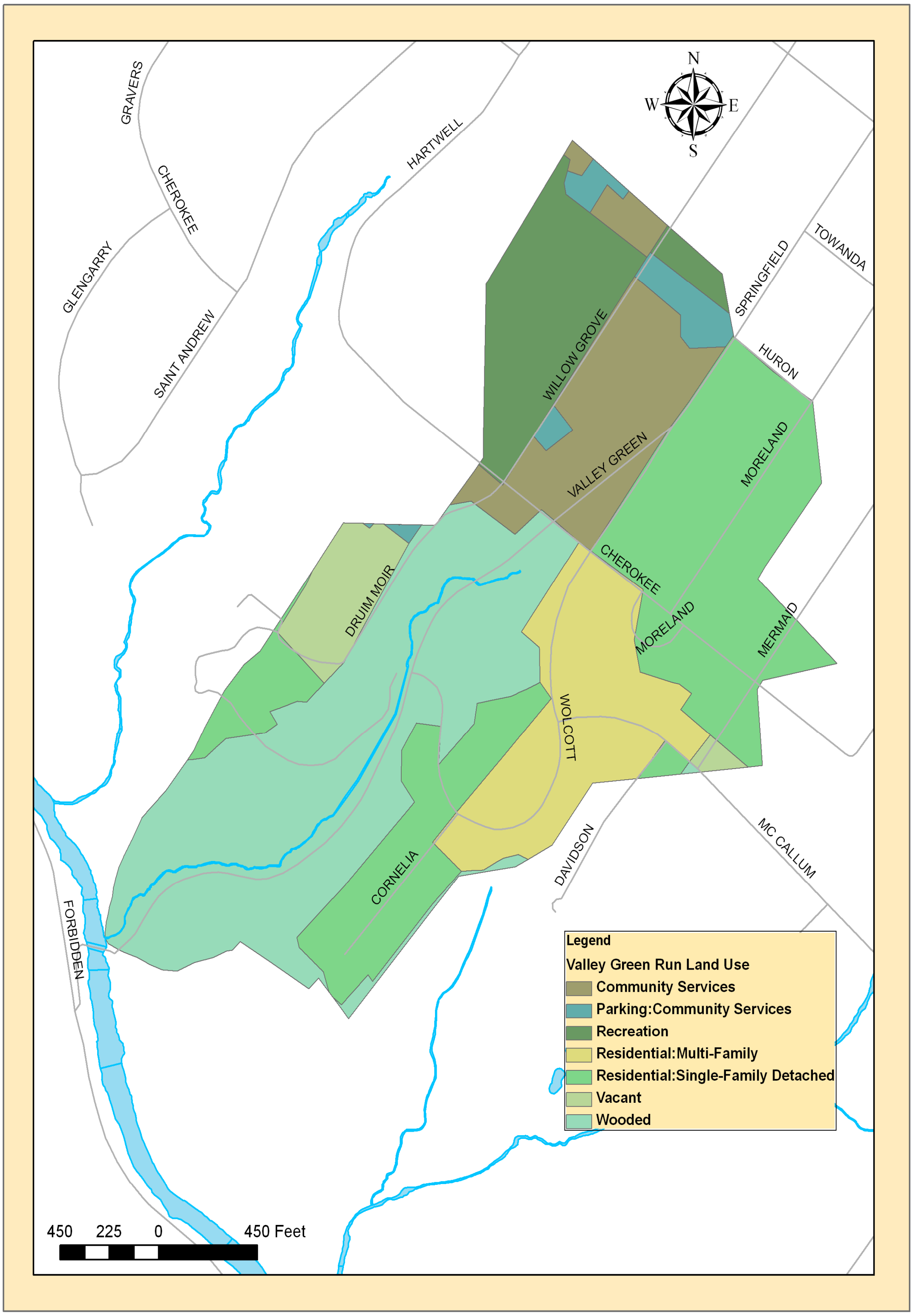


Figure 3-23: Valley Green Run Watershed Land Use

3.1.4.1 GEOLOGY

The entire Valley Green Run watershed is underlain by the Wissahickon Formation. The Wissahickon Formation consists of mica schist, gneiss and quartzite. The exposed schist near the surface is highly weathered. The Wissahickon Formation is also comprised of metamorphosed sedimentary rocks.

3.1.4.2 SOILS

According to the National Resource and Conservation Service Soil Survey, all soils for the Valley Green Run watershed are classified as hydrologic group B. These soils have a moderate rate of infiltration when the soils are wet (0.50-1.00 in/hr). Water movement through these soils is considered moderately rapid.

Table 3-25: Distribution of NRCS Soil Types in Valley Green Run Watershed

Group	Area (ft^2)	Percent of Total Area
B	5,575,680	100%
Total Area	5,575,680	100%

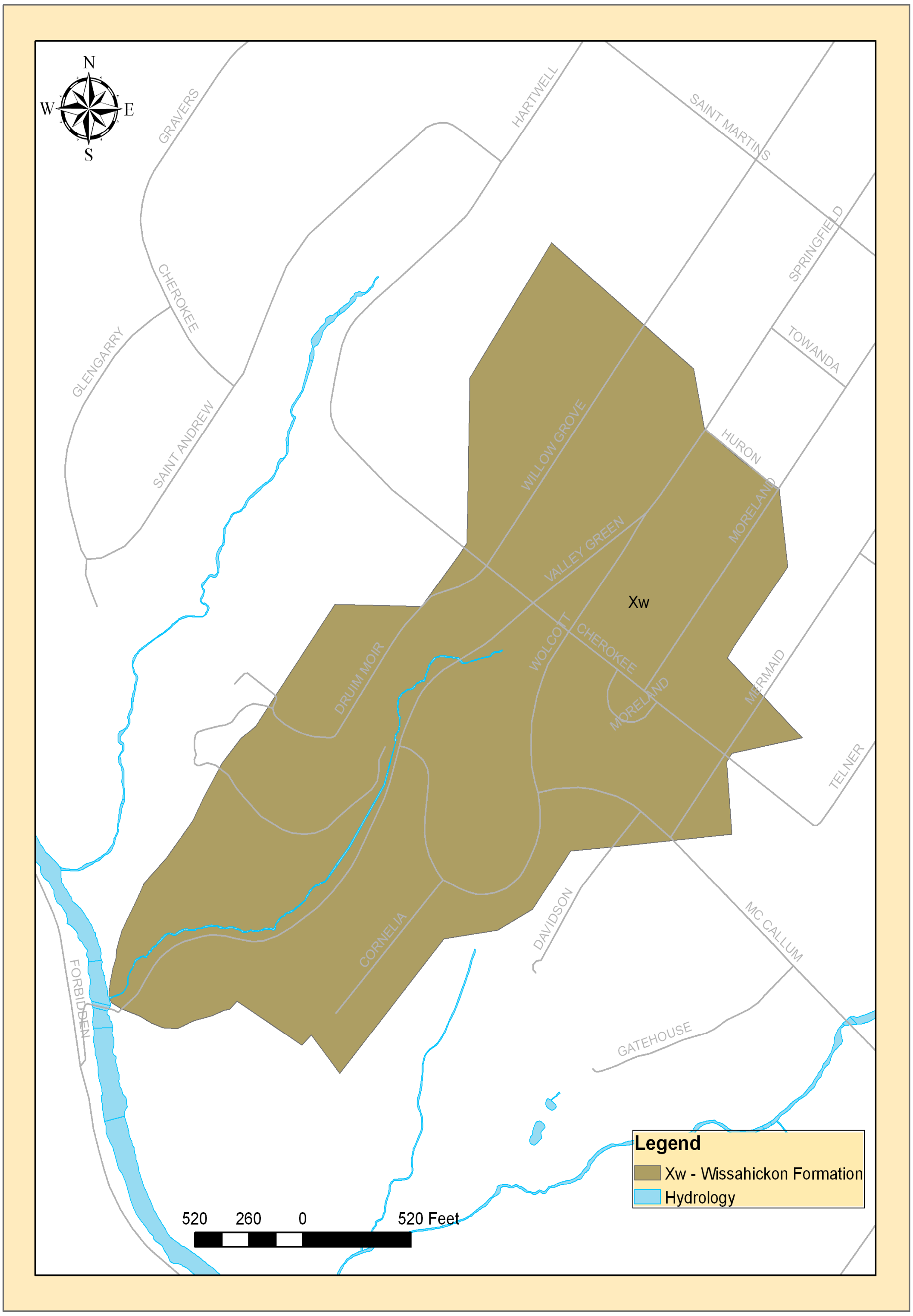


Figure 3-24Geology of Valley Green Run Watershed

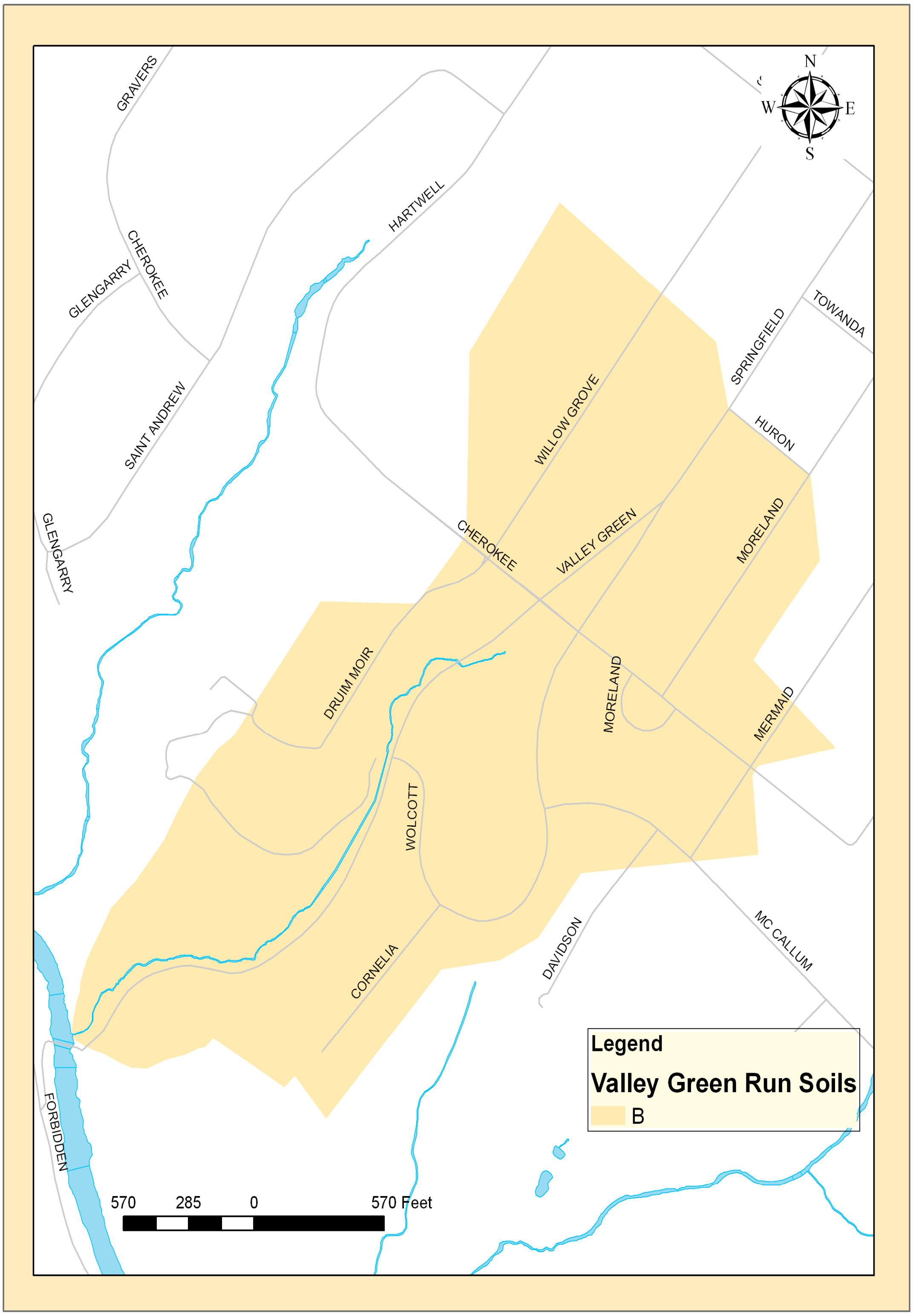


Figure 3-25: Distribution of NRCS Soil Types in Valley Green Run Watershed

3.1.4.3 BANK EROSION

There were two bank pin locations along Valley Green Run (Figure 3-26). The calculated erosion rates are included in Table 3-26. The spatial distribution of BEHI assessment results were represented graphically (Figure 3-26) for each of the segments assessed on Valley Green Run. Each bank within a respective segment was assessed and rated separately; however, channelized and culverted segments were not assessed as they confer a high degree of protection from bank erosion.

Table 3-26: Valley Green Run Bank Pin Locations

	BEHI	NBS	Baseline Reading	Most Recent Reading	Erosion Rate (ft)	Erosion Rate (ft/yr)	Eroding (-) or Aggrading (+)
Valley Green Run							
VG4	High	Low	11/15/2006	8/13/2008	0.15	0.085	A
VG8	High	Low	11/15/2006	8/10/2009	-0.40	-0.15	E

Total erosion rates were also calculated for the entire length of each tributary within the lower Wissahickon (Table 3-27). To assess the normalized erosion potential of each tributary, the erosion rate per acre of drainage area per year and the erosion rate per foot of stream length per year were calculated. This allowed direct comparison between each of the tributaries with respect to both watershed size and the length of the tributary. Valley Green Run was ranked ninth out of the twelve tributaries within the lower Wissahickon for erosion rate per foot of stream length. The rankings were based on a scale of one being the highest erosion rate and twelve being the lowest erosion rate.

Table 3-27: Erosion Rates for Lower Wissahickon Tributaries

Tributary	Drainage Area (Acres)	Stream Length (feet)	*2009*		
			Erosion Rate (lb/yr)	*Erosion Rate Per Acre*	*Erosion Rate Per Foot of Stream*
Bell's Mill	323	6,722	420,000	1,307	63
Cathedral Run	160	2,790	150,000	913	52
Cresheim Creek	1,218	16,431	840,000	690	51
Gorgas Run	499	2,170	170,000	345	79
Hartwell Run	217	3,530	200,000	918	56
Hillcrest	144	5,272	90,000	597	16
Kitchen's Lane	234	7,753	200,000	850	26
Monoshone Creek	1,056	6,926	160,000	156	24
Rex Ave	137	1,903	150,000	1,131	81
Thomas Mill Run	104	4,008	320,000	3,058	79
Valley Green Run	128	2,874	140,000	1,086	48
Wise's Mill Run	446	7,056	490,000	1,090	69
Total/*Average*	**4,666**	**67,435**	**3,300,000**	***1,012***	***54***

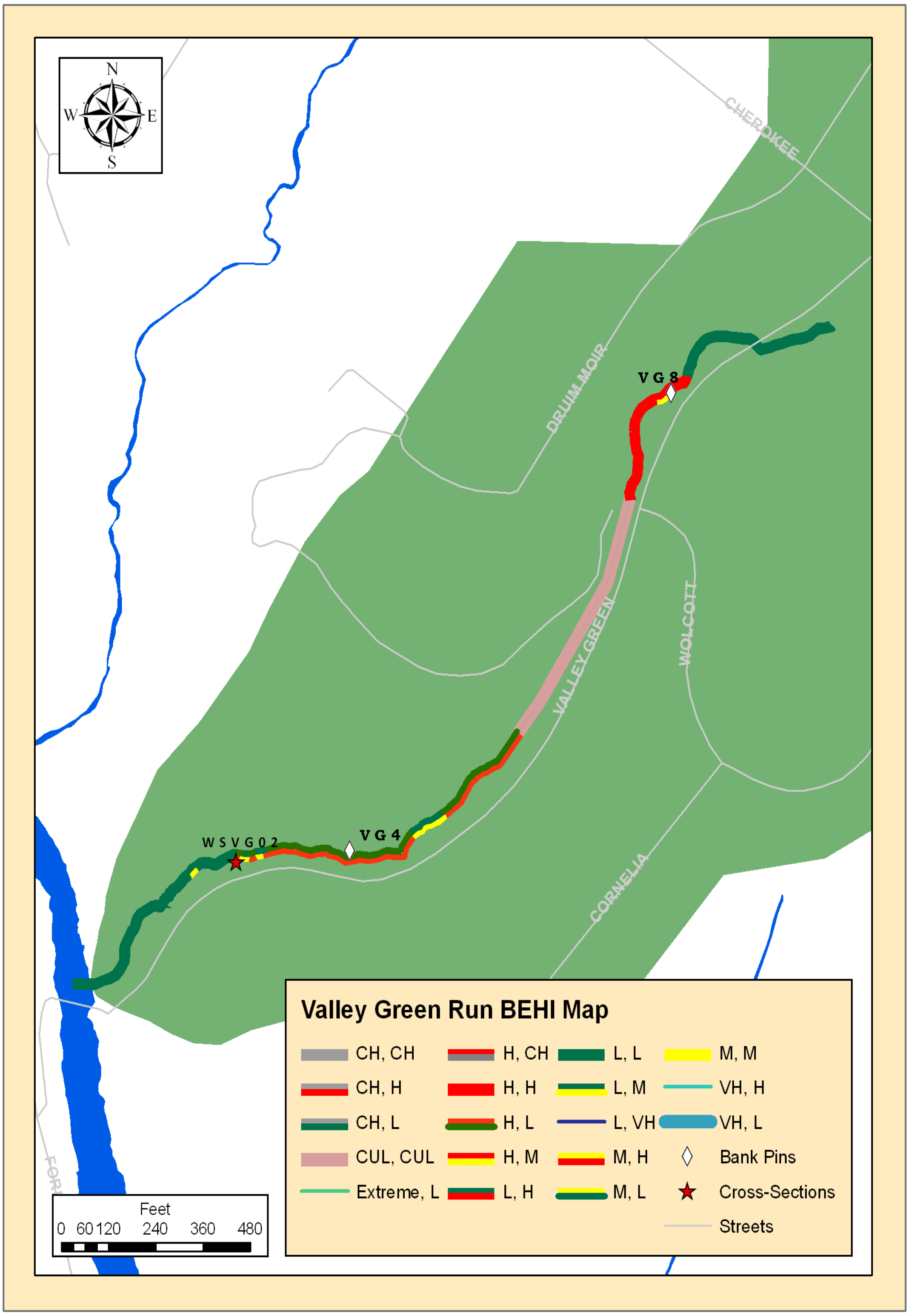


Figure 3-26: Valley Green Run Watershed BEHI Ratings and Bank Pin Locations

3.1.4.4 INFRASTRUCTURE TRACKDOWN SUMMARY

Most of Valley Green Run flows through Fairmount Park although the upper third of Valley Green Run flows through a wooded area that is not Park land. The wooded area on the DSL of this upper portion is vacant land owned by the Natural Lands Trust whereas the land on the DSR is owned by the Springside School. Valley Green Road runs parallel to the stream from the headwaters near Cherokee Street to the confluence with the main stem of Wissahickon Creek. Stormwater runoff from Cherokee Street and Valley Green Road was conveyed through four outfalls (Table 3-28) on the stream. None of these outfalls had very much dry weather flow, as WSout523 (W-076-10) was observed to have only a trickle of flow during dry weather.

Valley Green Road crosses the stream only once, at the upstream-most culvert WScul102. Culverts impacted this stream to a great extent as 24 percent of Valley Green Run was culverted (Table 3-29). The largest culverted segment was WScul104, which was 643 feet long. This culverted segment has the potential to impact large segments of the stream channel upstream and downstream of the culvert. A culvert of that length creates conditions where flow is constricted leading to the loss of conveyance and increased sediment deposition upstream of the culvert as well as high rates of scour at the downstream end. WScul105 was built to protect a 45-inch sanitary interceptor pipe and to convey the flow of Valley Green Run underneath it. Upstream of WScul105, a 15-inch sanitary sewer line runs parallel to the creek below Valley Green Road and discharges into the 45-inch Wissahickon High Level Interceptor next to WScul105.

The density and prevalence of infrastructure within the reach indicates that impairments within this tributary are likely magnified by stormwater flows. None of the infrastructure elements were identified as being in poor condition. There were also two small ephemeral channels that drained into Valley Green Run (WScon166 on DSL and WScon167 on DSR). During the infrastructure trackdown, flow was not observed in these channels although it is highly likely that these channels convey concentrated flow from overland runoff during wet weather events.

Table 3-28: Summary of Valley Green Run Infrastructure Points

Section ID	Culvert Count	Bridge Count	Outfall Count	Confluence Count	Infra Point Count	Combined Outfall Area (ft^2)
WSVG02	3	1	4	2	8	15.93

Table 3-29: Summary Valley Green Run Infrastructure Linear Features

Section ID	Segment Length (ft)	Culvert Length (ft)	Percent Culverted	Channel Length (ft)	Percent Channelized
WSVG02	2849	671	23.6	0	0

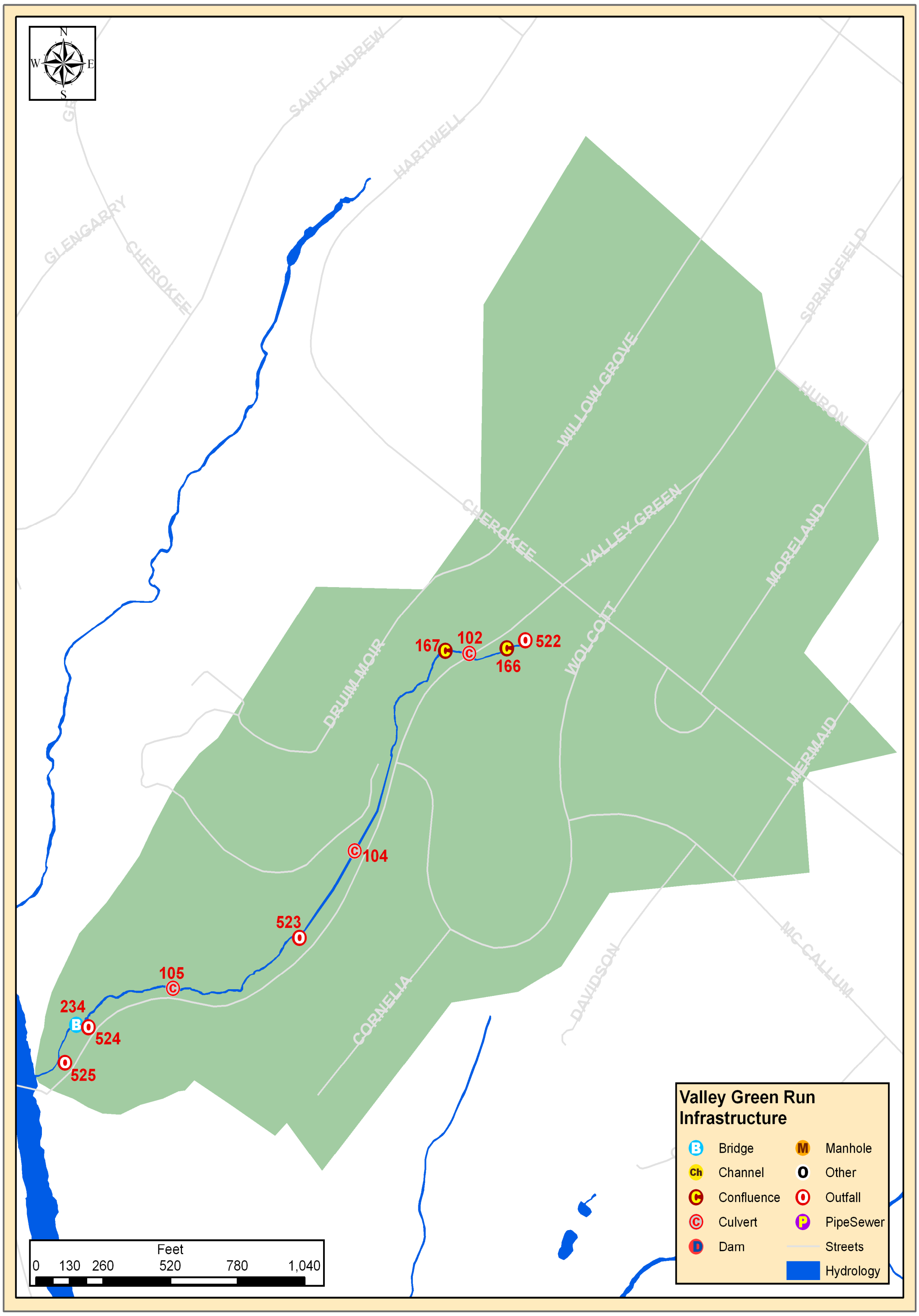


Figure 3-27: Valley Green Run Infrastructure Locations

3.1.4.5 UNIFIED STREAM ASSESSMENT RESULTS FOR THE VALLEY GREEN RUN WATERSHED

The majority of the first-order main stem channel of the Valley Green Run watershed is located within Fairmount Park. The upstream-most third of the channel was located outside of Fairmount Park, although the land cover abutting this segment of channel was forested. The Center for Watershed Protection's (CWP) Unified Stream Assessment Methodology (USAM) was used to score and rate the instream, riparian buffer and floodplain conditions of the stream corridor to allow for comparison to other reaches and watersheds within the Lower Wissahickon Basin.

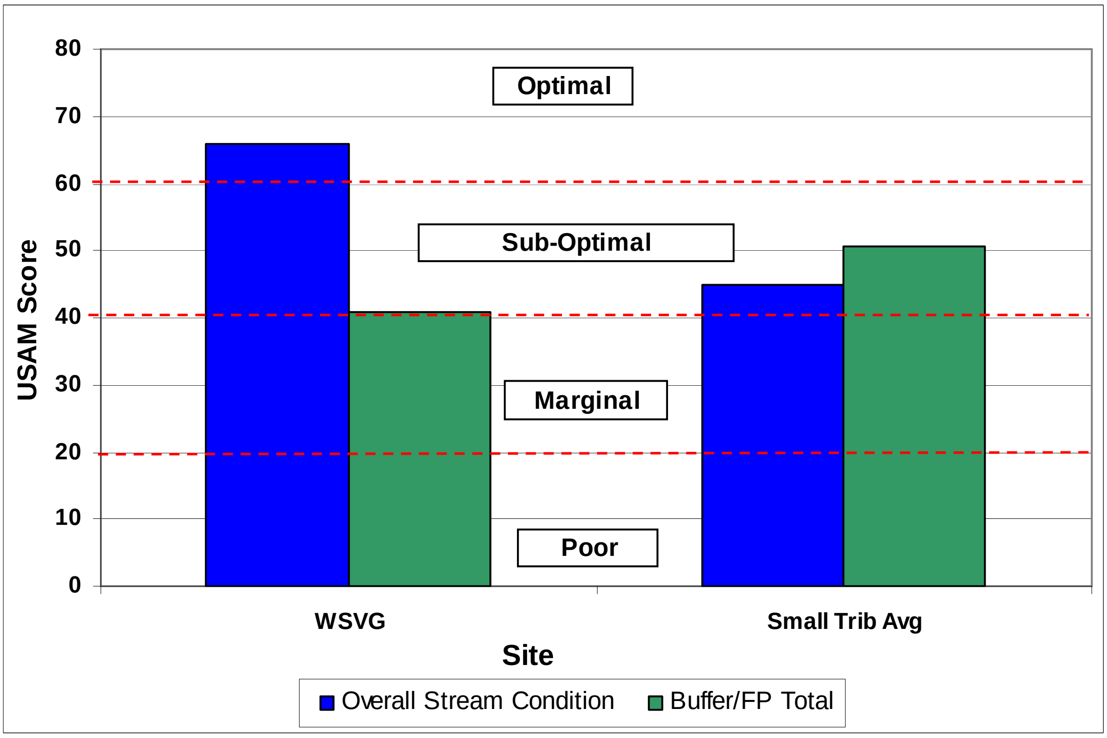


Figure 3-28: Results for Valley Green Run USAM Components

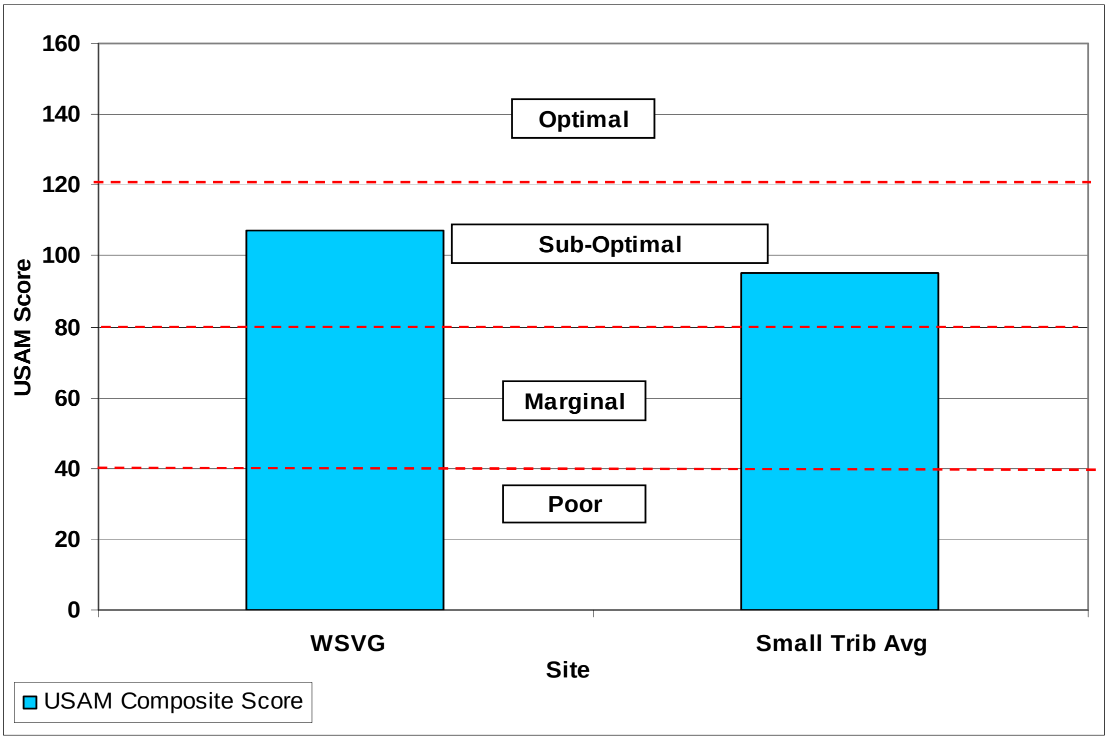


Figure 3-29: Valley Green Run USAM Results

3.1.4.5.1 WSVG02

The headwaters of reach WSVG02 began as flow from a privately owned outfall, WSout522, about 200 feet southwest of Cherokee Road. The total length of the main stem channel was 2,849 feet. The bankfull channel was rather small (6.9 ft^2) with an estimated bankfull capacity of 34.3 cfs. The bankfull discharge to drainage area ratio for WSVG02 was 180.5 cfs/mi^2, which was slightly below the median observation for the Lower Wissahickon Basin (185.6 cfs/ mi^2). The observed stream bed substrate distribution had a nearly equal proportion of gravel (44%) and cobble (37%), with sand (16%) and boulder (1%) particles represented in much smaller proportions. The stream was characterized by a relatively high width to depth ratio (18.9) and a moderately entrenched channel (ER=1.4) such that the reach was classified as a B4/a channel type. The USAM composite score (Figure 3-29) for the reach was 107/160.

3.1.4.6 SUMMARY OF UNIFIED STREAM ASSESSMENT RESULTS

The mean watershed scores for both the individual USAM components as well as the overall USAM score ranged from sub-optimal to optimal (Table 3-30). Average conditions within the Valley Green Run watershed's stream channels were considerably better than the conditions observed within the buffers and floodplains. For the *Overall Stream Condition* component, Valley Green Run scores were much higher than the Small Tributary average for all four parameters (Table 3-31). In fact, Valley Green Run had the highest *Overall Stream Condition* score among all the small Lower Wissahickon tributaries. The Small Tributary average was higher than Valley Green Run scores for all *Overall Buffer/Floodplain Condition* parameters except for the *Floodplain Habitat* and the right bank *Vegetated Buffer Width* parameters; however, the USAM composite score for Valley Green Run (107/160) was considerably higher than the mean Small Tributary USAM score of 95.4/160 which was classified as "suboptimal."

Table 3-30: USAM Results for Valley Green Run Watershed

Reach ID	Sub-watershed	Overall Stream Condition	Overall Buffer/FP Condition	USAM Score
WSVG02	Valley Green	66	41	107
Small Tributary Average	**----**	**44.8**	**50.6**	**95.4**

3.1.4.6.1 SUMMARY OF OVERALL STREAM CONDITION SCORES IN THE VALLEY GREEN RUN WATERSHED

The *Overall Stream Condition* score for the Valley Green Run watershed was the highest score recorded among the small Lower Wissahickon tributaries (107/160) and was rated as "optimal." Each parameter of this component was considerably higher than the small tributary average (Table 3-31). The most notable disparity in scores was for the *Floodplain Connection* parameter in which the watershed score (17/20) was rated as "optimal" compared to the small tributary average (9/20) which was rated as "marginal."

Table 3-31: USAM Overall Stream Condition Scoring for Valley Green Run Watershed

OVERALL STREAM CONDITION								
Reach ID	Sub-watershed	Instream Habitat	Vegetative Protection		Bank Erosion		Floodplain Connection	Overall Stream Condition
			Left	Right	Left	Right		
WSVG02	Valley Green	18	8	8	7	8	17	66
Small Tributary Average	**----**	**15.8**	**4.4**	**4.2**	**5.6**	**5.8**	**9**	**44.8**

3.1.4.6.1.1 INSTREAM HABITAT

Instream habitat in Valley Green Run was characterized by an abundance of stable habitat features such as cobble and boulder substrate as well as CWD of various sizes and levels of conditioning. The dominant substrate particle class was gravel (44%) although the vast proportion of the gravel in the reach was medium (8-11 mm) to very coarse gravel (32-64 mm). Larger-sized gravels offer moderate stability, but when interspersed with cobbles and boulders, these particles can create a considerable amount of interstitial spaces which serve as optimal habitat for benthic macroinvertebrates. The score of 18/20 was rated as "optimal" and was considerably higher than the Small Tributary average of 15.8/20 (Table 3-31).

3.1.4.6.1.2 VEGETATIVE PROTECTION

Scores for both the left and right banks (8/20) were rated as "marginal" although they were considerably higher than the left (4.4/20) and right (4.2/20) bank Small Tributary averages which were rated as "poor." The vegetative cover along the banks of Valley Green Run was abundant, however it had a patchy distribution due to the rocky soil along the banks as well as localized erosion.

3.1.4.6.1.3 BANK EROSION

Bank erosion was moderate within Valley Green Run as scores for the left (7/10) and right (8/10) banks were both rated as "suboptimal." In comparison, the left (5.6/10) and right (5.8/10) bank Small Tributary averages were both rated as "marginal" (Table 3-31). The abundance of boulders and large cobbles along the margins of the creek conferred extensive protection against localized scour in many segments of the reach.

3.1.4.6.1.4 FLOODPLAIN CONNECTION

The *Floodplain Connection* parameter was one of the highest scoring parameters for the Valley Green Run *Overall Stream Condition* component with a score of 17/20 (Table 3-31). The score was the highest recorded among the small tributaries and was second highest score recorded in the Lower Wissahickon (reaches WSHC02 and WSKL06 both scored 18/20).

3.1.4.6.2 SUMMARY OF OVERALL BUFFER AND FLOODPLAIN CONDITION SCORES IN THE VALLEY GREEN RUN WATERSHED

The *Overall Buffer and Floodplain Condition* score for the Valley Green Run watershed (41/80) were rated at the low end of the "suboptimal" range of scores. The Small Tributary averages were higher than scores for Valley Green Run (Table 3-31) for all parameters except for *Floodplain Habitat* which was considerably higher in Valley Green Run although the score of 8/20 was rated as "marginal." The *Vegetated Buffer Width* score for the left side of the corridor (5/10) was rated as "marginal" and was the lowest score among all Small Tributaries. The low scores for this as well as the *Floodplain Encroachment* parameter were attributed to the presence of Valley Green Road along the entire DSL extent of the corridor.

Table 3-32: USAM Buffer and Floodplain Condition Scoring for Valley Green Run Watershed

OVERALL BUFFER AND FLOODPLAIN CONDITION							
Reach ID	**Sub-watershed**	**Vegetated Buffer Width**		**Floodplain Vegetation**	**Floodplain Habitat**	**Floodplain Encroachment**	**Overall Buffer/FP Condition**
		Left	**Right**				
WSVG	Valley Green	5	9	15	8	4	41
Small Tributary Average	**----**	**9**	**8.8**	**16.2**	**5.6**	**11**	**50.6**

3.1.4.6.2.1 VEGETATED BUFFER WIDTH

The vegetated buffer on the downstream right side of Valley Green run was relatively extensive and uninterrupted and as such was given a score of 9/10, which was rated as "suboptimal" (Table 3-32). The downstream left vegetated buffer was impinged upon by Valley Green Road throughout the length of the reach. In some segments of the reach, the road was within twenty feet of the channel. The score for the DSL side of the corridor (5/10) was rated as "marginal" and was the lowest score observed among the small tributaries.

3.1.4.6.2.2 FLOODPLAIN VEGETATION

The dominant floodplain vegetation type throughout reach WSVG02 was young forest. Saplings of early successional and understory species had dense distributions throughout the watershed, although there were distinct stands of mature trees observed. The score for the watershed (15/20) was rated as "suboptimal", slightly lower than the small tributary average score (16.2/20) which was rated as "optimal" (Table 3-32).

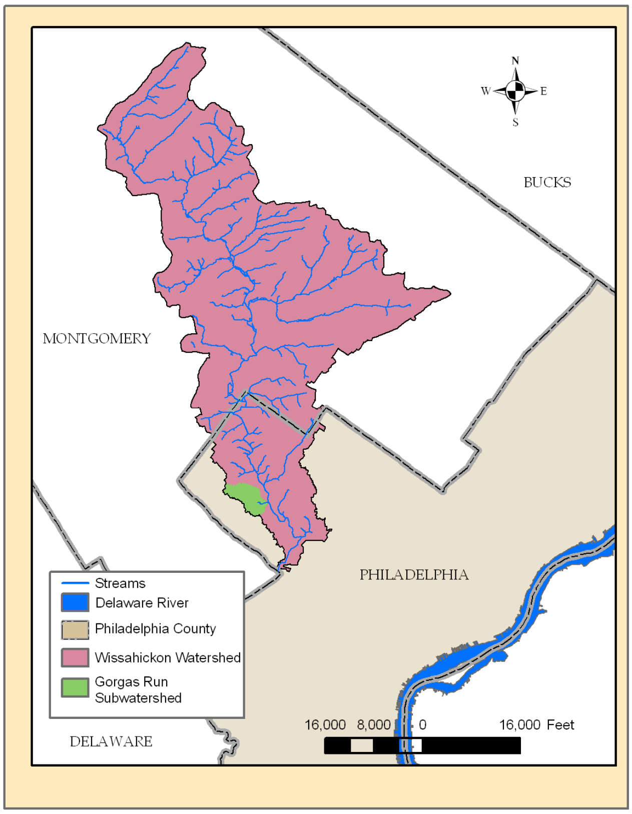
3.1.4.6.2.3 FLOODPLAIN HABITAT

Floodplain habitat was limited within the reach, likely due to the high floodplain bench observed throughout many segments of the reach. These high "benches" preclude the floodplain inundation that creates habitat features such as wetlands, ephemeral pools and backwater channels. The score for reach WSVG02 was 8/20 and was rated as "marginal," which was considerably higher than the small tributary average (5.6/20) which was rated at the low end of the "marginal" range of scores (Table 3-32).

3.1.4.6.2.4 FLOODPLAIN ENCROACHMENT

The presence of Valley Green Road on the DSL side of the corridor fragmented the floodplain and as such had an adverse impact on floodplain function. The DSR side of the corridor was relatively obstruction free; however, the extent of the fragmentation and obstruction on the DSL side of the corridor attributed to the low score for this reach. The score of 4/20 was rated as "poor" (Table 3-32) and was the lowest score recorded among the small Lower Wissahickon tributaries.

3.1.5 GORGAS RUN WATERSHED AND REACH CHARACTERISTICS



Gorgas Run is a tributary to the main stem of the Wissahickon Creek. Gorgas Run is a first-order tributary that is approximately 2,170 feet long. The stream originates from springs approximately 300 feet east of the end of Gorgas Lane. The tributary travels another 225 feet until stormwater outfall (WSout566), which is a 60" x 72" reinforced concrete pipe, discharges into Gorgas Run. The dominant substrate varies from course gravel to medium cobble material. Both the valley floor and channel have been substantially impacted by past and current land use within the watershed.

The Gorgas Run watershed is 499 acres. Major land use types within the watershed (Figure 3-30) include: wooded (53%), residential – row home (19%), residential – single family detached (12%), and residential – multi-family (9%). Gorgas Run is surrounded by Fairmount Park on both sides for the entire length. The Park buffer ranges from about 50 feet to about 2,000 feet.

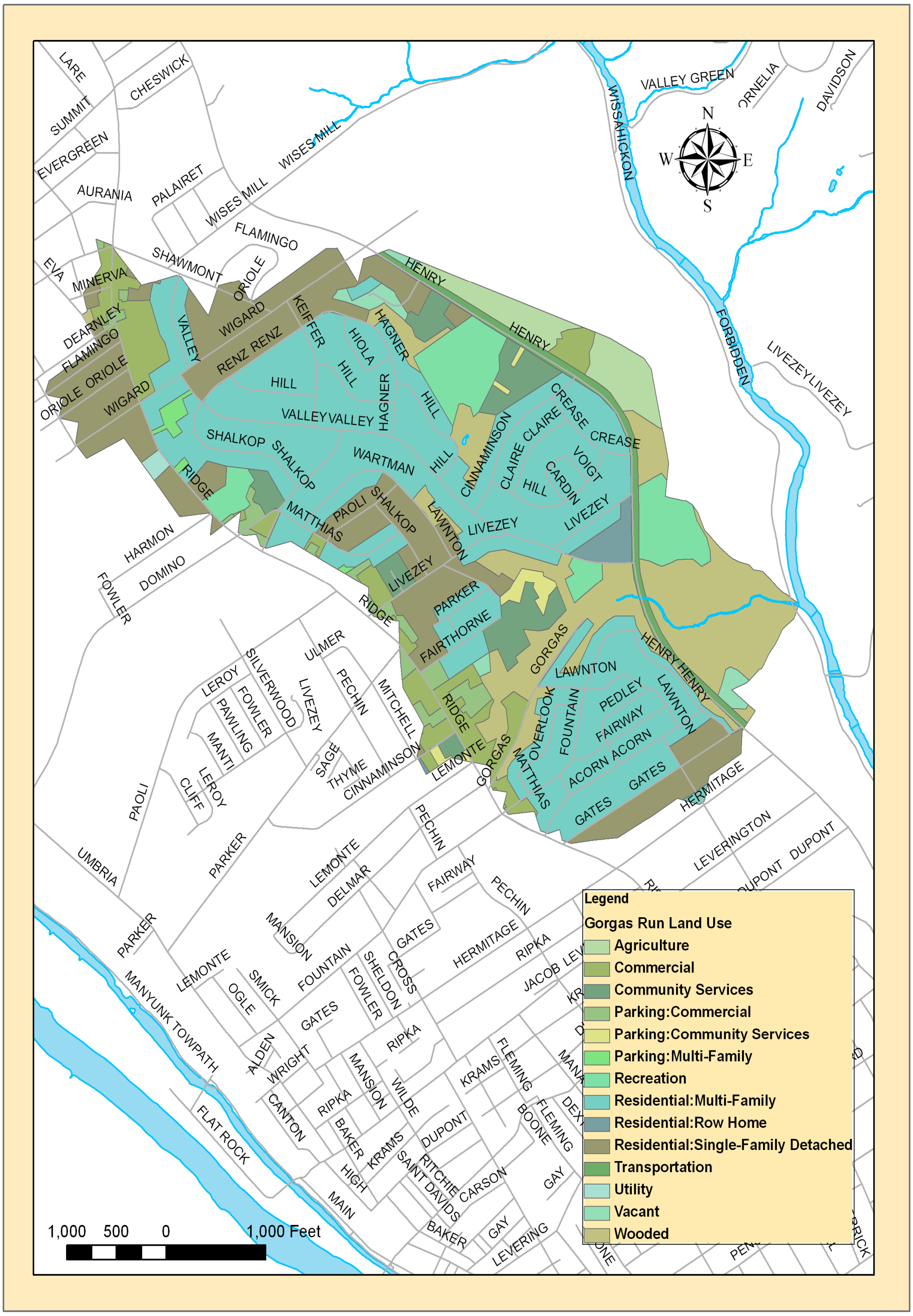


Figure 3-30: Gorgas Run Watershed Land Use

3.1.5.1 GEOLOGY

The Gorgas Run watershed is entirely underlain by the Wissahickon Formation (Figure 3-31). The Wissahickon Formation consists of mica schist, gneiss and quartzite. The exposed schist near the surface is highly weathered. The Wissahickon Formation is also comprised of metamorphosed sedimentary rocks.

3.1.5.2 SOILS

According to the National Resource and Conservation Service Soil Survey, the majority of soils for the Gorgas Run watershed are classified as hydrologic group B (Figure 3-32). These soils have a moderate rate of infiltration when the soils are wet (0.50-1.00 in/hr). Water movement through these soils is considered moderately rapid. There is a small band of group D soils along Gorgas Run (Table 3-33). These soils have a very slow rate of infiltration when saturated (0.02-0.10 in/hr) resulting in a high runoff potential.

There is a small section of C soils located on the northeast corner of the watershed. Group C soils are also located along Gorgas Run towards the confluence with Wissahickon Creek. Group C soils have a slow rate of infiltration when saturated (0.17-0.27 in/hr). Water movement through these soils is moderate or moderately slow.

Table 3-33: Distribution of NRCSS Soil Types in Gorgas Run Watershed

Group	Area (ft^2)	Percent of Total Area
B	21,571,243	99.24%
C	84,772	0.39%
D	80,424	0.37%
Total Area	**21,736,439**	**100%**

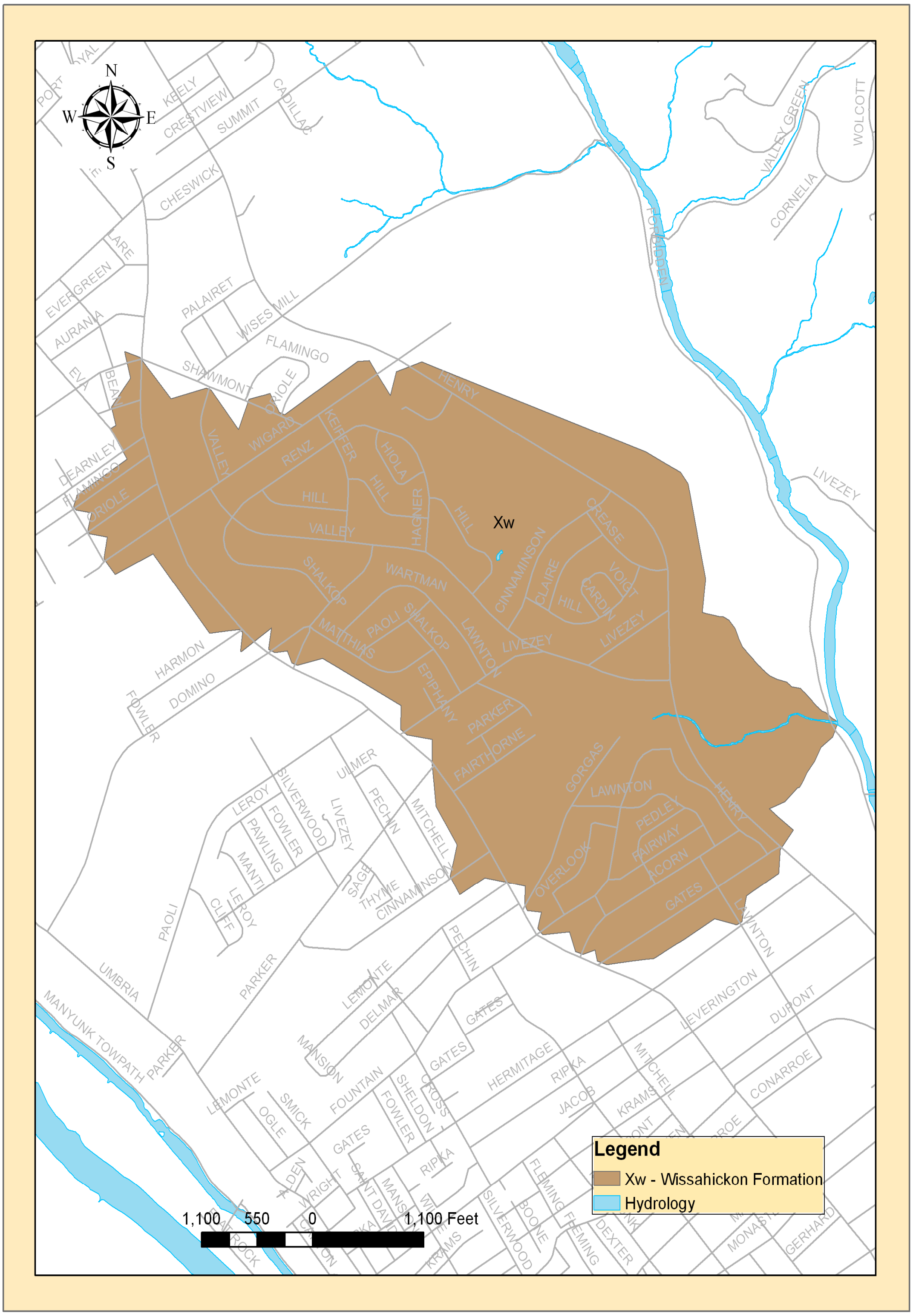


Figure 3-31: Geology of Gorgas Run Watershed

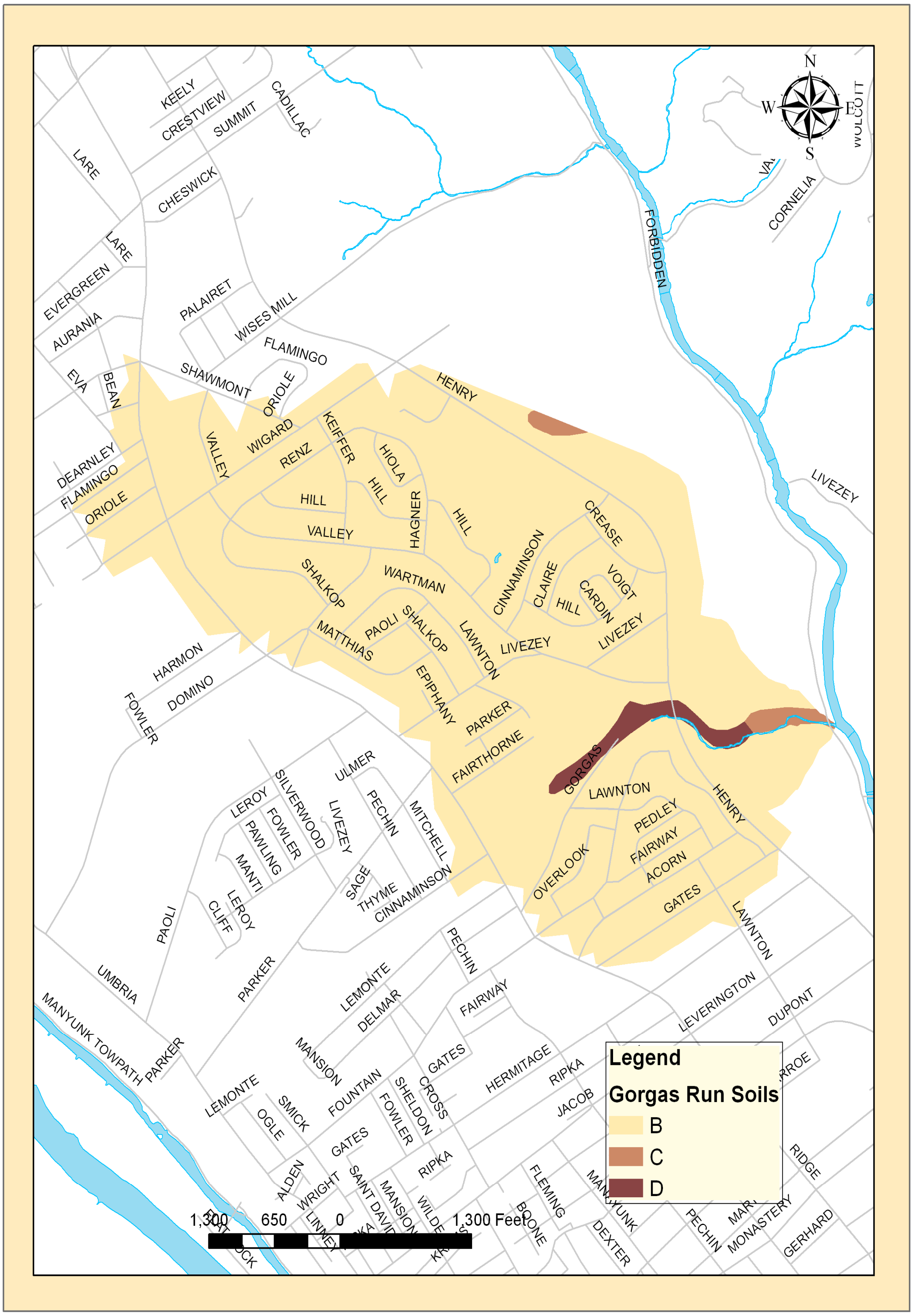


Figure 3-32: Distribution of NRCS Soil Types in Gorgas Run Watershed

3.1.5.3 Bank Erosion

There was one bank pin location along Gorgas Run (Figure 3-33). The calculated erosion rates are included in Table 3-34. The spatial distribution of BEHI assessment results were represented graphically (Figure 3-33) for each of the segments assessed on Gorgas Run. Each bank within a respective segment was assessed and rated separately; however, channelized and culverted segments were not assessed as they confer a high degree of protection from bank erosion.

Table 3-34: Gorgas Run Bank Pin Locations

	BEHI	NBS	Baseline Reading	Most Recent Reading	Erosion Rate (ft)	Erosion Rate (ft/yr)	Eroding (-) or Aggrading (+)
Gorgas							
GO790	Low	Very Low	4/24/2007	8/13/2009	-0.66	-0.29	E

Total erosion rates were also calculated for the entire length of each tributary within the lower Wissahickon (Table 3-35). To assess the normalized erosion potential of each tributary, the erosion rate per acre of drainage area per year and the erosion rate per foot of stream length per year were calculated. This allowed direct comparison between each of the tributaries with respect to both watershed size and the length of the tributary. Gorgas Run was ranked second out of the twelve tributaries within the lower Wissahickon for erosion rate per foot of stream length. The rankings were based on a scale of one being the highest erosion rate and twelve being the lowest erosion rate.

Table 3-35: Erosion Rates for Lower Wissahickon Tributaries

Tributary	Drainage Area (Acres)	Stream Length (feet)	*2009*		
			Erosion Rate (lb/yr)	*Erosion Rate Per Acre*	*Erosion Rate Per Foot of Stream*
Bell's Mill	323	6,722	420,000	1,307	63
Cathedral Run	160	2,790	150,000	913	52
Cresheim Creek	1,218	16,431	840,000	690	51
Gorgas Run	499	2,170	170,000	345	79
Hartwell Run	217	3,530	200,000	918	56
Hillcrest	144	5,272	90,000	597	16
Kitchen's Lane	234	7,753	200,000	850	26
Monoshone Creek	1,056	6,926	160,000	156	24
Rex Ave	137	1,903	150,000	1,131	81
Thomas Mill Run	104	4,008	320,000	3,058	79
Valley Green Run	128	2,874	140,000	1,086	48
Wise's Mill Run	446	7,056	490,000	1,090	69
Total/*Average*	**4,666**	**67,435**	**3,300,000**	***1,012***	***54***

Figure 3-33: Gorgas Run Watershed BEHI Ratings and Bank Pin Locations

3.1.5.4 INFRASTRUCTURE TRACKDOWN SUMMARY

Gorgas Run is a tributary to Wissahickon Creek that exists entirely within Fairmount Park; although, the stream is heavily influenced by infrastructure due to its vicinity to the residential neighborhoods in the watershed. There were 39 infrastructure elements identified on or near the creek with the most influential infrastructure elements being the 7 bridges, 6 channels, 5 outfalls, and 16 manholes (Table 3-36).

Many of the structures found during the assessment were associated with storm and sanitary sewers aligned parallel to the stream channel. A 15-inch vitrified clay sanitary line runs parallel to the channel from Gorgas Lane to the Wissahickon Low Level Interceptor near Forbidden Drive. A 12-inch sanitary line from Fountain Street connects with the 15-inch sanitary line upstream of WSbri247. Three large outfalls (WSout566, WSout762, and WSout764) were found near the creek that conveyed substantial volumes of stormwater to the channel. WSout566 (W-067-01), identified as the headwaters of Gorgas Run, discharges flow from a 6-foot diameter concrete pipe that drains the neighborhood surrounding Valley Avenue to the north and a 48-inch diameter brick pipe from Gorgas Lane to the west. The runoff from Fountain Street, to the southwest of Gorgas Run, is collected by a 42-inch brick storm sewer and is discharged from WSout764 (W-067-02). WSout762 (W-067-03) conveys runoff from Henry Avenue and the adjacent neighborhood to a small, steep tributary (unnamed tributary A) to Gorgas Run. WSout764 is 48 inches in diameter and discharges from a concrete pipe that runs under Henry Avenue. Outfalls WSout566 and WSout764 had dry weather flow during the assessment. All of the 16 manholes found during the study were affiliated with the storm or sanitary sewers in the corridor.

Of the seven bridges identified during the study, three of them were particularly important. Bridges WSbri247, WSbri248, and WSbri249 all span the main channel of Gorgas Run. These bridges create unfavorable hydraulic conditions upstream and downstream of their abutments such that the capacity to transmit peak flows and sediment downstream has been diminished. As a result, bedload sediment consisting of small to large cobble has been deposited upstream of these abutments. At WSbri248 such deposition, especially on the inside of the meander bend (downstream right), has adversely affected the alignment of the channel such that the majority of the streamflow is transmitted through the main span of the bridge and only a trickle of flow is transmitted through the “barrel” culvert on the downstream right. At WSbri247 high flows have been observed to overtop the bridge causing severe scour and degradation of the banks and stone “wing walls” upstream and downstream of WSbri247. The channelized segments within the Gorgas Run main stem and tributaries are another issue that needs to be addressed. There are several rather significant channelized portions within the Gorgas Run stream network (WScha282, Wscha142, and three channels downstream of WSout762). The discharge from WSout764 flows down WScha282 which is a steep, concrete half-pipe for about 200 feet before reaching the stream. During extreme storm events, it has been observed that storm flows escape the downstream portion of the channel and flow down the hill slope towards Gorgas Run causing the formation of rills adjacent to WScha282. These rills have been filled with stone to prevent undermining of the structure.

The stone channels downstream of WSout762, WScha280, WScha284, and WScha285, line the tributary downstream of the outfall for about 35 feet. The bottom (WScha280) and downstream left (WScha285) channels are in poor condition as the last five feet of the channel have broken off. WScha142 is an approximately 12-foot stone channel that lines the main stem of Gorgas Run for about 200 feet upstream of WSbri249 at Forbidden Drive. This channel is in poor condition as part of the wall and associated trail fencing had collapsed into the stream.

Priority infrastructure (Figure 3-36) on Gorgas Run included WScha280 (Figure 3-34), WScha285, WScha142 (Figure 3-34), and WSman57 which had no manhole cover and an exposed pipe orifice.


Figure 3-34: Degraded section of WScha280 (left). Degraded section of WScha142 (right).

Table 3-36: Summary of Gorgas Run Infrastructure Points

Section ID	Culvert Count	Bridge Count	Outfall Count	Channel Count	Confluence Count	Dam Count	Manhole Count	Pipe Sewer Count	Other Count	Infra Point Count	Combined Outfall Area (ft^2)
WSGO02	1	7	5	6	1	1	16	1	2	39	64.06

Table 3-37: Summary Gorgas Run Infrastructure Linear Features

Section ID	Segment Length (ft)	Segment Length (ft), 3 sides	Culvert Length (ft)	Percent Culverted	Channel Length (ft), 1 side	Channel Length (ft), 3 sides	Channel Length (ft)	Percent Channelized
WSGO02	2699	8097	8	0.3	218	215	863	3.3

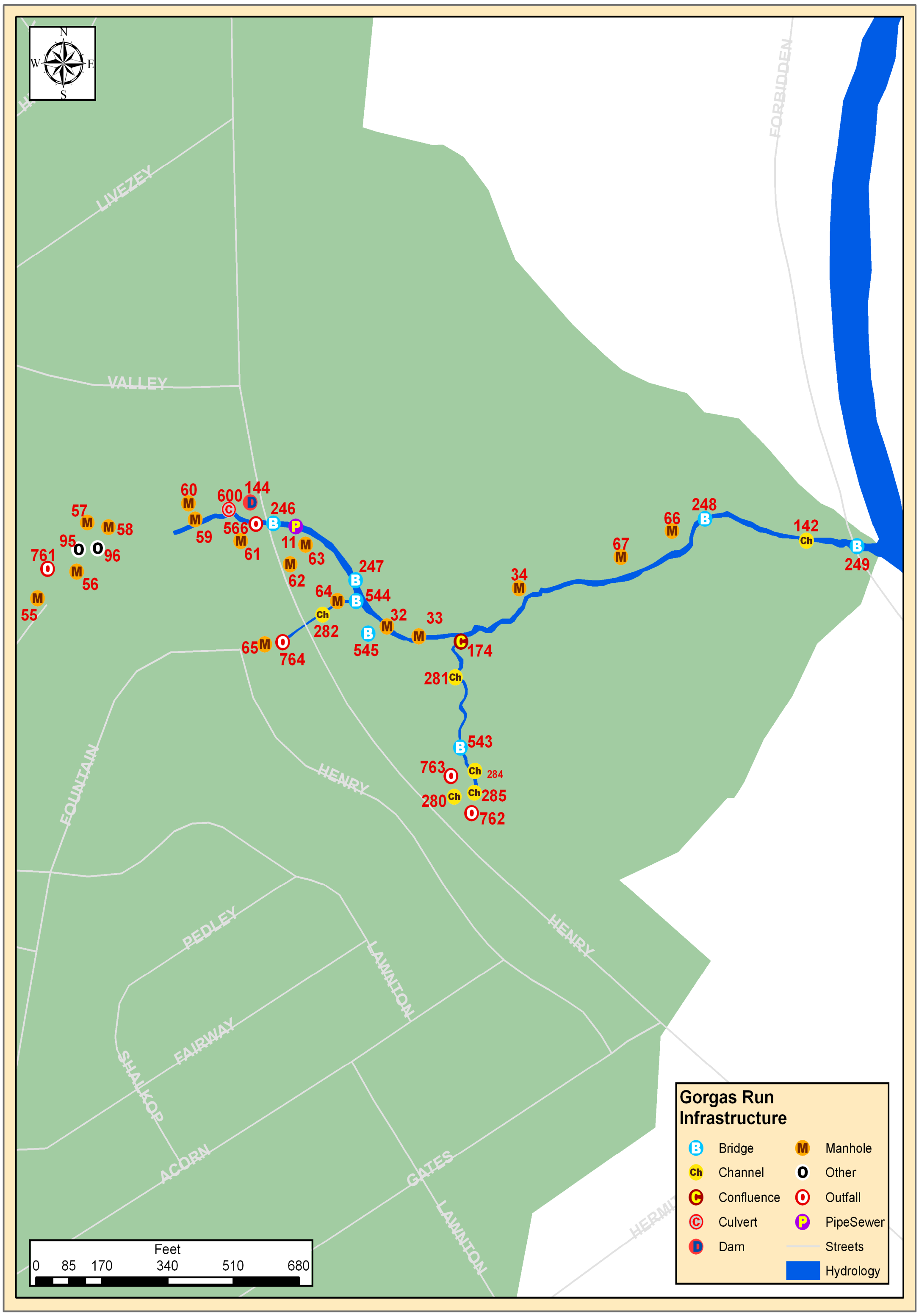


Figure 3-35: Gorgas Run Infrastructure Locations

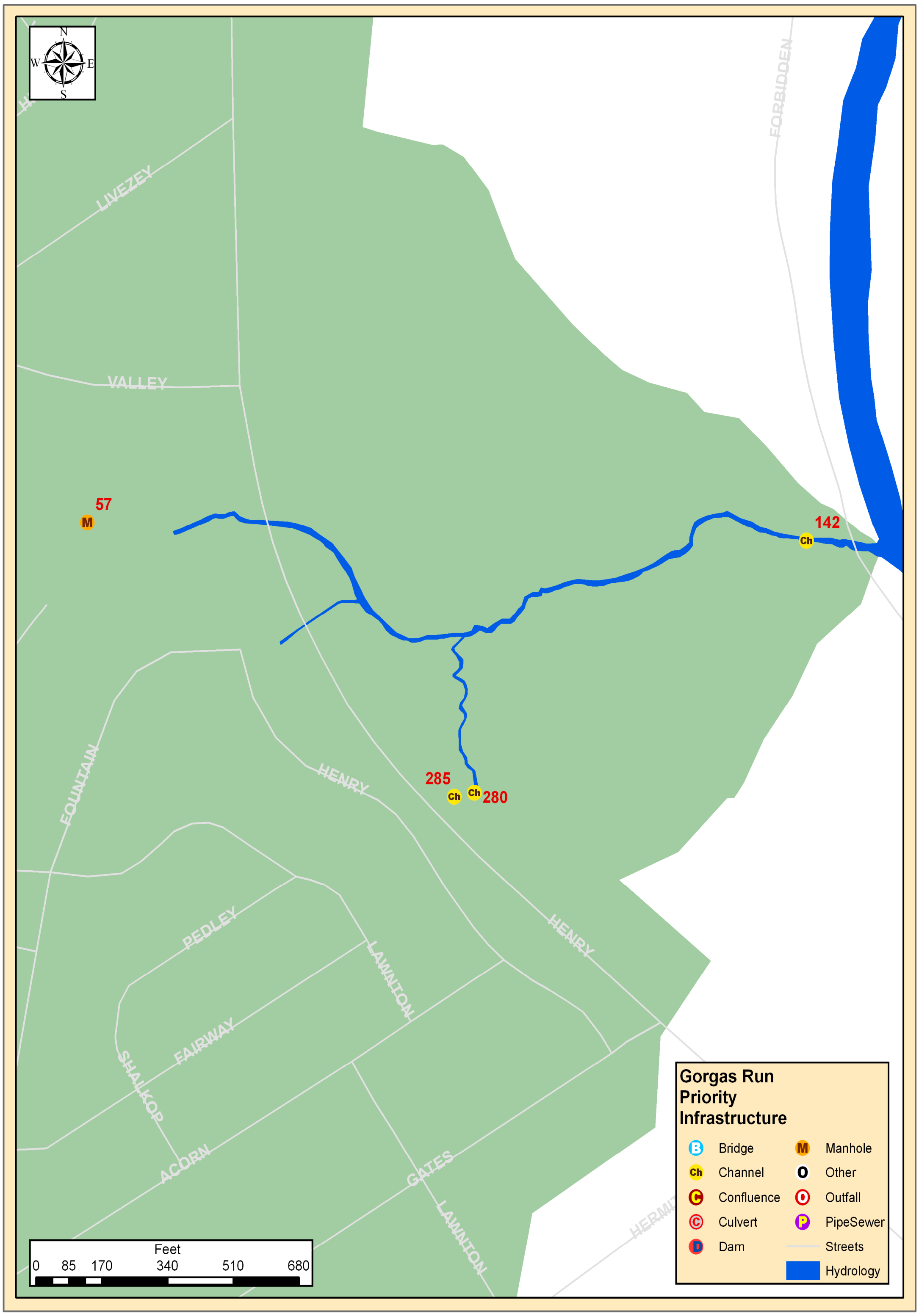


Figure 3-36: Gorgas Run Priority Infrastructure Locations

3.1.5.5 Unified Stream Assessment Results for the Gorgas Run Watershed

The Gorgas Run stream channel is a first-order, single thread channel with no tributaries. The majority of the channel is located entirely within Fairmount Park with the exception of an approximately 230-foot segment of the channel upstream of WSout566 (W-067-01). Gorgas Run is the last major tributary on the DSR side of the basin's corridor. The Center for Watershed Protection's (CWP) Unified Stream Assessment Methodology (USAM) was used to score and rate the instream, riparian buffer and floodplain conditions of the stream corridor to allow for comparison to other reaches and subwatersheds within the Lower Wissahickon Basin.

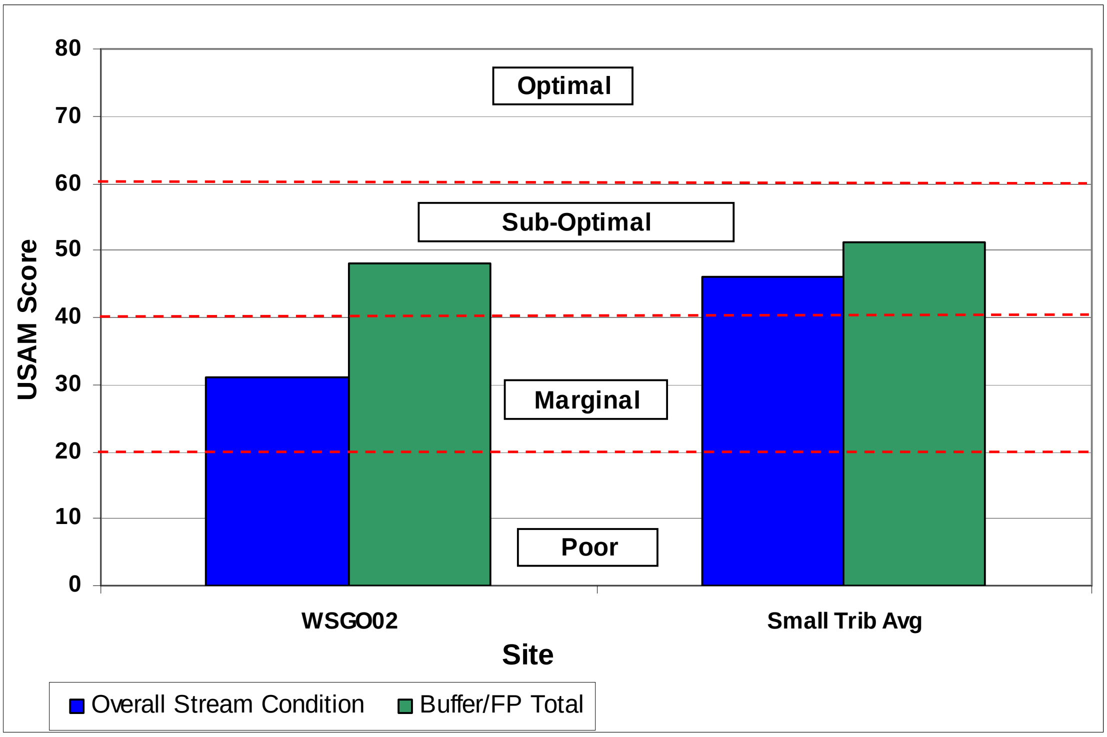


Figure 3-37: Results for Gorgas Run USAM Components

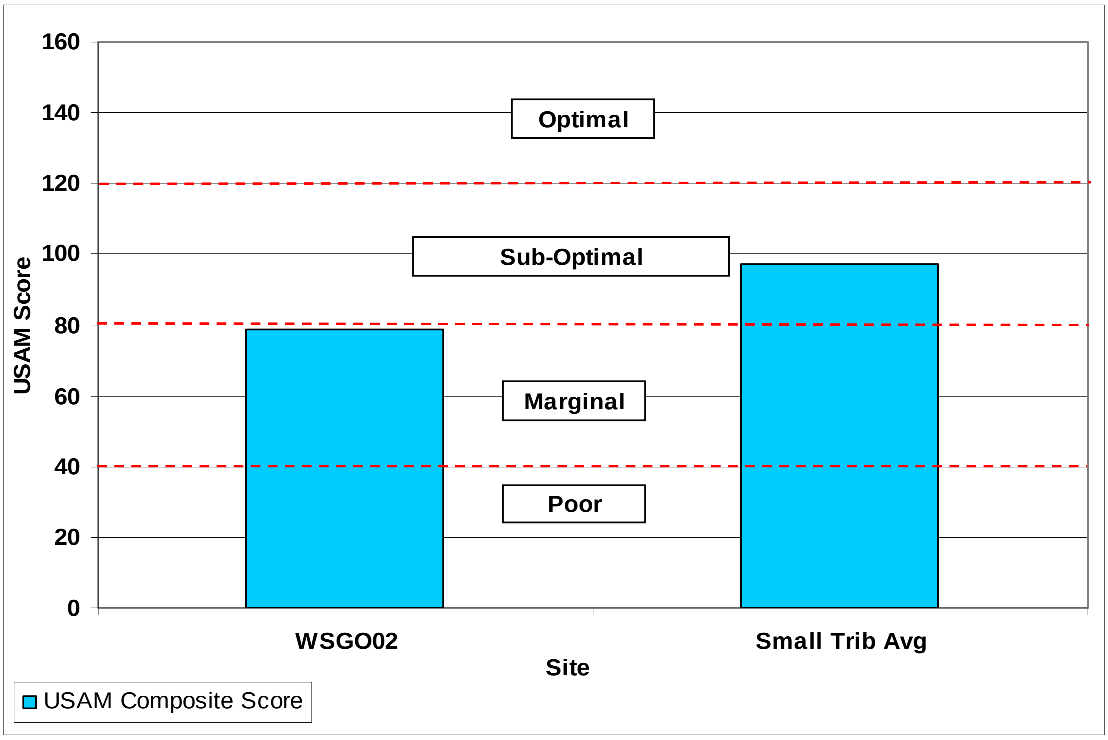


Figure 3-38: Gorgas Run USAM Results

3.1.5.5.1 WSGO02

The headwaters of reach WSGO02 begins approximately 230 feet upstream of WSout566 (W-067-01) and Henry Avenue. The channel is fed mainly by runoff from Gorgas Road as well as the trail adjacent to the channel. The main stem channel had a bankfull channel capacity relatively larger than the other small Lower Wissahickon tributaries; however the Gorgas Run drainage area (0.6 mi^2) was also larger than that of the other small tributaries. The bed substrate within the reach was dominated by cobble (62%) with gravel and boulder comprising the remainder of the substrate distribution. Reach WSGO2 was characterized by a deeply entrenched (Entrenchment Ratio=1.1), moderate gradient (slope of 2.9%) channel and a relatively high width to depth ratio (20.9) which classified the reach as an F3b channel type. The USAM composite score for the reach was 79/160 (Figure 3-38).

3.1.5.6 SUMMARY OF UNIFIED STREAM ASSESSMENT RESULTS

The mean watershed scores for the individual USAM components as well as the overall USAM score ranged from marginal to suboptimal (Table 3-38). Average conditions within the Gorgas Run watershed's floodplains and riparian buffers were slightly better conditions observed in stream channels. There was high variability between scores for the respective parameters of the two USAM components as *Overall Stream Condition* rankings ranged from poor to suboptimal and the *Overall Buffer Floodplain* rankings ranged from poor to optimal. Both the USAM component and composite scores (Table 3-38) were below the respective Small Tributary averages.

Table 3-38: USAM Results for Gorgas Run Watershed

Reach ID	Sub-watershed	Overall Stream Condition	Overall Buffer/FP Condition	USAM Score
WSGO02	Gorgas	31	48	79
Small Tributary Average	**----**	**44.8**	**50.6**	**95.4**

3.1.5.6.1 SUMMARY OF OVERALL STREAM CONDITION SCORES IN THE GORGAS RUN WATERSHED

The scores for the parameters within the *Overall Stream Condition* component of the USAM assessment ranged from "poor" to "suboptimal". The *Instream Habitat* parameter was the highest scoring parameter of the four *Overall Stream Condition* parameters at (13/20). The remaining parameters were poor to marginal and were affected by factors external to the stream channel such as infrastructure (e.g. Henry Avenue culvert, numerous footbridges and outfalls) and the large, residential drainage basin which delivers vast amounts of stormwater to the reach. The *Overall Stream Condition* score for Gorgas Run (31/80) was rated as "marginal" and compared poorly to the Small Tributary average of 44.8/80, which was rated as "suboptimal."

Table 3-39: USAM Overall Stream Condition Scoring for Gorgas Run Watershed

OVERALL STREAM CONDITION								
Reach ID	Sub-watershed	Instream Habitat	Vegetative Protection		Bank Erosion		Floodplain Connection	Overall Stream Condition
			Left	Right	Left	Right		
WSGO02	Gorgas	13	3	3	5	5	2	31
Small Tributary Average	**----**	**15.8**	**4.4**	**4.2**	**5.6**	**5.8**	**9**	**44.8**

3.1.5.6.1.1 INSTREAM HABITAT

The condition of the instream habitat observed in reach WSGO02 was rated as "suboptimal" with a score of 13/20, which was considerably lower than the Small Tributary average of 15.8/20, although both were rated as "suboptimal." The physical habitat template observed in the reach was characterized by a relatively high availability of stable substrate (i.e. cobble and boulder) which could be used as protective cover or attachment sites for macroinvertebrates. Pebble count results specify a D_{35} of 64.0 mm which can be interpreted to mean that at least 65% of the available substrate in the reach is larger than small cobble, which ranges in size from 64-90mm. One of the factors that reduced the potential for optimal habitat in the reach was the absence of habitat complexity in that adequate amounts of coarse woody debris (CWD) and undercut banks were not observed in the reach. CWD is a valuable component of the habitat template in a stream as it can provide protection from high flows. Similarly, undercut banks provide optimal habitat for many fish species, yet the past channel incision observed in the reach has precluded or eliminated the formation of undercut bank habitat within some segments of the reach where the "toe" of these banks are well above the active channel.

3.1.5.6.1.2 VEGETATIVE PROTECTION

Scores for the *Vegetative Protection* parameter were considerably low (3/10) for both the right and left banks of the reach and were rated as "poor" (Table 3-39). The reach was characterized as having fewer than 50% of the streambank surface covered by vegetation, which can be attributed to the presence of recreation trails along the length of the reach as well as severe erosion. The Small Tributary averages were moderate with scores of 4.4/10 and 4.2/10 for the left and right banks respectively, as both banks were rated as "marginal."

In many instances, the *Vegetative Protection* parameter was limited in many of the smaller tributaries to Wissahickon Creek by anthropogenic factors. Factors such as floodplain development and channelization alter channel and floodplain dynamics leaving stream channels susceptible to severe bank erosion by storm flows. Aside from delivering excess sediment loads to the channel, severe erosion can trigger a succession of events that propagate increased rates of erosion. Frequent disturbance (i.e. scouring) may preclude the establishment of stable, native plant communities such that invasive species such as Japanese knotweed (*Polygonum cuspidatum*) become established. *P. cuspidatum* has very shallow roots which are poor at stabilizing the soil matrix; furthermore, it is notoriously difficult to eradicate once established. Excessive bank erosion can also produce destabilizing undercut banks which ultimately cause trees to fall into the channel thereby causing more erosion and creating an opportunity for the establishment of non-native vegetation.

3.1.5.6.1.3 BANK EROSION

Bank erosion in WSGO02 was rated as "marginal", with a score of 5/10 (Table 3-39). There was evidence of active channel widening as well as observations of very high erosion rates, however bank erosion has yet to threaten property or infrastructure. Bank erosion within the reach can be attributed to a number of factors. Gorgas Run is channeled through an outfall (WSout566/W-067-01) as it flows beneath Henry Avenue and flows beneath four bridges in its short (2,170 feet) length. Furthermore, the steep slope of the channel (2.9%) and large urbanized drainage area (499 acres) in combination with the recreation trail that abuts the reach-produce large volumes of high-energy runoff from both the watershed as well as the hill slopes adjacent to the main channel.

3.1.5.6.1.4 FLOODPLAIN CONNECTION

The score for the *Floodplain Connection* parameter (2/20) was rated as "poor", and positioned WSGO02 among the worst reaches (after WSHW04 and WSCR08) observed in the Lower Wissahickon for this parameter and considerably lower than the Small Tributary average (9/20). The entrenchment ratio at cross section WSGO02 was 1.1, which indicates that only flows that exceed the estimated bankfull discharge of 150.6 cfs by a considerable margin can access the floodplain throughout the reach.

3.1.5.6.2 SUMMARY OF OVERALL BUFFER AND FLOODPLAIN CONDITION SCORES IN THE GORGAS RUN WATERSHED

The scores for the parameters within the *Overall Buffer and Floodplain Condition* component of the USAM assessment ranged from "poor" to "optimal". Both the *Vegetated Buffer Width* and the *Floodplain Vegetation* parameters were rated as "optimal" for WSGO02, with both parameters scoring higher than the Small Tributary average (Table 3-40). The *Overall Buffer and Floodplain* component for WSGO02 (48/80) was comparable to the score for the Small Tributary average (50.6/80) as both were rated as "suboptimal". It was evident that many of the parameters were significantly impacted by the presence of infrastructure and the effects of stormwater runoff as channel incision or "down-cutting" has worked to isolate the channel from its floodplain.

Table 3-40: USAM Buffer and Floodplain Condition Scoring for Gorgas Run Watershed

OVERALL BUFFER AND FLOODPLAIN CONDITION							
Reach ID	Sub-watershed	Vegetated Buffer Width		Floodplain Vegetation	Floodplain Habitat	Floodplain Encroachment	Buffer/FP Total
		Left	Right				
WSGO02	Gorgas	10	10	17	3	8	48
Small Tributary Average	**----**	**9**	**8.8**	**16.2**	**5.6**	**11**	**50.6**

3.1.5.6.2.1 VEGETATED BUFFER WIDTH

The vegetated buffers on both the right and left banks of WSGO02 were greater than 50 feet and were rated as "optimal" (Table 3-40). The scores for both banks were higher than the Small Tributary average of 9/ 10 and 8.8/10 for the left and right banks respectively. There are trails that abut some segments of the reach, however the trails are located very close to the stream channel and therefore do not significantly divide or impinge upon the width of the reach's riparian buffer.

3.1.5.6.2.2 FLOODPLAIN VEGETATION

Floodplain vegetation was rated as "optimal" in reach WSGO02 with a score of 17/20. Along with the *Vegetated Buffer Width* parameter, this parameter was one of two parameters for the *Overall Buffer and Floodplain Condition* component that scored higher than respective Small Tributary averages (Table 3-40). The dominant floodplain vegetation observed in the reach was characterized as mature forest with a mix of shrub and ground cover vegetation close to the stream banks. The mature forest cover that dominated the upland portions of the corridor precluded the establishment of a dense understory throughout most of the reach.

3.1.5.6.2.3 FLOODPLAIN HABITAT

Floodplain habitat was rated as "poor" throughout the reach with a score of 3 /10. The Small Tributary average was not much higher at 5.6/10, which was rated as "marginal". The low scores for the smaller, single cross section tributaries to Wissahickon Creek reflect a high level of channel incision which is manifested through the low entrenchment ratios observed on these reaches. After a considerable degree of channel incision, the floodplains associated with incised channels confer analogous responses to the lack of floodplain inundation and the subsequent reduction in the elevation of the water table. These responses range from shifts in the dominant vegetation type and the loss of wetland habitat to changes in the stability of stream banks comprised of cohesive soils.

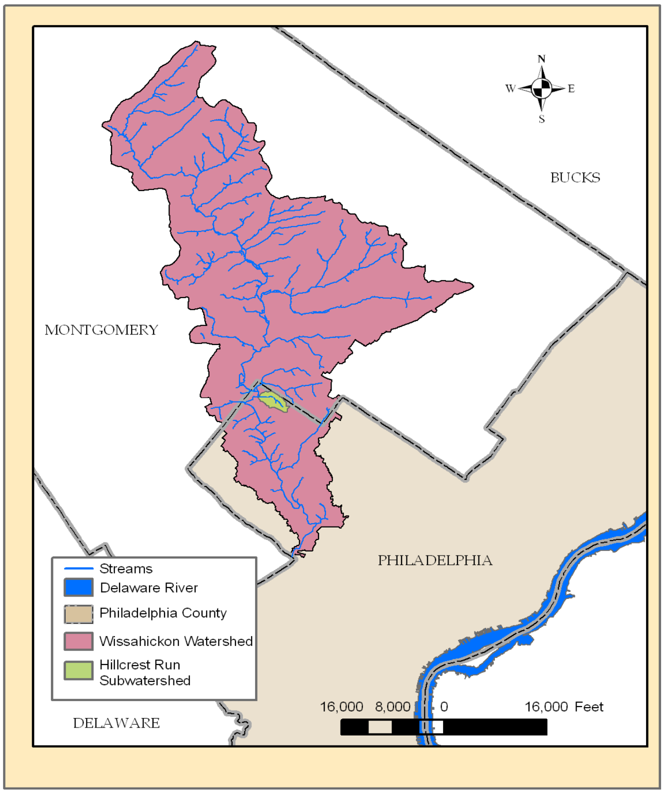
3.1.5.6.2.4 Floodplain Encroachment

The *Floodplain Encroachment* parameter was rated as "marginal" with a score of 8/20. The majority of the floodplain encroachment in the reach can be attributed to the presence of a recreational trail and infrastructure throughout the reach. Reach WSGO02 compared poorly to the score for the Small Tributary average of 11/20.

3.2 Large Tributary Watershed and Reach Characteristics

The Large Tributaries to Wissahickon Creek were defined as those having more than one cross section and representative reach. In the subsequent sections, "All Reaches Average" refers to the average Lower Wissahickon score for the respective metric excluding the scores for the reaches within the watershed tributary being described.

3.2.1 Hillcrest Run Watershed and Reach Characteristics



Hillcrest Run is a first-order tributary to the main stem of the Wissahickon Creek. The tributary arises from a privately owned outfall northwest of the intersection of Norwood and Chestnut Hill Avenues. It then travels for approximately 5,272 feet before the Confluence with the Wissahickon main stem. The majority of the tributary runs through a residential area. The lower portion of Hillcrest Run is located within Morris Arboretum.

The dominant substrate varies from very fine gravel to large cobble. The watershed is a total of 144 acres. Major land use types within the watershed include: residential – single family detached (86%), water (6%), and recreation (3%).

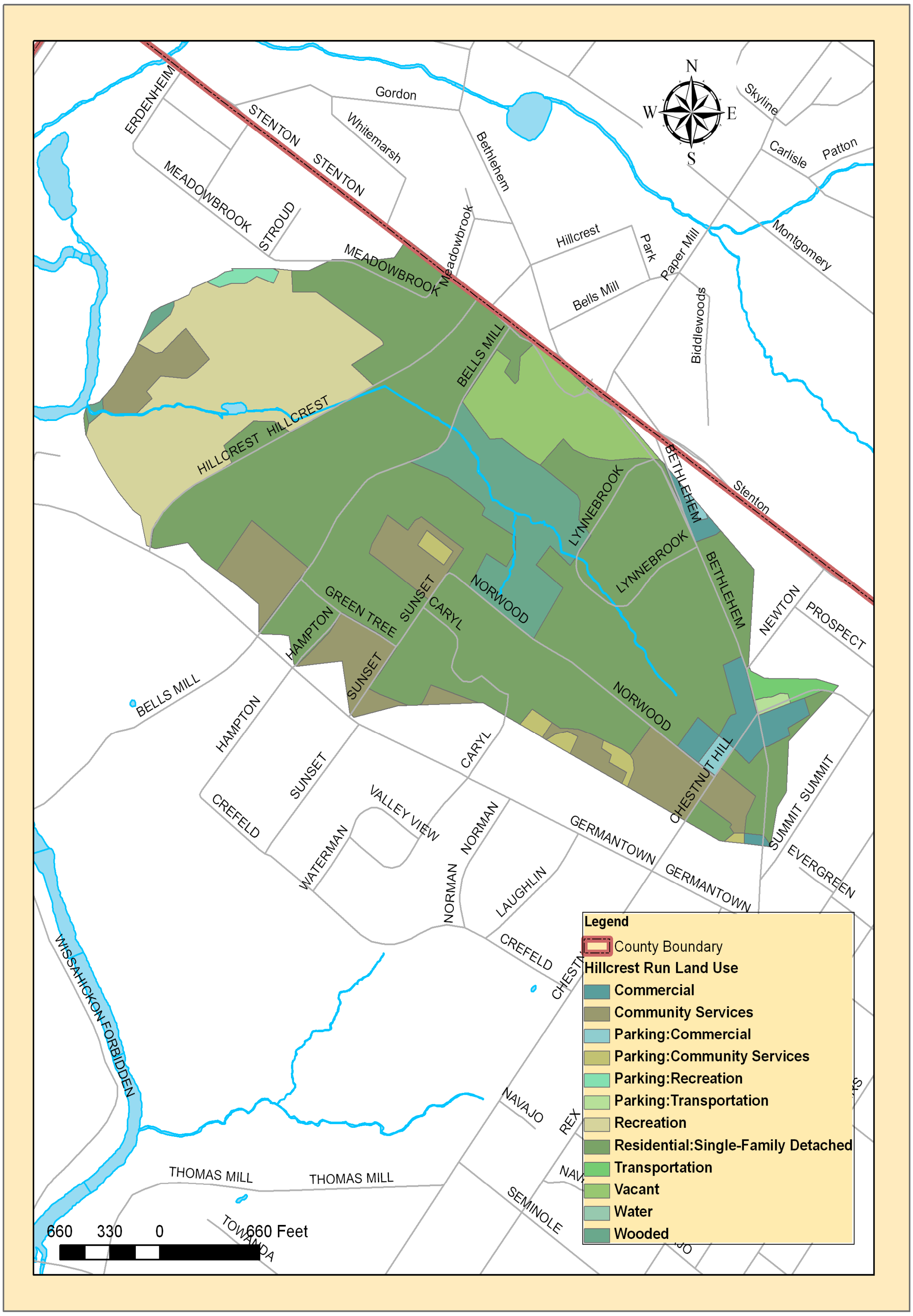


Figure 3-39: Hillcrest Run Watershed Land Use

3.2.1.1 GEOLOGY

The majority of the Hillcrest Run watershed is underlain by the Wissahickon Formation. The Wissahickon Formation consists of mica schist, gneiss and quartzite. The exposed schist near the surface is highly weathered. The Wissahickon Formation is also comprised of metamorphosed sedimentary rocks.

The northwestern portion of the Hillcrest Run watershed is underlain by the Bryn Mawr Formation. The Bryn Mawr Formation consists of white, yellow and brown gravel and sand. The Bryn Mawr Formation is considered a deeply weathered formation.

There is a small section of the Felsic Gneiss Formation located on the southeastern tip of the watershed. The Felsic gneiss Formation consists of metamorphic rock units that yield small quantities of water due to the cracks, joints and openings within the rock.

3.2.1.2 SOILS

According to the National Resource and Conservation Service Soil Survey, the majority of soils for the Hillcrest Run watershed are classified as hydrologic group B (Figure 3-41). These soils have a moderate rate of infiltration when the soils are wet (0.50-1.00 in/hr). Water movement through these soils is considered moderately rapid.

There is a very small portion of the watershed along the county boundary that is underlain by the Urban Land soils. Urban soils consist of material that has been disturbed by human activity during urbanization. Urban soils have been produced by mixing, filling and contamination of the native soils in both urban and suburban areas.

Table 3-41: Distribution of NRCS Soil Types in Hillcrest Run Watershed

Group	Area (ft^2)	Percent of Total Area
B	6,213,677	99.06%
Urban	58,962	0.94%
Total Area	**6,272,639**	**100%**

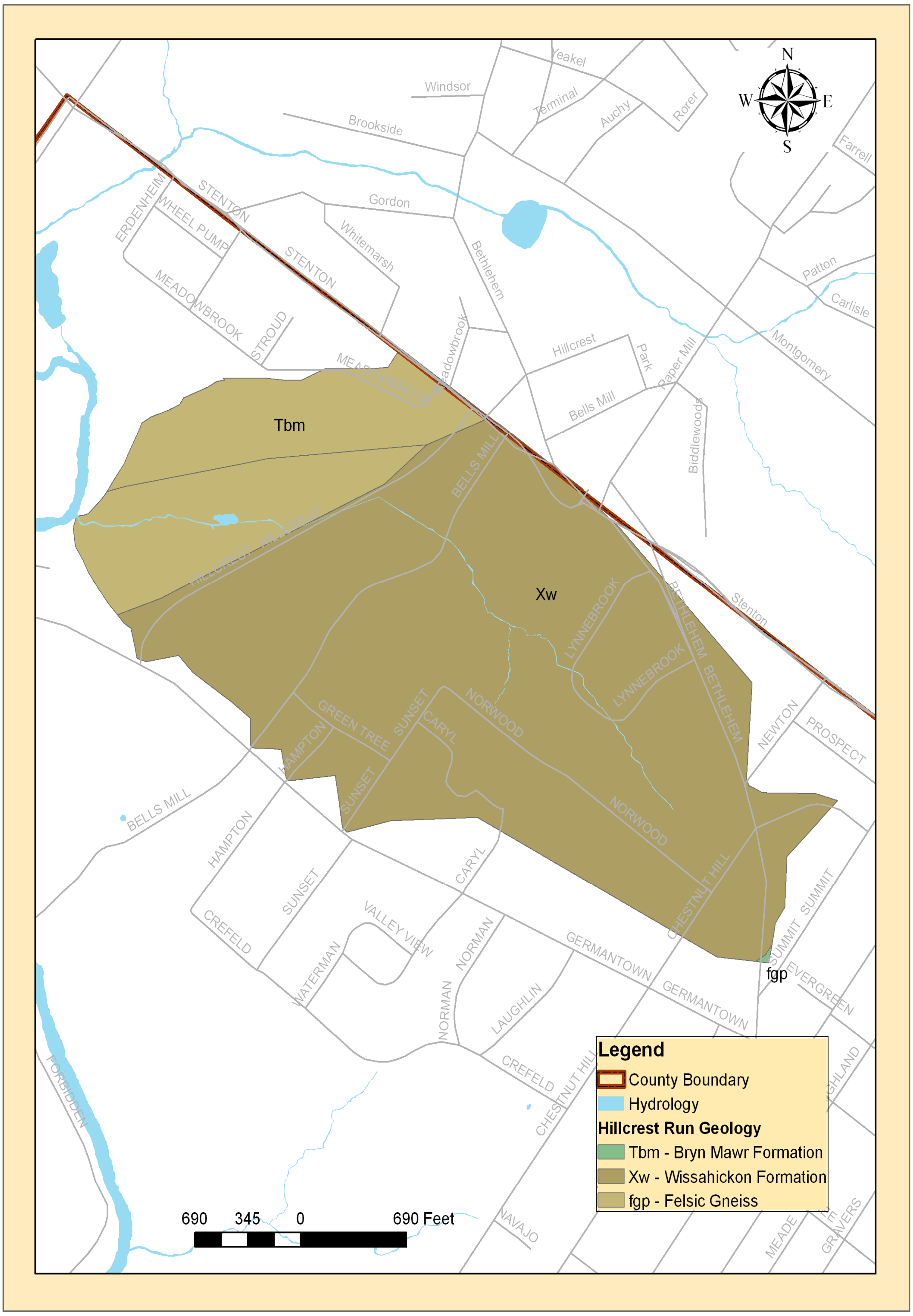


Figure 3-40: Geology of Hillcrest Run Watershed

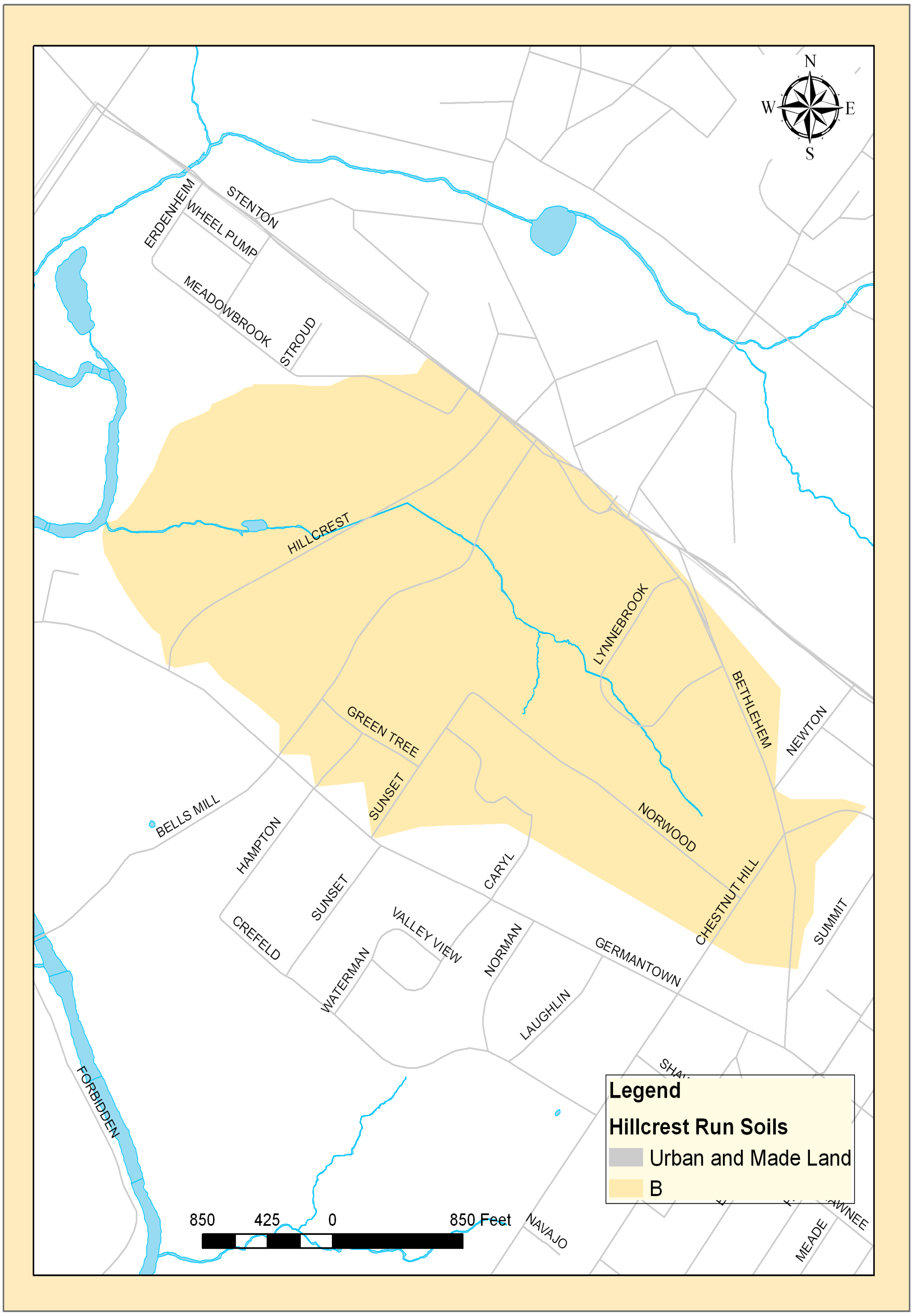


Figure 3-41: Distribution of NRCS Soil Types in Hillcrest Run Watershed

3.2.1.3 Bank Erosion

There was one bank pin location along Hillcrest Run (Figure 3-42). The calculated erosion rates are included in Table 3-42. The spatial distribution of BEHI assessment results were represented graphically (Figure 3-42) for each of the segments assessed on Hillcrest Run. Each bank within a respective segment was assessed and rated separately; however, channelized and culverted segments were not assessed as they confer a high degree of protection from bank erosion.

Table 3-42: Hillcrest Run Bank Pin Locations

	BEHI	NBS	Baseline Reading	Most Recent Reading	Erosion Rate (ft)	Erosion Rate (ft/yr)	Eroding (-) or Aggrading (+)
Hillcrest							
HC303	Low	Very Low	8/24/2006	8/10/2009	-0.22	-0.073	E

Total erosion rates were also calculated for the entire length of each tributary within the lower Wissahickon (Table 3-43). To assess the normalized erosion potential of each tributary, the erosion rate per acre of drainage area per year and the erosion rate per foot of stream length per year were calculated. This allowed direct comparison between each of the tributaries with respect to both watershed size and the length of the tributary. Hillcrest Run was ranked last out of the twelve tributaries within the lower Wissahickon for erosion rate per foot of stream length. The rankings were based on a scale of one being the highest erosion rate and twelve being the lowest erosion rate.

Table 3-43: Erosion Rates for Lower Wissahickon Tributaries

Tributary	Drainage Area (Acres)	Stream Length (feet)	*2009*		
			Erosion Rate (lb/yr)	*Erosion Rate Per Acre*	*Erosion Rate Per Foot of Stream*
Bell's Mill	323	6,722	420,000	1,307	63
Cathedral Run	160	2,790	150,000	913	52
Cresheim Creek	1,218	16,431	840,000	690	51
Gorgas Run	499	2,170	170,000	345	79
Hartwell Run	217	3,530	200,000	918	56
Hillcrest	144	5,272	90,000	597	16
Kitchen's Lane	234	7,753	200,000	850	26
Monoshone Creek	1,056	6,926	160,000	156	24
Rex Ave	137	1,903	150,000	1,131	81
Thomas Mill Run	104	4,008	320,000	3,058	79
Valley Green Run	128	2,874	140,000	1,086	48
Wise's Mill Run	446	7,056	490,000	1,090	69
Total/*Average*	**4,666**	**67,435**	**3,300,000**	***1,012***	***54***

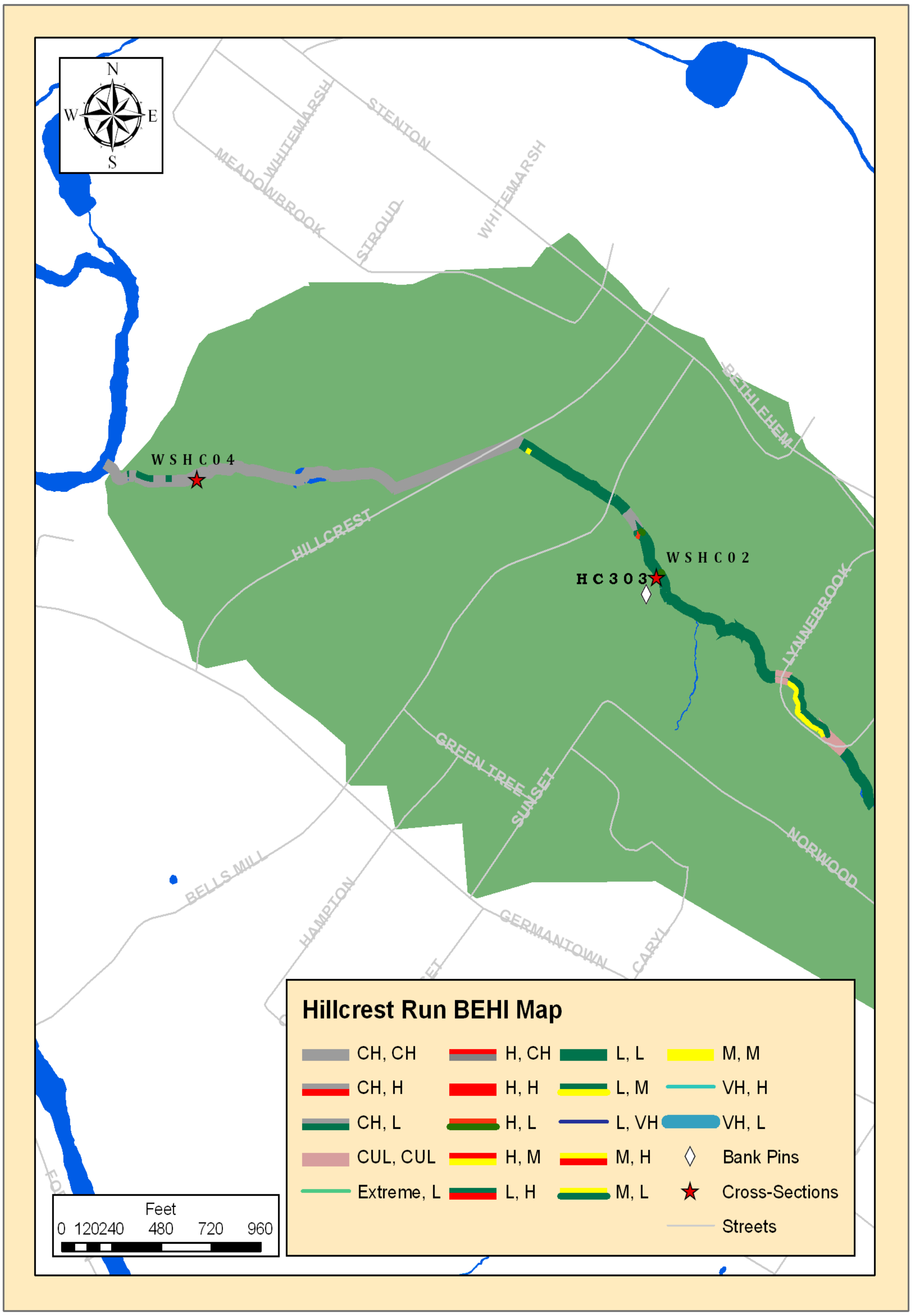


Figure 3-42: Hillcrest Run Watershed BEHI Ratings and Bank Pin Locations

3.2.1.4 INFRASTRUCTURE TRACKDOWN SUMMARY

The Hillcrest Run watershed was heavily influenced by urban residential development as it was one of the only watersheds in the Lower Wissahickon that was not within the Fairmount Park system. The upstream-most reach, WSHC02, had one of the highest infrastructure densities on the Lower Wissahickon with 25 elements within a 4,135 feet reach (Table 3-44). While the narrow riparian buffer does confer some protection from the various impacts of drainage and conveyance infrastructure, anthropogenic impairments to the Hillcrest Run hydrologic regime are evident. Of particular concern are the vast number of dams within the reach (n=11), which cumulatively impound tremendous volumes of streamflow. Impoundments subject streamflow to stagnation and thermal enrichment which can lower dissolved oxygen (DO) concentrations; furthermore, organic matter and sediment transport regimes are adversely impacted by impoundments such that the net impact of dams are manifest both upstream and downstream of the actual structure. Of the eleven dams in the reach, four (WSdam95, WSdam97, WSdam98, WSdam100) were in poor condition such that they functioned more as debris jams than dams given their reduced capacity and “silted-in” impoundments. There was also a considerable length of the stream that was culverted or channelized such that six culverts accounted for nearly 24% percent of the WSHC02 stream length and the entire length of unnamed tributary A (526 feet) was channelized.

Reach WSHC04 had less infrastructure elements than the upstream reach, however the density of infrastructure elements within the reach was far greater than the density observed in WSHC02. There were less dams, outfalls and culverts compared to WSHC02; however, reach WSHC04 was highly channelized (25.6%). In addition, the reach harbored a very large impoundment from WSdam106 on the property of Morris Arboretum which hosted water fowl (swans, ducks, geese) which likely contribute excessive concentrations of nutrients to the downstream segments of the reach.

Table 3-44: Summary Hillcrest Run Infrastructure Point Features

Section ID	Culvert Count	Bridge Count	Outfall Count	Channel Count	Confluence Count	Dam Count	Other Count	Infra Point Count	Combined Outfall Area (ft^2)
WSHC02	6	1	3	4	3	11	2	25	17.6
WSHC04	1	4	1	9	1	2	0	17	16
TOTAL	**7**	**5**	**4**	**13**	**4**	**13**	**2**	**42**	**33.6**

Table 3-45: Summary Hillcrest Run Infrastructure Linear Features

Section ID	Segment Length (ft)	Segment Length (ft), 3 sides	Culvert Length (ft)	Percent Culverted	Channel Length (ft), 1 side	Channel Length (ft), 2 sides	Channel Length (ft), 3 sides	Channel Length (ft)	Percent Channelized
WSHC02	4135	12405	983	23.8	0	617	0	1234	9.9
WSHC04	1468	4404	15	1.0	257	391	30	1129	25.6
TOTAL	**5603**	**16809**	**998**	**17.8**	**257**	**1008**	**30**	**2363**	**14.1**

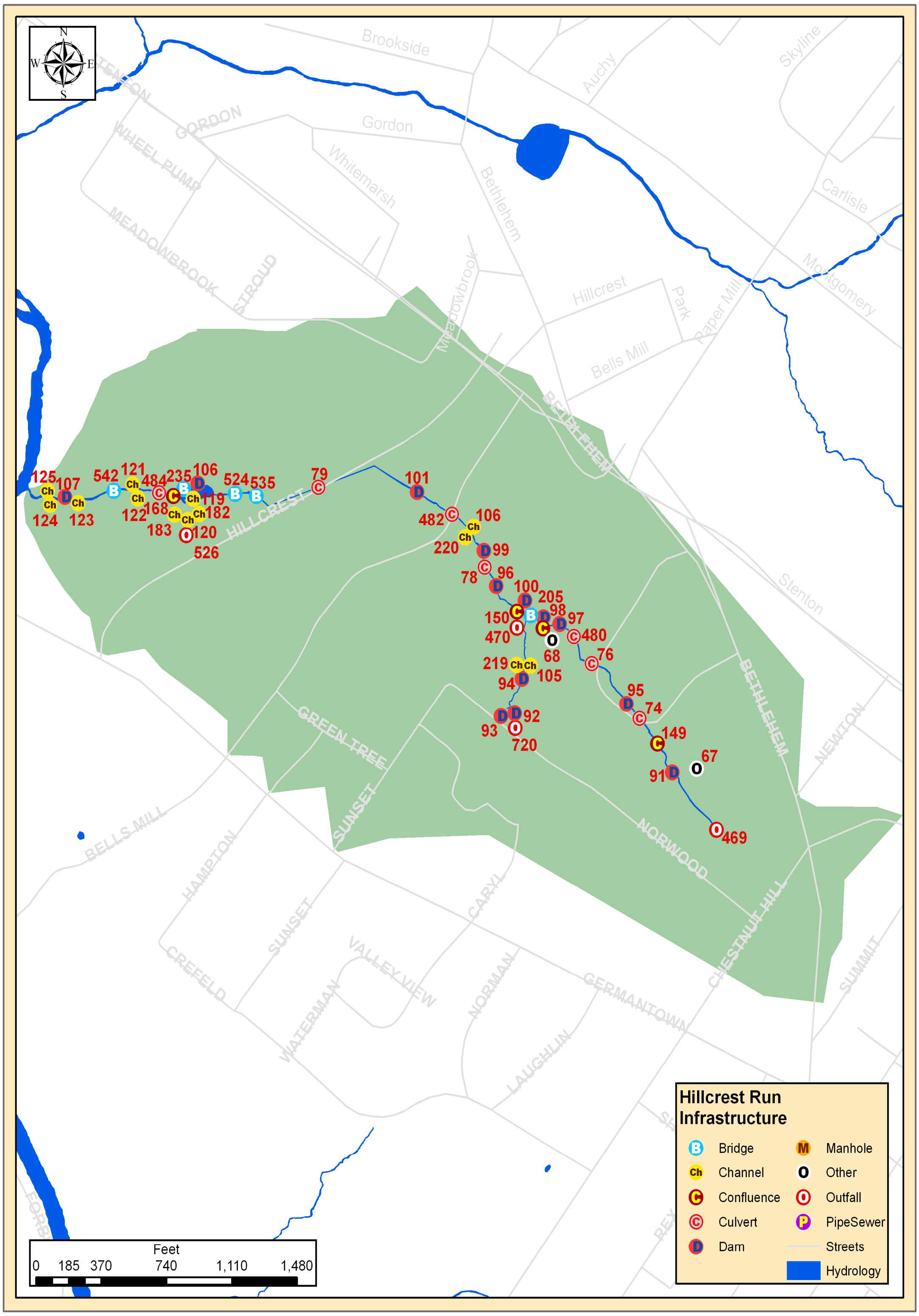


Figure 3-43: Hillcrest Run Infrastructure Locations

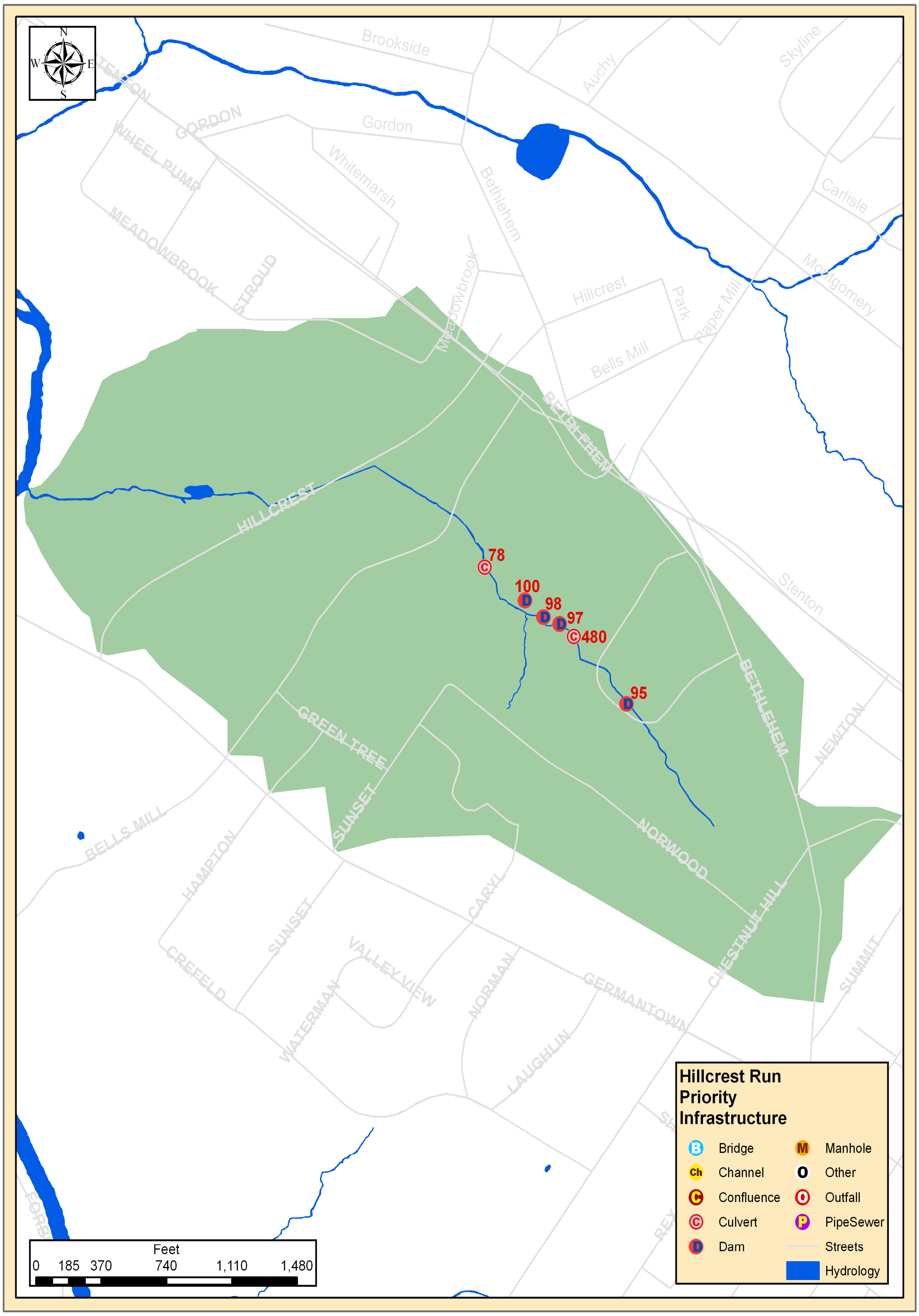


Figure 3-44: Hillcrest Run Infrastructure in Poor Condition

3.2.1.5 UNIFIED STREAM ASSESSMENT RESULTS FOR THE HILLCREST RUN WATERSHED

The Hillcrest Run watershed was the northern-most watershed in the Lower Wissahickon Basin. The majority of the Hillcrest Run main stem channel was second-order (downstream of WSHC02), characterized by a rather steep slope (4.7%) and a substrate distribution dominated by gravel (42%), although isolated areas of the watershed had segments of bedrock-controlled channel.

The Hillcrest Run watershed was heavily developed as the dominant land use was single-family residential. There were no portions of the watershed that are within the boundaries of Fairmount Park, which distinguished the Hillcrest Run watershed from the other watersheds of the Lower Wissahickon Basin. The Center for Watershed Protection's (CWP) Unified Stream Assessment Methodology (USAM) was used to score and rate the instream, riparian buffer and floodplain conditions of the stream corridor to allow for comparison to other reaches and watersheds within the Lower Wissahickon Basin.

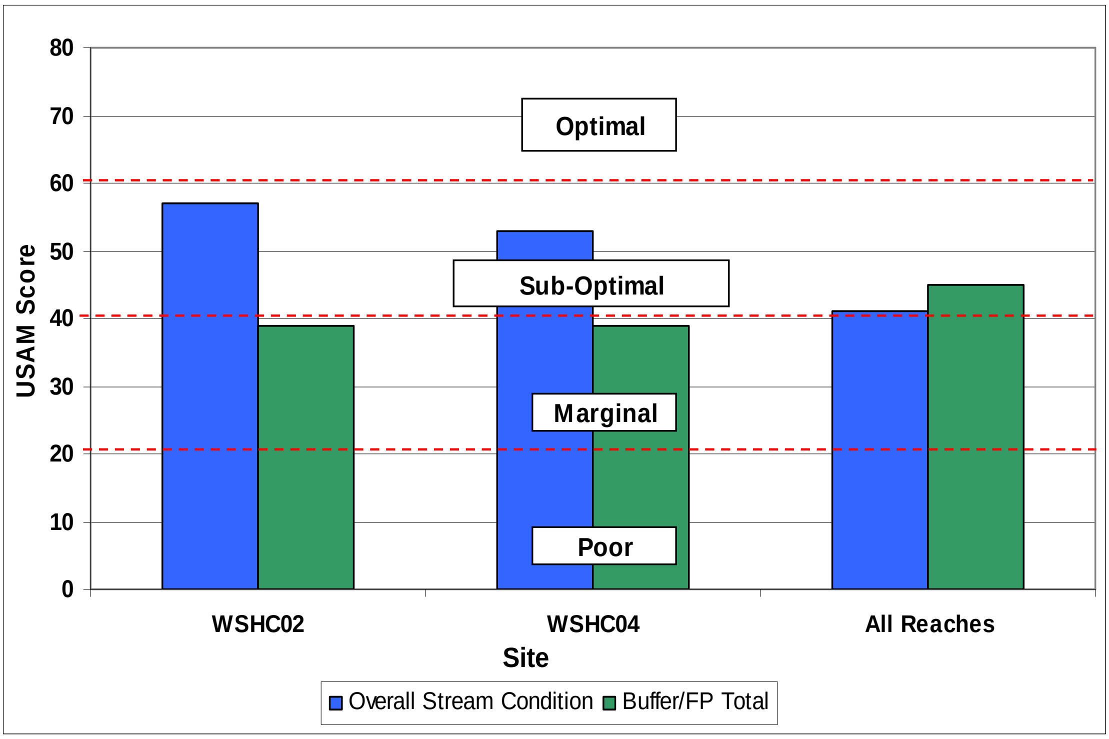


Figure 3-45: Results for Hillcrest Run USAM Components

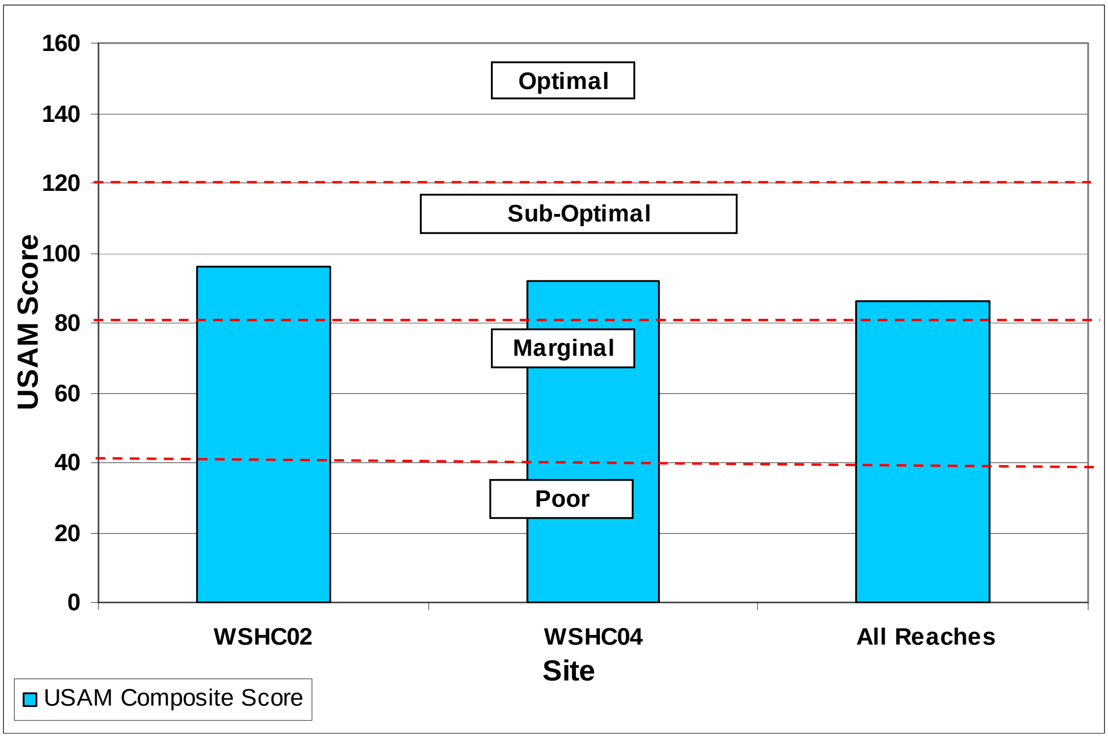


Figure 3-46: Hillcrest Run USAM Results

3.2.1.5.1 WSHC02

The headwaters of reach WSHC02 originated from an outfall, WSout469, located 485 feet from the intersection of Chestnut Hill Avenue and Norwood Avenue. There was a small tributary (530 feet) on reach WSHC02, of which the confluence with the main stem of Hillcrest Run was located 300 feet upstream of cross section WSHC02. In total, reach WSHC02 was 4,135 feet in length and ended at the culverted segment of the reach above Hillcrest Avenue. Reach WSHC02 was characterized by a low width to depth ratio (8.5), a moderately entrenched channel (ER=1.8) and a relatively steep slope (4.7%) which classified the channel as a B4a stream type based upon the Rosgen classification system. The composite USAM score (Figure 3-46) for reach WSHC02 was (96/160).

3.2.1.5.2 WSHC04

Reach WSHC04 began as a culverted segment downstream of Hillcrest Avenue and ended at the confluence of Hillcrest Run and Wissahickon Creek. In total, WSHC04 was 1,468 feet in length. There was a rather large impoundment caused by WSdam106, which was located within the Morris Arboretum complex. Reach WSHC04 was characterized by a low width to depth ratio, a relatively steep slope (4.7%) and a channel that was not entrenched as was observed in reach WSHC02 (ER=3.6). The gravel-dominated reach was classified as a B4a stream type and had a composite USAM score of (92/160).

3.2.1.6 SUMMARY OF UNIFIED STREAM ASSESSMENT RESULTS

The mean scores for both the *Overall Stream Condition* components as well as the composite USAM score were classified as “suboptimal” (Table 3-46). Average conditions within the Hillcrest Run watershed’s stream channels were considerably better than conditions observed within the buffers and floodplains. The watershed averages for the *Overall Stream Condition* component as well as the composite USAM were much higher than the respective All Reaches averages, however the *Overall Buffer and Floodplain* component was relatively low compared to the All Reaches average. The scores for individual parameters ranged from poor to optimal, displaying similar levels of variability between reaches.

Table 3-46: USAM Results for Hillcrest Run Watershed

Reach ID	Sub-watershed	Overall Stream Condition	Overall Buffer/FP Condition	USAM Score
WSHC02	Hillcrest	57	39	96
WSHC04	Hillcrest	53	39	92
WSHC mean		**55**	**39**	**94**
All Reaches Average		**42.4**	**44.5**	**86.9**

3.2.1.6.1 SUMMARY OF OVERALL STREAM CONDITION SCORES IN THE HILLCREST RUN WATERSHED

The scores for the individual parameters of the *Overall Stream Condition* component of the USAM analysis were generally moderate to high as some parameters were ranked among the highest scores recorded for the large, Lower Wissahickon tributaries. In fact, of the twenty-two large tributary reaches assessed, the two Hillcrest Run reaches had two of the top five *Overall Stream Conditions* scores at (57/80) and (53/80). The mean watershed score (55/80) was rated as “suboptimal” and was considerably higher than the All Reaches average score (42.4/80) which was rated towards the lower end of the “suboptimal” classification.

Two parameters had significant importance in terms of their scores relative to the average conditions observed in the Lower Wissahickon. The watershed mean scores for the *Bank Erosion* and *Floodplain Connection* parameters, which were observed to be low to moderate throughout most of the Lower Wissahickon, were rated as “suboptimal.” The mean scores for the left and right banks of the corridor were the highest observed in the Lower Wissahickon and the *Floodplain Connectivity* score for reach WSHC02 was the highest score observed for this parameter (tied with reach WSKL06).

Table 3-47: USAM Overall Stream Condition Scoring for Hillcrest Run Watershed

OVERALL STREAM CONDITION								
Reach ID	Sub-watershed	Instream Habitat	Vegetative Protection		Bank Erosion		Floodplain Connection	Overall Stream Condition
			Left	Right	Left	Right		
WSHC02	Hillcrest	13	5	5	8	8	18	57
WSHC04	Hillcrest	13	5	5	9	9	12	53
WSHC mean		**13**	**5**	**5**	**8.5**	**8.5**	**15**	**55**
All Reaches Average		**13.1**	**4.9**	**4.9**	**6.3**	**7.0**	**6.3**	**42.4**

3.2.1.6.1.1 INSTREAM HABITAT

Scores for the *Instream Habitat* parameter were consistent throughout both reaches in the Hillcrest Run watershed as both reaches were rated as "suboptimal" with scores of (13/20). The watershed mean was negligibly smaller than the All Reaches average (13.1/20). The reaches in Hillcrest Run were characterized by their abundance of stable cobble and boulder substrate which comprised 27% and 14% of the substrate respectively. There was a lack of large coarse woody debris which prevented these reaches from attaining an "optimal" rating however, instream macrophytes were observed in reach WSHC02.

3.2.1.6.1.2 VEGETATIVE PROTECTION

Both banks of reaches WSHC02 and WSHC04 had moderate amounts of bank vegetation and were rated as "marginal." The All Reaches averages for both banks were slightly lower at (4.9/10). The moderate scores for this parameter are attributed to the patchy (although dense) distribution of vegetation along the stream banks. Furthermore, the presence of bedrock outcrops along the stream banks along with erosion along the toe of the banks in these reaches may have precluded the establishment of some vegetation types.

3.2.1.6.1.3 BANK EROSION

Instances of severe bank erosion were minimal throughout the Hillcrest Run watershed. The mean watershed scores for the left and right banks were both (8.5/10) which rated as "suboptimal." The right and left banks of the Hillcrest Run watershed had the highest average scores among all the large tributaries as these averages were much higher than the All Reaches averages for the left (6.3/10) and right (7.0/10) banks which were rated towards the lower end of the "suboptimal" classification. The high scores in this watershed can be attributed to the presence of boulders and bedrock outcrops which offered "toe protection" along most of the length of the creek (although some segments were artificially channelized).

3.2.1.6.1.4 FLOODPLAIN CONNECTION

Scores for the *Floodplain Connection* parameter were among the best scores observed in the Lower Wissahickon. The watershed average score (15/20) was rated as "suboptimal" and was considerably greater then the All Reaches average score (6.3/20) which was rated towards the lower end of the "marginal" classification. The score for reach

WSHC02 (18/20) was rated as "optimal" and was the highest score recorded on the Lower Wissahickon (along with WSKL06). The high degree of floodplain connectivity in the Hillcrest Run watershed is an atypical observation considering the highly urbanized nature of the Wissahickon Creek Watershed and the dense distribution of infrastructure along Hillcrest Run. The presence of boulders and bedrock outcrops within these reaches likely prevented extensive channel incision.

3.2.1.6.2 SUMMARY OF OVERALL BUFFER AND FLOODPLAIN CONDITION SCORES IN THE HILLCREST RUN WATERSHED

The scores for the individual parameters of the *Overall Buffer and Floodplain Condition* component of the USAM analysis were all low to moderate except for the *Vegetated Buffer Width* parameter. The mean component score for the Hillcrest Run watershed (39/80) was less than the All Reaches average (44.5/80). The reduced function of the floodplains in this watershed can be attributed to a number of factors, with the most influential being development and its associated infrastructure.

There are numerous dams, bridges, culverts and channelized segments on Hillcrest Run, all with distinct impacts on the hydraulic regime of the reach. These impacts culminate in changes in the magnitude and hydraulic properties of flows within the watershed's channels and ultimately influence or restrict dominant floodplain processes such as flooding and sub-surface return flows. The timing, duration and frequency of many floodplain processes or the lack thereof, has vast ecological impacts on riparian fauna, vegetation types and the existence, persistence and maintenance of floodplain habitat.

Table 3-48: USAM Buffer and Floodplain Condition Scoring for Hillcrest Run Watershed

OVERALL BUFFER AND FLOODPLAIN CONDITION							
Reach ID	Sub-watershed	Vegetated Buffer Width		Floodplain Vegetation	Floodplain Habitat	Floodplain Encroachment	Overall Buffer/FP Condition
		Left	Right				
WSHC02	Hillcrest	9	9	6	5	10	39
WSHC04	Hillcrest	9	9	8	7	6	39
WSHC mean		**9**	**9**	**7**	**6**	**8**	**39**
All Reaches Average		**8.1**	**8.6**	**13.8**	**5.5**	**8.5**	**44.5**

3.2.1.6.2.1 VEGETATED BUFFER WIDTH

The widths of the vegetated buffers in both reaches of the Hillcrest Run watershed were rated as "optimal" such that on both the right and left side of the corridor, there were greater than 50 feet of un-impacted riparian zones along the majority of the reach. The mean watershed scores (9/10) for both sides of the corridor were higher than the All Reaches averages for both the right (8.1/10) and the left (8.6/10).

3.2.1.6.2.2 FLOODPLAIN VEGETATION

The dominant vegetation types throughout the reach were shrubs, understory trees, mowed turf and groundcover vegetation. There was a sparse distribution of large, mature trees in reach WSHC02, which had a score of (6/20) for this parameter. In some segments of reach WSHC02, there were distinct patches of both bare vegetation as well as mowed turf grass, often up to the edge of the streambank, which was a primary factor in the “marginal” rating at this site. In reach WSHC04, mature trees were much more abundant than they were in the upstream reach WSHC02. Most of the mature trees in reach WSHC04 were present in a clustered distribution at the top of the reach- west of Hillcrest Road. The mean watershed score (7/20) was rated as “marginal”, which was considerably lower than the All Reaches average (13.8/20) which was rated as “suboptimal.”

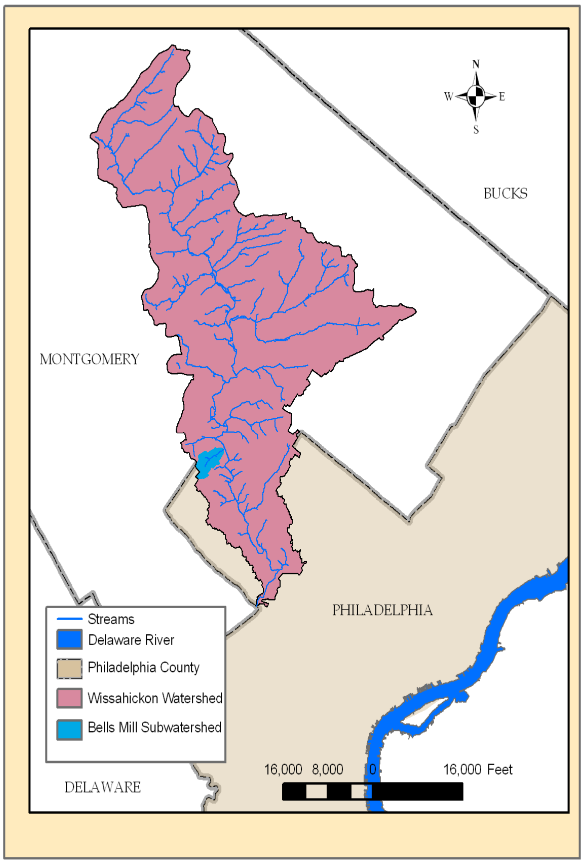
3.2.1.6.2.3 FLOODPLAIN HABITAT

Floodplain habitat was limited throughout the Hillcrest Run watershed. One of the primary causes of habitat limitation was the extent of artificial channelization observed throughout the watershed, especially in reach WSHC04 which was over 90% channelized. Reach WSHC04 had the potential to have more suitable floodplain habitat due to the entrenchment ratio (3.6) which suggest the channel has access to the floodplain during most bankfull events; however, the highly channelized reach was embedded within a highly manicured landscape where flooding was invariably removed from the channel’s hydraulic regime. The mean watershed score for this parameter (6/20) was rated as “marginal” and was slightly higher than the All Reaches average score (5.5/20) which was also rated as “marginal.”

3.2.1.6.2.4 FLOODPLAIN ENCROACHMENT

Scores for the *Floodplain Encroachment* parameter were low to moderate throughout the watershed. Scores were limited by the extent of development, landscaping and infrastructure which were all very pervasive throughout the watershed. The highest score was recorded in reach WSHC02, which ultimately had a higher density of infrastructure, but it was not as extensively channelized as reach WSHC02. The mean score for the watershed was (8/20) which was slightly lower than the All Reaches average score of (8.5/20) although both averages were rated as “marginal”.

3.2.2 Bell's Mill Run Watershed and Reach Characteristics



Bell's Mill Run is a second-order tributary to the main stem of the Wissahickon Creek. The tributary arises from an outfall near the intersection of Lykens and Bell's Mill roads. It then travels parallel to Bell's Mill Road for approximately 5,100 feet before the Confluence with the Wissahickon main stem. The tributary runs through a wooded area of Wissahickon Park; however, there are instances when the streambanks abut Bell's Mill Road. A small un-named tributary enters Bell's Mill approximately 1,300 feet from the headwaters.

Bell's Mill can be characterized as a type B stream for 400 feet until stormwater outfall (WSout472) discharges into it. At this point the tributary becomes entrenched and over-widened. Substrate is composed mainly of course gravel, cobble, and bedrock.

The watershed is a total of 328 acres. The majority of the watershed is comprised of wooded (50%), and residential area (44%). Minor components include parking (2%), agriculture (2%), and commercial area (1%).

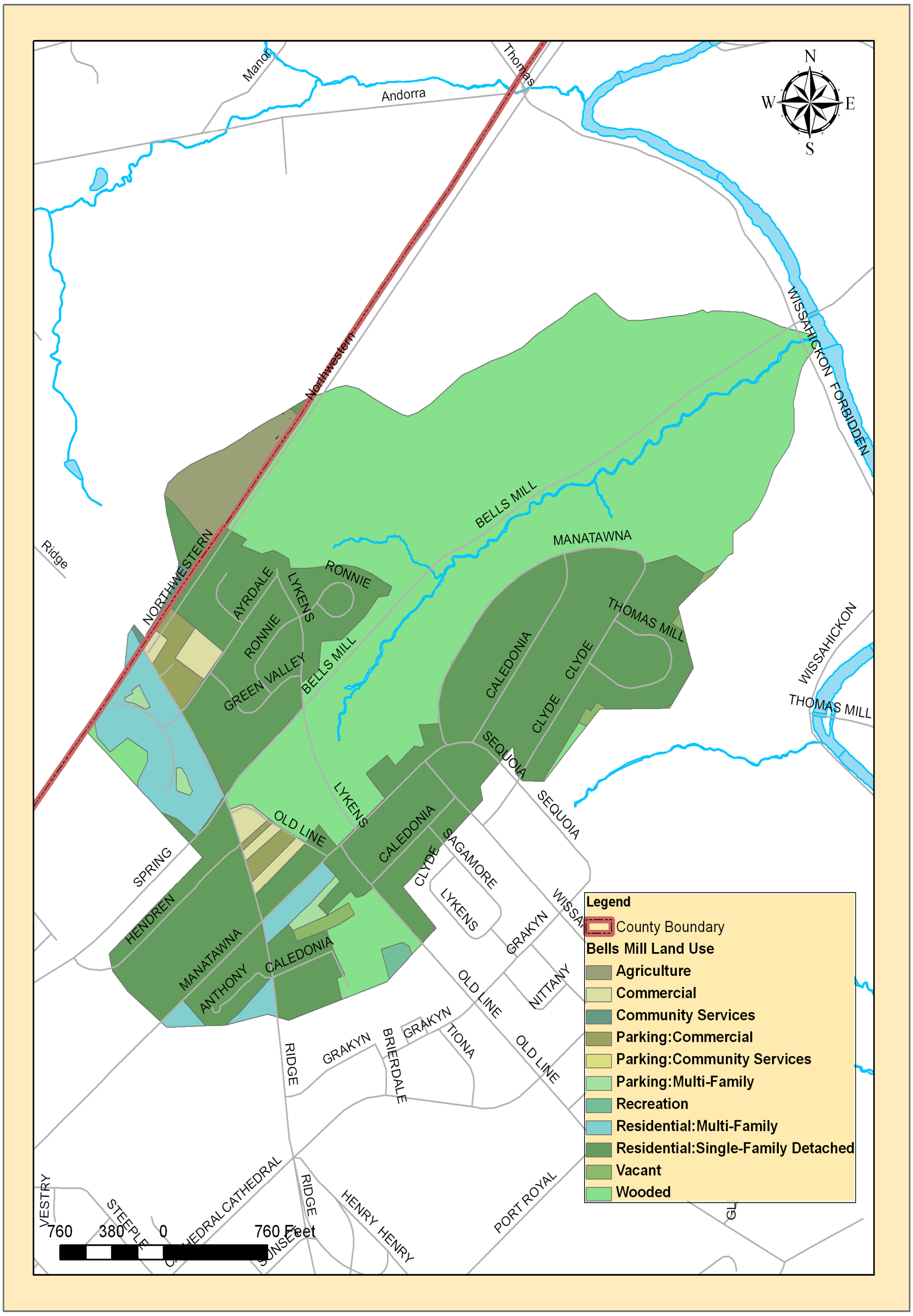


Figure 3-47: Bell's Mill Run Watershed Land Use

3.2.2.1 GEOLOGY

The majority of the Bell's Mill watershed is underlain by the Wissahickon Formation. The Wissahickon Formation consists of mica schist, gneiss and quartzite. The exposed schist near the surface is highly weathered. The Wissahickon Formation is also comprised of metamorphosed sedimentary rocks.

There is a band of Ultramafic rocks in the location of Bell's Mill Run. Ultramafic rocks are igneous rocks that contain very low silica content. Ultramafic rocks possess good surface drainage while being highly resistant to weathering at the same time.

3.2.2.2 SOILS

According to the National Resource and Conservation Service Soil Survey, the majority of soils for the Bell's Mill Run watershed are classified as hydrologic group B. These soils have a moderate rate of infiltration when the soils are wet. Water movement through these soils is considered moderately rapid. There is a band of alternating B and C soils along Bell's Mill Run. Combined, these soils have a slow rate of infiltration when saturated increasing the runoff potential.

Table 3-49: Distribution of NRCS Soil Types in Bell's Mill Run Watershed

Group	Area (ft^2)	Percent of Total Area
B	14,033,360	98.22%
C	95,727	0.67%
D	158,593	1.11%
Total Area	**14,287,680**	**100%**

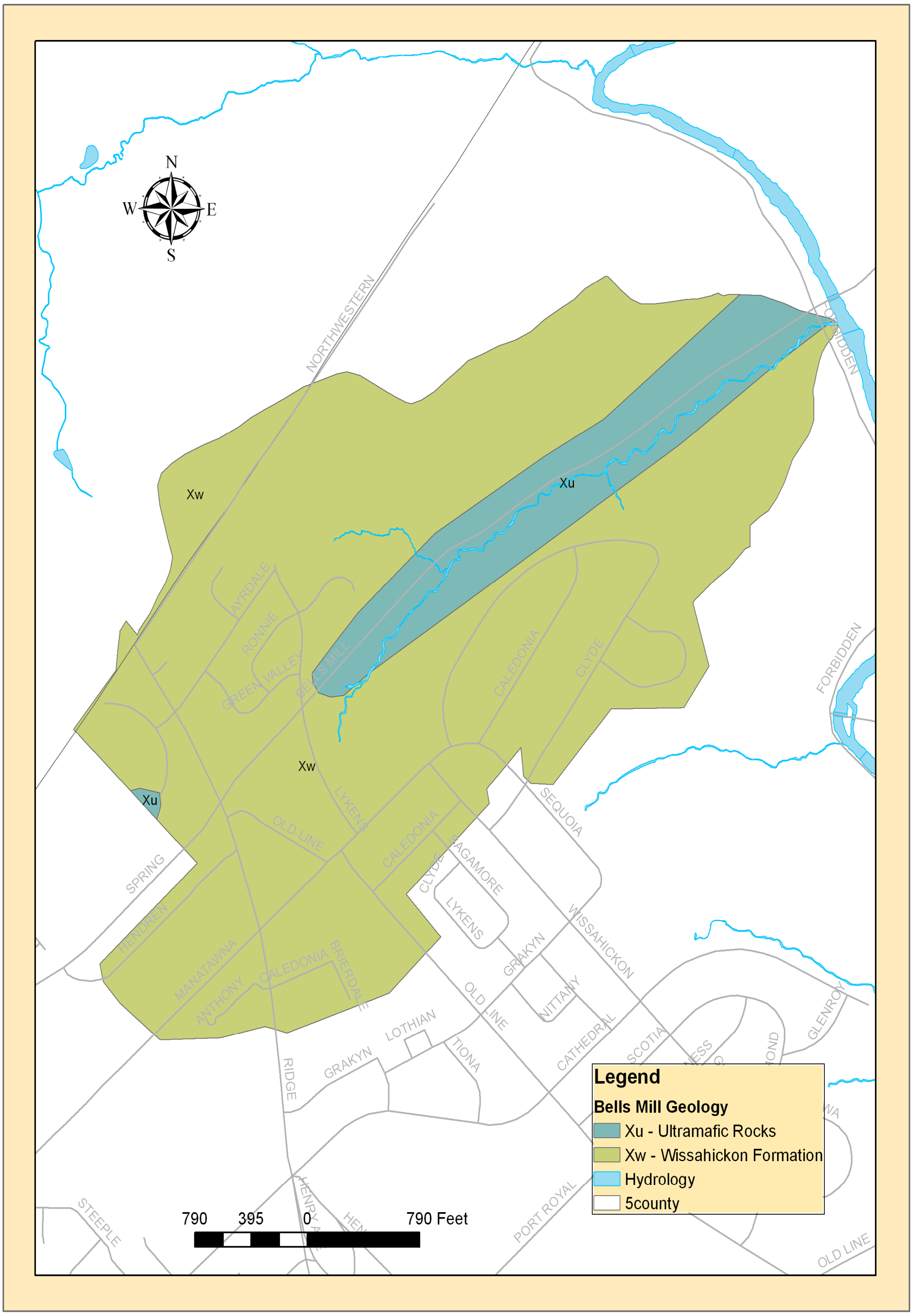


Figure 3-48: Geology of Bell's Mill Watershed

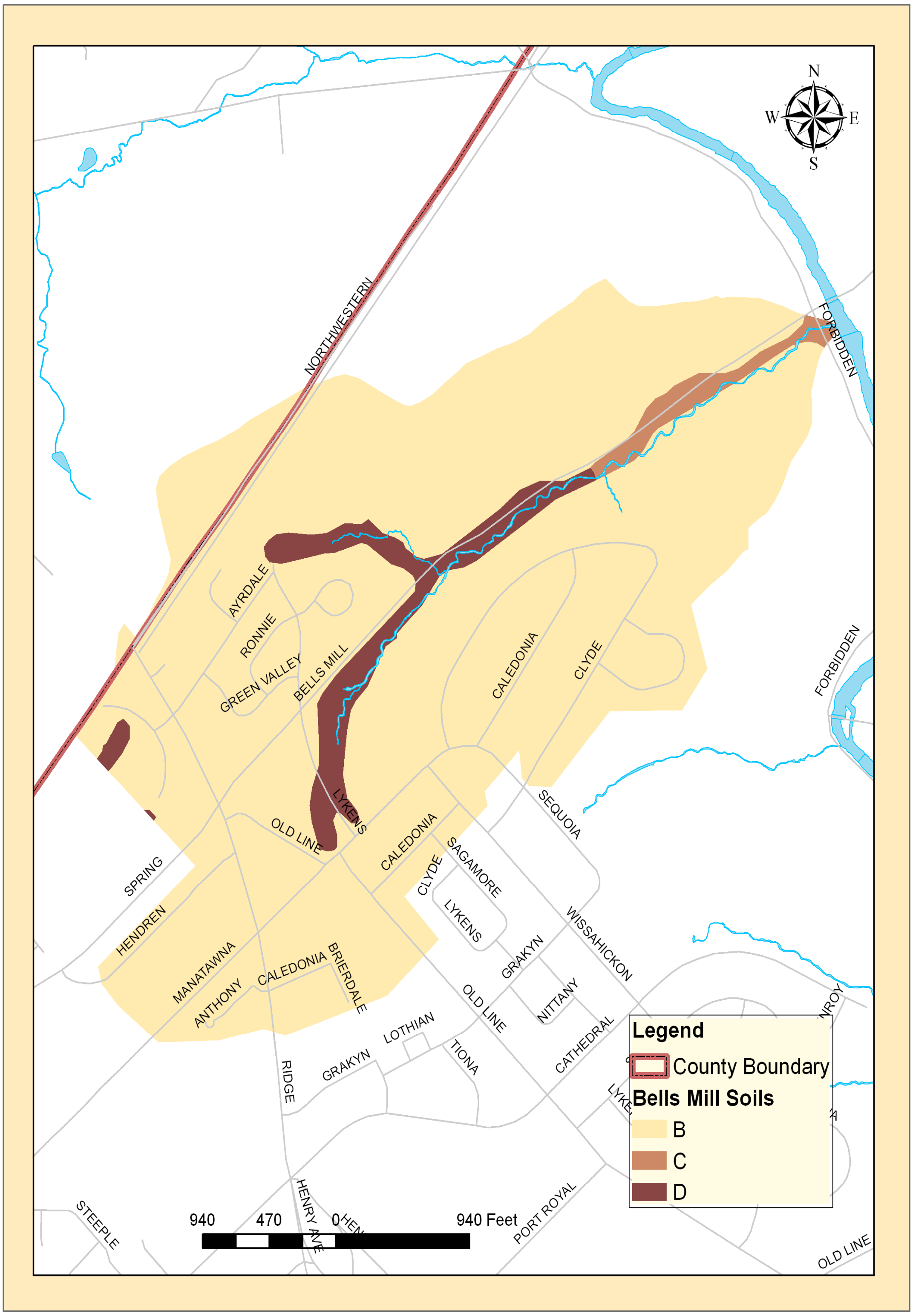


Figure 3-49: Distribution of NRCS Soil Types in Bell's Mill Run Watershed

3.2.2.3 BANK EROSION

There were 13 bank pin locations along Bell's Mill Run (Figure 3-50). The calculated erosion rates are included in Table 3-50. The spatial distribution of BEHI assessment results were represented graphically (Figure 3-50) for each of the segments assessed on Bell's Mill Run. Each bank within a respective segment was assessed and rated separately; however, channelized and culverted segments were not assessed as they confer a high degree of protection from bank erosion.

Table 3-50: Bell's Mill Run Bank Pin Locations

	BEHI	NBS	Baseline Reading	Most Recent Reading	Erosion Rate (ft)	Erosion Rate (ft/yr)	Eroding (-) or Aggrading (+)
Bell's Mill							
BM1120	Moderate	Low	5/11/2006	8/11/2008	0.14	0.063	A
BM13	High	Low	11/7/2005	8/12/2009	-0.81	-0.21	E
BM16	High	Extreme	11/13/2006	8/12/2009	-0.49	-0.18	E
BM21	Moderate	High	11/7/2005	8/12/2009	-0.92	-0.24	E
BM2450	Moderate	Low	5/11/2006	8/11/2008	-0.16	-0.072	E
BM25	Moderate	Moderate	11/7/2005	8/11/2008	-1.04	-0.38	E
BM31	High	Low	11/7/2005	8/11/2008	-0.29	-0.10	E
BM35	High	Moderate	8/7/2007	8/11/2008	0.56	0.56	A
BM4	Moderate	Low	11/7/2005	11/13/2006	-0.040	-0.039	E
BM414	Low	Very Low	8/18/2006	8/12/2009	0.37	0.12	A
BM422	Low	Very Low	8/18/2006	8/11/2008	0.29	0.15	A
BM530	Low	Low	5/15/2006	8/11/2008	-0.19	-0.086	E
BM8	High	High	8/18/2006	8/12/2009	0.15	0.050	A

Total erosion rates were also calculated for the entire length of each tributary within the lower Wissahickon (Table 3-51). To assess the normalized erosion potential of each tributary, the erosion rate per acre of drainage area per year and the erosion rate per foot of stream length per year were calculated. This allowed direct comparison between each of the tributaries with respect to both watershed size and the length of the tributary. Bell's Mill Run was ranked fifth out of the twelve tributaries within the lower Wissahickon for erosion rate per foot of stream length. The rankings were based on a scale of one being the highest erosion rate and twelve being the lowest erosion rate.

Table 3-51: Erosion Rates for Lower Wissahickon Tributaries

Tributary	Drainage Area (Acres)	Stream Length (feet)	*2009*		
			Erosion Rate (lb/yr)	*Erosion Rate Per Acre*	*Erosion Rate Per Foot of Stream*
Bell's Mill	323	6,722	420,000	1,307	63
Cathedral Run	160	2,790	150,000	913	52
Cresheim Creek	1,218	16,431	840,000	690	51
Gorgas Run	499	2,170	170,000	345	79
Hartwell Run	217	3,530	200,000	918	56
Hillcrest	144	5,272	90,000	597	16
Kitchen's Lane	234	7,753	200,000	850	26
Monoshone Creek	1,056	6,926	160,000	156	24
Rex Ave	137	1,903	150,000	1,131	81
Thomas Mill Run	104	4,008	320,000	3,058	79
Valley Green Run	128	2,874	140,000	1,086	48
Wise's Mill Run	446	7,056	490,000	1,090	69
Total/*Average*	**4,666**	**67,435**	**3,300,000**	***1,012***	***54***

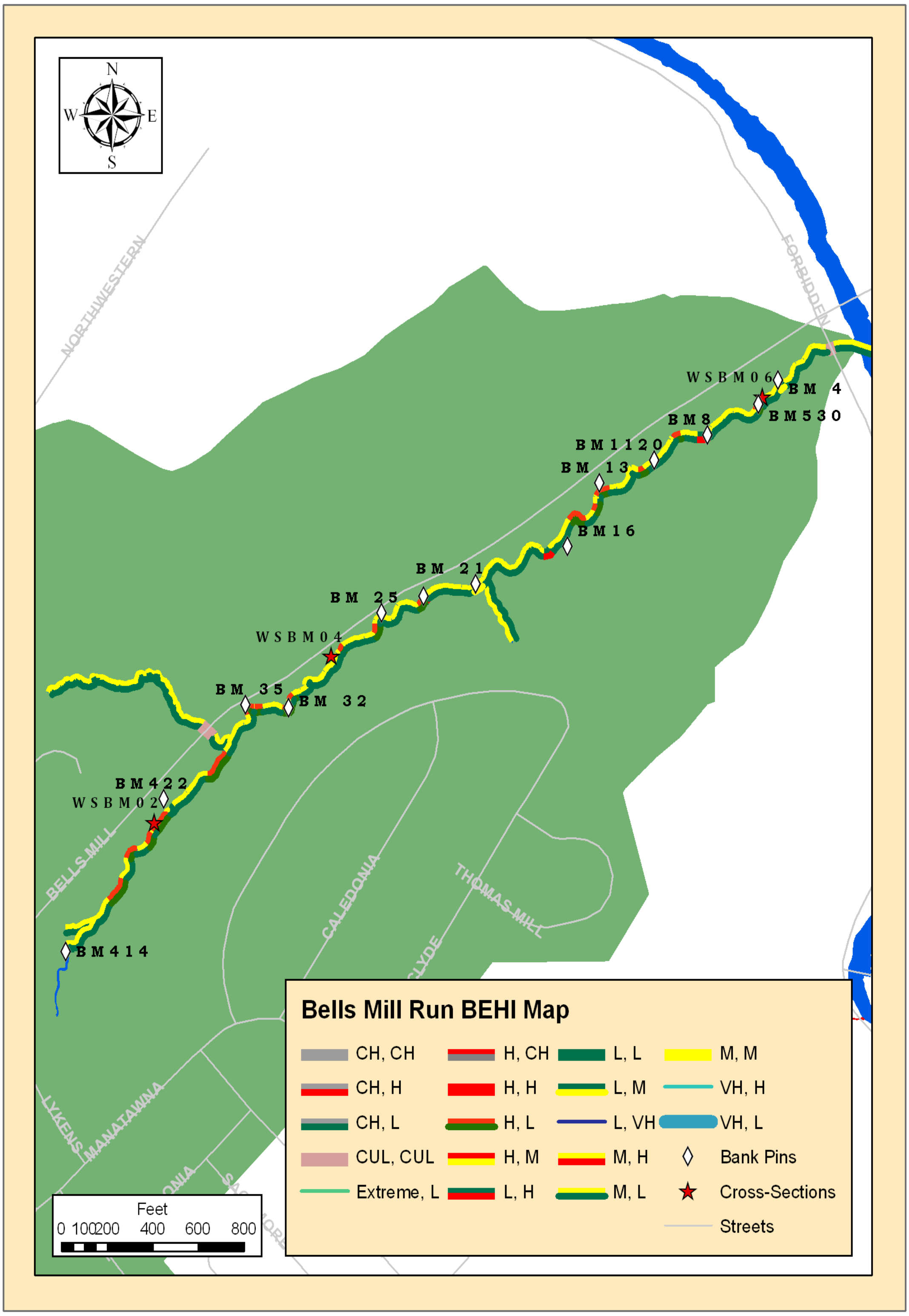


Figure 3-50: Bell's Mill Watershed BEHI Ratings and Bank Pin Locations

3.2.2.4 INFRASTRUCTURE TRACKDOWN SUMMARY

Bell's Mill Run is completely within Fairmount Park, although the sections of the Park closest to the upstream-most portion of the watershed are surrounded by residential neighborhoods and associated roadways. As such, the infrastructure in the Bell's Mill Run watershed reflected the drainage requirements of the dense urban development in the area near the stream. There were numerous outfalls and manholes, both of which comprised the vast majority of infrastructure in the reach. The high number of manholes can be attributed to the 12-inch diameter sanitary sewer line that runs parallel to Bell's Mill Run and passes underneath the stream upstream of the mouth and connects with the Wissahickon Low Level Interceptor about 120 feet south.. About 80 feet downstream of the start of reach WSBM06, the 12-inch sanitary sewer line from Manatawna Avenue crosses under the stream from right to left and connects to the pipe running adjacent to the stream. The large number of outfalls was attributed to Bell's Mill Road and the surrounding neighborhoods which contribute stormwater runoff to the stream. The largest outfall was privately owned outfall WSout473, located on the downstream right at the start of reach WSBM06. This outfall conveys discharge from a 36-inch pipe stemming from Manatawna Avenue.

The only other infrastructure elements throughout Bell's Mill Run were two culverts (WScul081 and WScul083) and a channel (WScha103). WScul083 was located underneath Bell's Mill Road on a small tributary and WScul081 conveyed the stream under Forbidden Drive before the confluence with the main stem of Wissahickon Creek. While these culverts confined the stream locally, they only constituted 2% of the entire stream length. The 39 feet of rip-rap channel in reach WSBM04 provided vital bank protection by restricting the channel from migrating laterally towards the road adjacent to the channel. Most of the infrastructure on Bell's Mill Run is in fair or good condition as only WSout476 was found to be in poor condition due to a debris jam which restricted its flow.

Table 3-52: Summary of Bell's Mill Run Infrastructure Point Features

Section ID	Culvert Count	Outfall Count	Channel Count	Confluence Count	Manhole Count	Other Count	Infra Point Count	Combined Outfall Area (ft^2)
WSBM02	1	1	0	5	1	5	3	12.57
WSBM04	0	4	1	0	2	0	7	6.05
WSBM06	1	2	0	0	6	0	9	16.77
TOTAL	**2**	**7**	**1**	**5**	**9**	**5**	**19**	**35.39**

Table 3-53: Summary of Bell's Mill Run Infrastructure Linear Features

Section ID	Segment Length (ft)	Culvert Length (ft)	Percent Culverted	Channel Length (ft), 1 side	Total Channel Length (ft)	Percent Channelized
WSBM02	2858	68	2	0	0	0
WSBM04	1838	0	0	39	39	0.7
WSBM06	1782	35	2	0	0	0
TOTAL	**6478**	**103**	**2**	**39**	**39**	**0.20**

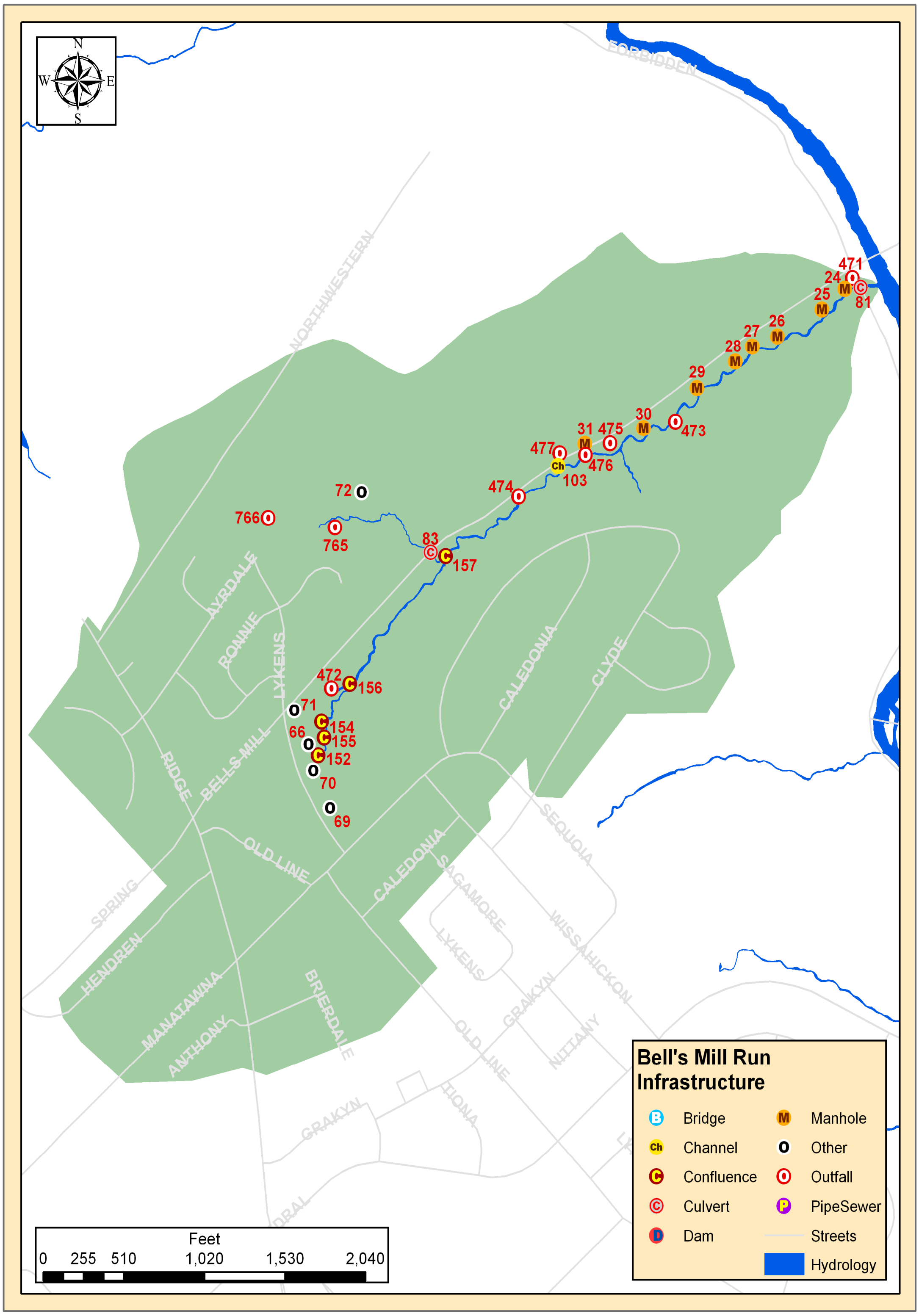


Figure 3-51: Bell's Mill Run Infrastructure Locations

Figure 3-52: Bell's Mill Run Infrastructure in Poor Condition

3.2.2.5 UNIFIED STREAM ASSESSMENT RESULTS FOR THE BELL'S MILL RUN WATERSHED

The Bell's Mill Run watershed's main stem was characterized by a rather shallow gradient, second-order channel. All three of the reaches assessed were dominated by gravel, although there were considerable amounts of cobble present throughout the main stem channel. Isolated segments within reaches WSBM02 and WSBM04 were bedrock-controlled.

The entire main stem channel, its tributaries and a large portion of the watershed were located within the boundaries of Fairmount Park. Greater than 95% of the watershed lies within the Greater Philadelphia proper however there was a small portion of the watershed located on the Montgomery County side of Northwestern Avenue. The Center for Watershed Protection's (CWP) Unified Stream Assessment Methodology (USAM) was used to score and rate the instream, riparian buffer and floodplain conditions of the stream corridor to allow for comparison to other reaches and watersheds within the Lower Wissahickon Basin.

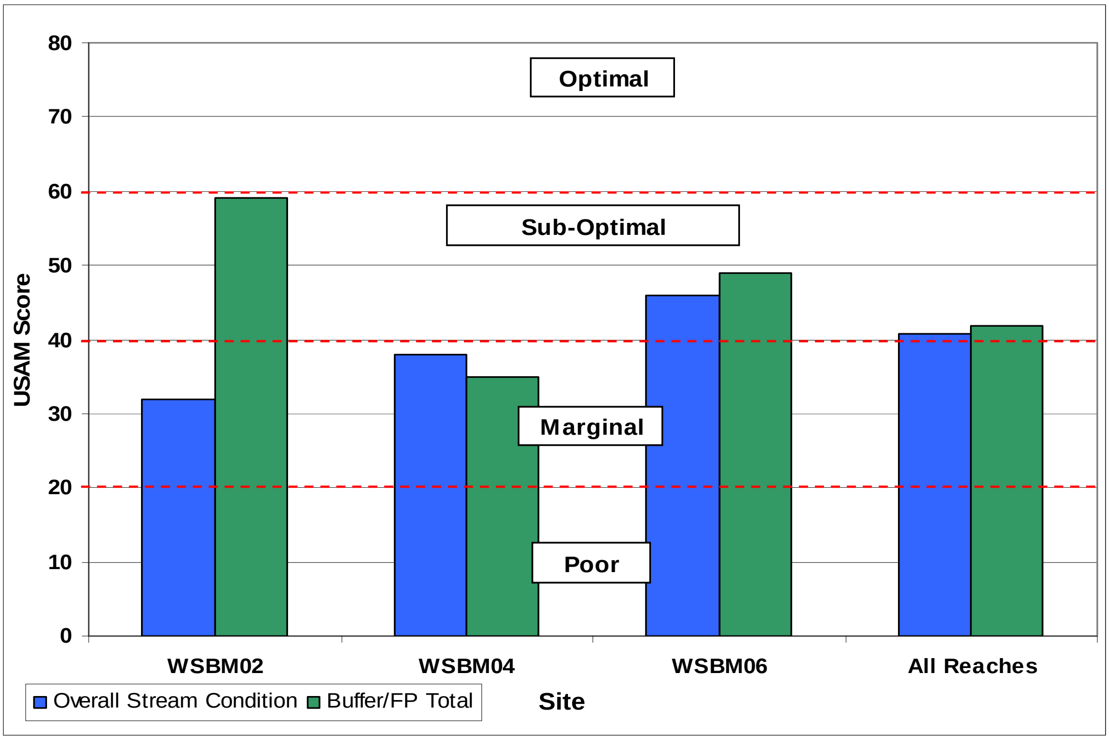


Figure 3-53: Results for Bell's Mill Run USAM Components

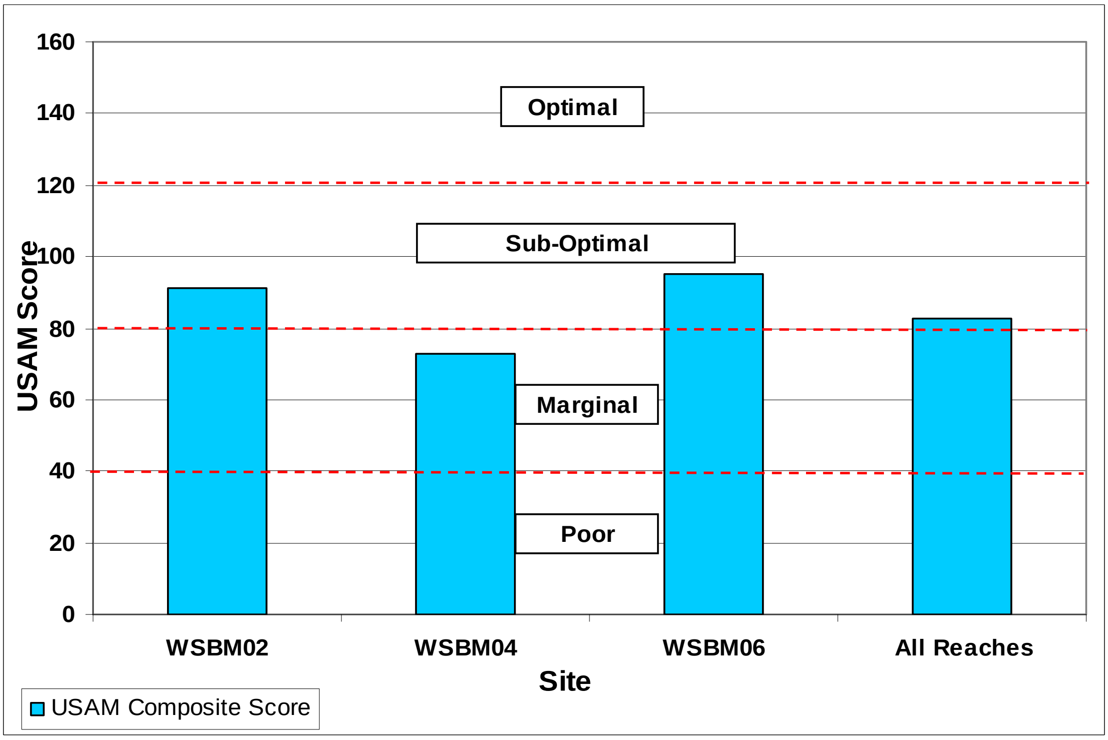


Figure 3-54: Bell's Mill Run USAM Results

3.2.2.5.1 WSBM02

Reach WSBM02 formed the headwaters of Bell's Mill Run and began about 230 feet northeast of Lykens Lane. There were two unnamed tributaries to Bell's Mill Run on reach WSBM02 as well as a number of small, zero order springs and seeps (WSmisc066,WSmisc069, WSmisc070). The upstream-most tributary was a small (125 feet), first-order tributary, which began as flow from WSout472 (W-084-02) which drains the residential neighborhood west of Bell's Mill Road. The second tributary (unnamed tributary B) was much longer (1,060 feet) and was formed as a result of groundwater return flow. Reach WSBM02 was characterized by a shallow slope (1.7%), moderate width to depth ratio (13.6) and a deeply entrenched channel. The reach was classified as a B4c type stream. The composite USAM score for reach WSBM02 was (91/160).

3.2.2.5.2 WSBM04

Reach WSBM04 began approximately 560 feet upstream from cross section WSBM04. There was one tributary (unnamed tributary A) to Bell's Mill Run on this reach, which was approximately 290 feet in length. The reach was characterized by a moderately shallow slope (2.9%), a deeply entrenched channel (ER=1.3) and a relatively high width to depth ratio (16.7). These characteristics classified the reach as a B4c type stream. The composite USAM score for reach WSBM02 was (73/160)

3.2.2.5.3 WSBM06

Reach WSBM06 began approximately 560 feet upstream from cross section WSBM06. There was one tributary (unnamed tributary A) to Bell's Mill Run on this reach, which was approximately 290 feet in length. The reach was characterized by a moderately shallow slope (2.9%), a deeply entrenched channel (ER=1.3) and a relatively high width to depth ratio (16.7). These characteristics classified the reach as a B4c type stream. The composite USAM score for reach WSBM02 was (73/160).

3.2.2.6 SUMMARY OF UNIFIED STREAM ASSESSMENT RESULTS

The mean scores for both the individual USAM components as well as the overall USAM score were classified as marginal to suboptimal (Table 3-54). Average buffer and floodplain conditions within the Bell's Mill Run stream corridors were slightly better than the average overall stream condition although there was high variability between scores for the respective USAM components among individual sites. The mean USAM composite score and *Overall Buffer and Floodplain Condition* score for the three Bell's Mill Run reaches were higher than the average scores respectively for all other reaches (excluding Bell's Mill Run reaches) in the Philadelphia portion of the Wissahickon Creek Watershed.

Table 3-54: Summary of Bell's Mill Run Infrastructure Linear Features

Reach ID	Sub-watershed	Overall Stream Condition	Overall Buffer/FP	USAM Score
WSBM02	Bells Mill	32	59	91
WSBM04	Bells Mill	38	35	73
WSBM06	Bells Mill	46	49	95
WSBM mean		**38.7**	**47.7**	**86.3**
All Reaches Average		**42.4**	**44.5**	**86.9**

3.2.2.6.1 SUMMARY OF OVERALL STREAM CONDITION SCORES IN THE BELL'S MILL RUN WATERSHED

The mean *Overall Stream Condition* score for the Bell's Mill reaches was slightly lower than the mean score for all reaches in the lower Wissahickon stream network (Table 3-55). The difference between the two scores was small yet significant in that the mean score for Bell's Mill Run reaches was below the marginal/sub-optimal threshold of 40/80. Most parameters were observed to be in the marginal to sub-optimal range for these reaches. None of the reaches on Bell's Mill Run were observed to have optimal conditions for any scoring parameter. Reach WSBM06 was the highest scoring reach (95/160) in the watershed as most of the scoring parameters were observed to be sub-optimal.

The lowest scores were observed for the *Floodplain Connection* parameter. All reaches in the watershed were rated as poor (scores of 0-5/20), which was a result of the low entrenchment ratios (1.2 – 1.3) observed for these reaches. The average score of all reaches in the lower Wissahickon (excluding Bell's Mill Run) was marginal (6.5/20). Due to the low entrenchment ratios, most flows equal to and in excess of the estimated channel-forming discharges (estimated $Q_{bankfull}$ ranged from 47.4 cfs to 62.6 cfs) for this watershed, would not reach the floodplain as these channels were deeply incised.

The highest scores observed among the Bell's Mill Run reaches were for the Instream Habitat parameter. Scores for all reaches in the watershed were rated as sub-optimal. This was the result of the very stable and complex habitat afforded by the abundant supply of cobble and small boulders observed in the watershed. Substantial amounts of CWD were also observed in all reaches.

Table 3-55: USAM Overall Stream Condition Scoring for Bell's Mill Run Watershed

OVERALL STREAM CONDITION								
Reach ID	**Sub-watershed**	**In-Stream Habitat**	**Vegetative Protection**		**Bank Erosion**		**Floodplain Connection**	**Overall Stream Condition Score**
			Left	**Right**	**Left**	**Right**		
WSBM02	Bells Mill	13	1	1	6	7	4	32
WSBM04	Bells Mill	15	5	5	3	7	3	38
WSBM06	Bells Mill	15	8	8	5	7	3	46
WSBM mean		**14.3**	**4.7**	**4.7**	**4.7**	**7.0**	**3.3**	**38.7**
All Reaches Average		**13.1**	**4.9**	**4.9**	**6.3**	**7.0**	**6.3**	**42.4**

3.2.2.6.1.1 INSTREAM HABITAT

Scores for the *Instream Habitat* parameter were all sub-optimal (Table 3-55). Two of the three reaches were rated higher than the All Reaches average, which was also rated as sub-optimal. The relatively high scores for instream habitat were attributed to the high proportion of cobble and boulder substrate observed in these reaches. The proportion of stable substrate observed in these reaches had a high correlation with the *Instream Habitat* scores as stable particles comprised 30%, 35.5% and 41% of the substrate for WSBM02, WSBM04 and WSBM06 respectively.

3.2.2.6.1.2 VEGETATIVE PROTECTION

The *Vegetative Protection* parameter measures the extent to which stream banks and immediately adjacent riparian areas are covered by vegetation in the form of trees, shrubs and non-woody, emergent macrophytes. Scores for the *Vegetative Protection* parameter ranged from poor to sub-optimal. The reach with the highest score was WSBM06 with a score of 8/10 for both the right and left banks. The lowest scores were observed in reach WSBM02, which received scored of 1/10 for both banks; however, the mean right and left bank scores for the entire watershed were still higher than the mean score for All Reaches. Site WSBM04 was rated as marginal with a score of 5/10 for both banks although these scores were still higher than the All Reaches scores for both the left and right banks (4.9/10).

The low scores for this parameter were most likely the result of channel incision observed throughout this watershed. Localized scour evidenced by exposed tree roots, was noted in each of the Bell's Mill reaches. The high degree of incision in these reaches has created nearly vertical banks in many areas, which precluded the establishment of rooted vegetation along the banks of Bell's Mill Run. The mean score for both the right and left banks of Bell's Mill Run was 4.7/10, which is classified as marginal. Under USAM scoring guidelines, marginal vegetative protection is characterized by obvious disruptions of vegetative production such as bare patches of soil or closely cropped patches of vegetation such that only 50-70% of the streambank surface is covered by vegetation.

3.2.2.6.1.3 BANK EROSION

Scores for the *Bank Erosion* parameter were all sub-optimal for the right bank and ranged from poor to marginal for the left bank. Scores for the right bank were 7/10 for all Bell's Mill Run reaches, which was equal to the "All Reaches" average of 7/10 for the right bank. The highest score for the left bank was observed in reach WSBM02 (6/10) and the lowest score was observed in reach WSBM04 (3/10). None of the Bell's Mill Run reaches scored higher than the "All Reaches" average of (6.3/10) for the left bank. The lower scores on the left bank can be attributed to the proximity of Bell's Mill Road to the channel, which was less than 30 feet from Bell's Mill Road in a number of locations along each of the reaches. The proximity of the road to the stream corridor left the corridor susceptible to high peak flows following storm events as well as hillside erosion from the sheet flow draining from the road. These issues were further exacerbated by the steep valley wall on the DSL side of the valley which increased the velocity of the stormwater runoff draining from the road.

3.2.2.6.1.4 FLOODPLAIN CONNECTION

Scores for the *Floodplain Connection* parameter were rated "poor" for all Bell's Mill Run reaches. The mean score for Bell's Mill Run (3.3/10) was substantially lower than the 'All Reaches" average (6.3/10), which was rated "marginal". As mentioned previously, the entrenchment ratios in the Bell's Mill Run watershed were very low (1.2-1.3) and indicated channel incision. Active downcutting and scour were visible on the banks throughout the watershed. Extreme incision ultimately prevents flood waters from entering the floodplain, which has adverse impacts on riparian vegetation and productivity. As the water table lowers, the soils of the streambank do not adequately support vegetation and become less cohesive, making them susceptible to more erosion and channel widening.

3.2.2.6.2 SUMMARY OF OVERALL BUFFER AND FLOODPLAIN CONDITION SCORES IN THE BELL'S MILL RUN WATERSHED

The *Overall Buffer and Floodplain* component of the USAM composite score was rated "marginal" for the Bell's Mill Run watershed. Scores for individual parameters exhibited substantial variation, ranging form poor to optimal, with the right side of the valley exhibiting the superior condition for parameters in which the right and left banks were assessed separately. This observation was attributed to the proximity of Bell's Mill Road to the left side of the valley, such that contributions of direct runoff from the road have caused localized scour and erosion on a substantial portion of the left bank throughout the watershed. In addition, the proximity to the road has limited the establishment of an adequate riparian buffer on the left banks of the WSBM04 and WSBM06 reaches.

Table 3-56: USAM Buffer and Floodplain Condition Scoring for Bell's Mill Run Watershed

OVERALL BUFFER AND FLOODPLAIN CONDITION								
Reach ID	Sub-watershed	Vegetated Buffer Width		Floodplain Vegetation	Floodplain Habitat	Floodplain Encroachment	Buffer/FP Total
		Left	Right				
WSBM02	Bells Mill	10	10	19	5	15	59
WSBM04	Bells Mill	3	10	13	5	4	35
WSBM06	Bells Mill	8	10	18	5	8	49
WSBM mean		**7**	**10**	**16.7**	**5**	**9**	**47.7**
All Reaches Average		**8.1**	**8.6**	**13.8**	**5.5**	**8.5**	**44.5**

3.2.2.6.2.1 VEGETATED BUFFER WIDTH

Scores for the *Vegetated Buffer Width* parameter ranged from poor to optimal. The right bank for all three reaches was rated as optimal with a score of 10/10. These high scores reflect a vegetated buffer of at least 50 feet, although vegetated buffers on the right side of the valley were in excess of 250 feet for all reaches. Scores on the DSL bank exhibited high variability; whereas scores ranged from poor (3/10) at WSBM04 to optimal (10/10) at WSBM02. The poor rating for WSBM04 reflects the close proximity of the reach to Bell's Mill Road, in that there were substantial segments of the reach that were within 10 feet of the stream channel. Collectively, the right banks of the Bell's Mill reaches compared favorably against the mean vegetated buffer width rating of the other large Wissahickon Creek tributary reaches (8.6/10); however, the mean left bank score for the Bell's Mill reaches (7/10) was slightly lower than the mean score of all other reaches (8.1/10).

3.2.2.6.2.2 FLOODPLAIN VEGETATION

Floodplain Vegetation ratings were based upon the predominant vegetation type (i.e. shrub, mowed turf, mature forest) observed throughout the reach as well as the successional stage of the observed vegetation stands (i.e. secondary forest, mature forest).

Generally, the scores were moderately high for Bell's Mill Run as WSBM02 and WSBM04 were rated as optimal and WSBM04 was rated as sub-optimal. Compared to the mean score for all reaches (13.8/20), the Bell's Mill Run watershed (16.7/20) had a considerably higher score which was classified as optimal. Optimal floodplain vegetation is defined as land cover dominated by mature forest. WSBM04 which was rated sub-optimal was dominated by a young forest comprised of early successional species and saplings.

3.2.2.6.2.3 FLOODPLAIN HABITAT

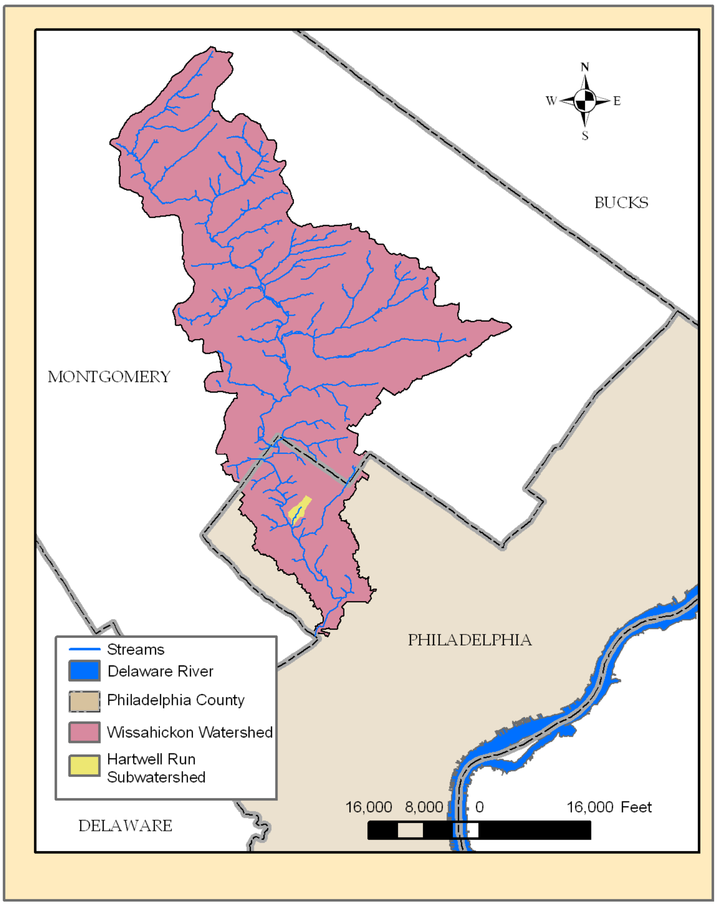
Floodplain Habitat scores were generally low in the Bell's Mill Run watershed. All sites were rated as poor due to the low entrenchment ratio observed at the three reach cross sections. The deeply incised channel precluded the inundation of the floodplain which resulted in poor floodplain habitat as wetland and riparian vegetation can not become established. Most of the reaches analyzed in this study also had poor floodplain habitat. The floodplain habitat score for Bell's Mill Run (5/10) was slightly lower than the "All reaches" mean score of 5.5/10.

3.2.2.6.2.4 FLOODPLAIN ENCROACHMENT

The *Floodplain Encroachment* parameter evaluates the level of floodplain disturbance attributed to human activities and man-made structures such as buildings, roads and other infrastructure or fill material. Scores for this parameter ranged from poor to sub-optimal. The mean score for the Bell's Mill Run reaches was 9/20, which was slightly higher than the mean score for "All Reaches" which was 8.5/20.

The reach that had the least amount of human-related floodplain disturbance was WSBM02 with a score of 15/20. There were short segments of this reach that were close to Bell's Mill Road, although the majority of this reach had extensive floodplain area free of intrusive structures that would adversely affect floodplain function. Conversely, within reach WSBM04 there were considerable segments of the reach where the channel was within 35 feet of Bell's Mill Road on the downstream right side of the valley wall. Reach WSBM06 was rated as marginal due to the fact that most of the reach was greater than 70 feet from Bell's Mill Road.

3.2.3 Hartwell Run Watershed and Reach Characteristics



Hartwell Run is a tributary to the main stem of the Wissahickon Creek. Hartwell Run originates within the City of Philadelphia. The tributary originates from two privately owned outfalls located in a single family residential neighborhood. Hartwell Run is a first-order tributary and travels approximately 3,530 feet before the confluence with the Wissahickon main stem. The dominant substrate varies from coarse gravel to small boulder material. Both the valley floor and channel have been substantially impacted by past and current land use.

The entire Hartwell Run watershed is 217 acres. Major land use types within the watershed include: wooded (59%), residential – single family detached (35%), recreation (3%), and community service (2%). Hartwell Run is surrounded by Fairmount Park on both sides for most of its length except for the top upstream quarter of the stream. The wooded buffer ranges from 50-2,000 feet.

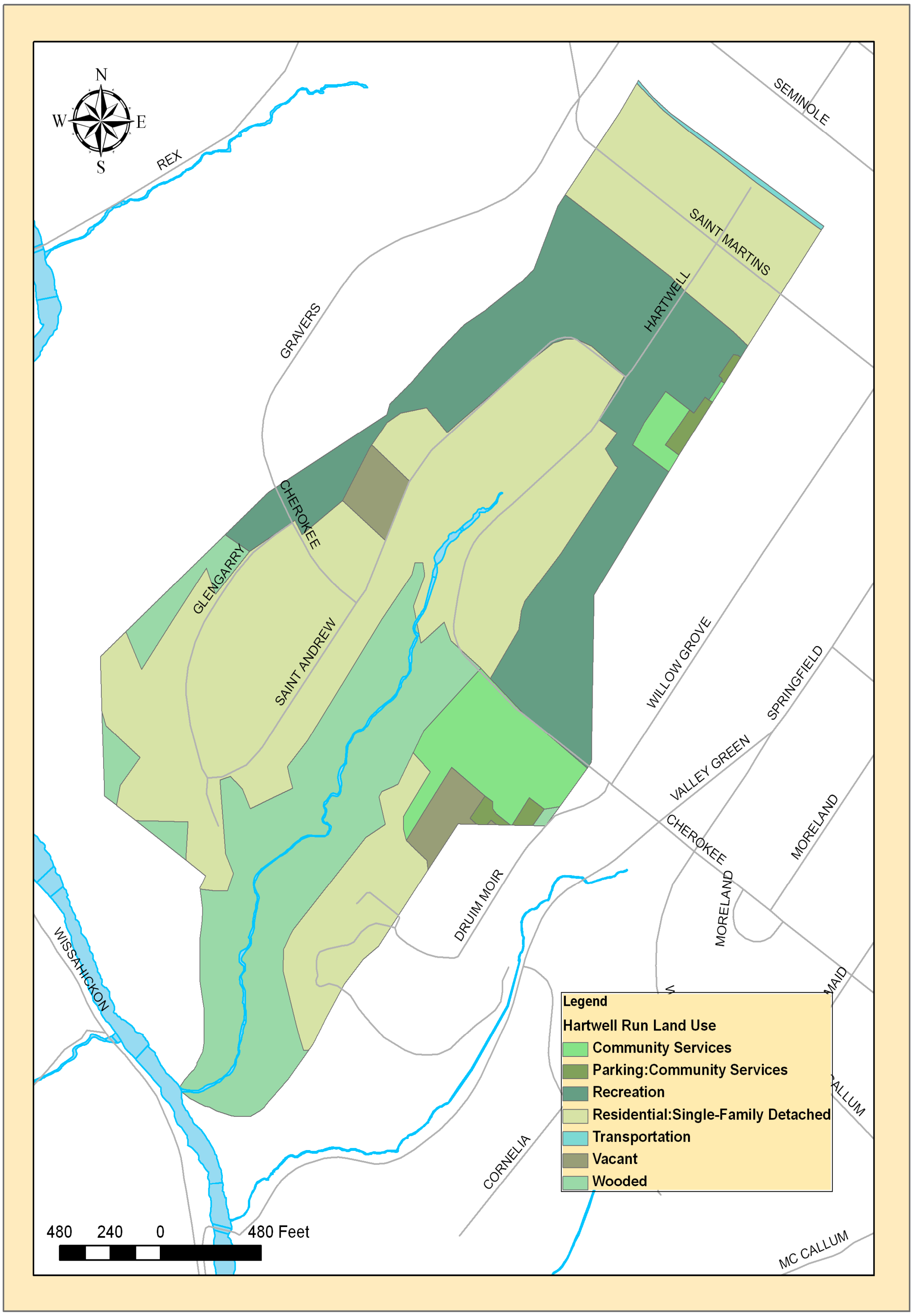


Figure 3-55: Hartwell Run Watershed Land Use

3.2.3.1 GEOLOGY

The Hartwell Run watershed is completely underlain by the Wissahickon Formation. The Wissahickon Formation consists of mica schist, gneiss and quartzite. The exposed schist near the surface is highly weathered. The Wissahickon Formation is also comprised of metamorphosed sedimentary rocks.

3.2.3.2 SOILS

According to the National Resource and Conservation Service Soil Survey, the soils for the entire Hartwell Run watershed are classified as hydrologic group B. These soils have a moderate rate of infiltration when the soils are wet (0.50-1.00 in/hr). Water movement through these soils is considered moderately rapid.

Table 3-57: Distribution of NRCS Soil Types in Hartwell Run Watershed

Group	Area (ft²)	Percent of Total Area
B	9,452,520	100%
Total Area	**9,452,520**	**100%**

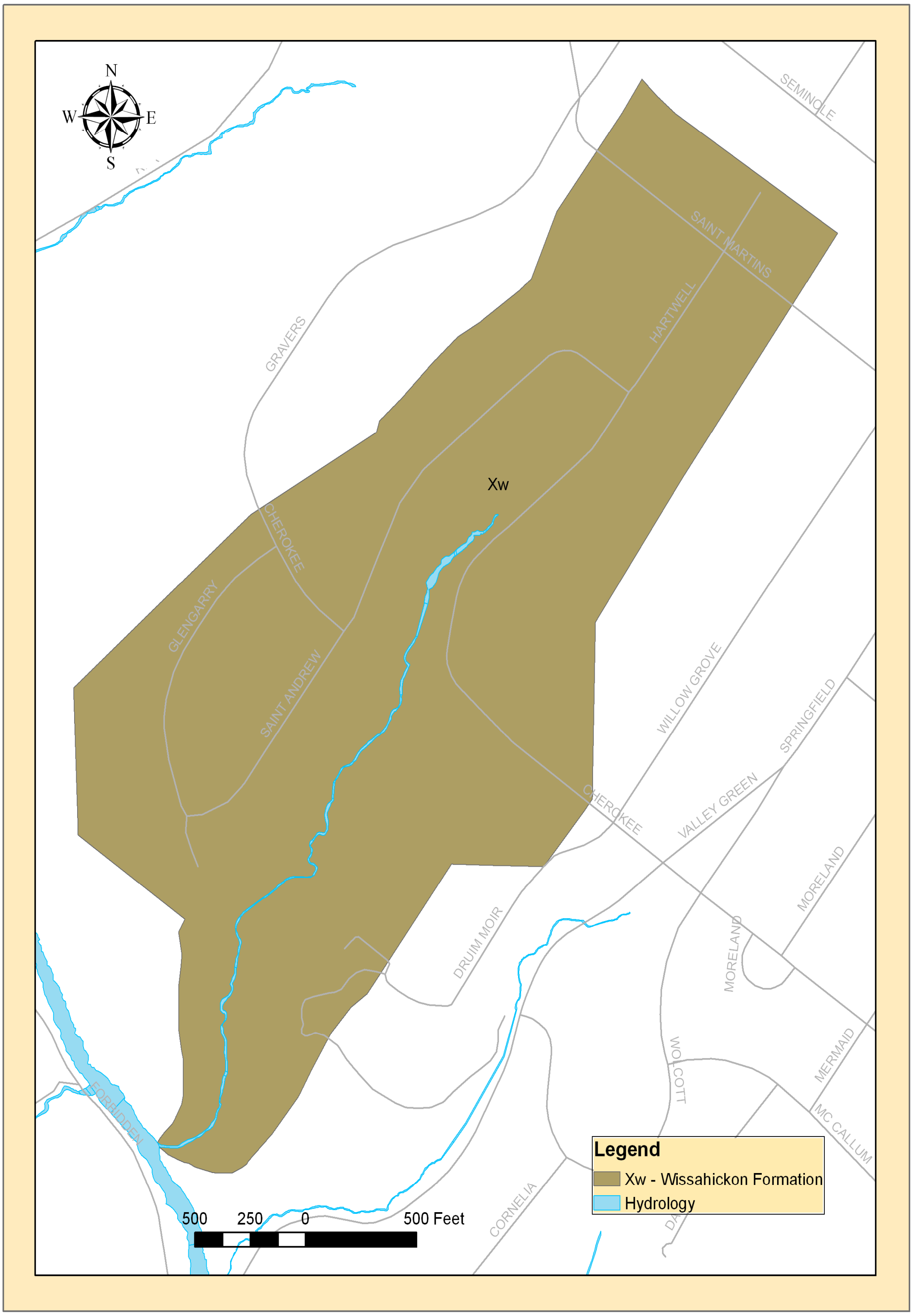


Figure 3-56: Geology of Hartwell Run Watershed

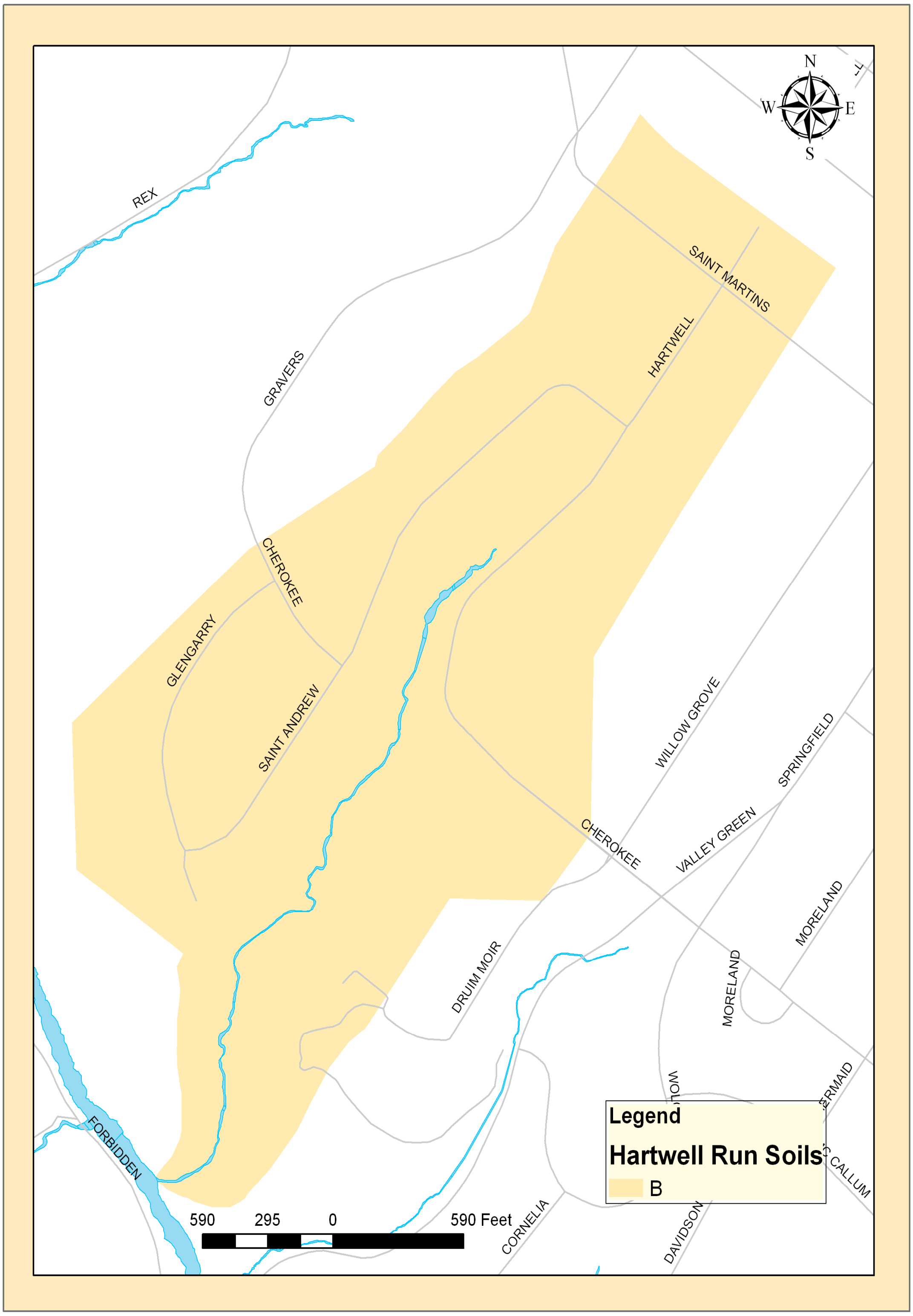


Figure 3-57: Distribution of NRCS Soil Types in Hartwell Run Watershed

3.2.3.3 BANK EROSION

There were four bank pin locations along Hartwell Run (Figure 3-58). The calculated erosion rates are included in Table 3-58. The spatial distribution of BEHI assessment results were represented graphically (Figure 3-58) for each of the segments assessed on Hartwell Run. Each bank within a respective segment was assessed and rated separately; however, channelized and culverted segments were not assessed as they confer a high degree of protection from bank erosion.

Table 3-58: Hartwell Run Bank Pin Locations

	BEHI	NBS	Baseline Reading	Most Recent Reading	Erosion Rate (ft)	Erosion Rate (ft/yr)	Eroding (-) or Aggrading (+)
Hartwell Run							
HW170	Low	Low	8/17/2007	8/10/2009	0.0055	0.0028	A
HW177	Moderate	Low	4/11/2007	8/12/2008	-0.72	-0.54	E
HW179	Low	Low	8/16/2007	8/10/2009	-0.12	-0.059	E
HW4	Very High	Low	8/17/2006	8/10/2009	0.10	0.034	A

Total erosion rates were also calculated for the entire length of each tributary within the lower Wissahickon (Table 3-59). To assess the normalized erosion potential of each tributary, the erosion rate per acre of drainage area per year and the erosion rate per foot of stream length per year were calculated. This allowed direct comparison between each of the tributaries with respect to both watershed size and the length of the tributary. Hartwell Run was ranked sixth out of the twelve tributaries within the lower Wissahickon for erosion rate per foot of stream length. The rankings were based on a scale of one being the highest erosion rate and twelve being the lowest erosion rate.

Table 3-59: Erosion Rates for Lower Wissahickon Tributaries

Tributary	Drainage Area (Acres)	Stream Length (feet)	*2009*		
			Erosion Rate (lb/yr)	*Erosion Rate Per Acre*	*Erosion Rate Per Foot of Stream*
Bell's Mill	323	6,722	420,000	1,307	63
Cathedral Run	160	2,790	150,000	913	52
Cresheim Creek	1,218	16,431	840,000	690	51
Gorgas Run	499	2,170	170,000	345	79
Hartwell Run	217	3,530	200,000	918	56
Hillcrest	144	5,272	90,000	597	16
Kitchen's Lane	234	7,753	200,000	850	26
Monoshone Creek	1,056	6,926	160,000	156	24
Rex Ave	137	1,903	150,000	1,131	81
Thomas Mill Run	104	4,008	320,000	3,058	79
Valley Green Run	128	2,874	140,000	1,086	48
Wise's Mill Run	446	7,056	490,000	1,090	69
Total/*Average*	**4,666**	**67,435**	**3,300,000**	***1,012***	***54***

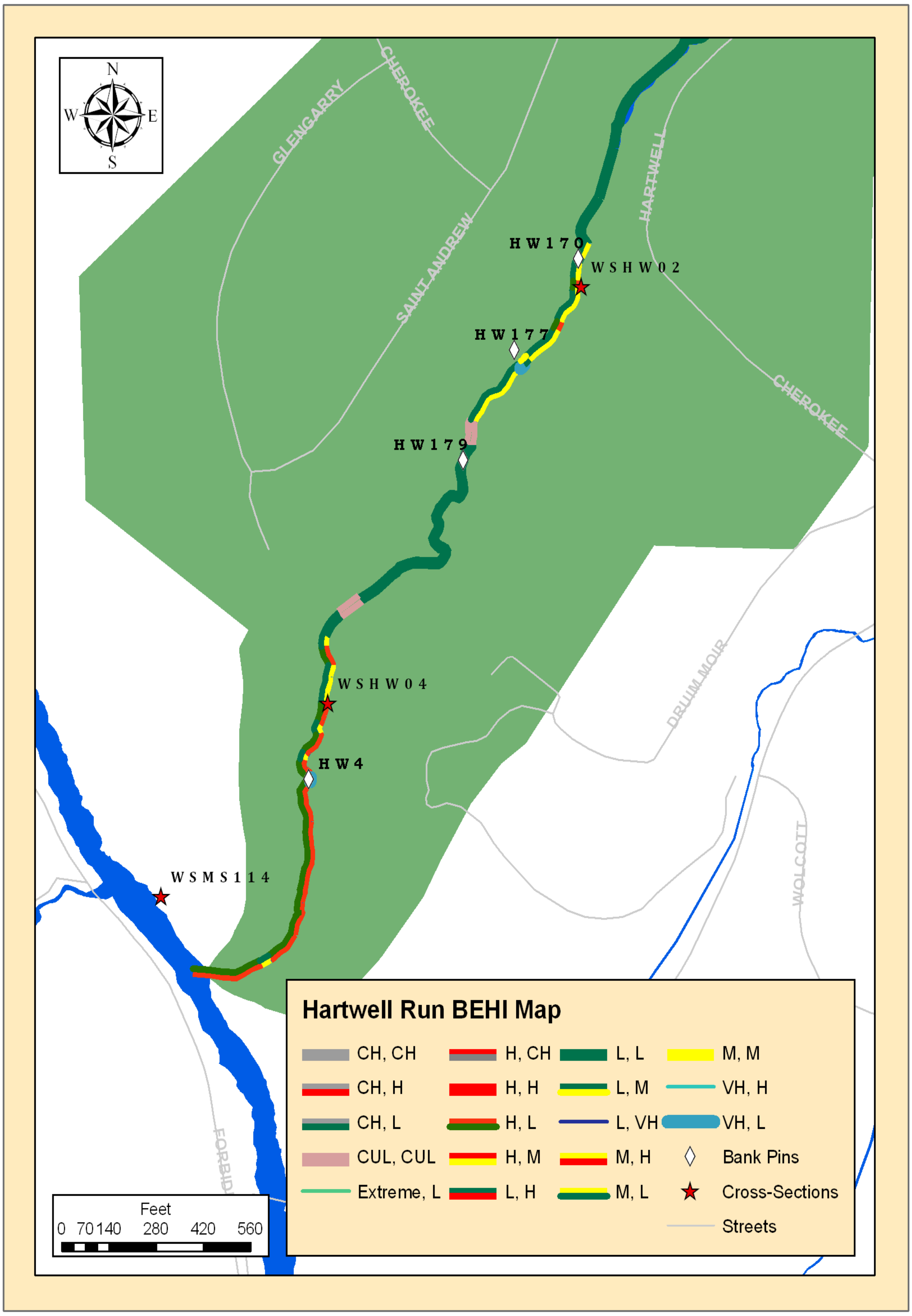


Figure 3-58: Hartwell Run Watershed BEHI Ratings and Bank Pin Locations

3.2.3.4 INFRASTRUCTURE TRACKDOWN SUMMARY

The majority of the Hartwell Run watershed was located within Fairmount Park. Half of reach WSHW02 was located outside Fairmount Park within a residential neighborhood between Hartwell Lane and St. Andrew Road. A substantial amount of infrastructure was observed within this residential corridor and included three (WSdam113, WSdam114 and WSdam115) of the four dams on Hartwell Run and the headwaters of Hartwell, which arose from a network of springs from old mill houses and outfalls (WSout577 and WSout729) that convey stormwater from Hartwell Lane. Downstream of the three dams was a channelized segment (Wscha279) of stream that ran beneath a house on Hartwell Lane. The dams may have been implemented as a means of controlling the amount of flow that passes under the house to prevent flooding.

Downstream in reach WSHW04, the channel was heavily influenced by stormwater. Increased flow from urban development has exceeded the capacity of the two culverts (Wscul13 and WScul114) in the reach. The culverts were built several decades ago and were not designed to transmit the current flow regime; therefore, these culverts can impede the downstream movement of water and sediment. At WScul116, which was constructed to protect the 45-inch Wissahickon High Level Interceptor, this occurred to such an extent that flow swept over the top of the culvert rather than through which caused substantial scour and mass slumping of the bank downstream of the culvert. PWD is currently modifying WScul116 so that it will no longer impede streamflow.

While a large portion of the flow came from the residential area upstream, WSout578 (W-076-07) in the upstream portion of WSHW04 conveyed stormwater from a 42-inch diameter pipe which drained St. Andrew Road and Glengarry Road. The majority of the infrastructure in the upstream residential area of WSHW02 was in good condition and only one infrastructure element, WScul114, was identified as being in poor condition.

Table 3-60: Hartwell Run Infrastructure Point Features

Section ID	Culvert Count	Bridge Count	Outfall Count	Channel Count	Dam Count	Infra Point Count	Combined Outfall Area (ft^2)
WSHW02	1	2	6	1	3	13	19
WSHW04	2	0	1	0	1	4	7.1
TOTAL	**3**	**2**	**7**	**1**	**4**	**17**	**26.1**

Table 3-61: Hartwell Run Infrastructure Linear Features

Section ID	Segment Length (ft)	Culvert Length (ft)	Percent Culverted	Channel Length (ft), 1 side	Channel Length (ft)	Percent Channelized
WSHW02	1752	71	4.1	141	141	2.7
WSHW04	1766	109	6.2	0	0	0
TOTAL	**3518**	**180**	**5.1**	**141**	**141**	**1.30**

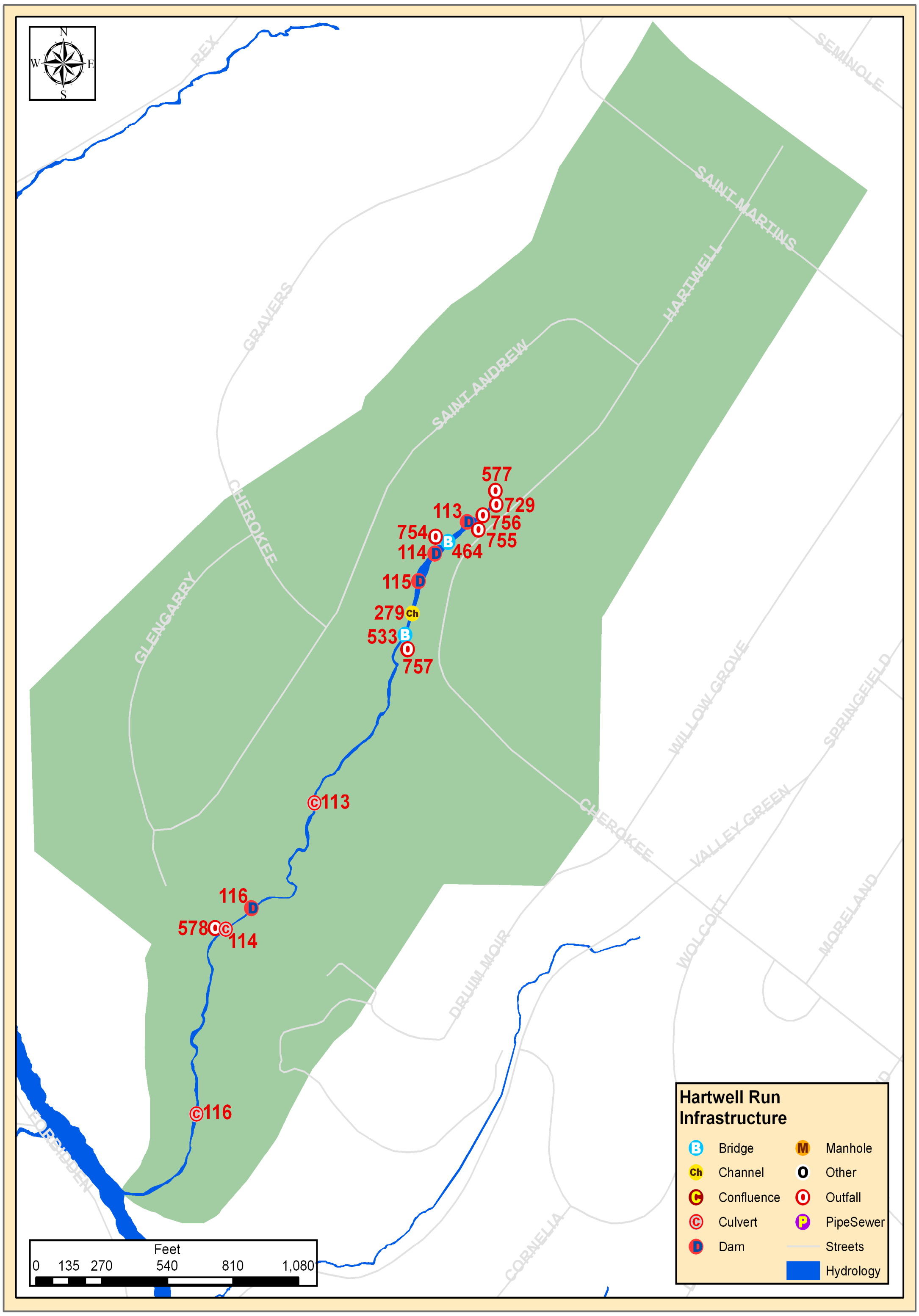


Figure 3-59: Hartwell Run Infrastructure Locations

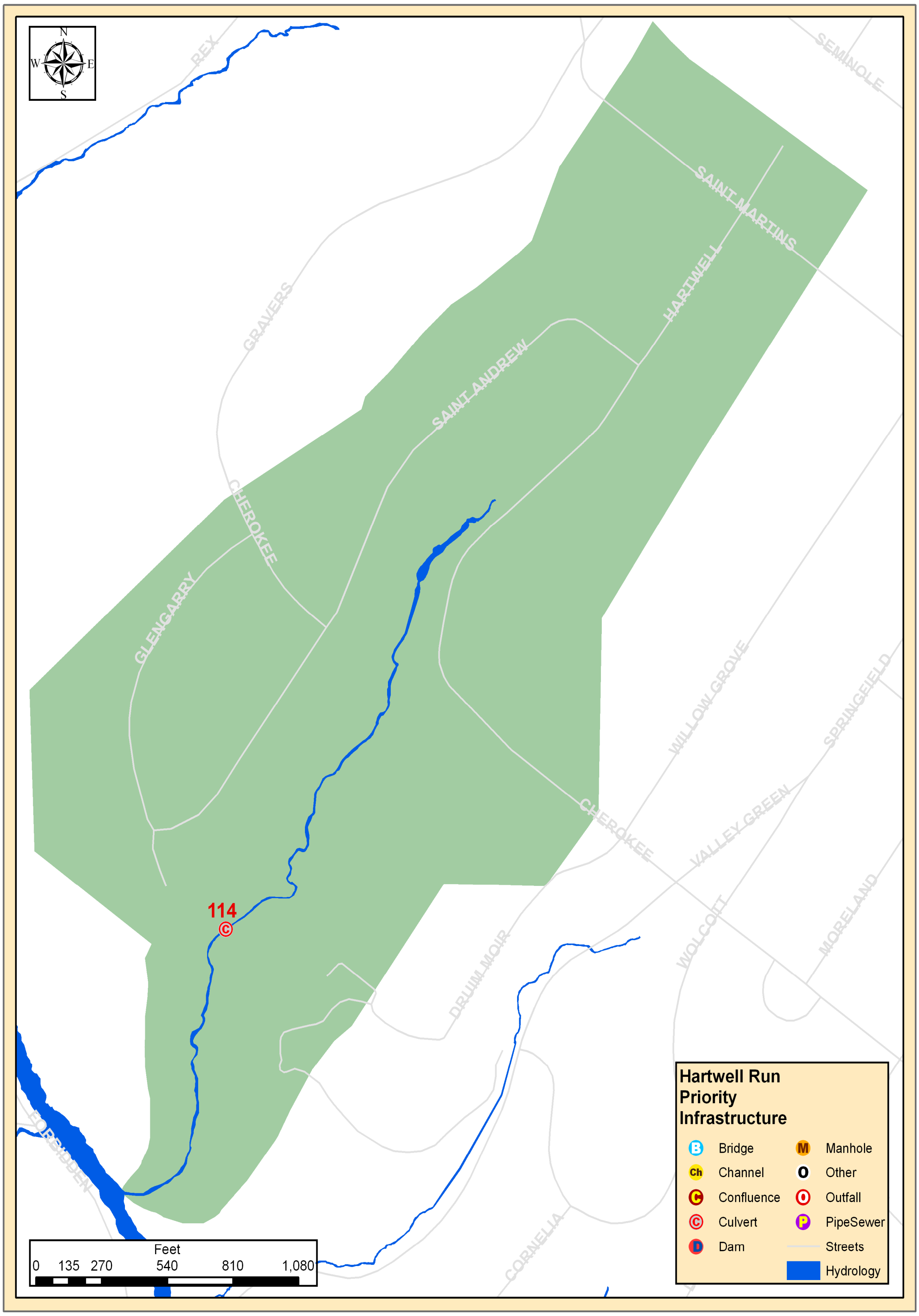


Figure 3-60: Hartwell Run Priority Infrastructure

3.2.3.5 Unified Stream Assessment Results for the Hartwell Run Watershed

The Hartwell Run watershed's stream channel was a first-order stream with no tributaries. The majority of Hartwell Run was situated within the borders of Fairmount Park with the exception of the upper reach which were embedded within a residential neighborhood. Other significant land uses included the Springside School as well as the Philadelphia Cricket Club, with the former having property boundaries that extended across both sides of the Hartwell Run stream corridor. The Center for Watershed Protection's (CWP) Unified Stream Assessment Methodology (USAM) was used to score and rate the instream, riparian buffer and floodplain conditions of the stream corridor to allow for comparison to other reaches and watersheds within the Lower Wissahickon Basin.

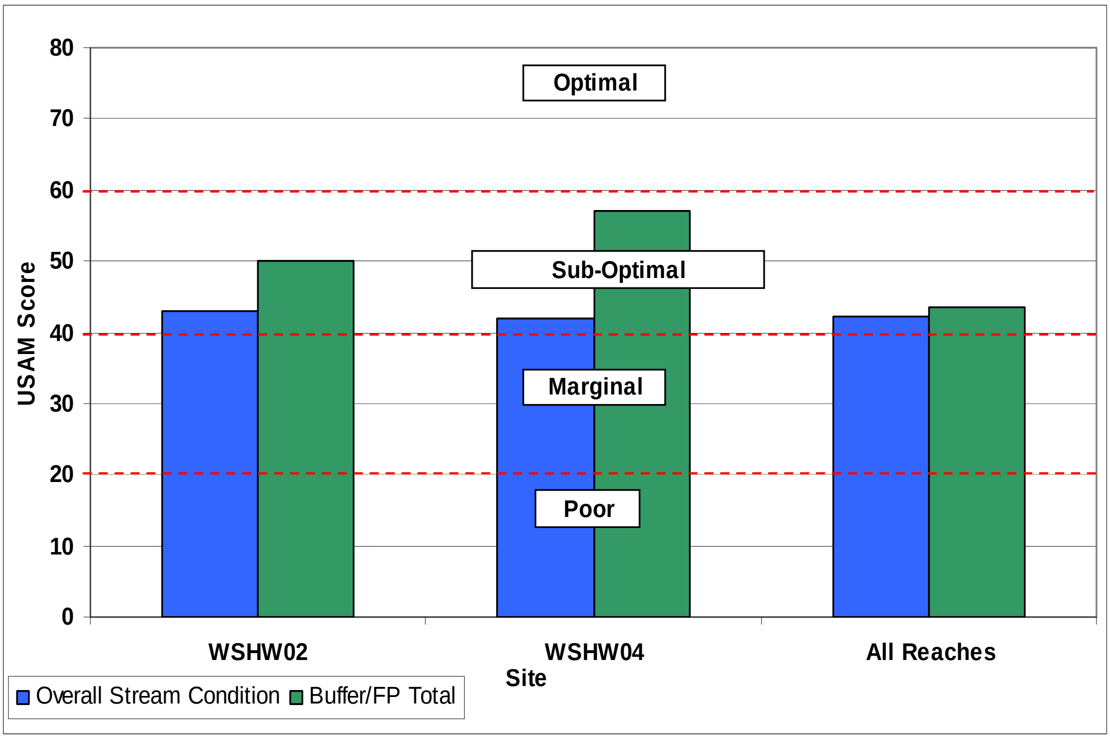


Figure 3-61: Results for Hartwell Run USAM Components

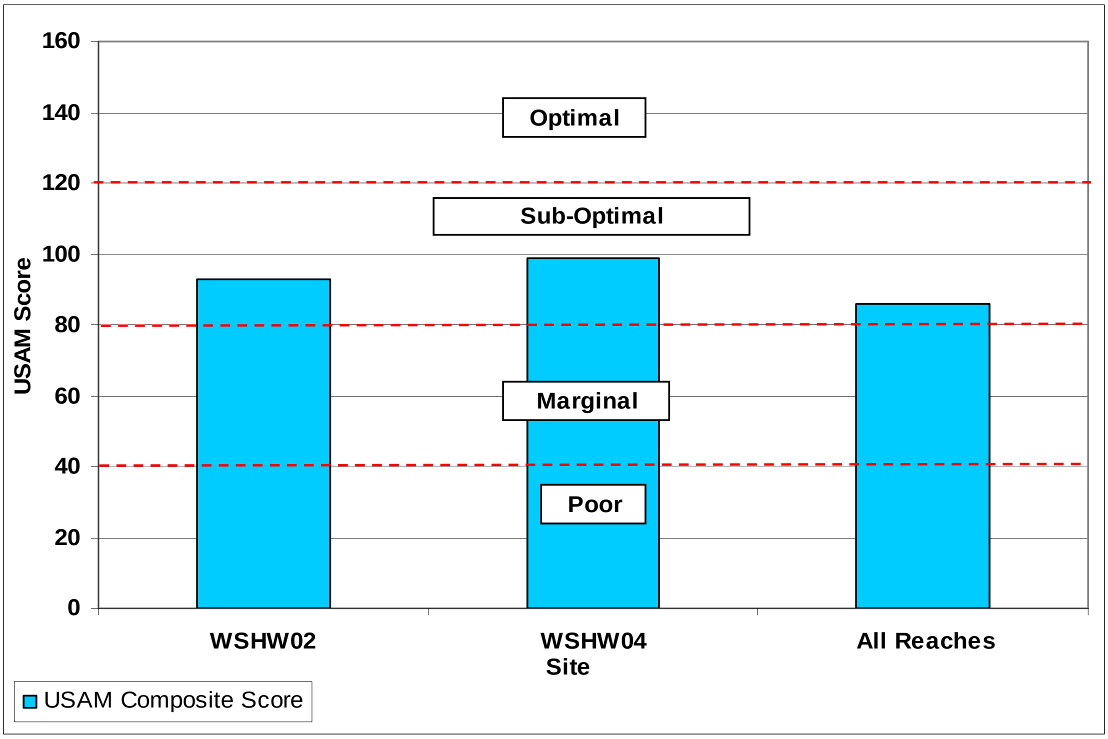


Figure 3-62: Hartwell Run USAM Results

3.2.3.5.1 WSHW02

Reach WSHW02 began as flow from WSout729 which was located 60 feet northwest of Hartwell Road. There were three dams (WSdam113, WSdam114 and WSdam115) located on WSHW02 which impounded considerable volumes of water. The gravel dominated (53%) reach was characterized by a steep slope (6.6%), a moderately entrenched channel (ER=2.2) and a moderate width to depth ratio (11.8). The reach was classified as a B4a type stream channel. The USAM composite score for WSHW02 was 93/160.

3.2.3.5.2 WSHW04

Reach WSHW04 began 230 feet downstream of WScul113. There was one dam (WSdam116) on the reach; however the impoundment caused by WSdam116 was considerably smaller than the upstream impoundments in reach WSHW02. The reach had a gradient (6.6%) and width to depth ratio (14.7) comparable to that of WSHW02; however, the reach WSHW04 channel exhibited a much higher degree of entrenchment (ER=1.1). The reach was classified as a B4a type stream channel and had a composite USAM score of 99/160.

3.2.3.6 Summary of Unified Stream Assessment Results

The mean scores for both of the individual USAM components as well as the overall USAM score were all classified as “suboptimal” (Table 3-62). Average conditions within the Hartwell Run watershed’s buffers and floodplains were considerably better than conditions observed within the stream channels. The watershed averages for each component as well as the composite USAM score compared very well against the All Reaches averages, especially for the *Overall Buffer and Floodplain Condition* component. The scores for individual parameters ranged from poor to optimal, displaying similar levels of variability between reaches.

Table 3-62: USAM Results for Hartwell Run Watershed

Reach ID	Sub-watershed	Overall Stream Condition	Overall Buffer/FP Condition	USAM Score
WSHW02	Hartwell	43	50	93
WSHW04	Hartwell	42	57	99
WSHW mean		**42.5**	**53.5**	**96**
All Reaches		**42.4**	**44.8**	**86.9**

3.2.3.6.1 SUMMARY OF OVERALL STREAM CONDITION SCORES IN THE HARTWELL RUN WATERSHED

The *Overall Stream Condition* scores recorded in the Hartwell Run watershed were similar in both reaches, yet the two shared few commonalities. The instream habitat in reach WSHW04 was far superior to that observed in reach WSHW02, as the reach WSHW04 had ample amounts of both coarse woody debris (CWD) and stable cobble and boulder substrate. Reach WSHW02 had less than suitable instream habitat characteristics however this reach had higher scores for the *Bank Erosion* and *Floodplain Connection* parameters.

The mean score for the Hartwell Run watershed (42.5/80) was rated as "suboptimal" and was only slightly higher than the All Reaches average score (42.4/80). The mean watershed scores for individual parameters of the *Overall Stream Condition* component were higher than All Reaches average scores for all parameters except the *Floodplain Connection* parameter. Scores for this parameter were consistently low throughout the Lower Wissahickon (average entrenchment ratio of 1.63).

Table 3-63: USAM Overall Stream Condition Scoring for Hartwell Run Watershed

OVERALL STREAM CONDITION								
Reach ID	Sub-watershed	Instream Habitat	Vegetative Protection		Bank Erosion		Floodplain Connection	Overall Stream Condition
			Left	Right	Left	Right		
WSHW02	Hartwell	9	5	5	7	8	9	43
WSHW04	Hartwell	18	5	5	6	7	1	42
WSHW mean		**13.5**	**5**	**5**	**6.5**	**7.5**	**5**	**42.5**
All Reaches Average		**13.1**	**4.9**	**4.9**	**6.3**	**7.0**	**6.3**	**42.4**

3.2.3.6.1.1 INSTREAM HABITAT

The instream habitat in the Hartwell Run watershed ranged from moderate to excellent and compared well against the habitat conditions observed in the Lower Wissahickon.

The mean watershed score for this parameter (13.5/20) was rated as “suboptimal” and was slightly higher than the All Reaches average score (13.1/20).

The reach with the most suitable habitat, WSHW04, was characterized by an abundance of various size classes of cobble and small boulders. These substrates provide optimal benthic habitat for both macroinvertebrates and cyprinid (minnow) species that prefer steep rocky streams due to their stability and their ability to dissipate flow velocities. There was also an abundance of large CWD which offers stable habitat and can accumulate organic matter and detritus (debris jams) which can serve as an important food supply, especially for organisms in lower trophic levels.

Reach WSHW02 was rated as “marginal” with a score of 9/20. The reduced habitat quality in the upstream-most reach was attributed to the lack of stable substrate, which is one of the most influential factors (aside from water quality) governing the distribution of benthic macroinvertebrates. The substrate was dominated by gravel (2-64 mm), which comprised 54% of the substrate, although there were ample amounts of cobble observed in the reach (34%). Large amounts of sand (9%) and gravel can be problematic from a benthic habitat perspective because these particles can settle between the interstitial spaces between larger cobble and boulders, effectively filling in these spaces. This occurrence, known as embeddedness, decreases the flow of oxygen through the stream bed (hyphoreic exchange) and also decreases the utility of interstitial spaces for foraging and shelter.

3.2.3.6.1.2 VEGETATIVE PROTECTION

Scores for the Vegetative Protection parameter were moderate for both sides of the corridor. Both the right and the left banks had a mean score of 5/10, which was rated as “marginal.” Even with the relatively low scores for this parameter, the Hartwell Run watershed had slightly higher mean scores than the All Reaches average which was (4.9/10) for both the right and the left banks. The amount of vegetated cover established on the banks of these reaches was limited by the extent of erosion and “downcutting” observed, especially in reach WSHW04 where many of the banks had nearly vertical slopes. If the erosion in these reaches were curtailed, it seems feasible that the extent of vegetative bank cover would increase as dense vegetation grew up to the edge of many of the near-vertical slopes.

3.2.3.6.1.3 BANK EROSION

Bank erosion was moderate throughout the Hartwell Run watershed relative to conditions observed in other Lower Wissahickon watersheds. The mean watershed scores for this parameter were rated as “suboptimal” for the both the left (6.5/10) and right banks (7.5/10), both of which scored higher than the left (6.3/10) and right banks (7/10) All Reaches averages. These results are in close agreement with the results of the PWD bank pin study. In the two-year study, estimated erosion rates (normalized to area and stream length) of 918 lbs/acre/yr and 56 lbs/ft/ yr were calculated for Hartwell Run. Similar to the results of the USAM analysis, Hartwell Run was relatively close to the average conditions observed throughout the Lower Wissahickon given the average erosion rates for the entire system were 1,012 lbs/acre/yr and 54 lbs/ft/yr.

3.2.3.6.1.4 FLOODPLAIN CONNECTION

Ratings for this parameter ranged from "poor" to "marginal" however, these results concur with the state of floodplain connection throughout the Lower Wissahickon. Reach WSHW04 (1/20) had the worst score among all of the large Lower Wissahickon tributaries (WSKL02 and WSCR08 also scored 1/20).The mean watershed score of (5/20) was rated as "marginal" and was within the same range as the mean score for the Lower Wissahickon (6.3/10), which was also rated as "marginal." The low scores for this parameter are symptomatic of the channel adjustments observed in many urban stream systems. Stream channels must reach equilibrium with "flashy" flows derived from impervious watersheds by adjusting laterally (channel widening) or vertically (incision or "downcutting").

3.2.3.6.2 SUMMARY OF OVERALL BUFFER AND FLOODPLAIN CONDITION SCORES IN THE HARTWELL RUN WATERSHED

In general, the *Overall Buffer and Floodplain* conditions observed within the Hartwell Run watershed were favorable. The mean watershed score (53.5/80) was rated as "suboptimal" and was considerably higher than the All Reaches average score (44.5/80) which was rated towards the lower end of the "suboptimal" range of scores. Reach WSHW04 had the second highest score (57/80) among the large, Lower Wissahickon tributaries (reach WSMO02 also scored 57/80) behind reach WSBM02. Reach WSHW02 (50/80) had a moderately high score but was limited by the proximity of Hartwell Road in the upper-most segments of the reach.

Hartwell Run's floodplains and vegetated buffers were rather extensive and consisted of mature and secondary forests; however, from an ecological perspective many floodplain functions and processes have been altered due to the altered channel morphology in both reaches. The stream channels in the Hartwell Run watershed were deeply entrenched and did not inundate their respective floodplains frequently enough to maintain adequate floodplain habitat. Furthermore, the impacts of infrastructure on the reach have altered the hydraulic characteristics of the watershed. There were four dams, three culverted segments, a channelized segment as well as a bridge within the approximately 3,500 feet creek. These infrastructure elements have tremendous impacts on both the flow (i.e. culverts and bridge abutments) and sediment (dam impoundments) regimes, which ultimately impacts floodplain processes such as flooding and sediment deposition.

Table 3-64: USAM Buffer and Floodplain Condition Scoring for Hartwell Run Watershed

OVERALL BUFFER AND FLOODPLAIN CONDITION								
Reach ID	Sub-watershed	Vegetated Buffer Width		Floodplain Vegetation	Floodplain Habitat	Floodplain Encroachment	Buffer/FP Total
		Left	Right				
WSHW02	Hartwell	10	10	17	5	8	50
WSHW04	Hartwell	10	10	17	5	15	57
WSHW mean		**10**	**10**	**17**	**5**	**11.5**	**53.5**
All Reaches Average		**8.1**	**8.6**	**13.8**	**5.5**	**8.5**	**44.8**

3.2.3.6.2.1 VEGETATED BUFFER WIDTH

Scores for the *Vegetated Buffer Width* parameter were very high throughout the entire watershed as both reaches were rated as “optimal” with scores of (10/10) for both sides of the corridor. The Hartwell Run watershed compared well to the left (8.1/10) and right (8.6/10) All Reaches averages, which were rated as “suboptimal.” The vegetated buffers on both sides of the corridor were well in excess of 50 feet in most segments of both reaches. In reach WSHW02, Hartwell Road limited the extent of the DSL vegetated buffer near the Hartwell Run the headwaters to just over 50 feet; otherwise, there was no development that impacted the extent of buffer zones in the reach. In reach WSHW04, vegetated buffers on both sides of the corridor were up to 300 feet in width.

3.2.3.6.2.2 FLOODPLAIN VEGETATION

Scores for this parameter were very high in both reaches. The dominant vegetation type within the Hartwell Run floodplains was mature forest, although there was also a well established understory throughout both reaches. The mean watershed score (17/20) was rated as “optimal” and was considerably higher than the All Reaches average (13.8/20) which was rated as “suboptimal.”

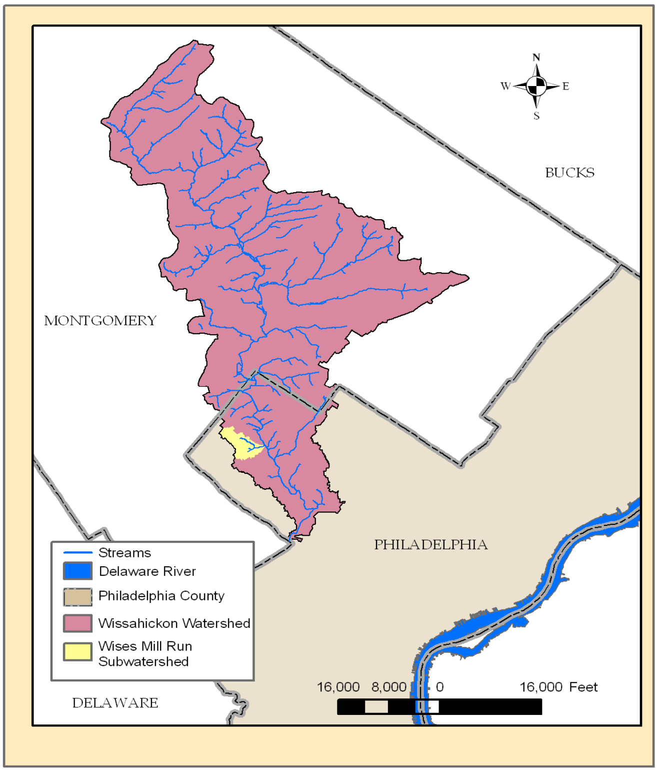
3.2.3.6.2.3 FLOODPLAIN HABITAT

Floodplain habitat was limited in the Hartwell Run reaches. The mean watershed score (5/20) was rated as “poor” and was slightly lower than the All Reaches average (5.5/20). Both reaches in the Hartwell Run watershed were deeply entrenched with entrenchment ratios of 1.9 and 1.0 for reaches WSHW02 and WSHW04 respectively. Reach WSHW04, the most deeply entrenched reach, would have to exceed the estimated bankfull discharge in the reach (230 cfs) by more than 1360% (3,313 cfs) to overtop its banks and access the floodplain. The dominance of mature forests in these reaches provides floodplain habitat in the form of snags and CWD; however, floodplain habitat types (i.e. backwater channels, ephemeral pools and wetlands) dependant on floodplain inundation are not supported or maintained in the Hartwell Run watershed.

3.2.3.6.2.4 FLOODPLAIN ENCROACHMENT

Scores for this parameter ranged from moderate to high. The mean watershed score (11.5/20) was rated as “suboptimal” and was considerably higher than the All Reaches average (8.2/20) which was rated as “marginal.” The highest score (15/20) was recorded for reach WSHW04, which had minimal development within the floodplain. Reach WSHW02 had a much lower score (8/20) due to the proximity of Hartwell Road in the upstream-most portions of the reach. Throughout reach WSHW02, the floodplain was extensive, often extending well over 100 feet. However in the vicinity of Hartwell Road the floodplain width was reduced to 50 feet on the DSL side of the corridor.

3.2.4 WISE'S MILL RUN WATERSHED AND REACH CHARACTERISTICS



Wise's Mill Run is a steep first-order tributary to the main stem of the Wissahickon Creek. The tributary consists of a northern branch, which is approximately 3,500 feet in length, and a southern branch, which is approximately 1,700 feet in length. The two branches merge just north of Wise's Mill Road and continue for another 1,900 feet before meeting the Wissahickon Creek. The stream channel is classified as a step-pool, or a Rosgen B3/1 stream. The dominant substrate varies from medium gravel to large cobble material. Both the valley floor and channel have been substantially impacted by past and current land use.

The southern branch originates from a 48-inch reinforced concrete pipe ending at outfall number WSout572 (W-076-13). Channel slopes range between three and six percent as the channel moves downstream to its confluence with the Wissahickon Creek. The watershed of WSout572 is approximately 92 acres. The area is marked exclusively by residential development which includes single-family homes, twins, apartment complexes, and supporting roadways. The entire watershed is drained by a separate storm sewer system that is directly connected to all impervious surfaces.

The northern branch begins from a 66-inch reinforced concrete pipe which ends at outfall number WSout571 (W-075-01). The stream continues for approximately 3,500 feet before merging with the southern branch. In total, the estimated drainage area of the outfalls on the northern branch is 169 acres. This drainage area is characterized by residential development, commercial development and parking, and wooded area.

The entire Wise's Mill Run watershed is 446 acres. Major land use types within the watershed include: wooded (51%), residential – single family detached (22%), residential – multi-family (7%), and vacant (5%). The majority of Wise's Mill Run is surrounded by Fairmount Park. The Park buffer ranges from about 50 feet to about 2,000 feet.

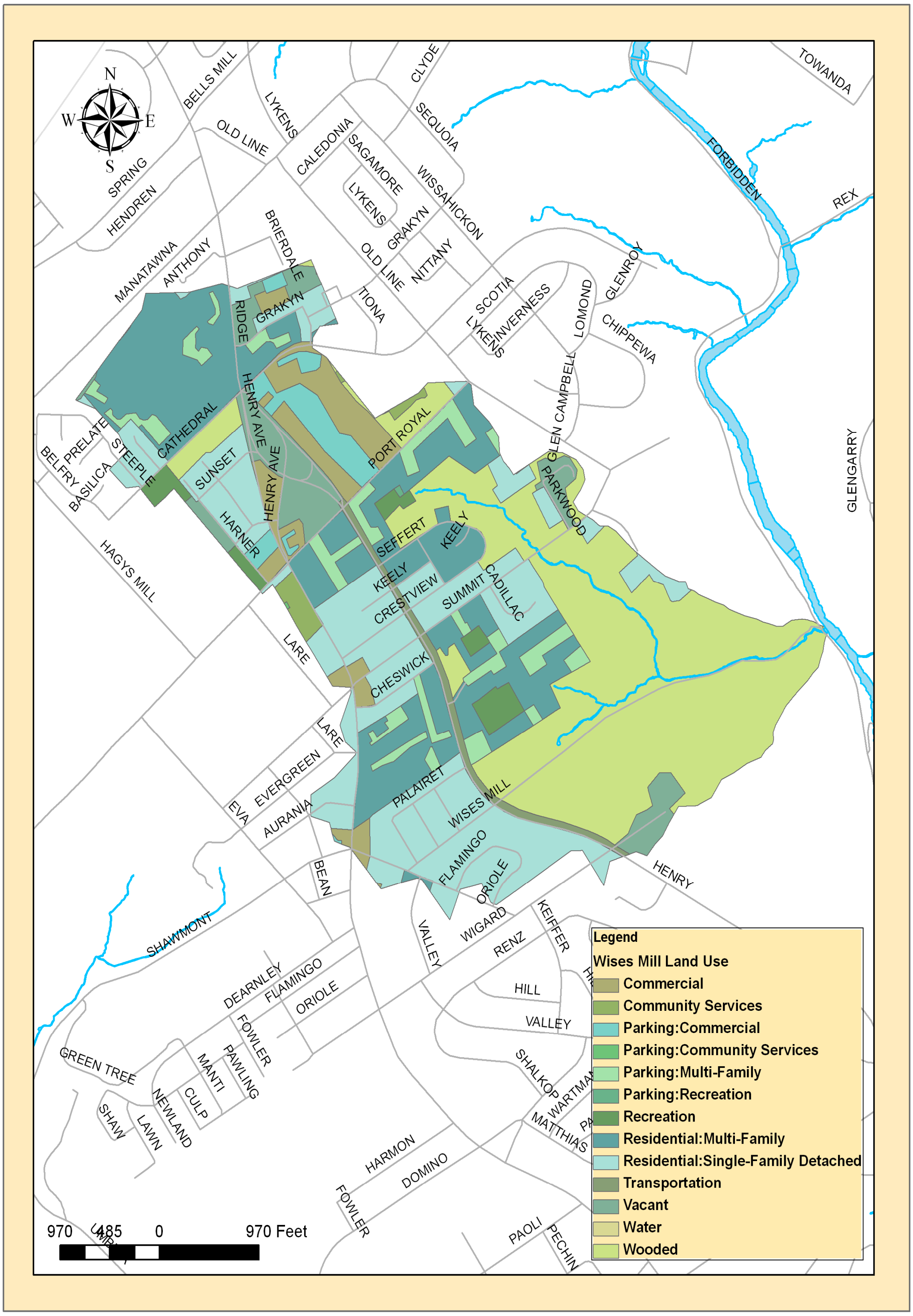


Figure 3-63: Wise's Mill Run Watershed Land Use

3.2.4.1 GEOLOGY

The majority of the Wise's Mill Run watershed is underlain by the Wissahickon Formation. The Wissahickon Formation consists of mica schist, gneiss and quartzite. The exposed schist near the surface is highly weathered. The Wissahickon Formation is also comprised of metamorphosed sedimentary rocks.

3.2.4.2 SOILS

According to the National Resource and Conservation Service Soil Survey, the majority of soils for the Wise's Mill Run watershed are classified as hydrologic group B. These soils have a moderate rate of infiltration when the soils are wet (0.50-1.00 in/hr). Water movement through these soils is considered moderately rapid.

There is a band of C soils surrounding the tributary on the northern and eastern portion of the watershed. Group C soils have a slow rate of infiltration when saturated (0.17-0.27 in/hr). Water movement through these soils is moderate or moderately slow.

Table 3-65: Distribution of NRCS Soil Types in Wise's Mill Run Watershed

Group	Area (ft^2)	Percent of Total Area
B	19,233,482	99.09%
C	194,277	0.91%
Total Area	**19,427,760**	**100%**

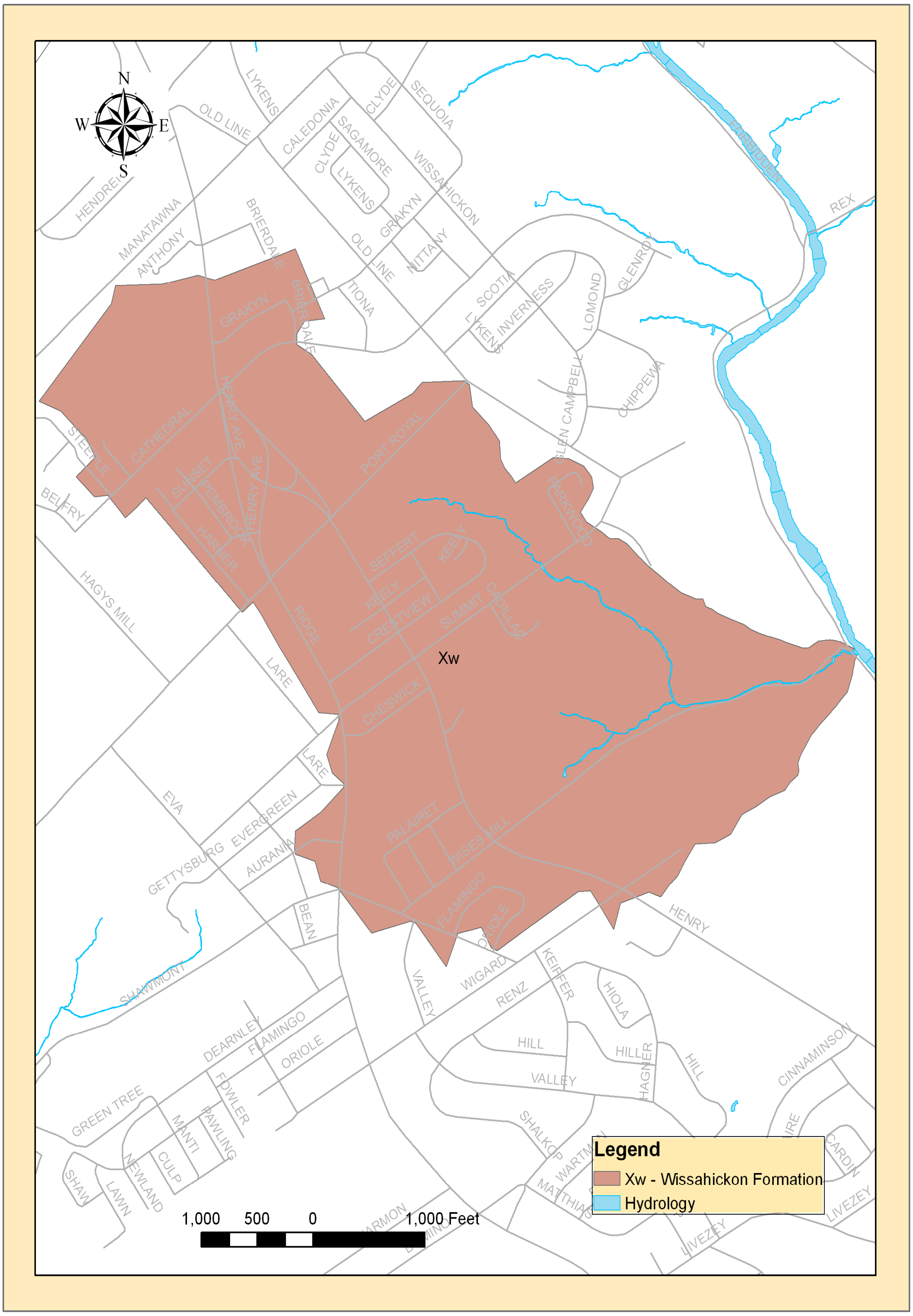


Figure 3-64: Geology of Wise's Mill Run Watershed

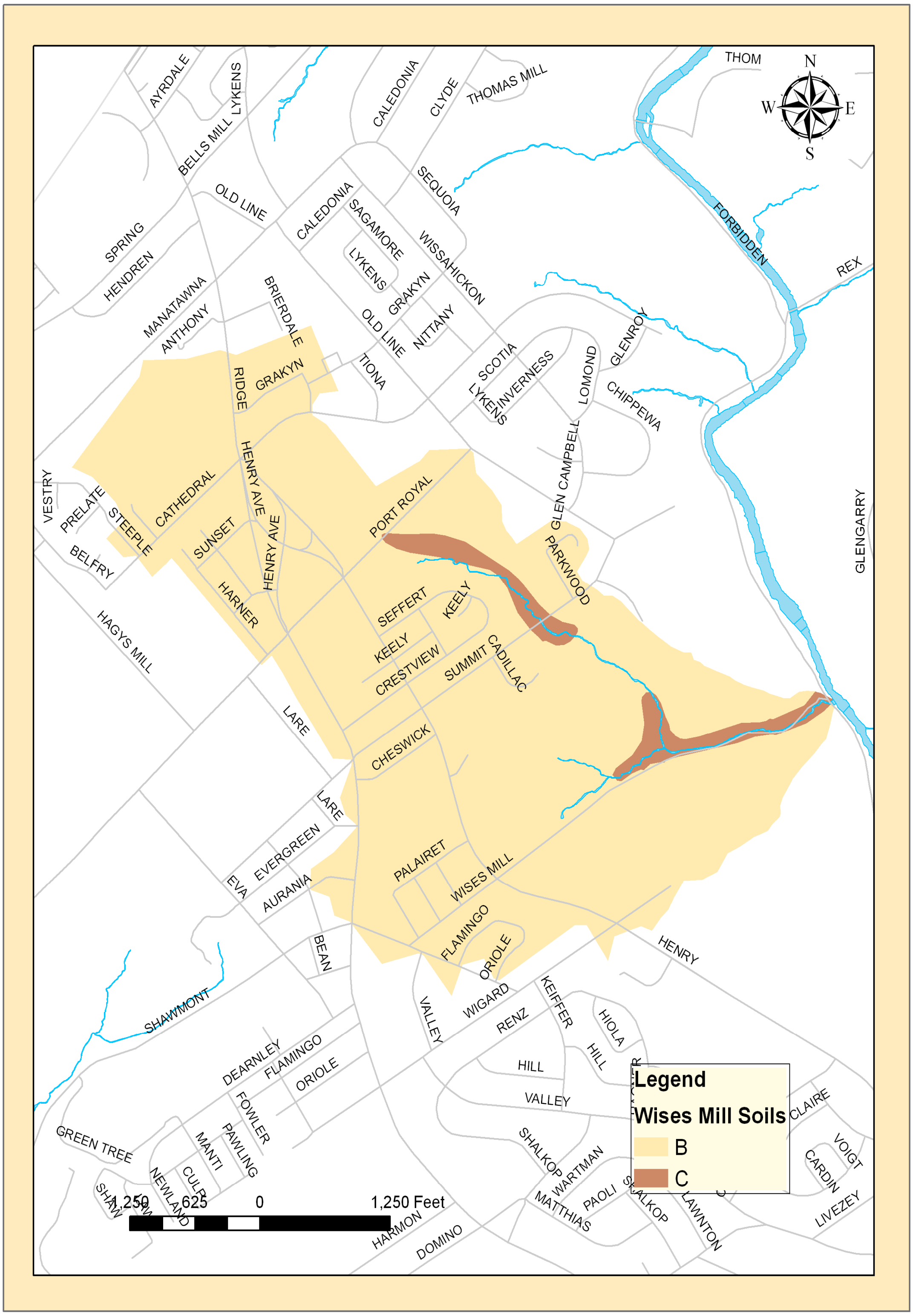


Figure 3-65: Distribution of NRCS Soils Types in Wise's Mill Run Watershed

3.2.4.3 Bank Erosion

There were 13 bank pin locations along Wise's Mill Run (Figure 3-66). The calculated erosion rates are included in Table 3-66. The spatial distribution of BEHI assessment results were represented graphically (Figure 3-66) for each of the segments assessed on Wise's Mill Run. Each bank within a respective segment was assessed and rated separately; however, channelized and culverted segments were not assessed as they confer a high degree of protection from bank erosion.

Table 3-66: Wise's Mill Run Bank Pin Locations

	BEHI	NBS	Baseline Reading	Most Recent Reading	Erosion Rate (ft)	Erosion Rate (ft/yr)	Eroding (-) or Aggrading (+)
Wise's Mill							
WM1260	Moderate	Low	5/15/2006	8/12/2008	-0.13	-0.060	E
WM13	High	Moderate	8/7/2007	8/12/2008	-2.68	-2.63	E
WM18	High	High	8/21/2006	8/12/2008	-0.70	-0.36	E
WM19	High	Low	11/5/2005	8/12/2009	-0.67	-0.18	E
WM21	Moderate	Low	11/5/2005	8/12/2009	-0.24	-0.064	E
WM2160	Low	Low	5/15/2006	8/8/2007	0.39	0.31	A
WM27	Low	High	8/18/2006	8/12/2009	-0.36	-0.12	E
WM29	Moderate	Low	4/22/2008	8/12/2009	0.74	0.57	A
WM3	High	Low	11/23/2005	8/12/2008	-0.72	-0.26	E
WM637	Low	Low	4/22/2008	8/12/2009	1.26	0.97	A
WM652	Low	Low	8/21/2006	8/12/2008	-0.083	-0.042	E
WM681	Very Low	Low	8/21/2006	8/13/2009	0.063	0.021	A
WM9	Moderate	Very Low	11/23/2005	8/12/2008	0.42	0.15	A

Total erosion rates were also calculated for the entire length of each tributary within the lower Wissahickon (Table 3-67). To assess the normalized erosion potential of each tributary, the erosion rate per acre of drainage area per year and the erosion rate per foot of stream length per year were calculated. This allowed direct comparison between each of the tributaries with respect to both watershed size and the length of the tributary. Wise's Mill Run was ranked fourth out of the twelve tributaries within the lower Wissahickon for erosion rate per foot of stream length. The rankings were based on a scale of one being the highest erosion rate and twelve being the lowest erosion rate.

Table 3-67: Erosion Rates for Lower Wissahickon Tributaries

Tributary	Drainage Area (Acres)	Stream Length (feet)	*2009*		
			Erosion Rate (lb/yr)	*Erosion Rate Per Acre*	*Erosion Rate Per Foot of Stream*
Bell's Mill	323	6,722	420,000	1,307	63
Cathedral Run	160	2,790	150,000	913	52
Cresheim Creek	1,218	16,431	840,000	690	51
Gorgas Run	499	2,170	170,000	345	79
Hartwell Run	217	3,530	200,000	918	56
Hillcrest	144	5,272	90,000	597	16
Kitchen's Lane	234	7,753	200,000	850	26
Monoshone Creek	1,056	6,926	160,000	156	24
Rex Ave	137	1,903	150,000	1,131	81
Thomas Mill Run	104	4,008	320,000	3,058	79
Valley Green Run	128	2,874	140,000	1,086	48
Wise's Mill Run	446	7,056	490,000	1,090	69
Total/*Average*	**4,666**	**67,435**	**3,300,000**	***1,012***	***54***

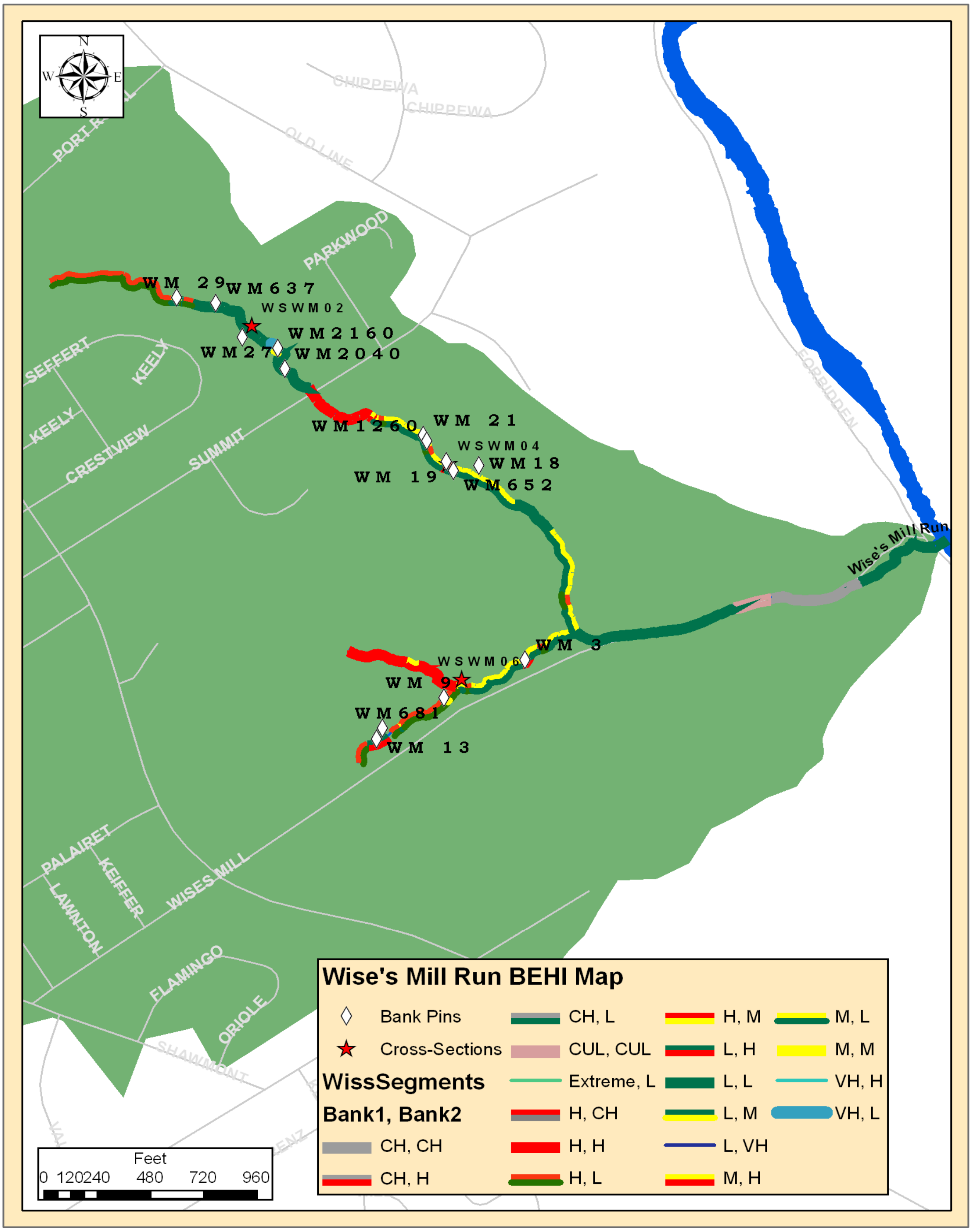


Figure 3-66: Wise's Mill Run Watershed BEHI Ratings and Bank Pin Locations

3.2.4.4 INFRASTRUCTURE TRACKDOWN SUMMARY

Wise's Mill Run exhibited characteristics of a stream that has been affected by infrastructure that is a result of urban development. While nearly the entire stream was within Fairmount Park, it was bordered by apartment complexes and private residences on Henry Avenue and Summit Street, which created the demand for drainage infrastructure. Stormwater outfalls were a major factor in the current condition of the stream as they formed the headwaters to the Wise's Mill main stem as well as the tributary reaches. Reach WSWM02 had three large outfalls, with diameters of 5.5 feet, 3.5 feet, and 2.25 feet. These outfalls conveyed runoff from Port Royal Avenue, Seffert Street, and Crestview Road through 66-inch, 42-inch, and 27-inch diameter pipes respectively. Along Wise's Mill Road there were several outfalls that carried runoff from Henry Avenue and Wise's Mill Road, the largest of which was WSout572 (48 inches). This outfall discharged such high flows that the stream had eroded and scoured the area around the outfall leaving the cascade hanging about five feet above the water level at base flow. Downstream of this outfall were four more outfalls which were 1-1.5 feet in diameter. Currently there is a project on Wise's Mill Road aimed at redirecting stormwater flows to a constructed wetland southwest of reach WSWM06. While there were no infrastructure elements designated as being in poor condition, WSout572 was undermined and its condition will likely worsen over time. There are currently plans being developed to redesign this outfall such that it can accommodate the flows associated with Wise's Mill Run flow regime.

Table 3-68: Wise's Mill Run Infrastructure Point Features

Section ID	Culvert Count	Bridge Count	Outfall Count	Confluence Count	Dam Count	Manhole Count	Infra Point Count	Combined Outfall Area (ft^2)
WSWM02	2	0	3	0	0	1	6	37.36
WSWM04	2	2	2	1	2	3	12	1.6
WSWM06	0	1	6	1	0	0	8	25.2
TOTAL	**4**	**3**	**11**	**2**	**2**	**4**	**26**	**64.08**

Table 3-69: Wise's Mill Run Infrastructure Linear Features

Section ID	Segment Length (ft)	Culvert Length (ft)	Percent Culverted	Channel Length (ft)	Percent Channelized
WSWM02	1271	93	7.3	0	0
WSWM04	3610	241	6.7	0	0
WSWM06	1297	0	0	0	0
TOTAL	**6178**	**334**	**5.4**	**0**	**0**

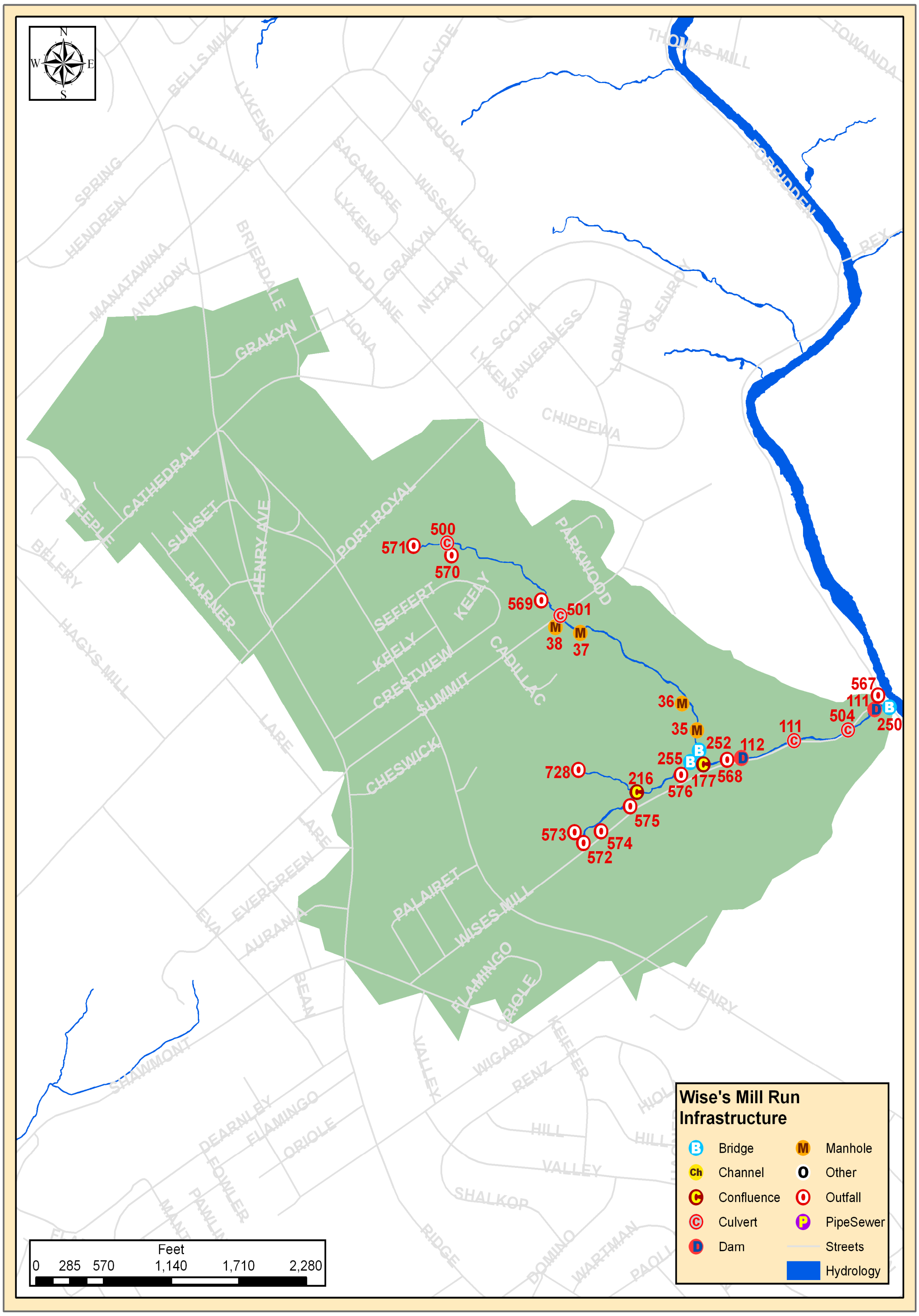


Figure 3-67: Wise's Mill Run Infrastructure Locations

3.2.4.5 UNIFIED STREAM ASSESSMENT RESULTS FOR THE WISE'S MILL RUN WATERSHED

The Wise's Mill watershed's main stem channel was a moderately sinuous first-order channel until it reached the confluence with the southern branch of the creek (WSWM06) just north of Wise's Mill Road, where the channel became a second-order stream channel. The majority of the channel was located within the boundaries of Fairmount Park with the exception of the upstream-most portion of the northern fork of the unnamed tributary as well as the main stem channel and unnamed tributary in the vicinity of their confluence. The Center for Watershed Protection's (CWP) Unified Stream Assessment Methodology (USAM) was used to score and rate the instream, riparian buffer and floodplain conditions of the stream corridor to allow for comparison to other reaches and watersheds within the Lower Wissahickon Basin.

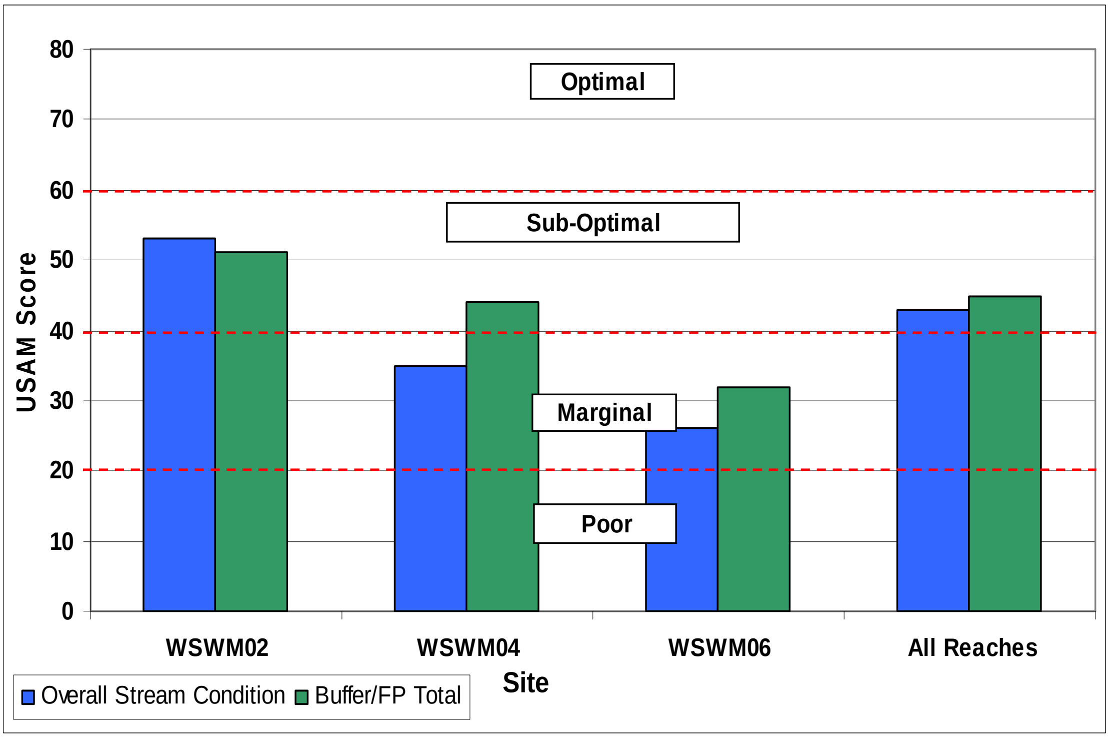


Figure 3-68: Results for Wise's Mill Run USAM Components

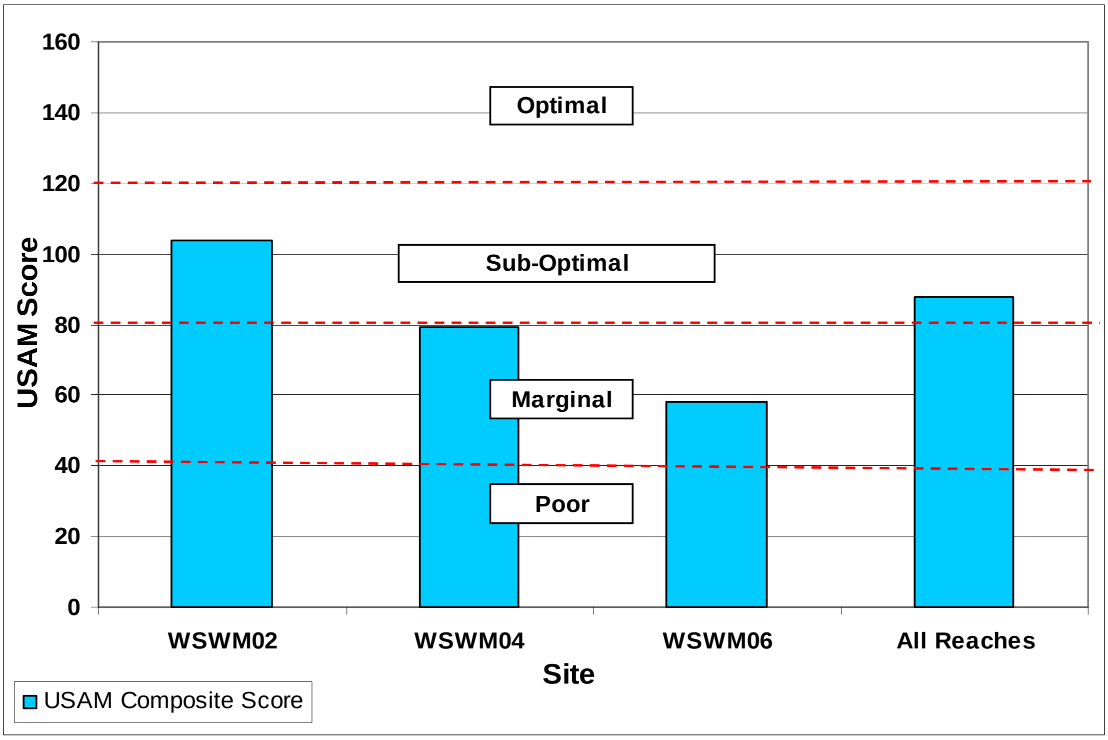


Figure 3-69: Main Stem Wise's Mill Run USAM Results

3.2.4.5.1 WSWM02

Reach WSWM02 began as flow from WSout571 (W-075-01) which was located on the grounds of the Summit Park East Apartment Complex on Henry Avenue. The reach flowed through Fairmount Park for 1,271 feet and ended at culvert WScul501 on Summit Avenue. The substrate particle size distribution was dominated by gravel (54%) although cobble substrate (42%) was present in considerable amounts throughout the reach. Reach WSWM02 had a relatively shallow slope (2.7%) compared to the other Wise's Mill reaches. It was characterized by a high width to depth ratio (30.8) and a deeply entrenched channel (ER=1.3), which classified the reach as a B4 stream channel. The composite USAM score (Figure 3-69) for the reach was (104/160).

3.2.4.5.2 WSWM04

Reach WSWM04 began at WScul501 (Summit Avenue) and ended at the confluence of Wise's Mill Run and Wissahickon Creek. The reach flowed through Fairmount Park for approximately 1,750 before it reached the confluence with the south fork (unnamed tributary A) of Wise's Mill Run. Downstream of the confluence, WSWM04 became a second-order stream as it flowed alongside Wise's Mill Avenue towards the confluence with Wissahickon Creek. The substrate particle size distribution was dominated by gravel (56%) and had comparable amounts cobble (38%) as reach WSWM02. The reach was also similar to reach WSWM02 in terms of cross sectional geometry in that reach WSWM04 likewise had a relatively high width to depth ratio (20.1) and was deeply entrenched (ER=1.4). Reach WSWM04 was classified as a B4a stream channel due to its steep gradient (5.8%) and had a USAM composite score of (79/160).

3.2.4.5.3 WSWM06

Reach WSWM06 represented the south fork (unnamed tributary) of Wise's Mill Run. The main stem of the south fork, which began as flow from WSout572 (W-076-13), had a tributary which began as flow from a privately owned outfall, WSout728, located on the grounds of the Fairfield Henry Apartments located on Henry Avenue. The main stem channel became a second-order stream downstream of WScon216, which was located 30 feet upstream of cross section WSWM06. The substrate particle size distribution was similar to that of the other two Wise's Mill Run reaches assessed, with predominance of gravel (58%) and an abundance of cobble (34%). The channel geometry was similar to that of the other two reaches with a width to depth ratio of 22.1 and an entrenchment ratio of 1.5; however, the slope of reach WSWM06 (5.2%) made it most similar to reach WSWM04. The reach was also classified as a B4a steam type and the USAM composite score was (58/160).

3.2.4.6 Summary of Unified Stream Assessment Results

The mean scores for both the *Overall Buffer and Floodplain Condition* and the *Overall Stream Condition* components as well as the composite USAM score were classified as "marginal" to "suboptimal." (Table 3-70) Average conditions within the Wise's Mill Run watershed's buffers and floodplains were slightly better than conditions observed within the stream channels. The watershed averages for the *Overall Stream Condition* component as well as the composite USAM were fairly lower than the respective All Reaches averages, however the *Overall Buffer and Floodplain* component was relatively close to the All Reaches average. The scores for individual parameters ranged from poor to optimal, displaying similar levels of variability between reaches.

Table 3-70: USAM Results for Wise's Mill Run Watershed

Reach ID	Sub-watershed	Overall Stream Condition	Overall Buffer/FP Condition	USAM Score
WSWM02	Wises Mill	53	51	104
WSWM04	Wises Mill	35	44	79
WSWM06	Wises Mill	26	32	58
WSWM mean		**38.0**	**42.3**	**80.3**
All Reaches		**42.4**	**44.5**	**86.9**

3.2.4.6.1 Summary of Overall Stream Condition Scores in the Wise's Mill Run Watershed

In general, the mean score for the *Overall Stream Condition* component was 38/80 and was rated as "marginal." Reach WSWM02 was the only reach that had a score greater than the All Reaches average score (42.4/80), which was rated as "suboptimal." There was a trend such that scores were observed to decrease in the downstream reaches (WSWM04 and WSWM06), which could be due to the increased density of infrastructure in the downstream reaches as well the proximity to Wise's Mill Road.

The *Instream Habitat* parameter had relatively high scores among all of the Wise's Mill Reaches as all reaches were rated as "suboptimal" or higher. The presence of a stable substrate (cobble and boulder) and the abundance of coarse woody debris (CWD) throughout the watershed were the factors most responsible for the habitat conditions score. The *Floodplain Connection* and *Bank Erosion* parameters were amongst the worst-scoring parameters. Most bank erosion was observed to be localized; however the lack of floodplain connection (low entrenchment ratios) was characteristic of the entire watershed.

Table 3-71: USAM Overall Stream Condition Scoring for Wise's Mill Run Watershed

OVERALL STREAM CONDITION								
Reach ID	Sub-watershed	Instream Habitat	Vegetative Protection		Bank Erosion		Floodplain Connection	Overall Stream Condition
			Left	Right	Left	Right		
WSWM02	Wises Mill	18	8	8	8	8	3	53
WSWM04	Wises Mill	13	4	4	5	6	3	35
WSWM06	Wises Mill	13	2	2	2	2	5	26
WSWM mean		**14.7**	**4.7**	**4.7**	**5**	**5.3**	**3.7**	**38**
All Reaches		**13.1**	**4.9**	**4.9**	**6.3**	**7.0**	**6.3**	**42.4**

3.2.4.6.1.1 INSTREAM HABITAT

Scores for the *Instream Habitat* parameter were relatively high as ratings at individual reaches ranged from "suboptimal" to "optimal." The watershed mean score (14.7/20) was higher than the All Reaches average (13.1/20) although both were rated as "suboptimal." Instream habitat in the Wise's Mill Reaches was characterized by an abundance of stable habitat features. Reaches WSWM02, WSWM04 and WSWM06 had substrates comprised of 42%, 38% and 34% cobble respectively. Moreover, the dominant size classes of cobble within these reaches were medium to very large cobble, which provides structurally complex and extremely stable habitat templates for a variety of macroinvertebrate and fish species. There were also ample supplies of CWD of various sizes and stages of conditioning.

3.2.4.6.1.2 VEGETATIVE PROTECTION

Scores for the *Vegetative Protection* parameter were moderate as ratings for each reach ranged from "poor" at WSWM06 to "suboptimal" at WSWM02. The mean score of the watershed for both banks was (4.7/10) which was rated as "marginal." The All Reaches average for both the left and right bank was slightly higher (4.9/10) but was likewise rated as "marginal." The worst reach, WSWM06 (2/10), was characterized by patches of bare soil and segments where localized erosion and scour had produced nearly vertical banks which precluded the establishment on bank vegetation. Reach WSWM02, which had the highest score (8/10) was characterized by an abundance of streambank vegetation in the form of shrubs (dominant vegetation type) and small to medium-sized saplings and groundcover vegetation. There were segments of reach WSWM02 where bank erosion had produced patches of bare soil; however, the banks were not scoured to the extent that they were vertical and precluded the establishment of streambank vegetative cover.

3.2.4.6.1.3 BANK EROSION

The Wise's Mill watershed was observed to have moderate to high levels of bank erosion, especially on the middle and lower reaches; however most instances of erosion were localized and rarely affected an entire reach. The mean watershed scores for both the left (5/10) and right banks (5.3/10) were rated as "marginal." The Wise's Mill Run watershed did not compare well against the All Reaches averages for neither the left (6.3/10) nor right banks (7.0/10) which were both rated as "suboptimal." As was noted for the *Vegetative Protection* parameter, the localized erosion observed in the lower reach (WSWM06) had produced nearly vertical banks in many segments of the reach. The high degree of erosion observed in WSMW06 is most likely due to the high density of infrastructure in the reach as there were three outfalls (WSout572, WSout573, and WSout574) in the upper part of the reach.

3.2.4.6.1.4 FLOODPLAIN CONNECTION

Scores for the *Floodplain Connection* parameter were very low and were indicative of the elevated levels of channel incision or "entrenchment" observed in many of the Lower Wissahickon tributaries. The mean watershed score (3.7/20) was rated as "poor" compared to the All Reaches average (6.3/20) which was rated as "marginal." The rather low scores for both the Wise's Mill Run watershed and the larger Lower Wissahickon tributaries indicate the extent to which large-scale, watershed wide imperviousness drives the hydrodynamic forces that influence channel morphology.

Channel incision, symptomatic of urban streams, essentially disconnects stream channels from their respective floodplains. The highly urbanized watersheds of the Lower Wissahickon have stream networks that are predisposed to the "flashy" hydrologic regimes prevalent in urbanized catchments such that stream channels have very low base-flow discharges and extremely high bankfull discharge capacities. The result is often a channel in a continual phase of adjustment (lateral and vertical) in response to a "flashy" hydrologic regime and its associated sediment load.

3.2.4.6.2 SUMMARY OF OVERALL BUFFER AND FLOODPLAIN CONDITION SCORES IN THE WISE'S MILL RUN WATERSHED

The scores for the *Overall Buffer and Floodplain* component ranged from low to moderate and generally decreased in the downstream direction. The decreasing trend was attributed to the increased density of infrastructure and the presence of roads and development in the downstream reaches. The mean watershed score (42.3/80) was rated as "suboptimal" and compared well with the All Reaches average score (44.8/80) which was also rated as "suboptimal."

The highest scores were observed for the *Vegetated Buffer Width* parameter. On average the DSL side of the corridor was observed to have one of the widest vegetated buffers in the Lower Wissahickon as the average score for the left banks of the watershed was (9.3/10), which was rated as "optimal." The lowest scores in the watershed were recorded for the *Floodplain Encroachment* and *Floodplain Habitat* parameters. As with many other parameters, scores tended to decrease in the downstream reaches.

Table 3-72: USAM Buffer and Floodplain Condition Scoring for Wise's Mill Run Watershed

OVERALL BUFFER AND FLOODPLAIN CONDITION							
Reach ID	Sub-watershed	Vegetated Buffer Width		Floodplain Vegetation	Floodplain Habitat	Floodplain Encroachment	Overall Buffer/FP Condition
		Left	Right				
WSWM02	Wises Mill	10	10	14	6	11	51
WSWM04	Wises Mill	10	7	12	5	10	44
WSWM06	Wises Mill	8	6	14	1	3	32
WSWM mean		**9.3**	**7.7**	**13.3**	**4**	**8**	**42.3**
All Reaches Average		**8.1**	**8.6**	**13.8**	**5.5**	**8.5**	**44.5**

3.2.4.6.2.1 VEGETATED BUFFER WIDTH

Scores for the *Vegetative Buffer Width* parameter were generally high, especially in the upstream reaches. The mean watershed scores for the left (9.3/10) and right (7.7/10) banks were rated as "optimal" and "suboptimal" respectively. The All Reaches averages were (8.1/10) and (8.6/10) for the left and right banks respectively as only the right bank average was higher than the watershed mean scores. The lower scores in the two lower reaches (WSWM04 and WSWM06), especially on the DSR side of the corridor, were attributed to the presence of development (WSWM04) and Wise's Mill Road (WSWM06).

3.2.4.6.2.2 FLOODPLAIN VEGETATION

The *Floodplain Vegetation* parameter serves as an estimate of the dominant vegetation type present within the stream corridor, with mature forest being optimal. Scores for this parameter were high as all reaches were rated as "suboptimal." The watershed average (13.3/20) was slightly lower than the All Reaches average (13.8/20) although both were rated as "suboptimal." A suboptimal rating for this parameter is characteristic of a stream corridor dominated by young or secondary forest, however, mature stands were observed.

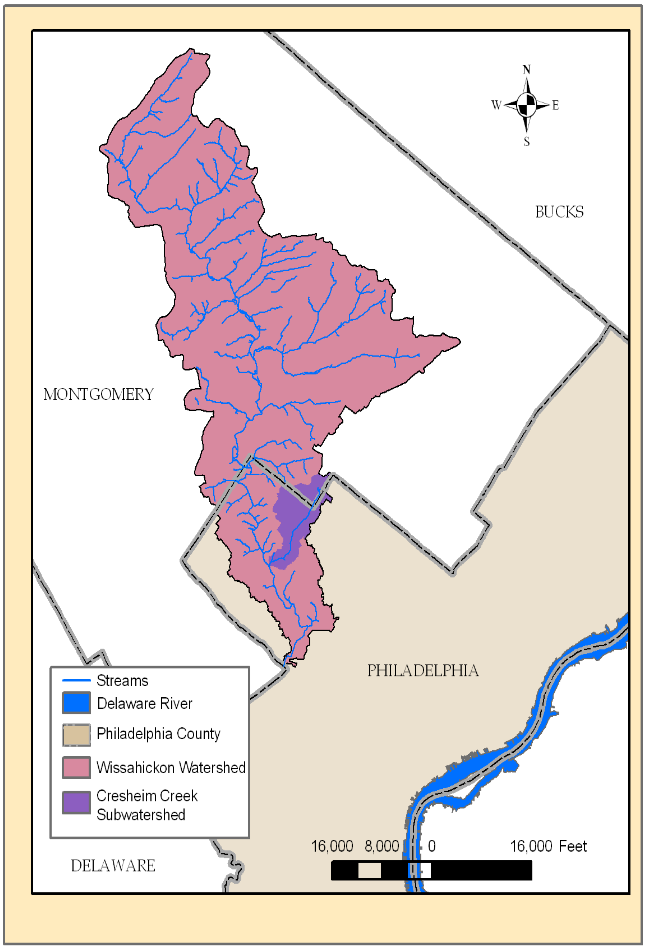
3.2.4.6.2.3 FLOODPLAIN HABITAT

Floodplain Habitat scores were very low throughout the watershed as only one reach (WSWM02) was rated higher than "poor." The watershed average (4/20) was considerably lower then the All Reaches average score (5.5/20) which was rated as "marginal." Many aspects of floodplain habitat rely on occasional or seasonal floodplain inundation (i.e. backwater channels, ephemeral pools), which delivers upstream sediment, nutrients and processed organic matter to the floodplain. Throughout the Wise's Mill watershed, values for the entrenchment ratio (metric that gauges a channel's "floodplain connectivity") were very low, which is an indicator of infrequent inundation. In the context of the USAM, floodplain systems that are infrequently inundated will most likely consist of habitat that is entirely non-wetland, with little evidence of standing water. In this context, such habitat would not be considered optimal because it lacks the potential diversity that would come with a habitat template composed of a combination of wetland and non-wetland habitat.

3.2.4.6.2.4 FLOODPLAIN ENCROACHMENT

Scores for the *Floodplain Encroachment* parameter were low to moderate throughout the watersheds as scores were rated from “poor” to “suboptimal.” Both the mean watershed score (8/20) and the All Reaches average (8.5/20) were rated as “marginal.” Scores were higher in the upstream-most reach (WSWM02) as lower in the watershed, infrastructure such as outfalls, dams, bridges and culverts impinged upon floodplain function. In reach WSWM06, the proximity of Wise’s Mill Road had a considerably adverse effect on floodplain function in the reach as some segments of the reach were within 30 to 40 feet of the road. As such, WSWM06 had a score of (3/20) and was rated as “poor.”

3.2.5 Cresheim Creek Watershed and Reach Characteristics



Cresheim Creek is a tributary to the main stem of the Wissahickon Creek. Cresheim Creek originates outside of the City of Philadelphia and travels for approximately half a mile before entering the City limits. The tributary originates from two outfalls, one from a single family residential neighborhood and one from a light industrial area. Due to the location outside of the City, information on these outfalls is limited. Cresheim Creek is a first-order tributary for approximately 2.6 miles until a smaller 0.3 mile tributary enters Cresheim approximately 0.1 miles from the Confluence with the Wissahickon main stem.. Reaches of the stream channel are classified as a Rosgen type C and a Rosgen type F. The dominant substrate varies from course gravel to small boulder material. Both the valley floor and channel have been substantially impacted by past and current land use.

The entire Cresheim Creek watershed is 1548 acres. Major land use types within the watershed include: residential – single family detached (46%), wooded (15%), residential – row home (7%), and community service (8%). Once the creek enters the City of Philadelphia, it is surrounded by Fairmount Park on both sides for the entire length. The Park buffer ranges from about 50 feet to about 2,000 feet.

The Philadelphia Water Department (PWD) owns and operates 12 stormwater outfalls that discharge into Cresheim Creek. The entire watershed is drained by a separate storm sewer system that is directly connected to all impervious surfaces. There are an additional 9 outfalls owned by an entity other than PWD that release into Cresheim Creek.

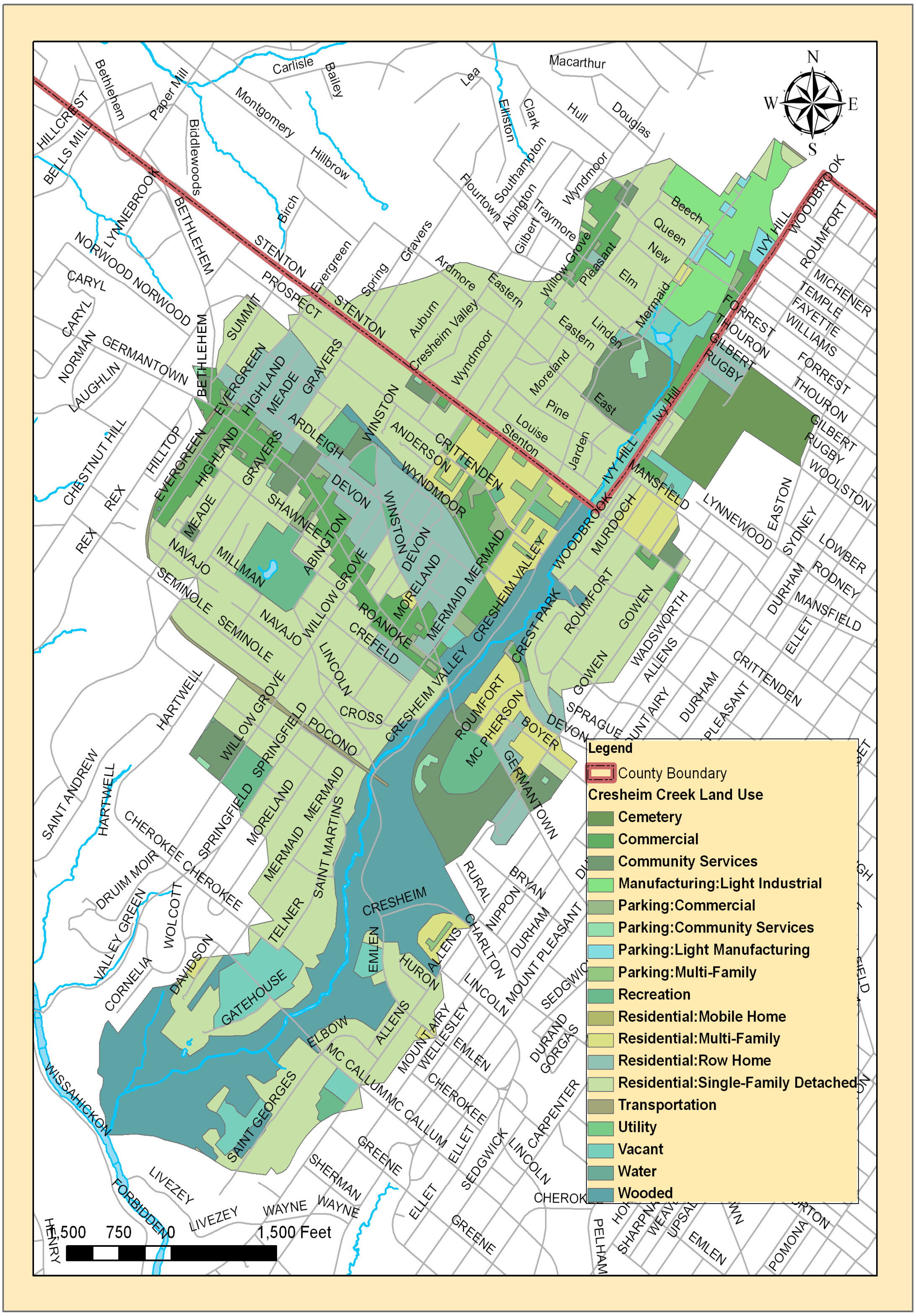


Figure 3-70: Cresheim Creek Watershed Land Use

3.2.5.1 GEOLOGY

The majority of the Cresheim Creek watershed is underlain by the Wissahickon Formation. The Wissahickon Formation consists of mica schist, gneiss and quartzite. The exposed schist near the surface is highly weathered. The Wissahickon Formation is also comprised of metamorphosed sedimentary rocks.

The northern portion of the Cresheim Creek watershed is underlain by the Bryn Mawr Formation. The Bryn Mawr Formation consists of white, yellow and brown gravel and sand. The Bryn Mawr Formation is considered a deeply weathered formation.

There is a small section of Ultramafic rocks in the southwest corner of the Cresheim Creek watershed. Ultramafic rocks are igneous rocks that contain very low silica content. Ultramafic rocks possess good surface drainage while being highly resistant to weathering at the same time.

3.2.5.2 SOILS

According to the National Resource and Conservation Service Soil Survey, the majority of soils for the Cresheim Creek watershed are classified as hydrologic group B. These soils have a moderate rate of infiltration when the soils are wet (0.50-1.00 in/hr). Water movement through these soils is considered moderately rapid. There is a small band of group D soils along Cresheim Creek. These soils have a very slow rate of infiltration when saturated (0.02-0.10 in/hr) resulting in a high runoff potential.

There is a small section of C soils located on the northeast corner of the watershed. Group C soils have a slow rate of infiltration when saturated (0.17-0.27 in/hr). Water movement through these soils is moderate or moderately slow.

The northern portion of the watershed in Montgomery County is underlain by the Urban Land soils. Urban soils consist of material that has been disturbed by human activity during urbanization. Urban soils have been produced by mixing, filling and contamination of the native soils in both urban and suburban areas.

Table 3-73: Distribution of NRCS Soil Types in Cresheim Creek Watershed

Group	Area (ft^2)	Percent of Total Area
B	9,939,312	14.74%
C	13,486	0.02%
D	87,660	0.13%
Urban	57,390,422	85.11%
Total Area	**67,430,880**	**100%**

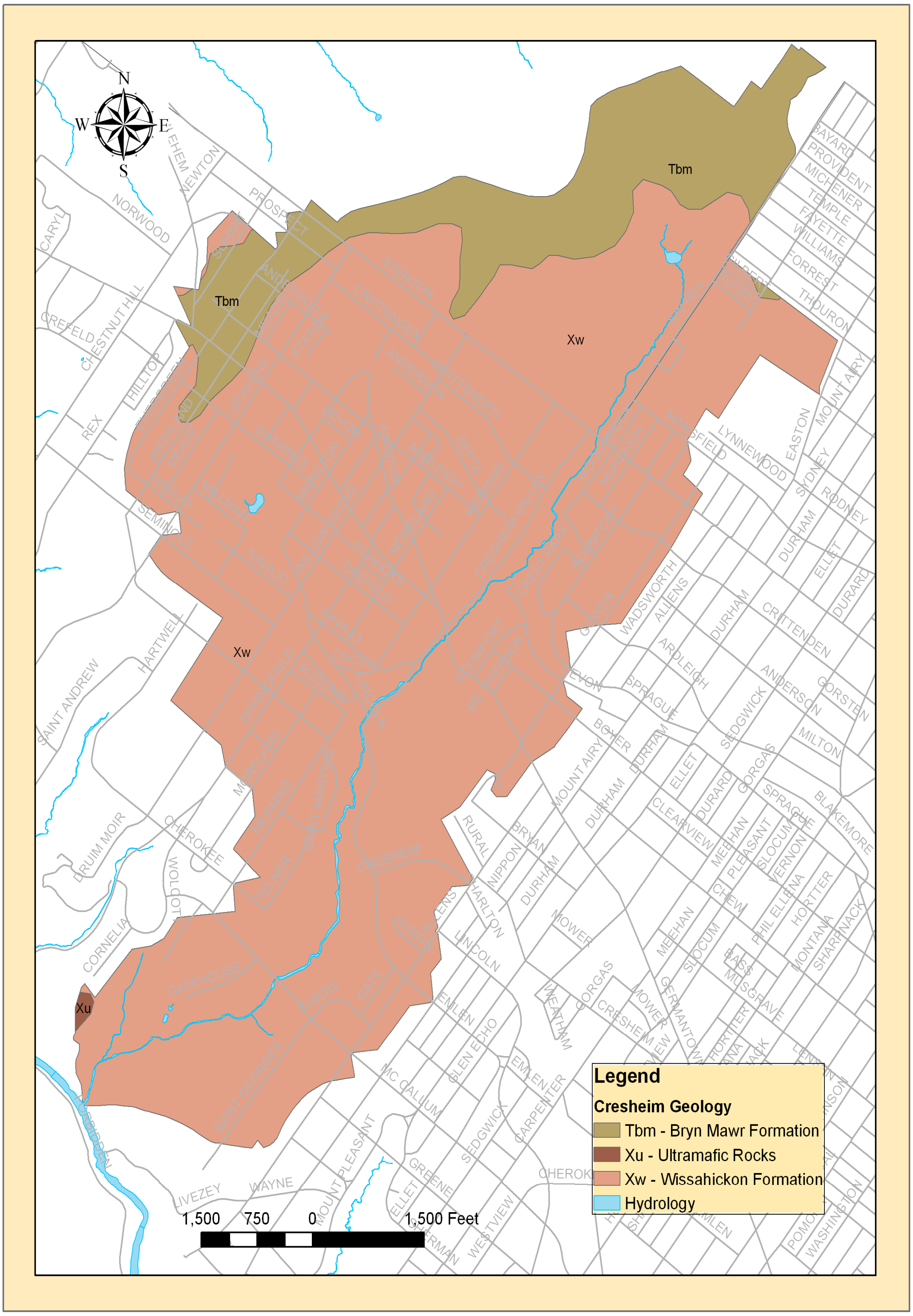


Figure 3-71: Geology of Cresheim Creek Watershed

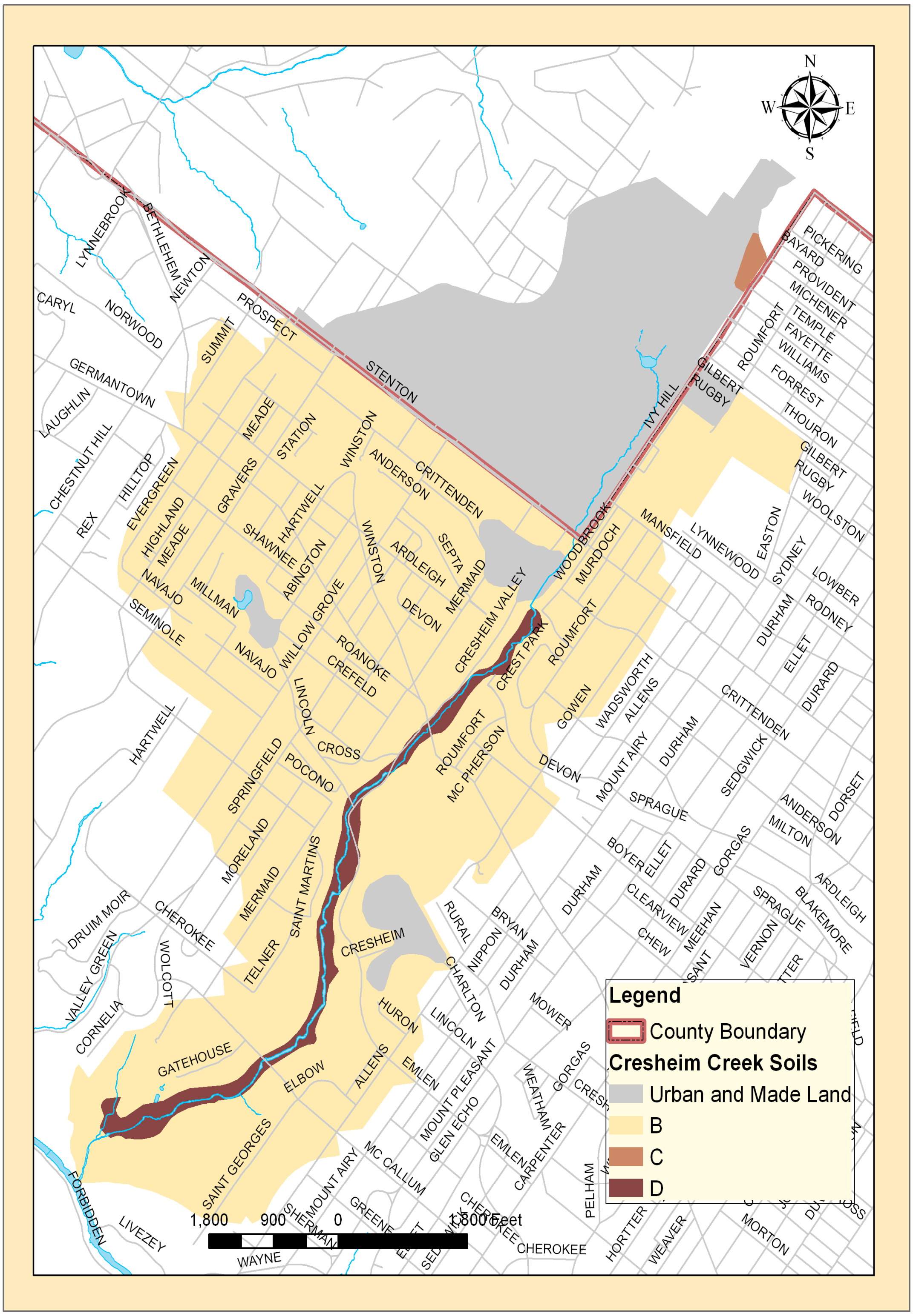


Figure 3-72: Distribution of NRCS Soil Types in Cresheim Creek Watershed

3.2.5.3 BANK EROSION

There were nine bank pin locations along Cresheim Creek (Figure 3-73). The calculated erosion rates are included in Table 3-74. The spatial distribution of BEHI assessment results were represented graphically (Figure 3-73) for each of the segments assessed on Cresheim Creek. Each bank within a respective segment was assessed and rated separately; however, channelized and culverted segments were not assessed as they confer a high degree of protection from bank erosion.

Table 3-74: Cresheim Creek Bank Pin Locations

	BEHI	NBS	Baseline Reading	Most Recent Reading	Erosion Rate (ft)	Erosion Rate (ft/yr)	Eroding (-) or Aggrading (+)
Cresheim Creek							
CC35	Moderate	Low	8/22/2006	8/11/2009	0.42	0.14	A
CC114	Low	Very Low	9/7/2006	8/12/2009	-0.18	-0.062	E
CC18	High	Low	8/22/2006	8/11/2009	-1.28	-0.43	E
CC43	High	Low	8/22/2006	8/11/2009	0.17	0.058	A
CC45	High	Low	8/22/2006	8/11/2009	-0.21	-0.070	E
CC46	High	Low	8/22/2006	8/15/2007	-0.09	-0.09	E
CC64	Low	Very Low	8/22/2006	8/11/2009	0.64	0.22	A
CC74	Low	Low	8/22/2006	8/11/2009	0.38	0.13	A
CC11	High	Low	9/7/2006	8/13/2008	0.87	0.45	A

Total erosion rates were also calculated for the entire length of each tributary within the lower Wissahickon (Table 3-75). To assess the normalized erosion potential of each tributary, the erosion rate per acre of drainage area per year and the erosion rate per foot of stream length per year were calculated. This allowed direct comparison between each of the tributaries with respect to both watershed size and the length of the tributary. Cresheim Creek was ranked eighth out of the twelve tributaries within the lower Wissahickon for erosion rate per foot of stream length. The rankings were based on a scale of one being the highest erosion rate and twelve being the lowest erosion rate.

Table 3-75: Erosion Rates for Lower Wissahickon Tributaries

Tributary	Drainage Area (Acres)	Stream Length (feet)	*2009*		
			Erosion Rate (lb/yr)	*Erosion Rate Per Acre*	*Erosion Rate Per Foot of Stream*
Bell's Mill	323	6,722	420,000	1,307	63
Cathedral Run	160	2,790	150,000	913	52
Cresheim Creek*	1,218	16,431	840,000	690	51
Gorgas Run	499	2,170	170,000	345	79
Hartwell Run	217	3,530	200,000	918	56
Hillcrest	144	5,272	90,000	597	16
Kitchen's Lane	234	7,753	200,000	850	26
Monoshone Creek	1,056	6,926	160,000	156	24
Rex Ave	137	1,903	150,000	1,131	81
Thomas Mill Run	104	4,008	320,000	3,058	79
Valley Green Run	128	2,874	140,000	1,086	48
Wise's Mill Run	446	7,056	490,000	1,090	69
Total/*Average*	**4,666**	**67,435**	**3,300,000**	***1,012***	***54***

* Drainage area listed above for Cresheim Creek reflects the drainage area located within Philadelphia County and not the entire Cresheim Watershed.

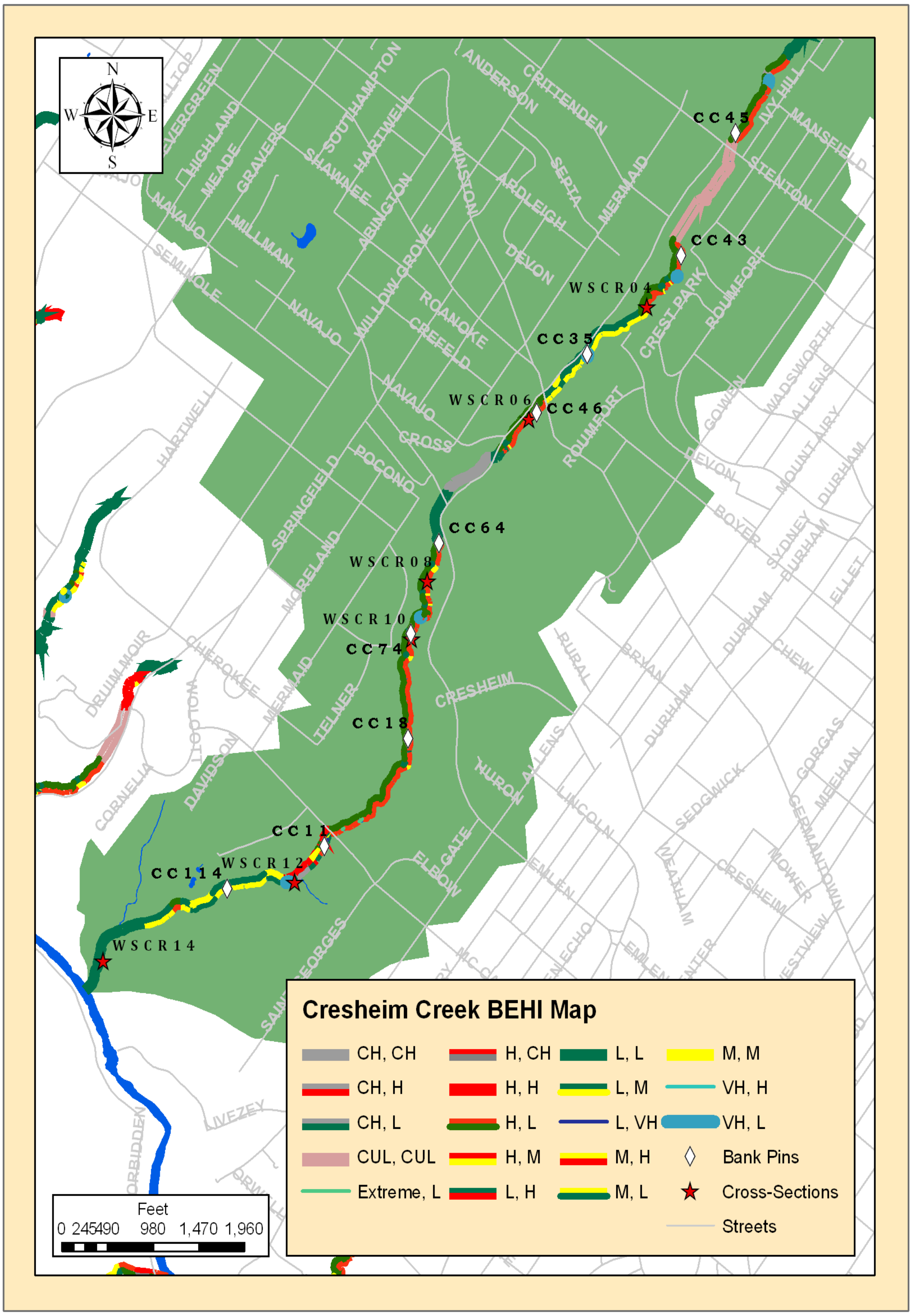


Figure 3-73: Cresheim Creek Watershed BEHI Ratings and Bank Pin Locations

3.2.5.4 INFRASTRUCTURE TRACKDOWN SUMMARY

The Cresheim Creek watershed was one of the downstream-most watersheds of the Lower Wissahickon Creek Watershed. Despite the fact that it was located inside the city of Philadelphia, only part of the stream exhibits the density of infrastructure endemic to such an intensely urban setting. A large proportion of the downstream reaches of Cresheim Creek ran through Fairmount Park which was entirely forested and therefore contained very few infrastructure elements; however, the headwater and upstream reaches of Cresheim Creek were heavily influenced by infrastructure.

Reach WSCR04 contained the highest number of total infrastructure points (i.e. culverts, outfalls, pipe crossings) and the second highest number of channels. The density of infrastructure in WSCR04 was comparatively low given that the reach was approximately 6,700 hundred feet long including 19% of culverted stream length. The remainder of the reaches in Cresheim Creek was about a third of that length. Reach WSCR08 had a large culvert that represented 10% of its length. WSCR06 was the most channelized reach in the watershed with 1,975 feet (33%) of channelization. WSCR08 also had a relatively large amount of channelized portions, as 11% of the total length was channelized. The downstream sections, WSCR10 and WSCR14, had the two dams associated with this creek. Since dams can affect the stream morphology and hydrologic regime for great distances in both directions, these dams were very important when considering the effects of infrastructure.

The Cresheim Creek watershed would likely have been completely besieged with infrastructure had the 3 downstream sections not been within the Park which only contained 9 of the 64 infrastructure points. The total percent of culverted channel length for the watershed was only 9%, which was small considering the large amount of culverts upstream. Most of the negative effects of the infrastructure in this watershed were attributed to the upstream portions of the stream. The majority of the infrastructure in this watershed was in good condition. There were some elements that exhibited signs of long-term use, although none were observed to be in extremely poor condition.

Table 3-76: Summary of Cresheim Creek Infrastructure Point Features

Section ID	Culvert Count	Bridge Count	Outfall Count	Channel Count	Confluence Count	Dam Count	Pipe/ Sewer Count	Other Count	Infra Point Count	Combined Outfall Area (ft^2)
WSCR04	9	1	12	4	0	0	2	1	28	74.5
WSCR06	1	1	9	5	1	0	1	1	17	14.8
WSCR08	1	0	3	2	1	0	1	0	7	25.9
WSCR10	0	0	0	0	0	1	0	0	1	0
WSCR12	0	2	1	1	0	0	0	0	4	1.8
WSCR14	0	1	1	0	1	1	0	0	3	1.8
TOTAL	**11**	**5**	**26**	**12**	**3**	**2**	**4**	**2**	**62**	**118.8**

Table 3-77: Summary of Cresheim Creek Infrastructure Linear Features

Section ID	Segment Length (ft)	Segment Length (ft), 3 sides	Culvert Length (ft)	Percent Culverted	Channel Length (ft), 1 side	Channel Length (ft), 2 sides	Channel Length (ft), 3 sides	Channel Length (ft)	Percent Channelized
WSCR04	6726	20178	1290	19.2	187	48	0	283	1.4
WSCR06	1980	5940	66	3.3	178	48	567	1975	33.2
WSCR08	1427	4281	139	9.7	6	224	0	454	10.6
WSCR10	1927	5781	0	0	0	0	0	0	0
WSCR12	2793	8379	0	0	168	0	0	168	2.0
WSCR14	1551	4653	0	0	0	0	0	0	0
TOTAL	**16404**	**49212**	**1495**	**9.1**	**539**	**320**	**567**	**2880**	**5.9**

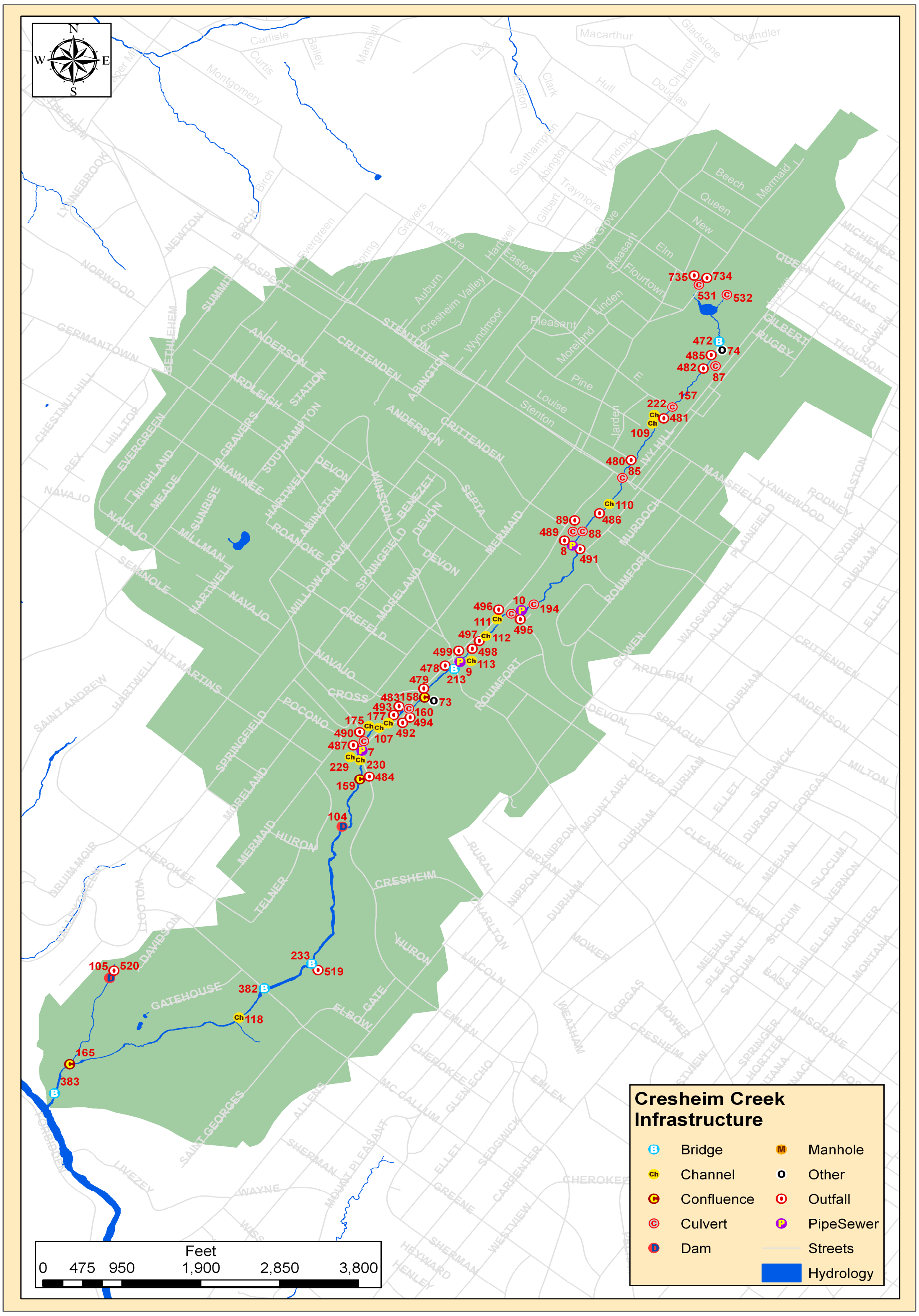


Figure 3-74: Cresheim Creek Infrastructure Locations

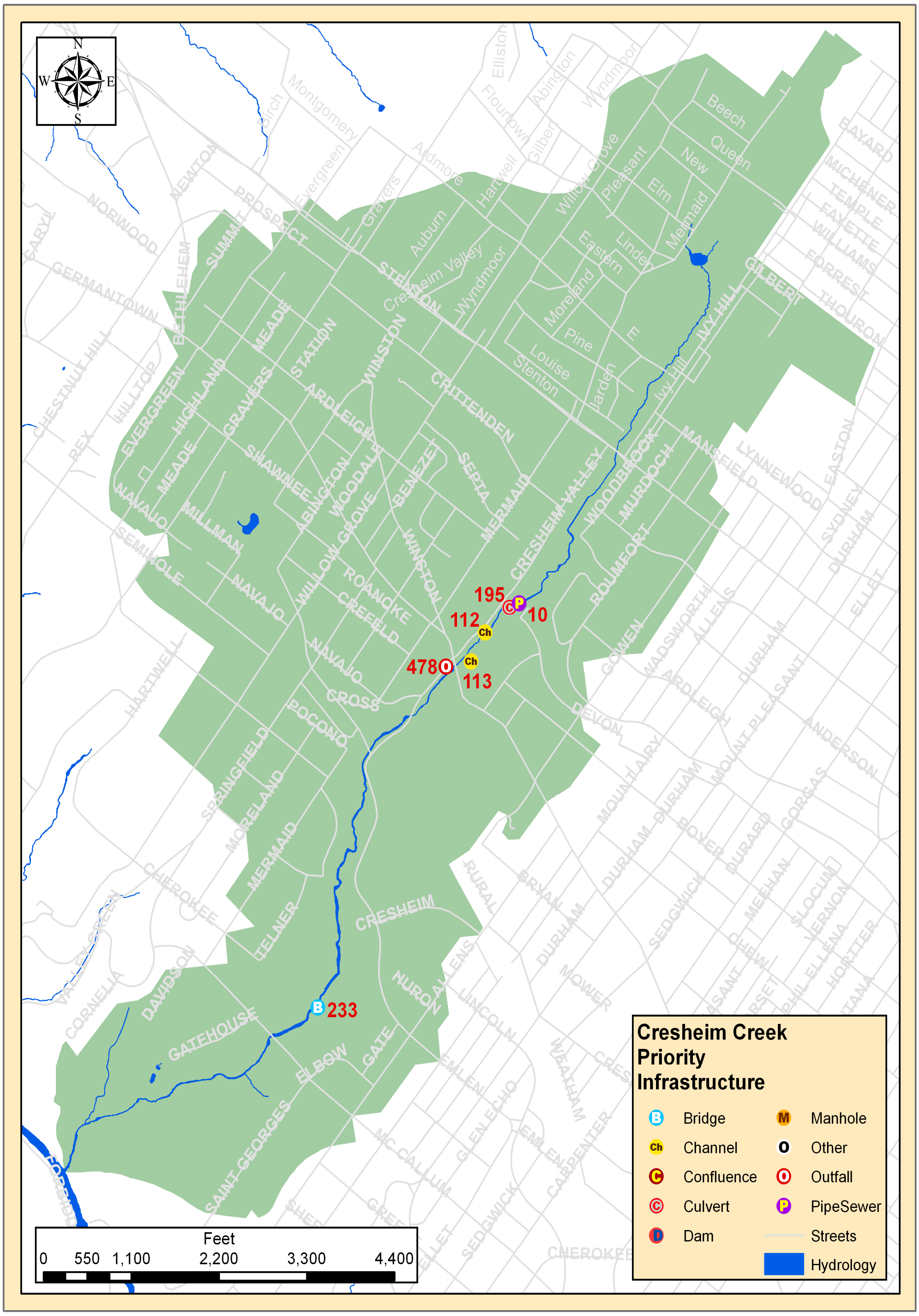


Figure 3-75: Cresheim Creek Priority Infrastructure

3.2.5.5 UNIFIED STREAM ASSESSMENT RESULTS FOR THE CRESHEIM CREEK WATERSHED

The Cresheim Creek watershed is by far the largest watershed of the Lower Wissahickon Basin with a total area of 1,548 acres (2.42 mi²). The majority of Cresheim Creek was within the City of Philadelphia, although the headwaters of the creek as well as an additional 0.5 miles of stream were located in Springfield Township, Montgomery County. Excluding the first 2,500 feet of the main stem channel within Philadelphia, Cresheim Creek and its two small tributaries were contained within Fairmount Park. Large parcels of significance within the watershed included New Covenant Church of Philadelphia and the Ivy Hill Cemetery.

The Center for Watershed Protection's (CWP) Unified Stream Assessment Methodology (USAM) was used to score and rate the instream, riparian buffer and floodplain conditions of the stream corridor to allow for comparison to other reaches and watersheds within the Lower Wissahickon Basin.

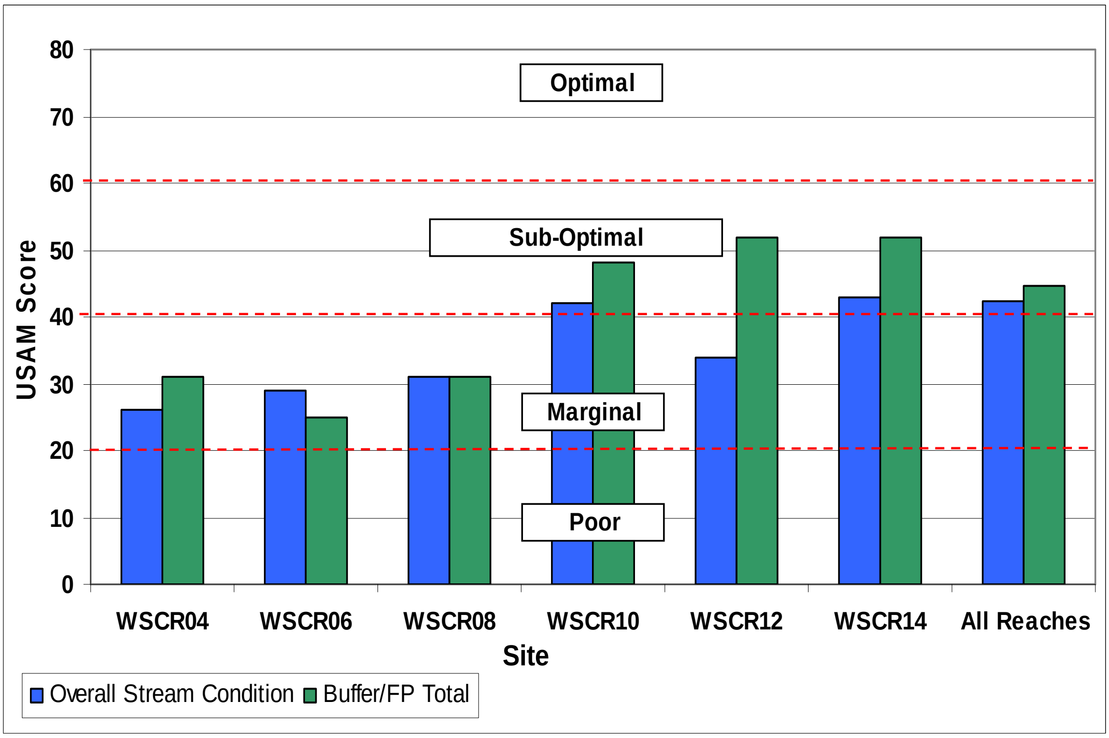


Figure 3-76: Results for Main Stem Cresheim Creek USAM Components

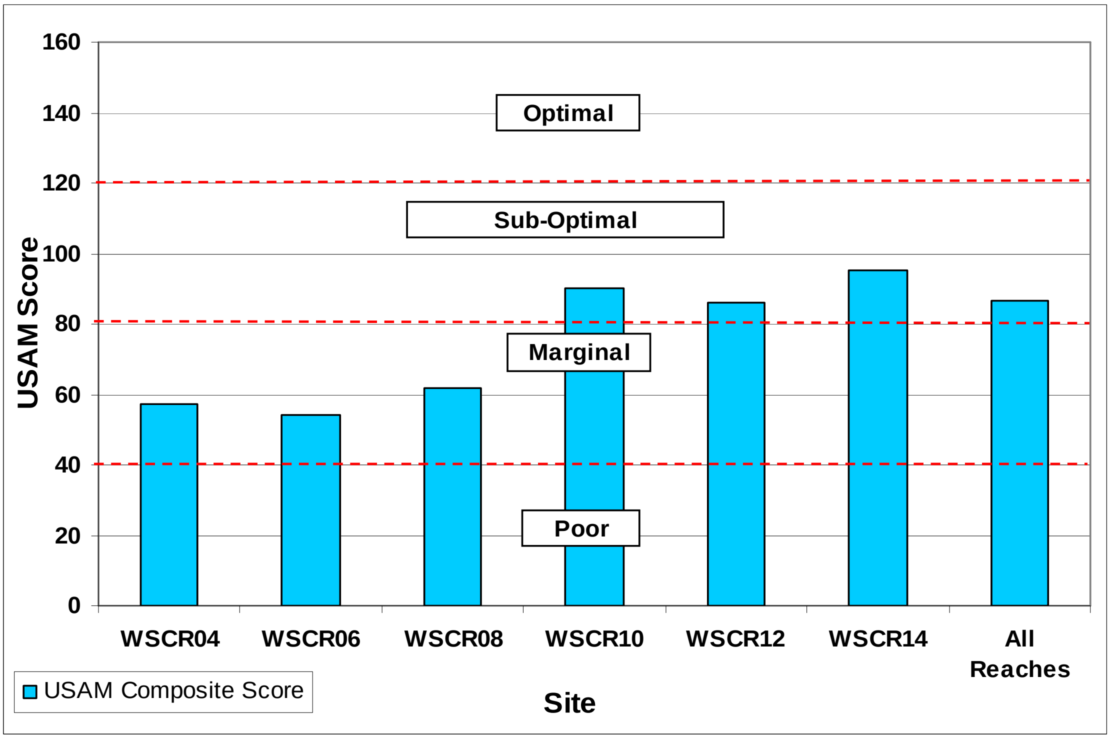


Figure 3-77: Cresheim Creek USAM Results

3.2.5.5.1 WSCR04

Reach WSCR04 formed the headwaters to Cresheim Creek and was the only reach with segments of stream channel in Montgomery County. The reach began as two small outfall-fed channels that drained to a shallow pond located 350 feet east of the intersection of Mermaid Lane and Flourtown Avenue. The larger of the two channels (DSR) received flow from WSout734 and WSout735. The DSL channel received flow from WScul532 which drained a large industrial park. Cross section WSCR04, used to characterize the reach, was located about 4,000 feet downstream within the Philadelphia portion of Cresheim Creek. The gravel-dominated (64%) reach was characterized by a very high width to depth ratio (41.7), a deeply entrenched channel (ER=1.2) and an extremely shallow gradient (0.9%). Overall, the reach was classified as an F4 stream type and had a composite USAM score (Figure 3-77) of (57/160).

3.2.5.5.2 WSCR06

Reach WSCR06 began at the upstream end of WScha112, which was located approximately 560 feet northeast of the Germantown Avenue Bridge (WSbri213). The reach extended 1,980 feet downstream to the end of the channelized segment (WScha175 on DSR and WScha177 on DSL) of stream west of Cresheim Valley Road. The substrate particle size distribution was dominated by gravel (64%) although cobble-sized particles were present in abundance (31%). The reach was characterized by a moderate width to depth ratio (15.6), a deeply entrenched (ER=1.2) channel and a relatively shallow gradient (1.7%). The channel was classified as an F4 stream type and had a USAM composite score of (54/160).

3.2.5.5.3 WSCR08

Reach WSCR08 began approximately 150 feet north of the intersection of Lincoln Drive and Cresheim Valley Road. The upstream segments of the reach were highly channelized (WScha229 on DSR and WScha230 on DSL) and culverted (WScul161 beneath Lincoln Drive). There was a small (approximately 75 feet) ephemeral channel located about 300 feet upstream of cross section WSCR08. This small channel received intermittent flow from WSout484, which drains Cresheim Valley Road. The bottom of the reach was located 150 feet upstream from WSdam104. Reach WSCR08 was characterized by a high width to depth ratio (28.2), a deeply entrenched channel (ER=1.1) and a relatively shallow gradient (1.8%). The reach was classified as an F4 type stream and had a USAM composite score of (62/160).

3.2.5.5.4 WSCR10

Reach WSCR10 began 130 feet upstream of WSdam104, which was the only infrastructure element present within the 1,927-foot reach. The reach was characterized by a high width to depth ratio (25.9), a moderately entrenched channel (ER=1.5) and a mild gradient (1.6%). As opposed to the upstream reaches, WSCR10 had a substrate particle size distribution dominated by cobble-sized particles (52%) although gravel (34%) was abundant throughout the reach. The channel was characterized as a B4c stream type and served as a transitional reach between the upstream B-type stream. Reach WSCR10 had a composite USAM score of (90/160), which was the second highest score observed in the Cresheim Creek watershed.

3.2.5.5.5 WSCR12

Reach WSCR12 began 170 feet downstream of WSbri233, a stone arch bridge that connected a pedestrian footpath. There was a small (approximately 415 feet) tributary on the DSL side of the main stem channel about 75 feet upstream of cross section WSCR12. Reach WSCR12 was the second longest reach (2,793 feet) after reach WSCR04. The substrate particle size distribution was dominated by cobble-sized particles (47%) although gravel was present in a nearly equal proportion (39%). The reach had similar channel morphology to WSCR10 in that the channel had a high width to depth ratio (20.3), a moderately entrenched channel (1.6) and moderately shallow gradient (3%). The reach was classified as a B4 stream channel and had a USAM composite score of (86/160).

3.2.5.5.6 WSCR14

Reach WSCR14 was the downstream-most reach on Cresheim Creek. There was one tributary on the reach, unnamed tributary A, which had a total length of 1,497 feet. As with reach WSCR12, there were few infrastructure elements within the reach. In total, there was one bridge (WSbri213), an outfall (WSout520) and a dam (WSdam105), the latter two were both located near the headwaters of unnamed tributary A. The substrate particle size distribution had a nearly equal proportion of gravel (44%) and cobble-sized particles (42%). Overall, the reach was characterized by a large width to depth ratio (29.7) and an entrenched channel (ER=1.4) and was similar to the channel morphology observed in reaches WSCR10 and WSCR12; however, reach WSCR14 had a much steeper gradient (4.7%) and was classified as a B4a stream type. The reach had a composite USAM score of (95/160), which was the highest score observed for the Cresheim Creek watershed.

3.2.5.6 SUMMARY OF UNIFIED STREAM ASSESSMENT RESULTS

The mean scores for both the individual USAM components as well as the overall USAM score were all classified as "marginal" (Table 3-78). Average conditions within the Cresheim Creek watershed's buffers and floodplains were slightly better than conditions observed within the stream channels. The watershed averages for each component as well as the composite USAM score did not compare well against the respective All Reaches averages, especially for the *Overall Stream Condition* component. The scores for individual parameters ranged from poor to optimal, displaying similar levels of variability between reaches.

Table 3-78: USAM Results for Cresheim Creek Watershed

Reach ID	Sub-watershed	Overall Stream Condition	Overall Buffer/FP Condition	USAM Score
WSCR04	Cresheim	26	31	57
WSCR06	Cresheim	29	25	54
WSCR08	Cresheim	29	31	62
WSCR10	Cresheim	42	48	90
WSCR12	Cresheim	34	52	86
WSCR14	Cresheim	43	52	95
WSCR mean		**34.2**	**39.8**	**74.0**
All Reaches Average		**42.4**	**44.5**	**86.9**

3.2.5.6.1 SUMMARY OF OVERALL STREAM CONDITION SCORES IN THE CRESHEIM CREEK WATERSHED

The mean *Overall Stream Condition* score of the Cresheim Creek reaches was 33.8/80, which rated as marginal. In comparison, the All Reaches average was 46/80, which was rated as "suboptimal." The parameter that compared most favorably with the average conditions present in the other Lower Wissahickon tributaries was the *Bank Erosion* parameter. The mean *Instream Habitat* score for Cresheim Creek (9.3/20) was relatively low compared to average conditions observed in the Lower Wissahickon (14.5/20). This can be partially explained by the characteristically shallow, wide channels observed in the upper reaches of Cresheim Creek. These reaches (WSCR04, WSCR06, WSCR08) had shallow, homogenous depth regimes, substrate distributions skewed toward less stable (i.e. gravel) particles and minimal abundances of coarse woody debris (CWD). The cumulative affects of these factors results in a habitat template that has a reduced ability to provide shelter from high velocity scouring flows and limited food production potential (aside from filamentous algae). From a geomorphic perspective, Cresheim Creek was characteristic of many impacted urban streams as width to depth ratios were relatively high and entrenchment ratios were extremely low. These ratios are manifest in wide, shallow channels with little variation in depth as well as channels that are isolated from their respective floodplains. Both of these factors have adverse effects on benthic macroinvertebrates and fish as well as riparian vegetation.

Table 3-79: USAM Overall Stream Condition Scoring for Cresheim Creek Watershed

OVERALL STREAM CONDITION								
Reach ID	Sub-watershed	Instream Habitat	Vegetative Protection		Bank Erosion		Floodplain Connection	Overall Stream Condition
			Left	Right	Left	Right		
WSCR04	Cresheim	5	3	3	5	8	2	26
WSCR06	Cresheim	5	4	4	5	8	3	29
WSCR08	Cresheim	4	5	5	8	9	1	31
WSCR10	Cresheim	14	6	6	7	4	5	42
WSCR12	Cresheim	14	3	3	4	4	6	34
WSCR14	Cresheim	14	4	4	8	9	4	43
WSCR mean		**9.3**	**4.2**	**4.2**	**6.2**	**6.8**	**3.5**	**33.8**
All Reaches Average		**13.1**	**4.9**	**4.9**	**6.3**	**7.0**	**6.3**	**42.4**

3.2.5.6.1.1 INSTREAM HABITAT

Scores for the *Instream Habitat* parameter ranged from “poor” to “suboptimal” throughout the watershed. The highest scores (14/20) were observed in reaches WSCR10, WSCR12 and WSCR14, which were rated as “suboptimal.” These reaches were characterized by ample supplies of stable substrate (52%, 47% and 42% cobble respectively) and CWD. The moderate entrenchment ratios observed in these reaches (1.5, 1.6 and 1.4 respectively) allowed for the recruitment of CWD from the adjacent floodplain and upland areas while also creating an opportunity for exposed root wads to function as usable instream habitat.

In comparison, the worst reach, WSCR08, had geomorphic characteristics that precluded the establishment of optimal instream habitat criterion. The entrenchment ratio (1.1) in reach WSCR08 effectively isolated the channel from the floodplain, which limits the recruitment of CWD from the “upland fringe.” Furthermore, the substrate in reach WSCR08 was dominated by gravel (2-64 mm), which does not confer the same stability properties as would cobble substrate. The width to depth ratio (28.2) in this reach was elevated compared to the “suboptimal” reaches. An elevated width to depth ratio decreases the depth of flow in the channel such that the depth profile throughout the reach becomes relatively homogenous which limits the potential for habitat suitability amongst a diverse array of aquatic fauna. The width to depth ratio observed in WSCR14 was higher than the ratio observed in WSCR08; however, the colluvial deposits of boulders present at the stream margins of reach WSCR14 function to concentrate a larger volume of stream flow in the center of the channel therefore providing a much more heterogeneous depth profile.

In general, the upstream reaches (WSCR04, WSCR06 and WSCR08) of the Cresheim Creek watershed were observed to have diminished habitat quality when compared to the downstream reaches. Each of the upstream reaches was rated as "poor" compared to the downstream reaches which were all rated as "suboptimal." In comparison to the rest of the watersheds in the Lower Wissahickon, the mean score for the watershed (9.3/20) was rated as "marginal" whereas the mean *Instream Habitat* score for All Reaches was (13.1/20), which was rated as "suboptimal."

3.2.5.6.1.2 VEGETATIVE PROTECTION

Scores for the *Vegetative Protection* parameter were generally low to moderate throughout the Lower Wissahickon. The All Reaches averages for the left and right (both 4.9/10) bank were rated as "marginal." The mean score for both banks of the Cresheim Creek watershed was (4.2/10) and was also rated as "marginal" for this parameter. The highest score (6/10) was observed in reach WSCR10 and the lowest score (3/10) was observed in reaches WSCR04 and WSCR12. The "poor" and "marginal" ratings for the reaches downstream of WSCR10 can be attributed to the extent of localized scour observed at these sites which can preclude the establishment of most rooted vegetation. At sites WSCR12 and WSCR14 the "poor" and "marginal" ratings for these reaches were due to factors other than degradation. The presence of bedrock outcrops and colluvial deposits of boulders, often from the channel margin (edge of water) up to the bankfull elevation in some segments, precluded the establishment of vegetation patches.

3.2.5.6.1.3 BANK EROSION

In general, scores for the *Bank Erosion* parameter were moderate to good in the Cresheim Creek watershed. The mean scores for the watershed's right (6.8/10) and left (6.2/10) banks were comparable to the respective All Reaches averages with many of the banks at individual reaches scoring higher than the All Reaches averages for both the right (7.0/10) and left (6.3/10) banks. The best reaches within the watershed were WSCR08 and WSCR14 as both were rated as "suboptimal" for both banks. The lowest scores in the watershed for both the right and left banks were recorded for reach WSCR12, which was rated as "marginal."

3.2.5.6.1.4 FLOODPLAIN CONNECTION

All stream reaches within the Cresheim Creek watershed exhibited varying levels of entrenchment and floodplain disconnection. Entrenchment ratios ranged from (1.1–1.6) suggesting that floodplain inundation is very rare in this watershed, except for large events. In comparison, the mean entrenchment ratio for the Cresheim Creek watershed was 1.35 whereas the mean for the large Lower Wissahickon tributaries was considerably higher at 1.8. The bankfull discharge in the reach with the lowest score (i.e. most deeply entrenched reach), WSCR08 (1/20), was 185 cfs. Flows in this reach would have to exceed 428 cfs to inundate the floodplain.

3.2.5.6.2 SUMMARY OF OVERALL BUFFER AND FLOODPLAIN CONDITION SCORES IN THE CRESHEIM CREEK WATERSHED

The scores for the *Overall Buffer and Floodplain Condition* in the Cresheim Creek stream corridor were generally low to moderate for most parameters. The parameters that were most comparable to the average conditions observed in the other large Lower Wissahickon tributaries were the *Vegetated Buffer Width* and *Floodplain Vegetation* parameters. The other two parameters, *Floodplain Habitat* and *Floodplain Encroachment* were rated in the "poor" to "marginal" range for most parameters. The low scores for the *Floodplain Habitat* parameter were attributed to the fact that the stream channels of the watershed were "disconnected" from their respective floodplains due to corridor-wide channel entrenchment of varying degrees. The scores for the *Floodplain Encroachment* parameter were influenced heavily by the extensive development in the upper portions of the watershed. In many of the upstream reaches, roads were constructed in close proximity to stream reaches either normal or parallel to the respective stream reaches. Development of this nature not only reduces the amount of contiguous floodplain area adjacent to a stream channel, but also contributes extensive volumes of high-velocity stormwater runoff that ultimately degrades channels and has a net adverse impact on downstream reaches as well.

Table 3-80: USAM Buffer and Floodplain Condition Scoring for Cresheim Creek Watershed

OVERALL BUFFER AND FLOODPLAIN CONDITION							
Reach ID	Sub-watershed	Vegetated Buffer Width		Floodplain Vegetation	Floodplain Habitat	Floodplain Encroachment	Overall Buffer/FP Condition
		Left	Right				
WSCR04	Cresheim	7	7	8	6	3	31
WSCR06	Cresheim	6	3	8	4	4	25
WSCR08	Cresheim	8	8	9	3	3	31
WSCR10	Cresheim	9	9	12	8	10	48
WSCR12	Cresheim	9	9	17	4	13	52
WSCR14	Cresheim	9	9	17	4	13	52
WSCR mean		**8.0**	**7.5**	**11.8**	**4.8**	**7.7**	**39.8**
All Reaches		**8.1**	**8.6**	**13.8**	**5.5**	**8.5**	**44.5**

3.2.5.6.2.1 VEGETATED BUFFER WIDTH

The vegetated buffer widths throughout the Cresheim Creek watershed were rather extensive. The mean scores for the right (7.5/10) and left (8/10) banks were rated as "suboptimal" and compared favorably with the other large Lower Wissahickon tributaries (Table 3-80). Extensive variation between sites was not observed as all sites except for WSCR06 had ratings of "suboptimal" for both banks.

3.2.5.6.2.2 FLOODPLAIN VEGETATION

The *Floodplain Vegetation* parameter takes into account the dominant vegetation type (i.e. shrub, mature forest, herbaceous ground cover or mowed turf) observed throughout a reach, with mature forest being the optimal condition. The presence of a mature riparian forest is an indicator of low levels of disturbance from factors such as development and extreme flooding given mature forests may take decades to become established. Scores for this parameter exhibited considerable variation between reaches as ratings ranged from "marginal" to "optimal." The mean score for Cresheim Creek (11.8/20) was lower than the mean condition observed for the Lower Wissahickon (13.8/20) although both were rated as "suboptimal." A distinct trend was observed where scores increased dramatically in a downstream stream direction. WSCR04 and WSCR06, the upstream-most reaches were rated as "marginal", with both reaches scoring (8/20). The downstream sites WSCR12 and WSCR14 were both rated as "optimal" with both reaches scoring 17/20. The trend may be attributed to a number a factors such as differences in light availability, slope, hydrology or level of disturbance between the two ends of the watershed.

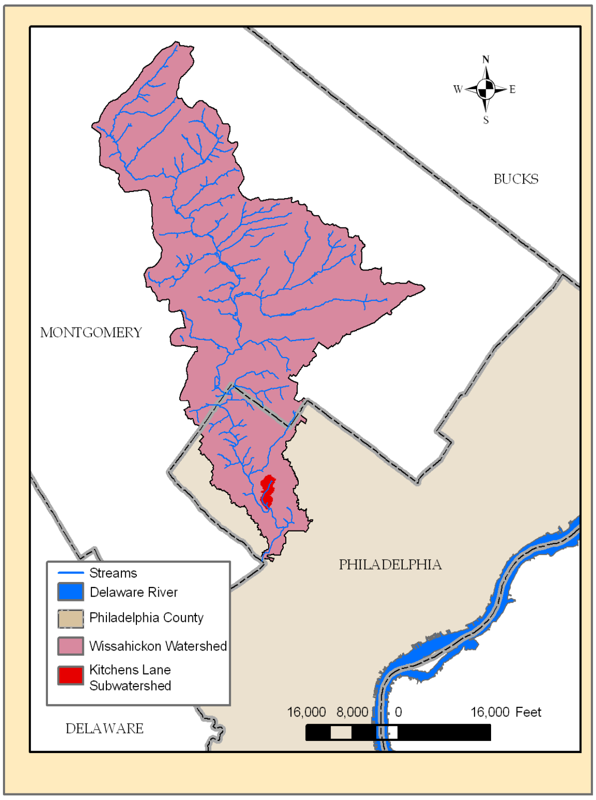
3.2.5.6.2.3 FLOODPLAIN HABITAT

The scores for *Floodplain Habitat* were generally very low and ranged from "poor" to "marginal." The average score for the watershed was 4.8/20 which was rated as "marginal." The average score for the large Lower Wissahickon tributaries was 5.5/20, which was also rated as "marginal." The "poor" and "marginal" ratings observed in the Cresheim Creek watershed can be attributed to the high degree of "floodplain disconnection" within the channels of the corridor as evidenced by the range of low entrenchment ratios (1.1-1.6). Low entrenchment ratios are an indicator that floodplains within the corridor are rarely inundated by flood flows. Over-bank flood flows are vital to a riparian ecosystem because these flows provide inputs of sediment, nutrients and other organic matter such as CWD. Without these inputs and occasional inundation, floodplain habitats such as ephemeral pools and backwater channels cannot be formed or maintained.

3.2.5.6.2.4 FLOODPLAIN ENCROACHMENT

Scores for the *Floodplain Encroachment* parameter ranged from "poor" to "suboptimal" and increased in a downstream trend. The average condition within the watershed's corridors was rated as "marginal" with a score of 7.7/20. The average condition of the large Lower Wissahickon tributaries was slightly better with a score of 8.5/20. In general, scores in the upstream reaches were low due to the high level of development in these sections of the watershed. WSCR04 and WSCR08, two of the three upstream sites, had the lowest scores in the watershed (3/20) and were rated as "poor." In contrast the downstream sites WSCR12 and WSCR14, which are closer to Fairmount Park, both scored (13/20) and were rated as "suboptimal."

3.2.6 Kitchen's Lane Watershed and Reach Characteristics



Kitchen's Lane Run is a tributary to the main stem of the Wissahickon Creek. The tributary originates from three outfalls (2 City-owned, 1 privately owned) located within an area of Fairmount Park that is surrounded by a residential neighborhood. Kitchen's Lane Run is a first-order tributary for approximately 1.1 miles until a smaller 0.1 mile tributary enters Cresheim approximately 0.15 miles from the Confluence with the Wissahickon main stem. The dominant substrate varies from course gravel to medium cobble material. Both the valley floor and channel have been substantially impacted by past and current land use.

The entire Kitchen's Lane Run watershed is 234 acres. Major land use types within the watershed include: wooded (46%), residential – row home (27%), and residential – single family detached (26%). Kitchen's Lane Run is surrounded by Fairmount Park on both sides for the entire length. The Park buffer ranges from about 50 feet to about 2,000 feet.

The Philadelphia Water Department (PWD) owns and operates four stormwater outfalls that release into Kitchen's Lane Run. The entire watershed is drained by a separate storm sewer system that is directly connected to all impervious surfaces. There are five additional private stormwater outfalls that release into Kitchen's Lane Run.

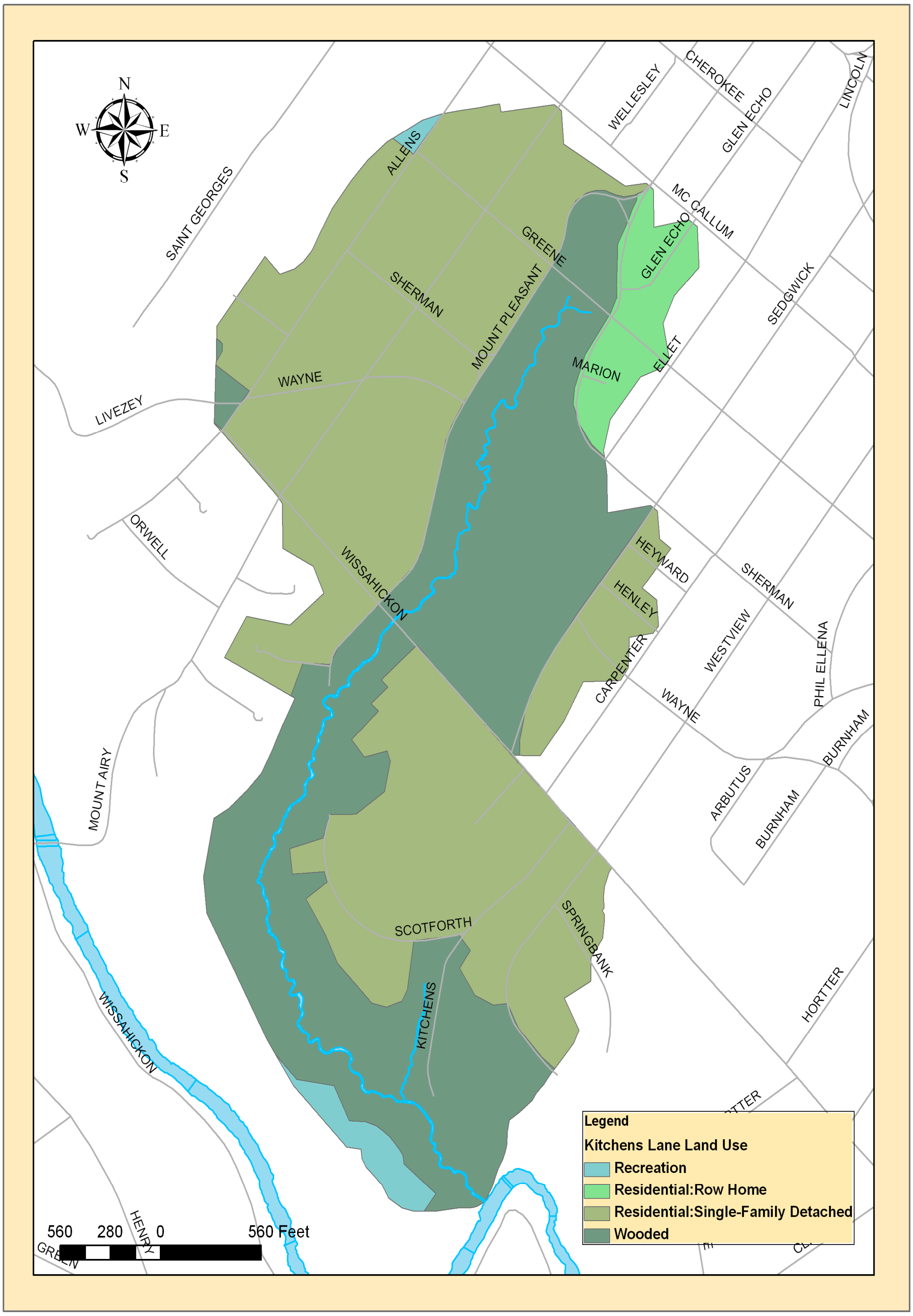


Figure 3-78: Kitchen's Land Watershed Land Use

3.2.6.1 GEOLOGY

The Kitchen's Lane Run watershed is completely underlain by the Wissahickon Formation. The Wissahickon Formation consists of mica schist, gneiss and quartzite. The exposed schist near the surface is highly weathered. The Wissahickon Formation is also comprised of metamorphosed sedimentary rocks.

3.2.6.2 SOILS

According to the National Resource and Conservation Service Soil Survey, the majority of soils for the Kitchen's Lane Run watershed are classified as hydrologic group B. These soils have a moderate rate of infiltration when the soils are wet (0.50-1.00 in/hr). Water movement through these soils is considered moderately rapid.

There is a small band of group D soils along Kitchen's Lane Run. These soils have a very slow rate of infiltration when saturated (0.02-0.10 in/hr) resulting in a high runoff potential.

There is a small section of C soils located near the confluence with the Wissahickon Creek. Group C soils have a slow rate of infiltration when saturated (0.17-0.27 in/hr). Water movement through these soils is moderate or moderately slow.

There is a small portion of Urban Land soils on the downstream left side of the tributary near the headwaters. Urban soils consist of material that has been disturbed by human activity during urbanization. Urban soils have been produced by mixing, filling and contamination of the native soils in both urban and suburban areas.

Table 3-81: Distribution of NRCS Soil Types in Kitchen's Lane Watershed

Group	Area (ft^2)	Percent of Total Area
B	10,149,210	99.57%
C	11,212	0.11%
D	29,560	0.29%
Urban	3,058	0.03%
Total Area	**10,193,040**	**100%**

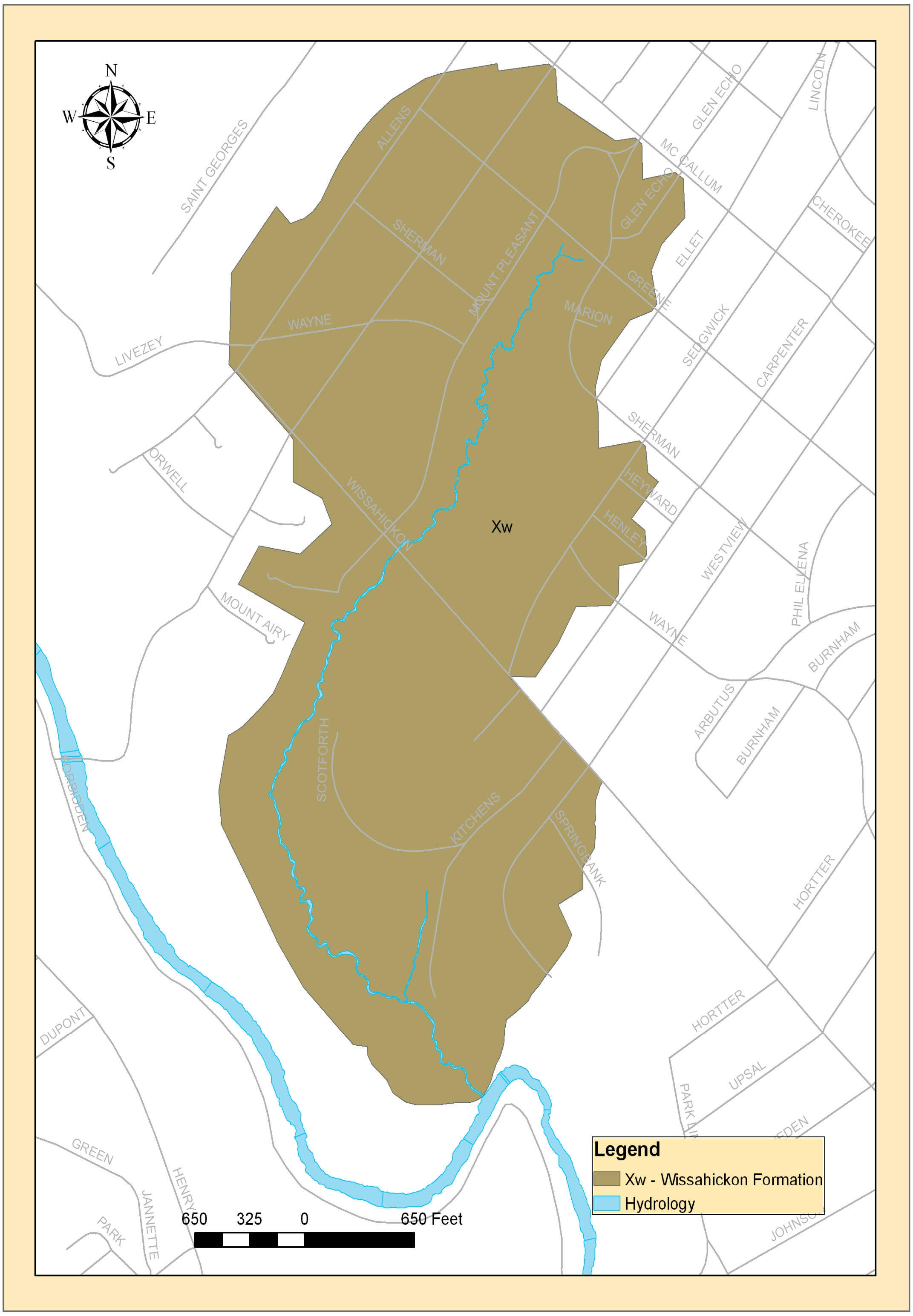


Figure 3-79: Geology of Kitchen's Lane Watershed

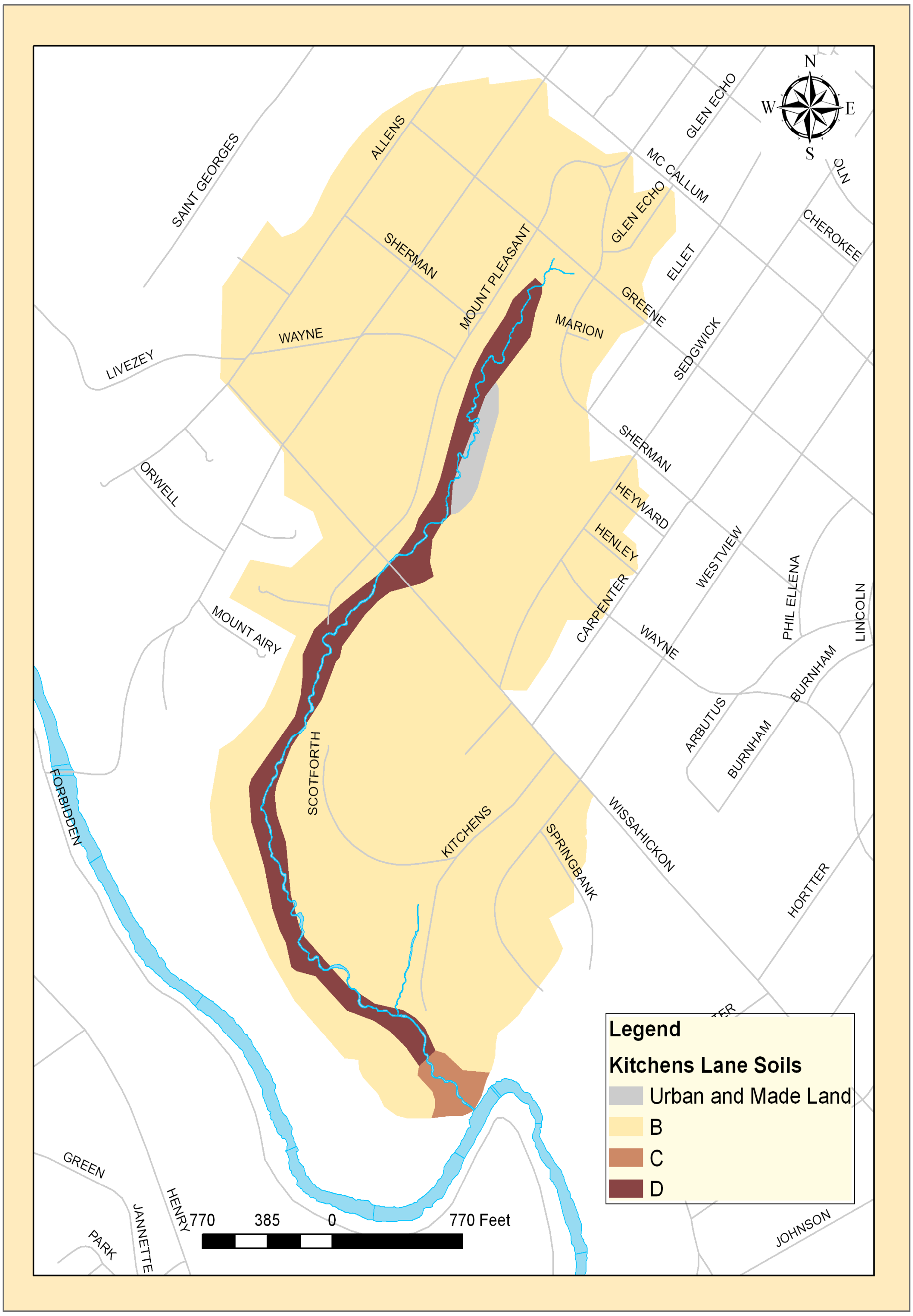


Figure 3-80: Distribution of NRCS Soil Types in Kitchen's Lane Watershed

3.2.6.3 BANK EROSION

There were ten bank pin locations along Kitchen's Lane Run (Figure 3-81). The calculated erosion rates are included in Table 3-82. The spatial distribution of BEHI assessment results were represented graphically (Figure 3-81) for each of the segments assessed on Kitchen's Lane Run. Each bank within a respective segment was assessed and rated separately; however, channelized and culverted segments were not assessed as they confer a high degree of protection from bank erosion.

Table 3-82: Kitchen's Lane Run Bank Pin Locations

	BEHI	NBS	Baseline Reading	Most Recent Reading	Erosion Rate (ft)	Erosion Rate (ft/yr)	Eroding (-) or Aggrading (+)
Kitchen's Lane							
KL32	High	High	8/15/2006	8/11/2009	-0.24	-0.080	E
KL35	Very High	Moderate	8/15/2006	8/11/2009	-0.97	-0.33	E
KL38	High	Low	8/15/2006	8/11/2009	-0.56	-0.19	E
K44L42	Very High	High	8/15/2006	8/11/2009	-0.23	-0.076	E
KL44	High	Very High	8/15/2006	8/14/2008	-0.57	-0.29	E
KL909	Low	Low	8/15/2006	8/11/2009	0.12	0.04	A
KL915	Moderate	Low	8/15/2006	8/11/2009	-0.36	-0.12	E
KL939	Low	Low	8/15/2006	8/11/2009	0.13	0.042	E
KL946	Low	Low	8/15/2006	8/14/2009	-0.16	-0.055	E
KL950	Low	Low	8/14/2006	8/11/2009	-0.41	-0.14	E

Total erosion rates were also calculated for the entire length of each tributary within the Lower Wissahickon (Table 3-83). To assess the normalized erosion potential of each tributary, the erosion rate per acre of drainage area per year and the erosion rate per foot of stream length per year were calculated. This allowed direct comparison between each of the tributaries with respect to both watershed size and the length of the tributary. Kitchen's Lane Run was ranked tenth out of the twelve tributaries within the lower Wissahickon for erosion rate per foot of stream length. The rankings were based on a scale of one being the highest erosion rate and twelve being the lowest erosion rate.

Table 3-83: Erosion Rates for Lower Wissahickon Tributaries

Tributary	Drainage Area (Acres)	Stream Length (feet)	*2009*		
			Erosion Rate (lb/yr)	*Erosion Rate Per Acre*	*Erosion Rate Per Foot of Stream*
Bell's Mill	323	6,722	420,000	1,307	63
Cathedral Run	160	2,790	150,000	913	52
Cresheim Creek	1,218	16,431	840,000	690	51
Gorgas Run	499	2,170	170,000	345	79
Hartwell Run	217	3,530	200,000	918	56
Hillcrest	144	5,272	90,000	597	16
Kitchen's Lane	234	7,753	200,000	850	26
Monoshone Creek	1,056	6,926	160,000	156	24
Rex Ave	137	1,903	150,000	1,131	81
Thomas Mill Run	104	4,008	320,000	3,058	79
Valley Green Run	128	2,874	140,000	1,086	48
Wise's Mill Run	446	7,056	490,000	1,090	69
Total/*Average*	**4,666**	**67,435**	**3,300,000**	***1,012***	***54***

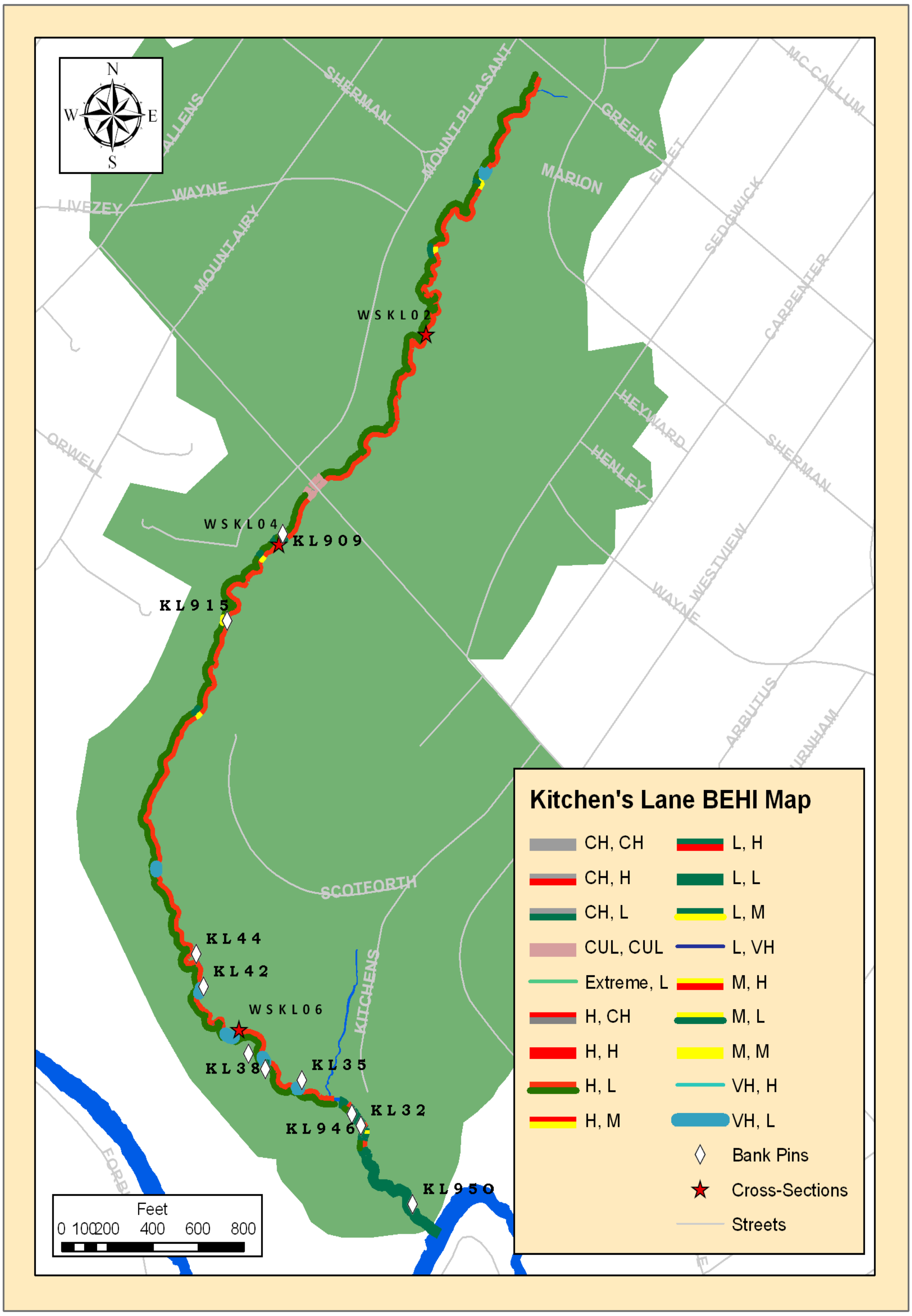


Figure 3-81: Kitchen's Lane BEHI Ratings and Bank Pin Locations

3.2.6.4 INFRASTRUCTURE TRACKDOWN SUMMARY

Kitchen's Lane Run was located entirely within Fairmount Park. Despite its location, the stream had numerous pieces of infrastructure associated with the urban development within the area. The majority of the infrastructure on Kitchen's Lane Run was located in reach WSKL06 on a tributary to Kitchen's Lane. The tributary (unnamed tributary A) ran parallel to Kitchen's Lane and had three homes along its banks. There were two bridges (WSbri230 and WSbri231), two culverts (WScul100 and WScul512), a dam (WSdam103), and 345 feet of channelization on both sides (Wscha117 on DSR and WScha179 on DSL) of the small stream. The channelization accounted for 7% of the stream length of WSKL06 and was the only channelized portion of Kitchen's Lane Run. The bridges and culverts on the tributary can be attributed to residents living in the area and their access to both sides of the creek.

In reach WSKL02 there were five large outfalls, 2-3 feet in diameter, which contributed a considerable amount of stormwater to the channel. There were two culverts on Kitchen's Lane that conveyed the stream under sewer pipes. WScul510 in reach WSKL04 passed a 15-inch sanitary sewer line from Mount Pleasant Road over the stream to the Wissahickon High Level Interceptor east of WScul099, which passes the high level interceptor over Kitchen's Lane Run. These culverts did not appear to have the capacity to convey the necessary flow of water and sediment downstream to stabilize the channel. Evidence of this can be seen in the photos (Appendix B) which show a debris jam behind WScul510 and fine sediment deposition downstream of WScul099. Along Kitchen's Lane Run, there were three infrastructure elements that were in poor condition (WScha117, WScha179 and WScul100), all of which were located on unnamed tributary A.

Table 3-84: Kitchen's Lane Infrastructure Point Features

Section ID	Culvert Count	Bridge Count	Outfall Count	Channel Count	Confluence Count	Dam Count	Infra Point Count	Combined Outfall Area (ft^2)
WSKL02	0	1	5	0	0	0	6	23.6
WSKL04	2	0	1	0	0	0	3	3.1
WSKL06	3	5	3	2	3	1	14	11.0
TOTAL	**5**	**6**	**9**	**2**	**3**	**1**	**23**	**37.7**

Table 3-85: Kitchen's Lane Infrastructure Linear Features

Section ID	Segment Length (ft)	Culvert Length (ft)	Percent Culverted	Channel Length (ft), 2 sides	Channel Length (ft)	Percent Channelized
WSKL02	2223	0	0	0	0	0
WSKL04	1973	128	6	0	0	0
WSKL06	3370	28	1	351	702	6.9
TOTAL	**7566**	**156**	**2**	**351**	**702**	**6.9**

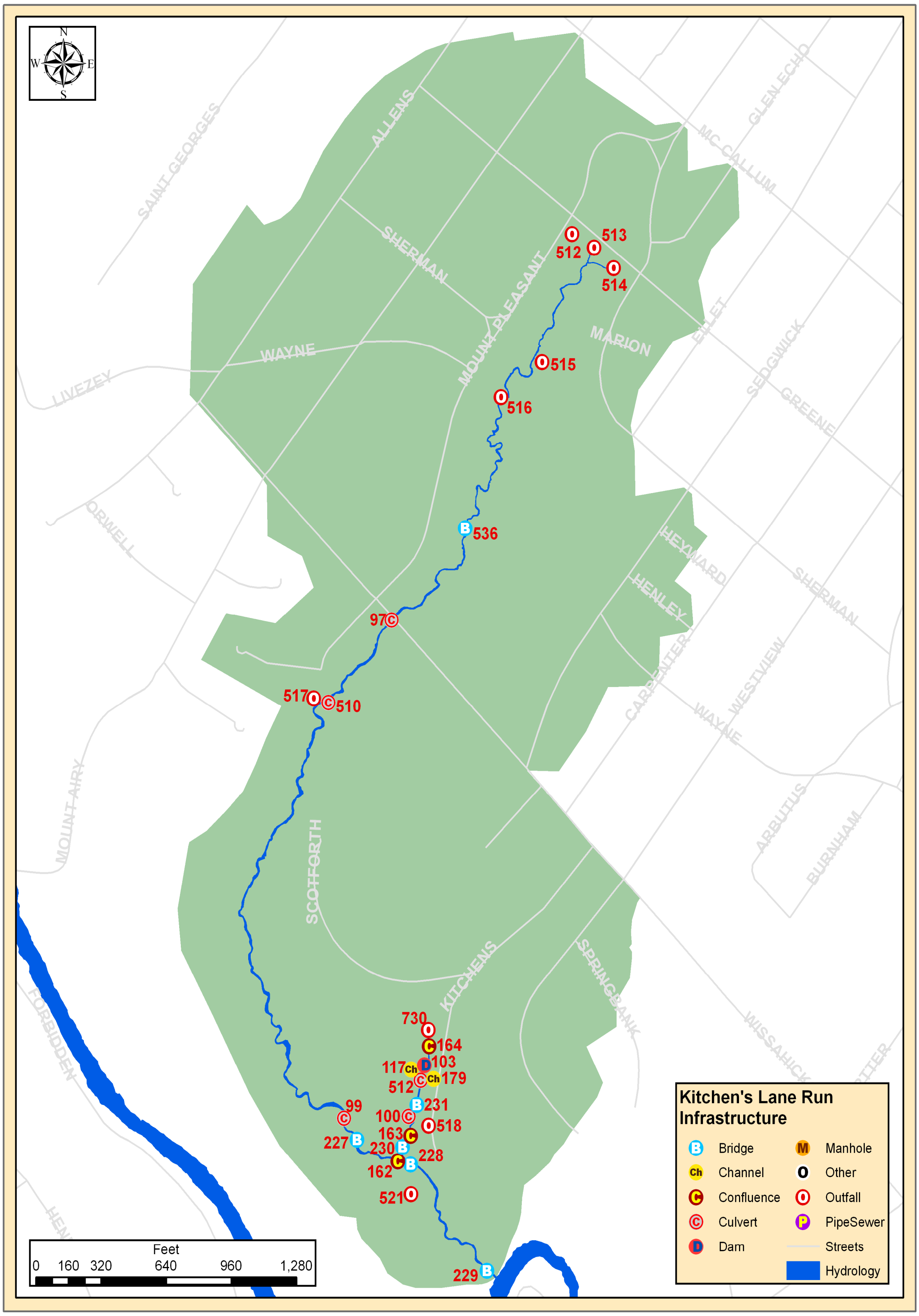


Figure 3-82: Kitchen's Lane Infrastructure Locations

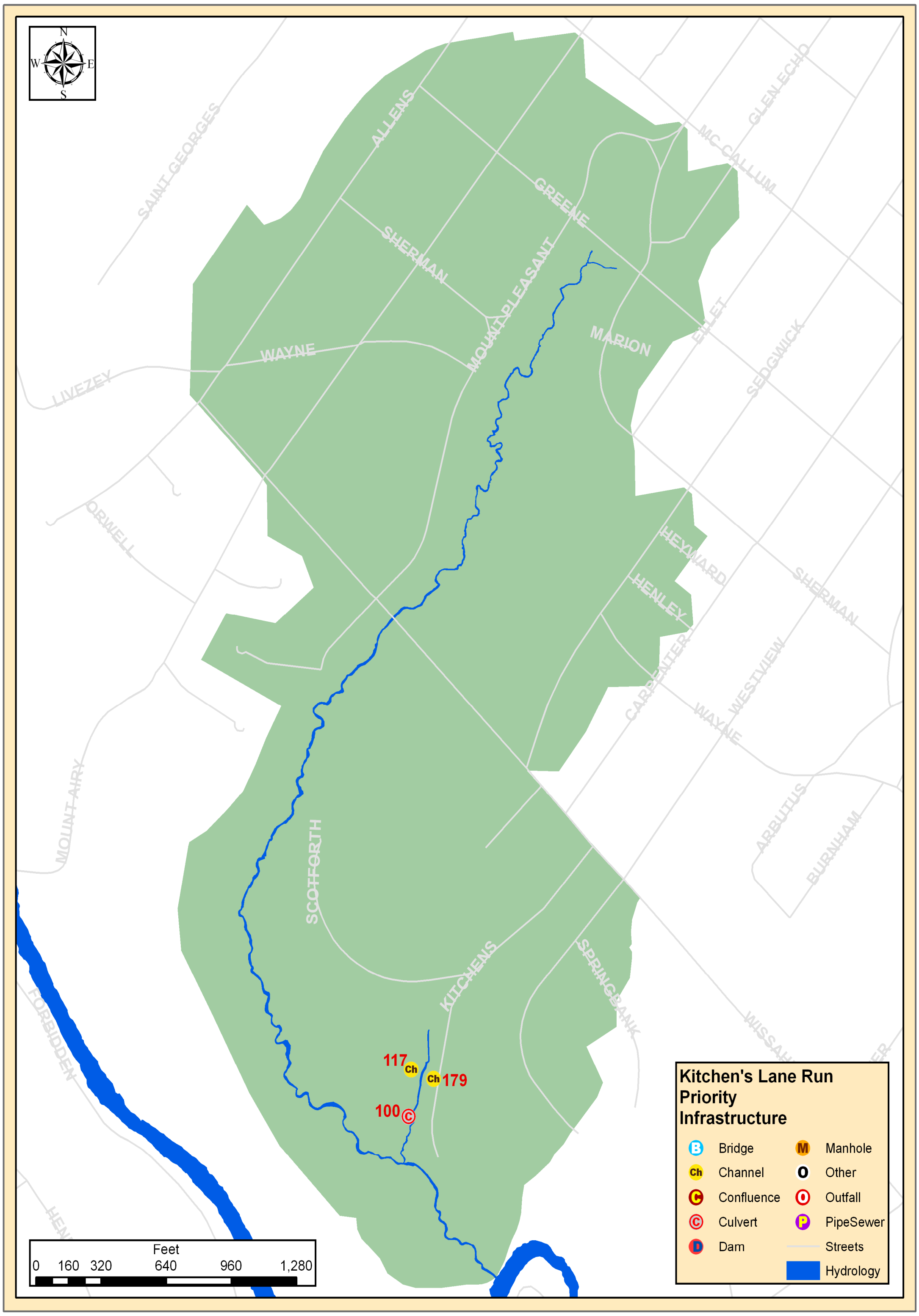


Figure 3-83: Kitchen's Lane Priority Infrastructure

3.2.6.5 UNIFIED STREAM ASSESSMENT RESULTS FOR THE KITCHEN'S LANE WATERSHED

The Kitchen's Lane watershed was extensively developed although the Kitchen's Lane main stem channel and its single tributary were both completely within the boundaries of Fairmount Park. North of Wissahickon Avenue, the Park is referred to as Carpenter's Woods whereas below Wissahickon Avenue, the Park is referred to as Kitchen's Lane. The Center for Watershed Protection's (CWP) Unified Stream Assessment Methodology (USAM) was used to score and rate the instream, riparian buffer and floodplain conditions of the stream corridor to allow for comparison to other reaches and watersheds within the Lower Wissahickon Basin.

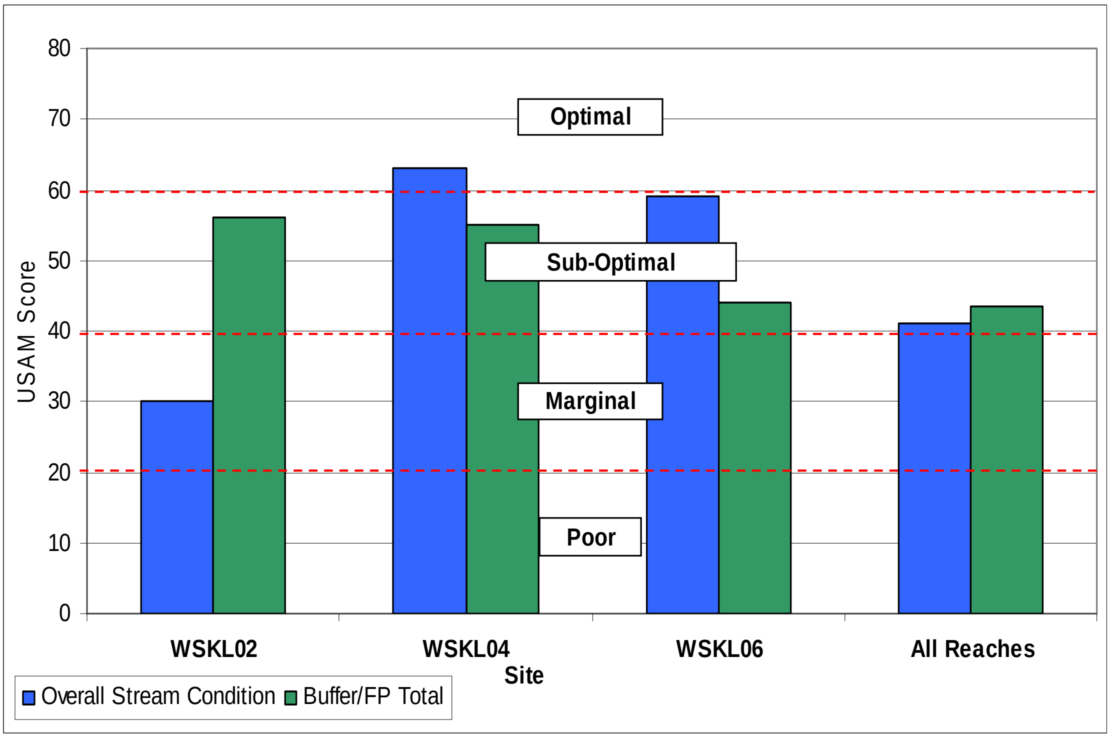


Figure 3-84: Results for Main Stem Kitchen's Lane USAM Components

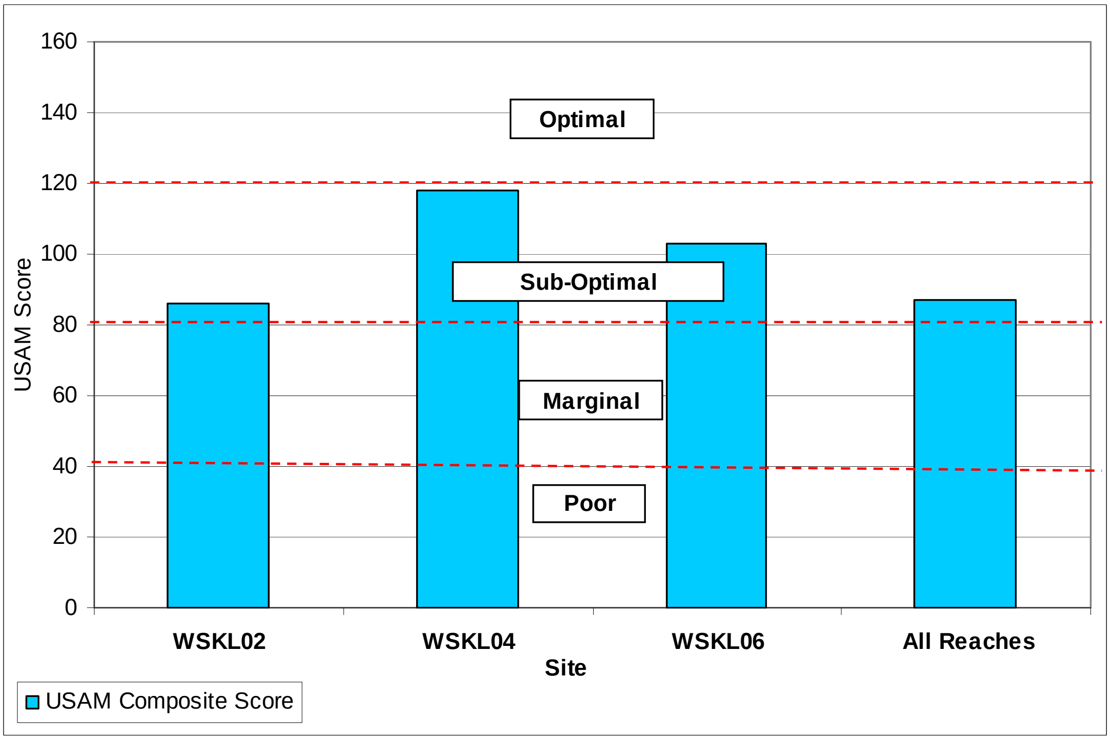


Figure 3-85: Kitchen's Lane USAM Results

3.2.6.5.1 WSKL02

The upstream-most segments of reach WSKL02 formed the headwaters of Kitchen's Lane. Reach WSKL02 began as flow from one privately owned outfall, WSout513, and one City owned outfall, WSout514 (W-068-02), each of which were located approximately 50 feet southwest of Green Street. The flow from each of these outfalls created short channels (80 feet and 145 feet respectively for WSout513 and WSout514) which were consolidated a short distance downstream. There were relatively few infrastructure elements along the length of the highly sinuous reach - there were two additional outfalls (WSout515 and WSout516) and a small pedestrian footbridge (WSbri536) that crossed Kitchen's Lane downstream of cross section WSKL02. The substrate particle size distribution was dominated by gravel-sized particles (64%), while sand (18%) and cobble particles (16%) were observed at much smaller proportions. The reach was characterized by a very high width to depth ratio (30.9), a deeply entrenched channel (ER=1.1) and a shallow gradient (1.7%). Reach WSKL02 was classified as an F4 stream type and had a composite USAM score (Figure 3-77) of (86/160).

3.2.6.5.2 WSKL04

Reach WSKL04 began 350 feet northeast of Wissahickon Avenue. There were very few infrastructure elements along the reach – only two culverts and a 24-inch outfall (WSout517) such that there were very few anthropogenic flow alterations on the reach. The substrate particle size distribution was dominated by gravel (50%) however cobble (27%) and sand (22%) were present in relative abundance throughout the reach. The reach was characterized by a moderate width to depth ratio (16.9), a slightly entrenched channel (ER=2.5) and a steeper gradient (2.3%) than the upstream reach WSKL02. The channel was classified as a type C4b stream channel. The moderately sinuous reach represented a transition between the wide, highly entrenched F-type stream channel in the segments of the reach upstream of WSKL04 and the steeper, more narrow and less entrenched C-type stream channel downstream. The USAM composite score for the reach was 118/160 and was the highest score observed among all reaches in the Lower Wissahickon Basin.

3.2.6.5.3 WSKL06

Reach WSKL06 was the downstream-most reach in the Kitchen's Lane watershed. There was a small tributary (650 feet) to Kitchen's Lane that began as flow from a privately owned outfall, WSout730, which was located approximately 280 feet southwest of the intersection of Scotforth Road and Kitchen's Lane [road]. The majority of the infrastructure elements present in the Kitchen's Lane watershed were located on or in the vicinity (upstream and downstream of the Kitchen's Lane confluence) of the small, highly channelized unnamed tributary. The reach was highly sinuous and ran parallel to Wissahickon Creek until it reached the Wissahickon Creek confluence, which was located about 260 feet downstream of cross section WSMS126. Reach WSKL06 was the only reach with a substrate particle size distribution dominated by cobble (34%) although gravel-sized particles (34%) were present in nearly equal proportions. Reach WSKL06 had channel geomorphology very similar to that of reach WSKL04 and was characterized by a moderate width to depth ratio (17.2), an extremely low degree of entrenchment (ER=2.8) and moderately gradient (2.8%). The reach was classified as a B4c type stream and had a USAM composite score of 103/160.

3.2.6.6 SUMMARY OF UNIFIED STREAM ASSESSMENT RESULTS

The mean scores for both the individual USAM components as well as the overall USAM score were all classified as "suboptimal" (Table 3-86). Average conditions within the watershed's riparian buffers and floodplains were slightly better than conditions observed within the stream channels. The watershed averages for each component as well as the composite USAM score compared well against the respective All Reaches averages, especially for the *Overall Buffer and Floodplain* component. The ratings for individual parameters ranged from poor to optimal, displaying similar levels of variability between reaches.

Table 3-86: USAM Results for Kitchen's Lane Watershed

Reach ID	Sub-watershed	Overall Stream Condition	Overall Buffer/FP Condition	USAM Score
WSKL02	Kitchen's Lane	30	56	86
WSKL04	Kitchen's Lane	63	55	118
WSKL06	Kitchen's Lane	59	44	103
WSKL mean		**50.7**	**51.7**	**102.3**
All Reaches Average		**42.4**	**44.5**	**86.9**

3.2.6.6.1 SUMMARY OF OVERALL STREAM CONDITION SCORES IN THE KITCHEN'S LANE WATERSHED

Scores for the *Overall Stream Condition* parameter were moderate to high ranging from "marginal" to "optimal". The mean watershed score for all three reaches (50.7/80) was rated as "suboptimal" and compared favorably with the All Reaches average of 42.4/80 which was also rated at the lower end of the "suboptimal" range. The reach observed to be in the best condition was reach WSKL04 (63/80), which was rated as "optimal" and was the highest scoring reach among the large Lower Wissahickon tributaries (second highest in the Lower Wissahickon after WSVG). Reach WSKL06 had a score of (59/80) and was rated as "suboptimal" which ranked this reach as the third highest scoring reach among the large Lower Wissahickon tributaries (fourth in the Lower Wissahickon). With respect to the individual parameters that comprise the *Overall Stream Condition* component, the *Floodplain Connection* parameter exhibited the largest degree of between-reach variation. The reaches WSKL02 and WSKL06 were observed to be in the worst and the best condition, respectively, among all the reaches in the Lower Wissahickon.

Table 3-87: USAM Overall Stream Condition Scoring for Kitchen's Lane Watershed

OVERALL STREAM CONDITION								
Reach ID	Sub-watershed	Instream Habitat	Vegetative Protection		Bank Erosion		Floodplain Connection	Overall Stream Condition
			Left	Right	Left	Right		
WSKL02	Kitchen's Lane	11	3	4	5	6	1	30
WSKL04	Kitchen's Lane	17	8	8	8	7	15	63
WSKL06	Kitchen's Lane	15	7	7	6	6	18	59
WSKL mean		**14.3**	**6.0**	**6.3**	**6.3**	**6.3**	**11.3**	**50.7**
All Reaches Average		**13.1**	**4.9**	**4.9**	**6.3**	**7.0**	**6.3**	**42.4**

3.2.6.6.1.1 INSTREAM HABITAT

Instream Habitat scores for all three reaches were relatively high and ranged from "marginal" to "optimal." The reach-wide average score (14.3/20) was rated as "suboptimal" and was slightly higher than the All Reaches average (13.1/20) which was rated as "suboptimal" as well. The reach with the highest rating was WSKL04 with a score of 17/20. This reach was the only reach in the Kitchen's Lane watershed that was deemed to have "optimal" instream habitat. The habitat template observed in this reach was characterized by an abundance of cobble (27%) and an even distribution of small boulders. Other habitat features included coarse woody debris (CWD) and the presence of undercut bank habitat, which is an important component of suitable fish habitat-especially on small, low-order tributaries. The lack of extensive channel incision and widening created the opportunity for a heterogeneous depth and velocity regime throughout the reach, which is usually an aspect of habitat suitability absent from urban systems.

Reach WSKL02 had a score of 11/20 for this parameter which put this reach at the threshold between marginal and suboptimal. The reduced habitat quality in this reach can be attributed to a number of factors. This reach had the highest percentage of gravel at 64%. Gravel is a key component of fish spawning habitat, however, it does not convey a high degree of stability [resistance to disturbance] which is an important component of macroinvertebrate habitat suitability. Furthermore, the effect of channel morphology on habitat suitability is evident in this reach. The width to depth (30.9) and entrenchment (1.1) ratios observed in this reach are indicative of an overly widened channel with limited floodplain access. In effect this creates a wide, flat channel that lacks the depth and velocity heterogeneity present in reach WSKL04 as well as the ability to deposit finer sediment onto the floodplain and retain larger more stable particles.

3.2.6.6.1.2 VEGETATIVE PROTECTION

The *Vegetative Protection* parameter reflects the extent to which streambanks are protected by vegetative cover. In general scores were rather high for this parameter in all reaches except for reach WSKL02, in which the left bank was rated as "poor" and the right bank was rated slightly higher with a "marginal" rating. Overall, the Kitchen's Lane stream corridor offered a great deal of vegetative protection as the mean watershed score for both the left (6/10) and right (6.3/10) banks were higher than the All Reaches averages for the left (4.9/10) and right (4.9/10) banks respectively.

3.2.6.6.1.3 BANK EROSION

Bank Erosion in the Kitchen's Lane watershed corridor was moderate as the scores for the basin were all rated as "marginal" to "suboptimal" for this parameter. The average watershed score was 6.3/10 for both the left and right banks. The mean score for the left bank of the Kitchen's Lane corridor was equal to the All Reaches average (6.3/10). However, the average score for the All Reaches right bank (7.0/10) was considerably higher than the Kitchen's Lane right bank average (6.3/10).

Reach WSKL04 had the highest scores for this parameter with a score of 8/10 for the left bank and a score of 7/10 for the right bank, both of which were rated as "suboptimal". The worst bank condition was observed in reach WSKL02 with scores of 5/10 and 6/10 for the left and right banks respectively. The disparity in streambank erosion between these two sites can be attributed to distinct features of the two reaches. WSKL04 has a larger proportion of its streambanks covered by vegetation as well as a higher distribution of large cobble and boulders, both mid-channel and along the channel margins. Larger substrate particles such as cobbles and boulders have much higher "roughness" than less coarse substrate such as gravel (65% of the substrate at WSKL02), and work to dissipate much of the kinetic energy conveyed through the channel during bankfull flow events.

3.2.6.6.1.4 FLOODPLAIN CONNECTION

Scores for the *Floodplain Connection* parameter exhibited extreme variation throughout the watershed. Reach WSKL02 had the lowest score (1/20) observed for this parameter throughout the entire Lower Wissahickon; whereas reach WSKL06 had the highest score (18/20) observed in the Lower Wissahickon. Given the extreme variation in floodplain connection, the Kitchen's Lane watershed compared well against the All Reaches average for the larger Lower Wissahickon tributaries. The mean score for the watershed (11.3/20) was rated as "suboptimal", and was considerably higher than the All Reaches average (6.3/20) which was rated as "marginal".

3.2.6.6.2 Summary of Overall Buffer and Floodplain Condition Scores in the Kitchen's Lane Watershed

The *Overall Buffer and Floodplain* scores for Kitchen's Lane watershed were relatively high for most parameters. Although, scores were low for the *Floodplain Habitat* parameter, the mean watershed score (7.9/20) was relatively high given scores for this parameter were low throughout the Lower Wissahickon (likely due to the high occurrence of stream incision). In general, most of the riparian buffers within the watershed were unperturbed as the scores for the *Vegetated Buffer Width* parameter were rated as "suboptimal" and "optimal" for the left and right banks of the corridor respectively. Mean scores for the Kitchen's Lane watershed were higher than respective All Reaches averages for every parameter except for the left bank *Vegetated Buffer Width* parameter (8/10) which was negligibly less than the All Reaches average of 8.1/10.

Table 3-88: USAM Buffer and Floodplain Condition Scoring for Kitchen's Lane Watershed

OVERALL BUFFER AND FLOODPLAIN CONDITION							
Reach ID	Sub-watershed	Vegetated Buffer Width		Floodplain Vegetation	Floodplain Habitat	Floodplain Encroachment	Buffer/FP Condition
		Left	Right				
WSKL02	Kitchen's Lane	10	10	18	3	15	56
WSKL04	Kitchen's Lane	8	8	15	11	13	55
WSKL06	Kitchen's Lane	6	9	13	8	8	44
WSKL mean		**8.0**	**9.0**	**15.3**	**7.3**	**12.0**	**51.7**
All Reaches Average		**8.1**	**8.6**	**13.8**	**5.5**	**8.5**	**44.5**

3.2.6.6.2.1 Vegetated Buffer Width

Vegetated buffers within the watershed were observed to be in good condition. The reach where the largest riparian buffer was observed was WSKL02 (10/10), which was rated as "optimal" and had buffers in excess of 50 feet on both the right and left banks. The watershed averages for the left (8/10) and right (9/10) banks were rated as "suboptimal" and "optimal" respectively and compared well with the All Reaches averages of 8.1/10) for the left bank and 8.6/10 for the right bank.

3.2.6.6.2.2 Floodplain Vegetation

The predominant floodplain vegetation within the watershed was consistently observed to be mature and secondary forest although other vegetation types such as shrubs and wetland obligates were also observed. The mean watershed score for this parameter was 15.3/20, which was rated as "suboptimal." Reach WSKL02 had the highest score (18/20) and was rated as "optimal." Overall, the watershed compared favorably against the All Reaches average (13.8/20) which was rated as "suboptimal" as well.

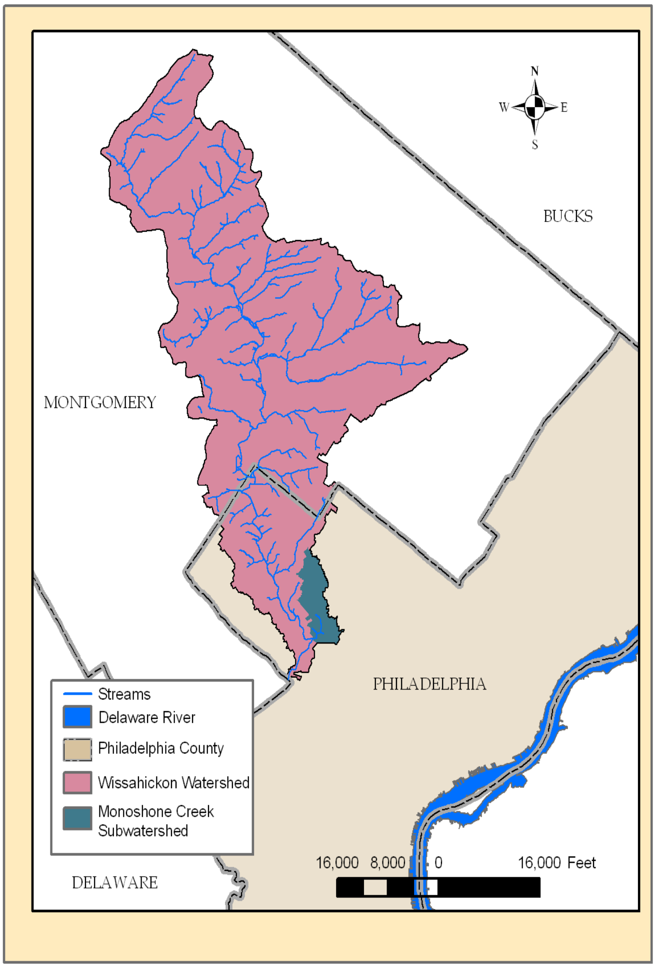
3.2.6.6.2.3 FLOODPLAIN HABITAT

Floodplain Habitat scores were rated as "poor" to "marginal" within the watershed. However, the observed conditions were somewhat better than the average conditions observed in the other large Lower Wissahickon tributaries. The watershed average score was 7.3/20 compared to the All Reaches mean score of 5.5/20, although both were rated as "marginal." WSKL04 and WSKL06 were not deeply incised indicating that channels in these reaches are able to access the floodplain. Observations of obligate wetland vegetation (Eastern Skunk Cabbage - *Symplocarpus foetidus)* further support the fluvial geomorphology-based assumption of frequent floodplain inundation in these reaches.

3.2.6.6.2.4 FLOODPLAIN ENCROACHMENT

Scores for this parameter ranged from moderate to high throughout the watershed such that there was a relatively small impact of man-made structures and infrastructure on floodplain function. The watershed mean score (12/20) was rated as "suboptimal" and was considerably higher than the All Reaches average (8.5/20) which was rated as "marginal." Most of the watershed had an extensive, uninterrupted floodplain whereas the only significant encroachment was Kitchen's Lane, which impinged upon the floodplain in the lower third of WSKL06.

3.2.7 Monoshone Creek Watershed and Reach Characteristics



Monoshone Creek is a tributary to the main stem of the Wissahickon Creek. The tributary originates from three outfalls, two privately owned (WSout544 and WSout545) and one city owned, WSout543 (W-068-04). Monoshone Creek is a first-order tributary for approximately 0.5 miles until a smaller 0.1 mile tributary enters the Monoshone approximately 0.4 miles from the confluence with the Wissahickon main stem. Another small 0.25 mile tributary enters Monoshone Creek approximately 0.25 miles from the confluence with the Wissahickon main stem. The substrate varies from clay and silt to large boulders at different sections along the tributary. Both the valley floor and channel have been substantially impacted by past and current land use.

The entire Monoshone Creek watershed is 1,056 acres. Major land use types within the watershed include: wooded (31%), residential – row home (29%), residential – single family detached (21%), and commercial (5%). The Monoshone Creek is surrounded by Fairmount Park on both sides for the entire length. The Park buffer ranges from about 100 feet to about 2,000 feet.

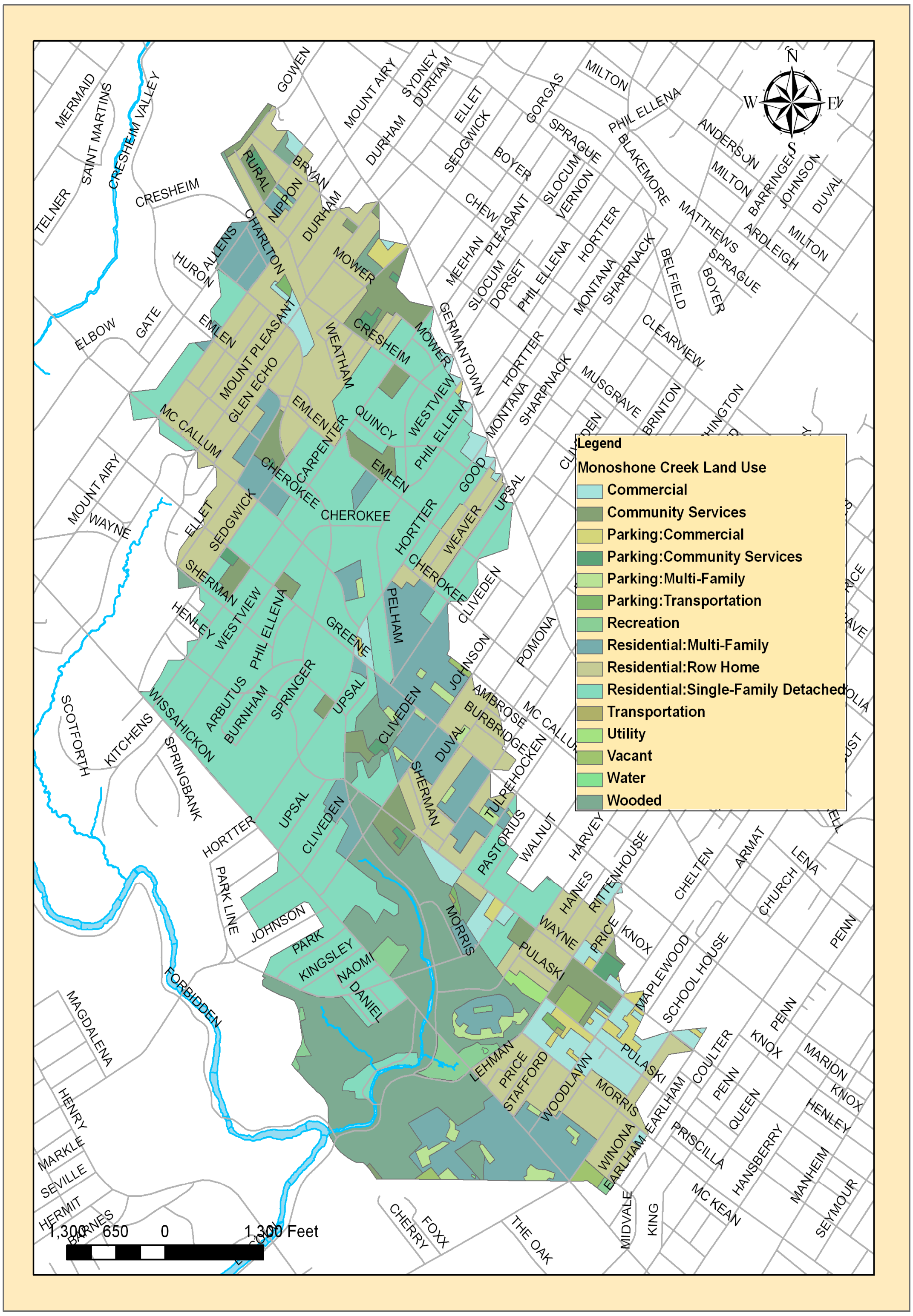


Figure 3-86: Monoshone Creek Watershed Land Use

3.2.7.1 GEOLOGY

The majority of the Monoshone Creek watershed is underlain by the Wissahickon Formation. The Wissahickon Formation consists of mica schist, gneiss and quartzite. The exposed schist near the surface is highly weathered. The Wissahickon Formation is also comprised of metamorphosed sedimentary rocks.

There is a small section of mafic gneiss in the southern portion of the Monoshone Creek watershed. The mafic gneiss formation consists of weather-resistant rocks that show good surface drainage.

3.2.7.2 SOILS

According to the National Resource and Conservation Service Soil Survey, the majority of soils for the Monoshone Creek watershed are classified as hydrologic group B. These soils have a moderate rate of infiltration when the soils are wet (0.50-1.00 in/hr). Water movement through these soils is considered moderately rapid. There is a small band of B/D soils along the western tributary of the Monoshone Creek. Group D soils have a very slow rate of infiltration when saturated (0.02-0.10 in/hr) resulting in a high runoff potential.

There is a small section of hydrologic group A soils on the southern portion of the tributary. Group A soils have a low runoff potential. These soils also have a high rate of infiltration (1.00-8.3 in/hr) when saturated.

A small band of Urban soils borders the Monoshone Creek. Urban soils consist of material that has been disturbed by human activity during urbanization. Urban soils have been produced by mixing, filling and contamination of the native soils in both urban and suburban areas.

Table 3-89: Distribution of NRCS Soil Types in Monoshone Creek Watershed

Group	Area (ft^2)	Percent of Total Area
A	4,600	0.01%
B	7,079,301	15.39%
B/D	4,600	0.01%
Urban	38,910,858	84.59%
Total Area	**45,999,360**	**100%**

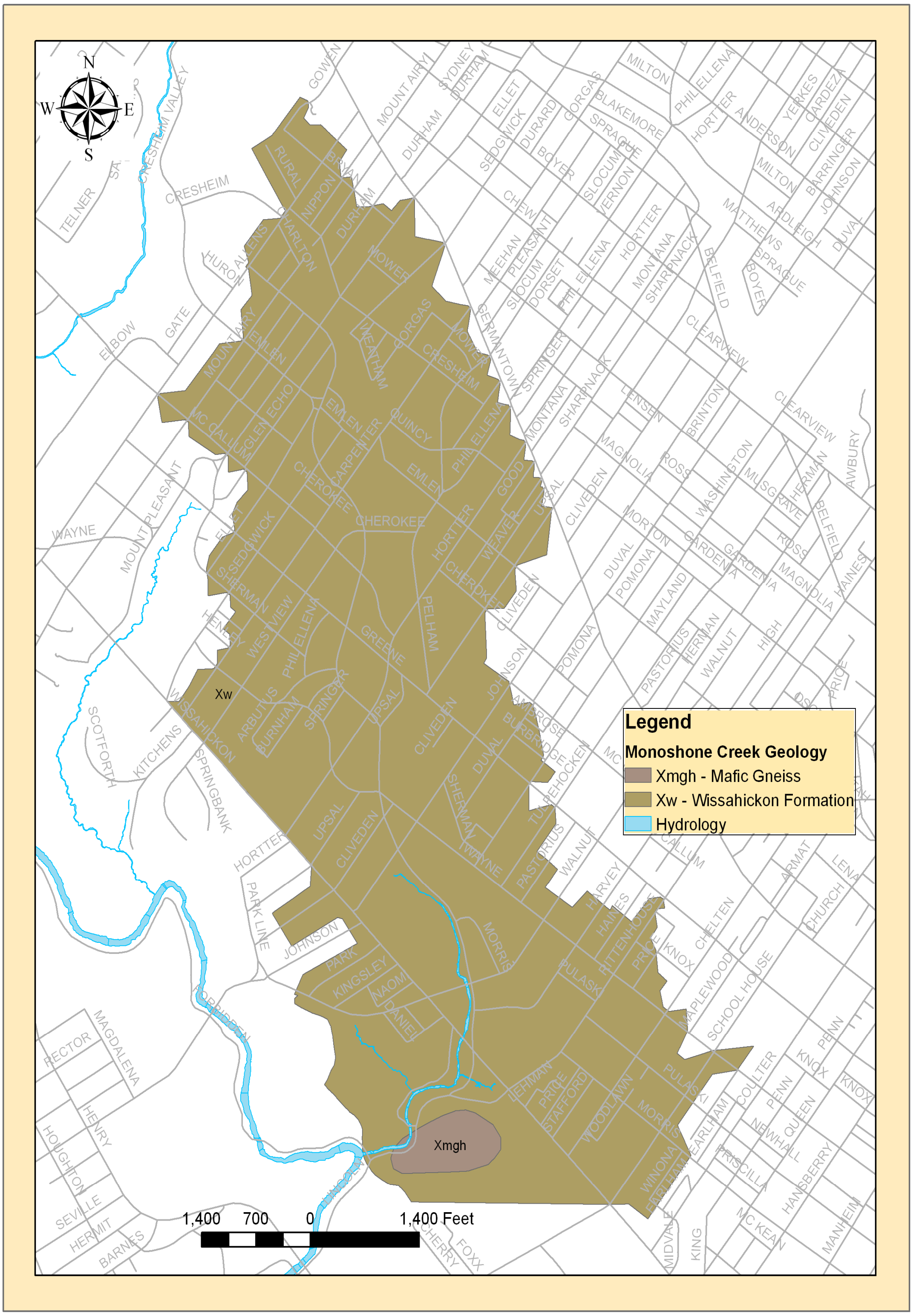


Figure 3-87: Geology of Monoshone Creek Watershed

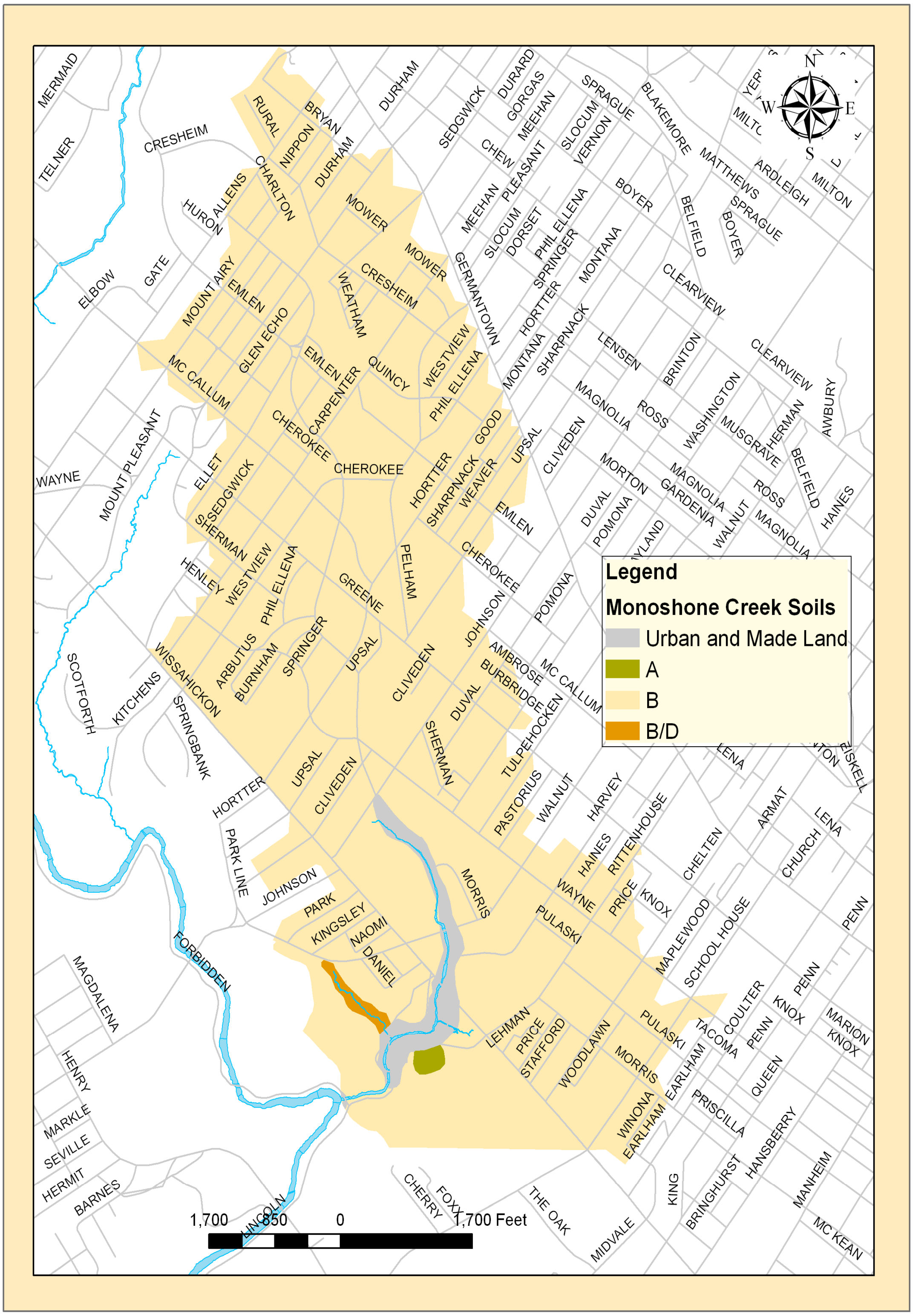


Figure 3-88: Distribution of NRCS Soil Types in Monoshone Creek Watershed

3.2.7.3 BANK EROSION

There were seven bank pin locations along Monoshone Creek (Figure 3-89). The calculated erosion rates are included in Table 3-90. The spatial distribution of BEHI assessment results were represented graphically (Figure 3-89) for each of the segments assessed on Monoshone Creek. Each bank within a respective segment was assessed and rated separately; however, channelized and culverted segments were not assessed as they confer a high degree of protection from bank erosion.

Table 3-90: Monoshone Creek Bank Pin Locations

	BEHI	NBS	Baseline Reading	Most Recent Reading	Erosion Rate (ft)	Erosion Rate (ft/yr)	Eroding (-) or Aggrading (+)
Monoshone Creek							
MN1	Moderate	Very Low	11/2/2005	8/13/2009	-0.55	-0.14	E
MN2	Moderate	High	11/2/2005	8/13/2009	-0.47	-0.12	E
MN3	High	High	11/2/2005	8/13/2009	-0.48	-0.13	E
MN4	Moderate	Low	11/2/2005	8/13/2009	-0.15	-0.04	E
MN962	Low	Low	8/24/2006	8/14/2008	0.19	0.095	A
MN963	Low	Low	8/13/2007	8/13/2009	0.58	0.29	A
MN964	Low	Low	8/13/2007	8/13/2009	-0.081	-0.041	E

Total erosion rates were also calculated for the entire length of each tributary within the Lower Wissahickon (Table 3-91). To assess the normalized erosion potential of each tributary, the erosion rate per acre of drainage area per year and the erosion rate per foot of stream length per year were calculated. This allowed direct comparison between each of the tributaries with respect to both watershed size and the length of the tributary. Monoshone Creek was ranked eleventh out of the twelve tributaries within the lower Wissahickon for erosion rate per foot of stream length. The rankings were based on a scale of one being the highest erosion rate and twelve being the lowest erosion rate.

Table 3-91: Erosion Rates for Lower Wissahickon Tributaries

Tributary	Drainage Area (Acres)	Stream Length (feet)	*2009*		
			Erosion Rate (lb/yr)	*Erosion Rate Per Acre*	*Erosion Rate Per Foot of Stream*
Bell's Mill	323	6,722	420,000	1,307	63
Cathedral Run	160	2,790	150,000	913	52
Cresheim Creek	1,218	16,431	840,000	690	51
Gorgas Run	499	2,170	170,000	345	79
Hartwell Run	217	3,530	200,000	918	56
Hillcrest	144	5,272	90,000	597	16
Kitchen's Lane	234	7,753	200,000	850	26
Monoshone Creek	1,056	6,926	160,000	156	24
Rex Ave	137	1,903	150,000	1,131	81
Thomas Mill Run	104	4,008	320,000	3,058	79
Valley Green Run	128	2,874	140,000	1,086	48
Wise's Mill Run	446	7,056	490,000	1,090	69
Total/*Average*	**4,666**	**67,435**	**3,300,000**	***1,012***	***54***

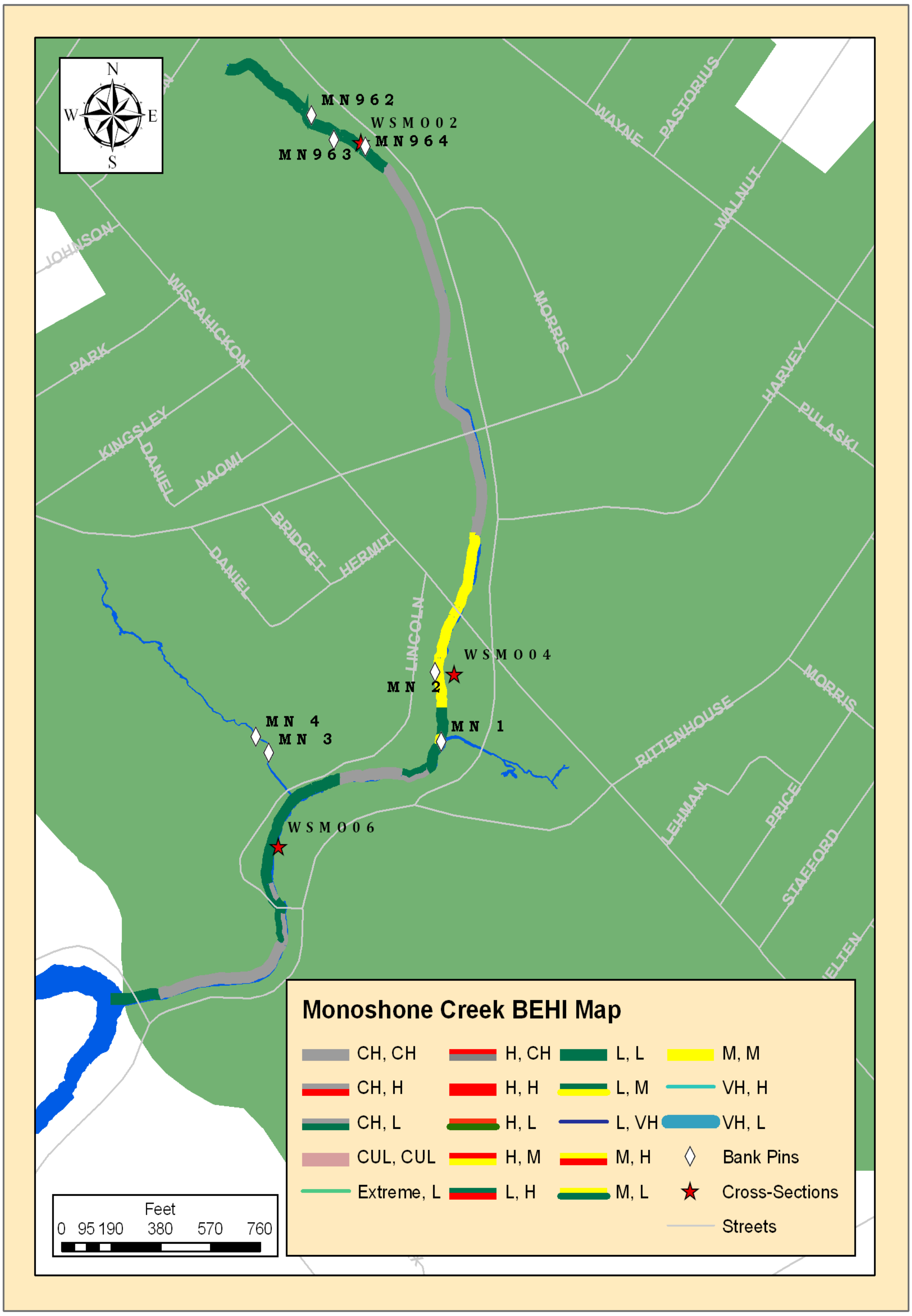


Figure 3-89: Monoshone Creek Watershed BEHI Ratings and Bank Pin Locations

3.2.7.4 INFRASTRUCTURE TRACKDOWN SUMMARY

Monoshone Creek was the furthest downstream of all of the tributaries in the Lower Wissahickon Basin. It ran parallel to Lincoln Drive from Johnson Street to the confluence with Wissahickon Creek. While this stream was located entirely within Fairmount Park, it was heavily influenced by the urban development in the surrounding areas. Several outfalls conveyed direct runoff from Lincoln Drive as well as the cross streets, Walnut Lane, Wissahickon Avenue, Johnson Street, etc. Outfalls were numerous, as there were 23 outfalls throughout the three reaches with a total outfall area of about 240 square feet.

Aside from the outfalls, channelization and dams impacted the stream both locally, as well as upstream and downstream of the respective structures. Over one-fifth of the stream length was channelized. The channels were installed to prevent the lateral movement of the stream and protect other infrastructure within the corridor. Three dams, one in each reach, were impediments to streamflow and sediment transport downstream. The flow from outfalls WSout731 and WSout732 has been captured to a degree by PWD and Fairmount Park's Saylor Grove Wetland Project. The flow from the outfalls is retained in the wetland which settles out sediment and returns flow to Monoshone Creek through WScul519. None of the infrastructure on Monoshone Creek was identified as being in poor condition; however, the cumulative impacts of Monoshone Creek infrastructure caused many of the physical attributes of the stream to be in poor condition.

Table 3-92: Monoshone Creel Infrastructure Point Features

Section ID	Culvert Count	Bridge Count	Outfall Count	Channel Count	Confluence Count	Dam Count	Other Count	Infra Point Count	Combined Outfall Area (ft^2)
WSMO02	1	0	7	2	0	1	1	11	37.76
WSMO04	1	2	6	2	1	1	0	12	75.46
WSMO06	2	2	10	5	1	1	0	20	126.27
TOTAL	**4**	**4**	**23**	**9**	**2**	**3**	**1**	**43**	**239.49**

Table 3-93: Monoshone Creel Infrastructure Linear Features

Section ID	Segment Length (ft)	Culvert Length (ft)	Percent Culverted	Channel Length (ft), 1 side	Channel Length (ft), 2 sides	Channel Length (ft)	Percent Channelized
WSMO02	1665	28	1.7	86	532	1150	23
WSMO04	2083	115	5.5	7	689	1385	22.2
WSMO06	2845	191	6.7	193	727	1647	19.3
TOTAL	**6593**	**334**	**5.1**	**286**	**1948**	**4182**	**21.1**

Figure 3-90: Monoshone Creek Infrastructure Locations

3.2.7.5 Unified Stream Assessment Results for the Monoshone Creek Watershed

The Monoshone Creek watershed was the downstream-most watershed within the Lower Wissahickon Basin. The main stem channel of Monoshone Creek originated near the intersection of Lincoln Drive and Johnson Street. The main stem channel as well as its two tributaries was entirely within the boundaries of Fairmount Park. The main stem channel was relatively short compared to the expanse of the watershed as Monoshone Creek was located entirely within the lower third of the watershed. Historically Monoshone Creek had a much larger stream network, which over time was truncated and encapsulated to allow for development - as were many streams throughout the City of Philadelphia. The historic extent of Monoshone Creek had headwaters near the intersection of Glen Echo Road and Lincoln Drive, as well as an additional three tributaries.

The Center for Watershed Protection's (CWP) Unified Stream Assessment Methodology (USAM) was used to score and rate the instream, riparian buffer and floodplain conditions of the stream corridor to allow for comparison to other reaches and watersheds within the Lower Wissahickon Basin.

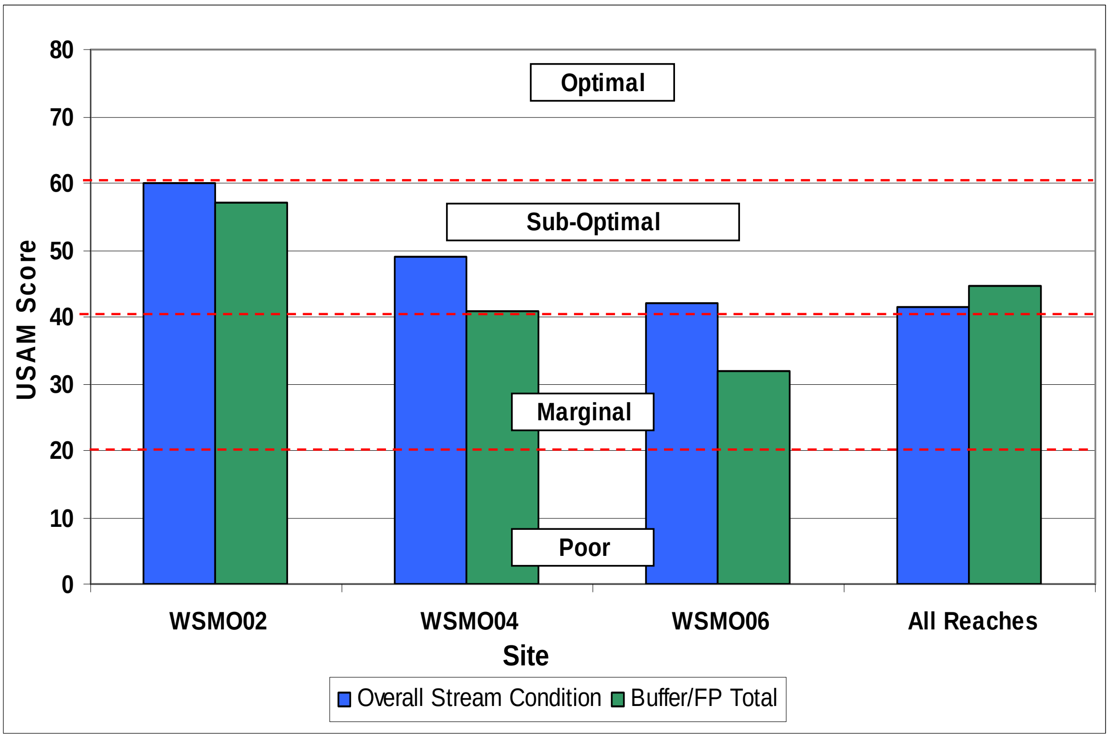


Figure 3-91: Results for Monoshone Creek USAM Components

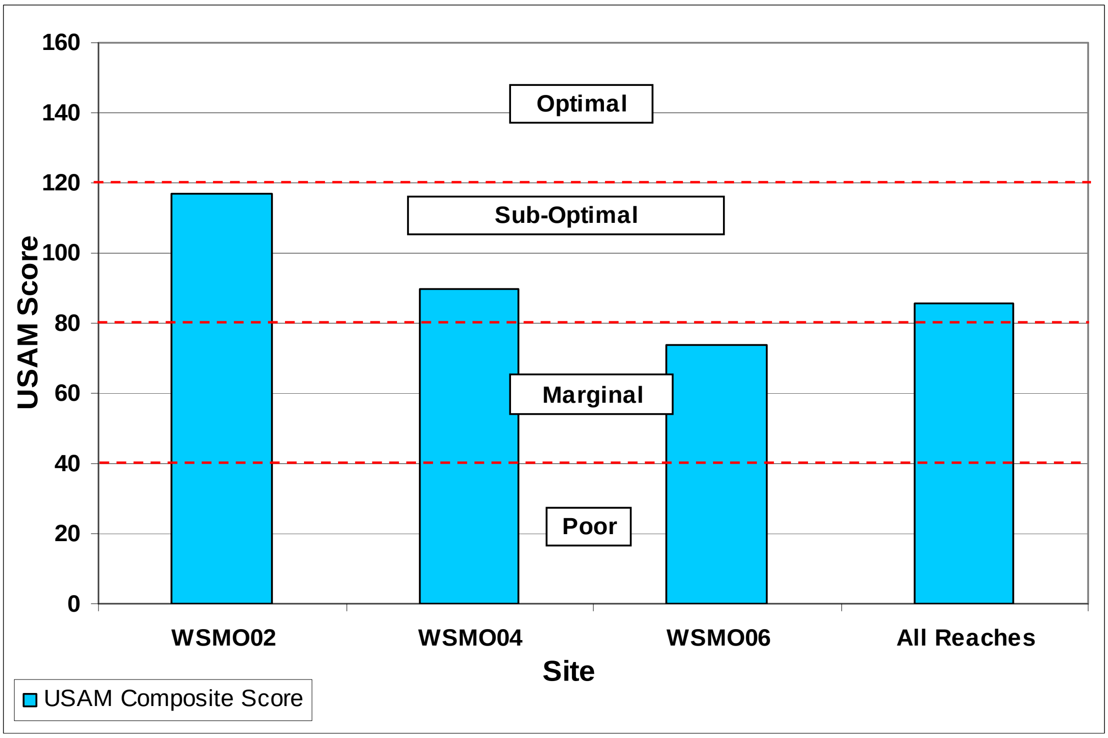


Figure 3-92: Monoshone Creek USAM Results

3.2.7.5.1 WSMO02

Reach WSMO02 contained the headwaters of Monoshone Creek which began as flow from WSout544 located 315 feet southwest of the intersection of Johnson Street and Lincoln Drive. The entire reach ran parallel to Lincoln Drive and was highly channelized (WScha203 on the DSR and WScha132 on the DSL) along the segment of the reach that was located within 40 feet of Lincoln Drive. The substrate particle size distribution was dominated by silt (67%) with sand (33%) comprising the remainder of the sediment in the reach. The channel morphology in reach WSMO02 was characterized by a moderate width to depth ratio (12), a deeply entrenched channel (ER=1.6) and a moderately shallow gradient (3.1%). The reach was classified as a type B6 stream channel and had a USAM composite score (Figure 3-92) of 117/160 which was the second highest score of all reaches assessed in the Lower Wissahickon Basin.

3.2.7.5.2 WSMO04

Reach WSMO04 began about 100 feet upstream of the Walnut Lane Bridge (WSbri242) and ended at a channelized segment (WScha139 on the DSR and WScha140 on the DSL) upstream of a footbridge (WSbri527) within the Rittenhouse Town complex. There was a small tributary on the reach that began as flow from two privately owned outfalls (WSout731 and WSout732) that drained into the PWD treatment wetland, Saylor's Grove, which was bounded by Rittenhouse Avenue to the south and east, Wissahickon Avenue to the north and Lincoln Drive to the west. Flow from the wetland was diverted through WScul519 to the main stem of Monoshone Creek. The substrate particle size distribution was dominated by cobble (46%) although gravel (20%) and sand (17%) were also abundant throughout the reach. The channel morphology of the reach was characterized by a high width to depth ratio (23.6), a deeply entrenched channel (ER=1.7) and a moderately shallow gradient (2.5%). The reach was classified as a B3 stream channel and the USAM composite score for the reach was 90/160.

3.2.7.5.3 WSMO06

Reach WSMO06 began at a channelized segment (WScha139 on the DSR and WScha140 on the DSL) of Monoshone Creek located within the Rittenhouse Town complex and ended at the confluence of Monoshone Creek and Wissahickon Creek. There was a 1,280-foot tributary on the DSR side of the creek that had its headwaters 80 feet south of Walnut Lane between Daniel Street and Kingsley Street and reached its confluence with Monoshone Creek 35 feet downstream of WSdam109. The substrate particle size distribution within the reach was dominated by cobble (58%) with smaller amounts of gravel (20%) and sand (17%) present in nearly equal proportions. The channel morphology was characterized by a high width to depth ratio (18.3), a deeply entrenched channel (ER=1.4) and a shallow slope. The reach was classified as a B3c stream type and had an USAM composite score of 74/160.

3.2.7.6 SUMMARY OF UNIFIED STREAM ASSESSMENT RESULTS

The mean scores for both the *Overall Stream Condition* component as well as the composite USAM score were classified as "optimal" (Table 3-94). Average conditions within the Monoshone Creek watershed's stream channels were slightly better than conditions observed within the buffers and floodplains. The watershed averages for the *Overall Stream Condition* component, as well as the composite USAM score, compared very well against the respective All Reaches averages, however the *Overall Buffer and Floodplain* component was relatively close to the All Reaches average. The scores for individual parameters ranged from poor to optimal, displaying similar levels of variability between reaches.

Table 3-94: USAM Results for Monoshone Creek Watershed

Reach ID	Sub-watershed	Overall Stream Condition	Overall Buffer/FP Condition	USAM Score
WSMO02	Monoshone	60	57	117
WSMO04	Monoshone	49	41	90
WSMO06	Monoshone	42	32	74
WSMO mean		**50.3**	**43.3**	**93.7**
All Reaches Average		**42.4**	**44.5**	**86.9**

3.2.7.6.1 SUMMARY OF OVERALL STREAM CONDITION SCORES IN THE MONOSHONE CREEK WATERSHED

The *Overall Stream Condition* scores observed in the Monoshone Creek watershed was among the best in the Lower Wissahickon. The mean *Overall Stream Condition* score for the Monoshone Creek reaches (50.3/80), rated as "suboptimal" and was higher than the All Reaches average (42.4/80) for the large Lower Wissahickon tributaries which was also rated as "suboptimal." The mean watershed scores for each of the four *Overall*

Stream Condition parameters were higher then the respective All Reaches averages. The most notable parameter scores in the watershed were for the *Instream Habitat* and *Bank Erosion* parameters which ranked among the best observed in the Lower Wissahickon.

Table 3-95: USAM Overall Stream Condition Scoring for Monoshone Creek Watershed

OVERALL STREAM CONDITION								
Reach ID	**Sub-watershed**	**Instream Habitat**	**Vegetative Protection**		**Bank Erosion**		**Floodplain Connection**	**Overall Stream Condition**
			Left	**Right**	**Left**	**Right**		
WSMO02	Monoshone	16	8	6	10	10	10	60
WSMO04	Monoshone	18	5	5	7	7	7	49
WSMO06	Monoshone	15	4	4	7	7	5	42
WSMO mean		**16.3**	**5.7**	**5.0**	**8.0**	**8.0**	**7.3**	**50.3**
All Reaches Average		**13.1**	**4.9**	**4.9**	**6.3**	**7.0**	**6.3**	**42.4**

3.2.7.6.1.1 INSTREAM HABITAT

Instream habitat conditions in the Monoshone Creek watershed were observed to be exceptional, as all sites were rated as “suboptimal” and “optimal.” The mean watershed score (16.3/20) was rated as” optimal” and was considerably higher than the All Reaches average (13.1/20) which was rated as “suboptimal.”

Reach WSMO02 was rated as “optimal” however the habitat template observed in this reach had noticeably different characteristics compared to the other two sites. The dominant substrate within reach WSMO02 was silt (67%) compared to the other two reaches WSMO04 and WSMO06, in which the substrate was dominated by cobble (46% and 58% respectively). The habitat features in the reach WSMO02 that contributed the most to an “optimal” rating were the presence of adequate amounts of CWD as well as emergent macrophytes along the margins of the stream channel. The emergent macrophytes, some of which were obligate wetland species (Eastern Skunk Cabbage - *Symplocarpus foetidus*) offered adequate cover along the margins of the narrow (8.7 feet wide) first-order stream with CWD and a sparse distribution of cobble providing cover in the actual channel. The distribution of CWD in reaches WSMO04 and WSMO06 was not as dense as was observed in WSMO02; however the presence of instream vegetation in WSMO06 and the dominance of stable cobble and boulder (17% and 5% at WSMO04 and WSMO06 respectively) substrate helped compensate for the lack of adequate CWD.

3.2.7.6.1.2 VEGETATIVE PROTECTION

Scores for the *Vegetative Protection* parameter were moderate although the watershed averages for the left (5.7/10) and right (5.0/10) banks were both higher than the All reaches averages for the left and right banks (both 4.9/10). The highest scores observed in the watershed were for the left (8/10) and right (6/10) banks of reach WSMO02. There were minimal indicators of stream bank erosion and degradation in the narrow channel which permitted the growth of vegetation at or near the margins of the channel throughout the reach and up to 90% coverage of the stream bank surfaces. The other reaches, WSMO04 and WSMO06, were rated as “marginal” with scores of 5/10 and 4/10 respectively for both banks. These reaches had adequate vegetative coverage throughout most of the reach although bare patches of soil were observed as a result of localized scour.

3.2.7.6.1.3 Bank Erosion

Bank erosion was minimal throughout the Monoshone Creek watershed. Average watershed scores for the this parameter (both banks 8/10) were rated as "suboptimal" and were considerably higher than the All Reaches averages for both the left (6.3/10) and right (7.0/10) banks. Reach WSMO02 was observed to be in the best condition with an "optimal" rating and a score of 10/10) for both banks. The other reaches were rated as "suboptimal," both with scores of 7/10 for both the left and right banks. In the lower reaches of the watershed (WSMO04 and WSMO06) vegetative cover and the presence of colluvial deposits of small (256-362 mm) to large (1024-2048 mm) boulders offered protection from most erosive forces, although there were short segments of these reaches that were affected by localized scour.

3.2.7.6.1.4 Floodplain Connection

The *Floodplain Connection* parameter measures the extent to which flood flows within a channel can access the floodplain, which is gauged by entrenchment ratios calculated at riffle cross sections. Scores were moderate to low throughout the watershed but the watershed mean (7.3/20) still compared favorably against the All Reaches average (6.3/20) for the large Lower Wissahickon tributaries. The reach with the highest score (10/20) was WSMO02, which was rated as "marginal." The worst reach was WSMO06, which was rated as "poor" with a score of 5/20.

3.2.7.6.2 Summary of Overall Buffer and Floodplain Condition Scores in the Monoshone Creek Watershed

The scores for the *Overall Buffer and Floodplain Condition* parameters ranged from "poor" to "optimal" throughout the watershed, but were generally low to moderate. The watershed mean score for all parameters, except for the average left bank *Vegetated Buffer Width* and *Floodplain Encroachment* parameters, was higher than the All Reaches average for the large Lower Wissahickon tributaries. Of special significance were the scores for the *Floodplain Vegetation* parameter as the watershed mean score was among the highest observed in the Lower Wissahickon.

Table 3-96: USAM Buffer and Floodplain Condition Scoring for Monoshone Creek Watershed

OVERALL BUFFER AND FLOODPLAIN CONDITION							
Reach ID	Sub-watershed	Vegetated Buffer Width		Floodplain Vegetation	Floodplain Habitat	Floodplain Encroachment	Overall Buffer/FP Condition
		Left	Right				
WSMO02	Monoshone	7	10	19	13	8	57
WSMO04	Monoshone	7	9	17	4	4	41
WSMO06	Monoshone	5	8	12	4	3	32
WSMO mean		**6.3**	**9**	**16**	**7**	**5**	**43.3**
All Reaches Average		**8.1**	**8.6**	**13.8**	**5.5**	**8.5**	**44.5**

3.2.7.6.2.1 VEGETATED BUFFER WIDTH

Scores for the *Vegetated Buffer Width* parameter were relatively high for the right bank of the corridor and moderate for the left side. The mean watershed score for the left bank (6.3/10) was rated as "suboptimal" and for the right bank (9/10) was rated as "optimal." The All Reaches averages for the left and right bank were 8.1/10 and 8.6/10 respectively, both rated as "suboptimal."

The major impediments to the establishment of optimal (>50 feet) vegetated buffers in the watershed were Lincoln Drive, which explains the lower scores for the downstream left side (DSL) of the stream corridor. Reach WSMO02, which was the least impacted by Lincoln Drive, having over 100 feet of separation from the road at the upstream-most segments and up to 45 feet of separation on the downstream segment of the reach. Conversely, the reach most impacted by Lincoln Drive was WMMO06, which had less than 30 feet of floodplain between the channel and Lincoln Drive on the DSL and less than 40 feet of floodplain on the downstream right (DSR) side of the channel due to Forbidden Drive.

3.2.7.6.2.2 FLOODPLAIN VEGETATION

The scores for the *Floodplain Vegetation* parameter were generally good throughout the watershed. The mean watershed score for this parameter 16/20 rated as "optimal" and compared favorably to the All Reaches average (13.8/20) which rated as "suboptimal." The dominant vegetation type throughout the watershed was mature forest. However closer to the stream margins, herbaceous ground cover vegetation and shrubs were present in most reaches, especially WSMO02.

3.2.7.6.2.3 FLOODPLAIN HABITAT

Floodplain habitat in the Monoshone Creek watershed was rated as "marginal" with a mean watershed score of 7/20. However, the average floodplain habitat conditions observed in the Lower Wissahickon (5.5/20) were slightly worse and also rated as "marginal." The most influential factor in determining the condition of floodplain habitat structure is the entrenchment ratio, which is a measure of the likelihood that a channel will overtop its banks at flows in excess of bankfull discharge. This is a crucial process in the formation of floodplain habitat as features such as ephemeral pools, important to macroinvertebrates and amphibians, and backwater channels are not formed or maintained without occasional floodplain inundation.

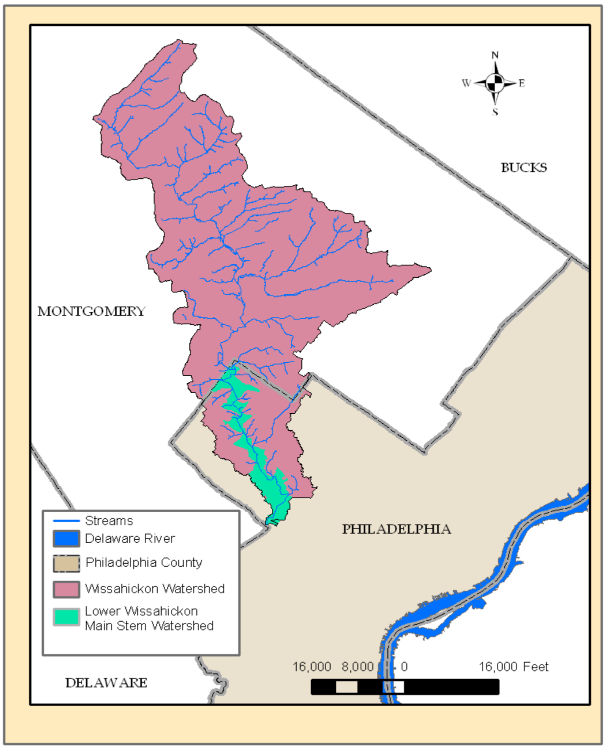
3.2.7.6.2.4 FLOODPLAIN ENCROACHMENT

Scores for the *Floodplain Encroachment* parameter were generally very low with a mean watershed score of 5/20 which was rated as "poor." The mean score for the large Lower Wissahickon tributaries was considerably higher and was rated as "marginal." The major floodplain encroachment in the watershed was Lincoln Drive which runs along the DSL side of the Monoshone Creek corridor. The reach least affected by Lincoln Drive was WSMO02, which had a score of 8.5/20 and was rated as "marginal." There was a trend where the scores for this parameter decreased in the downstream direction as both Lincoln Drive (DSL) and Forbidden Drive (DSR) impinged upon the floodplain in the downstream-most reach WSMO06.

3.3 Main Stem Lower Wissahickon Watershed and Reach Characteristics

The main stem Lower Wissahickon Creek was defined as the main stem of Wissahickon Creek extending from Northwestern Avenue downstream to the confluence with the Schuylkill River. In the subsequent sections, "All Reaches Average" refers to the average main stem Lower Wissahickon score for the respective metric.

3.3.1 Main Stem Lower Wissahickon Watershed and Reach Characteristics



The Lower Wissahickon main stem is considered the main stem within Philadelphia City Limits. The headwaters of the Wissahickon main stem originate just below a parking lot at the Montgomeryville Mall complex in Montgomery Township. The main stem then flows for approximately 19 miles before entering into Philadelphia County where it is known as the Lower Wissahickon main stem. The Lower Wissahickon main stem then travels approximately 7.65 miles before reaching its confluence with the Schuylkill River. Both the valley floor and channel have been substantially impacted by past and current land use within the watershed.

The Lower Wissahickon main stem watershed is approximately nine square miles. Major land use types within the watershed (Figure 3-93) include: wooded (23%), residential – single family detached (22%), residential – row home (6%), and recreation (3%). The Lower Wissahickon main stem is surrounded by Fairmount Park on both sides for the entire length.

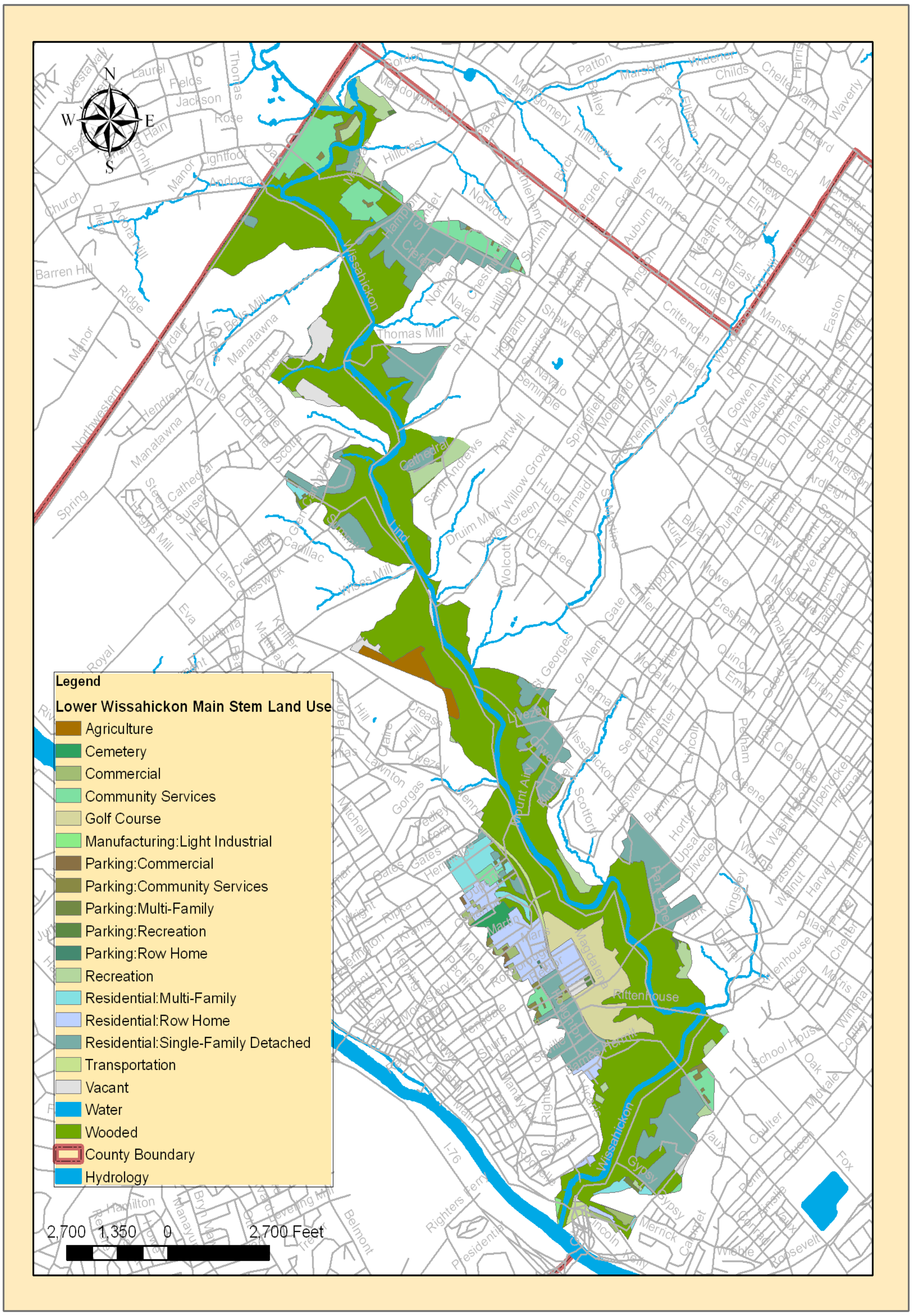


Figure 3-93: Land Use in the Lower Wissahickon Main Stem Watershed

3.3.1.1 GEOLOGY

The majority of the Lower Wissahickon main stem watershed is underlain by the Wissahickon Formation (Figure 3-94). The Wissahickon Formation consists of mica schist, gneiss and quartzite. The exposed schist near the surface is highly weathered. The Wissahickon Formation is also comprised of metamorphosed sedimentary rocks.

There are two bands of the Chickies Formation and the Felsic Gneiss Formation located at the top of the watershed. The Chickies Formation is composed of quartzite and quartz schist. This formation has good surface drainage. The Felsic Formation consists of metamorphic rocks that are resistant to weathering but still show good surface drainage.

There are small sections of the Ultramafic Gneiss Formation located in the center as well as the northern portion of the watershed. This formation consists of highly resistant rocks with good surface drainage. There is a small section of the Pennsauken Formation in the southern portion of the watershed. This formation is composed mostly of quartz, quartzite and chert. These rocks are deeply weathered. Then there is a small section of the Bryn Mawr Formation at the southern tip of the watershed. The Bryn Mawr Formation is made up of deeply weathered gravel and sand.

3.3.1.2 SOILS

According to the National Resource and Conservation Service Soil Survey, the majority of soils for the Lower Wissahickon main stem watershed are classified as hydrologic group B (Table 3-97). These soils have a moderate rate of infiltration when the soils are wet (0.50-1.00 in/hr). Water movement through these soils is considered moderately rapid. There is a small band of group D soils along the northern portion of the Lower Wissahickon main stem (Figure 3-95). These soils have a very slow rate of infiltration when saturated (0.02-0.10 in/hr) resulting in a high runoff potential. There are small sections of C soils located throughout the watershed. Group C soils have a slow rate of infiltration when saturated (0.17-0.27 in/hr). Water movement through these soils is moderate or moderately slow. The northern and southern portions along the main stem are underlain by the Urban Land soils. Urban soils consist of material that has been disturbed by human activity during urbanization. Urban soils have been produced by mixing, filling and contamination of the native soils in both urban and suburban areas.

Table 3-97: Distribution of NRCS Soil Types in Lower Wissahickon Main Stem Watershed

Group	Area (ft^2)	Percent of Total Area
B	222,051,456	88.43%
C	7,527,168	3.0%
D	1,756,339	0.7%
Urban and Made Land	19,570,636	7.8%
Total Area	**250,905,600**	**100%**

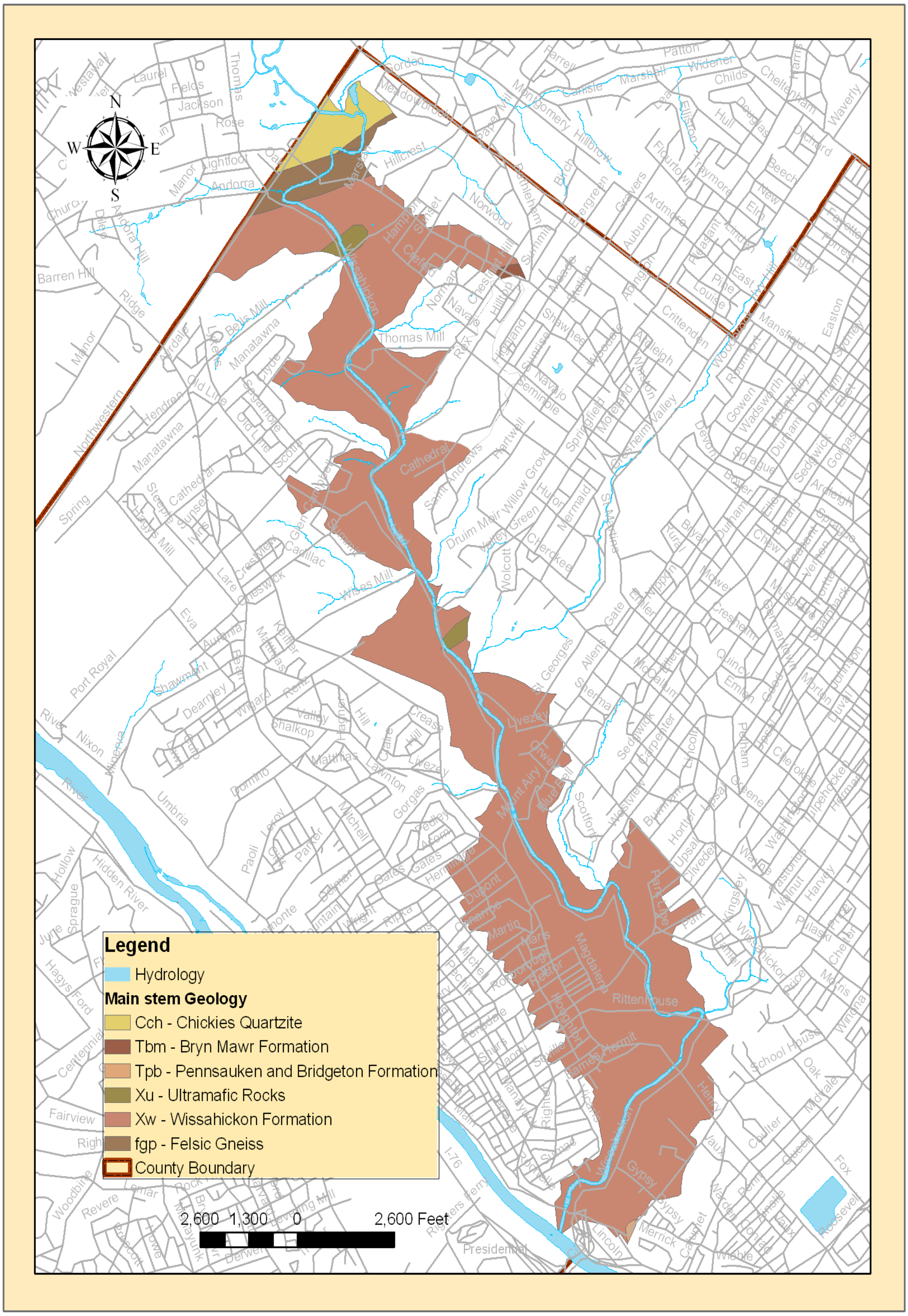


Figure 3-94: Geology of Lower Wissahickon Main Stem Watershed

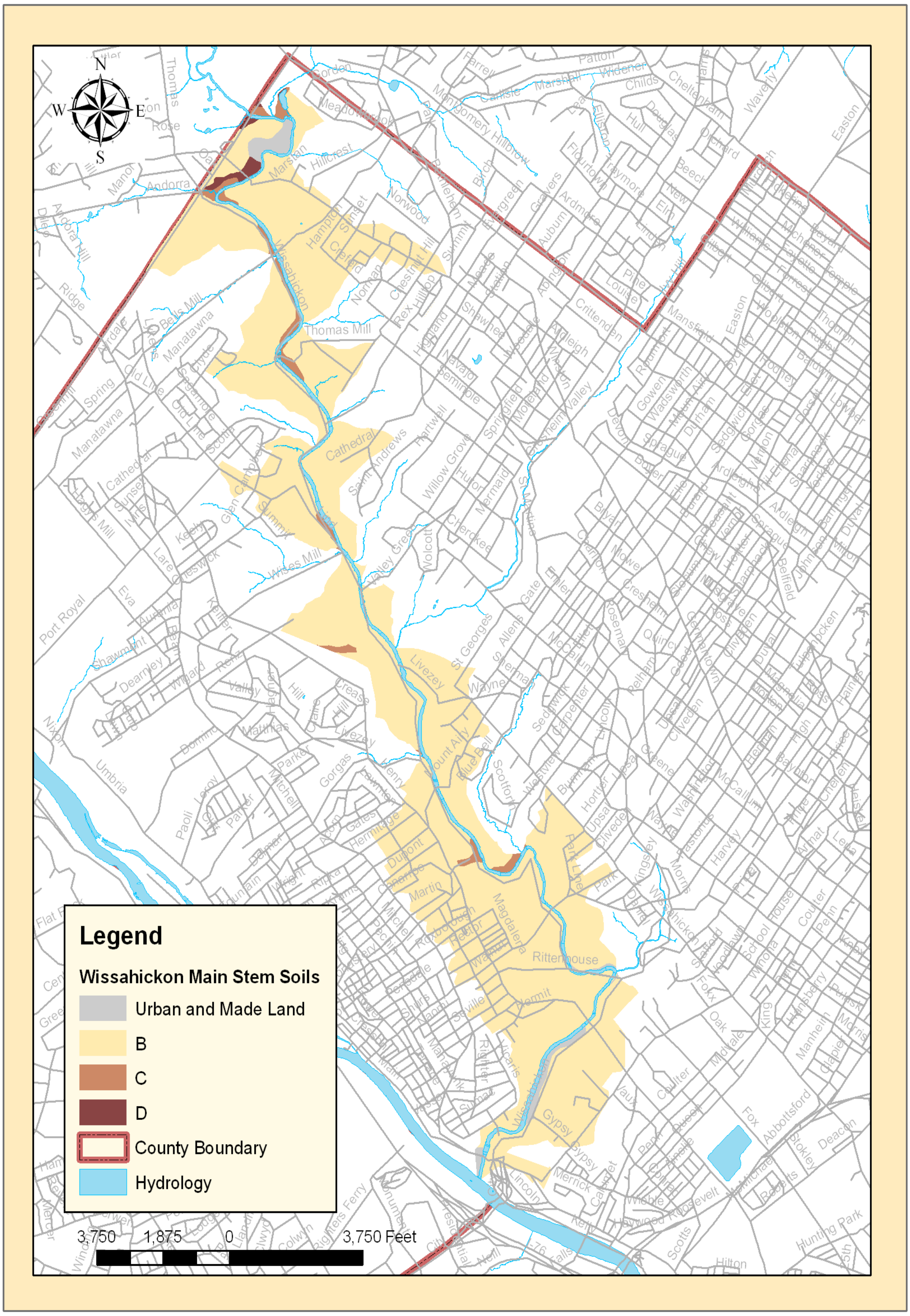


Figure 3-95: Distribution of NRCS Soil Types in Lower Wissahickon Main Stem Watershed

3.3.1.3 BANK EROSION

Refer to section 3.3.1.6.1.3

3.3.1.4 INFRASTRUCTURE TRACKDOWN SUMMARY

The infrastructure assessment of the main stem of Wissahickon Creek illustrates some of the anthropogenic impacts associated with development - both within the stream channel as well as the riparian corridor. These impacts are still quite evident although the main stem of Wissahickon Creek flows within Fairmount Park for the entirety of its length. The main stem channel itself is buffered by Park land, however, its watershed is heavily developed. The high degree of urbanization within the Wissahickon Creek watershed, as well as past land-uses, has resulted in the construction of multiple infrastructure elements. Many of which affect the timing, duration and magnitude of high and low flows within the main stem channel as well as the channel's sediment transport regime. Such infrastructure elements include bridges, dams, stormwater outfalls, channels, etc. Understanding the relationship between development, drainage area, stream hydraulics, and infrastructure constitutes the rationale behind conducting infrastructure assessments.

The Wissahickon Creek main stem possesses many infrastructure elements of a detrimental nature to the hydraulic function of the stream. The most recognizable of these are stream crossings such as culverts, bridges, dams, and pipes. These obstructions control the hydraulic grade line of the creek and render it incapable of transmitting the bulk of the bedload sediment and flow to downstream reaches as it should. The main stem has six dams (Thomas Mill and mill race, Magargee, Livezy, Little Ridge and Big Ridge dams). Some of the dams were once mill dams, but are no longer of importance for industrial use, but have historic significance. These upstream mill dams are major impediments to the flow of sediment and water, and are impediments to fish migration into the upstream tributaries of Wissahickon Creek.

All of the dams on the Wissahickon main stem are quite large. An example is Thomas Mill Dam (WSdam119) in reach WSMS108 which is 150 feet across and 5 feet high. Similarly, pipe crossings such as WSpip004 in reach WSMS120 also serve as formidable obstructions. WSpip004 is only 0.5 feet above of the stream bed, but it still creates enough of an obstruction that it hinders sediment transport and the upstream movement of some aquatic species. It has a dam-like effect although to a much lesser extent than the dams on the main stem.

The large bridges on the main stem channel also affect stream hydraulic function. Bridge abutments along stream banks constrict stream flow, which in turn can cause increased deposition upstream of the abutments and scour downstream. Several of the downstream bridges completely span the valley such as the Henry Avenue Bridge (WSbri311). Bridges that span that much distance have less of an effect on the hydraulic capacity of the stream, but still contribute runoff. There are a total of 16 bridges crossing the main stem, most of which alter stream function to some degree.

All of the culverts associated with the main stem are associated with Forbidden Drive to either convey trail drainage near the creek or to convey tributaries that contribute flow to the Wissahickon beneath the trail system. None of the culverts are within the main channel of Wissahickon Creek as most end near the confluence of tributaries' and the main stem channel.

Two large sanitary sewers run parallel to the Wissahickon Creek main stem. They are the Wissahickon Low Level and High Level Interceptors. The Wissahickon High Level Interceptor extends from Rex Avenue to Lincoln Drive along the downstream left side of the creek. This sewer starts as a 15-inch pipe at Rex Avenue. As the High Level Interceptor approaches the confluence of Wissahickon Creek and Monoshone Creek (WSconf172) its diameter is 60 inches. The diameter increases to 72-inches after merging with 42-inch Monoshone Interceptor which is situated east of Monoshone Creek. The High Level Interceptor crosses each of the eastern tributaries along its alignment and in a few cases necessitated additional infrastructure development such as culverts which were constructed to protect the pipe and convey tributary flow beneath it.

The Low Level Interceptor starts at the county-city boundary at Northwestern Avenue in Germantown. Due to the meandering of the stream the interceptor crosses below the stream a few times before staying on the downstream right side from just downstream of Bells Mill to the Blue Stone Bridge (WSbri313) where Forbidden Drive crosses the stream about 1,500 feet downstream of Walnut Lane. Just upstream of WSbri313, the Low Level Interceptor enters into a siphon, which conveys the interceptor beneath the main stem channel. At Northwestern Avenue the pipe is 20 inches in diameter and reaches 42 inches at Lincoln Drive and then 54 inches when it turns left and follows Ridge Avenue near the confluence with the Schuylkill River.

Outfalls are one of the most notable pieces of infrastructure along the main stem of Wissahickon Creek. With a large amount of impervious surface within the drainage area, the outfalls contribute a significant quantity of flow to the creek. Several of the outfalls are large, at or over three feet in diameter, and one is 9 square feet (WSout591). The main stem has a total of 33 outfalls along its banks with a total outfall area of 99.85 square feet. These outfalls all convey stormwater runoff from the areas adjacent to the creek. These outfalls can be detrimental to the stream's health and function. Combined with the tributaries that also contribute flow and sediment, the Wissahickon main stem takes on a tremendous influx of stormwater flow and sediment.

In an effort to prevent the continued erosion of the banks and protect infrastructure channels were built along parts of the stream. Reaches WSMS116 and WSMS136 were most impacted at 8% and 16% channelized respectively. The channels may prevent erosion over their lengths, but they can create local scour upstream and downstream. This was escalated by the fact that the channels create smooth banks that did nothing to dissipate the energy of the high flows. Furthermore, the channels disconnected the stream from its floodplain and provided poor habitat.

Reach WSMS136 had the largest amount of infrastructure in the Lower Wissahickon main stem. This is due to its proximity to Lincoln Drive which runs parallel to the stream. WSMS136 had the highest amount of several types of infrastructure. The reach had the most bridges and outfalls, and outfall area. It was tied with a few other reaches for the most culverts, channels, and dams. It also had the longest channelized length within the watershed and the highest percentage of channelization. These statistics should be somewhat expected given that WSMS136 was more than 2,000 feet longer than any other reach on the main stem in the Lower Wissahickon.

There were four pieces of infrastructure identified as being in poor condition along the main stem of Wissahickon Creek. They were WScha143 and in WSMS102, and WScha146 in WSMS114, and WScul122 in reach WSMS120. Also WSpip04, a 20-inch water main, in section WSMS120, appeared to be in good condition, but was exposed by the creek.

Table 3-98: Lower Wissahickon Creek Main stem Infrastructure Point Features

Section ID	Culvert Count	Bridge Count	Outfall Count	Channel Count	Conflu-ence Count	Dam Count	Manhole Count	PipeSewer Count	Other Count	Infra Point Count	Combined Outfall Area (ft^2)
WSMS102	0	2	2	3	5	0	1	0	0	8	10.2
WSMS104	0	1	3	0	2	0	0	0	1	5	10.6
WSMS106	0	0	1	0	1	0	0	0	0	1	1.8
WSMS108	1	2	1	0	1	2	0	0	0	6	1.8
WSMS110	0	1	1	0	2	0	0	0	0	2	0.8
WSMS112	2	0	1	0	3	0	0	0	0	3	3.1
WSMS114	0	0	0	1	2	1	0	0	0	2	0.0
WSMS116	0	1	2	1	1	0	0	0	0	4	4.9
WSMS120	2	0	3	0	3	1	3	1	0	10	12.9
WSMS122	0	0	0	0	2	0	0	0	0	0	0.0
WSMS124	2	1	3	0	2	0	0	0	0	6	13.1
WSMS126	0	0	1	0	0	0	0	0	0	1	7.1
WSMS128	0	1	0	0	1	0	0	0	0	1	0.0
WSMS130	1	0	0	0	2	0	0	0	0	1	0.0
WSMS132	1	1	0	0	1	0	0	0	0	2	0.0
WSMS134	1	1	3	0	1	0	0	0	0	5	14.3
WSMS136	2	5	12	2	4	2	0	0	0	23	19.2
TOTAL	**12**	**16**	**33**	**7**	**33**	**6**	**4**	**1**	**1**	**80**	**99.9**

Table 3-99: Lower Wissahickon Creek Main Stem Infrastructure Linear Features

Section ID	Total Segment Length (ft)	Total Segment Length (ft), 3 sides	Culvert Length (ft)	Percent Culverted	Channel Length (ft), 1 side	Channel Length (ft), 2 sides	Channel Length (ft), 3 sides	Total Channel Length (ft)	Percent Channelized
WSMS102	6050	18150	0	0	143	0	0	143	1
WSMS104	2102	6306	0	0	0	0	0	0	0
WSMS106	1620	4860	0	0	0	0	0	0	0
WSMS108	2006	6018	0	0	0	0	0	0	0
WSMS110	1502	4506	0	0	0	0	0	0	0
WSMS112	2044	6132	0	0	0	0	0	0	0
WSMS114	2315	6945	0	0	93	0	0	93	1
WSMS116	1654	4962	0	0	405	0	0	405	8
WSMS120	2549	7647	78	3	0	0	0	0	0
WSMS122	2001	6003	0	0	0	0	0	0	0
WSMS124	1732	5196	100	6	0	0	0	0	0
WSMS126	1642	4926	0	0	0	0	0	0	0
WSMS128	1446	4338	0	0	0	0	0	0	0
WSMS130	1342	4026	31	2	0	0	0	0	0
WSMS132	1288	3864	35	3	0	0	0	0	0
WSMS134	1840	5520	51	3	0	0	0	0	0
WSMS136	7570	22710	60	1	3366	112	0	3590	16
TOTAL	**40703**	**122109**	**355**	**1**	**4007**	**112**	**0**	**4231**	**3**

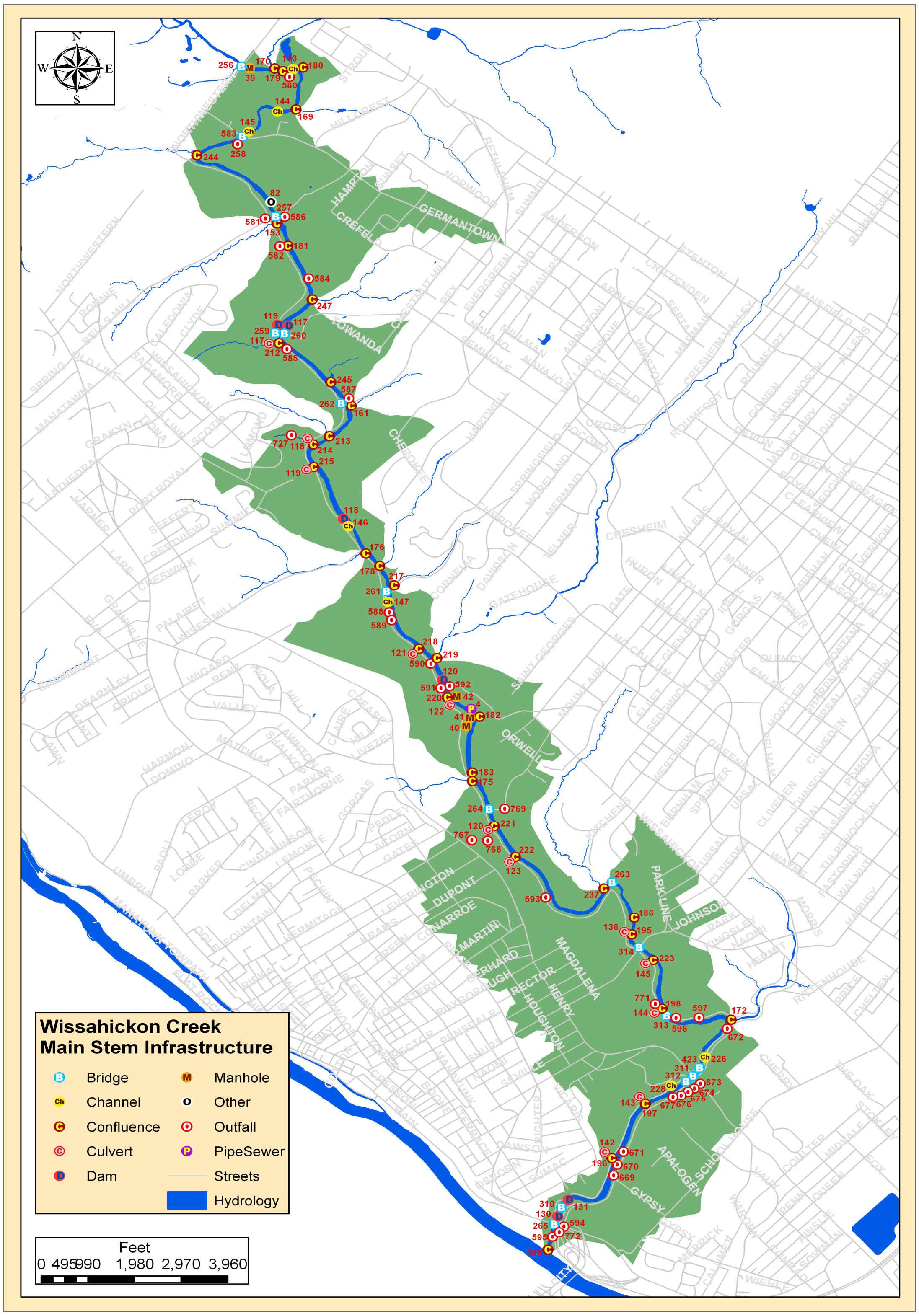


Figure 3-96: Lower Wissahickon Creek Main Stem Infrastructure Locations

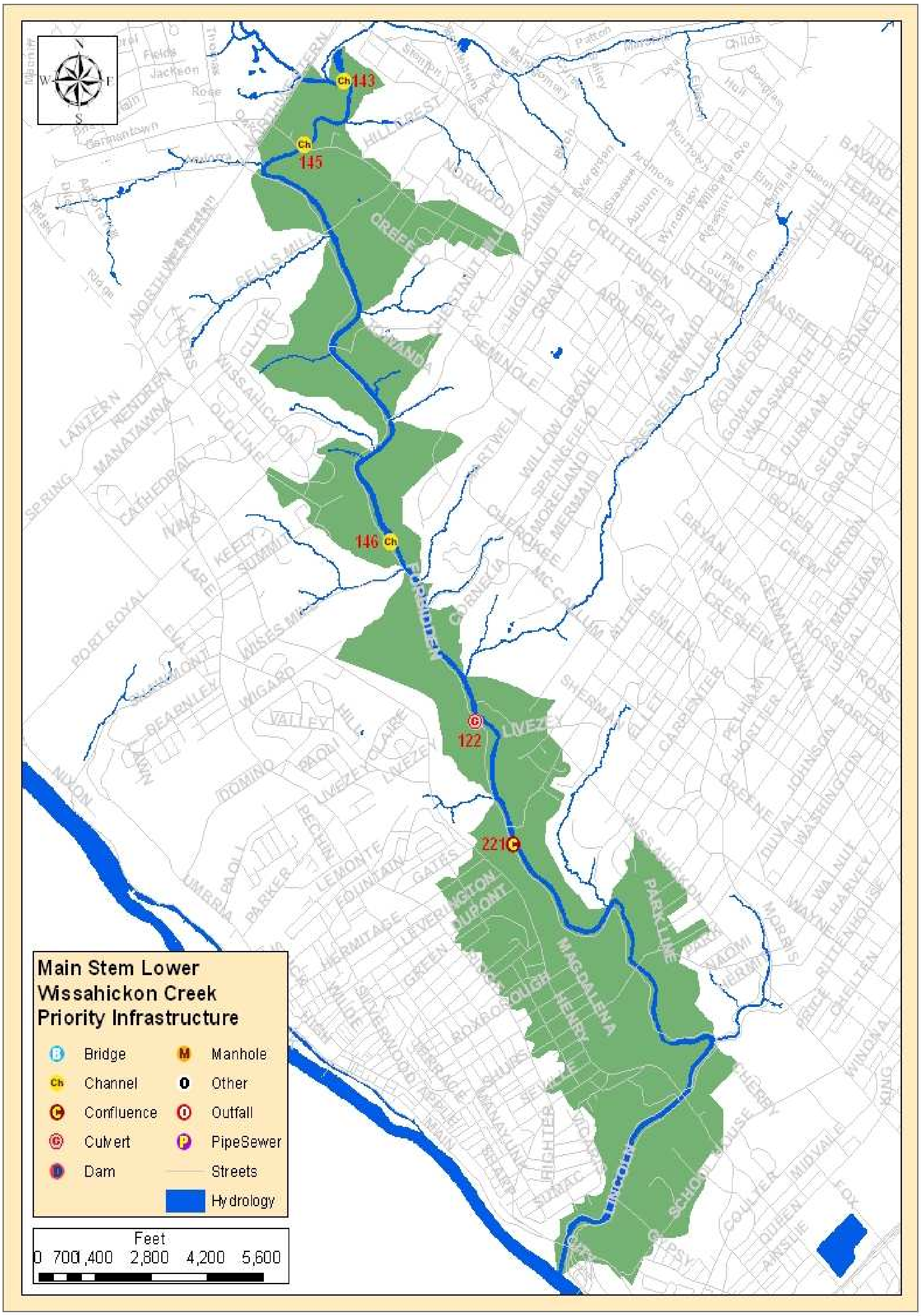


Figure 3-97: Lower Wissahickon Creek Main Stem Priority Infrastructure Locations

3.3.1.5 UNIFIED STREAM ASSESSMENT RESULTS FOR THE LOWER WISSAHICKON MAIN STEM WATERSHED

The Lower Wissahickon main stem channel began at WSbri256 at Northwestern Avenue and was a moderately sinuous channel until it reached the confluence with the Schuylkill River about 500 feet south of Ridge Avenue in reach WSMS136. The Lower Wissahickon main stem channel had a relatively shallow gradient with a 0.23% water surface slope (Appendix A).

The main stem channel was divided into 17 reaches sharing two distinct channel morphology forms. The upstream reaches (WSMS102-WSMS116) were Rosgen type B3c or B4c channels with the exception of WSMS108 which was classified as an F3 channel. The downstream reaches (WSMS120-WSMS136) had either F3 or F4 type channel morphology with the exception of WSMS126, which was classified as a B3c channel type. With the exception of the two upstream-most reaches, the main stem channel was dominated by cobble substrate.

Estimated bankfull flows within the Lower Wissahickon main stem channel exhibited substantial variability whereas discharge was not found to increase along the conventional longitudinal gradient. There is evidence that supports the notion that the main stem Wissahickon Creek is “a losing stream” whereas in some reaches, there is a net export of surface water to the groundwater table. This is a process most likely influenced by the intricacies of the karst geology underlying portions of the main stem channel.

The Center for Watershed Protection’s (CWP) Unified Stream Assessment Methodology (USAM) was used to score and rate the instream, riparian buffer and floodplain conditions of the stream corridor to allow for comparison to other reaches and watersheds within the Lower Wissahickon Basin.

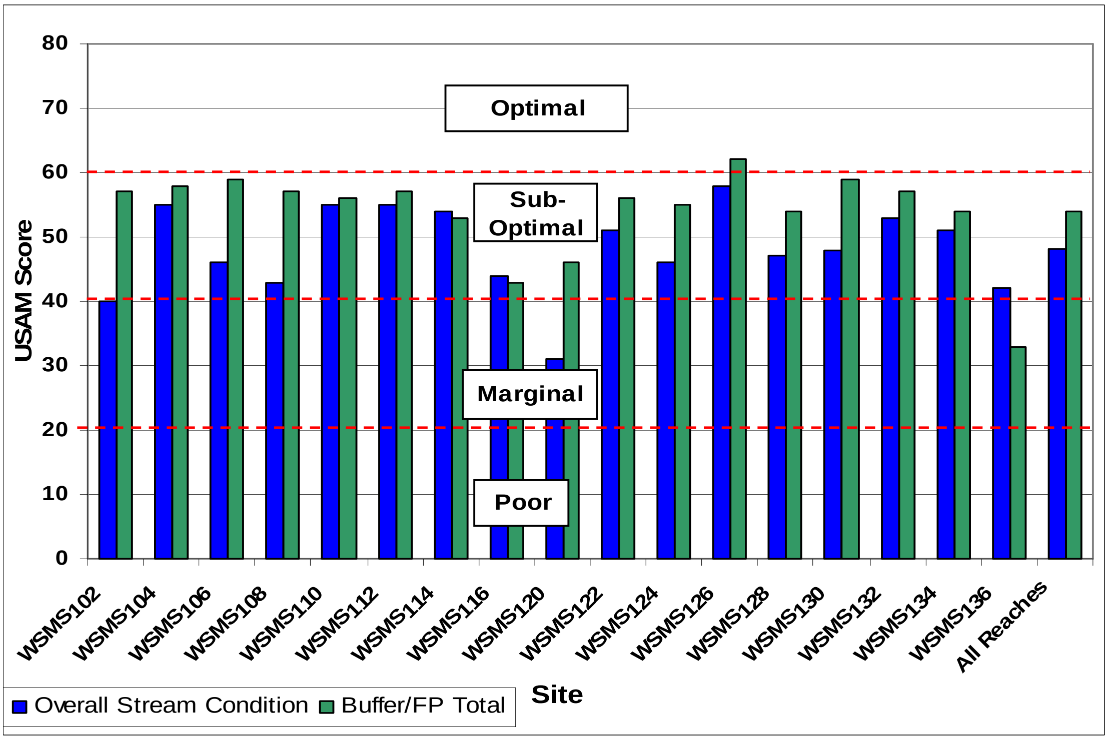


Figure 3-98: Results for Lower Wissahickon Main Stem USAM Components

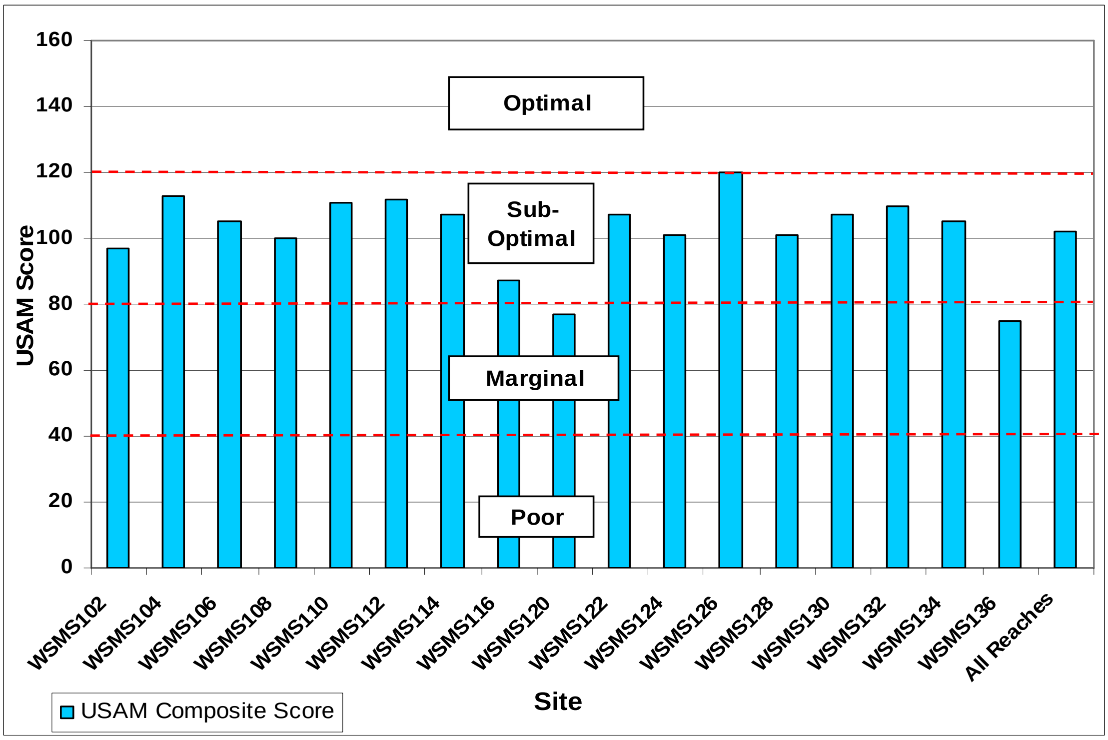


Figure 3-99: Lower Wissahickon Main Stem USAM Results

3.3.1.5.1 WSMS102

Reach WSMS102 began at WSbri256 at Northwestern Avenue, which marks the boundary between Philadelphia and Montgomery counties. The downstream boundary of the reach was situated about 1000 feet downstream of the confluence with a large unnamed tributary that spans both Philadelphia and Montgomery County. Nestled within the large, upstream meander's belt width was the campus of Chestnut Hill College, which along with the Morris Arboretum comprised the only developed land cover abutting either side of the reach.

The main stem channel in reach WSMS102 had confluences with Papermill Run (WSconf170), a small stream draining a large impoundment (WSconf142), Hillcrest Run (WSconf169) and at the downstream end of the reach the aforementioned unnamed tributary (WSconf214). The reach was classified as a B4c type channel with a moderate degree of entrenchment (ER=1.7), gravel-dominated substrate (71%) and a very shallow gradient (0.25%).

3.3.1.5.2 WSMS104

Reach WSMS104 was approximately 2,100 feet in length and was bisected by Bell's Mill Road towards the downstream half of the reach. There were relatively few infrastructure elements within the reach, with the largest being the Bell's Mill Road bridge (WSbri257) and the confluence with Bell's Mill Run (WSconf153) which was about 120 feet downstream of the Bell's Mill Road bridge. There were three outfalls within the reach (WSout581, WSout586 and WSout582) - two provided drainage to WSbri257 and the third (WSout582) provided drainage to Forbidden Drive on the DSR side of the reach.

In reach WSMS104, the main stem was classified as a Rosgen type B4c channel and was similar to WSMS102 in some respects. Like WSMS102, reach WSMS104 had a moderately shallow gradient (0.25% water surface slope), moderate entrenchment ratio (ER=1.8) and a gravel-dominated substrate (54%); however, the estimated bankfull discharge within reach WSMS104 (3,093.7 cfs) was more than double that of the estimated bankfull discharge in reach WSMS102 (1533.7 cfs). This discrepancy may speak to the difference in cross sectional area between the two reaches, the uncertainty associated with identifying bankfull indicators in urban systems, karst geology and "losing streams" or aspects of each of these potential explanations.

3.3.1.5.3 WSMS106

Reach WSMS106 was approximately 1,600 feet in length and contained only two infrastructure elements within the reach, an 18-inch outfall (WSout584) and a pedestrian footbridge over Thomas Mill Run. The land cover within the areas immediately adjacent to the reach was forested with the exception of Forbidden Drive. The confluence of the main stem Lower Wissahickon channel and Thomas Mill Run (WSconf247) was a few hundred feet downstream of the WSMS106 cross section (Appendix C).

Reach WSMS106 was similar to the upstream reaches WSMS102 and WSMS104 in regards to gradient; however, the WSMS106 reach had a slightly higher degree of connection to the floodplain (ER=2.0) and was dominated by cobble substrate (48%) such that the channel was classified as a B3c stream.

3.3.1.5.4 WSMS108

Reach WSMS108 was approximately 2,000 feet in length and occupied the meander between Thomas Mill Run and Cathedral Run. There were relatively few infrastructure elements within the reach although many were significant both historically and in terms of size. The historic Thomas Mill Dam (WSdam119) and the dam's mill race (WSdam117) were located in this reach. There was also a large mid-channel island formed from historic deposition along the inside of the meander. Upon this mid-channel island rested the abutments of another historic feature, the Thomas Mill Road Covered Bridge (WSbri259), which was built in 1737 to connect the Chestnut Hill and Roxborough communities ("Bridges", Friends of the Wissahickon). Approximately 175 feet downstream of WSbri259, an unnamed tributary (2,000 feet in length) reached its confluence (WSconf212) with the main stem channel after passing beneath Forbidden Drive through a culvert (Wscul117).

Reach WSMS108 represented a change in channel type from the upstream Rosgen type "B" channels to an F3 channel type. The reach had a higher degree of entrenchment (ER=1.3) and a steeper gradient (0.35%) than the upstream channels (WSS=0.25%), most likely a product of the elevated water surface caused by WSdam119. Another characteristic of this reach that was likely a product of the dam is the coarse, armored streambed. There was a relative paucity of fine grained sediment downstream of the dam and an abundance of large cobble (59%). The D_{50} in the reach was 84.5 mm and represented the third largest D_{50} among all Lower Wissahickon main stem reaches. Reach WSMS108 also contained the largest proportion of bed rock (5%) among all Lower Wissahickon main stem reaches.

3.3.1.5.5 WSMS110

Reach WSMS110 was approximately 1,500 feet in length and had only two infrastructure elements associated with the main stem channel. There were two confluences with small tributaries in the reach. A small unnamed tributary (1,100 feet in length) came to a confluence (WSconf245) with the main stem channel about 200 feet downstream of the beginning of the reach. Approximately 650 feet downstream from WSconf245, Rex Avenue Run reached its confluence (WSconf161) with the main stem channel. The only structural infrastructure elements were the Rex Avenue Bridge (WSbri262) and an outfall (WSout587) which received stormwater runoff from Rex Avenue.

Reach WSMS110 was classified as a B3c stream channel. The substrate was dominated by cobble (55%) although the D_{50} was only 32.6 mm, which is within the coarse gravel substrate size class. The channel was slightly entrenched, with an entrenchment ratio of 1.9, Relative to the reaches both upstream and downstream of WSMS110, the reach had a very shallow gradient. The water surface slope was 0.17% compared to the steeper gradients observed upstream in WSMS108 (0.35%) and downstream at WSMS112 (0.32%).

3.3.1.5.6 WSMS112

Reach WSMS112 was approximately 2,050 feet in length not including the three tributaries that reach a confluence with the main stem channel in the reach. The reach was classified as a B3c type channel and was a relatively stable reach aside from the moderate to severe localized erosion and scour. This reach had the highest degree of floodplain connectivity amongst all the Lower Wissahickon main stem reaches. The substrate was dominated by cobble (50%) and gravel (40%) and had a D_{50} of 74.2 mm which corresponds to the small cobble substrate size class.

There were no infrastructure elements along the main stem; likewise, no development or manmade structures abutted the reach with the exception of Forbidden Drive on the DSR side of the channel. The upstream-most confluence was Cathedral Run followed by a small (approximately 950 feet) unnamed tributary that reached its confluence with the main stem 370 feet downstream of the Cathedral Run confluence. Both of these tributaries have outfalls that receive stormwater from the Roxborough neighborhood bounded by Cathedral Road to the north and west and Glenroy and Chippewa Roads to the south. WSout727, which was included in the infrastructure assessment of WSMS112 discharges stormwater to the aforementioned small unnamed tributary. The downstream-most tributary was a very small unnamed spring. The two small tributaries pass through culverts beneath Forbidden Drive as they approach the main stem channel. These culverts (WScul214 and WScul215) were included within the WSMS112 infrastructure assessment.

3.3.1.5.7 WSMS114

Reach WSMS118 was one of the longest reaches at 2,315 feet in length. There was no development of man-made structures that abutted the main stem channel with the exception of Forbidden Drive. There were only two infrastructure elements within the reach, although they had significance in that they were large and had considerable upstream and downstream impacts. The historic Magargee Dam (WSdam118) was situated at the upstream end of the reach. About 140 feet downstream of the dam, the main stem was channelized (WScha145) for 80 feet on the DSR side of the channel. The tributaries, Wise's Mill and Hartwell Run reached confluences (WSconf176 and WSconf178 respectively) with the main stem channel in WSMS114.

Reach WSMS114 was very similar to reach WSMS112 in slope, dimension and substrate composition; likewise, it was also classified as a B3c type channel. Reach WSMS114 was more entrenched than WSMS112 with an entrenchment ratio of 1.7. The substrate in the reach was composed mainly of cobble (53%) and gravel (40%) with a D_{50} of 72.1 mm which corresponds to the small cobble substrate size class.

3.3.1.5.8 WSMS116

Reach WSMS116 began about 200 feet upstream of the Valley Green Bridge (WSbri261) and extended 1000 feet downstream of the historic Valley Green Inn for a total reach length of 1,650 feet. Just upstream of the bridge, Valley Green Run reached its confluence (WSconf217) with the main stem channel. Reach WSMS116 was one of the more developed reaches with the Lower Wissahickon main stem, though most development was centered around the Inn. Aside from the bridge, there was also a parking lot adjacent to the main stem channel (DSR) as well a 405-foot stone retaining wall (WScha17).

Reach WSMS116 was very similar to reach WSMS110 in that it was a B3c type channel with a water surface slope (WSS=0.13%) much lower than the reaches upstream and downstream of it. The two reaches also had almost identical substrate composition with 55% cobble and 40% gravel although WSMS110 had more boulders and bedrock outcrops whereas there was no bedrock in WSMS116. The D_{50} in WSMS116 was 71mm which corresponds to the small cobble substrate size class.

3.3.1.5.9 WSMS120

Reach WSMS120 was a rather large reach at just over 2,550 feet in length. There were a total of four confluences within the reach, with the largest being the Cresheim Creek confluence (WSconf219) with the main stem channel. The other three confluences were very small brooks that originated as springs on the valley walls of the Lower Wissahickon. A large portion of the reach was within the Livezy Dam (WSdam120) impoundment, thus the WSMS120 riffle cross section was about 975 feet downstream of the dam. Near the riffle was the Upper Roxborough transmission gravity main (WSpip004) which crossed the main stem channel just upstream of the riffle cross section.

The main stem channel downstream of the dam was classified as an F3 channel. As such, much of the channel was deeply entrenched and disconnected form the floodplain. The entrenchment ratio (1.2) in reach WSMS120 was the second worst among all the Lower Wissahickon main stem reaches. The substrate distribution was dominated by cobble (52%) although there was a considerable amount of gravel (43%) within the reach as well.

3.3.1.5.10 WSMS122

Reach WSMS122 was approximately 2,000 feet in length. There was no infrastructure along the reach although there were two confluences (WSconf175 and WSconf183). A small brook (approximately 650 feet in length), which originated at the base of a swale reached its confluence (WSconf183) with the main stem 300 feet upstream of the WSMS122 cross section. Approximately 200 feet downstream of WSconf183, Gorgas Run reached its confluence with the main stem (Wsconf175).

Reach WSMS122 had some similarity to reach WSMS120. Both reaches were classified as deeply entrenched (ER=1.2) Rosgen type F3 channels and had similar substrate distributions.

3.3.1.5.11 WSMS124

Reach WSMS124, one of the least sinuous reaches along the Lower Wissahickon main stem was approximately 1,730 feet in length. Aside from the Mount Airy Avenue Bridge (WSbri264), there were no infrastructure elements situated along or within the main stem channel. Four outfalls situated within the reach WSMS124 corridor flowed to the main stem channel and were included in the WSMS124 infrastructure assessment. There were also two culverts (WScul120 and WScul123) which conveyed enough drainage from Forbidden Drive and the adjacent valley wall, to form confluences (Wsconf221 and WSconf222) with the main stem channel.

Reach WSMS124 was similar two the upstream reaches WSMS120 and WSMS124 in dimension and substrate composition. Like the two upstream reaches, it was also a Rosgen type F channel. The substrate distribution was dominated by cobble (49%) in reach WSMS124 although there was a considerable proportion of gravel (45%) throughout the reach. The reach D_{50} was 64mm, which is the threshold dimension between the gravel (2mm - 64mm) and cobble (64mm-256 mm) size classes. The reach was classified as an F4 channel given that very coarse gravel particles (45-64 mm) are more likely to be mobilized given the reduced slope of the reach (WSS=0.10%).

3.3.1.5.12 WSMS126

Reach WSMS126 was approximately 1,640 feet in length and comprised half of the large meander bend that encompasses Fairmount Park's historic Monastery Stables. Aside from the stables, non-forested land cover was scarce with the exception of Forbidden Drive. Infrastructure within the reach was limited to a sole stormwater outfall (WSout593) from Henry Avenue to the west.

Reach WSMS126 was the downstream-most Rosgen type B3c channel type on the Lower Wissahickon main stem. It was the also the last reach in the main stem study area with the potential for moderate levels of floodplain access at flows in excess of bankfull with an entrenchment ratio of 1.5. The substrate distribution was dominated by cobble (54%) and had a relatively abundant proportion of boulders (7%).

Downstream of reach WSMS126 the remainder of the Wissahickon main stem was a Rosgen type F channel with relatively high width to depth ratios (16.9-24.7).These high width to depth ratios were associated with relatively low shear stresses which may ultimately preclude the transport of boulders in the downstream-most reaches. The diminished competency of the downstream reaches to move boulders was further supported by the observations of the boulder distributions upstream and downstream of reach WMMS126. Upstream of reach WSMS126, boulders comprised an average of only 3% of the substrate distribution (reaches WSMS102-WSMS124); however, downstream of reach WSMS126, boulders comprised an average of 10.4% of the substrate distribution (reaches WSMS1280-WSMS36).

3.3.1.5.13 WSMS128

Reach WSMS128 was approximately 1,445 feet in length. The only infrastructure within the reach was the Kitchen's Lane Bridge (WSbri263) which links Kitchen's Lane with Forbidden Drive. Kitchen's Lane reached its confluence (WSconf237) with the main stem channel 150 feet upstream of the bridge.

Reach WSMS128 was classified as an F3 stream channel. The channel was deeply entrenched and characterized by extremely coarse substrate. The cobble-dominated reach was distinct from other main stem reaches in that it had the highest percentage (59%) of cobble and boulder (13%) substrate and the largest D_{50} at 109.2mm (medium cobble).

3.3.1.5.14 WSMS130

Reach WSMS130 was approximately 1,340 feet in length. The surrounding land cover was completely forested and there were no significant infrastructure elements within the reach. A very small, unnamed tributary reached its confluence (WSconf186) with the main stem channel 100 feet upstream from the WSMS130 cross section. Farther downstream another very small unnamed tributary reached its confluence (WSconf195) with the main stem channel after flowing through a culvert (WScul136) under Forbidden Drive.

Reach WSMS130 was classified as an F3 channel. As was observed in the upstream reach WSMS128, this reach had a substrate composition dominated by cobble (56%) and boulder (11%). The severely entrenched (ER=1.1) reach was relatively steep (WSS=0.31%) compared to the three reaches immediately downstream of WSMS130, which had water surface slopes between 0.13-0.15%.

3.3.1.5.15 WSMS132

Reach WSMS132 was approximately 1,290 feet in length. At the upstream end of the reach was the Walnut Lane Bridge (WSbri22) which comprised the entirety of the infrastructure in the reach. There was a confluence with a small tributary that flowed beneath Forbidden Drive through culvert WScul145 15 feet downstream of the WSMS132 cross section.

Reach WSMS132 was a deeply entrenched F3 stream channel. The substrate composition was dominated by cobble (53%). There was a high percentage of sand (12%) throughout the reach as WSMS132 had the highest relative abundance of sand of all Lower Wissahickon main stem reaches with the exception of WSMS130.

3.3.1.5.16 WSMS134

Reach WSMS134 was approximately 1,840 feet in length. This reach was the last relatively undeveloped reach on the Lower Wissahickon main stem. The most significant infrastructure feature present within the main stem channel was the Blue Stone Bridge trail crossing for Forbidden Drive. There were a total of three stormwater outfalls in the reach, all situated in the vicinity of Forbidden Drive. The upstream-most outfall (WSout771, privately owned) was rather large with a diameter of 4 feet and conveyed stormwater runoff from the Roxborough neighborhood bordered by Henry Avenue and the Walnut Lane Golf Course. The other two outfalls were not connected to the PWD stormwater network, but rather convey overland flow from inlets on Forbidden Drive.

The reach WSMS134 channel was very similar in substrate composition, profile and dimension as the reach WSMS132 channel. Likewise, the channel was classified as an F3 channel type with a substrate composition dominated by cobble (49%) and gravel (31%).

There was also a considerable proportion of boulder (10%) and sand (11%) throughout the reach.

3.3.1.5.17 WSMS136

Reach WSMS136 was the downstream-most reach within the Lower Wissahickon and was by far the longest reach amongst all the main stem reaches at 7,570 feet in length. The reach was the most developed and heavily impacted reach along the Wissahickon. Near the top of the reach, Monoshone Creek reached its confluence with the main stem channel (WSconf178) as the channel alignment followed a sharp meander that put the channel parallel with Lincoln Drive in the historic Rittenhouse Town area. Here the main stem channel was channelized (WScha228 on the DSR and WScha226 on the DSL) for over 3,500 feet along Lincoln Drive. Other large structures included the Henry Avenue and Ridge Avenue Bridges (WSbri310 and WSbri311 respectively) as well as the two Ridge Avenue Dams (WSdam130 and WSdam131).

The WSMS136 riffle cross section was purposely located upstream from the numerous bridges and dams which significantly altered the sediment regime and flow conditions of the channel, thus the results of the fluvial geomorphic study reflected upstream conditions in WSMS136 more so than downstream conditions. WSMS136 had a strong semblance to all the main stem reaches downstream of WSMS126 in terms of substrate composition, dimension and stream type.

3.3.1.6 SUMMARY OF UNIFIED STREAM ASSESSMENT RESULTS

The mean scores for the *Overall Buffer and Floodplain Condition*, *Overall Stream Condition*, and composite USAM score were classified as “suboptimal” (Table 3-100). Average conditions within the Lower Wissahickon main stem’s buffers and floodplains (53.9/80) were slightly better than conditions observed within the stream channels (48.2/80). The scores for individual parameters ranged from poor to optimal, displaying similar levels of variability between reaches.

Table 3-100: USAM Results for the Lower Wissahickon Main Stem

Reach ID	Sub-watershed	Overall Stream Condition	Overall Buffer/FP Condition	USAM Score
WSMS102	Main stem	40	57	97
WSMS104	Main stem	55	58	113
WSMS106	Main stem	46	59	105
WSMS108	Main stem	43	57	100
WSMS110	Main stem	55	56	111
WSMS112	Main stem	55	57	112
WSMS114	Main stem	54	53	107
WSMS116	Main stem	44	43	87
WSMS120	Main stem	31	46	77
WSMS122	Main stem	51	56	107
WSMS124	Main stem	46	55	101
WSMS126	Main stem	58	62	120
WSMS128	Main stem	47	54	101
WSMS130	Main stem	48	59	107
WSMS132	Main stem	53	57	110
WSMS134	Main stem	51	54	105
WSMS136	Main stem	42	33	75
All Reaches		**48.2**	**53.9**	**102.1**

3.3.1.6.1 SUMMARY OF OVERALL STREAM CONDITION SCORES IN THE LOWER WISSAHICKON MAIN STEM WATERSHED

In general, the mean score for the *Overall Stream Condition* component (48.2/80) was moderately high and fell within the suboptimal range of scores. Within individual reaches, all but two (WSMS102 and WSMS120) were rated as “suboptimal.” The highest score (58/80) was observed in reach WSMS126. Reach WSMS126 had an extensive riparian buffer interrupted only by the presence of Forbidden Drive; furthermore, the only infrastructure within the reach was an outfall (WSout593) which was situated about 100 feet from the channel on the DSR side of the corridor. The reach with the worst score was WSMS120 with a score of 31/80 which was rated as “marginal.’’ The relatively low score for this reach was attributed to the presence of development and infrastructure within the reach. The most adversely influential infrastructure element within the reach was the Livezy Dam (WSdam120) due to the extent of its impoundment. The impoundment had an affect on streamflow and floodplain function for almost 2,500 feet upstream close to the location of the Valley Green Inn. The majority of the reach upstream of the dam contained segments where low velocities deposited fine sediment, thus creating poor instream habitat conditions.

The *Instream Habitat* parameter had very high scores among many of the main stem reaches, as 13 of the 17 reaches were rated as “optimal” with scores greater than 15/20. The presence of stable substrate (cobble and boulder) throughout these reaches was the single-most factor responsible for the habitat conditions observed. The *Floodplain Connection* parameter was the worst-scoring parameter with an average of only 5.1/20 barely above the poor-marginal threshold score of 5/20. Most bank erosion was observed to be localized; however, the lack of floodplain connection (e.g. low entrenchment ratios) was a factor which could exacerbate bank erosion and was characteristic of the vast majority of main stem reaches.

Table 3-101: USAM Overall Stream Condition Scoring for the for Lower Wissahickon Main Stem

OVERALL STREAM CONDITION								
Reach ID	Sub-watershed	Instream Habitat	Vegetative Protection		Bank Erosion		Floodplain Connection	Overall Stream Condition
			Left	Right	Left	Right		
WSMS102	Main stem	13	5	5	5	5	7	40
WSMS104	Main stem	18	7	8	6	8	8	55
WSMS106	Main stem	16	6	4	5	5	10	46
WSMS108	Main stem	18	5	5	6	6	3	43
WSMS110	Main stem	18	7	5	8	8	9	55
WSMS112	Main stem	18	8	4	9	4	12	55
WSMS114	Main stem	19	7	7	7	7	7	54
WSMS116	Main stem	12	5	4	8	8	7	44
WSMS120	Main stem	5	5	5	7	7	2	31
WSMS122	Main stem	19	7	7	8	8	2	51
WSMS124	Main stem	14	8	6	6	9	3	46
WSMS126	Main stem	19	9	7	9	9	5	58
WSMS128	Main stem	19	5	7	5	8	3	47
WSMS130	Main stem	17	7	7	9	7	1	48
WSMS132	Main stem	17	8	8	9	9	2	53
WSMS134	Main stem	19	7	7	9	7	2	51
WSMS136	Main stem	10	6	7	8	8	3	42
All Reaches		**15.9**	**6.6**	**6.1**	**7.3**	**7.2**	**5.1**	**48.2**

3.3.1.6.1.1 INSTREAM HABITAT

Scores for the *Instream Habitat* parameter were relatively high as 13 of 17 reaches were rated as “optimal” with scores greater than 15/20. The main stem mean score (15.9/20) was higher than both the Small Tributary average (15.8/20) as well as the Large Tributary average (13.1/20). Instream habitat in the Lower Wissahickon main stem was characterized by an abundance of stable cobble and boulder habitat features. On average, the main stem reaches had substrate particle distributions containing 49.5% cobble and 5.4% boulder

Four reaches, WSMS114, WSMS122, WSMS126 and WSMS128 has scores of 19/20. Reach WSMS128 was distinguished in that it contained 59% cobble, 13% boulder and a D50 of 109.2 mm. All of these metrics were the highest observed among main stem Lower Wissahickon reaches. The reach with the lowest score was WSMS120, which was rated as “poor” with a score of 5/20. Near the bottom of the reach where the WSMS120 cross section was located, the instream habitat was superb given the abundance of shading and coarse substrate in the form of cobble (52%), boulders (2%) and bedrock outcrops. The upstream two thirds of the reach was heavily impacted by the Livezy Dam (WSdam120) impoundment. Impoundments are characterized by extreme depths and very low velocities such that they create conditions where fine sediment deposition, low dissolved oxygen and high temperature produce suitable habitat for very few species-usually only the most hardy, non-specialized species.

3.3.1.6.1.2 VEGETATIVE PROTECTION

The *Vegetative Protection* parameter reflects the extent to which stream banks are protected by vegetative cover in the form of trees, shrubs and non-woody, emergent macrophytes. In general scores were moderate and ranged from marginal to suboptimal. The highest scores were recorded in reach WSMS132 as both the left and right banks had scores of 8/10 and were rated as “optimal”. Reach WSMS126 also scored well with a score of 9/10 on the left bank and 7/10 on the right bank. Both of these reaches compared well to the main stem averages of 6.6/10 for the left bank and 6.1/10 for the right bank. The lowest scores were recorded in reach WSMS116, with the left bank having a score of 5/10 and the right bank scoring 4/10.

3.3.1.6.1.3 BANK EROSION

Bank Erosion scores along the main stem were rather high considering the high flows that the channel conveys. The scores ranged from marginal to suboptimal with many sites having one bank with a marginal score and the other scoring in the suboptimal range. The main stem averages for the left (7.3/10) and right (7.2/10) banks were rather high and were well within the suboptimal range of scores.

In many sites there were bedrock outcrops and boulder or cobble depositional features that precluded severe erosion, although localized scour was evident in many reaches. Larger substrate particles such as cobbles and boulders have much higher "roughness" than smaller substrate such as gravel, dissipating kinetic energy in the channel during bankfull flow events. There were only a few sites with bedrock located within the channel (reaches WSMS106 through WSMS110), however many sites had large bedrock outcrops on or near the stream banks which prevented substantial bank erosion. One such reach was WSMS132 which had a score of 8/10 on both banks. The DSL bank in WSMS132 was protected by boulders and bedrock outcrops while the DSR bank was protected by boulders and cobble deposits.

3.3.1.6.1.4 FLOODPLAIN CONNECTION

Scores for the *Floodplain Connection* parameter were generally very low among the main stem reaches, especially in the Rosgen type F reaches downstream of WSMS116. A total of 10/17 reaches had scores rated as "poor" which signified moderate to severe entrenchment in these channels. The mean score along the main stem was 5.1/20 which corresponds to an entrenchment ratio of 1.5. The reach with the highest degree of floodplain connection was WSMS112 with a score of 12/20, which was rated as suboptimal. Reach WSMS130, an F3 channel, had the lowest score at just 1/20. Deeply entrenched channels such as the WSMS130 reach rarely access their floodplains during flows in excess of bankfull.

3.3.1.6.2 SUMMARY OF OVERALL BUFFER AND FLOODPLAIN CONDITION SCORES IN THE LOWER WISSAHICKON MAIN STEM WATERSHED

The scores for the *Overall Buffer and Floodplain Condition* in the Lower Wissahickon main stem stream corridor were considerably high for all parameters except for *Floodplain Habitat*. The *Overall Buffer and Floodplain* scores for 15/17 reaches fell in the suboptimal range. The two exceptions were WSMS126 which was rated as "optimal" and WSMS136 which was rated as "marginal." Scores for this component of the USAM assessment were consistently high due to the location of the entire Lower Wissahickon main stem inside of Fairmount Park where development is maintained at a minimum. Overall, the average *Buffer and Floodplain Condition* (53.9/80) score for the Lower Wissahickon scored higher than the *Overall Stream Condition* component (48.2/80). In many reaches, there were uninterrupted vegetated buffers that extended well beyond 100 feet, although the presence of Forbidden Drive did in many instances encroach upon the Lower Wissahickon floodplains.

Table 3-102: USAM Buffer and Floodplain Condition Scoring for the Lower Wissahickon Main Stem

Reach ID	Sub-watershed	Vegetated Buffer Width		Floodplain Vegetation	Floodplain Habitat	Floodplain Encroachment	Overall Buffer/FP Condition
		Left	Right				
WSMS102	Main stem	10	9	14	8	16	57
WSMS104	Main stem	10	10	17	6	15	58
WSMS106	Main stem	10	10	16	6	17	59
WSMS108	Main stem	10	10	16	4	17	57
WSMS110	Main stem	10	9	15	6	16	56
WSMS112	Main stem	10	9	15	8	15	57
WSMS114	Main stem	10	9	16	6	12	53
WSMS116	Main stem	8	7	13	5	10	43
WSMS120	Main stem	9	9	13	4	11	46
WSMS122	Main stem	10	9	16	4	17	56
WSMS124	Main stem	10	9	17	5	14	55
WSMS126	Main stem	10	10	17	7	18	62
WSMS128	Main stem	9	8	16	5	16	54
WSMS130	Main stem	10	9	17	4	19	59
WSMS132	Main stem	10	9	17	4	17	57
WSMS134	Main stem	9	9	16	4	16	54
WSMS136	Main stem	2	9	14	5	3	33
All Reaches		**9.2**	**9.1**	**15.6**	**5.4**	**14.6**	**53.9**

3.3.1.6.2.1 VEGETATED BUFFER WIDTH

The vegetated buffers widths throughout the Lower Wissahickon main stem were rather extensive. The mean scores for the left (9.2/10) and right (9.1/10) banks were rated as "optimal" and were higher than both the Small and Large Tributary averages for this parameter. Extensive variation between sites was not observed as most sites had vegetated buffers rated as either "suboptimal" or "optimal" although some had a combination of the two. The one exception was observed in reach WSMS136 where the left side of the corridor was rated as "poor" with a score of 2/10. Reach WSMS136 was channelized for more than half of its length due to the proximity of Lincoln Drive to the channel. In the lower portion of WSMS136, near Ridge Avenue, the vegetated buffer on the DSL was less than 25 feet.

3.3.1.6.2.2 FLOODPLAIN VEGETATION

The *Floodplain Vegetation* parameter takes into account the dominant vegetation type (i.e. shrub, mature forest, herbaceous ground cover or mowed turf) observed throughout a reach, with mature forest being the optimal condition. The presence of a mature riparian forest is an indicator of low levels of disturbance from factors such as development and extreme flooding given mature forests may take decades to become established. Scores for this parameter were generally high throughout the Lower Wissahickon main stem. 11/17 reaches were rated as “optimal” with the remainder of the reaches scoring in the “suboptimal” range. Such high scores for this parameter would be expected given the relatively unaltered and undeveloped nature of Fairmount Park.

3.3.1.6.2.3 FLOODPLAIN HABITAT

The scores for *Floodplain Habitat* were generally very low and ranged from “poor” to “marginal.” The average score for the main stem channel was 5.4/20 which was rated as “marginal.” The “poor” and “marginal” ratings observed in the Lower Wissahickon main stem can be attributed to the high degree of “floodplain disconnection” within the channels of the corridor as evidenced by the average entrenchment ratio (1.5) for the main stem reaches.

Low entrenchment ratios are an indicator that floodplains within the corridor are rarely inundated by flood flows. Another factor which was present, although not prevalent was channelized segments along the main stem. These vertical walls prevent most flood events from inundating the floodplain. Over-bank flood flows are vital to a riparian ecosystem because these flows provide inputs of sediment and nutrients. Without these inputs and occasional inundation, floodplain habitats such as floodplain wetlands, ephemeral pools and backwater channels can neither be formed nor maintained.

3.3.1.6.2.4 FLOODPLAIN ENCROACHMENT

Scores for the *Floodplain Encroachment* parameter ranged from “poor” to “optimal” but were generally high in most reaches as 10/17 reaches were rated as “optimal”. The average condition within the main stem corridor was rated as “suboptimal” with a score of 14.6/20. The two lowest scores were observed in reaches WSMS116 (10/20) and WSMS136 (3/20). The “marginal” rating in WSMS116 was attributed to the proximity of Valley Green Inn, a parking lot, and Forbidden Drive to the main stem channel. This reach also had a channelized segment on both sides of the channel in the vicinity of Valley Green Inn. Reach WSMS136 was rated as “poor” due to numerous factors which included five bridges, the two Ridge Avenue dams, extensive channelization, as well as the proximity of Lincoln Drive which parallels the reach for its entire length. Reach WSMS136 had a length of 7,570 feet yet had 3,590 linear feet of channelization (includes both sides and bottom channelization).

3.4 SUMMARY

Over time, the Wissahickon Creek Watershed has experienced continual and extensive urban land development. More than half of the Wissahickon Creek Watershed is covered by residential development with single family residential and row home residential making up the bulk of that development. A large portion of the riparian corridor of the Wissahickon Creek and its tributaries has remained covered as wooded land, mostly protected through long-term preservation efforts. Additionally, large tracts of privately owned open space such as agricultural land remain undeveloped and are dispersed throughout the watershed, perhaps presenting opportunities for future preservation efforts.

Geology and soils play a role in the hydrology, water quality, and ecology of a watershed. The Lower Wissahickon watershed is within the Piedmont Upland physiographic region, which is underlain by a variety of sedimentary, metamorphic and igneous rocks. The geology of the Lower Wissahickon watershed is mostly underlain by the Wissahickon Formation. Soils beneath the Lower Wissahickon watershed are mainly comprised of Group B soils.

Over the last four years, PWD has conducted a sediment study within the Lower Wissahickon watershed to estimate sediment loading from more than 24 miles of stream bank in the study area. This effort produced data suggesting that roughly 3.3 million pounds of sediment are eroded from the study area annually. Given the relative consistency in this estimate over the last four years, PWD is confident that this estimate can be considered accurate at an order of magnitude level. The sediment loading estimate suggests that the Lower Wissahickon watersheds have been affected by their location within an urban setting.

3.4.1 Small Tributaries

3.4.1.1 Infrastructure

The following tables are a summary of the data presented in previous sections. The purpose of these tables is to allow comparisons between individual reaches such that the relative impacts of point and linear infrastructure elements within each respective reach can be clearly distinguished.

In Table 3-105, select infrastructure metrics have been presented in order to identify the reaches in the Small Tributary infrastructure assessment most impacted by certain types of infrastructure.

Table 3-103: Small Tributary Infrastructure Point Summary

Section ID	Culvert Count	Bridge Count	Outfall Count	Channel Count	Conflu-ence Count	Dam Count	Manhole Count	PipeSewer Count	Other Count	Infra Point Count	Combined Outfall Area (ft^2)
WSCA02	2	0	3	0	0	0	0	0	0	5	26.7
WSGO02	1	7	5	6	1	1	16	1	2	39	64.1
WSTM02	0	3	4	0	1	0	0	0	0	7	22.3
WSMSI02	0	2	3	1	0	0	0	0	0	6	17.5
WSVG02	3	1	4	0	2	0	0	0	0	8	15.9
TOTAL	**6**	**13**	**19**	**7**	**4**	**1**	**16**	**1**	**2**	**65**	**146.5**

Table 3-104: Small Tributary Infrastructure Linear Summary

Section ID	Segment Length (ft)	Segment Length (ft), 3 sides	Culvert Length (ft)	Percent Culverted	Channel Length (ft), 1 side	Channel Length (ft), 2 sides	Channel Length (ft), 3 sides	Total Channel Length (ft)	Percent Channelized
WSCA02	3123	9369	50	2	0	0	0	0	0
WSGO02	2699	8097	8	0	218	0	215	863	11
WSTM02	3648	10944	0	0	0	0	0	0	0
WSMSI02	1865	5595	0	0	45	0	0	45	1
WSVG02	2849	8547	0	0	0	0	0	0	0
TOTAL	**14184**	**42552**	**58**	**0**	**263**	**0**	**215**	**908**	**2**

Table 3-105: Summary of Small Tributary Infrastructure by Reach

Parameter	Small Tributaries	
	Max	Mean
Total Infrastructure	WSGO02 (39)	13
Priority Infrastructure	WSGO02 (4)	1
Culverts	WSVG02 (3)	1.2
Bridges	WSGO02 (7)	2.6
Outfalls	WSGO02 (5)	3.8
Channels	WSGO02 (6)	1.4
Dams	WSGO02 (1)	0.2
Manholes	WSGO02 (16)	3.2
Pipes	WSGO02 (1)	0.2
Outfalls >3 ft diameter	WSGO02 (3)	1.6
Outfall Area	WSGO02 (64.06 ft^2)	29.3
Mean Outfall Area	WSGO02 (12.81 ft^2)	---
Single Outfall	WSGO02 (36 ft^2)	---
Segment Length	WSTM02 (3648 ft)	2837 ft
Culvert Length	WSVG02 (671 ft)	146 ft
% Culverted	WSVG02 (24%)	---
Total Channel Length	WSGO02 (863 ft)	181.6 ft
% Channelized	WSGO02 (11%)	--

3.4.1.2 Unified Stream Assessment

The following table has been presented as a means of quickly assessing the performance of individual reaches within the Small Tributary USAM assessment. The reaches presented correspond to the extreme values among the dataset; however by comparing these values to the mean Small Tributary value for each respective metric, it is possible to quickly gauge the variability of conditions within the small tributaries of the Lower Wissahickon watershed. The USAM scores for each Small Tributary watershed are included in Appendix D.

Table 3-106: Summary of Small Tributary USAM Results by Reach

Overall Stream Condition							
Parameter	Instream Habitat	Vegetative Protection		Bank Erosion		Floodplain Connection	OSC Score
		Left	Right	Left	Right		
MIN	WSCA02 (13)	WSCA02 (2)	WSCA02 (2)	WSCA02 WSGO02 WSMSI02 (5)	WSCA02 WSGO02 WSMTM02 (5)	WSGO02 (2)	WSGO02 (31)
MAX	WSMSI02 (19)	WSVG02 (8)	WSVG02 (8)	WSVG02 (7)	WSVG02 (8)	WSVG02 (17)	WSVG02 (66)
MEAN	15.8	4.4	4.2	5.6	5.8	9	44.8

Overall Buffer Floodplain Condition						
Parameter	Vegetated Buffer Width		Floodplain Vegetation	Floodplain Habitat	Floodplain Encroachment	OBF Score
	Left	Right				
MIN	WSVG02 (5)	WSCA02 (5)	WSCA02 (14)	WSGO02 (3)	WSVG02 (4)	WSVG02 (41)
MAX	WSCA02 WSMSI02 WSTM02 WSGO02 (10)	WSGO02 WSMSI02 WSTM02 (10)	WSTM02 (18)	WSVG02 (8)	WSTM02 (18)	WSTM02 (63)
MEAN	9	8.8	16.2	5.6	11	50.6

3.4.2 Large Tributaries

3.4.2.1 Infrastructure

The following tables are a summary of the data presented in previous sections. The purpose of these tables is to allow comparisons between individual reaches such that the relative impacts of point and linear infrastructure elements within each respective reach can be clearly distinguished.

In Table 3-109, select infrastructure metrics have been presented in order to identify the reaches in the Large Tributary infrastructure assessment most impacted by certain types of infrastructure.

Table 3-107: Large Tributary Infrastructure Point Summary

Section ID	Culvert Count	Bridge Count	Outfall Count	Channel Count	Conflu-ence Count	Dam Count	Manhole Count	Pipe-Sewer Count	Other Count	Infra Point Count	Combined Outfall Area (ft^2)
WSBM02	1	0	3	0	5	0	1	0	5	5	20.0
WSBM04	0	0	4	1	0	0	2	0	0	7	6.1
WSBM06	1	0	2	0	0	0	6	0	0	9	16.8
WSHC02	6	1	3	4	3	11	0	0	2	25	17.6
WSHC04	1	4	1	9	1	2	0	0	0	17	16.0
WSHW02	1	2	6	1	0	3	0	0	0	13	19.0
WSHW04	2	0	1	0	0	1	0	0	0	4	7.1
WSWM02	2	0	3	0	0	0	1	0	0	6	28.5
WSWM04	2	2	2	0	1	2	3	0	0	11	1.6
WSWM06	0	1	6	0	1	0	0	0	0	7	25.2
WSCR04	9	1	12	4	0	0	0	2	1	29	74.5
WSCR06	1	1	9	5	1	0	0	1	1	17	14.8
WSCR08	1	0	3	2	1	0	0	1	0	7	25.9
WSCR10	0	0	0	0	0	1	0	0	0	1	0.0
WSCR12	0	2	1	1	0	0	0	0	0	4	1.8
WSCR14	0	1	1	0	1	1	0	0	0	3	1.8
WSKL02	0	1	5	0	0	0	0	0	0	6	23.6
WSKL04	2	0	1	0	0	0	0	0	0	3	3.1
WSKL06	3	5	3	2	3	1	0	0	0	14	11.0
WSMO02	1	0	7	2	0	1	0	0	1	11	37.8
WSMO04	1	2	6	2	1	1	0	0	0	12	75.5
WSMO06	2	2	10	5	1	1	0	0	0	20	126.3
TOTAL	**36**	**25**	**89**	**38**	**19**	**25**	**13**	**4**	**10**	**231**	**553.7**

Table 3-108: Large Tributary Infrastructure Linear Summary

Section ID	Total Segment Length (ft)	Total Segment Length (ft), 3 sides	Culvert Length (ft)	Percent Culverted	Channel Length (ft), 1 side	Channel Length (ft), 2 sides	Channel Length (ft), 3 sides	Total Channel Length (ft)	Percent Channelized
WSBM02	2858	8574	68	2	0	0	0	0	0
WSBM04	1838	5514	0	0	39	0	0	39	1
WSBM06	1782	5346	35	2	0	0	0	0	0
WSHC02	4135	12405	983	24	0	617	0	1234	10
WSHC04	1468	4404	15	1	257	391	30	1129	26
WSHW02	1752	5256	71	4	141	0	0	141	3
WSHW04	1766	5298	109	6	0	0	0	0	0
WSWM02	1271	3813	93	7	0	0	0	0	0
WSWM04	3610	10830	241	7	0	0	0	0	0
WSWM06	1297	3891	0	0	0	0	0	0	0
WSCR04	6726	20178	1290	19	187	48	0	283	1
WSCR06	1980	5940	66	3	178	48	567	1975	33
WSCR08	1427	4281	139	10	6	224	0	454	11
WSCR10	1927	5781	0	0	0	0	0	0	0
WSCR12	2793	8379	0	0	168	0	0	168	2
WSCR14	1551	4653	0	0	0	0	0	0	0
WSKL02	2223	6669	0	0	0	0	0	0	0
WSKL04	1973	5919	128	6	0	0	0	0	0
WSKL06	3370	10110	28	1	0	351	0	702	7
WSMO02	1665	4995	28	2	86	532	0	1150	23
WSMO04	2083	6249	115	6	7	689	0	1385	22
WSMO06	2845	8535	191	7	193	727	0	1647	19
TOTAL	**52340**	**157020**	**3600**	**7**	**1262**	**3627**	**597**	**10307**	**7**

Table 3-109: Summary of Large Tributary Infrastructure by Reach

Parameter	Large Tributaries	
	Max	Mean
Total Infrastructure	WSCR04 (29)	11.1
Priority Infrastructure	WSHC02 (6)	0.8
Culverts	WSCR04 (9)	1.6
Bridges	WSKL06 (5)	1.1
Outfalls	WSCR04 (12)	4.1
Channels	WSHC04 (9)	1.7
Dams	WSHC02 (11)	1.1
Manholes	WSBM06 (6)	0.6
Pipes	WSCR04 (2)	0.2
Outfalls >3 ft diameter	WSCR04 (4)	0.7
Outfall Area	WSMO06 (126.27 ft^2)	25.2 ft^2
Mean Outfall Area	WSMO04 (12.58 ft^2)	---
Single Outfall	WSWM02 (19.63 ft^2)	---
Segment Length	WSCR04 (6726 ft)	2379 ft
Culvert Length	WSCR04 (1290 ft)	163.6 ft
Percent Culverted	WSHC02 (24%)	---
Total Channel Length	WSCR06 (1975 ft)	468.5 ft
Percent Channelized	WSCR06 (33%)	---

3.4.2.2 UNIFIED STREAM ASSESSMENT

The following table has been presented as a means of quickly assessing the performance of individual reaches within the Small Tributary USAM assessment. The reaches presented correspond to the extreme values among the dataset; however by comparing these values to the mean Small Tributary value for each respective metric, it is possible to quickly gauge the variability of conditions within the small tributaries of the Lower Wissahickon watershed. The USAM scores for each Large Tributary watershed are included in Appendix D.

Table 3-110: Summary of Large Tributary USAM Results by Reach

Overall Stream Condition							
Parameter	Instream Habitat	Vegetative Protection		Bank Erosion		Floodplain Connection	OSC Score
		Left	Right	Left	Right		
MIN	WSCR08 (4)	WSBM02 (1)	WSBM02 (1)	WSWM02 (2)	WSWM02 (2)	WSHW04 WSCR08 WSKL02 (1)	WSCR04 WSWM06 (26)
MAX	WSHW04 WSMO04 WSWM02 (18)	WSBM06 WSKL04 WSMO02 WSWM02 (8)	WSBM06 WSKL04 WSWM02 (8)	WSMO02 (10)	WSMO02 (10)	WSKL06 WSHC02 (18)	WSKL04 (63)
MEAN	13.1	4.9	4.9	6.3	7.0	6.3	42.3

Overall Buffer and Floodplain Condition						
Parameter	Vegetated Buffer Width		Floodplain Vegetation	Floodplain Habitat	Floodplain Encroachment	OBF Score
	Left	Right				
MIN	WSBM04 (3)	WSCR06 (3)	WSHC02 (6)	WSWM02 (1)	WSCR04 WSCR08 WSMO06 WSWM06 (3)	WSCR06 (25)
MAX	WSBM02 WSHW02 WSHW04 WSKL02 WSWM02 WSWM04 (10)	WSBM02 WSBM04 WSBM06 WSHW02 WSHW04 WSKL02 WSMO02 WSWM02 (10)	WSBM02 WSMO02 (19)	WSMO02 (13)	WSBM02 WSHW04 WSKL02 (15)	WSBM02 (59)
MEAN	8.1	8.6	13.8	5.5	8.5	44.5

3.4.3 MAIN STEM

3.4.3.1 INFRASTRUCTURE

In Table 3-111, select infrastructure metrics have been presented in order to identify the reaches in the Large Tributary infrastructure assessment most impacted by certain types of infrastructure.

Table 3-111: Summary of Main Stem Infrastructure by Reach

Parameter	Main Stem	
	Max	Mean
Total Infrastructure	WSMS136 (23)	4.7
Priority Infrastructure	WSMS120 (2)	0.3
Culverts	WSMS112 WSMS120 WSMS124 WSMS136 (2)	0.7
Bridges	WSMS136 (5)	0.9
Outfalls	WSMS136 (12)	1.9
Channels	WSMS102 (3)	0.4
Dams	WSMS108 WSMS136 (2)	0.4
Manholes	WSMS120 (3)	0.2
Pipes	WSMS120 (1)	0.1
Outfalls >3 ft diameter	WSMS102 WSMS104 WSMS120 WSMS124 WSMS126 WSMS134 (1)	0.4
Outfall Area	WSMS136 (19.24 ft^2)	3.0 ft^2
Mean Outfall Area	WSMS102 (5.11)*	---
Single Outfall	WSMS120 (9 ft^2)	---
Segment Length	WSMS136 (7570 ft)	2394 ft
Culvert Length	WSMS124 (100 ft)	20.9 ft
Percent Culverted	WSMS124 (6 %)	---
Total Channel Length	WSMS136 (3590 ft)	248.9 ft
Percent Channelized	WSMS136 (16 %)	---

*** Excludes WSMS126 which has 1 outfall 3 ft diameter**

3.4.3.2 Unified Stream Assessment

The following table has been presented as a means of quickly assessing the performance of individual reaches within the Lower Wissahickon main stem USAM assessment. The reaches presented correspond to the extreme values among the dataset; however by comparing these values to the mean value for each respective metric, it is possible to quickly gauge the variability of conditions within the main stem of the Lower Wissahickon watershed.

Table 3-112: Summary of Main Stem USAM Results by Reach

Overall Stream Condition							
Parameter	Instream Habitat	Vegetative Protection		Bank Erosion		Floodplain Connection	OSC Score
		Left	Right	Left	Right		
MIN	WSMS120 (5)	WSMS102 WSMS108 WSMS110 WSMS120 WSMS128 (5)	WSMS106 WSMS112 WSMS116 (4)	WSMS102 WSMS106 WSMS128 (5)	WSMS112 (4)	WSMS130 (1)	WSMS120 (31)
MAX	WSMS114 WSMS122 WSMS126 WSMS128 WSMS134 (19)	WSMS126 (9)	WSMS104 WSMS132 (8)	WSMS112 WSMS126 WSMS130 WSMS132 WSMS134 (9)	WSMS124 WSMS126 WSMS132 (9)	WSMS112 (12)	WSMS126 (58)
MEAN	15.9	6.6	6.1	7.3	7.2	5.1	48.2

Overall Buffer Floodplain Condition						
Parameter	Vegetated Buffer Width		Floodplain Vegetation	Floodplain Habitat	Floodplain Encroachment	OBF Score
	Left	Right				
MIN	WSMS136 (2)	WSMS116 (7)	WSMS116 WSMS120 (13)	WSMS108 WSMS120 WSMS122 WSMS130-134 (4)	WSMS136 (3)	WSMS136 (33)
MAX	WSMS102-114 WSMS122-126 WSMS130-132 (10)	WSMS104-108 WSMS126 (10)	WSMS104 WSMS124 WSMS126 WSMS130 WSMS132 (17)	WSMS102 WSMS112 (8)	WSMS130 (19)	WSMS126 (62)
MEAN	9.2	9.1	15.6	5.4	14.6	53.9

3.5 RECOMMENDATIONS

Stream restoration is a general term that may be used to describe a broad spectrum of activities undertaken to correct problems affecting streams or improve stream habitat, structure and function. However, stream restoration and streambank reinforcement activities that do not take into account the stream's current morphological state and the tendency of streams to adjust to new hydrologic conditions may not be successful, and in some cases may be counterproductive. In order to be successful, stream restoration activities should:

1.) work with the stream's tendency to establish a dynamic equilibrium between land and water
2.) take into account new hydrologic conditions that accompany changes in land use, and
3.) seek establishment of a natural stream dimension, pattern, and profile. Stream corridors represent a micro-ecosystem within a watershed, consisting not only of the channel, but also of the adjacent floodplain and a transitional area where the floodplain ends and merges into an upland area. Stream restoration, therefore is the restoration of multiple micro-habitats that are a part of a larger watershed.

A comprehensive approach to watershed management and restoration is essential and should be planned and prioritized according to representative watershed indicators and identified issues. All information should be organized, maintained and be made easily accessible to residents. Components of an ideal watershed master plan should include information organized on a watershed basis for existing channel condition, impervious cover, sewer and storm drain infrastructure, drainage network, stormwater outfalls, stormwater problem locations, industrial sites, open space, and natural areas. The assessment of the Valley Green Run Watershed has provided some of these essential elements that can be used independently or built upon to identify and prioritize watershed indicators and issues. All strategies should complement existing regulations, management strategies, and community efforts.

Restoration strategies that would alleviate or minimize identified direct and future cumulative impacts to the Valley Green Run watershed are discussed in the following section. These strategies have been divided into three categories:

- ✓ Restoration Strategy Category I: Channel Stability & Infrastructure
- ✓ Restoration Strategy Category II: Habitat
- ✓ Restoration Strategy Category III: Land management.

3.5.1 RESTORATION STRATEGY CATEGORY I: CHANNEL STABILITY & INFRASTRUCTURE

3.5.1.1 BANK STABILIZATION

Many parameters that were evaluated throughout the Lower Wissahickon watershed may be applied as metrics to gauge the applicability of bank stabilization techniques for a given reach. Bank stabilization measures can vary, based on the severity of the erosion and whether it is localized or continues for some distance along a bank, from small plantings to the installation of boulder walls. Bank stabilization measures may consist of boulder bank and/or boulder "toe of slope" reinforcement in areas where the greatest erosive potential exists. Boulder structures may also be used in smaller channels when the stream is eroding and over-widening to the point where property is, or is expected, to be lost. Other more natural bank stabilization methods such as bioengineering, root wads, plantings and log and woody structures should be used in areas where the bankfull channel has not been severely overwidened and significant additional channel changes are not expected. These methods are best suited to small, local areas of bank erosion scattered throughout the smaller tributaries where discharges are the lowest. Bank stabilization can reduce erosion, sediment supply, tree fall, channel widening and migration.

3.5.1.2 BED STABILIZATION

Bed stabilization is recommended for those reaches that are currently degrading through incising or downcutting. Bed stabilization measures such as rock/log vanes with grade control, rock/log cross vanes, and using naturally occurring boulders and bedrock are examples of methods that could be used to stabilize channel beds. Rock/log vanes differ from cross vanes because they do not extend the entire width of the channel. However, both structures provide grade control while diverting flow away from the channel banks. Bed stabilization should be used to eliminate headcuts or knickpoints. Advantages of bed stabilization consist of bank protection through diverting flow and elimination of migrating bed scour through providing grade control. Bed stabilization techniques can also aid in re-establishing natural pool-riffle-run sequences that are often lacking in degraded reaches.

In general, bank and bed stabilization restoration potential should be evaluated together such that the maximum amount of stream improvement value may be obtained for the funds allotted for a particular project. This is also important because of the implicit relationship that one has with the other. For example, spacing and alignment of bed stabilization structures must also be coordinated with bank stabilization features so that the restoration design features complement one another and work with the stream's natural meander pattern rather than against it. It is also often necessary to secure stream-crossing structures such as rock and log vanes by trenching them into the streambanks.

3.5.1.3 REALIGNMENT & RELOCATION

Stream channel realignment and relocation are the most severe restoration measures involving the greatest amount of channel changes. These methods should be employed when it is more advantageous to realign the channel than it is to stabilize degrading, out-of-pattern sections. Channel realignment and relocation are commonly implemented for shorter portions of a channel rather than for extensive lengths of channel due to construction and maintenance costs, and the amount of disturbance that occurs to existing natural habitat. Stream channel realignment and relocation is best suited to consecutive severely degraded reaches where existing land uses are threatened.

3.5.1.4 INFRASTRUCTURE IMPACTS

Large structures or facilities within stream channels can interrupt natural flow patterns and alter the hydrology and hydraulics of the creek in which they are present. Anthropogenic alterations to the natural balance or progression towards the natural balance between land and water generally have adverse impacts on the channel. For example, some features, such as dams, can disrupt the natural movement of sediment and block upstream migration of stream biota. Other infrastructure features, such as stormwater outfalls or culverts, can create local erosion by causing stormwater shear forces to be directed at a small area or creating high velocity scour at constrictions. These local disturbances often serve as “knickpoints”, from which additional destabilizing erosion, scour, and sediment transport problems may propagate.

3.5.1.4.1 STORMWATER OUTFALLS

126 outfalls greater than 12” in diameter were found in the Lower Wissahickon watershed. 28 of these outfalls were greater than three feet in diameter. Due to their size and density within the watershed and the degree to which they may cause local erosion, stormwater outfalls are considered one of the most important considerations in assessing stream reach stability. Outfalls often drain large areas of impervious surfaces and efficiently deliver large volumes of water to small streams. Streambank erosion and bed erosion (scour pools) were often observed at these outfalls, and in some cases, this local erosion served as a knickpoint, causing headcutting in an upstream direction. Because outfalls may be positioned to direct flow at banks from a disadvantageous angle, it may be necessary to armor the opposite bank or install energy dissipating structures where the outfall meets the stream. The presence of a large outfall or outfalls may also constrain the final pattern and profile of a stream restoration design.

3.5.1.4.2 CULVERTS

Culverts may have many of the same destabilizing influences as dams and stormwater outfalls and must also be considered in stream restoration design. In some cases, a large culvert may serve as a stable starting or end point for a stream restoration project, with the remainder of the restoration designed to mitigate the destabilization and sediment transport issues at the site.

3.5.1.4.3 DAM AND POND IMPACTS

There were 32 dams present within the Lower Wissahickon Watershed that provide little or no positive value to the hydraulic regime of the stream. Observations made during the various field investigations and infrastructure assessment suggested that most dams accrued large amounts of fine sediments upstream, and that reaches downstream of these structures are likely to have undergone a greater amount of channel degradation than those channels not influenced by dams. There are also a small number of ponds located in Lower Wissahickon watershed most of which are associated with golf courses, large estates and developments. Ponds often develop serious management problems, and are associated with algal blooms, overheating of impounded water and an overabundance of resident Canadian geese.

Despite these facts, their installation may also have created some beneficial habitat. Additional consideration must be given to the fact that any beneficial habitat may now rely on the existence of these dams, in which case removing dams to create a more natural channel may outweigh the benefits that resulted from its installation. Overall, dam and pond removal have been presented as possible channel stability restoration measures. It should be noted that careful evaluation of all environmental costs and benefits, specifically habitat and any potential historical significance associated with each structure must be taken into consideration.

3.5.1.4.4 REMEDIATION OF INFRASTRUCTURE IN POOR CONDITION

Products of the infrastructure assessment conducted during this study were observations and locations of infrastructure in poor condition. This classification was attributed to those dams, bridges and outfalls that exhibited the characteristics of being broken, exposed, or the potential of such issues based upon their proximity to the stream and ongoing bank erosion. Reach by reach summaries, statistics, and location maps of all points of infrastructure are documented in detail in Appendix D.

3.5.2 RESTORATION STRATEGY CATEGORY II: HABITAT

3.5.2.1 RIPARIAN BUFFER EXPANSION/IMPROVEMENT

Riparian buffer expansion and improvement can act as strategies which can significantly improve the habitat characteristics of the associated stream reaches. Several parameters were qualitatively and quantitatively evaluated along each reach which can be utilized in the prioritization of stream sections with respect to this strategy. Although priority reforestation areas consist of floodplains, steep slopes, and wetlands, smaller areas such as public right-of-ways, parks, schools, and neighborhoods also provide reforestation opportunities. Benefits of reforestation are numerous. Cooler temperatures, stream shading, rainfall interception, reduced runoff, reduced sediment load, reduced discharge velocities, increased groundwater recharge, increased species diversity and habitat, and improved air quality and aesthetics are all positive effects associated with a healthy riparian buffer.

3.5.2.2 INVASIVE SPECIES MANAGEMENT

Maintaining a healthy riparian plant community within the Lower Wissahickon Basin will retain biodiversity and support a healthy stream ecosystem. Invasive species provide little value to native animals that depend on native species for habitat and/or food. Because of this threat to the biodiversity of native communities, an invasive species management plan would assist natural succession within the riparian buffer through decreasing possible further impacts of invasive species. An invasive species management plan will require, at a minimum, a three-year commitment to ensure success. Planting plans for all restoration efforts should compliment the invasive species management plan by recommending appropriate native planting to supplement areas where invasive species have been eliminated. Although invasive species management priority areas are considered those that contain 80% or greater invasive species, invasive species management should also be implemented for all preliminary recommended channel restoration sites.

3.5.2.3 WETLAND CREATION

Land currently available for reforestation located adjacent to the channel is also ideal for wetland creation. Wetland creation adjacent to the channel is best suited to those areas where stream relocation and realignment are suitable. Because stream relocation and realignment typically involve large quantities of grading, replanting the disturbed areas can be customized to create specific habitats. Wetlands, a rich habitat that relies on saturated soils and vegetation adapted to these conditions could be created concurrently with channel relocation and realignment. Therefore, the best opportunities for wetland creation may be adjacent to those channels that are also suitable relocation /realignment sites.

Further investigation of all potential restoration and realignment sites should include the following: rainfall data collection and evaluation, runoff calculations, soils investigation, water budget, native species investigation, and groundwater monitoring. Ideally, groundwater levels for all potential wetland creation sites should be monitored to determine their suitability prior to design. Advantages of wetland creation are groundwater recharge, increased habitat, increased plant and animal species diversity, and improved water quality.

3.5.2.4 PRESERVATION OF EXISTING FORESTED AREAS

Existing forests are valuable habitat and should be protected. All of these areas throughout the watershed should be protected and managed, if necessary, to preserve the forested riparian buffer present surrounding all creeks within the watershed. Educational/informational signage, creating small parks or designated green space, and installing fences or prohibiting access in areas where the riparian area has been disturbed are additional strategies to help preserve existing forests.

3.5.3 RESTORATION STRATEGY CATEGORY III: LAND MANAGEMENT

3.5.3.1 REDUCE DIRECTLY CONNECTED IMPERVIOUS SURFACES

Stream channels within each watershed have responded to high density development and increased runoff through downcutting and over-widening in an attempt to accommodate higher flows. In addition to preserving land available for reforestation or to protect from becoming developed, the amount of existing impervious surfaces should be reduced. Examples of strategies to reduce the amount of existing impervious surfaces and/or decrease the severity of runoff include:

- ✓ Stormwater management basins – both wet/dry ponds have the ability to collect storm flow, hold water temporarily and release water to a stream at a constant rate. Disadvantages of basins are finding the available land to build them and the associated maintenance over many years. In areas where additional development is still possible, or re-development may occur, stormwater management ponds are a suitable method to reduce runoff. Planned species selection for vegetating the pond perimeter, banks, and edges may also help reduce nutrients delivered to streams. Similarly, in areas where adequate space is not available, grass swales can be used to increase infiltration while decreasing the velocity of runoff prior to delivering it to the creeks.

- ✓ Bioretention – bioretention facilities are similar to stormwater management ponds in their function, but differ since they are much better suited for small areas. Bioretention facilities can be installed next to parking lots, curbs, major roads, etc. to immediately catch runoff, filter sediment and allow rainwater to infiltrate back into the groundwater table.

- ✓ Parking Lot Island Installation and Plantings – parking lot islands can be installed and planted within large paved areas to create less contiguous impervious surfaces. Islands can be depressed to catch stormwater and planted to provide water quality benefits, shade and aesthetic value. Often, planted parking lot islands can serve dual purposes and provide water quality benefits if they are also bioretention facilities. At a minimum, efforts should aim to steady the existing percent impervious surfaces associated with parking lots. When and if the opportunity arises, unnecessarily paved and oversized parking lots could be converted to have smaller spaces and contain islands to create less contiguous paved surfaces. Parking lots and other paved right-of-ways should also be evaluated when adding or relocating utilities. To fully utilize existing paved surfaces instead of creating new impervious surfaces utilities could be located underneath existing pavement.

3.5.3.2 APPROPRIATE ROAD AND CULVERT MAINTENANCE

Often inappropriately sized culverts or poorly stabilized roads will impact a channel through eroding the bed and banks. Bed scour may cause a headcut or knickpoint that is capable of migrating upstream. A headcut or knickpoint will continue to scour the bed and deepen the channel as it moves upstream until it is inhibited by a natural bed formation or man-made structure resistant to erosion. Although the headcut or knickpoint may have stopped migrating, it is still present in the channel and if channel conditions change may begin to migrate again.

3.5.3.3 PUBLIC EDUCATION

Because watersheds are so diverse in their land use and ownership, a public educated in the ways and means of being a good steward to their watershed is perhaps one the best ways of addressing its restoration. Disturbances such as footbridges, landscaping, and mowing adjacent to the channel will continue so long as public education and awareness are not increased. Public education provides opportunities to relate the importance of stream habitat and stability and to influence and/or change the behavior of residents.

Public education begins with public involvement. One principal avenue for educating residents is through forming local watershed groups. Local watershed groups are most effective when strong, mutually beneficial relationships are established early between the volunteers and local government agencies. Planning agencies and volunteers could then communicate and work together to educate neighbors through activities such as stream clean-ups, re-vegetating stream banks, long-term monitoring, and publishing articles in the local newspaper(s), among many others. Additional opportunities for the community to participate in all aspects of the planning/development phase increases not only public education, but also recreation and habitat enhancement opportunities.

In November of 2005, the Wissahickon Watershed Partnership was formed, consisting of a consortium of proactive environmental groups, community groups, government agencies, businesses, residents and other watershed stakeholders interested in improving their watershed. The goals of the partnership initiative are to protect, enhance, and restore the beneficial uses of the waterways and riparian areas. The partnership seeks to achieve greater levels of environmental improvement by sharing information and resources.

More information about the Wissahickon Watershed Partnership can be found on the Philadelphia Water Department's website (http://www.phillyriverinfo.org/).

3.6 COMPLETED AND PROPOSED PROJECTS

3.6.1 CATHEDRAL RUN

3.6.1.1 COMPLETED PROJECTS

In April of 2006, emergency repair work was completed 60 feet upstream of Forbidden Drive to protect a gas line crossing that was in danger of being exposed. Repairs consisted of the installation of a grouted native stone protection upstream and downstream of the pipe crossing as well as a grouted native stone weir downstream of the pipe crossing.

3.6.1.2 PROPOSED PROJECTS

In the fall of 2010 PWD will begin construction of a stormwater wetland, designed by AKRF Inc., at the headwaters of Cathedral Run which is located near the intersection of Cathedral Road and Glenn Campbell Road. The wetland will be constructed within a forested depression currently owned by Fairmount Park. It will divert the majority of the flow from WSout760 (W-076-01), which currently discharges flow from a 48 inch storm sewer into Cathedral Run. The benefits will include reduced bank erosion and fine sediment deposition in the Cathedral Run stream channel as well as improved water quality.

3.6.2 VALLEY GREEN RUN

3.6.2.1 COMPLETED PROJECTS

In 2008, stream bank and channel bed stabilization and were completed by Skelly and Loy. The project reach was a 350 foot stretch along Fairmount Park's Parking Area 9, which is adjacent to Valley Green Run. Upstream of the project reach Valley Green Run was culverted for 643 feet (WScul104), which contributed to bed scour and bank erosion in the project reach. Another contributing factor was the storm flow from WSout523 (W-076-10) which discharges storm flow from a 30 inch storm sewer. The stabilization work consisted of boulder revetments on the DSL adjacent to the parking lot, boulder stream bed armoring and boulder toe protection on the DSR bank.

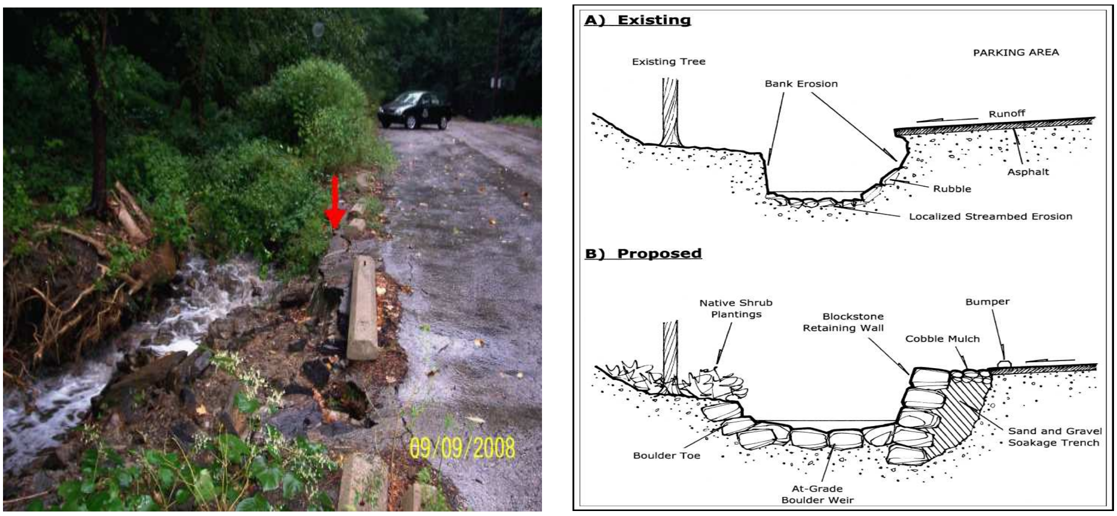


Figure 3-100: Bank erosion caused by parking lot runoff (left); schematic of restored condition (right).

Source: Skelly & Loy

3.6.3 GORGAS RUN

3.6.3.1 COMPLETED PROJECTS

In June of 2009 the Pennsylvania Department of Transportation (PENNDOT) repaired two gullies that formed beneath the Henry Avenue Bridge (WSbri246). The stormwater scuppers that drained the bridge were causing severe erosion due to the high potential energy created by the height differential between the scupper outlets and the hill slope beneath the bridge. Overland flow down the hill slope had also threatened the structural integrity of the FPC trial system abutting Gorgas Run. The two large gullies were stabilized with boulder step-pool structures and the “splash pads” beneath the scupper outlets were lined with geotextile fabric and armored with ballast stone. To further reduce the energy of stormflows, a trench and berm system was constructed to allow stormwater to be impounded before flowing into one of the two existing gullies.

3.6.3.2 CURRENT PROJECTS

PWD has contracted the design and engineering services of AKRF Inc. in order to complete a natural stream channel design and restoration framework for Gorgas Run. The primary objectives include infrastructure protection (both PWD and FPC infrastructure), bank stabilization, increased floodplain connection and improved ecological integrity. As with many of the small Lower Wissahickon tributaries, Gorgas Run has been severely impacted by stormwater. Preliminary concepts to mitigate the impacts of stormwater have considered the construction of a stormwater wetland and creation of an open channel system upstream of WSout566 (W-067-01).

3.6.4 BELL'S MILL RUN

3.6.4.1 CURRENT PROJECTS

PWD has contracted the design and engineering services of GTS Inc. to provide natural stream channel design concepts for the extent of Bell's Mill Run. Key project objectives and design elements address infrastructure protection (e.g. manholes and stormwater outfalls), bank erosion and channel incision. Elements of the design include potential channel realignment and outfall naturalization, both of which will be beneficial to the overall ecological and aesthetic integrity of Bell's Mill Run.

3.6.5 HARTWELL RUN

3.6.5.1 COMPLETED PROJECTS

In October of 2009 emergency repairs were completed on Hartwell Run at the stream crossing of the Wissahickon High Level Interceptor (WScul116). The concrete masonry encased pipe had succumbed to severe erosion which had exposed the interceptor. Frequent blockage of the three foot conveyance orifice by boulders, woody debris and fine sediment cause stream flow to overtop the culvert, which where blocked functioned as a dam. The combination of reduced flood flow conveyance, the steep slope of Hartwell Run cause severe bank erosion and plunge pool formation downstream of WScul116, as well as undermined a portion of the concrete-encase sanitary crossing (Figure 3-101).

The team of Skelly & Loy Environmental Consultants, WRT and Gebhart Construction Inc. completed repairs to the concrete encasement and stabilized the banks upstream and downstream of WScul116. Upstream of the structure, a step-terrace system was installed to reduce the energy of flood flows, which will alleviate the high shear stress in and around the conveyance orifice (Figure 3-101).

Figure 3-101: Upstream view of WScul116 pre-construction (left); Downstream view of WScul116 post-construction (right).

3.6.6 WISE'S MILL RUN

3.6.6.1 COMPLETED PROJECTS

In 2005 PWD's Waterways Restoration Team (WRT), following the natural stream channel design concepts of Skelly & Loy, constructed a boulder step-pool system on the lower reaches of Wise's Mill Run. The entire channel had experienced significant erosion and sediment deposition following two severe tropical storms in 2004. FPC stone masons also repaired a stone low-head dam which was damaged as a result of the storms. The boulder weir and step-pool system (Figure 3-102) dissipates much of the shear stress and concomitant erosion during high flows on the very steep stream thus dramatically increasing the stability of the downstream reaches of Wise's Mill Run.

Figure 3-102: View of boulder step-pool system looking upstream (left): scour pool at the base of the step-pool system (right).

3.6.6.2 Current Projects

AKRF Inc. is in the process of designing a stormwater wetland at the headwaters of the southern branch of reach WSWM06. The stormwater management facility would intercept flow from WSout572 (W-0776-13) which discharges flow from a 48 inch storm sewer draining 92 acres of residential development.

AKRF Inc. is also designing natural stream channel design concepts for five reaches on Wise's Mill Run. Three are located in reach WSWM02, one in WSWM04 and another on WSWM06. Restoration objectives include outfall modification (to dissipate energy), floodplain reconnection and regarding, riparian buffer enhancement bank stabilization and habitat enhancement (large woody debris jams).

3.6.7 Kitchen's Lane

3.6.7.1 Completed Projects

In the upstream-most reach of Kitchen's Lane (WSKL02), emergency repair work was completed in 2009 in a section of Fairmount Park known as Carpenter's Woods. Two outfalls, WSout513 and WSout514 (W-068-02), were severely undermined due to high velocity stormwater flows from Green Street. The erosion was so severe that the aprons for these outfalls were suspended up to five feet from their respective conveyance channels. Terraced boulder infiltration swales were installed to compensate for the vertical drop as well as reduce the energy of future storm flows. Cobble and boulder armoring was installed within the conveyance channels to reduce erosion and stabilize the banks of the conveyance channels. The emergency repair work was supplemented with shrub and tree plantings to further stabilize the site.

Figure 3-103: WSout513 conveyance channel during (left) and after (right) construction

Further downstream, gully repairs were completed by Friends of Wissahickon (FOW) in 2010. FOW Site 3 (Appendix E) was a gully that formed adjacent to a FPC trail on the steep eastern valley wall of Kitchen's Lane Run. FOW Site 4 (Appendix E) was a gully that formed along a "bench" on the western valley wall where it ultimately intersected and undermined a FPC trail at the downstream extent of the gully. The majority of the gully repair work has been completed at FOW Site 4 however the section in the immediate vicinity of the trail will be completed at a later date.

3.6.8 Monoshone Creek

3.6.8.1 Completed Projects

In the fall of 2005, PWD completed the construction of the City's first stormwater treatment wetland. The one acre wetland is designed to treat 70 million gallons of stormwater before an outlet structure discharges flow to Monoshone Creek. Besides water quality improvements, secondary benefits of the wetland include a reduction in high energy flows discharging to Monoshone Creek as well as the provision of habitat for a diverse assemblage of fish, amphibians, macroinvertebrates and birds.

In 2009, the Saylor Grove treatment wetland was dredged for the first time as part of the post-construction maintenance program. The wetland dredging had two main objectives-to expand the capacity of the wetland to store and treat stormwater and to redefine the wetland's low flow channels. Results of the post-dredging sediment composition analysis revealed that the vast majority of sediment removed consisted of sand (0.075mm – 4.75mm) and silt (0.005mm – 0.075mm). These results had implied that the wetland is in fact removing a large part of the suspended sediment load delivered from the Monoshone Creek watershed. If not for the wetland, the fine sediment component of stormwater would enter Monoshone Creek where it would have adverse implications for water quality (e.g. turbidity and total suspended sediment (TSS)) as well as instream habitat (e.g. stream bed embeddedness).

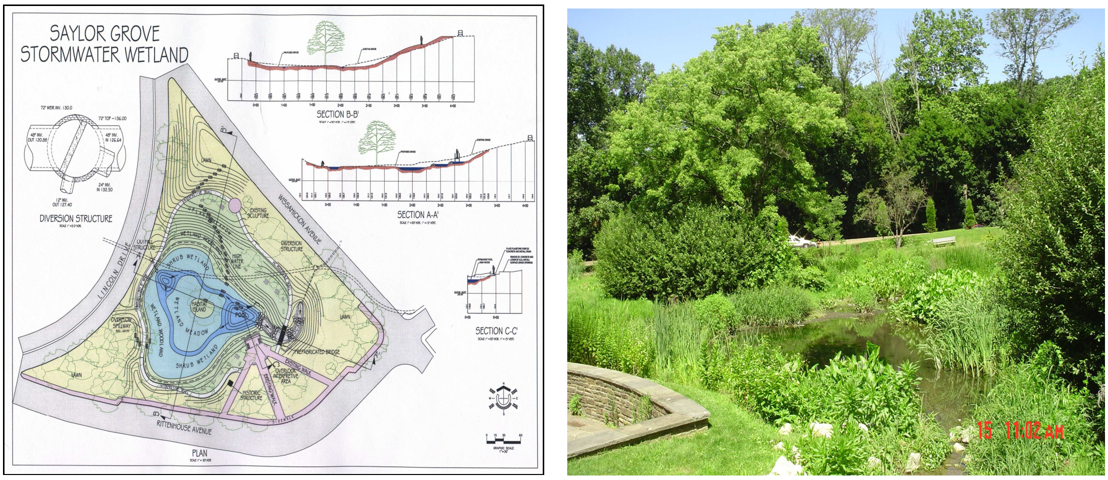


Figure 3-104: Plan view rendering of Saylor Grove Stormwater Wetland (left); fully vegetated view of Saylor Grove (right).

3.6.9 WISSAHICKON MAIN STEM

3.6.9.1 COMPLETED PROJECTS

Directly across from the confluence of Rex Avenue Run and the main stem of Wissahickon Creek (WSconf161) on the DSR bank of the Lower Wissahickon reach WSMS110, a large 30 inch water main collapsed in December of 2008. Following immediate emergency repairs by PWD which required extensive excavation, the DSR bank was severely destabilized (Figure 3-105) and threatened to both undermine a stacked masonry wall which ran parallel to the bank as well as deliver excessive sediment loads to the downstream segments of the main stem Wissahickon via erosion.

In March of 2009 PWD contracted the environmental engineering services of Skelly and Loy, who designed and constructed 175 feet of staggered boulder bank stabilization. In addition, two log vanes and a log deflector were installed at the “toe” of the DSR bank (Figure 3-105). These features provide key instream habitat to fish and macroinvertebrates. Instream boulder clusters and log structures create “velocity shelters” as well as backwater areas which serve as vital habitat for fish, especially during high flows. The naturalized, staggered bank stabilization structure will be further stabilized as the live dogwood and willow stakes planted by PWD’s Waterways Restoration Team, begin to fully mature.

Figure 3-105: DSR bank in reach WSMS110 following emergency repairs (left); DSR bank following bank stabilization and instream flow structure installation (right).

4 REFERENCES

"Bridges". Friends of the Wissahickon. 02/26/10 <http://www.fow.org/sbridge.php>

Brown, Ken. 2004. The Unified Stream Assessment – A Comprehensive Stream Walk Protocol for Evaluating Physical Conditions in Small Urban Watersheds. Center for Watershed Protection.

Dunne and Leopold. 1978. Water in Environmental Planning. W.H. Freeman and Company, New York.

Fairmount Park Commission, Montgomery County Planning Commission and Pennsylvania Department of Conservation and Natural Resources.2000.Wissahickon Creek River Conservation Plan.

Federal Interagency Stream Restoration Workgroup (FISRWG),1998. Stream Corridor Restoration: Principles, Processes, and Practices. By the Federal Interagency Stream Restoration Working Group (FISRWG)(15 Federal agencies of the US gov't). GPO Item No. 0120-A; SuDocs No. A 57.6/2:EN 3/PT.653. ISBN-0-934213-59-3.

Prince George's County Department of Environmental Resources et. al., undated, "Comparison of volume and duration of stormwater runoff before and after land development, and reductions in runoff from BMP's".

Rosgen, Dave. 1996. Applied River Morphology. Wildland Hydrology, Pagosa Springs, Colorado.

Rosgen, D. L. 2006. Watershed Assessment of River Stability and Sediment Supply (WARSSS). Wildland Hydrology, Fort Collins, Colorado.

Sparks, Richard, E. "Need for Ecosystem Management on Large Rivers and Their Floodplains." Bioscience 45:3 (1995):168-182.

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Field Indicators of Hydric Soils in the United States, Version 6.0. G.W.
Hurt and L.M. Vasilas (eds.). USDA,NRCS, in cooperation with the National Technical Committee for Hydric Soils.

Wolman, M.G., 1954, A Method of Sampling Coarse River-Bed Material: Transactions of the American Geophysical Union (EOS), v. 35, p. 951-956.

APPENDIX L –
SAYLOR GROVE STORMWATER TREATMENT WETLAND

Saylor Grove Stormwater Treatment Wetland

Operation, Maintenance, and Monitoring Report

May, 2010

1. Introduction

Saylor Grove is a small park in Philadelphia located at the terminus of a 156 acre urbanized watershed adjacent to Fairmount Park. This watershed drains from the W-060-10 outfall into Monoshone Creek, a major tributary of Wissahickon Creek that has been heavily impacted by urban runoff.

In 2003, the Philadelphia Water Department (PWD) retained TRC Omni Environmental Corporation (Omni) to develop a design to convert a portion of Saylor Grove into a stormwater wetland. The wetland was designed to divert the first flush of runoff from the storm sewer system draining the watershed. The primary design goal of the Saylor Grove wetland was to filter out the most polluted runoff from frequent events that generate the majority of pollutant load, and reduce the peak flows from these events, which are most responsible for downstream bank erosion.

In addition to these design goals, an additional design objective of the restoration plan was to install native plants and forbs around the wetland to replace the existing turf. Proposed amenities included an interpretive trail with signage, a pedestrian bridge, and conversion of the former fountain into a gathering area.

The Saylor Grove Stormwater Treatment Wetland was constructed during fall, 2005. Final site stabilization and landscaping was completed in spring, 2006. Since that time, the facility has been in operation detaining and treating runoff.

2. Hydrological and Hydraulic Performance Analysis

In October, 2009, OOW deployed a HOBO datalogger to monitor the water level inside the wetland to assess the performance of the Saylor Grove treatment wetland in attaining the stated stormwater management goals. The datalogger was installed at the outlet structure on October 7, 2009 and retrieved on November 9, 2009. During that time, the HOBO logged four major storm events that were used for the calibration of the SWMM model (Figure 1, Figure 2, Figure 3, Figure 4).

Table 1 - Storm Events used for calibration of the Saylor Grove SWMM Model

Date	Duration (hr)	Rainfall (in)
10/15/09 – 10/18/09	73.00	2.12
10/23/09 – 10/24/09	27.25	1.80
10/27/09 – 10/28/09	33.00	1.77
10/31/09 – 11/01/09	31.75	0.32

The calibration curves for each of these events showed good agreement between the SWMM model and the observed data as measured by the HOBO datalogger.

The calibrated SWMM model of Saylor Grove was used to model the typical rainfall year. The typical rainfall year represents a hyetograph that is based upon the rainfall measured by PWD rain gages during 2005. Total precipitation was 46.22 inches, of which 5.01 inches were attributed to evaporation loss, 33.94 inches were attributed to infiltration loss, and 7.34 inches were attributed to surface runoff in the Saylor Grove watershed. The model estimated 34.8 millions gallons of surface runoff arrived at Saylor Grove over the course of the year. Of that amount, 9.4 million gallons was diverted from the Saylor Grove facility, while 25.4 million gallons or 73% of the watershed's annual stormwater runoff was diverted into the treatment wetland.

The percent reduction in peak flow was also analyzed when rainfall intensity was considered (Figure 5). During the typical year, 81 distinct rainfall events were identified, of which, 61 (75%) resulted in peak rainfall intensities less than 0.50 inches per hour. 71 (88%) of the year's rainfall events resulted in peak rainfall intensities less than one inch per hour (Figure 6). This analysis also revealed that as rainfall intensity increased, the range of the 95% confidence interval of the peak flow reduction also increased. The percent peak flow reduction range of the 95% confidence interval for events less than 0.5 in/hr was +/- 6%, while for those events greater than 2.0 in/hr, the interval was greater than +/- 30%. This effect can be attributed primarily to the number of events in each class, as well as the variation in the facility's performance during such events.

A similar analysis described the percent peak flow reduction as a function of total event rainfall in inches. Of the 81 rainfall events modeled during the typical rainfall year, the Saylor Grove Wetland reduced the peak flow by more than 50% in 63 events (78%). The total rainfall of these events ranged from 0.03 – 1.53 in, with an average total event rainfall of 0.34 in. The total rainfall of the remaining 18 events ranged from 0.34 – 3.57 in with an average total event rainfall of 1.33 in. Saylor Grove reduced peak flows of these events by 9 – 42%,.

3. <u>The Maintenance Dredging Operation</u>

In March, 2007, OOW staff completed a detailed topographic survey of the treatment area of the facility, which is considered the "as-built" topographic survey of the fully functional wetland (Figure 7). The treatment volume of the facility, based upon the 2007 survey was 75,993 ft^3. This estimate defined treatment volume at the facility as available storage volume up to the elevation of the weir on the outlet structure (127.2 ft).

In May, 2009, OOW staff completed a follow-up topographic survey to determine the treatment volume of the facility after two full years of operation (Figure 8). This effort provided an estimate of 54,661 ft^3 of treatment volume, or a 28% reduction in the wetland's treatment volume. Based upon the difference between the 2007 and 2009 surveys, the treatment volume was reduced by 21,332 ft^3, or roughly 10,000 ft^3 per year.

The Operations and Maintenance Manual for the Saylor Grove Stormwater Treatment Wetland recommends "periodic sediment removal from the pool area" of the facility. A comparison of the 2007 and 2009 topographic surveys revealed that not only did the pool area of the facility sustain significant sedimentation, but the entire wetted footprint of the facility.

After multiple meetings between OOW, Collectors, and Sewer Maintenance personnel, the decision was made to pursue the dredging of targeted areas within the facility. Dredge depth targets for the site ranged between 1-3 feet as depicted in Figure 9. The targeted areas within the facility included:

- The upper forebay
- Both low flow channels around the "habitat island"

- The wetland meadow area between the low flow channel and Rittenhouse St.

The wetland meadow on the north side of the facility was avoided due to concerns with heavy equipment operating in the area of the 48” brick pipe just below the surface of the facility.

The dredging operation commenced on Monday, January 11, 2010. Geppert Bros. provided a track hoe and operator that worked under the direction of Pat Ford (PWD – Waterways Restoration Team). Pat Ford also had a work crew on-site to implement the E&S plan for the duration of the operation. The E&S plan was implemented with two main goals:

(1) Divert all clear water flowing into the wetland around the disturbed area
(2) Prevent all mud from leaving the disturbed area via the outlet structure.

This was accomplished by closing the valves at both the Wissahickon Avenue and Rittenhouse Avenue diversion structures. In addition, the outfall from each diversion was blocked with a balloon to capture any flow that may have leaked through the upstream valve. For the duration of the dredge operation, this flow was diverted beneath the wetland and into the existing 48” brick stormwater conduit. Groundwater seeps entering the wetland were also captured and diverted to promote the driest possible conditions.

Excavation began in the forebay area at the upper portion of the wetland. The targeted excavation depth for this area was 1-3 feet. As this depth was achieved, the track hoe continued excavating the southern wet meadow area to a targeted depth of approximately 1 foot. In addition, the southern low-flow channel was restored, with a targeted excavation depth of 2 feet. Throughout the operation, the track hoe continually worked towards the egress area, while loading the dredge spoils onto dump trucks as they arrived on-site. The dredge operation was completed on Friday, January 15, 2010.

Dredge Data Analysis

At the completion of the dredging operation, Rick Howley and Erik Haniman completed a topographic survey of the facility (Figure 10). In addition, a Cut/Fill analysis was completed to provide a comprehensive description of where material was removed or deposited (Figure 11). The post-dredge treatment volume at Saylor Grove was determined to be 64,169 ft^3, representing a total removal of 9,508 ft^3 of sediment.

BLS performed analysis of a sample of the dredge spoils. The sample’s density was 95 lb/ft^3 and had a moisture content of 63%. Based upon this analysis, the total weight of dredge spoils removed was estimated to be 903,260 lb (569,054 lb water, 334,206 soil). Sieve analysis was done and is presented in Table 2.

Table 2 - Soils Physical Analysis (Performed by BLS - 1/27/10)

GRADATION SIEVE SIZE U.S. MESH	Percent Passing (%)		SOIL COMPOSITION	%
1"	100		*GRAVEL (4.75 - 75.00 MM)*	12
#4	87.9		*SAND (0.075 - 4.75 MM)*	47.3
#10	83.4		*FINES (< 0.075 MM)*	40.7
#20	77.3		*SILT (0.005 - 0.075 MM)*	*31.9*
#40	68.7		*CLAY (< 0.005 MM)*	*8.8*
#60	59.8			
#100	51.1		**SOIL CLASSIFICATION**	SM -Silty Sand
#200	40.7			
MOISTURE CONTENT	63%			
DENSITY (lb/ft^3)	95.4			

Elemental analysis of the dredge spoils sample was also performed and is presented in Table 3. This analysis showed the sample to be very comparable to the accepted median elemental concentrations presented.

Table 3 - Elemental Analysis of Saylor Grove Dredge Spoil Sample

		Dredged Material Elemental Analysis (%'s)		Median %'s and mg/kg conc. Of Elements in Earth's Soils		
pH	6.8			-	**%'s**	**mg/kg**
% Organics	5.8	**N**	0.12	**N**	0.200	2000
Density of sludge (lbs / ft^3)	95	**P**	0.08	**P**	0.080	800
		Al	7.88	**Al**	7.100	71000
		As	0.001			
		Ca	1.6	**Ca**	1.500	15000
		Cd	0.001			
		Fe	4.96	**Fe**	4.000	40000
		Hg	0.0001			
		Mg	1.06	**Mg**	0.500	5000
		Mn	0.061	**Mn**	0.100	1000
		Pb	0.01			
		Si	30.48	**Si**	33.000	330000
		Zn	0.017	**Zn**	0.009	90

4. Annual Maintenance

Perhaps the most important factor in retaining the optimum performance of any stormwater treatment wetland is maintenance. Over its four years of operation, this has certainly been the case at Saylor Grove. Structural elements such as the diversion structures, inlets, and the outlet structure require frequent inspection and maintenance to assure proper function. Debris and sediment have caused clogging of inlets and other structural elements, affecting the drainage in the immediate area. This has produced concentrated stormwater discharges over the path thereby delivering excessive sediment loads to the upper forebay.

Similarly, the vegetative elements at Saylor Grove also require regular monitoring and maintenance. The primary issue present at the facility is invasive species prevention and removal. In these instances, less desirable plants species must be controlled to allow for the growth of other more desirable species. Lastly, monitoring of the aesthetic elements of the Saylor Grove wetland is also important; specifically, the removal of trash and debris from the area such that a clean, maintained appearance is preserved.

To assure that the Saylor Grove stormwater wetland is operated and maintained at an optimal level, a basic inspection and maintenance schedule has been developed. Key tasks and personnel are identified to promote the long-term sustainability of this facility (Table 4).

Table 4 - Saylor Grove Maintainence and Monitoring Schedule

Maintenance Task	Frequency	Lead	Support	Description
Monitor Invasive Vegetation	Monthly Inspection*	Sarah Low-FP	Fairmount Park Staff, Rick Howley-OOW, Pat Ford-WRT, Waterways Restoration Team	Identify and track invasive species growth within the wetland.
Replacement of Vegetation	Annually*	Sarah Low-FP	Fairmount Park Staff, Rick Howley-OOW, Pat Ford-WRT	Vegetation lost during invasives management, winter, general die off, or due to dredging must be replaced using recommended species. With seeding/planting plan developed, stakes and seeds should be planted around the rim and in the wetland.
Mowing	Biweekly / As Needed*	Fairmount Park		Mowing is managed by Fairmount Park.
General Care of herbaceous, shrub, and tree plantlife	Annually*	Fairmount Park	Waterways Restoration Team	Annual mowing of herbaceous vegetation conducted in either fall or spring. Mowing should be no less than 6" and all material left in place. Shrubs and trees should be watered during first year, if necessary. Inspect shrubs and trees for pests and diseases. Occasional pruning of trees and shrubs will be done as needed. Invasive species should be treated and removed as appropriate
Slope Erosion Protection on West Side of the Area	As Needed	Pat Ford-WRT	Waterways Restoration Team, Sarah Low-FP	Restablize slope by removing current plastic blanket, raking hillside, seeding the exposed soil, and installing straw and cloth string blanket.
Trail Renovation	Monthly Inspection	Pat Ford-WRT	Waterways Restoration Team, Rick Howley-OOW	Trail erosion near footbridge must be corrected. Need to establish a manner in which to get overland flow to channel from Wissahickon Ave. Install gravel where the trail has eroded. Herbicide vegetation that has overgrown trail.
Trash and Debris Removal	Biweekly/After Storm Events	Waterways Restoration Team	Pat Ford-WRT	All trash and undesirable debris must be removed from the wetland and surrounding area consistently.
Inspection of Diversion Structures	Monthly	Waterways Restoration Team	Pat Ford-WRT	The grates over the chambers and the conditions within the chambers themselves should be checked and cleaned accordingly when necessary.
Dredging Wetland Forebay	Annually	Waterways Restoration Team	Geppert Bros, Ecological Restoration Unit	The sediment delivered to the wetland by the stormwater runoff flows settles in the basin and reduces the volume of water that the basin can contain. Dredging of the basin was contracted to Geppert Bros through Sewer Maintenance. The dredging of the forebay pond area, which settles most of the mass of sediment, is being considered an annual maintenance task.
Topographic Survey	Annually	Ecological Restoration Unit-OOW		Survey of the elevations and contours in and around the wetland to determine sediment catchment and removal.
Water Level Monitoring	Continuously	Ecological Restoration Unit-OOW		Generate data on the water level at the outlet structure in the wetland using HOBO monitoring units. Defines information needed to create H&H models for the wetland.
Photo Monitoring	Monthly	Ecological Restoration Unit-OOW		Photos taken from several consistent locations showing different angles and aspects of the wetland. This will display the seasonal changes of the wetland site.

* **During Growing Season**

5. Next Steps

In addition to performing those tasks necessary to operate and maintain the Saylor Grove facility at its optimum performance level, PWD will also expand its monitoring plan. While the existing SWMM model of the Saylor Grove watershed represents a good estimation of the hydrological and hydraulic operation of the facility, additional calibration will only increase the model's accuracy. A HOBO datalogger will be deployed in summer, 2010 to monitor the water level within Saylor Grove. As additional storm event data is obtained, the accuracy of the SWMM model will increase, thereby increasing the model's predictive capacity.

Concurrently, PWD will be collecting wet weather water quality data in an effort to better understand the pollutant removal performance of Saylor Grove. ISCO samplers will be deployed during multiple wet weather events throughout the growing season (May – September, 2010). PWD hopes to characterize the inflow and outflow concentrations of total suspended solids (TSS), as well as nitrogen and phosphorus. In combination with a calibrated SWMM model, annual loading and removal performance of the facility can be estimated. The availability of this data will improve PWD's ability to meet MS4 permit requirements, as well as better inform the design and operation of similar stormwater management facilities in the future.

In the years to come, PWD also anticipates the need to conduct maintenance dredging at Saylor Grove. Annual monitoring of the facility's topography will provide estimates of sedimentation rates and allow for dredging to take place in an efficient and targeted fashion. PWD also hopes to significantly reduce the cost of maintenance dredging operations. Rather than conducting operations in the winter, it is recommended that this sort of operation take place in the later summer or early fall. Doing so will significantly reduce the moisture content, and therefore the overall volume of the dredge spoils. In addition, spoils with lower moisture content would prove more attractive to nearby Fairmount Park district facilities. As a result, dredge operation costs at Saylor Grove may be reduced by as much as 50%.

As PWD's only operating stormwater treatment wetland, Saylor Grove has been a shining example of the implementation of naturalized stormwater treatment in the urban environment. In addition, the success of Saylor Grove has demonstrated that existing stormwater infrastructure can be modified to accommodate naturalized systems. The realization of this goal is extremely significant. Naturalized systems, such as Saylor Grove, offer many advantages over traditional stormwater conveyance infrastructure. While traditional stormwater infrastructure expedites the delivery of pollutant-laden runoff to receiving creeks and streams, systems like Saylor Grove are able to reduce the quantity of water delivered and remove pollutants, thereby improving its quality.

The success of Saylor Grove has stimulated even greater interest on the part of PWD in constructing two similar naturalized stormwater management facilities. In June, 2010, construction will begin on the Cathedral Run stormwater treatment wetland and the Wises Mill stormwater treatment wetland. Both facilities will receive and treat diverted stormwater from existing stormwater infrastructure. Due to the larger available footprint for these facilities, PWD expects them to provide even greater benefits than those demonstrated at Saylor Grove.

Appendix A – Saylor Grove H&H Analysis

Figure 1 - Outlet Calibration Curves for the 10/15/09 Event

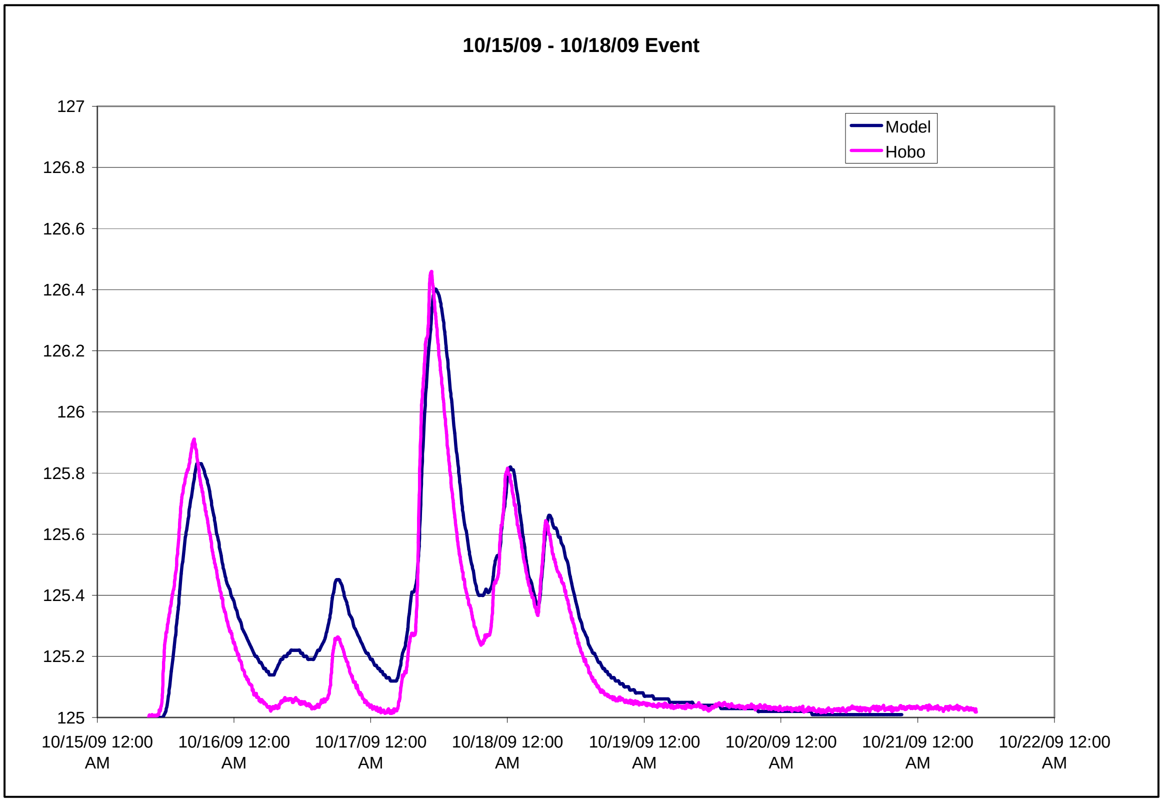


Figure 2 - Outlet Calibration Curves for the 10/23/09 Event

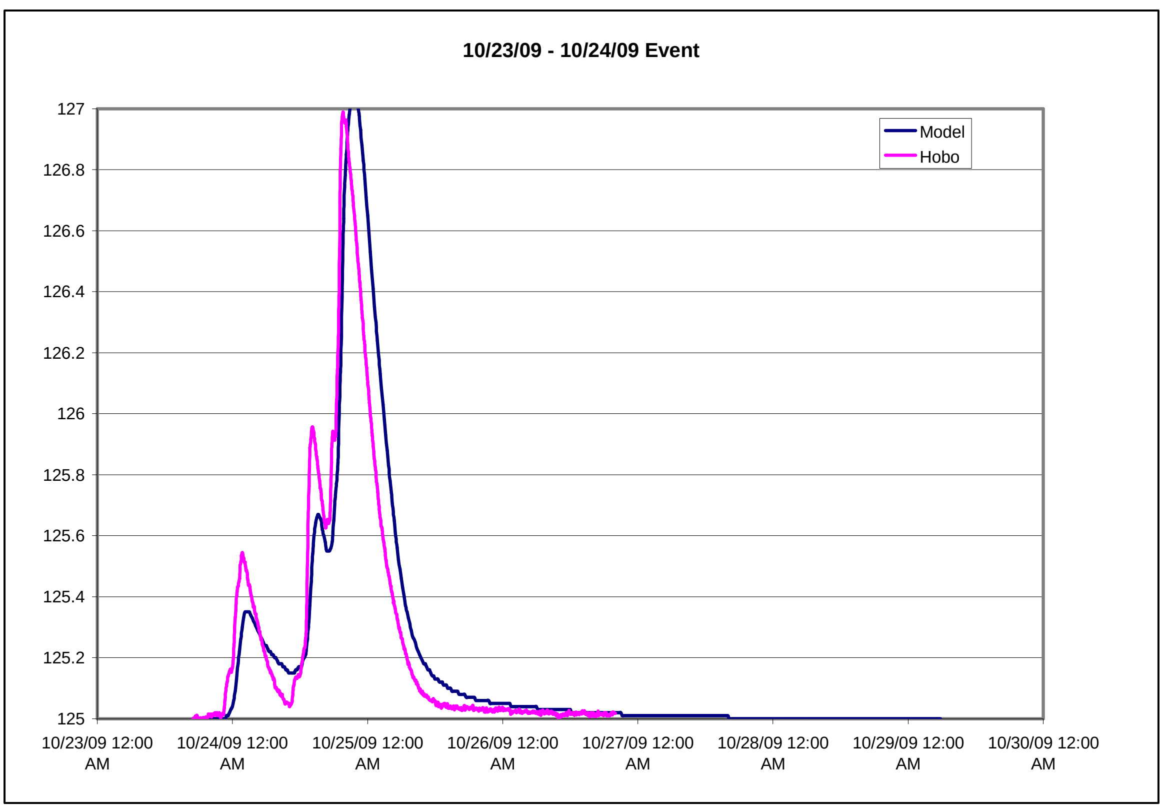


Figure 3 - Outlet Calibration Curves for the 10/27/09 Event

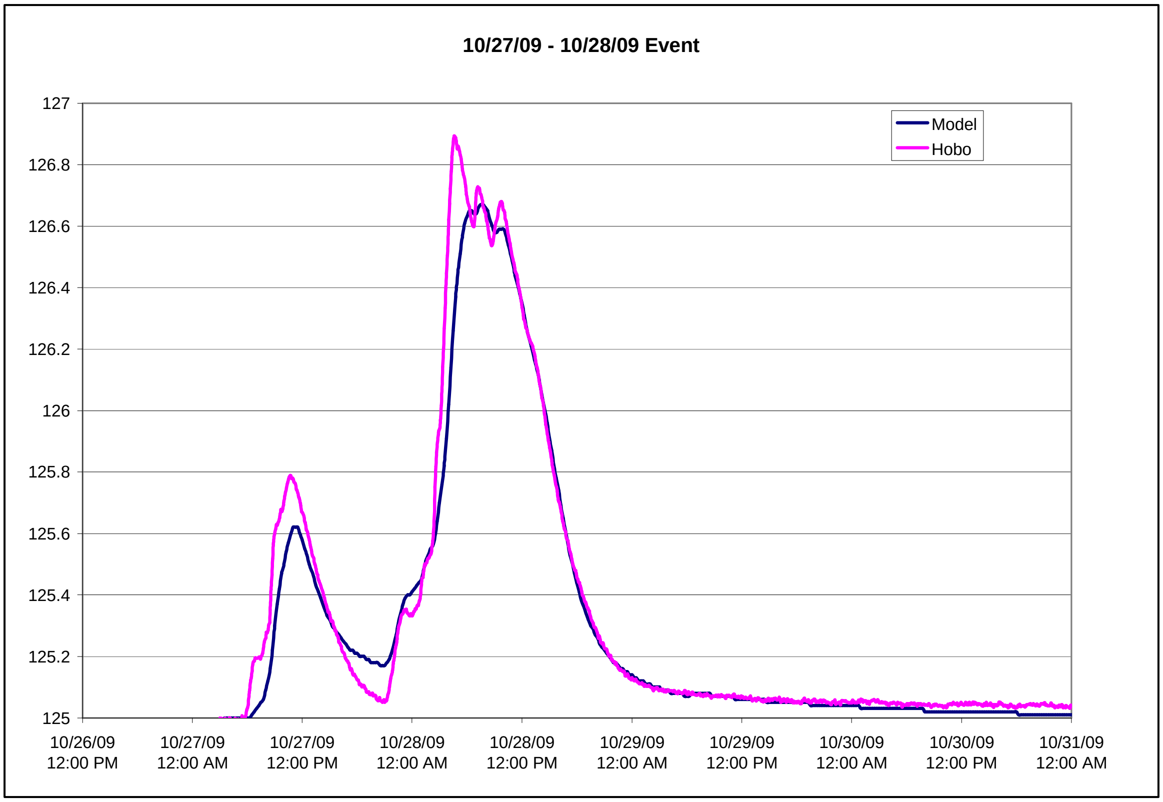
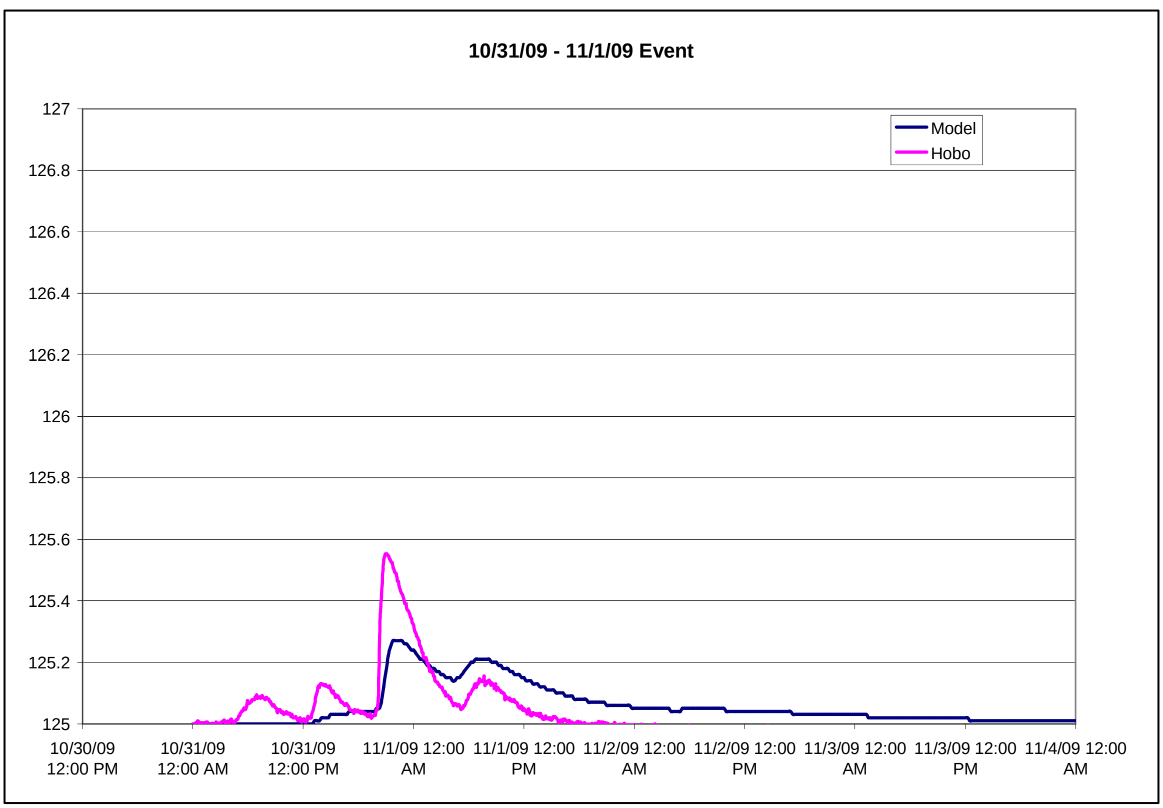


Figure 4 - Outlet Calibration Curves for the 10/31/09 Event



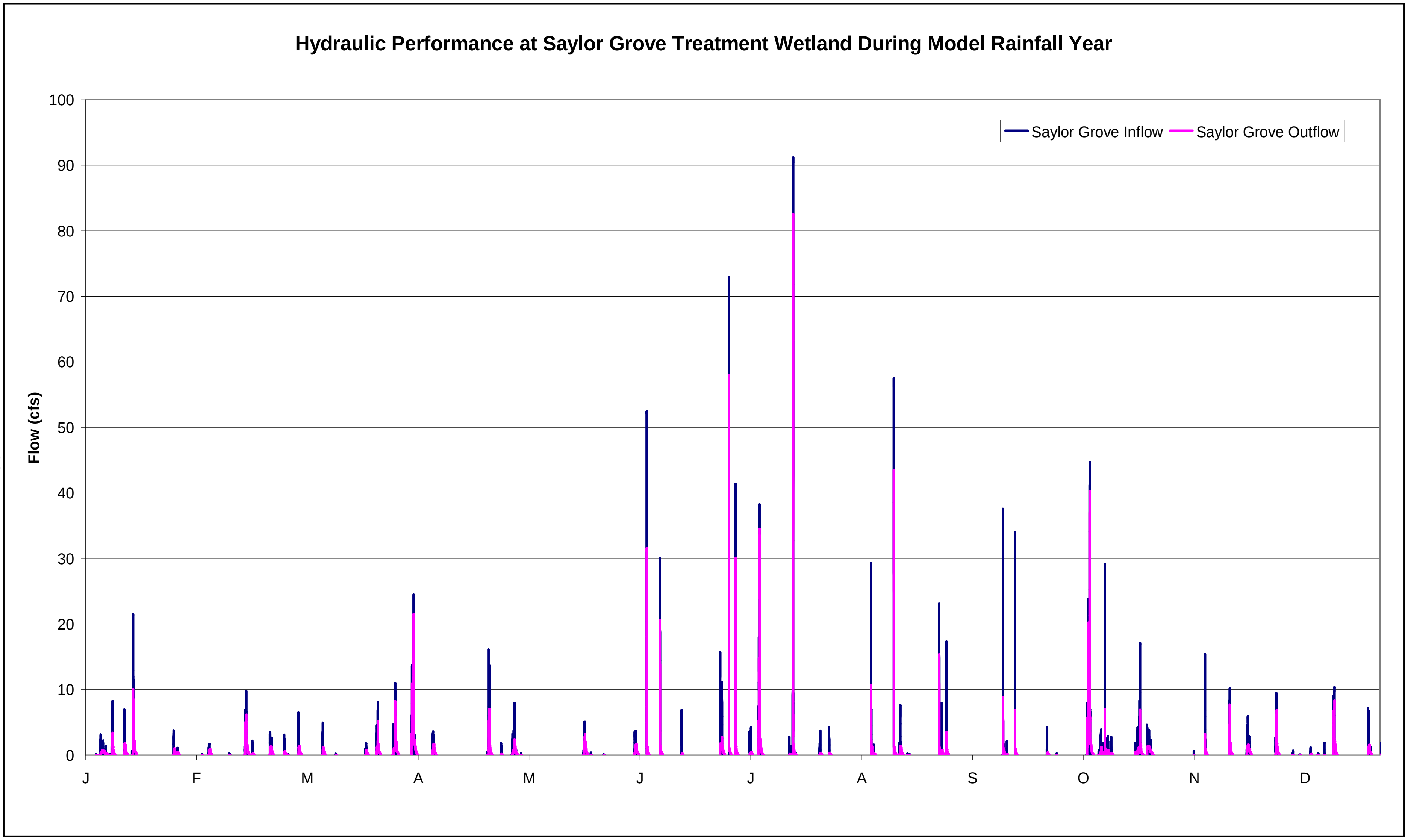
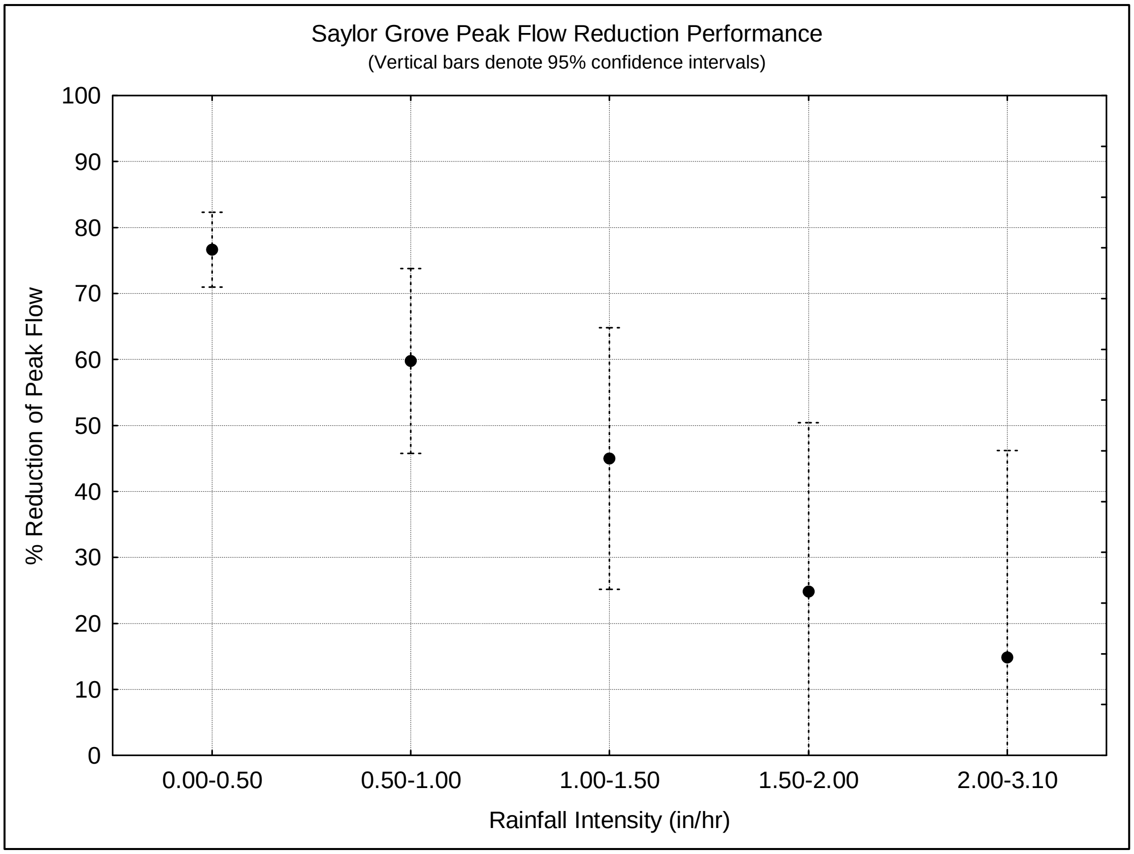
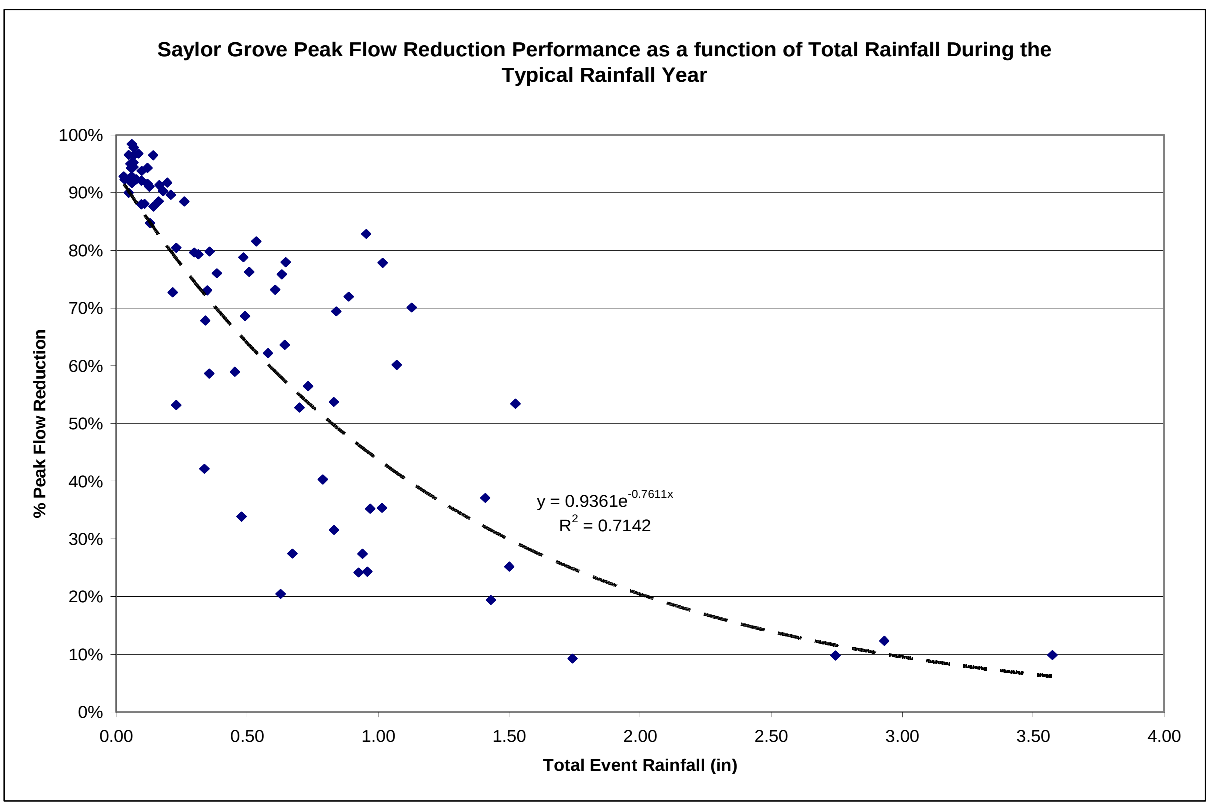


Figure 5 - Saylor Grove Flows During Model Rainfall Year

Figure 6 - Peak Flow Reduction at Saylor Grove as predicted by Rainfall Intensity





Appendix B – Saylor Grove Dredge Plans

Figure 7 - 2007 ("As-Built) Topographic Survey at Saylor Grove Stormwater Wetland

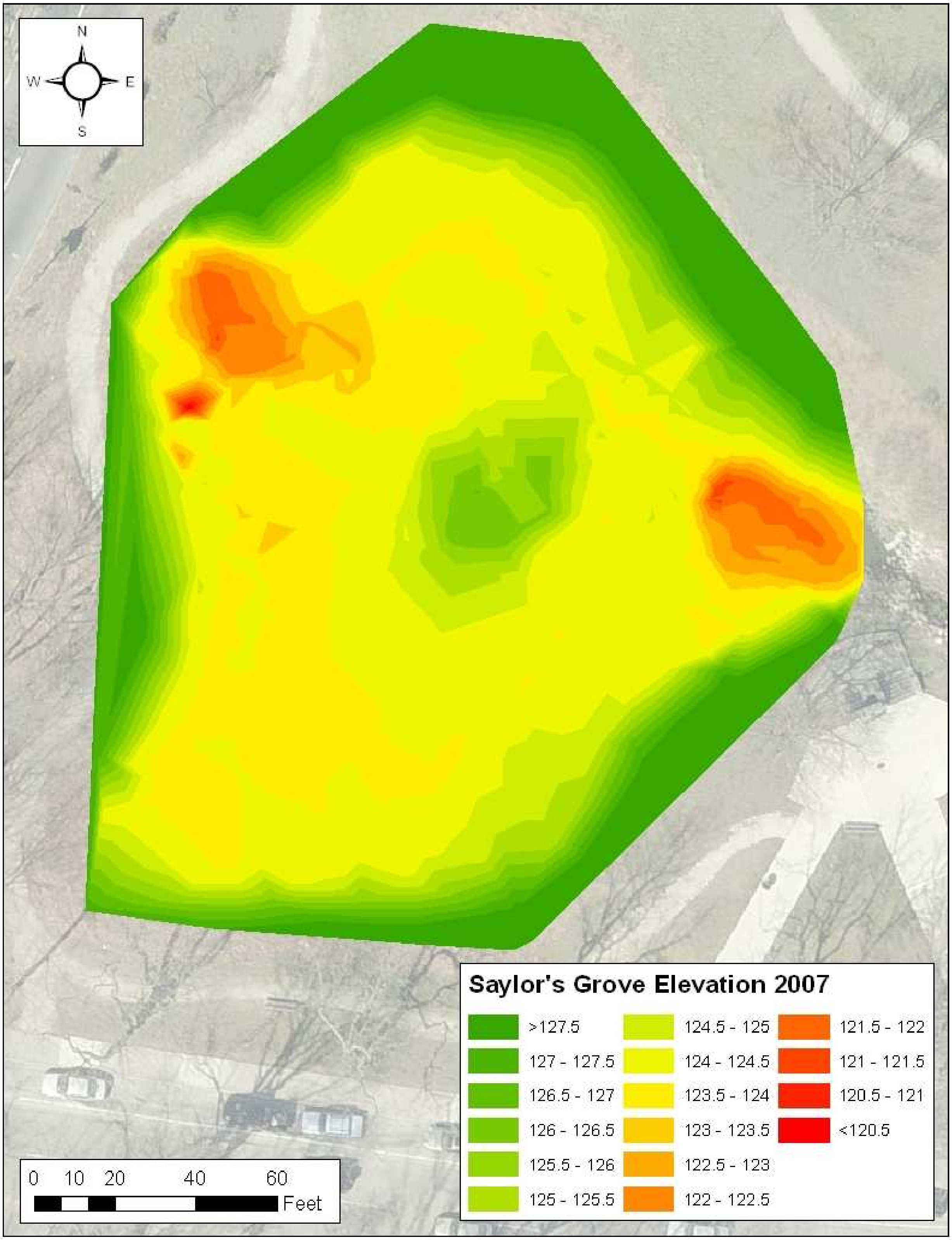


Figure 8 - 2009 Topographic Survey at Saylor Grove Stormwater Wetland

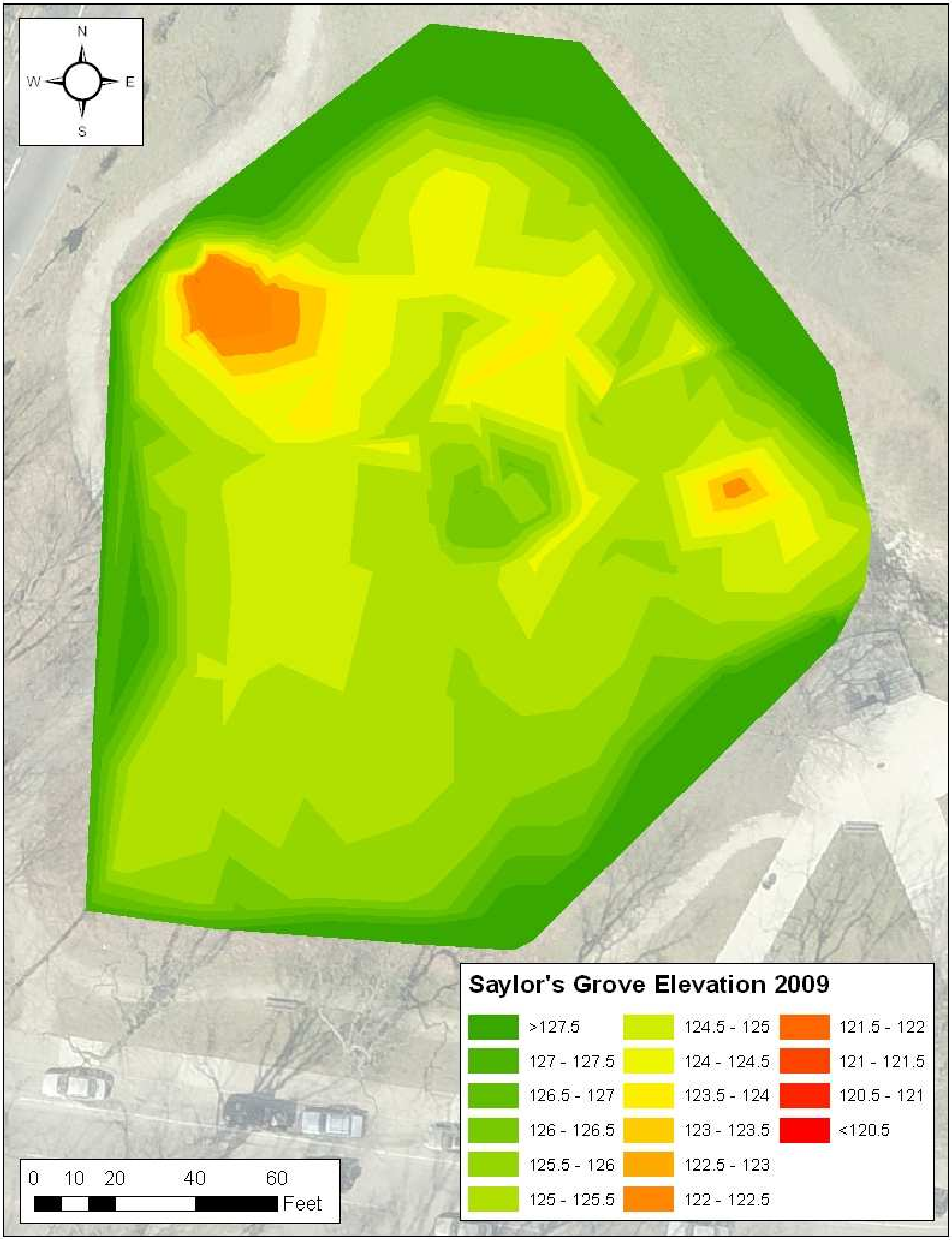


Figure 9 - 2010 Saylor Grove Dredging Plan

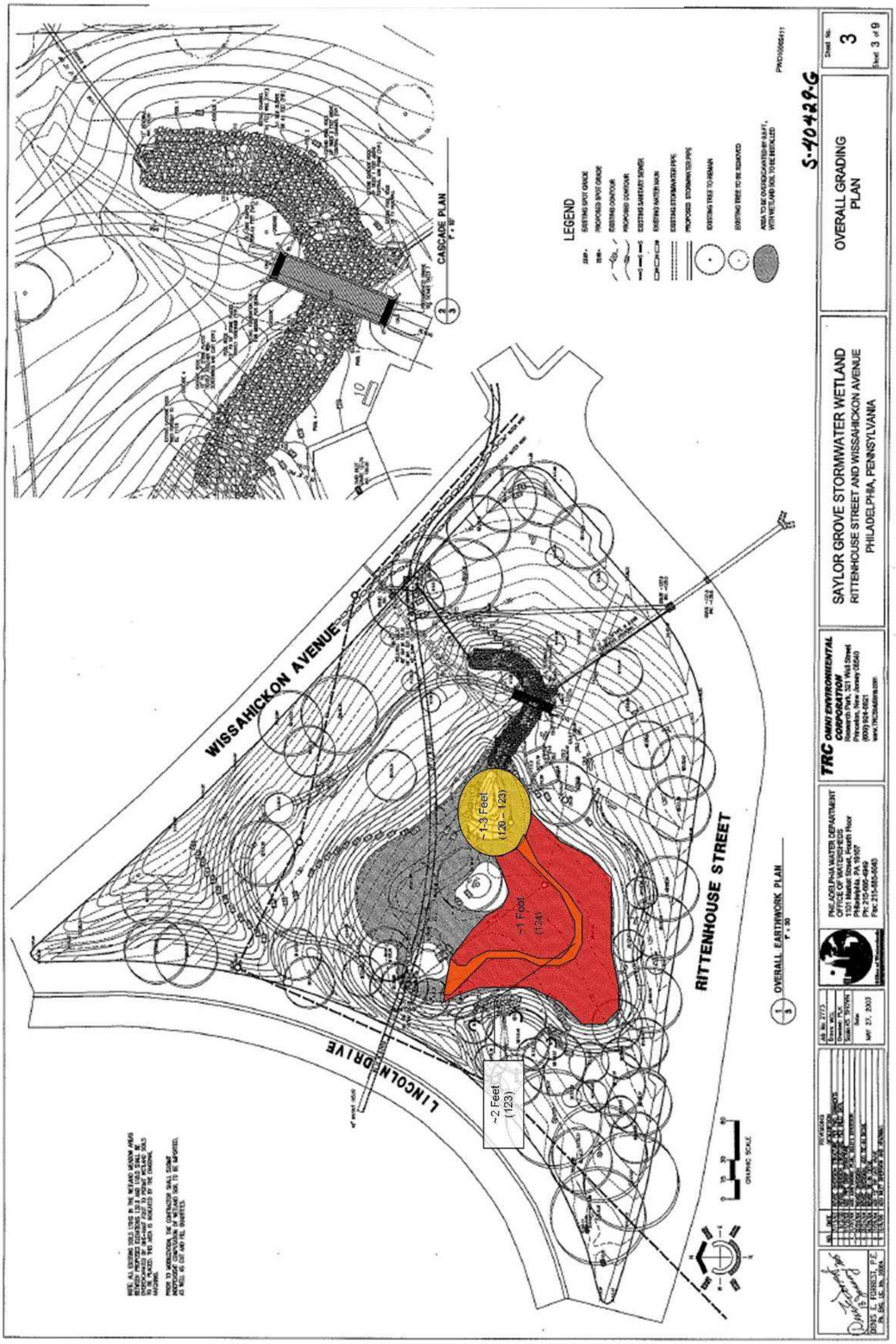


Figure 10 - 2010 Post-Dredge Topographic Survey at Saylor Grove Stormwater Wetland

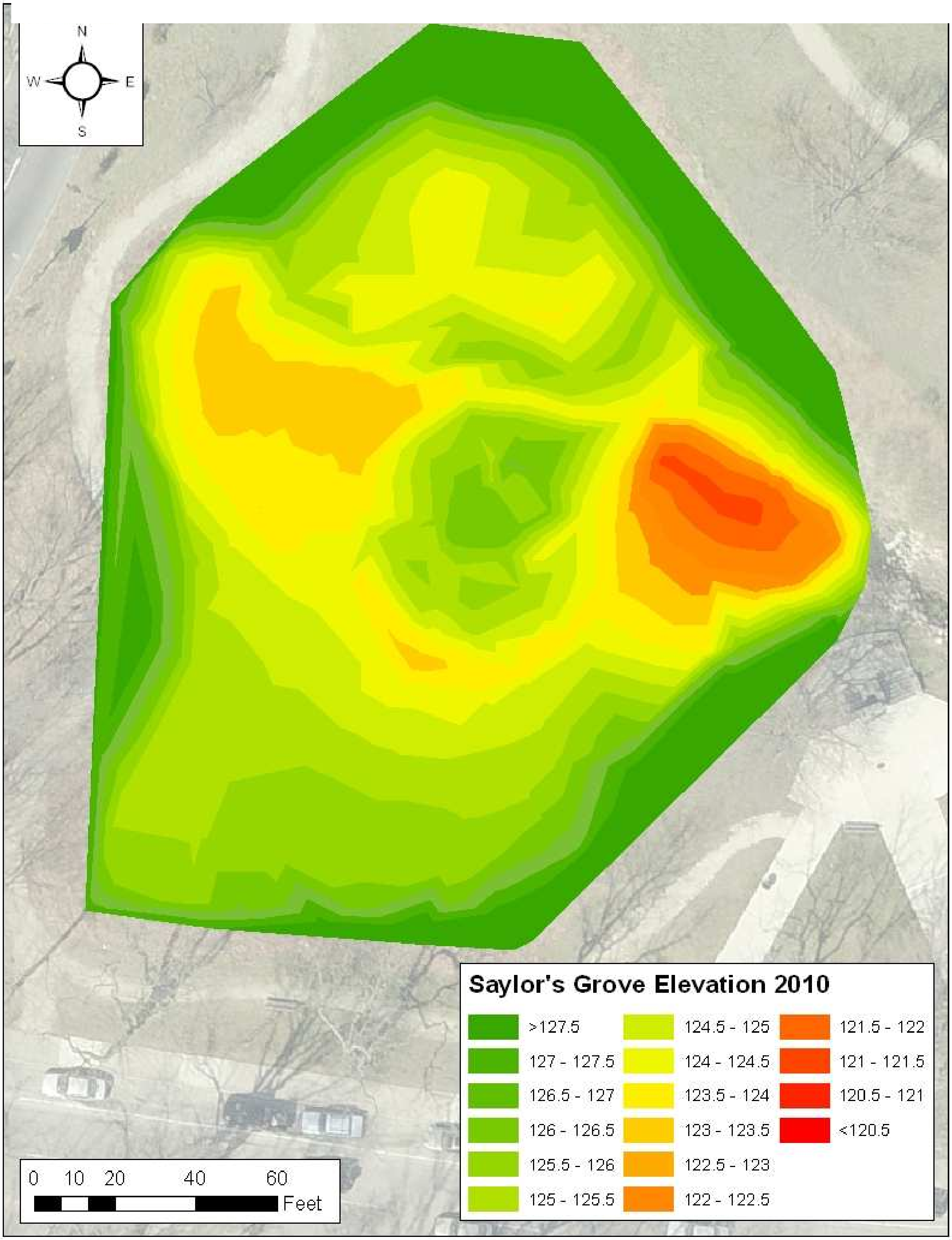
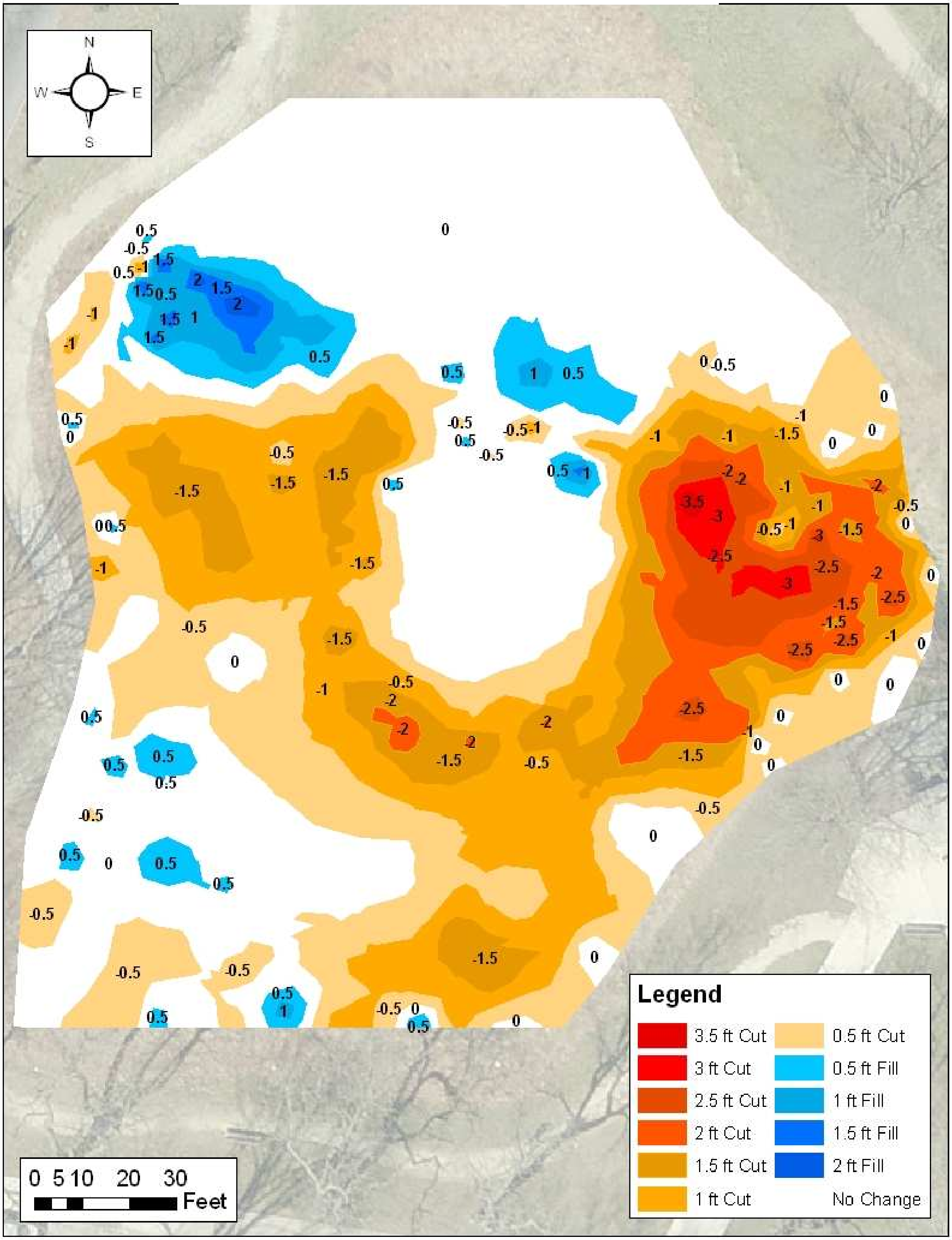


Figure 11 - Saylor Grove Dredge Cut/Fill Analsis



Appendix C – Saylor Grove Dredge Cost Report

PWD EMERGENCY PROJECT COST REPORT

Name of Unit	Sewer Maintenance
Emergency Project Name:	Saylor Grove Wetland
Date of work:	January 11,2010

(Use separate tab/page for each date.)

Brief Description of Work

The scope of work being done is dredging the wetland of sediment that has accumulated in three years.

For each employee, enter payroll #, name, straight time hours, hourly rate, 1.5x OT hours & 2x overtime hours.

Labor

Payroll #	Name	Straight time hours worked.	Hourly Rate	Weighted Average Fringe Rate	Straight Time Cost	1.5X Hrs Worked	1.5X Hr Cost w/ Fringe Cost	2X Hrs Worked	2X Hr Cost w/ Fringe Cost	Overtime Cost	Total Labor Cost
Enter Info.	**Enter Info.**	**Enter Info.**	**Enter Info.**			**Enter Info.**	Fringe rate 39.874%	**Enter Info.**	Fringe rate 39.874%	1.5x + 2x Subtotal	Labor Total
198837	Robert P. Ford	40.0	$21.37	70.86%	$1,460.51	9.5	$425.95	0.0	$0.00	$425.95	$1,886.46
133450	Carl Watson	48.0	$19.37	70.86%	$1,588.59	9.0	$365.76	0.0	$0.00	$365.76	$1,954.35
169547	Tyrone Plummer	48.0	$16.75	70.86%	$1,373.71	1.0	$35.14	0.0	$0.00	$35.14	$1,408.86
231721	Neal Spennato	48.0	$18.25	70.86%	$1,496.73	9.0	$344.61	0.0	$0.00	$344.61	$1,841.35
242728	Darin Dawson	64.0	$16.62	70.86%	$1,817.40	9.0	$313.84	0.0	$0.00	$313.84	$2,131.24
244277	Frank Carter	68.0	$15.00	70.86%	$1,742.77	9.0	$283.24	0.0	$0.00	$283.24	$2,026.02
248490	Ron Dean	48.0	$15.50	70.86%	$1,271.20	17.0	$552.85	0.0	$0.00	$552.85	$1,824.05
264132	Ray Lyman	56.0	$15.00	70.86%	$1,435.22	17.0	$535.02	0.0	$0.00	$535.02	$1,970.24
197232	W.Newton	32.0	$19.08	70.86%	$1,043.20	0.0	$0.00	0.0	$0.00	$0.00	$1,043.20
237745	M. Jones	32.0	$15.08	70.86%	$824.50	0.0	$0.00	0.0	$0.00	$0.00	$824.50
168172	Denis Mora	32.0	$21.37	70.86%	$1,168.41	0.0	$0.00	0.0	$0.00	$0.00	$1,168.41
251294	D. Frazier	32.0	$16.62	70.86%	$908.70	0.0	$0.00	0.0	$0.00	$0.00	$908.70
241878	A. Wheeler	8.0	$18.25	70.86%	$249.46	0.0	$0.00	0.0	$0.00	$0.00	$249.46
240742	C. Shaw	8.0	$19.37	70.86%	$264.76	0.0	$0.00	0.0	$0.00	$0.00	$264.76
234674	G.Green	8.0	$15.50	70.86%	$211.87	0.0	$0.00	0.0	$0.00	$0.00	$211.87
215874	M.Pettus	8.0	$15.50	70.86%	$211.87	0.0	$0.00	0.0	$0.00	$0.00	$211.87
	SUBTOTALS, Labor									**$2,856.42**	**$19,925.33**

Other Costs (not vehicle or equipment)			
Enter Elec., Gas, Chemical, Chem. Test & Other Category Name, with Unit of Measure (if any).	# of Units	Unit Cost	Total Cost
(Geppert Contractor Trac-Hoe)	1.00	$14,800.00	$14,800.00
			$0.00
Sediment Debris Removal		$36,434.43	$36,434.43
			$0.00
SUBTOTAL - Other Costs			**$51,234.43**

Note: To save space on your submission, you can delete some unused rows. Only experienced users should

			Vehicle/ Equipment Costs			
	Enter	Vehicle ID #	Vehicle/Equipment Name	# of Hours	$ Cost per Hour	Total Cost
	vehicle $					$0.00
Pickup small	cost per	30022		64.0	$8.94	$572.16
$8.94	hour					$0.00
Stakebody	from	40014		64.0	$16.96	$1,085.44
$16.96	list on					$0.00
Dump Truck	the left.	90002		16.0	$29.07	$465.12
$29.07	If not on					$0.00
Dump Truck La	list, enter	55		32.0	$46.50	$1,488.00
$46.50	all other					$0.00
Dump Truck	available	182		48.0	$29.07	$1,395.36
$29.07	info.					$0.00
Dump Truck La		50027		56.0	$46.50	$2,604.00
$46.50						$0.00
Dump Truck Large		56		48.0	$46.50	$2,232.00
46.5						$0.00
Generator				96.0	$18.10	$1,737.60
18.1						$0.00
Pump Tag Along				108.0	$6.76	$730.08
6.76						$0.00
						$0.00
						$0.00
			SUBTOTAL - V & E			**$12,309.76**
				Total Labor Cost		$19,925.33
				Total Other Costs		$51,234.43
				Total Vehicle/Equip. Cost		$12,309.76
				Total Event Cost-this day		**$83,469.52**

Appendix D – Saylor Grove Dredge Photos

Saylor's Grove Dredging Photos

Dredging of forebay pond. View from footbridge. 1/11/2010

Dredging of forebay pond. 1/11/2010

Forebay pond after dredging. 1/15/2010

Grading the soutwest area away from forebay pond. 1/15/2010

Dredging and grading southwest area. 1/15/2010

Loading dredged material onto trucks for transfer and disposal. 1/15/2010

Saylor's Grove Dredging Photos - Final Grading

View from Rittenhouse St. sidewalk.

Dredged forebay pond. View from south.

Dredged forebay pond. View from fountain.

Dredged forebay pond. View from over fountain.

Dredged forebay pond. Veiw from channel.

Grading around forebay pond area.

Saylor's Grove Post-Dredge Photos

View from Rittenhouse to the intersection of Lincoln Dr and Wissahickon Ave

View from path off Rittenhouse to Lincoln Dr

View from the fountain across the wetland

View from Lincoln Drive to Rittenhouse

View from Lincoln Drive to the forebay area of the wetland

View from the outlet structure to Rittenhouse

Appendix E – Saylor Grove Monitoring Photos

Saylor's Grove Monitoring Photos

Saylor's Grove Monitoring Photo 1-Looking toward Rittenhouse St from Outlet Structure

7/15/2009

10/14/2009

11/9/2009

3/1/2010

4/23/2010

Saylor's Grove Monitoring Photo 2-Looking Across Exit Bay Toward Habitat Island

5/23/2007

3/19/2008

10/14/2009

11/9/2009

3/1/2010

4/23/2010

Saylor's Grove Monitoring Photo 3-Looking From SW Corner Toward Wissahickon Ave

12/30/2005

4/10/2007

3/19/2008

5/2/2008

7/29/2008

10/14/2009

Saylor's Grove Monitoring Photo 3-Looking From SW Corner Toward Wissahickon Ave

11/9/2009

3/1/2010

4/23/2010

Saylor's Grove Monitoring Photo 4-Looking N Across Wetland

12/30/2005

4/10/2007

3/19/2008

5/2/2008

7/29/2008

7/15/2009

Saylor's Grove Monitoring Photo 4-Looking N Across Wetland

10/14/2009

11/9/2009

3/10/2010

4/23/2010

Saylor's Grove Monitoring Photo 5-Looking NW at Forebay Pond

5/17/2006

6/28/2006

7/17/2007

3/19/2008

5/2/2008

7/29/2008

Saylor's Grove Monitoring Photo 5-Looking NW at Forebay Pond

7/15/2009

10/14/2009

11/9/2009

3/1/2010

4/23/2010

Saylor's Grove Monitoring Photo 6-Looking US Toward Bridge

5/23/2007

3/18/2008

7/15/2009

11/9/2009

3/1/2010

4/23/2010

Saylor's Grove Monitoring Photo 7-Looking at DSL Outfall from Bridge

5/23/2007

7/15/2009

10/14/2009

11/9/2009

3/1/2010

4/23/2010

Saylor's Grove Monitoring Photo 8-Looking US at Primary Outfall

5/23/2007

6/20/2007

6/15/2008

12/30/2008

7/15/2009

10/14/2009

Saylor's Grove Monitoring Photo 8-Looking US at Primary Outfall

11/9/2009

3/1/2010

4/23/2010

Saylor's Grove Monitoring Photo 9-Looking SSW at Habitat Island from N Bank

4/20/2006

5/1/2006

4/10/2007

7/2/2007

3/19/2008

7/29/2008

Saylor's Grove Monitoring Photo 9-Looking SSW at Habitat Island from N Bank


7/15/2009


10/14/2009


11/9/2009


3/1/2010


4/23/2010

Saylor's Grove Monitoring Photo 10-Looking SSE Toward Habitat Island

3/13/2006

4/10/2007

3/19/2008

7/15/2009

10/14/2009

11/9/2009

Saylor's Grove Monitoring Photo 10-Looking SSE Toward Habitat Island

3/1/2010

4/23/2010

Saylor's Grove Monitoring Photo 11-Looking DS at Forebay Pond from Bridge

4/10/2007

6/20/2007

7/17/2007

7/15/2009

10/14/2009

11/9/2009

Saylor's Grove Monitoring Photo 11-Looking DS at Forebay Pond from Bridge

3/1/2010

4/23/2010

APPENDIX M – FY2010 MARSHALL ROAD MONITORING REPORT

Marshall Road
Stream Restoration Project

Physical and Biological Monitoring Report
June, 2009

Philadelphia
PWD
Water Department

Office of Watersheds
philadelphia water

Table of Contents

List of Figures

List of Tables

List of Photos

1. **Background and Introduction**

The goal of the Marshall Road Stream Restoration project was to implement a sustainable approach to stream habitat restoration that would help mitigate the impacts of urban development and related hydrologic and hydraulic modifications. By enlisting the members of the Darby-Cobbs Watershed Partnership and national experts, this local watershed restoration effort restored 900 linear feet of the Cobbs Creek stream corridor between Pine Street and Cedar Avenue using natural restoration techniques. The primary goal of this project was to identify and document existing stream conditions, develop conceptual alternatives, prepare final design and construction drawings, and stabilize a reach of Cobbs Creek using fluvial geomorphologic principles and natural channel design techniques. The most appropriate restoration techniques were selected based upon a comprehensive, watershed-wide, fluvial geomorphologic characterization completed by our project team using Rosgen methods.

The project team assembled believed that a holistic approach to stream restoration was necessary to ensure the successful restoration and stabilization of Cobbs Creek. This holistic approach recognized that a stable stream channel is not just a function of the balance of in-stream morphological features but also recognizes the importance and interconnections with the surrounding riparian ecosystem. Consequently, the Philadelphia Water Department assembled a project team that developed an approach for the restoration of Cobbs Creek that encompassed the replication of natural hydrologic and ecological cycles, sustainability, enhancement to riparian and in-stream aquatic habitat, improved aesthetics, and significant cost savings over structural solutions. The results of this approach include not just stable stream bank geometry, but also long term ecological stability.

In general, this approach to stream restoration combines the disciplines of fluvial geomorphology, hydraulics, hydrology, and applied ecology. This approach depends on accurate identification of stream classification type, an understanding of hydrologic actions within the watershed and their effects on a stream channel, and clearly defined restoration goals. Sound fluvial geomorphologic principles and an understanding of the natural stream system are integral to creating a stable stream channel that facilitates the restoration of the riparian ecosystem.

In summary, the objective was to create a segment of the stream system that was stable, required little maintenance, and was self-sustaining. A holistic, ecologically sensitive approach to stream restoration has many benefits to the Commonwealth of Pennsylvania, including replication of natural hydrologic and ecologic cycles, enhancement of riparian and in-stream aquatic habitat, improved aesthetics, and significant long-term cost savings over structural or simplified natural streambank solutions. This project was a product of the Darby-Cobbs Watershed Initiative and was a priority project recommended as part of the Fairmount Park Commission's Natural Lands Restoration and Environmental Education Program (NLREEP).

1.1. Project Area Description

The Darby and Cobbs Creeks Watershed drains parts of Chester, Delaware, Montgomery, and Philadelphia Counties to the Delaware River through the Tinicum Wildlife Refuge. The Watershed is bounded on its southern edge by Interstate 95. The Watershed is highly urbanized in the lower reaches and is suburban in the upper reaches. Approximately 500,000 people live within the Darby and Cobbs Creeks Watershed, based on the 1990 census, with an average population density of almost 10 people/acre. The waters in the drainage area receive point source discharges including municipal wastewater, CSO and other urban and suburban stormwater, sanitary sewer overflows, and industrial storm, process, and cooling waters. Non-point sources in the basin include atmospheric deposition, areas of runoff sheet flow from urban and suburban areas, and individual on-lot domestic sewage systems discharging through shallow groundwater.

The Watershed receives urban and suburban stormwater discharges from about 94 percent of the total basin area. Combined sewers serve approximately 6 percent of the basin. Two percent is agricultural, although some of the area categorized as agricultural is not actively farmed.

The project area is located on the border of West Philadelphia and Upper Darby Township in Delaware County. The restoration site was approximately 900 feet in length (between Pine Street and Cedar Avenue) and was located 450 feet south of Marshall Road, 300 feet west of Cobbs Creek Parkway and 150 feet east of Short Lane in Delaware County. There is a trail on the Philadelphia side that runs adjacent to the creek and is situated midway between Cobbs Creek Parkway and the creek.

Multiple assessments and studies conducted by the PWD have found the Cobbs Creek to be impaired due to a variety of biological and physical impacts (PWD 2004). Generally, dissolved oxygen is a constituent of concern for all natural waters receiving point, non-point, and/or stormwater discharges. High organic loads cause the depletion of dissolved oxygen through digestion by microorganisms. Typical causes of low dissolved oxygen concentrations, high fecal coliform loads, high dissolved iron concentrations and increased nitrogen nutrient levels include:

- Urban stormwater runoff;
- Combined sewer overflows (CSOs);
- Separate sanitary sewer overflows (SSOs) (both dry and wet weather);
- Septic tank failures;
- Leaking or broken pipes;
- Discharges from malfunctioning pumping stations;
- Agricultural and lawn fertilizer runoff;
- Industrial point sources, including publicly-owned wastewater treatment plants; and
- Re-suspension of oxygen demanding benthic sediments.

Fecal coliform usually is a constituent of concern for natural receiving waters in urban areas, particularly those that are accessible by the public. Fecal coliform is an indicator bacteria for known human pathogens. Even though excessively high fecal coliform concentrations are not a threat to aquatic biota, they are considered a public health threat and worthy of further investigation. In the Philadelphia area, improvements are already in progress from the PWD's implementation of its approved Long Term CSO Control Plan. However, these improvements will not correct the extensive damage done to stream habitat by high flows stemming from increased development within the watershed.

In addition to the screening level biologic and chemical assessments previously conducted by PWD, a physical habitat assessment was performed at the site. Results showed a highly embedded site (50%-70% of gravel, cobble, and boulder were surrounded by fine sediment) with baseflow filling less than 25% percent of the channel. Increased channel bar development and bank erosion were prevalent throughout the entire Marshall Road Reach (Photo 1, Photo 2).

Photo 1 - Channel Bar Formation in Creek Due to Upstream Bridge Abutments

Photo 2 - Severe Bank Erosion along the Marshall Road Project Reach

Specifically, abandoned bridge abutments upstream of the project area were constricting flow and directing it downstream into an outside meander bend. Additionally, high flows were being diverted around the outside of one of the abutments, accelerating erosion downstream and subsequently depositing sediment into the middle of the channel. As a result, a sanitary sewer line (Photo 3) had become exposed and its structural integrity was jeopardized. The erosion

Photo 3 - Exposed Sewer Line

and sedimentation was also causing the loss of riparian vegetation and increasing the embeddedness of downstream substrate. As a result, fine particles of soil were being deposited on the streambed, covering gravel and cobbles, and making the bed unsuitable for macro-invertebrate habitat and fish spawning. Excessive discharges continued to erode the stream channel, removing in-channel features like pools and riffles and altering the flow hydraulics. The loss of in-stream habitat structure, coupled with excess sedimentation, is one reason for declines in aquatic diversity in the Cobbs Creek.

1.2. <u>Project Scope of Work</u>

The project team assembled to complete this restoration was exceptionally and uniquely qualified to ensure that this project was not only a success in creating and enhancing natural resources for the local community, but also served as a model for future projects. Represented on the project team were nationally recognized experts in watershed planning, stormwater management, fluvial geomorphologic assessment and restoration plan development, hydrology, and capital project implementation.

The specialty firm of Biohabitats Inc. ("Biohabitats") and a national environmental consulting firm, Camp Dresser & McKee, were enlisted to complete the critically important hydraulic analysis, restoration design, and to provide support services for the implementation process.

The project team collected and reviewed existing maps, documents, and data, which included:

- Applicable existing hydrologic and hydraulic reports and stormwater management studies
- Topographic maps, digital aerial photographs, and other relevant GIS datasets
- Existing watershed assessments
- Zoning, utility, property, and ROW maps
- Plans for proposed or ongoing development within the drainage basin
- Soil, geology, and wetland maps

- Rare, threatened, and endangered species database review
- Pennsylvania Historical Trust database review

1.2.1. Geology

The project area is located in the Piedmont physiographic province. Local geologic formations included various mica schists in the immediate project area characteristic of the Wissahickon Formation found in the project watershed. Schist formation characteristics include platy minerals that break down readily. The large particles found in the project area's bed materials are derived from local bedrock.

1.2.2. Soils

The Soil Survey of Bucks and Philadelphia Counties (1975), Map 96 lists the soils in the project area as a deep, medium textured surface layer with medium or moderately fine texture subsoil. The Soil Association listed for the project area is an Urban land – Howell Association. This particular association is characterized by nearly level and gently sloping, well-drained land types and soils on terraces. The Soil Series represented within the project area include the Manor Loam and Urban land series. These groups of soils formed from a particular parent material and are similar in character and arrangement of horizons. Manor Series soils are typically deep, well-drained, gently sloping to very steep soils on uplands. They are loamy and weathered from schist and gneiss. In a representative profile, the plow layer is a dark brown loam approximately 7 inches thick. The subsoil is a yellowish-red loam about 12 inches thick, often mixed with long, thin stone fragments. The substratum is a sandy loam extending up to 60 inches deep. Runoff is medium to rapid, and the hazard of erosion is moderate to high. Available water capacity is moderate, and permeability is moderately rapid. Urban land includes developed areas of upland terraces and floodplains. Most of these areas have been regraded historically so that the original soil material has been disturbed, filled over, or otherwise destroyed.

1.2.3. Field Reconnaissance

The project team studied the entire project reach and floodplain to determine and document existing conditions within the project area. The project area included a 100-foot corridor (approximately 50 feet on each side of the centerline of the stream channel) to determine suitability of the floodplain for plan geometry changes. Detailed field investigations of stream morphology and man-made structures were made within the study area.

The project team performed a detailed fluvial geomorphological assessment on Cobbs Creek and stream classification (Rosgen 1994). A field crew walked the stream channel to identify and measure the following geomorphological features:

- Bankfull width/depth
- Water surface slope
- Stream centerline
- Meander belt width
- Entrenchment ratio
- Locations of bank erosion
- Pool/riffle sequence
- Percent riffle embeddedness
- Debris dams
- Channel slope
- Stream sinuosity
- Meander radius
- Floodplain width
- Specimen trees over 30" DBH & vegetation greater than 12" DBH
- Non-tidal Wetlands
- Sediment size distribution
- Channel improvements

Bedload material and composition were determined using the Wolman pebble count method (Wolman 1954). Sediment size distributions were calculated.

The project team installed semi-permanent benchmarks at each of field cross-section locations. These field cross-sections were used to help determine bankfull discharges in Cobbs Creek and in some cases to determine stability of the project reach. Jurisdictional wetland delineation adjacent to the channel and within the project area was also performed.

A detailed topographic survey of the channel and major tributaries was performed by the Philadelphia Water Department. The topographic survey included topography within 100 feet of the top of bank on both sides of the channel, field cross-sections, existing utilities, wetland flags, trees over 12" in diameter at breast height (DBH) within 50 feet of the channel and preliminary property line locations. This information was used as a base sheet for fieldwork and to illustrate restoration design measures.

Information obtained through the field survey, stream classification, and reference reach search provided a thorough basis for the development of a natural channel stabilization design.

Some results of the field reconnaissance performed for geology and soils, vegetation and geomorphology are as follows:

1.2.3.1. **Geology and Soils**

Field reconnaissance by Biohabitats confirmed the predominance of loamy soils at the site. Soil samples were collected from three soil pits evenly spaced throughout the project area near the top of bank just above the limits of bankfull. Laboratory results indicated that all three samples classify as a sandy loam, with pH in the 7.0 to 7.2 range, organic matter in the 3.5 to 5.0 range, CEC (cation exchange capacity) in the 13.9 to 16.7 range and levels of phosphorous and potassium in the optimum range of 51 to 100 ppm. Severe bank erosion was occurring at two locations, the first being along the exposed sewer pipe on the downstream left bank and the second just downstream of this pipe, also on the left bank. Exposed banks at these locations show unconsolidated, stratified, sandy loam soil that is highly susceptible to erosion, particularly with the flashy conditions in this area of Cobbs Creek.

1.2.3.2. **Vegetation**

The plant community that exited within the project area included a wide variety of species, both native and non-native. Tree species included box-elder (*Acer negundo*), red maple (*Acer rubrum*), silver maple (*Acer saccharinum*), speckled alder (*Alnus rugosa*), river birch (*Betula nigra*), American beech (*Fagus grandifolia*), honey locust (*Gleditsia triacanthos*), crab apple (*Malus sylvestris*), dawn redwood (*Metasequoia glyptostroboides*), American sycamore (*Platanus occidentalis*), scarlet oak (*Quercus coccinea*), pin oak (*Quercus palustris*), northern red oak (*Quercus rubra*), black willow (*Salix nigra*), and eastern hemlock (*Tsuga canadensis*). Shrub species include silky dogwood (*Cornus amomum*) and currant (*Ribes* spp.). Herbaceous species included wild onion (*Allium canadens*), Canada bluejoint grass (*Calamagrostis canandensis*), elephant's foot (*Elephantopus carolinianus*) and Japanese pachysandra (*Pachysandra terminalis*). Invasive species included Japanese honeysuckle (*Lonicera japonica*), bush honeysuckle (*Lonicera* spp.), Japanese knotweed (*Polygonum cuspidatum*) and multiflora rose (*Rosa multiflora*).

Elephant's foot is listed as endangered in Pennsylvania. Restoration activities avoided and protected this plant throughout the project area during construction.

1.2.3.3. **Geomorphology**

The majority of Cobbs Creek is over-widened and fully entrenched, and classifies as a Rosgen F stream type. Rosgen type F channels are highly entrenched systems with a low gradient (< 2%), moderate sinuosity (>1.2), and moderate to high width to depth ratio (>12). Extreme sensitivity to disturbance, poor unaided recovery potential, and very high sediment supply (Rosgen 1994, Rosgen 1996) further characterize an F type stream. F streams tend to be entrenched to such a degree that even low-frequency flood flows are contained within the channel and do not access the wide floodplain for volume storage and energy dissipation. Consequently, shear stresses tend to be high within the channel resulting in severe bank erosion and subsequent sediment accumulation within the channel. Common observations in these channels include moderate to high sediment supply and depositional bars within the channel. Table 1 compares existing and proposed channel parameters.

Table 1 - Existing and Proposed Channel Parameters

Bankfull Channel Parameter	*Existing Channel, Representative Riffle Cross-Section*	*Typical C Stream Type Morphology*	*Proposed Channel, Riffle Cross-Section*
Rosgen Stream Type	F4	C	C4
Width (ft)	103	n/a	50
Maximum Depth (ft)	2.6	n/a	5
Mean Depth (ft)	2.1	n/a	3.4
Cross-Sectional Area (ft^2)	214	n/a	170
Slope (ft/ft)	0.0057	< 0.02	0.0056
Entrenchment Ratio (ft/ft)	1.1	> 2.2	2.6
Width/Depth Ratio (ft/ft)	50	> 12	15
Radius of Curvature (ft)	100-130	n/a	107 - 139

n/a = not applicable

1.2.4. Hydrologic and Hydraulic Analysis

Development of natural channel design requires an understanding of the hydrologic and hydraulic inputs to the stream system. The project team made use of applicable, existing watershed studies of Cobbs Creek and supplemented this information by performing a preliminary hydrologic and hydraulic analysis for the study area.

Hydrologic conditions in Cobbs Creek were estimated using the US EPA SWMM Model. Values of peak discharge estimated by the model for bankfull, 2-year, 10-year, 50-year and 100-year floods were corroborated with field observations of morphological features in and along the stream that were used to estimate the magnitude of relevant flood events.

Hydrologic soil grouping was identified through the Soil Conservation Service's (SCS) Soil Survey Mapping and the Hydrologic Soil Groups for the United States found within the SCS TR-55 manual (USDA 1986). Drainage area, ground cover, land slope, land use, and zoning were obtained from photogrammetric maps, USGS quadrangle maps, field survey, aerial photographs, and zoning maps.

The hydrologic model was compared with field data and other available discharge data to determine existing bankfull discharges in Cobbs Creek.

The methods and results of the design discharge used in the hydraulic analysis are as follows:

1.2.4.1. **Design Discharge Determination**

The establishment of a design discharge is an element essential to channel design. Design discharge helps to establish the appropriate channel dimensions along the project reach. In adjustable, alluvial, transport-limited rivers in temperate climates, flows of moderate frequency (*e.g.*, the 1.5- to 2-year storm event) and magnitude perform most of the geomorphic work (Wolman & Miller 1960). The concept of "effective discharge" provides a statistical index for the flow that corresponds with the peak volume of sediment transported. Therefore, effective discharge is the maximum possible product of the frequency of flow occurrence and the amount of sediment transported by a flow event. Ultimately, channel morphology results from all flows above a sediment transport threshold that do some geomorphic work. However, the effective discharge is commonly used as a single-value estimate for a flow that may be largely responsible for the resulting dominant geomorphic form, also referred to as a "dominant discharge". In many cases, the morphological features associated with the bankfull discharge correspond fairly well to the flow stage of the effective and dominant discharges. For this reason, bankfull elevation represents an excellent proxy for a design discharge in stream restoration design. Biohabitats used bankfull discharge for interpreting geomorphic form, with the assumption that it is roughly equivalent to the dominant and effective discharges.

1.2.4.2. **Field Determination of Bankfull Discharge**

Biohabitats personnel identified bankfull elevations in the field at varied locations as part of the Cobbs Creek watershed study, one of which was surveyed as a component of this restoration project. As a result of channel disequilibrium, bankfull indicators were not easily identified. Bankfull elevation at this cross-section was derived from all available indications including depositional features, changes in bank angle, vegetation, scour lines and storm debris lines. Depositional features were the primary indicator used in the final determination of bankfull elevation. Bankfull discharge was estimated by solving the Manning equation for discharge given the estimated bankfull elevation and measurements of the local channel geometry, slope, and roughness. Channel roughness, represented by Manning's "n," was approximated using the results of a pebble count, best professional judgment and the standard references Chow (1959) and Barnes (1967). Refer to Table 2 below for Field Determination bankfull estimate values.

1.2.4.3. **Regional Curves for Predicting Bankfull Discharge**

For the purpose of comparison, Biohabitats also calculated the bankfull discharge predicted by regional curve data. The first comparison used Baltimore County regression relationships (Baltimore County DEPRM 1999), developed for urban drainages (>20% impervious area) in the Piedmont physiographic province, similar to the Cobbs Creek watershed. Based on five urban gages, Baltimore County developed the following regression relationships:

$$\log Qbf = 0.5601(\log DA) + 2.4351$$
$$\log CX = 0.762(\log DA) + 1.556$$

where Qbf is the bankfull discharge in cubic feet per second (cfs), DA is the drainage area in square miles (mi^2), and CX is the bankfull cross-sectional area in square feet (ft^2). The percent impervious area for Cobbs Creek watershed at the Marshall Road site was approximately 46%, as calculated by the Philadelphia Water Department. It should be noted that the drainage areas used in the Baltimore County regressions span the project drainage area of 12 mi^2 (used gages of between 2.47 to 20.5 mi^2).

Table 2 - Calculated and Predicted Bankfull Discharge and Cross-Sectional Areas

Location	*Bankfull Estimates*	
	Discharge (cfs)	*X/S Area (ft2)*
Field Determination	**1194**	**214**
Baltimore County Regression Equation	**1095**	**239**
Christina River Regional Curve	**953**	**157**

The second comparison used a regional curve developed from gage sites in the Christina Watershed in Delaware. The majority of this watershed falls within the Piedmont physiographic province with only a small portion of the watershed in the Coastal Plain. The predominant watershed land use is urban development. Forest and agricultural are the only other additional significant land uses. Gage sites for developed land were used to develop the regional curve. Bankfull indicators were difficult to determine at many of the selected gage sites. However, the data collected at the gage sites showed that, at three of the six sites, the 1-year discharge elevation approached the top of the bank elevation. Thus, the top of the bank elevation represented a viable surrogate for bankfull discharge with regression relationships expressed by the following equations:

$$\text{1-year } Q = 34.054(DA) + 543.96$$
$$CX = 3.8615(DA) + 110.64$$

Where 1-year Q is the one-year partial duration series discharge in cubic feet per second (cfs), DA is the drainage area in square miles (mi^2), and CX is the bankfull cross-sectional area in square feet (ft^2). The bankfull discharge computed using this method is included in Table 2.

For additional comparison, Biohabitats used regression relationships developed by the U.S. Geological Survey (USGS) and the Maryland Geological Survey (MGS) to estimate the magnitude of peak flows for specific recurrence intervals in Maryland streams (Dillow, 1996 and Carpenter, 1983, respectively). The USGS based regional regressions on a least-squares regression of drainage area and forest cover data from gauged basins in each physiographic province. For existing conditions, forest cover comprised approximately 8.4 percent of the Cobbs Creek watershed area upstream of the Marshall Road restoration area. The drainage area to the site (12 mi^2) was within the range of drainage areas used by the USGS to develop the regression equations for the Piedmont Region (81 gauging stations between 0.26 to 165 mi^2).

MGS based regional regressions on the same techniques as the USGS equations, except that the MGS also included the 2-year, 24-hour precipitation in inches as a variable in the regression relationships. The drainage area of the Cobbs Creek watershed area upstream of the Marshall Road restoration area (12 mi^2) was also within the range (0.1 to 875 mi^2) of the 225 gauging locations used to develop these regressions ().

An existing condition SWMM model (US EPA) was developed by the Philadelphia Water Department Office of Watersheds to perform hydrologic and water quality analyses of the Cobbs Creek. Assessment areas included the watershed area draining to the project reach immediately downstream of the Marshall Road crossing. Biohabitats used the bankfull and 2-year peak discharge values produced by the SWMM model for additional calibration/comparison with the design discharge determined for this design.

Table 3 - Predicted Peak Discharges for Design Events

Recurrence Interval of Storm Event (yr)	***SWMM Predicted Peak Discharges (cfs)***	***USGS Predicted Peak Discharge, Existing Conditions (cfs)***	***MGS Predicted Peak Discharge, Existing Conditions (cfs)***
	Existing Conditions	*Piedmont Province*	*Northern Region*
2	2426	1007.0	925.9
10	3585	2584.3	2551.9
100	6664	6053.5	7407.4

The similarity between field determined and predicted bankfull discharges supported the argument that the bankfull flow may occur with an average frequency of 1 to 2 years along Cobbs Creek. Based on calculations presented above, the field determined bankfull discharge of 1,200 cfs was determined to be an appropriate value for use as a preliminary design discharge along the project area. Development of the proposed channel dimensions including cross-sectional geometry, plan form pattern and profile were based on this discharge.

1.3. Design Plans, Specifications

1.3.1. Preliminary Restoration Concept – 10% Submittal

The project team used the data collected above to thoroughly define the existing conditions in the study area. With a clear definition of the existing conditions in the stream, the project team identified the constraints and opportunities associated with the study area, including but not limited to:

- Easement and access considerations
- Existing and future hydrologic inputs
- Regulatory requirements
- Economic considerations
- Public concerns
- Limitations imposed by existing utilities
- Limitations imposed by adjacent privately owned properties

According to the constraints and opportunities afforded by the study area, the project team developed a preliminary restoration concept, which consisted of:

- Partial or complete channel realignment
- Channel stabilization using soil bioengineering techniques
- Floodplain modifications

The preliminary restoration design included a plan view illustrating the design alternatives, details and supporting graphics, appropriate documentation, field data information, engineering computations, preliminary restoration cost estimates, operation and maintenance requirements, monitoring recommendations, and photographs.

1.3.2. Final Design and Construction Package - 60% Submittal

The project team prepared design drawings, details, notes, special provision specifications, and an engineer's cost estimate for a 60% final design and construction package. Specifically, the package included the following components:

- Geometry Layout
- Grading Plan, Details, and Notes
- Erosion and Sediment Control Plan

- E&S Sequence of Construction, Details, Notes
- Existing and Proposed Grading Cross-Sections
- Existing and Proposed Stream Profile
- Soil Bioengineering Details
- Planting Plan, Details, Notes
- Maintenance Schedule
- Preliminary Cost Estimate
- Special Provision Specifications

Using SWMM-EXTRAN the project team modeled the stream's existing hydrology and hydraulics to determine velocities and shear stresses within the channel. A GIS was used to delineate the floodplain and values of peak discharges were computed by the models for bankfull, 2-year, 10-year, 50-year and 100-year floods. The project team prepared a proposed conditions hydrologic and hydraulic study with the results of this analysis. Shear stresses of the proposed channel were documented and floodplain limits were delineated.

The project team calculated the bankfull critical shear stress in both the study and reference reaches and then compared these to the size of sediment potentially entrained to the largest size measured in a bar sample. This information provided guidance in targeting a bankfull critical shear stress for the restored channel that can transport the largest particle size made available to the system without scouring stream banks.

1.3.3. Final Design and Construction Package - 90% Submittal

The project team prepared final design sketches, notes, and specifications for a 90% final drawing package, which included the following:

- Geometry Layout
- Grading Plan, Details, and Notes
- Erosion and Sediment Control Plan
- E&S Sequence of Construction, Details, Notes
- Grading Cross-Sections
- Stream Profile
- Soil Bioengineering Details
- Planting Plan, Details, Notes
- Maintenance Schedule
- Special Provision Specification Package
- DPW Engineers Cost Estimate using Baltimore County Cost Commodity Codes

1.3.4. Final Design and Construction Package - 100% Submittal

Once the 90% submittal was approved, the project team prepared the following items for final submittal:

- Bid Set Plan Submittal
- Final Specifications
- Final Cost Estimate

1.3.5. Restoration Design Philosophy

Biohabitats proposed modification of the channel for the area adjacent to the bridge abutments at the upstream limit of the project area and continuing downstream for approximately 900 linear feet, including realignment of the channel away from the sewer line along the downstream left.

The channel design mimicked a Rosgen C stream type providing stable geometry and sufficient floodprone area. Rosgen type C channels, characterized by developed floodplains (slightly entrenched systems), possess low gradient (1-2%), moderate sinuosity (>1.2), and moderate to high width/depth ratio (>12). These channels exhibit alternating riffles and pools closely associated with the meander geometry. Characteristic features include low relief, sinuous, well developed alluvial floodplains and point bars in the bankfull channel. C type streams have access to a floodplain for volume storage and energy dissipation. The design integrated appropriate ranges of parameters including reach slope, bankfull width/depth ratios, sinuosity, valley width, and stream discharge.

Bankfull width and depth, and entrenchment relationships of stable C reach morphology were used as design reference while developing new channel dimensions. In out-of-pattern areas of the channel, any changes or increases in sinuosity were accomplished by increasing meander bend amplitude, increasing meander belt width and/or decreasing meander length. In most cases, the proposed radius of curvature was similar to the existing radius of curvature with the exception of the upstream limit of the project area. This exception was at the abandoned bridge abutments, south of Marshall Road, where the abutments severely constricted the channel and caused channel scouring at the abutment. Biohabitats proposed removal of the abutment along Cobbs Creek Parkway to accommodate new planform geometry with increased sinuosity and decreased channel width-depth ratio. The ideal meander width ratios (belt width/bankfull width) ratios were limited by: 1) the adjacent sewer line on the downstream right side of the project area; 2) a desire to limit encroachment into the existing riparian area (including limiting tree loss and protecting endangered plant species); and 3) private property concerns along the downstream right side of the channel.

Channel modifications included bank stabilization measures to ensure channel stability and limit channel migration. These bank stabilization measures included vegetation, root wads, and boulder bank stabilization. Vegetation and root wads provided bank protection and enhanced habitat diversity. Boulder bank stabilization was incorporated along the project area for several reasons: the natural occurrence of rock within the watershed area, a means to protect banks prior to full vegetation establishment, and a mechanism to reinforce the channel boundaries adjacent to the sewer line and the bridge abutments.

Grade control measures were used to establish and maintain grade along the invert of the restored channel. Grade control structures used along the proposed riffles of the project reach included rock vanes and J-hook vanes. A summary of the channel design parameters employed are provided in Table 4.

Table 4 - Summary of Channel Design Parameters

Channel design	***C stream type morphology***
Design discharge	**1200 cfs**
Bankfull slope	**.57%**
Entrenchment ratio	**> 2.2**
Riffle width/depth ratio	**15**

1.3.5.1. Native Plant Restoration

The restoration of the project area included revegetation at all areas with grading disturbance. Plant species included native vegetation in planting zones that are representative of Riparian Woodlands and Upland Woodlands. An additional plant zone was designated for the soil bioengineering planting technique of Live Branch Layering that occurred upslope of portions of the boulder bank stabilization. The native plants chosen for the Riparian Woodland and Live Branch Layering could withstand some stream inundation during flood events while the plants chosen for the Upland Woodland zone preferred drier conditions. At rock structures, shrubs and trees were installed closely and larger plants were specified for added protection at these structures. Soil testing carried out in the project area showed that the soil needed minimal amending to successfully establish the plants used.

1.4. Permitting

The project team prepared a §401 State Water Quality Certification, a §404 Federal wetland, and a §105 stream encroachment permit in accordance with current regulatory requirements for submittal to the Pennsylvania Department of Environmental Protection. In order to expedite the process, the application was prepared upon completion and approval of the 60% design and construction package submittal.

1.5. **Construction**

For the City of Philadelphia Water Department, construction projects require that a contractor be selected through a competitive bid process.

The PWD put the restoration design bid package and specifications out for advertisement on March 23, 2004 and March 30, 2004, setting a pre-bid meeting for April 15, 2004 at the project site, and a bid due date of April 28, 2004.

Five companies submitted bids ranging in total price from $768,000 to $991,000. Buckley & Company Inc, a Philadelphia based construction firm, was awarded the contract at a winning bid of $768,737.80.

Throughout May – July, 2004 the contract between the PWD and Buckley & Company was finalized – bonding, insurance, and legal document review. In August, 2004, Buckley & Company, the PWD construction inspectors, and Biohabitats Inc., finalized scheduling and construction sequencing. In September, 2004, the stone to be used on site was procured from Dyer Quarry, Inc. in Birdsboro, PA. Numerous transmittals were exchanged and reviewed regarding some additional tree removal and tree and shrub substitutions. In late September, 2004, the contractor commenced work on the rock construction entrance. The path was cleared and stone was placed.

During October and November, 2004, the following tasks were completed in entirety:

- Creation of the Rock Construction Entrance
- Removal of Existing Bridge Abutment
- Invasive Species Management
- Rehabilitation of the Existing Sewer

While the following tasks were mostly or partially completed at the site:

- Erosion and Sediment Control
- Clearing and Grubbing
- Construction Survey
- Installation of a Rock Vane, a "J" Vane, and 250 yd^3 of Constructed Riffles
- Boulder Bank Stabilization

- Installation of Blaze Orange Fencing

Erosion and sediment control measures were used throughout the construction process. The limits of construction were clearly defined and the work area minimized to protect existing resources. To the maximum extent possible, materials were used in the restoration that were obtained locally from the project area, from recycling process, or natural materials discarded as part of another project. Specifically, this project utilized an old bridge pier to supply materials for applying the restorative measures.

In early December, 2004, Buckley & Company finished all of the partially completed components listed above (Photo 4, Photo 5).

Photo 4 - Upstream View of Cobbs Creek

Photo 5 - Downstream View of Cobbs Creek

The planting of trees, shrubs, live branch layering, and native seeding and mulching began in mid-December. Native riparian vegetation was established along each stream bank to provide shade, detritus, and to intercept and filter stormwater runoff from surrounding upland areas. The Fairmount Park Commission provided assistance in identifying appropriate native plantings for the riparian corridor that were consistent with the natural lands restoration master plan and serviceable by commission maintenance staff (Photo 6).

Photo 6 - Tree and Shrub Planting at the Restoration Site

The planting component of this project was completed during the dormant season (mid-March to mid-April).

In April, 2006, some additional follow-up construction was conducted by PWD's Waterways Restoration Team (WRT) with direction from David Derrick of the U.S. Army Corps of Engineers (COE). As a result of some large flow events that took place during 2005, some cutting was occurring at some of the outer bends of the project reach. Additional rock and riparian vegetation was brought on site to correct these problems.

2. Methods

2.1. Introduction

To effectively monitor the success of the Marshall Road Stream Restoration project, it was understood from the onset that a replicable protocol that allowed for the tracking of physical and biological conditions would be required. The implementation of such a protocol would then allow for the tracking of these variables to analyze the behavior of the project reach of Cobbs Creek, as well as identify potential areas of success or failure. In large part, this monitoring effort has been designed to track fluvial geomorphologic variables over time using methods recommended by Rosgen and others (Rosgen, 2006; Rosgen 2008). In addition, biological monitoring of macroinvertebrates and fish, as well as regular photo monitoring were incorporated into the protocol. Although this project was completed in the Spring, 2005, because of deficient resources, a detailed monitoring assessment of the project reach was not performed until June, 2009. PWD's monitoring plan calls for revisiting the Marshall Road reach annually through 2012. Major monitoring efforts that have been incorporated into this effort are as follows:

- Topographic Survey
- Monumented Cross-Sectional Survey
- Longitudinal Profile Survey
- Bed Material Analysis
    - Pebble Counts
    - Bar Samples
    - Scour Chain Monitoring
- Bank Erosion Monitoring
    - BANCS Model
    - Bank Profiling
- Biological Monitoring
- Photographic Monitoring

2.2. Topographic Survey

All topographic survey work was performed with a Topcon Total Station Survey Instrument, Model Number GTS-235. Control points were established by the PWD Survey Unit on behalf of the Office of Watersheds. Control points were provided in the NAD 1983 Pennsylvania State Plane – South Coordinate System, Philadelphia City Vertical Datum (Figure 1, Table 5).

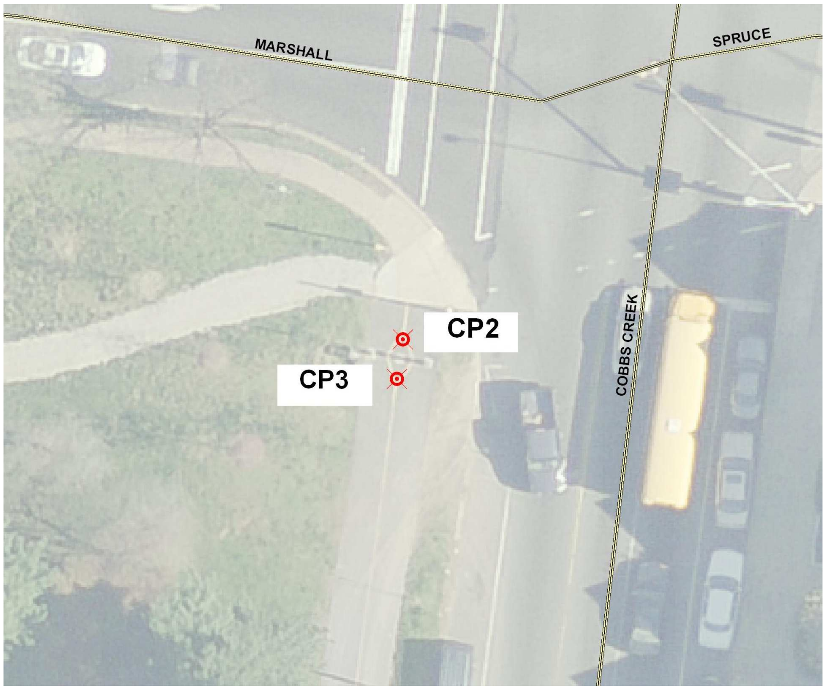


Figure 1 - Marshall Road Topographic Survey Control Points

CP2 is a magnetic nail placed at the northern vertex of the traffic control diamond painted on the bicycle path. CP3 is a magnetic nail placed at the southern vertex of the traffic control diamond painted on the bicycle path.

Table 5 - Marshall Road Topographic Survey Control Point Coordinates

Point Name	Northing (ft)	Easting (ft)	Elevation (ft)
CP2	237171.339	2669790.172	98.158
CP3	237180.579	2669791.476	98.248

2.3. Monumented Cross-Sectional Survey

2.3.1. Survey

To monitor the geomorphologic changes in the project reach of Cobbs Creek several cross-sections were surveyed via the techniques described in WARSSS (Rosgen 2005) in order to determine the factors that describe the characteristics of a particular part of the stream.

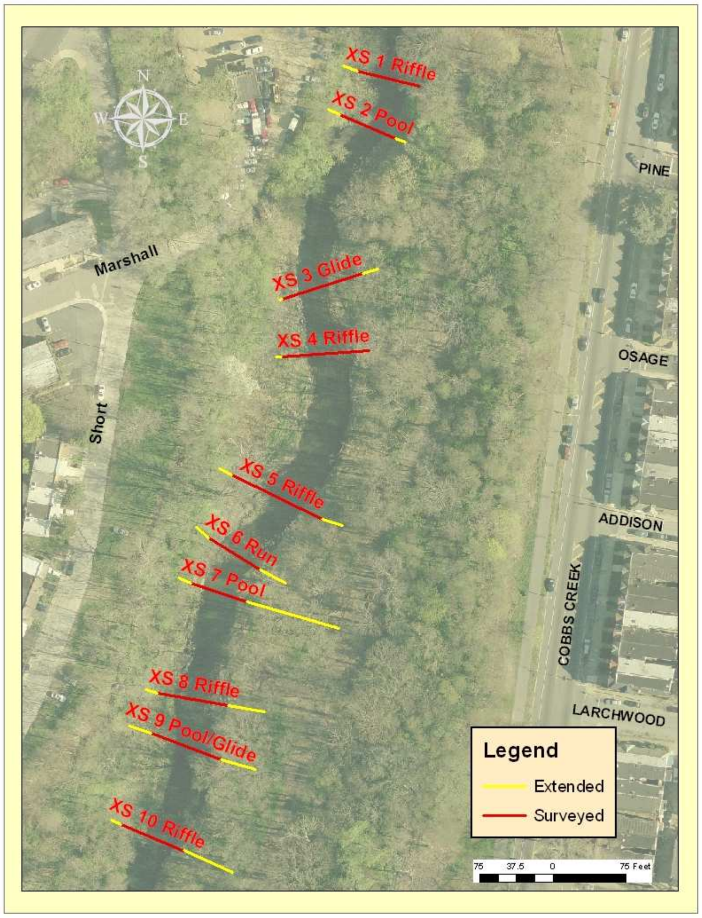


Figure 2 - Cross-Sectional Survey Loctions

After the physical survey was completed, extensions were created for each of the cross-sections using the 2008 City of Philadelphia digital elevation model (DEM). The DEM is a raster dataset that creates a digital representation of the ground surface topography. By adding points for the elevations moving away from the surveyed cross-sections, the extensions to the sections were created. This was done to enable the floodplain elevation to be captured by the ground elevation line in the cross-section graphs. In future monitoring efforts, actual field measurements will be obtained to increase the accuracy of the extended cross-section data.

2.3.2. <u>Bankfull Calculations</u>

Bankfull velocity and discharge was calculated at each riffle cross-section. Velocities were estimated using Manning's Equation (Equation 1), where Manning's 'n' was determined using Limerinos' Equation (Equation 2).

Equation 1 - Manning's Equation

$$u = 1.49 R_h^{2/3} S^{1/2} / n$$

where:
u = velocity (ft/s)
S = slope

Equation 2 - Limerinos' Equation

$$n = (0.0929R_h^{1/6}) / (1.16+2Log(D_{84}/304.8))$$

where:
n = Manning's roughness coefficient
R_h = hydraulic radius (ft)
D_{84} = 84th Percentile Size Class of bed material (ft)

Cross-sectional geometry for all surveyed cross-sections was determined using RIVERMorph 4.0 (RIVERMorph, LLC).

2.4. Longitudinal Profile

The longitudinal profile of the project reach started at the upstream boundary of the restoration work at first riffle (XS-1) and ended to the downstream boundary of the restoration work at the last riffle (XS-10). The survey was conducted using the Topcon GTS-235 total station survey instrument. Bed elevation points were measured at roughly twenty foot intervals along the thalweg. Water surface elevation points were taken at roughly the same frequency at both the left edge of water (LEW) and right edge of water (REW). Bankfull elevations were flagged during the streamwalk where appropriate bankfull indicators were present and measured. Stationing was assigned by connecting LEW points using Rivermorph 4.0.

2.5. Bed Material Analysis

The size distribution of bedload sediments were sampled at each cross-section according to the Watershed Assessment of Stability and Sediment Supply (WARSSS) methods described by Rosgen (2006). Assessment of the channel's bed materials is an essential component of both planning and monitoring, as sediment has the potential to cause adjustments to the slope, planform and dimensions of a stream channel. A "stable" channel is in equilibrium with the sediment made available to it from its upstream channel such that under steady-state conditions, excessive amounts of sediment are neither stored within the channel (*i.e.*, aggradation) nor transported to downstream reaches (*i.e.*, degradation). An "unstable" channel that is not in equilibrium with its sediment supply is often associated with a sediment load that exceeds the stream channel's capacity to transport it downstream causing an increase in storage and potential aggradation. Channel instability from excess sediment has the potential to both decrease the storage capacity of the channel and increase the slope of the channel promoting downstream erosion and concomitant changes in channel dimension. The impacts of increased or decreased sediment supply and transport also affect aquatic life, as well as the quality and availability of aquatic habitat; thus, a comprehensive understanding of the channel's bed material distribution is necessary to predict the trajectory of key in-stream processes.

2.5.1. **Pebble Counts**

Pebble counts were conducted at each cross-section according to the method described by Wolman (1964). The reach-wide pebble count was completed by distributing count data for each stream feature type (riffle, run, pool, glide) using a weighted average approach. The weighted average was developed based upon the percentage of stream length occupied by each stream feature type (Table 10)

2.5.2. **Bar Samples**

Gravel bars were sampled using a "bottomless bucket" according to the methods described in Table 5-15 ((Rosgen 2006)
Figure 4) of the WARSSS Prediction Level Assessment (PLA). A total of two gravels bars were sampled-the first was located between cross-sections one and two and the other was located between cross-sections three and four. Sampling locations within each bar corresponded to points within the downstream third of the gravel bar at an elevation that was approximately halfway between the thalweg and the bankfull elevation. The objective of the bar sample analysis was to determine the size classes of bedload sediment subject to transport during bankfull flows. Data gathered from the gravel bar assessment were than used in the stream channel competency calculations. The approximate locations of the bar samples are shown in Figure 3

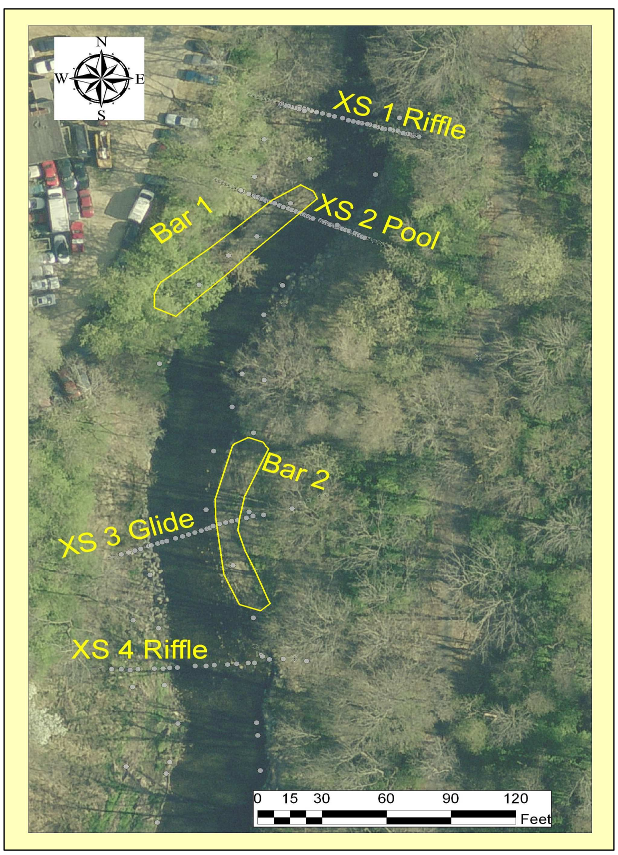
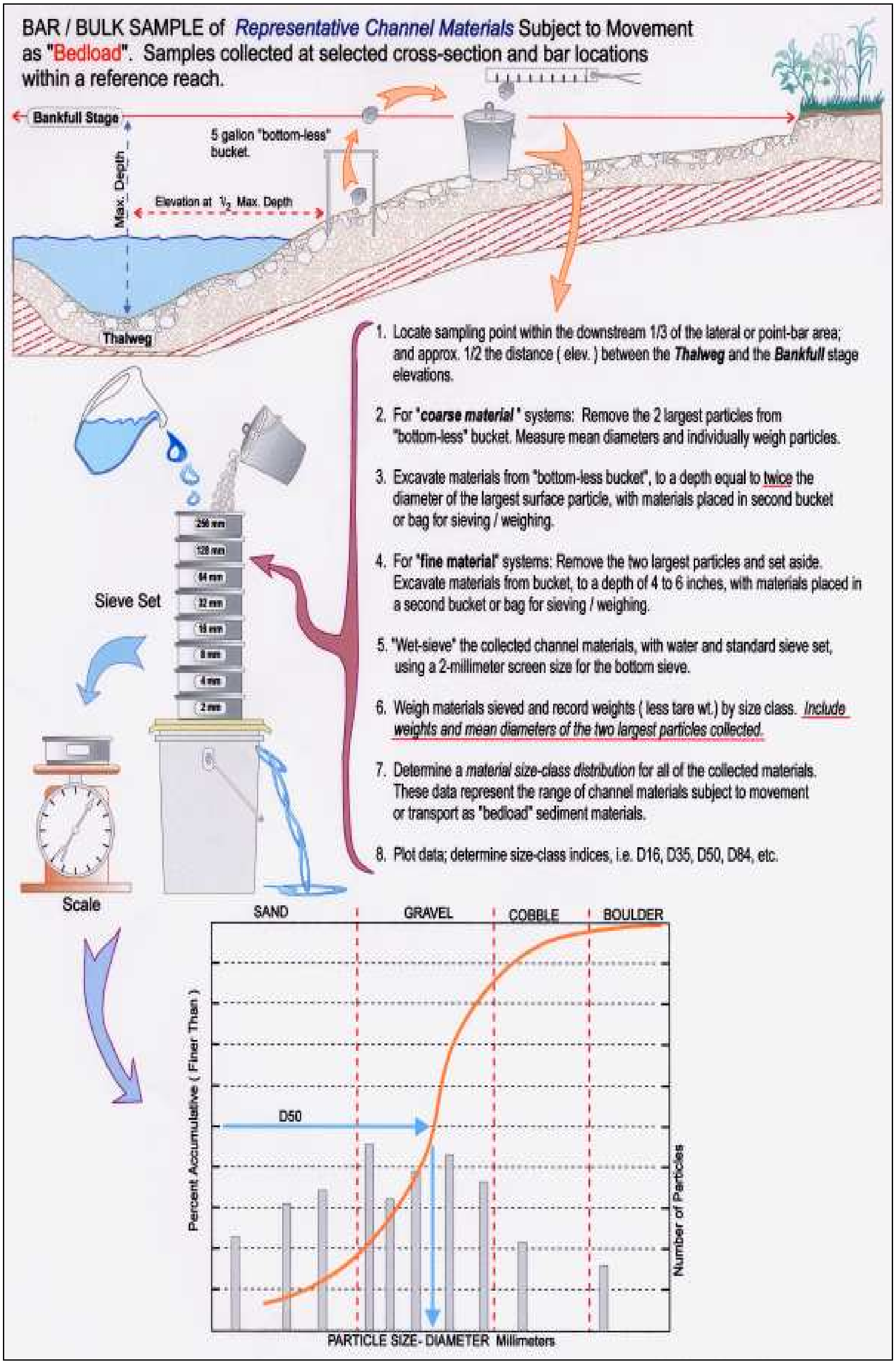


Figure 3 - Bar Sample Locations



(Rosgen 2006)

Figure 4 - Gravel Bar Sampling Procedure

2.5.3. **Scour Chain Monitoring**

Figure 5 - Scour Chain Locations

Scour chains were constructed from Tree Saver™ Model 40-DB-1 duckbill anchors secured to lengths of fifteen-link, 3/8″ stainless steel chain by reinforced cable-ties. Two scour chains were installed in each of two monitoring stations located at the third and fourth cross-sections which represent a glide and a riffle respectively (Figure 5). Scour chains were driven flush with the stream bed using a driving rod.

For each scour chain the station along the cross-section was recorded so that the scour chains could be located with ease upon resurvey. The two largest substrate particles within the vicinity of each scour chain were collected and their diameters were recorded. This data will be compared to the data collected during the subsequent annual surveys to provide empirical data regarding sediment transport patterns within the project reach.

2.5.4. **Stream Competency**

Stream competency refers to the largest size class of sediment that a channel can transport given its slope and depth at the bankfull stage. Data gathered from the gravel bar assessment was used in the determination of stream stability in terms of predicting a state of aggradation or degradation at the cross-sections where bar samples were taken. Stream competency calculations were completed using Worksheet 5-15 (Appendix E) of the WARSSS Prediction Level Assessment (PLA).

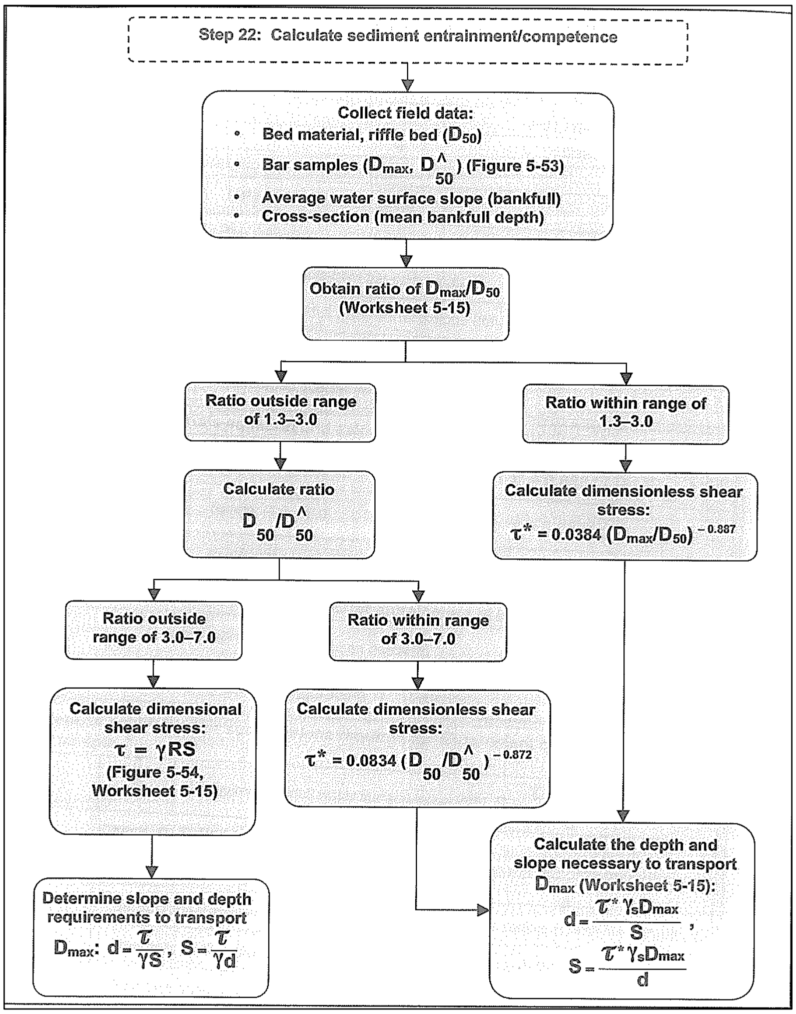


Figure 6 - Generalized Procedure for Calculating Stream Competence (Rosgen 2006)

The largest particle from respective bar samples was used as the D_{max} (*i.e.*, D_{100}) and represented the largest bedload particle made available to the channel from the upstream catchment. The parameter (τ*), which denotes critical dimensionless shear stress was used to determine the depth and slope necessary to initiate movement of the D_{max} particle. Determination of stream stability based on shear stress calculations is heavily influenced by ratios describing the relationship between the median particle size classes of riffle and channel bar materials, as well as the largest surface particle sampled on respective gravel bars (i.e. D_{50}: $D^{\wedge}_{50}$ and D_{max}/D_{50}).

Critical dimensionless shear stress (τ*) at the bankfull discharge was used in the equation:

$$\tau^* = 0.0384\ (D_{max}/D_{50})^{-0.887} \qquad \textbf{(Equation 3)}$$

Respective values of critical dimensionless shear stress (τ^*) were then used in the following equations to predict the depth and slope required to move the D_{max} particle.

$$\textbf{Depth} = \tau^* \gamma_s D_{max} / \textbf{Slope} \quad \textbf{(Equation 4)}$$

where:
γ_s - equals the submerged specific weight of water
S - equals slope of the water surface elevation at bankfull discharge

$$\textbf{Slope} = \tau^* \gamma_s D_{max} / \textbf{Depth} \quad \textbf{(Equation 5)}$$

where:
Depth - observed mean bankfull depth in riffles

The depth and slope estimates for respective values of (τ^*) were then compared to the mean bankfull depth and slope at the cross-sections that encompassed the bar samples. If the observed mean depth and slope were considerably less than the values estimated by (τ^*), then the project reach was classified as aggrading and therefore unstable. The opposite (*i.e.*, degrading) case would be true if the observed mean depth and slope were considerably greater than the values estimated by (τ^*).

Sediment competence analysis was also conducted using dimensional values of shear stress. These calculations were made using two methods. Method 1, used to calculate bankfull dimensional shear stress, was derived from the traditional shear stress equation ($\tau = \gamma_s R_h S$); however, mean bankfull depth was substituted for hydraulic radius (R_h) according to the WARSS methodology to yield:

$$\tau = \gamma_s d S \quad \textbf{(Equation 6)}$$

where:
γ_s - equals the submerged specific weight of water
d- equals mean depth at bankfull discharge
S - equals slope of the water surface elevation at bankfull discharge

Method 2 was used to calculate the dimensional shear stress required to move the D_{max} particle. It was derived from the Leopold, Wolman and Miller (1964) Power-Trendline to yield the equation:

$$\tau_c = e^{\mathrm{LN}\,((77.966/D_{max}(\mathrm{mm}))\,*\,(1/1.042)} \quad \textbf{(Equation 7)}$$

As with dimensionless shear stress, the depth and slope required to initiate movement of the D_{max} particle was calculated using dimensionless shear stress according to (Equation 8) and (Equation 9) derived from WARSS.

Equation 8 - Mean Depth Required for Particle Entrainment

$$Depth = \tau_C / (\gamma\, S)$$

Equation 9 - Water Surface Slope Required for Particle Entrainment

$$S = \tau_C / (Depth_{bankfull} * \gamma)$$

In a subsequent analysis, the cross-sectional geometry of the five riffles in the project reach was analyzed using Microsoft Excel-based Mecklenberg spreadsheets. The water surface elevations within the five riffle cross sections were manipulated such that they were scaled to the average depth (4.81 ft) required to initiate movement of the D_{max} particle. The calculated values for hydraulic and channel dimension parameters at the five riffle cross-sections were then averaged. These values give an approximation of the hydraulic conditions within the channel that are required to move particles in the D_{max} size class. The Mecklenberg spreadsheet uses the traditional shear stress equation (Method 3) to calculate shear stress.

$$\tau = 62.4\ (R_h)\ S \qquad \textbf{(Equation 10)}$$

This shear stress value was then used in a "step" function to derive an estimate of the threshold grain size that is entrained at respective shear stress values.

2.6. Bank Erosion Monitoring

2.6.1. The BANCS Model

PWD employed the Bank Assessment for Non-point source Consequences of Sediment (BANCS) Model as defined by Rosgen (2006) to predict erosion rates and classify tributary erosion potential of the tributaries. The BANCS method utilizes two bank erosion estimation tools: the Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS). The BEHI is an assessment tool that allows the erosion potential of a stream bank to be quantified. The NBS method evaluates the amount of shear stress along the stream bank. BEHI and NBS methods were used to assess 10 stream segments along the Cobbs Creek. Stream segments were determined by grouping like BEHI characteristics into individual segments. Bank lengths were assessed based on visual inspection of obvious signs of erosion.

At each assessment location, a specific value and index score were assigned to the bank for the five different BEHI categories. The five categories included in the BEHI Rating Guide are Bank Height to Bankfull Height ratio, Root Depth to Bank Height ratio, Root Density, Bank Angle and Surface Protection.

In conjunction with the BEHI assessment, the banks were also assessed with the Near Bank Stress method. For the purposes of this study, Methods 1 and 5 were used most frequently. Method 1 consisted of field reconnaissance to observe the presence or lack of presence of transverse bars, chute cutoffs and extensive deposition (Rosgen, 2006). Method 5 calculated the near-bank maximum bankfull depth to mean depth from a riffle cross-section (Rosgen, 2006). Methods 1 and 5 were chosen because these methods were both easily measured in the field.

The completed field assessment sheets for the BEHI and NBS scores are included in Appendix C. The BEHI and NBS field assessment data were then entered into RIVERMorph 4.0 where BEHI and NBS scores for each bank were determined.

2.6.2. <u>Bank Pin Installation and Monitoring</u>

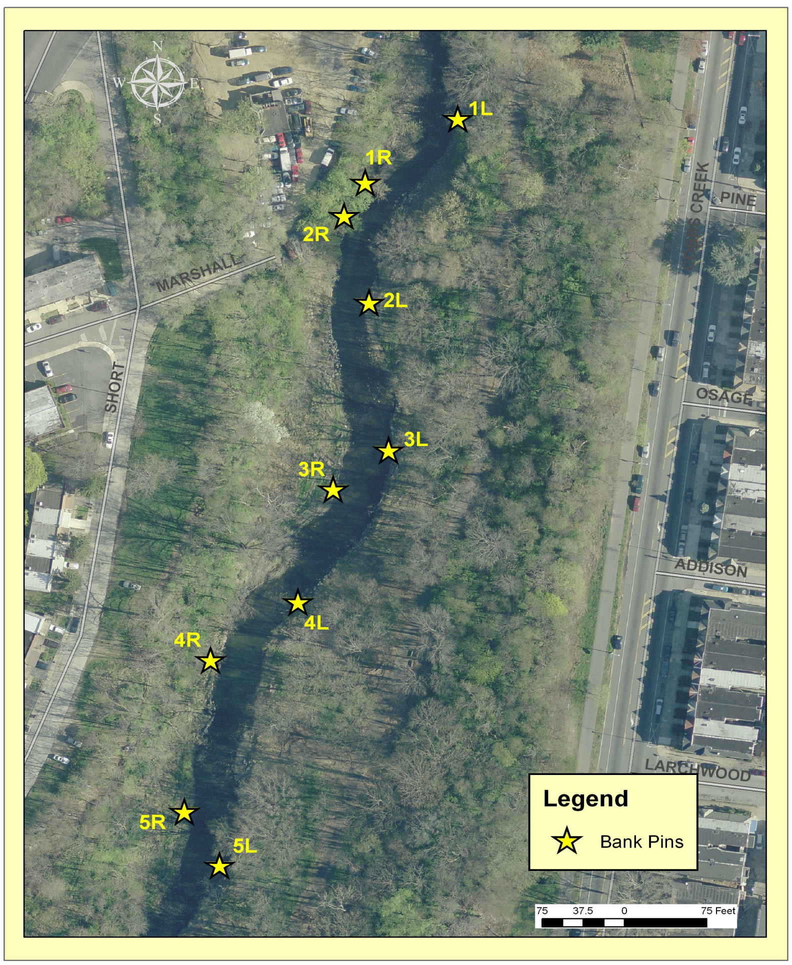


Figure 7 - Bank Pin Monitoring Locations

To field verify predictions made by the BANCS model, bank pins (18" lengths of ¼" iron rods) were driven horizontally into the stream bank normal to the curve of the bank at the location where radius of curvature was minimized (most severe bend) (Figure 7). At least one bank pin was installed below field-estimated bankfull elevation. Depending on bank height, one or two additional pins were installed such that the total number of bank pins at a site ranged from one to three (Figure 8). To enable measurement of lateral erosion, toe pins (12″ lengths of 5/8″ rebar) were also installed at each site. Toe pins were driven vertically into the stream bed at the toe of slope inline with the bank pins along a line normal to the curve in the bank (Figure 9). Toe pin locations were captured using a Total Station (Topcon GT235) and yellow plastic survey caps were installed. To further assist field teams in re-locating bank pin sites, pink spray paint was applied to bank pins and survey flagging was hung from nearby vegetation.

Photos of each bank pin site are included in Appendix C. A total of ten bank pin sites were chosen to reflect varying BEHI and NBS scores in order to validate and calibrate an erosion rate prediction model. Bank pins were installed at these ten sites during June 2009.

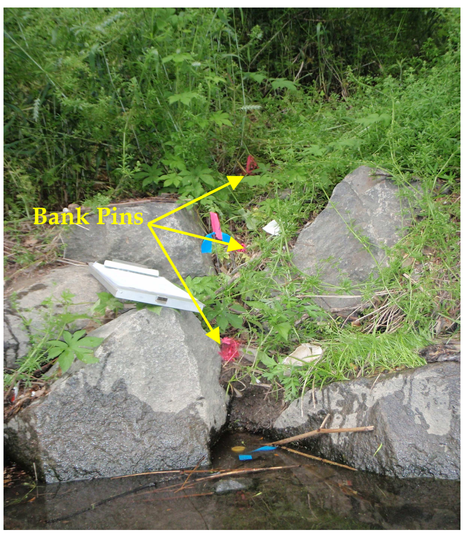


Figure 8 - Stream bank at site 3L showing typical bank pin configuration

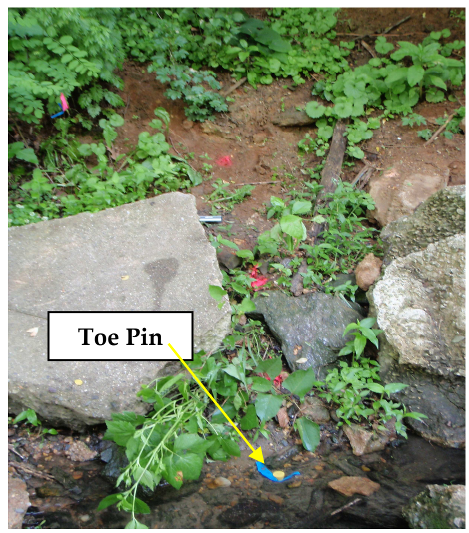


Figure 9 - Bank Pin Monitoring Site showing installation of toe pin relative to bank pin locations

Measurements were made using a survey rod (CRAIN, SFR Series Leveling Rod), a flexible "pocket rod" (Keson, Inc.) and two small cylindrical spirit levels. The survey rod was placed on the edge of the toe pin and held vertical using a level. The pocket rod was placed above the bank pin flush with the streambank and leveled with the second level. The distance from the bank to the edge of the survey rod closest to the bank was recorded on the field data sheet. Lateral erosion or aggradation of the stream bank will be determined by measuring annual changes in bank pin distance from a line extending vertically from the toe pin . In order to obtain a better measurement of bank profile, a series of vertical reference points were measured in addition to the bank pins for several of the bank pin sites. These vertical reference points were measured at predetermined vertical points on the survey rod.

2.7. Biological Monitoring

The biomonitoring component of the monitoring study was conducted during May 2009 by PWD's Bureau of Laboratory Services (BLS) personnel. The biomonitoring assessment included an evaluation of in-stream and riparian habitat as well as an evaluation of the fish and macroinvertebrate communities within the project reach. Both the habitat evaluation and the macroinvertebrate assessment were conducted using the PADEP Instream Comprehensive Evaluation (ICE) methods, as described in Appendix A of the 2006 PADEP Bureau of Water Standards and Facility Regulation ICE Surveys. The habitat evaluation was based on a qualitative assessment of twelve variables which describe the composition and condition of bed substrate, riparian condition and bank stability, flow regime, geomorphic habitat unit distribution and level of disturbance within the channel. Following the semi-quantitative macroinvertebrate sampling, six metrics were computed (EPT richness, total taxa richness, percent intolerant taxa, Shannon Diversity Index, Beck's Index, Hilsenhoff Biotic Index) and their values were compared to pre-construction values as well as PADEP ICE reference conditions.

The parameters assessed in the 2002 EPA RPB Habitat assessment varied slightly from the parameters assessed in 2009 in that three parameters (pool substrate, pool variability and sinuosity) were not assessed during the 2009 habitat evaluation. The habitat assessment data presented in this report consists of ten variables common to both data sets. In addition, the macroinvertebrate collection and processing methodologies between the two assessment years differed slightly as well. In 2002 the pre-construction monitoring sites were sampled using the RPB III protocol as opposed to the newer PADEP ICE protocol used in 2009. These new procedures differ from the previous protocol in that: a D-frame net has replaced the standard 1m² kicknet (500µm); samples are a composite of 6 riffles instead of two; and finally, large substrate is no longer scrubbed manually by hand. Composited samples from each biological monitoring location were then preserved in 95% ETOH (ethyl alcohol) and returned to the laboratory in polyethylene containers.

Updated PADEP protocols required changes to the standard laboratory procedures as well. Using the new guidelines, each composited sample was placed into an 18 x 12 x 3.5 inch pan marked with 28 four-square inch grids. Debris from four randomly selected grids was extracted from the pan, using a four-square inch circular "cookie cutter," and placed into another identical empty pan. From this second pan, organisms were picked from randomly selected grids or "plugs" until a 200-organism sub-sample (+/- 20%) was obtained. The previous protocol was very similar; whereas it required a 100 individual sub-sample taken from an 11 x 14 inch pan with 20 grids or "plugs." Organisms in the sub-sample were then identified and counted. Midges were identified to the family level of Chironomidae. Roundworms and proboscis worms were identified to the phylum levels of Nematoda and Nemertea, respectively. Flatworms were identified to the class level of Turbellaria. Segmented worms, aquatic earthworms, and tubificids were identified to the class level of Oligochaeta. All other macroinvertebrates were identified to genus.

2.8. **Photo Monitoring**

To properly document the changes that occur at the restoration site, PWD will conduct post-construction photo monitoring of the ten cross-sections and ten bank pin locations. During the initial post-constructing monitoring phase at Marshall Road, four photos were taken at each cross-section location. The four photo locations consisted of the downstream left edge of water facing towards the downstream right edge of water, the center of the cross-section facing upstream, the center of the cross-section facing downstream and the downstream right edge of water facing toward the downstream left edge of water. The photos for each cross-section are included in Appendix A.

Photos were also taken at each of the ten bank pin locations. One picture was taken of the bank profile showing the bank pins, toe pin and entire bank height. Then, standing next to the toe pin, one picture was taken looking upstream along the bank and another picture was taken looking downstream. The photos for each bank pin location are included in Appendix D.

3. Results

3.1. Topographic Survey

In total, the June 2009 survey effort produced 411 unique survey points, 10 monumented cross-sections, and 32 benchmark monuments that may be used for future monitoring work (Table 6, Table 7).

Table 6 - Topographic Survey Point Count

Point Type	*Code*	*Count*
BEHI	BEHI	10
Bankfull	BF	29
Control Points	CP	4
Edge of Water	EOW	85
Groundshots	GS	91
In-stream Points	ISP	112
Rebars	RBAR	21
Top of Bank	TOB	1
Toe Pins	TOEPN	10
Turning Points	TP	6
Thalweg	TW	42

Table 7 - Topographic Survey Control Point Data

Point Name	*Code*	*Northing (ft)*	*Easting (ft)*	*Elevation (ft)*
CP2	CP	2669790.325	237172.301	98.158
CP3	CP	2669791.328	237179.265	98.248
TP3	CP	2669600.215	236819.782	65.316
5	RBAR	2669495.118	236737.497	48.908
6	RBAR	2669600.233	236819.796	65.313
7	RBAR	2669430.324	236716.813	49.034
104	RBAR	2669489.394	236906.938	49.208
149	RBAR	2669541.579	236885.260	50.227
156	RBAR	2669571.495	236935.474	53.649
194	RBAR	2669507.953	236951.900	49.793
246	RBAR	2669514.460	236663.328	50.223
263	RBAR	2669437.830	236657.487	48.241
324	RBAR	2669461.908	236495.400	50.165
350	RBAR	2669380.138	236534.766	47.971
358	RBAR	2669358.308	236469.951	46.558
375	RBAR	2669401.532	236442.852	47.391
409	RBAR	2669390.113	236407.003	47.182
428	RBAR	2669337.607	236424.576	48.729
445	RBAR	2669372.784	236299.761	48.834
465	RBAR	2669301.997	236312.314	48.598
475	RBAR	2669367.737	236243.318	49.629
476	RBAR	2669295.517	236270.451	48.361
532	RBAR	2669329.084	236149.713	49.001
548	RBAR	2669264.301	236177.033	47.863
401	TOEPN	2669415.969	236462.360	44.891
430	TOEPN	2669336.648	236405.719	44.822
531	TOEPN	2669344.654	236204.396	43.837
549	TOEPN	2669312.566	236257.172	44.036
553	TOEPN	2669448.081	236573.428	45.989
554	TOEPN	2669498.701	236611.489	45.918
556	TOEPN	2669561.632	236936.945	47.214
557	TOEPN	2669477.353	236874.328	46.349
558	TOEPN	2669458.027	236841.511	46.299
559	TOEPN	2669480.896	236756.751	46.955
TP1	TP	2669627.093	237102.883	82.514

3.2. Monumented Cross-Sections

In total, ten monumented cross-sections were installed and monitored throughout the project reach. Each riffle (XS1, XS4, XS5, XS8, XS10) in the project reach was surveyed and used to calculate average bankfull geometry through the project reach. Bankfull width (ft) ranged between 57.35 and 72.12, with an average width of 63.97. Mean bankfull depth (ft) ranged between 2.03 and 2.82, with an average depth of 2.53. Bankfull area (ft^2) ranged between 147.5 and 182.38, with an average area of 160.56. Estimated bankfull discharge (ft^3/s) ranged between 580 and 890, with an average discharge of 751 (Table 8, Table 9).

Table 8 - Marshall Road Cross-Sectional Data

Cross-Section	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Type	Riffle	Pool	Glide	Riffle	Riffle	Run	Pool	Riffle	Pool/ Glide	Riffle
Bankfull Width	60.72	49.99	69.57	72.12	68.35	52.97	48.68	61.32	58.85	57.35
Bankfull Elevation	49.68	49.14	49.04	48.36	48.5	47.04	46.9	47.17	46.33	46.72
Mean Depth	2.43	3.32	2.34	2.03	2.67	2.45	3.44	2.68	2.39	2.82
Maximum Depth	3.36	7.05	4.6	2.77	3.27	3.3	4.87	3.73	3.42	3.91
Bankfull Area	147.5	165.87	162.44	146.71	182.38	129.96	167.54	164.55	140.51	161.66
Floodprone Elevation	53.04	56.19	53.64	51.13	51.77	50.34	51.77	50.9	49.75	50.63
Floodprone Width	71.44	83.63	102	92.14	119.6	75.84	141.96	113.07	90.53	109
Entrenchment Ratio	1.18	1.67	1.47	1.28	1.75	1.43	2.92	1.84	1.54	1.9
Width/Depth Ratio	24.99	15.06	29.73	35.53	25.6	21.62	14.15	22.88	24.62	20.34
Wetted Perimeter	62.7	54.09	71.72	72.66	70.83	54.31	51.05	62.38	59.48	58.39
Hydraulic Radius	2.35	3.07	2.26	2.02	2.57	2.39	3.28	2.64	2.36	2.77
D84	131	9	32	92	75	42	33	82	54	68
D50	40.4	3.1	10.1	60.2	35.1	13.9	10.4	36.1	16	34.4
Manning's 'n'	0.0406	--------	--------	0.0372	0.0340	--------	--------	0.0347	--------	0.0329
Velocity	3.99	--------	--------	3.95	5.07	--------	--------	5.05	--------	5.51
Bankfull Discharge	589.21	--------	--------	579.54	924.39	--------	--------	830.98	--------	890.61

Table 9 - Average Cross-Sectional Data by Feature Type

Cross-section Type	*Riffle*	*Pool*	*Glide*	*Run*
Bankfull Width	63.97	49.34	69.57	52.97
Bankfull Elevation	48.09	48.02	49.04	47.04
Mean Depth	2.53	3.38	2.34	2.45
Maximum Depth	3.41	5.96	4.60	3.30
Bankfull Area	160.56	166.71	162.44	129.96
Floodprone Elevation	51.49	53.98	53.64	50.34
Floodprone Width	101.05	112.80	102.00	75.84
Entrenchment Ratio	1.59	2.30	1.47	1.43
Width/Depth Ratio	25.87	14.61	29.73	21.62
Wetted Perimeter	65.39	52.57	71.72	54.31
Hydraulic Radius	2.47	3.18	2.26	2.39
D84	89.60	21.00	32.00	42.00
D50	41.24	6.75	10.10	13.90
Manning's 'n'	0.0359	----------	----------	----------
Velocity	4.68	----------	----------	----------
Bankfull Discharge	750.94	----------	----------	----------

Worksheet 5-3. Field form for Level II stream classification (Rosgen, 1996; Rosgen and Silvey, 2005).

Stream: **Cobbs Creek**	
Basin:	Drainage Area: **10240** acres **16** mi^2
Location: **Marshall Road Riffles Average**	
Twp.&Rge: **Philadelphia**	Sec.&Qtr.:
Cross-Section Monuments (Lat./Long.):	Date: **7-15-09**
Observers: **EH, RH, MR, GB**	Valley Type: V

Bankfull WIDTH (W_{bkf}) WIDTH of the stream channel at bankfull stage elevation, in a riffle section.	**63.97**	ft
Bankfull DEPTH (d_{bkf}) Mean DEPTH of the stream channel cross-section, at bankfull stage elevation, in a riffle section ($d_{bkf} = A / W_{bkf}$).	**2.53**	ft
Bankfull X-Section AREA (A_{bkf}) AREA of the stream channel cross-section, at bankfull stage elevation, in a riffle section.	**160.56**	ft^2
Width/Depth Ratio (W_{bkf} / d_{bkf}) Bankfull WIDTH divided by bankfull mean DEPTH, in a riffle section.	**25.87**	ft/ft
Maximum DEPTH (d_{mbkf}) Maximum depth of the bankfull channel cross-section, or distance between the bankfull stage and Thalweg elevations, in a riffle section.	**3.41**	ft
WIDTH of Flood-Prone Area (W_{fpa}) Twice maximum DEPTH, or (2 x d_{mbkf}) = the stage/elevation at which flood-prone area WIDTH is determined in a riffle section.	**101.05**	ft
Entrenchment Ratio (ER) The ratio of flood-prone area WIDTH divided by bankfull channel WIDTH (W_{fpa} / W_{bkf}) (riffle section).	**1.59**	ft/ft
Channel Materials (Particle Size Index) D_{50} The D_{50} particle size index represents the mean diameter of channel materials, as sampled from the channel surface, between the bankfull stage and Thalweg elevations.	**41.24**	mm
Water Surface SLOPE (S) Channel slope = "rise over run" for a reach approximately 20–30 bankfull channel widths in length, with the "riffle-to-riffle" water surface slope representing the gradient at bankfull stage.	**0.0035**	ft/ft
Channel SINUOSITY (k) Sinuosity is an index of channel pattern, determined from a ratio of stream length divided by valley length (SL / VL); or estimated from a ratio of valley slope divided by channel slope (VS / S).	**1.12**	

Stream Type → **B4c** ← (See **Figure 2-14**)

WARSSS page 5-29

Figure 10 - Level II Classfication worksheet for average riffle cross-section (Rosgen 2006)

3.3. **Longitudinal Profile & River Reach Summary Data**

The Marshall Road restoration reach begins roughly 300 feet south of the Marshall Road Bridge. Stationing of both cross-section locations (Figure 2) and bank pin monitoring locations (Figure 7) were assigned according to the longitudinal profiles using the path traced through the left edge of water (LEW). The longitudinal profile starts at the head of the riffle at XS1 (Station 0+11) and ends at the head end the riffle at XS10 (Station 8+68). The project reach encompasses four full riffle-run-pool-glide sequences. The average baseflow water surface slope was 0.38%. In total, 23 bankfull elevation points were surveyed. The best-fit trendline through the bankfull points gave a 0.35% bankfull water surface slope. While slightly less than the measured average baseflow water slope, the bankfull water surface slope was within 10% of the average baseflow water surface slope and considered an appropriate approximation.

The project reach's riffle-run-pool-glide sequencing included some significant variance worth noting. A compound pool was present beginning at Station 0+32 and ending a Station 2+37. This 205-foot long pool section represents the project reach's longest pool. Fairly normal sequencing then follows this pool from Station 2+83 (XS4-Riffle) through Station 7+09 (XS8-Riffle) where two full sequences are present. This segment was then followed by a compound riffle beginning at Station 7+09 and ending at Station 8+68, which includes XS8-Riffle, XS9-Glide, and XS10-Riffle. The section between XS8 and XS10 can best be described as a pool or extended glide section. Its characteristics exhibit little to no resemblance to the other pool sections along the rest of the project reach.

Overall, the project reach was dominated by pools (57%) with multiple short riffle sections (12%) interspersed throughout. The proportion of each stream section type is summarized below in Table 10. The distance from head of riffle to head of riffle ranged between 148 – 284 feet and averaged 211 feet. A total of four riffle-run-pool-glide sequences were observed in the project reach. More detailed reach summary is provided in Figure 13 below.

Table 10 - Stream Features as a Proportion of Total Reach Length

Stream Section Type	*Stream Length (ft)*	*Percentage of Reach*
Riffle	101	12%
Run	156	18%
Pool	494	57%
Glide	117	13%

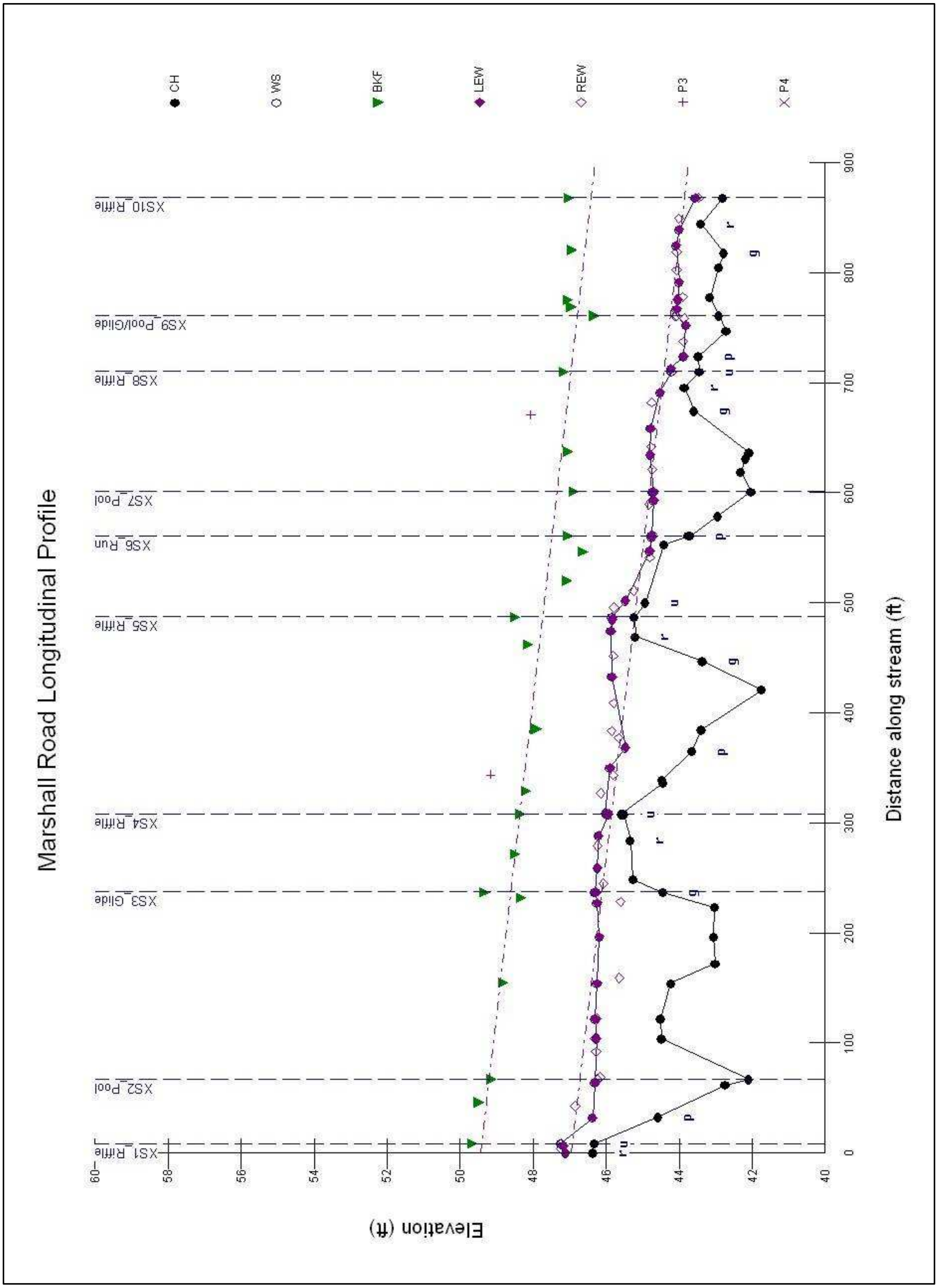


Figure 11 - Longitudinal Profile with Cross-Section Locations

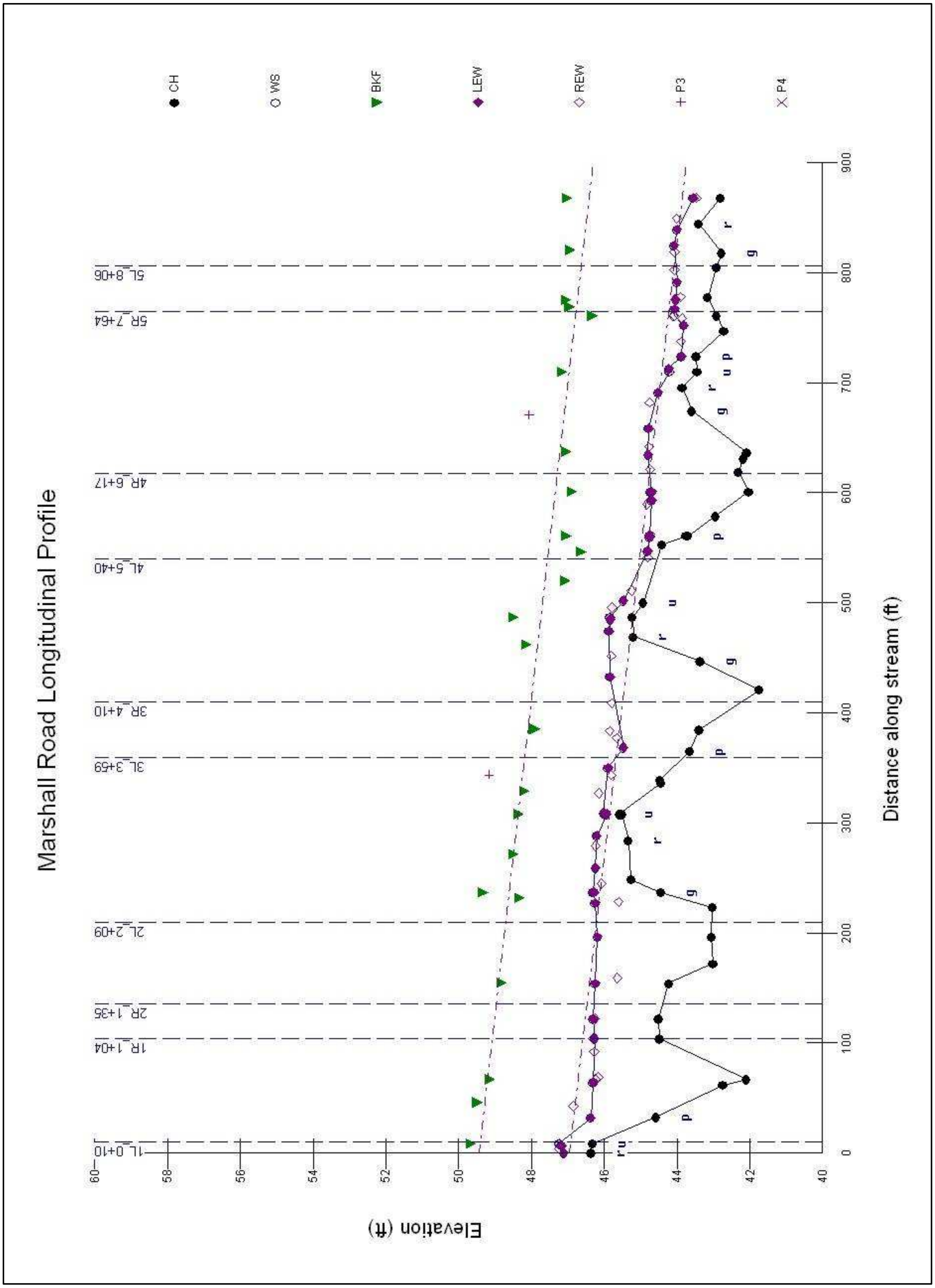


Figure 12 - Longitudinal Profile with Bank Pin Locations

Stream: **Cobbs Creek** Location: **Marshall Road**

Observers: **EH, RH, MM, GB** Date: **6/1/09 - 6/5/09** Valley Type: Stream Type: **B4c**

River Reach Summary Data

Channel Dimension

Mean Riffle Depth (d_{bkf})	2.53	ft	Riffle Width (W_{bkf})	64	ft	Riffle Area (A_{bkf})	161	ft^2
Mean Pool Depth (d_{bkfp})	3.4	ft	Pool Width (W_{bkfp})	49	ft	Pool Area (A_{bkfp})	167	ft^2
Mean Pool Depth/Mean Riffle Depth	1.34	d_{bkfp}/ d_{bkf}	Pool Width/Riffle Width	0.77	W_{bkfp}/ W_{bkf}	Pool Area / Riffle Area	1.04	A_{bkfp}/A_{bkf}
Max Riffle Depth (d_{mbkf})	3.41	ft	Max Pool Depth (d_{mbkfp})	5.96	ft	Max Riffle Depth/Mean Riffle Depth	1.348	
Max Pool Depth/Mean Riffle Depth	2.356					Point Bar Slope	----------	
Streamflow: Estimated Mean Velocity at Bankfull Stage (u_{bkf})				4.68	ft/s	Estimation Method	Mannings (Limerino's)	
Streamflow: Estimated Discharge at Bankfull Stage (Q_{bkf})				751	cfs	Drainage Area	12	mi^2

Channel Pattern

Geometry	Mean	Min	Max		Dimensionless Geometry Ratios	Mean	Min	Max
Meander Length (Lm)	388	364	412	ft	Meander Length Ratio (Lm/W_{bkf})	6.063	5.688	6.438
Radius of Curvature (Rc)	167	141	200	ft	Radius of Curvature/Riffle Width (Rc/W_{bkf})	2.609	2.203	3.125
Belt Width (W_{blt})	91	75	106	ft	Meander Width Ratio (W_{blt}/W_{bkf})	1.422	1.172	1.656
Individual Pool Length	122	80.5	205	ft	Pool Length/Riffle Width	1.902	1.258	3.209
Pool to Pool Spacing	101	61.1	128	ft	Pool to Pool Spacing/Riffle Width	1.582	0.955	2.005
Riffle Length	23.6	14.4	31.7	ft	Riffle Length/Riffle Width	0.369	0.225	0.495

Channel Profile

Valley Slope (VS)	----	ft/ft	Average Water Surface Slope (S)	0.00344	ft/ft	Sinuosity (VS/S)	####	
Stream Length (SL)	752	ft	Valley Length (VL)	669	ft	Sinuosity (SL/VL)	1.12	
Low Bank Height (LBH)	start ----	ft	Max Riffle Depth	start 3.36	ft	Bank-Height Ratio (BHR) (LBH/Max Riffle Depth)	start ----	
	end ----	ft		end 3.91	ft		end ----	

Facet Slopes	Mean	Min	Max		Dimensionless Slope Ratios	Mean	Min	Max
Riffle Slope (S_{rif})	0.013	0.009	0.017	ft/ft	Riffle Slope/Average Water Surface Slope (S_{rif} / S)	3.669	2.735	4.919
Run Slope (S_{run})	0.017	0.008	0.037	ft/ft	Run Slope/Average Water Surface Slope (S_{run} / S)	4.875	2.439	10.69
Pool Slope (S_p)	0.0007	0.0004	0.0009	ft/ft	Pool Slope/Average Water Surface Slope (S_p / S)	0.189	0.128	0.256
Glide Slope (S_g)	0.0021	0.0003	0.0040	ft/ft	Glide Slope/Average Water Surface Slope (S_g / S)	0.610	0.073	1.172

Feature Midpoint [a]	Mean	Min	Max		Dimensionless Depth Ratios	Mean	Min	Max
Riffle Depth (d_{rif})	3.06	2.56	3.33	ft	Riffle Depth/Mean Riffle Depth (d_{rif} / d_{bkf})	1.21	1.01	1.32
Run Depth (d_{run})	3.55	2.97	3.83	ft	Run Depth/Mean Riffle Depth (d_{run} / d_{bkf})	1.4	1.17	1.51
Pool Depth (d_p)	5.7	4.19	7.09	ft	Pool Depth/Mean Riffle Depth (d_p / d_{bkf})	2.25	1.66	2.8
Glide Depth (d_g)	3.41	3.28	3.5	ft	Glide Depth/Mean Riffle Depth (d_g / d_{bkf})	1.35	1.3	1.38

Channel Materials

	Reach[b]	Riffle[c]	Bar		Reach[b]	Riffle[c]	Bar	Protrusion Height[d]	
% Silt/Clay	0	0	0	D_{16}	0.57	19.96	1.03	---------	mm
% Sand	30	2	18.26	D_{35}	4	40.67	7.63	---------	mm
% Gravel	61	53	72.31	D_{50}	8.99	58.41	17.63	---------	mm
% Cobble	9	45	9.44	D_{84}	39.8	98.14	55.72	---------	mm
% Boulder	0	0	0	D_{95}	81.33	128	83.93	---------	mm
% Bedrock	0	0	0	D_{100}	179.99	255.99	119	---------	mm

a Min, max, mean depths are the average mid-point values except pools, which are taken at deepest part of pool.

b Composite sample of riffles and pools within the designated reach.

c Active bed of a riffle.

d Height of roughness feature above bed.

Figure 13 - River Reach Summary Data

3.4. Bed Material Analysis

3.4.1. Pebble Counts

Table 11 - Pebble Count Particle Size Analysis Summary Table in millimeters

Feature	Location	D16	D35	D50	D84	D95	D100
Riffle	XS1	11	26	41	131	176	256
	XS4	21	45	61	93	120	180
	XS5	13	24	36	76	141	512
	XS8	12	22	37	83	123	256
	XS10	18	26	34	67	97	128
	Average	***15***	***29***	***42***	***90***	***131***	***266***
Run	XS6	***1***	***10***	***14***	***42***	***100***	***256***
Pool	XS2	0.3	1	3	9	11	23
	XS7	0.5	4	11	34	74	90
	Average	***0.4***	***2.5***	***7***	***22***	***43***	***57***
Glide	XS3	1	6	10	32	63	128
	XS9	1	8	16	55	80	180
	Average	***1***	***7***	***13***	***44***	***72***	***154***
Reach-wide	*Average*	***0.6***	***4***	***9***	***40***	***81***	***180***

3.4.2. Bar Samples

During the analysis of the gravel bar sediment sample, the largest surface particle from the downstream gravel bar was deemed an outlier and removed from the gravel bar and subsequent stream competency analyses. The intermediate axis of the particle was 165 mm and much larger than the other surface particles obtained from the two gravel bars. From the larger size, composition and angular shape of the particle, it is likely that this particle was not a component of the bedload sediment delivered to the gravel bar from upstream reaches. It was assumed that this particular particle was a remnant of a temporary stream crossing erected during the construction process.

After the outlier was removed, both the largest surface particle and the particle size distributions between the two gravel bars were relatively consistent between the respective upstream and downstream gravel bars (74mm, 73mm). These values both correspond to the "small cobble" sediment size class. The D_{50} of the gravel bars was 17mm and 18mm, and corresponds to the coarse gravel sediment size class.

Table 12 - Bar Sample Particle Size Analysis in millimeters

Location	D16	D35	D50	D84	D95	D100
Bar Sample 1	0	8	17	53	67	74
Bar Sample 2	2	8	18	59	69	73

3.4.3. Scour Chain Monitoring

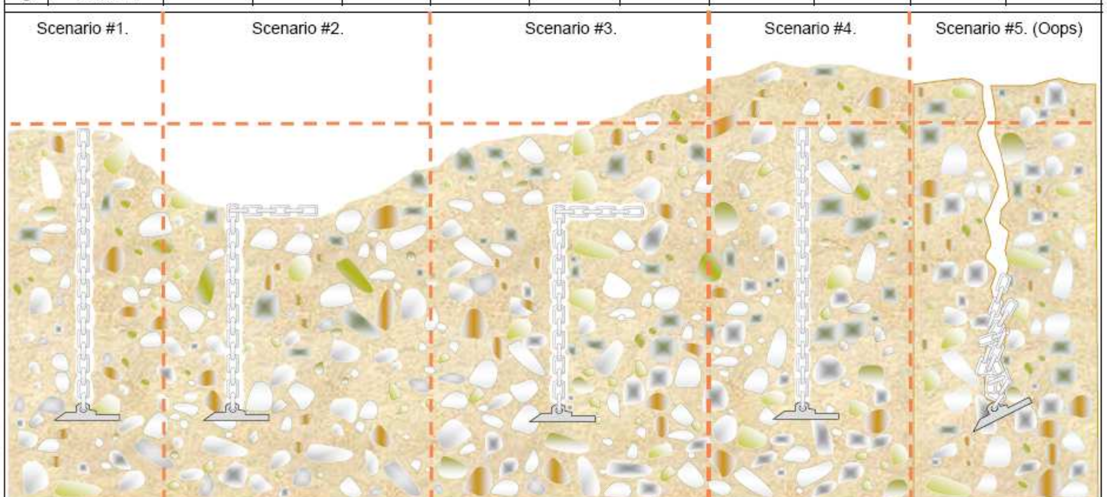
Scour chains were installed at cross-section XS3-Glide, stations 31 and 42 and at cross-section XS4-Riffle, stations 35 and 52. Cross-sections with scour chains will be resurveyed and compared to previous cross-sections to determine if degradation or aggradation processes are prominent in the project reach. Data relevant to determining the extent of bed scour will include: the length of exposed chain (or depth of burial in the instance of bed aggradation), the distribution of particle sizes with the cross-section and the diameter of the two largest particles closest to the scour chain (used to estimate shear stress), and the scenario observed as depicted in Figure 14. In the instance that scour chains are buried, bed material will be excavated and the depth of burial will be recorded. If the scour chain has been exposed, the length of exposed scour chain will be measured. Scour chains will be monitored annually over the next three years.

Worksheet 6-1. Field form for documenting scour chain results and corresponding bed-elevation changes.

Stream name: Location:

Observers: Stream Type: Valley Type: Date:

		Installation Data (1st Year)				Recovery Data (2nd Year)					
		From cross-section		Particles near chain		Chain recovery				Particles near chain	
		Station (ft)	Elevation (ft)	Largest (mm)	2nd Largest (mm)	Scenario # (1–5)	Scour depth[a] (ft)	Elevation[b] (ft)	Net change[c] (ft)	Largest (mm)	2nd Largest (mm)
Riffle	Chain #1										
	Chain #2										
Glide	Chain #3										
	Chain #4										



[a] Scenario 2 or 3. Scenario 2: Enter length of chain exposed. Scenario 3: Enter length of chain exposed then subsequently buried.
[b] Scenario 3 or 4. Scenario 3: Enter elevation of bed at same station @ 2nd year. Scenario 4: Enter depth of material over chain.
[c] Scenario 3: Subtract 1st and 2nd year elevations to calculate net change in bed.

 WARSSS page 6-12

Figure 14 - Scour Chain Monitoring Worksheet

3.4.4. <u>Stream Competency</u>

The project reach was rated as relatively stable based on the WARSSS stream competency assessment (Appendix E). The observed mean riffle depth and slope at bankfull discharge were greater than the calculated slope and depth required to move the channel's bed load materials. The mean riffle depth within the project reach was 2.53 ft compared to the calculated depth of 2.20 ft for the upstream and downstream composite gravel bar samples (Table 13). Similarly, the observed bankfull water surface slope of the project reach (0.0035 ft/ft) was relatively close to the predicted slope required to move the bedload (0.0030 ft/ft). The values of bankfull water surface slope and depth were calculated using dimensionless shear stress. Separate calculations were done to derive dimensional shear stress estimates at bankfull discharge and at the discharge required to move the D_{max} particle. Based on these results (Appendix E), it is highly likely that the majority of the bedload, with the exception of particles greater than or equal to the D_{max}, are being transported downstream during bankfull events.

Table 13 - Stream Channel Competency Results Using Dimensionless Shear Stress at Bankfull

2009 Marshall Road Post-Construction Monitoring	*Composite Bar Sample*	
	Observed[1]	*Predicted*
Mean Depth $_{bkf}$ (ft)	2.53	2.20
Slope $_{bkf}$ (ft/ft)	0.0035	0.00304
Shear Stress (τ*)	0.0195	--------

[1] Bankfull critical dimensionless shear stress

At the calculated bankfull dimensional shear stress $\tau = \gamma s d S$ (Equation 6Method 1) for the project reach (0.5526 lbs/ft²), it was predicted that particles with an intermediate axis of 42.02 mm or less would be entrained at bankfull discharge (Table 14). Particles within the size class that encompasses 42.02mm particles (very coarse gravel) correspond to the D_{60} of the cumulative riffle particle size distribution and the D_{87} of the project reach, which validates the prediction that the project reach is transporting most of its bedload sediment.

Table 14 - Predicted Hydraulic Conditions at Bankfull Discharge and Conditions Required to Entrain D_{MAX} Particle

Parameter	*Composite Bar Sample*
Bankfull Shear Stress (lbs/ft²)	0.60
Movable Particle Size$_{bkf}$ (mm)	42.02
Shear Stress (lbs/ft²)	1.05
Mean Depth (ft)	4.81
Slope	0.0067

Method 2 provides a power relationship ($\tau_c = e^{LN((77.966/D_{max}(mm)) * (1/1.042)}$ (Equation 7) between grain diameter and critical shear stress (τ_c) derived from (Leopold, Wolman and Miller 1964), (τ_c) such that a value of 1.0514 lbs./ft² was predicted to be necessary to initiate movement of the D_{max} size class (small cobble). Within the project reach, this (τ_c) value would correspond to an average depth (Equation 8) of 4.81 ft within the five riffle cross-sections and a value of 0.0067 (ft/ft) for required slope (Equation

9). Based on cross-section analysis of the five riffle cross-sections, a stage of 4.81 ft would correspond to a mean discharge of 2,507.87 ft^3/s, a discharge that would inundate the flood prone area; thus, most sediment found on gravel bars are subject to transport during bankfull events; however, the particles similar in size to the D_{max} will most likely be entrained at flows in excess of bankfull discharge.

Table 15 - Results of Cross-sectional Geometry Analysis

Channel Dimension	
Parameter	*Value*
Cross-section Area (ft^2)	383.48
Hydraulic Radius (ft)	3.95
Width (ft)	79.73
Mean Depth (ft)	4.81
Max Depth (ft)	6.14
Width to Depth Ratio	16.58
Channel Hydraulics	
Parameter	*Value*
Discharge (ft^3)	2507.87
Velocity (ft^3/s)	6.46
Shear Stress (lbs./ ft^2)	0.86
Shear Velocity (ft/s)	0.67
Unit Stream Power (lbs./ft/s)	6.78
Froude Number	0.27
Friction Factor	9.69
Threshold Grain Size (mm)	54.25

Dimensional shear stress values were relatively close (within 18.09%) using Method 2 ($\tau_c = e^{LN ((77.966/D_{max}(mm)) * (1/1.042)}$ (Equation 7) and the traditional shear stress equation used in the Mecklenburg spreadsheet even though the two methods calculate shear stress from bar sample data and channel cross-section data, respectively.

There was a discrepancy between the two methods in terms of predicted grain size diameter at the shear stress necessary to initiate movement of the D_{max} particle (Table 14). The threshold grain size calculated in the Mecklenburg spreadsheet utilizes a "step" function to calculate the threshold grain diameter whereas Method 2 utilizes a power relationship. The Mecklenburg spreadsheet utilizes the Shield's Curve to back-calculate the threshold grain diameter as a function of the shear stress calculated for the cross-section $\tau = 62.4\ (R_h)\ S$ (Equation 10). As the mean riffle shear stress from the cross-section analysis (Table 15) was lower than the value calculated from Method 2 (Table 14), the mean threshold grain diameter was thus underestimated. Furthermore, shear stress values derived from Method 2 were scaled to the D_{max} particle, whereas the shear stress values calculated in the Mecklenburg spreadsheets were influenced by the hydraulic radius of the channel at the depth required to move the D_{max} particle. Figures Figure 15 and

Figure 16 represent the different relationships between shear stress and threshold grain diameter using Method 2 ($\tau_c = e^{LN((77.966/D_{max}(mm)) * (1/1.042)}$ (Equation 7) and Method 3 (τ = 62.4 (Rh) S (Equation 10) respectively.

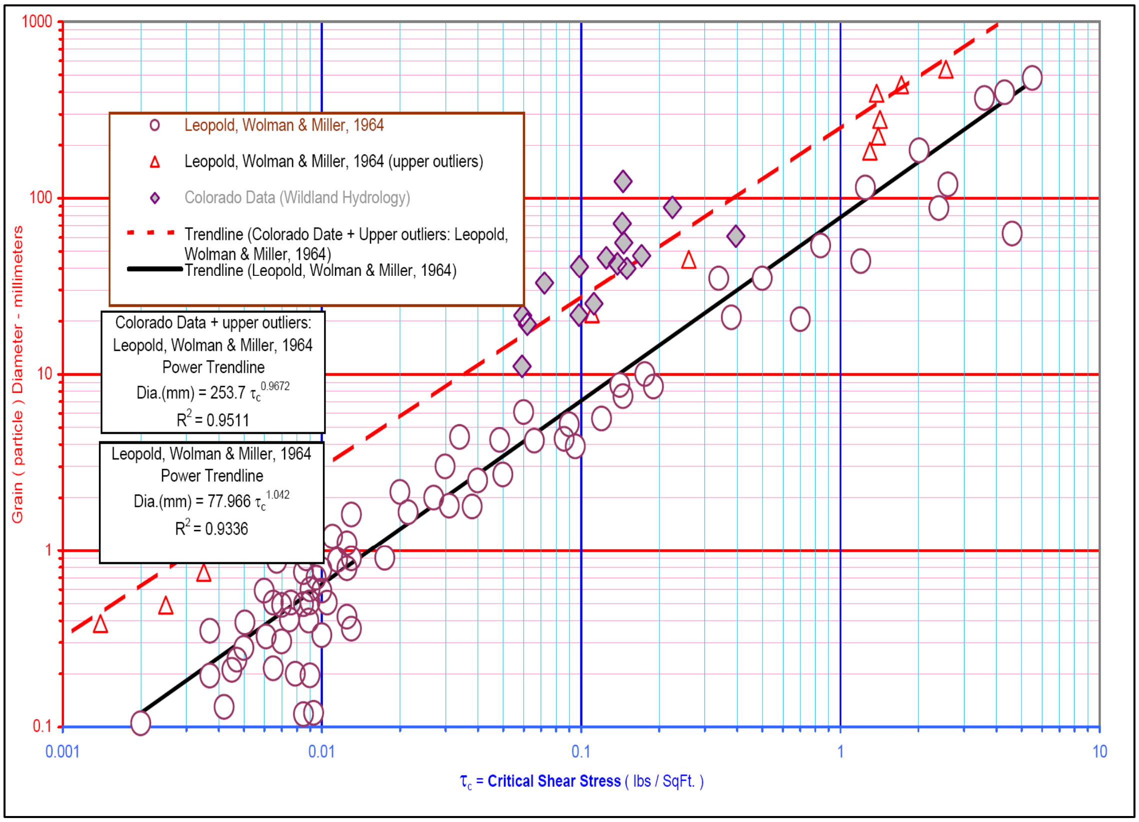


Figure 15 - Critical Shear Stress Required to Initiate Movement of Sediment Grains

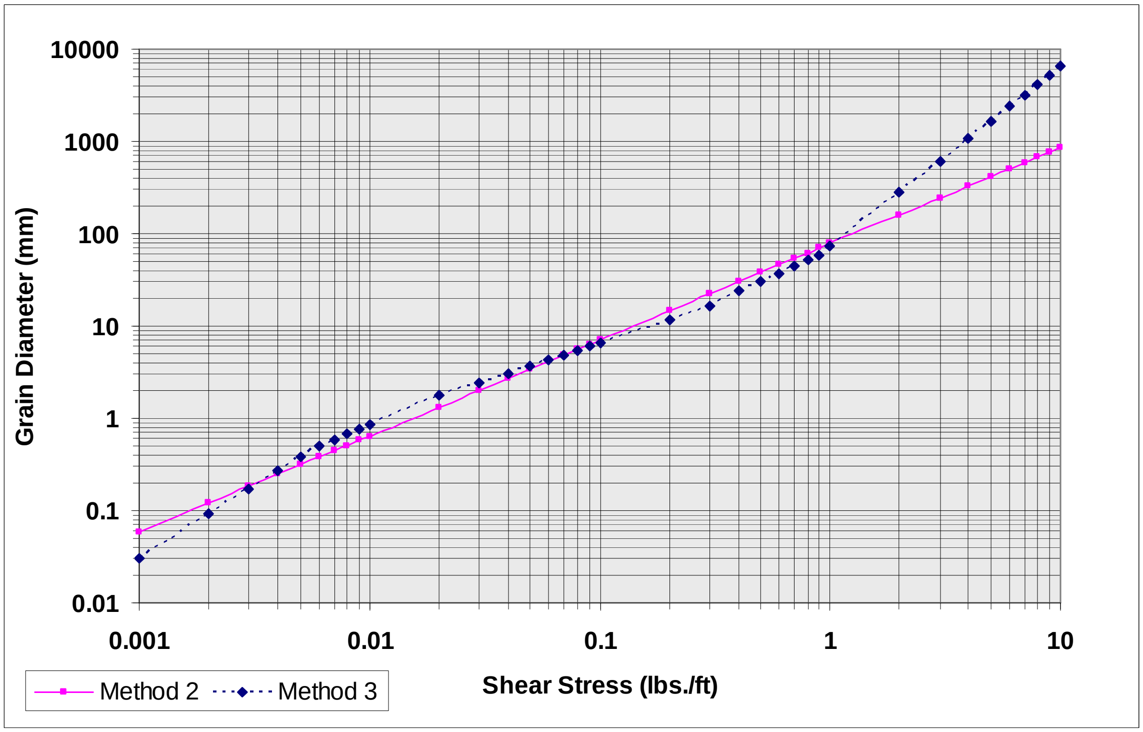


Figure 16 - Comparison of Curves used to Calculate Critical Shear Stress and Threshold Grain Diameter

3.5. Bank Erosion Monitoring

3.5.1. The BANCS Model

Ten different banks along the Marshall Road stream restoration site were assessed with the BANCS model (Table 16). The BEHI scores for the ten banks consist of one moderate rating, three low ratings and six very low ratings (Figure 17). A bank material adjustment for the large boulders was applied to five different banks changing the scores to a very low BEHI. NBS scores for the ten banks were one high rating, one moderate rating, six low ratings and two very low ratings (Figure 18). The BANCS model predicted an annual erosion rate of 3.16 yd^3/yr. Assuming a density of 1.3 ton/yd^3, this estimate equates to 8,220 lb/yr (4.11 ton/yr) over the approximately 1,700 feet of streambank assessed. The erosion rate per foot of streambank was estimated to be 9.2 lb/yr.

Table 16 - BEHI and NBS Scores

Reach ID	*BEHI Score*	*BEHI Rating*	*NBS Rating*
1R 0+00	21.7	Moderate	Very Low
1L 0+00	28.9*	Very Low	High
2R 1+04	21.2*	Very Low	Low
2L 1+12	12.7	Low	Very Low
3R 2+75	11.5	Low	Low
3L 3+04	23.9*	Very Low	Low
4R 5+33	24.3*	Very Low	Low
4L 5+27	18.6	Low	Moderate

5R 6+91	9.1	Very Low	Low
5L 6+99	19.7*	Very Low	Low

* BEHI Score was overridden due to the presence of boulder stone-toe protection

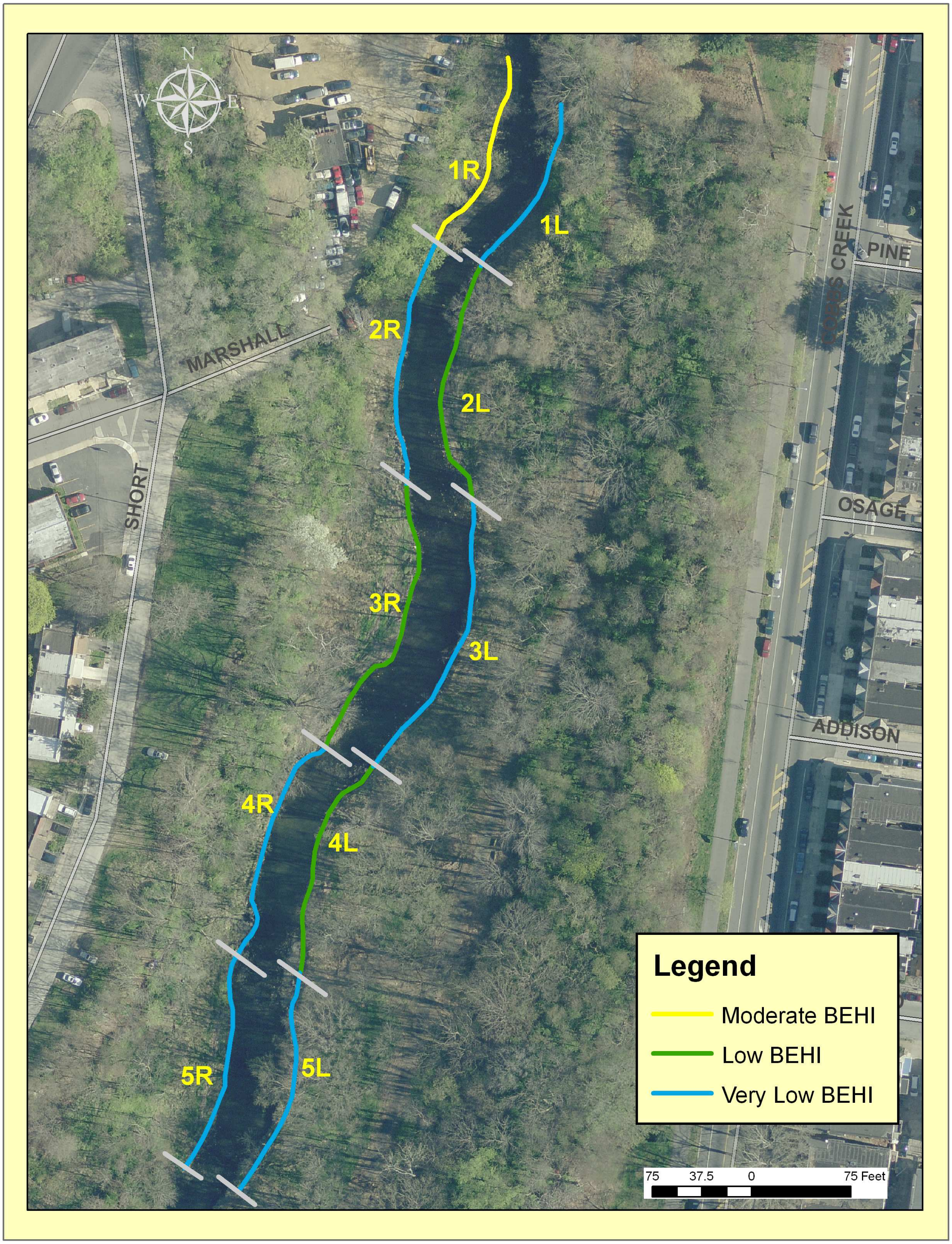


Figure 17 - BEHI Bank Scores

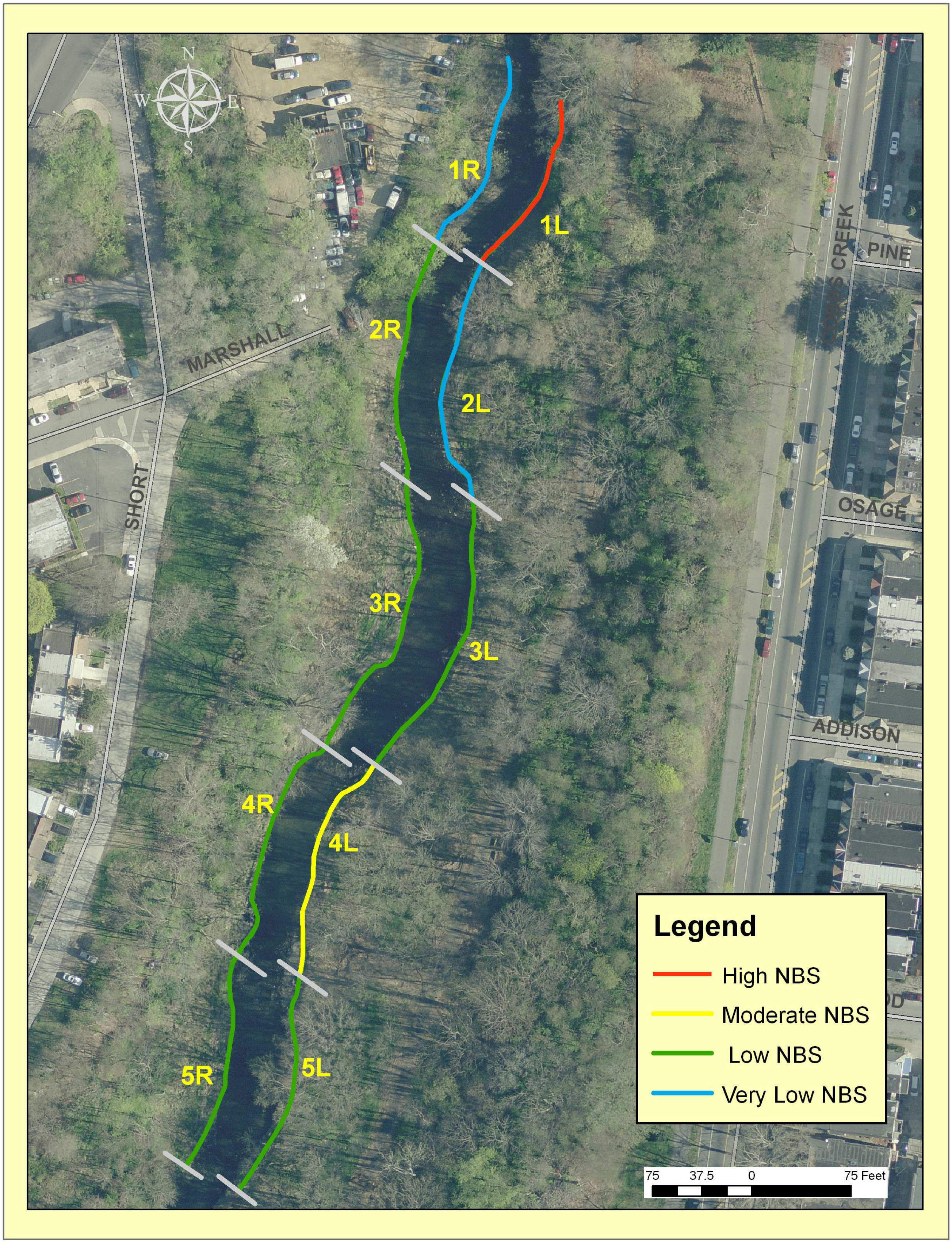


Figure 18 - NBS Bank Scores

3.5.2. **Bank Pin Monitoring**

Bank pins were installed in ten locations to measure erosion at varying BEHI and NBS combinations. Photos and bank profiles for each bank pin location are included in Appendix D.

The bank pins will be measured annually, beginning in June 2010. At that time, a lateral erosion rate will be calculated for each of the bank pin locations and it will be compared to the predicted erosion estimates. The lateral erosion rate will calculated after each round of bank pin measurements to track the changes in the sediment load over time.

3.6. **Biological Monitoring**

3.6.1. **Pre-construction Biomonitoring**

Macroinvertebrate, fish and habitat assessments were conducted at two sites (DCC490 and DCC455) in 2002 (Figure 19), along the reach that spans from Marshall Road at the upstream extent to the Cobbs Creek Community and Environmental Education Center at the downstream extent. Habitat and biological results were similar for both sites and indicated considerable water quality impairment as well as habitat degradation. Habitat scores for DCC490 and DCC455 were 133 and 145 respectively, which classified those sites as "partially supporting".

Biologically, the sites were characterized by low taxa richness, dominance of tolerant and generalist-feeding taxa and a lack of EPT taxa. Similarly, the fish assessment returned results indicative of an impaired reach. The fish community was characterized by a lack of both taxonomic and functional diversity (i.e. dominance of generalists and lack of top predators) as well as sensitive species when compared to the French Creek reference community.

The greatest departure from reference conditions was observed in frequency of taxa with deformities, anomalies, lesions, tumors or other anomalies (DELTA). Most notable was the predominance of taxa with deformities, lesions, tumors or other anomalies (DELTA). The PADEP standard reference value for the DELTA metric is <1%; however, at the Marshall Road site, 46% of the fish population (313 of 680) sampled had an anomaly of some kind.

It should be noted that 308 of the 313 observations of fish with DELTA, were due to the presence of "Black spot" also known as "Black grub." This anomaly, caused by the parasitic worm (*Neascus* sp.), is relatively harmless to adult fish unless infestations occur near the eyes which may cause blindness; furthermore, 179 of the 308 cases of Black spot were classified as "BS1" which signifies only a mild infection. Exempting these cases, the percentage of taxa with DELTA would decrease to 19.7%. Generally, the presence of *Neacus* sp. is associated with the intermediate hosts needed to complete its complex life cycle such as snails and birds (e.g. kingfishers, herons).

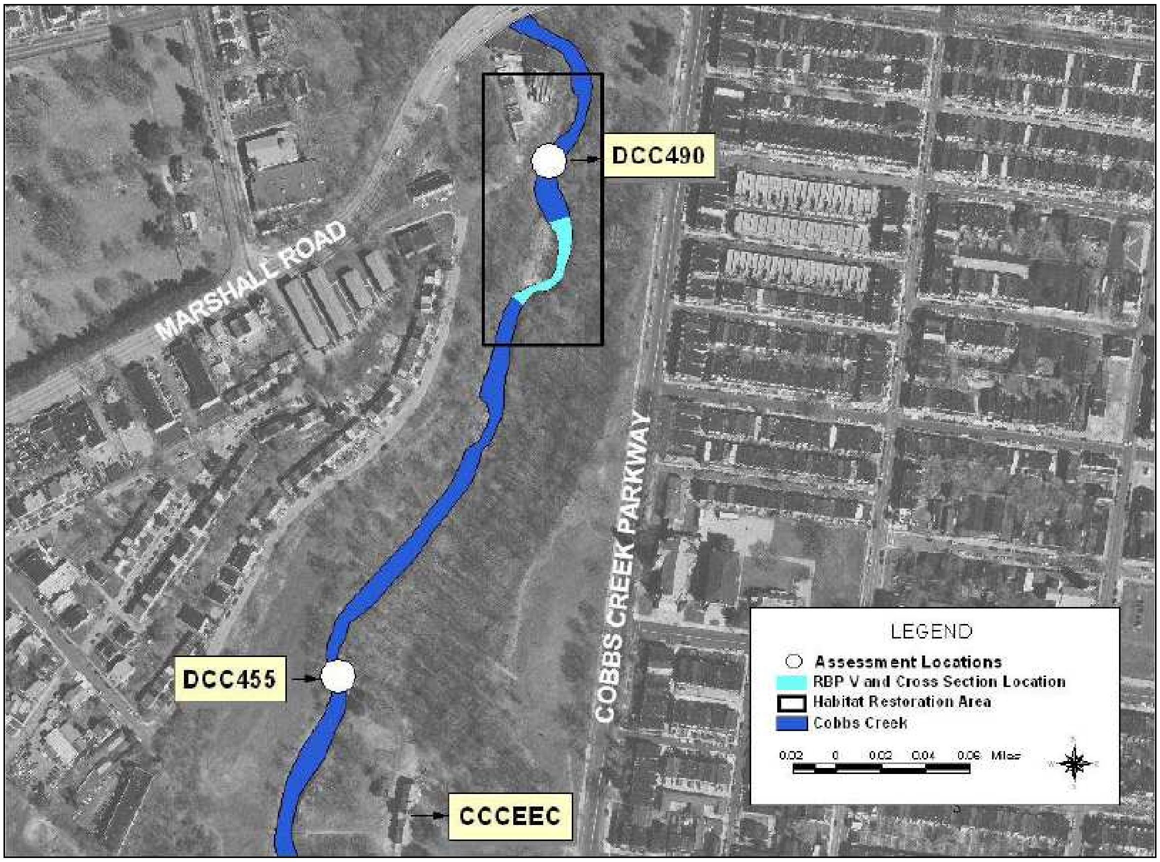


Figure 19 - Pre-construction Biomonitoring Sites (2002)

3.6.2. **Post-construction Biomonitoring**

3.6.2.1. **Habitat Evaluation**

The physical habitat conditions at the Marshall Road restoration site improved considerably compared to the pre-construction conditions observed in 2002 (**Figure 20**); furthermore, the EPA Rapid Bioassessment Protocol (RBP) Physical Habitat score for the 2009 assessment (MR09) was 114.6% greater than that of the French Creek reference site (FC472). The most notable improvements attributed directly to restoration at the site were observed for the bank stability, vegetative bank protection and riparian vegetative zone width parameters (Figure 21), as these parameters were addressed directly via bank stabilization and riparian planting activities during construction.

The bank stability and bank vegetative protection parameters, which directly addressed the issue of the exposed interceptor, exhibited the greatest improvement among all of the habitat parameters assessed; whereas these parameters were categorized as poor and marginal in the 2002 assessment, they had been upgraded to optimal in the 2009 assessment – almost three years after construction had been finalized.

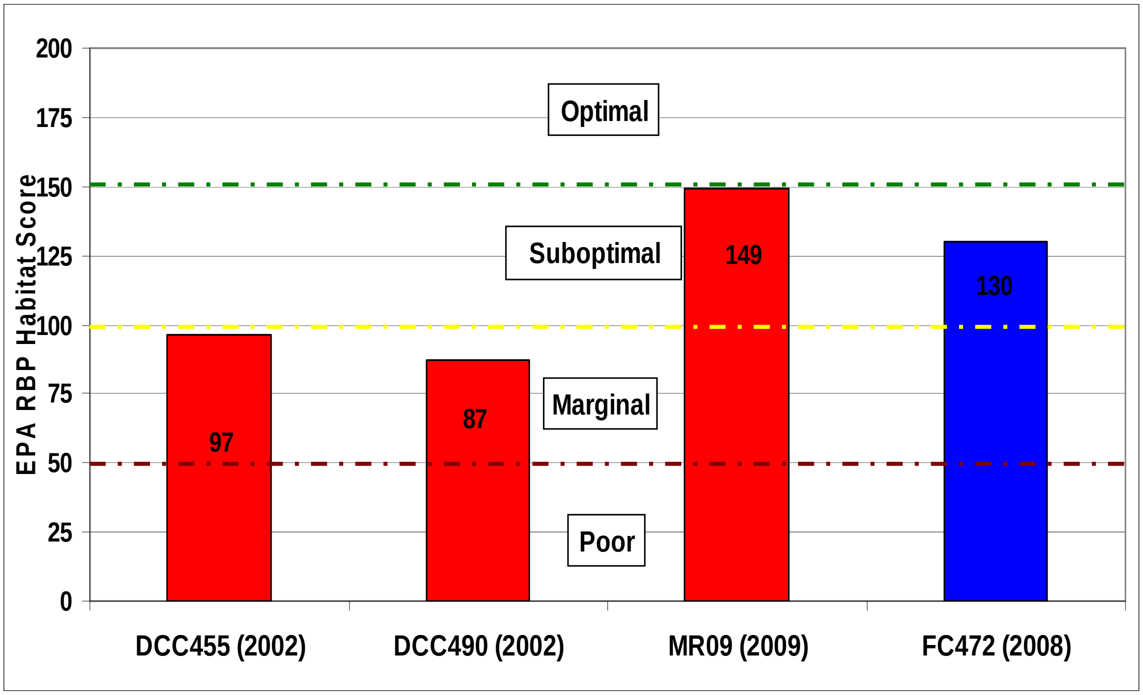


Figure 20 - EPA RBP Physical Habitat Total Scores for Marshall Road Restoration Site and French Creek Reference Site

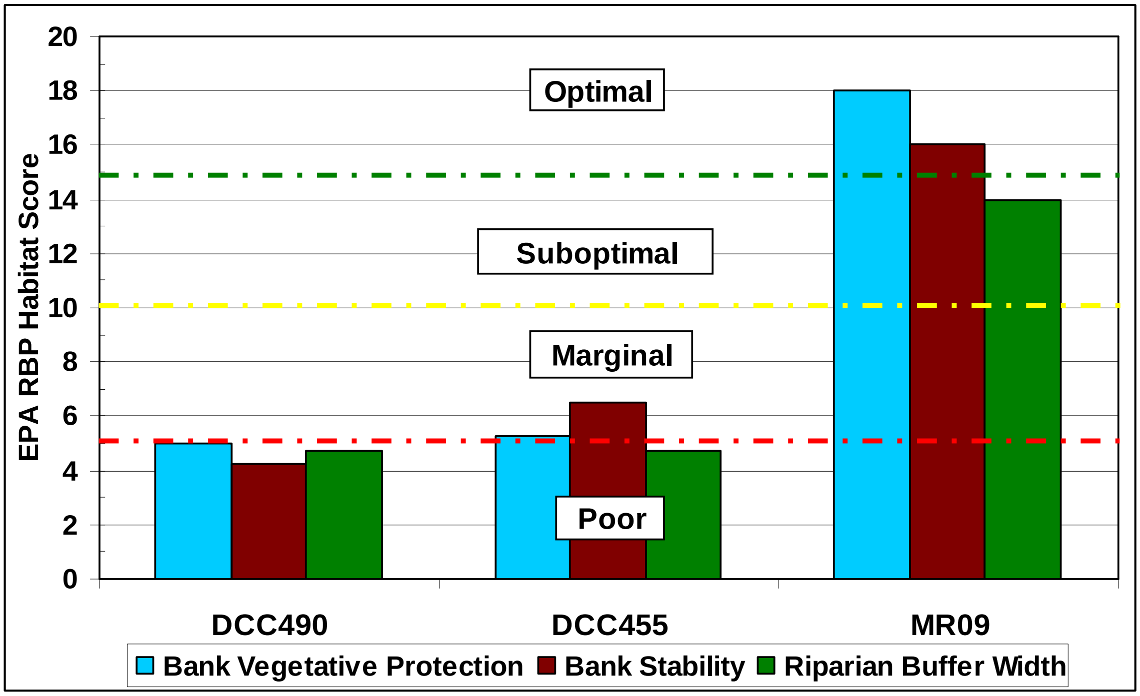


Figure 21 - EPA RBP Physical Habitat Assessment Scores for Bank Vegetation Protection, Bank Stability and Riparian Vegetative Zone Width*

* Scores for these parameters were averaged between the DRL and DSR banks

Habitat at the Marshall Road restoration site was found to be in better physical condition than that of the French Creek site FC472, which was included as an example of a local reference site (Figure 20). Scores for the EPA RPB Habitat parameters: "Sediment Deposition", "Embeddedness" and "Epifaunal Substrate," also exhibited improvement when compared to the 2002 habitat assessment results. These three parameters are associated with many aspects of channel stability in that increased scores may likely be correlated with an increased capacity of the MR09 channel to transport sediment (especially fine sediment) delivered from upstream reaches. Reduced deposition of fine sediment within the restored reach likely contributed to the considerable increase in the score for the "Epifaunal Substrate" parameter. This parameter addresses the relative complexity of riffle and run habitat features such as cobble, boulders and coarse woody debris, which often diminish in quality and complexity as rates of fine sediment deposition increase.

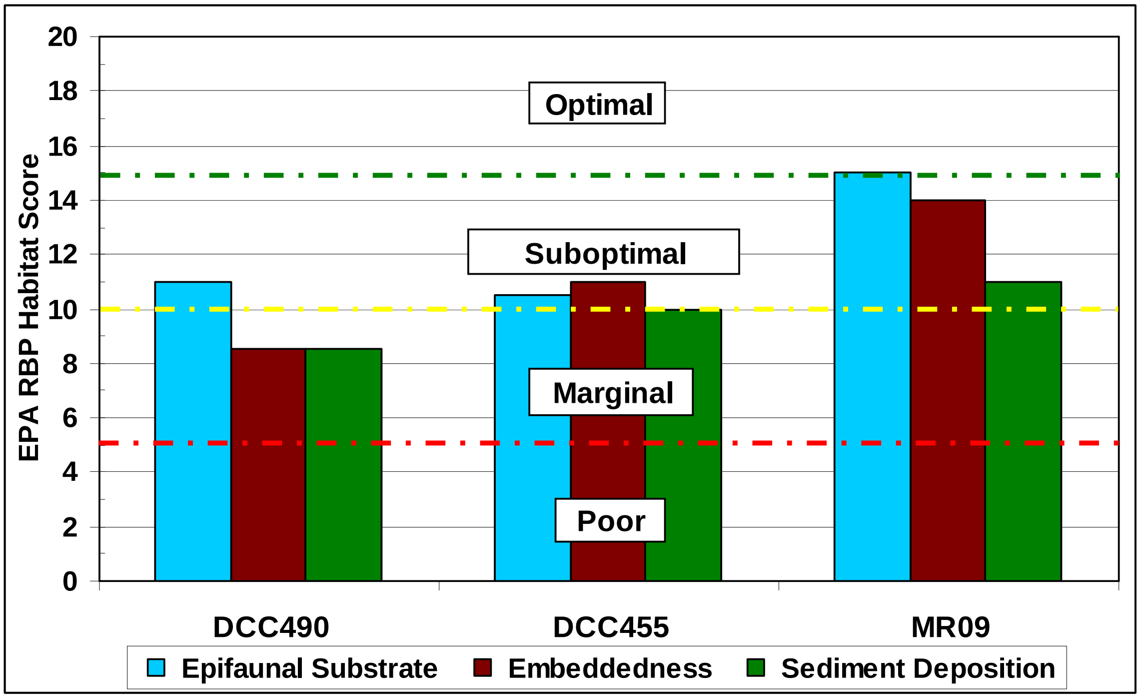


Figure 22 - EPA RBP Physical Habitat Assessment Scores for Epifaunal Substrate, Embeddedness, and Sediment Deposition.

3.6.2.2. <u>Macroinvertebrate Assessment</u>

Results of the macroinvertebrate assessment of the Marshall Road restoration site revealed that the benthic community at the site has been further degraded with respect to functional and taxonomic diversity. As was observed in the 2002 assessment, the macroinvertebrate assemblage sampled in 2009 was dominated by collector-gatherer generalist taxa; however, the numerical dominance of these taxa increased from 68.2% (DCC490) and 68.8% (DCC455) in 2002 to 77.9% in the most recent sampling (Figure 23).

Between the 2002 and 2009 assessments, shifts were observed in the functional and trophic diversity within the reach such that scrapers, which were 1.3% and 3.9% of the relative abundance at DCC455 and DCC490 respectively, now comprise 18.6% of the relative abundance of the reach. Similarly, a shift was observed in the relative abundance of "filterers" in the most recent assessment. The relative abundance of "filterers" was 28.9% and 27.4% for DCC455 and DCC490, respectively in 2002. In 2009, they only accounted for 3% of the sample abundance. Absent from the macroinvertebrate assemblage were "shredders", such as pollution sensitive tipulids (Crane Fly larvae) which were collected (very low relative abundance) during the 2002 assessment.

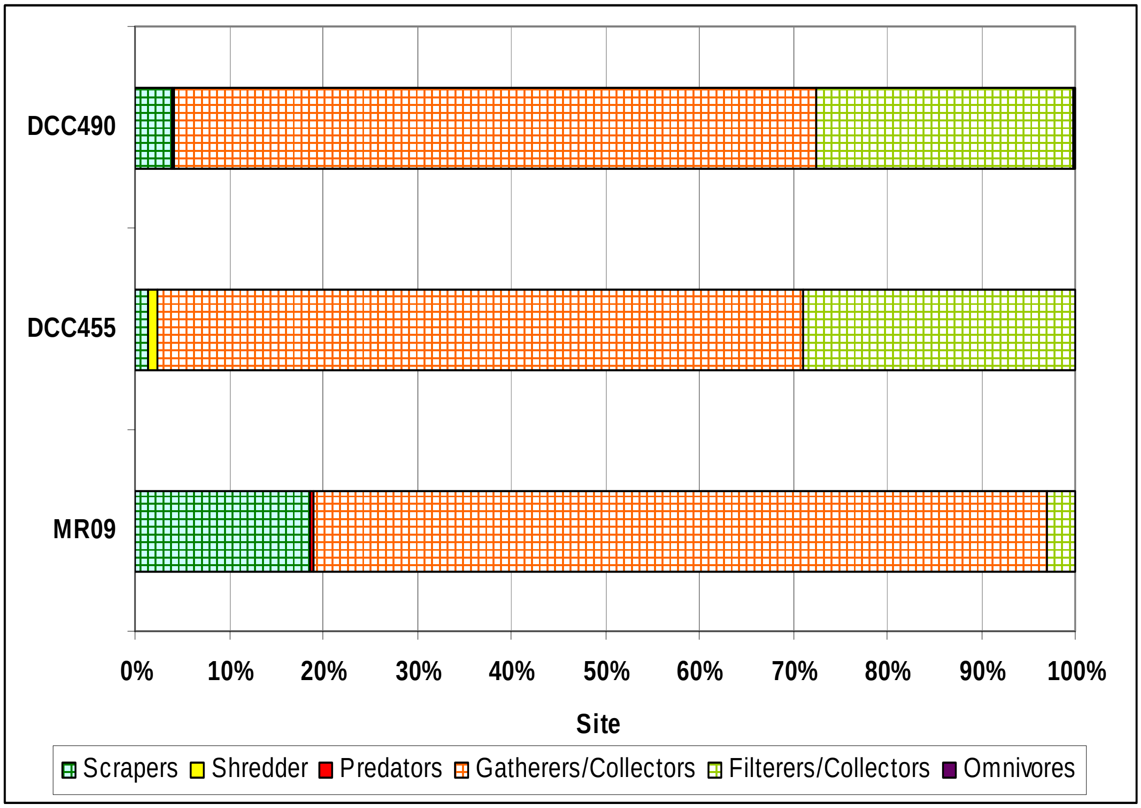


Figure 23 - Trophic Distribution, 2002 vs. 2009

A shift in the taxonomic diversity at the Marshall Road site was also observed in the most recent assessment. The total number of species collected ranged from n=11 to n=14 during the 2002 assessment compared to only 10 species in 2009 (Table 18). The numerical dominance of chironomids, a family common to urban and impaired streams was low compared to the relative abundance of chironomids observed at DCC455. An expected result of the reduction in numerical dominance of chironomids would be the increase in taxa abundance and diversity. The MR09 assemblage was in fact more diverse (SDI= 1.6) than both the DCC455 (SDI= 1.42) and DCC490 (SDI= 1.53) assemblages; however, many of the species collected in 2002 were not observed again the 2009 assessment (see Appendix F, Tables F.1 and F.2). These species were in turn replaced by taxa that had higher tolerance to pollution and disturbance (Table 18). These "unique species" were not observed in the 2002 assessment.

The unique species observed among two assessment sites or between assessment years can often serve as a secondary indicator of changes in environmental conditions over spatial or temporal scales respectively. Similarly, the Hilsenhoff Biotic Index (HBI) is a metric that is often used to assess changes in a macroinvertebrate community between sites or between assessment years. This metric scales the pollution tolerance of a macroinvertebrate community to a number between zero and ten, with ten being a completely tolerant community. In the 2009 assessment, the macroinvertebrate community was found to be more pollution tolerant that the community assessed in 2002 (Table 17). The unique species that were collected at Marshall Road in 2009 were all pollution tolerant or moderately tolerant of pollution; furthermore, there were no sensitive species collected in the 2009 assessment. The combination of these factors is an indicator that water quality has either further degraded since the 2002 assessment, or that more sensitive species have been gradually extirpated since the last macroinvertebrate assessment.

Table 17 - Comparison of Macroinvertebrate Assessment Metrics, 2002 vs. 2009

Marshall Road Post-Construction Biomonitoring Assessment	Assessment Year	Taxa Richness	Modified EPT Taxa	Hilsenhoff Biotic Index	Percent Dominant Taxa	Shannon Diversity Index
DCC455	2002	11	0	5.89	54.5% CHIRONOMIDAE	1.42
DCC490	2002	14	0	5.94	46.3 ASSELLIDAE	1.53
MR09	2009	10	0	6.37	38.6% CHIRONOMIDAE	1.60
FC472	2008	27	12	4.00	29.3% CHIRONOMIDAE	2.42

Table 18 - Unique Species List, 2009

2009 Marshall Road Unique Species					
Common Name	**Order**	**Family**	**Genus**	**Tolerance Value**	**Relative Abundance**
Black Fly	Diptera	Simuliidae	Simulium	6	0.87%
Small Minnow Mayfly	Ephemeroptera	Baetidae	Baetis	6	13.42%
Bladder Snail	Gastropoda	Physidae	----	8	16.45%
Leech	Hirudinea[1]	----	----	8	0.43%
Aquatic Earthworm	Oligochaeta[1]	----	----	10	1.73%

3.7. Photo Monitoring

The four photo locations at each cross-section and the three photo locations at each bank pin site will remain as permanent reference points for every future round of photo monitoring. During the first year of photo monitoring, PWD will take pictures quarterly, during each season to track the geomorphologic and vegetative changes throughout the year.

4. Discussion and Conclusions

Monitoring and assessing the long-term performance of a capital project is extremely important, especially as it relates to stream restoration. Unlike a sewer construction or a plant infrastructure upgrade where full benefits are immediately apparent at the conclusion of construction, stream restoration projects are *most* vulnerable at the conclusion of the construction, and tend to strengthen and mature over time. This vulnerability was evidenced by the erosion that occurred in 2005, just after construction, at several meander bends. While the harder elements of a design, like stone protection, provide protection immediately, dense riparian vegetation takes time to root and mature. In such, bankfull events, which produce flows three to four feet above baseflow conditions, are able to access these less stable areas along the stream channel producing erosive conditions. However, usually after one or two growing seasons, a properly designed and constructed stream restoration project will convey the bankfull flow with minimal erosion or sedimentation. Ultimately, the long-term goal of all stream restoration projects is to exist in a state of dynamic equilibrium and provide good habitat conditions for macroinvertebrate and fish communities. In this state, the channel is able to transport the full spectrum of flow and sediment without having substantial adverse impacts on the stability of the channel, the floodplain, or the surrounding infrastructure.

In June, 2009, PWD commenced a monitoring program that will allow for the observation of the Marshall Road stream restoration project over the next three to five years. Using physical, biological, and visual observation methods, PWD anticipates collecting a large amount of data that will measure the level of success of the Marshall Road project and inform future stream restoration projects in the Cobbs Creek watershed and beyond.

Topographic Survey, Cross-Sections, and Longitudinal Profile

The topographic survey resulted in the installation of 32 benchmarks throughout the project reach. These benchmarks will allow continued monitoring of the ten installed cross-sections and the longitudinal profile for the duration of the monitoring component at the Marshall Road Project Reach.

At the five riffle sections, the bankfull cross-sectional area ranged from 147 – 182 ft^2, with an average value of 161 ft^2. At these riffle sections, bankfull discharge estimates ranged from 579 – 924 cfs, with an average value of 751 cfs. USGS Bulletin 17B Analysis of PWD's Cobbs Creek Open-Channel SWMM Model suggests that the 1.0 – 1.5 Year flow return frequency ranges from 840 – 2,496 cfs. This data supports the suggestion that the bankfull discharge is closer to the 1-Year return frequency in highly urbanized watersheds.

The observed bankfull cross-sectional area (161 ft^2) was comparable to the design value (170 ft^2). However, width-depth ratio, discharge, and water surface slope (WSS) were significantly different from the values presented in the design. The average Width-Depth Ratio was measured to be 26, while the design suggested 15. The observed water surface slope (WSS) of 0.35% was rather surprising given that the pre-construction WSS was stated to be 0.57% and the designed WSS was stated to be 0.56%. Such a substantial decrease in slope is rarely encountered. This suggests that some difference in measurement technique or human error in the pre-construction survey. The average bankfull discharge of 751 cfs was substantially smaller than the 1,194 cfs design discharge. Given that the bankfull cross-sectional areas matched fairly well between the design and monitoring, this disparity can most likely be attributed to differences in width-depth ratio and water surface slope.

Stream Competency

The WARSSS Stream Competency assessment for the Marshall Road reach predicted that project reach was relatively stable; however, there is evidence that could implicate future degradation of the streambed. There is a direct relationship between competency and depth such that increasing depth within the channel would result in the transport of more sediment. The predicted bankfull depth required to entrain the D_{50} particle from the bar sample (20.8 mm) was 13.04% lower than the existing mean bankfull depth of the project reach; therefore, the existing channel has the capacity at bankfull discharge to move slightly more sediment than is delivered to the project reach according to these results. The WARSSS competency assessment does not quantitatively estimate sediment yield from the upstream catchment or transport rates through the channel, but rather makes the fundamental assumption that a stable channel will move the sediment made available from upstream reaches. Within this framework, the disparity between the predicted depth and the observed mean depth could thus provide evidence that slightly more bedload sediment could be transported at the bankfull discharge than predicted. At this time it is uncertain if the disparity between the predicted and observed bankfull depths is enough to cause a response from the channel such that the stable-degrading threshold would be crossed. Results of scour chain monitoring over the next three years and additional bar samples will provide more concrete evidence of stability or degradation.

In the next field assessment, additional samples on each channel bar will be taken during bar assessments. This additional sampling effort will reduce the probability that the D_{max} particle will be an introduced particle or a particle not transported from upstream as was the case in the most recent bar sampling; Furthermore, additional samples will allow for an increased level of confidence in future competency calculations. Comparable results for samples taken at the same bar would serve to validate competency predictions as well as allow mean hydraulic conditions (*i.e.*, shear stress) to be calculated for each bar.

The BANCS Model

According to the BANCS model, a bank material adjustment should be applied to a bank with boulder protection during a BEHI assessment. The WARSSS textbook lists the bank material adjustment as an overall low when boulders are present. During the BEHI assessments along the Marshall Road stream restoration project, there were five different sites where a bank material adjustment was applied due to the presence of boulder stone-toe protection along the banks. The BEHI data collected in the field was entered into RIVERMorph to calculate the overall BEHI scores. RIVERMorph automatically applied a very low bank material adjustment for boulder protection rather than a low score as is stated in the WARSSS textbook. Since RIVERMorph applied an overall very low score for these BEHI banks, the predicted annual erosion rates for these reaches was considered to be zero. If these BEHI banks had been assigned an overall low BEHI score, the total predicted annual erosion rates would have been higher for the project area.

Due to the boulder stone-toe protection placed along the banks throughout the project area, the bank pin locations could only be installed where there were significant breaks (approximately 1-2 feet wide) between the boulders or where the depth of the boulders was shallow enough to allow bank pin installation in the cracks between the boulders. Therefore, the bank pin locations might not be representative of the entire BEHI bank that the bank pin site is associated with. The bank pin locations could possibly measure more erosion at that specific location when the rest of the bank that is completely protected by the boulders is actually not eroding. Also, some of the vertical reference points at the bank pin locations were measured at a specific location on the boulder. Due to human error, this specific reference point might not be measured at that same exact location each time causing differences in the measurements.

Biological Monitoring

Based on the results of the physical habitat assessment, the biological metrics at the Marshall Road restoration site were expected to have improved considerably compared to the 2002 macroinvertebrate metrics. Habitat at the Marshall Road restoration site (MR09) was found to be in better physical condition than the French Creek site FC472, which is extraordinary considering that the restoration site is in a heavily urbanized watershed. Compared to the results of the 2002 habitat evaluation, where the physical habitat was determined to be capable of "partially supporting" a diverse array of aquatic biota (Figure 24), the physical habitat template at the Marshall Road site has the potential to encourage the establishment of a functionally (i.e. functional feeding groups) and taxonomically diverse macroinvertebrate community. The improvement in the RBP scores of parameters such as sediment deposition, embeddedness and epifaunal substrate (Figure 22) support this notion, as these parameters are among the most important physical factors in determining the distribution and abundance of benthic macroinvertebrates aside from disturbance frequencies related to stream hydrodynamics.

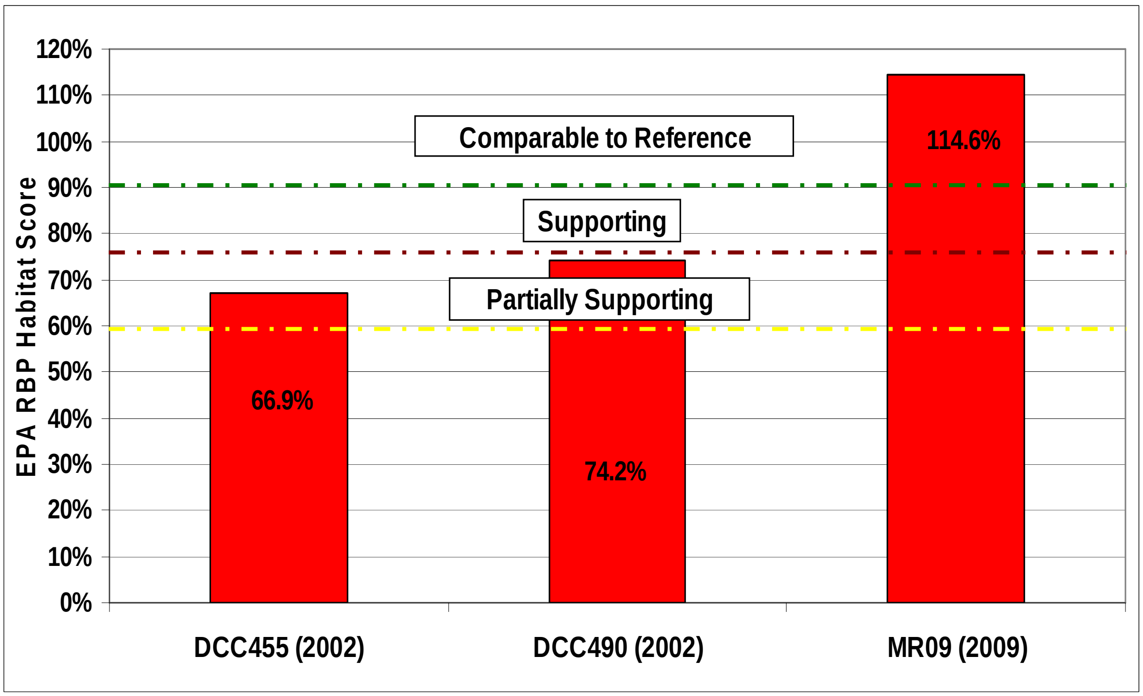


Figure 24 - Comparison of Habitat Quality, 2002 vs. 2009

Given that physical habitat parameters such as sediment deposition and embeddedness have improved since restoration activities were completed (Table 19), it is possible that diminished water quality as well as an altered flow regime could be is hindering the establishment of an ecologically diverse macroinvertebrate community. There are several factors which could serve to correlate these disturbances to the absence of an ideal ecological community within MR09, although causative relationships could only be established with additional monitoring data.

The most compelling data was the composition and relative abundance of the "unique" taxa observed in the MR09 macroinvertebrate assessment. Five species (Table 18) that were not present in the 2002 macroinvertebrate collection were observed in the MR09 assessment and each of these species was moderately tolerant or tolerant to pollution. The proliferation of these tolerant taxa, coupled with the increase in HBI (Table 17) is an indicator of disturbance, likely attributed to diminished water quality and the "flashy" hydrologic regime of the

Darby-Cobbs Watershed. Additional evidence in support of this conclusion is reflected in the absence of pollution sensitive species and reduced abundance of specialist-feeding taxa in the 2009 sampling; furthermore, there was a decrease in moderately tolerant taxa and a considerable increase in pollution tolerant taxa (Figure 25) and generalist-feeding taxa. Such increases in the proportion of generalists are not favorable from an ecological perspective due to the associated reduction in the numbers of specialist-feeding taxa.

Table 19 - EPA RBP Habitat Data Comparison

Habitat Parameter	DCC490	DCC455	MR09	FC472
Epifaunal Substrate	11	10.5	15	14.5
Embeddedness	8.5	11	14	14.5
Velocity/depth Regimes	13	12.5	16	17
Channel Alteration	11.5	15	15	15
Sediment Deposition	8.5	10	11	13
Frequency of Riffles	11.5	10.5	15	12
Channel Flow Status	9	10.5	15	14
Condition of Banks/Stability	4.25	6.5	16	11
Bank Vegetation Protection	5	5.25	18	10
Riparian Zone Width	4.75	4.75	14	9
Total	**87**	**96.5**	**149**	**130**
Comparison to Reference	**66.9%**	**74.2%**	**114.6%**	**---**

Specialist taxa such as "filterers", "shredders" and "scrapers" are vital to the ecological integrity of an aquatic system because of their role in processing the longitudinal and lateral inputs of organic material (e.g. coarse particulate organic matter, fine particulate organic matter) that enter the system. Interestingly the proportion of Chironomidae and Asellidae, which were the dominant taxa in DCC455 (54.5%) and DCC490 (46.3%) respectively, were relatively low in the MR09 assemblage. In general, the low relative abundance of chironomids or any dominant species within a macroinvertebrate assemblage promotes the optimization of resource (i.e. food, habitat) allocation and use such that there is a reduced probability that one species will inhibit the use of particular resources by other species in the assemblage. In a fully functional system, such resource partitioning usually increases taxa richness as well as trophic diversity; however, this was not the elicited response observed in MR09.

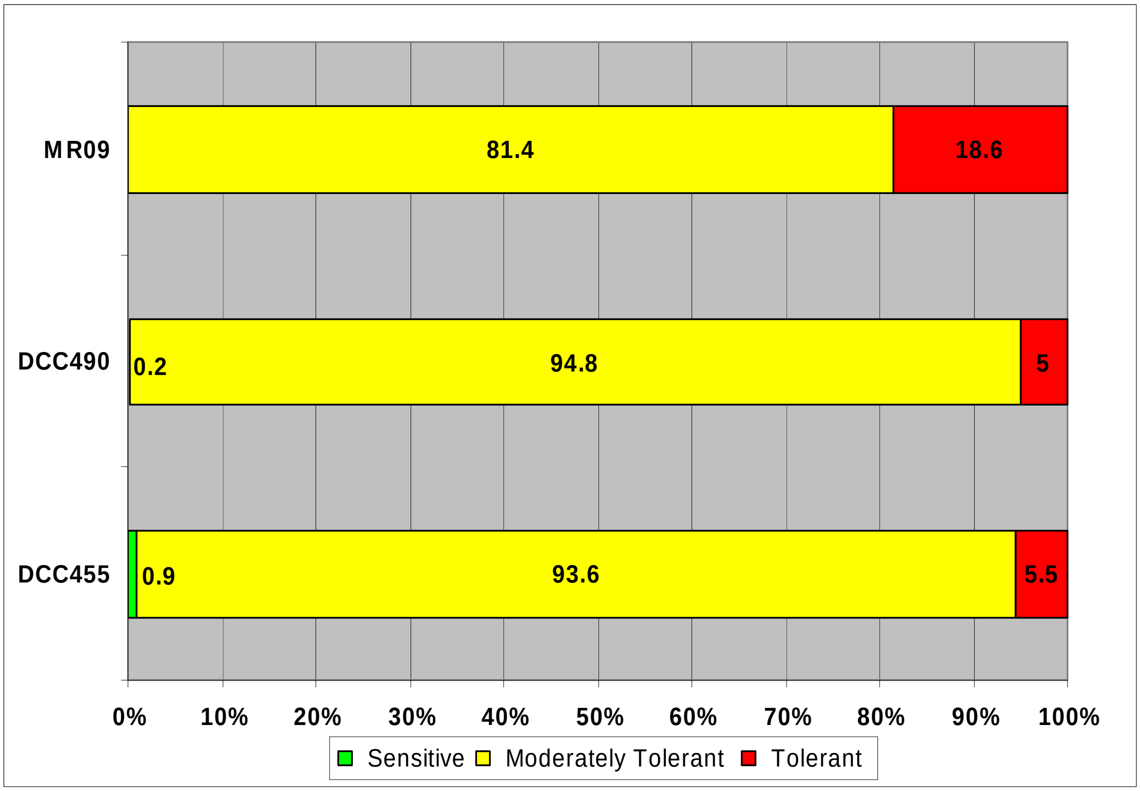


Figure 25 - Pollution Tolerance Distribution, 2009

Photo Monitoring

The regular photo monitoring component of this effort will allow for the performance of the Marshall Road reach to be assessed along the 900 feet of restored area. PWD expects to track stability, erosion, aggradation, and riparian vegetation using these photographs over the entire monitoring period to supplement measured data at cross-sections, the longitudinal profile, and bank pins.

Conclusions and Next Steps

The monitoring data collected as part of this efforts suggests that the Marshall Road restoration reach is a geomorphically stable reach. The reach does not exhibit significant signs of excessive erosion or deposition. WARSSS competency analysis suggests the potential for the reach to cut down. More detailed analysis will follow in the coming years to evaluate this suggestion in greater detail. However, the BANCS model predicts minimal erosion, which will be verified annually at the installed bank pin monitoring locations. The biological monitoring results are interesting and beg further interpretation, given the relatively healthy geomorphic conditions exhibited in the project reach. While the EPA RBP Physical Habitat score exceeded that of the reference site, the macroinvertebrate community did not respond accordingly.

Poor scores could be attributed to several factors exhibited in the biological monitoring:

- Short Length of the Marshall Road Stream Restoration – The project reach was just over 900 feet in comparison to the more than 60,000 feet of stream and 12 square miles of watershed above the reach.
- Extreme Flow Regime – While the baseflow at this reach ranges between 10-20 cfs, the bankfull discharge of 751 cfs is far larger.
- Water Quality - The Cobbs Creek Watershed is highly urbanized and contains multiple CSOs that regularly contribute combined sewage into the watercourse.

It is unlikely that any one of these factors is the sole cause the poor biological response that has been observed to date at Marshall Road. The most likely scenario is that a combination of these factors has contributed to this situation. PWD will continue to monitor these factors through 2011 in effort to gain a better understanding of how stream restoration practices can improve streams in highly urbanized watersheds.

References

Baltimore County Department of Environmental Protection and Resource Management (1999), Hydrologic, Hydraulic and Geomorphological Assessment of Streams in the Piedmont Region of Maryland.

Barnes, H.H. Jr. (1967), Roughness characteristics of natural channels, U.S. Geological Survey Water-Supply Paper, U.S. Geological Survey, 1849.

Chow, V.T. (1959), *Open-channel hydraulics*, McGraw-Hill, Inc., New York, p. 680.

Pennsylvania Department of Environmental Protection (2009), A Benthic Index of Biotic Integrity for Wadeable Freestone Riffle-Run Streams in Pennsylvania, Division of Water Quality Assessment and Standards

Philadelphia Water Department (2004) Cobbs Creek Integrated Watershed Management Plan

Rosgen, D. L. (1994), *A classification of natural rivers*, Catena, 22:169-199.

Rosgen, D.L. (2006), Watershed Assessment of River Stability and Sediment Supply (WARSSS)

U.S. Department of Agriculture (1986), Urban hydrology for Small Watersheds TR-55,
Natural Resources Conservation Service, Technical Release 55.

Wolman, M.G. (1954), A method of sampling coarse river-bed material, *Transactions of American Geophysical Union*, 35: 951-956.

Wolman, M.G. & W.P. Miller (1960), Magnitude and frequency of forces in geomorphic processes, *Journal of Geology*, 68: 54-74.

Appendix A - Monumented Cross-section Photos/Data

Marshall Road
Philadelphia Water Department
Office of Watersheds

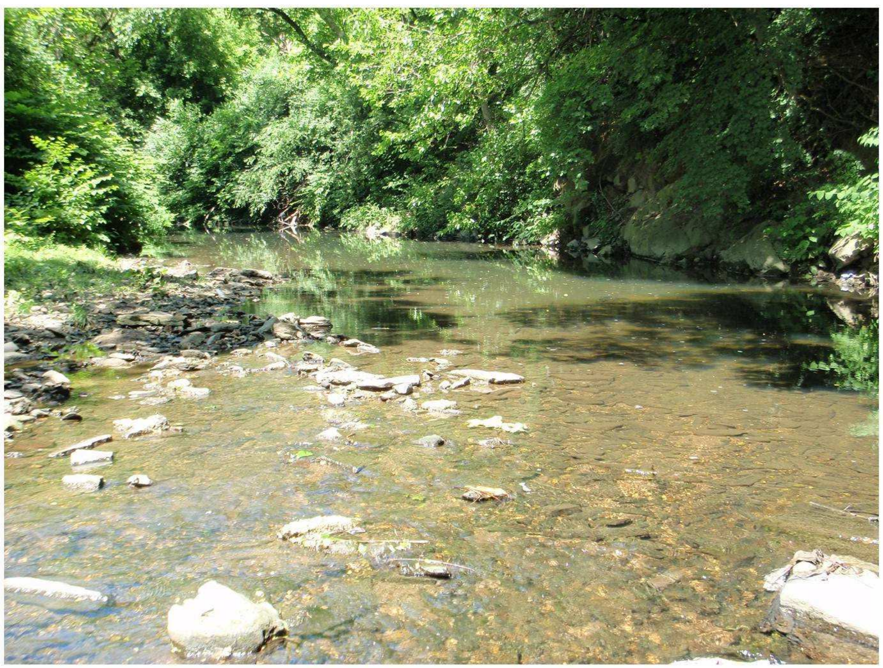
X/S 1 - Riffle

June 1st, 2009

XS – DSR to DSL

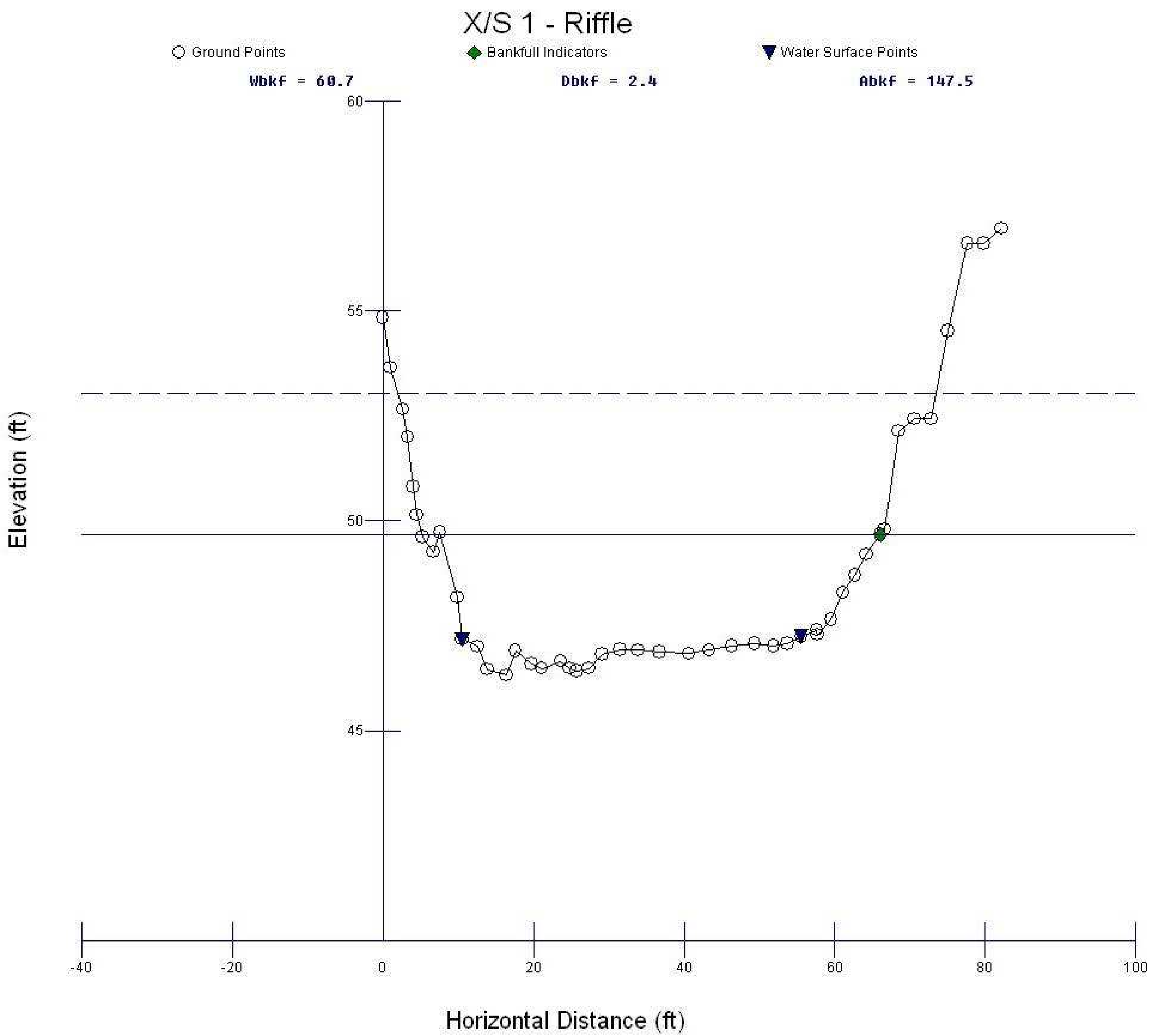
XS – DSL to DSR

Upstream View



Downstream View

XS = cross section / DSL = Downstream Left / DSR = Downstream Right


X/S 1 - Riffle
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 60.7
Dbkf = 2.4
Abkf = 147.5
Elevation (ft)
60
55
50
45
-40
-20
0
20
40
60
80
100
Horizontal Distance (ft)

Marshall Road
Philadelphia Water Department
Office of Watersheds

X/S 2 - Pool

June 1st, 2009

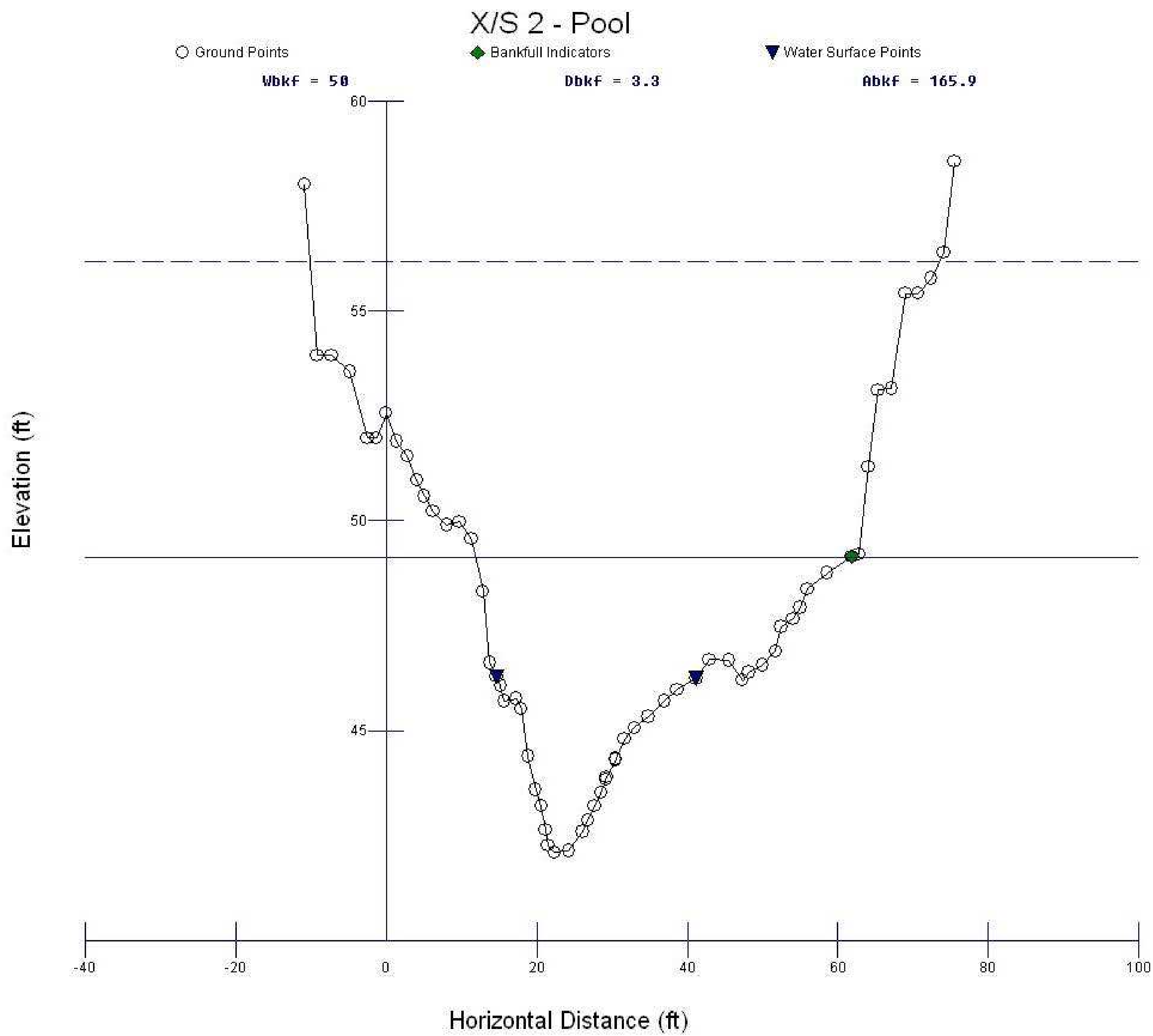
XS – DSR to DSL

XS – DSL to DSR

Upstream View

Downstream View

XS = cross section / DSL = Downstream Left / DSR = Downstream Right


X/S 2 - Pool
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 50
Dbkf = 3.3
Abkf = 165.9
60
55
50
45
Elevation (ft)
-40
-20
0
20
40
60
80
100
Horizontal Distance (ft)

Marshall Road
Philadelphia Water Department
Office of Watersheds

X/S 3 - Glide

June 1st, 2009

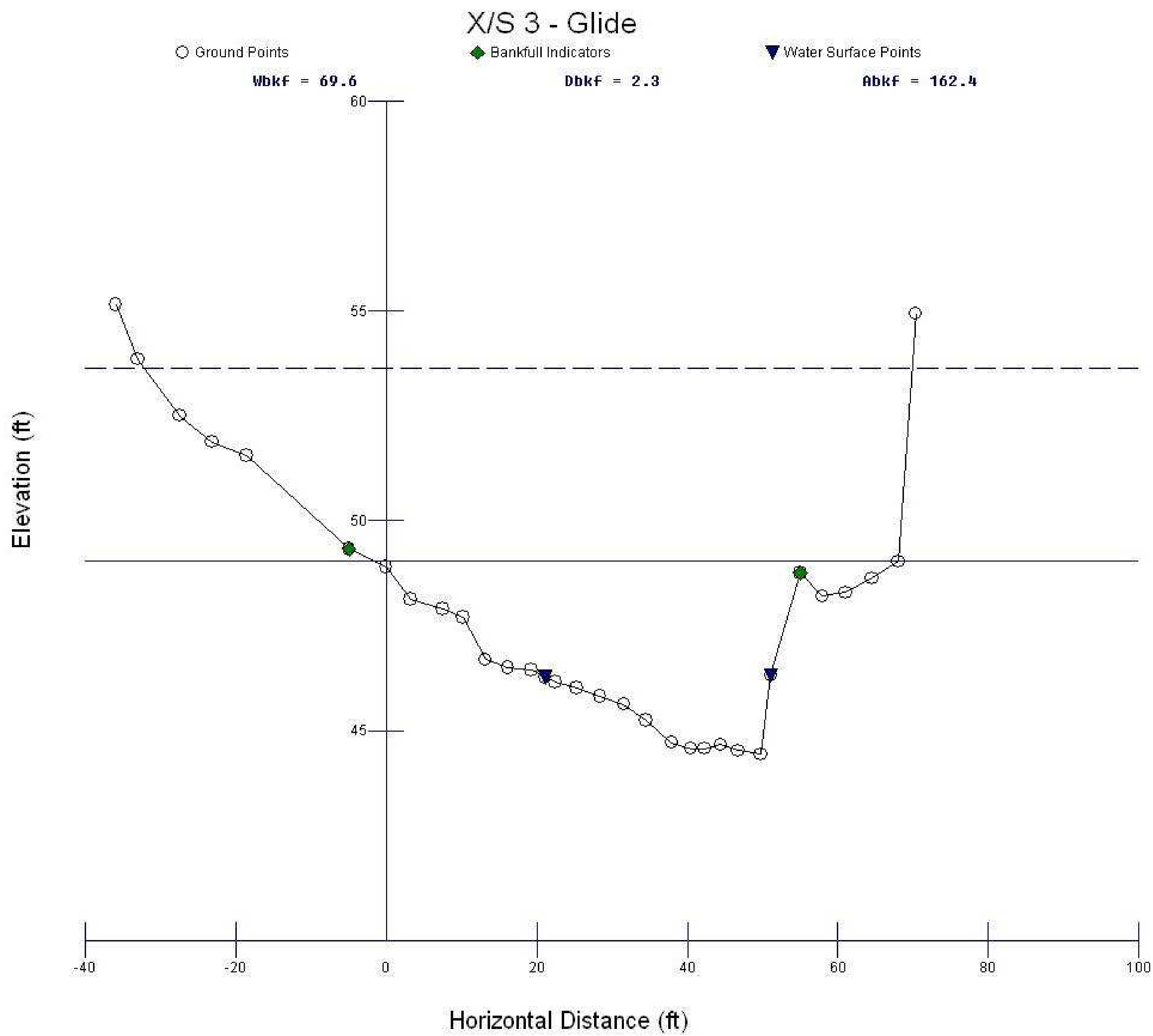
XS – DSR to DSL

XS – DSL to DSR

Upstream View

Downstream View

XS = cross section / DSL = Downstream Left / DSR = Downstream Right


X/S 3 - Glide
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 69.6
Dbkf = 2.3
Abkf = 162.4
60
55
50
45
Elevation (ft)
-40
-20
0
20
40
60
80
100
Horizontal Distance (ft)

Marshall Road
Philadelphia Water Department
Office of Watersheds

X/S 4 - Riffle

June 1st, 2009

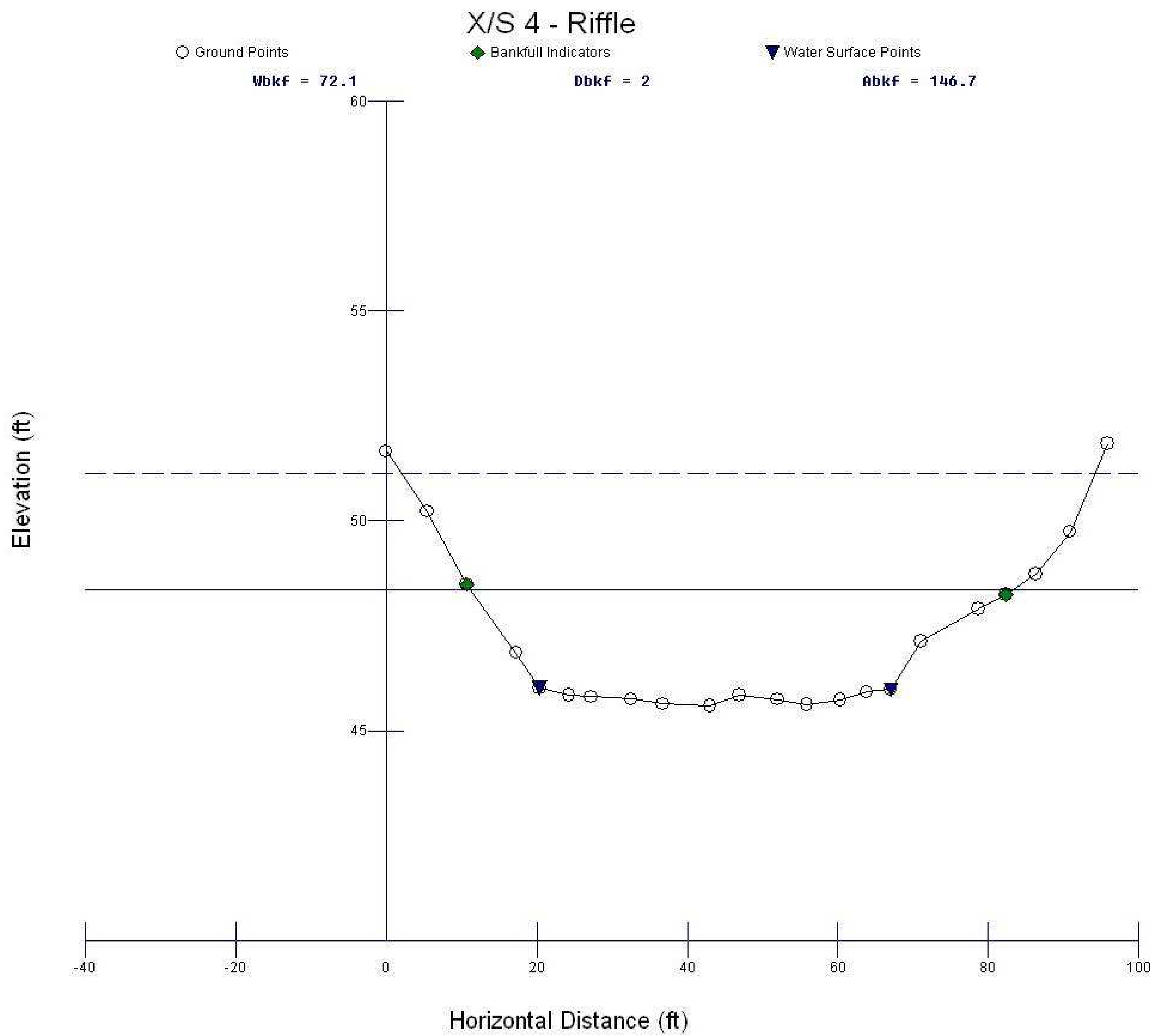
XS – DSR to DSL

XS – DSL to DSR

Upstream View

Downstream View

XS = cross section / DSL = Downstream Left / DSR = Downstream Right


X/S 4 - Riffle
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 72.1
Dbkf = 2
Abkf = 146.7
60
55
50
45
-40
-20
0
20
40
60
80
100
Elevation (ft)
Horizontal Distance (ft)

Marshall Road
Philadelphia Water Department
Office of Watersheds

X/S 5 - Riffle

June 1st, 2009

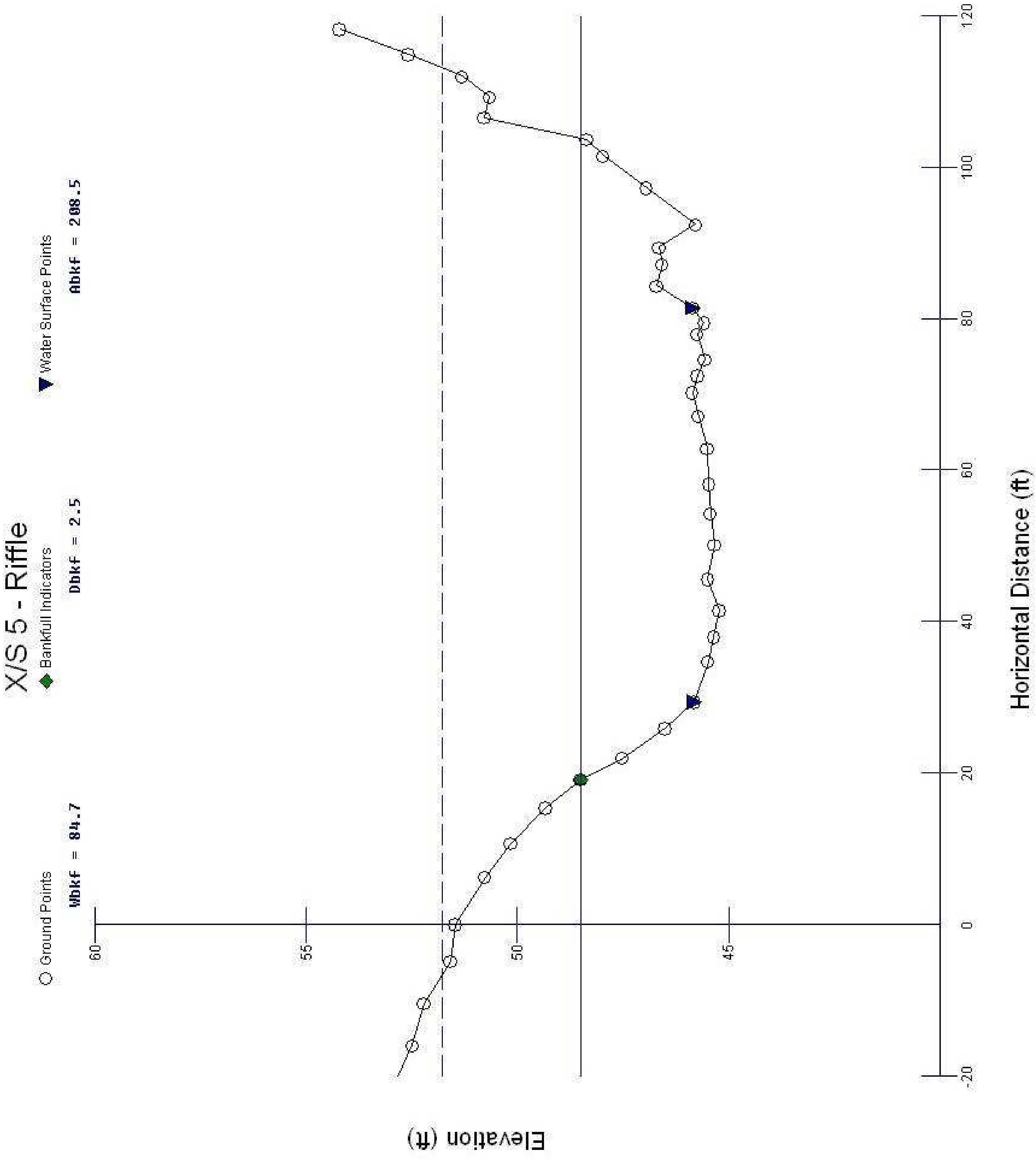
XS – DSR to DSL

XS – DSL to DSR

Upstream View

Downstream View

XS = cross section / DSL = Downstream Left / DSR = Downstream Right


X/S 5 - Riffle
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 84.7
Dbkf = 2.5
Abkf = 208.5
Elevation (ft)
60
55
50
45
Horizontal Distance (ft)
-20
0
20
40
60
80
100
120

Marshall Road
Philadelphia Water Department
Office of Watersheds

X/S 6 - Run

June 3rd, 2009

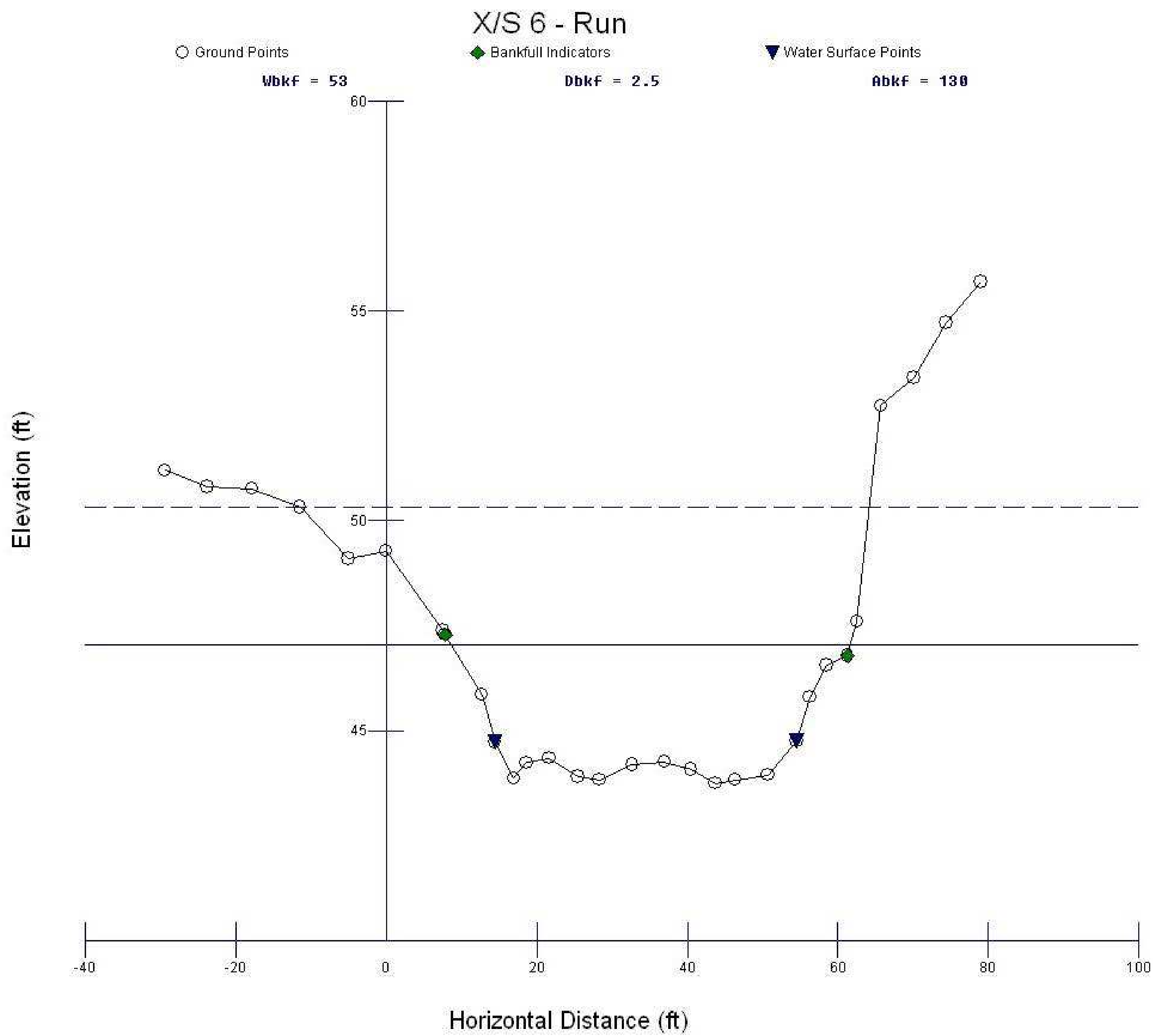
XS – DSR to DSL

XS – DSL to DSR

Upstream View

Downstream View

XS = cross section / DSL = Downstream Left / DSR = Downstream Right


X/S 6 - Run
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 53
Dbkf = 2.5
Abkf = 130
60
55
50
45
-40
-20
0
20
40
60
80
100
Elevation (ft)
Horizontal Distance (ft)

Marshall Road
Philadelphia Water Department
Office of Watersheds

X/S 7 - Pool

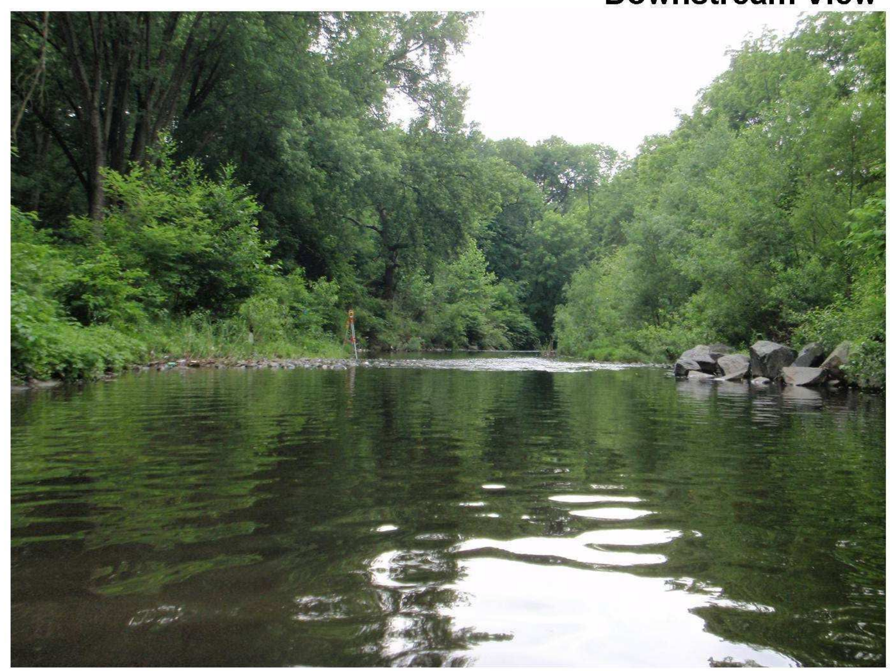
June 3rd, 2009

XS – DSR to DSL

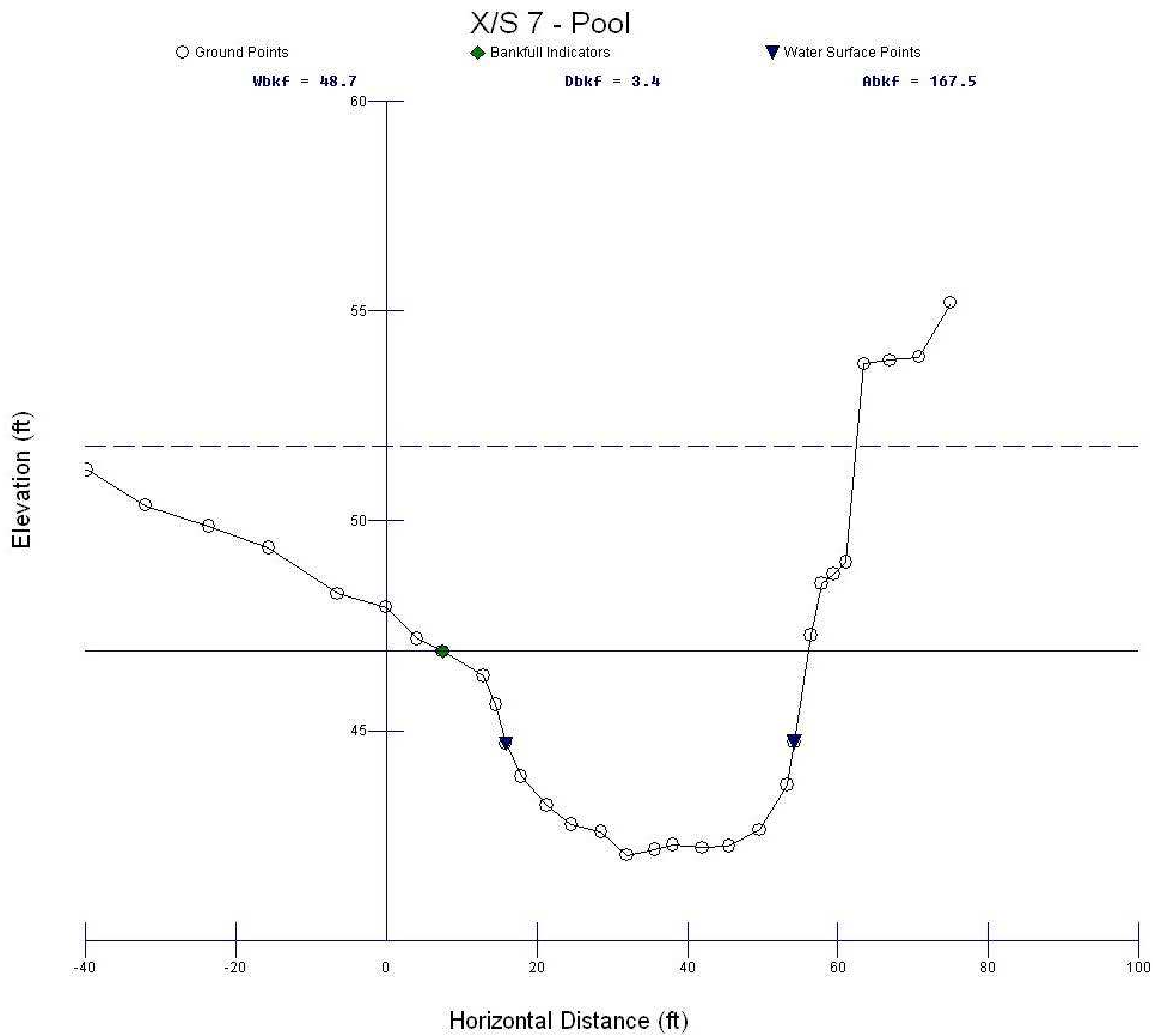
XS – DSL to DSR

Upstream View

Downstream View



XS = cross section / DSL = Downstream Left / DSR = Downstream Right



X/S 7 - Pool
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 48.7
Dbkf = 3.4
Abkf = 167.5
60
55
50
45
Elevation (ft)
-40
-20
0
20
40
60
80
100
Horizontal Distance (ft)

Marshall Road
Philadelphia Water Department
Office of Watersheds

X/S 8 - Riffle

June 1st, 2009

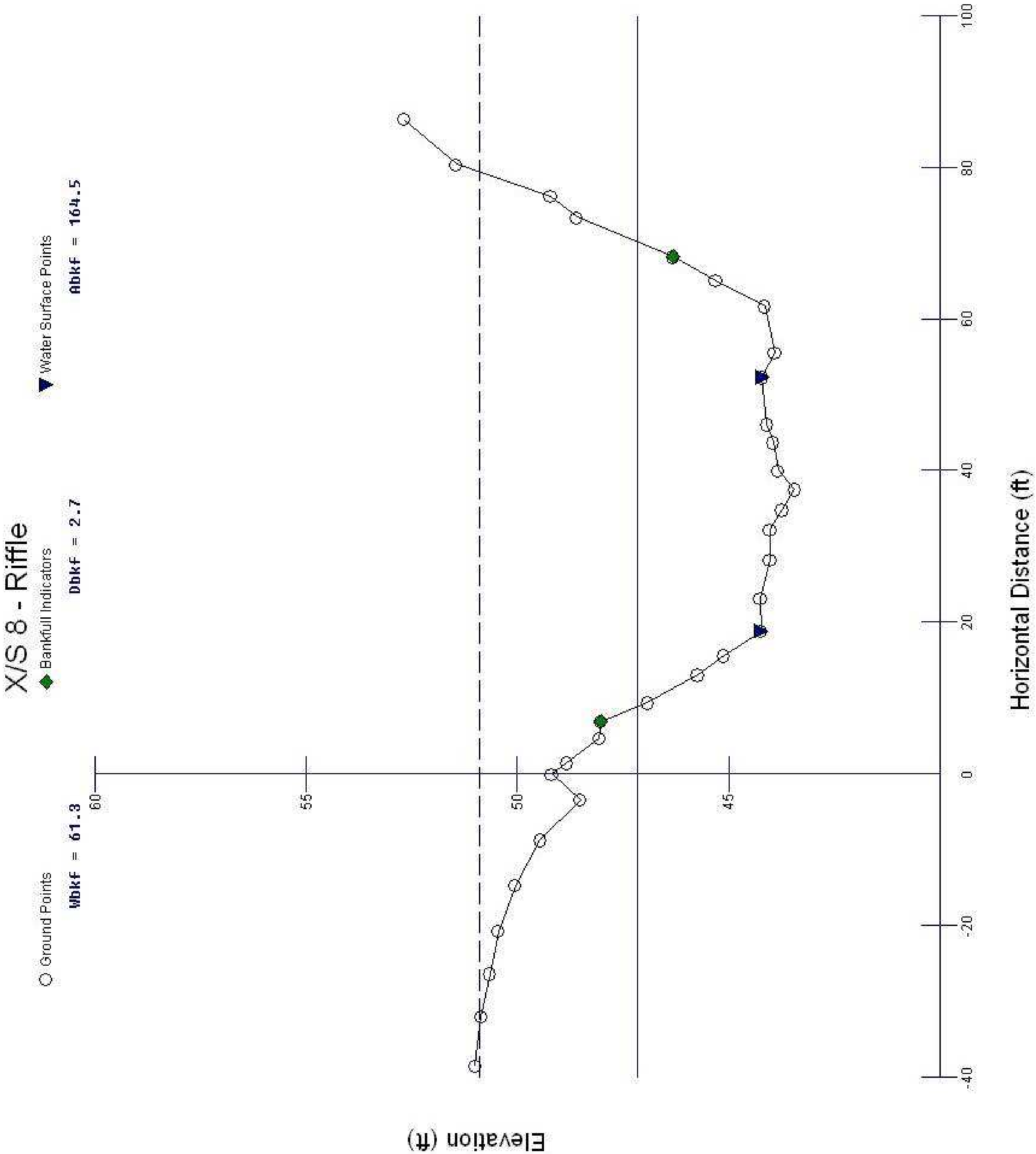
XS – DSR to DSL

XS – DSL to DSR

Upstream View

Downstream View

XS = cross section / DSL = Downstream Left / DSR = Downstream Right



X/S 8 - Riffle
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 61.3
Dbkf = 2.7
Abkf = 164.5
Elevation (ft)
Horizontal Distance (ft)
60
55
50
45
-40
-20
0
20
40
60
80
100

Marshall Road
Philadelphia Water Department
Office of Watersheds

X/S 9 – Pool/Glide

June 1st, 2009

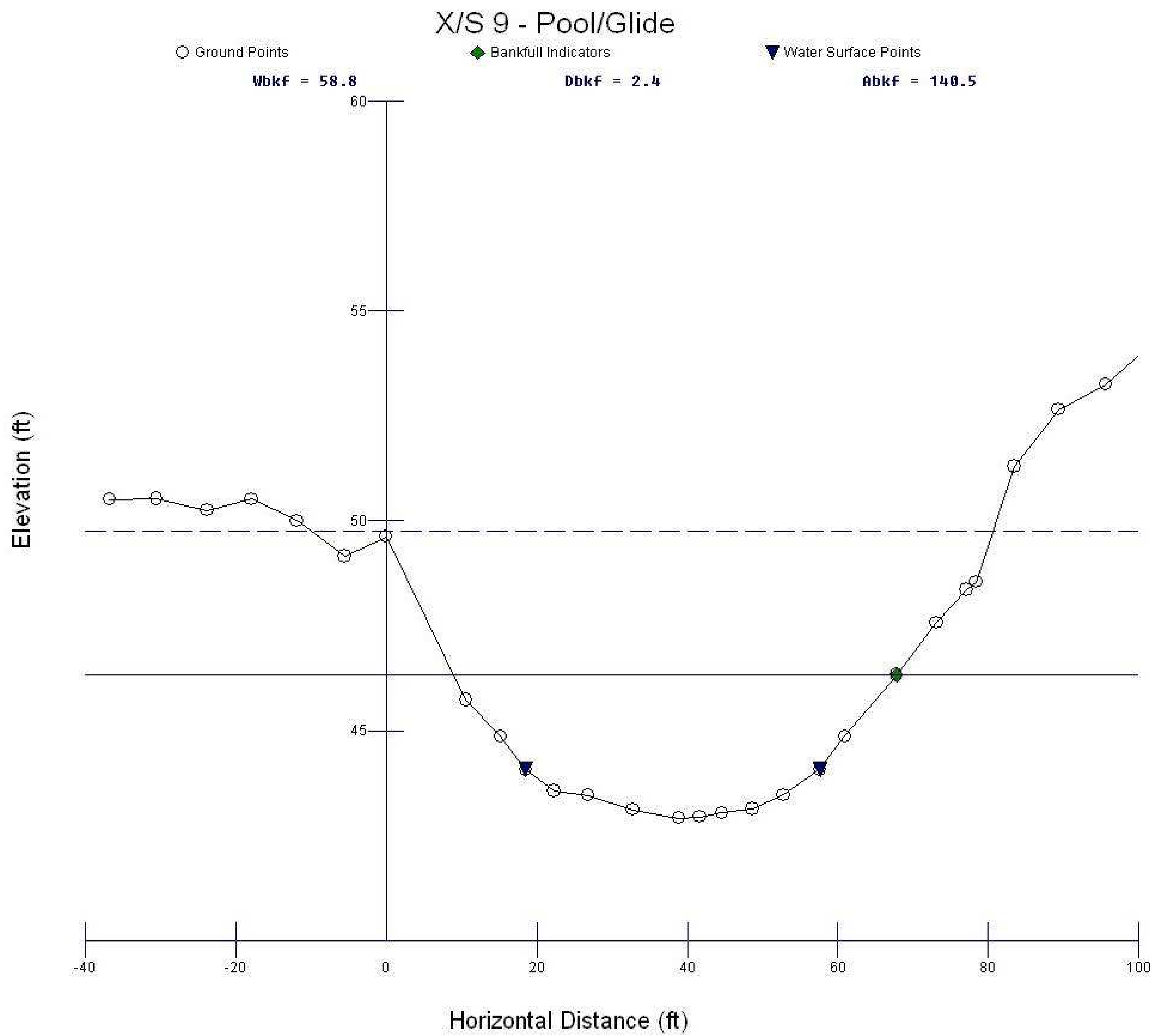
XS – DSR to DSL

XS – DSL to DSR

Upstream View

Downstream View

XS = cross section / DSL = Downstream Left / DSR = Downstream Right


X/S 9 - Pool/Glide
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 58.8
Dbkf = 2.4
Abkf = 140.5
60
55
50
45
Elevation (ft)
-40
-20
0
20
40
60
80
100
Horizontal Distance (ft)

Marshall Road
Philadelphia Water Department
Office of Watersheds

X/S 10 - Riffle

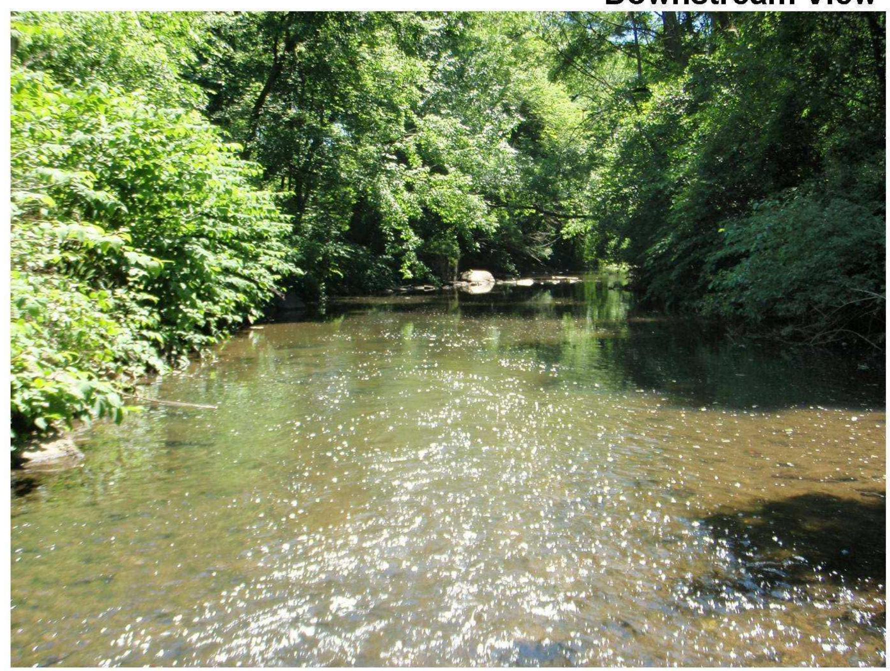
June 1st, 2009

XS – DSR to DSL

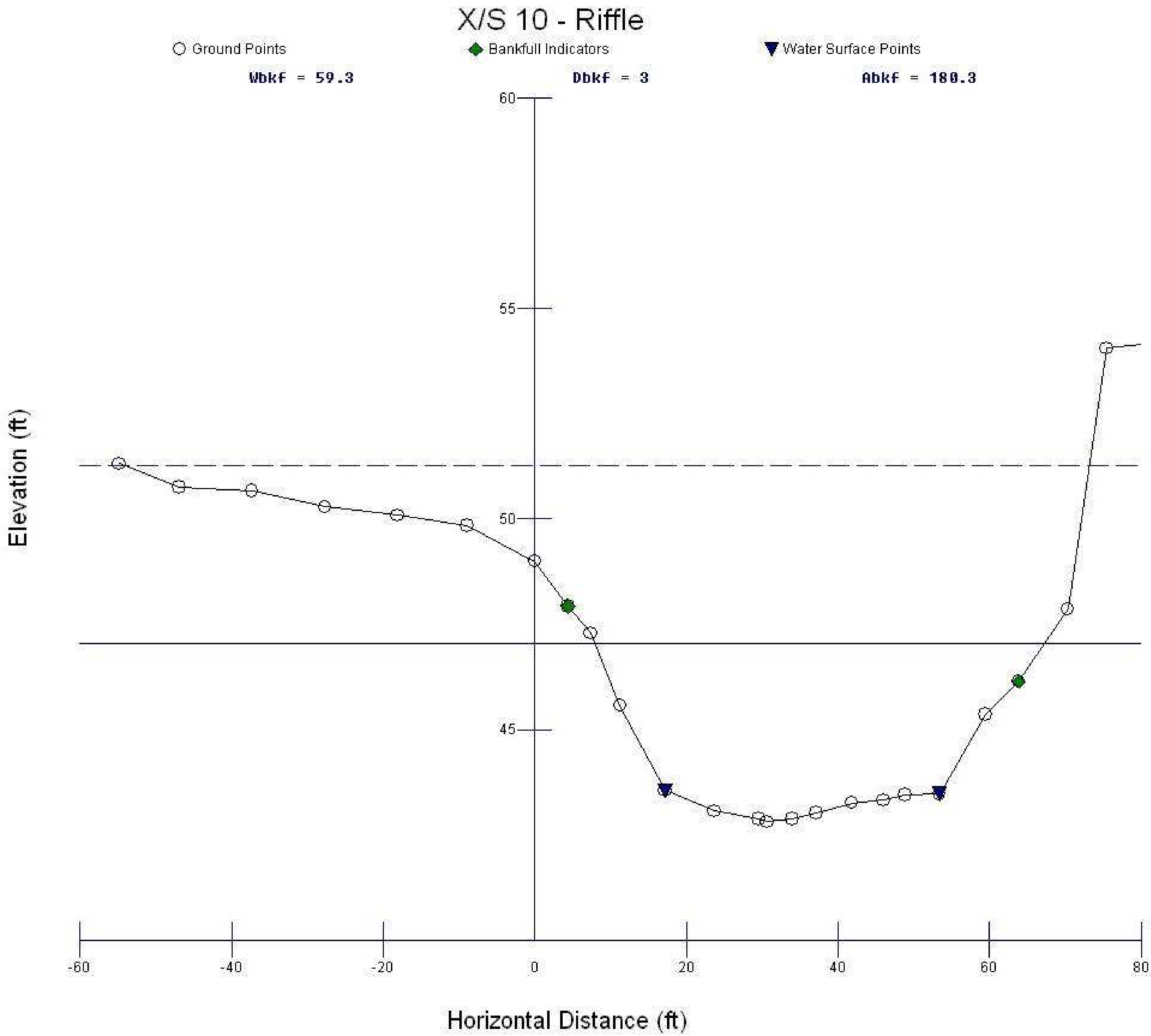
XS – DSL to DSR

Upstream View

Downstream View

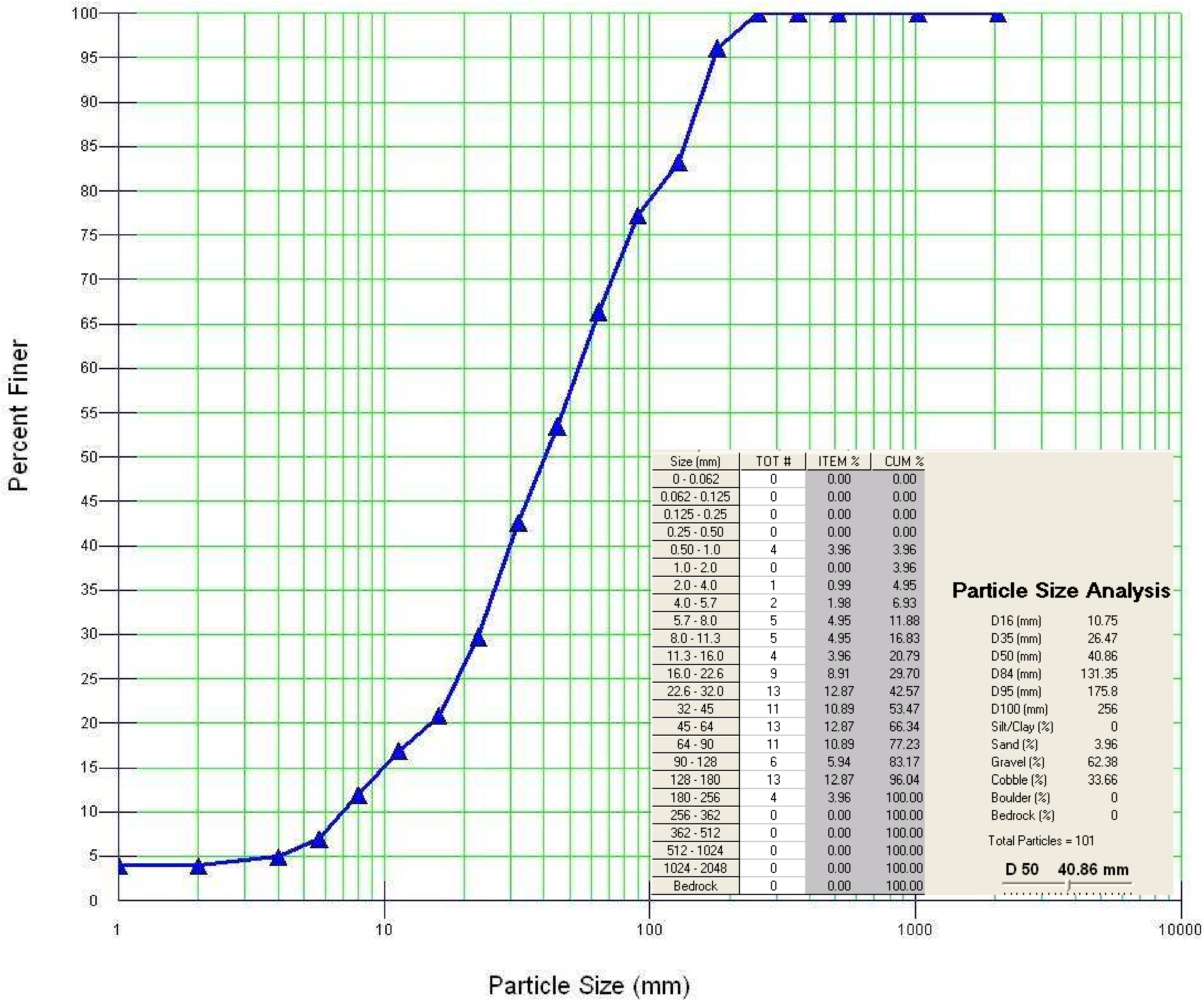


XS = cross section / DSL = Downstream Left / DSR = Downstream Right

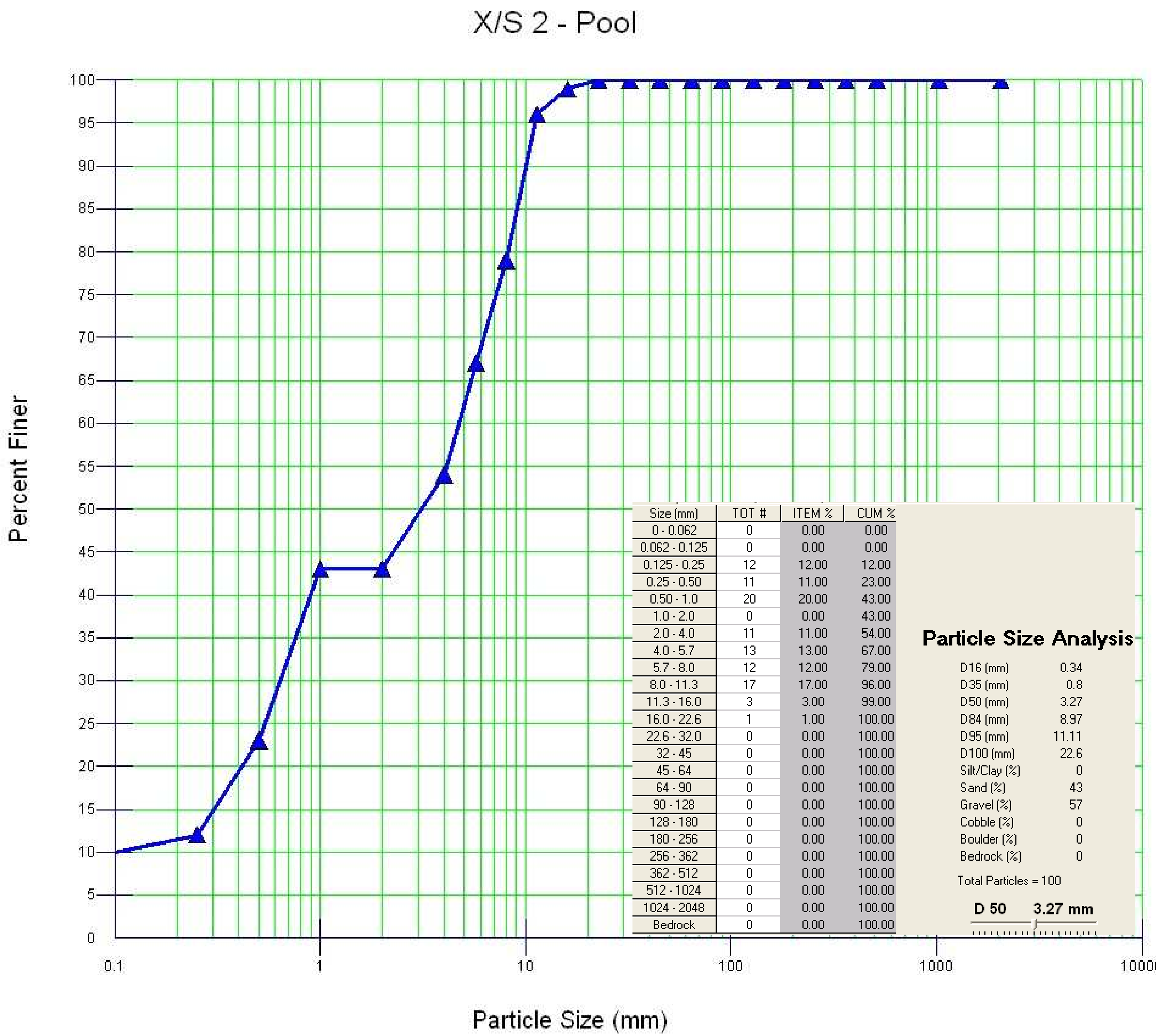

X/S 10 - Riffle
Ground Points
Bankfull Indicators
Water Surface Points
Wbkf = 59.3
Dbkf = 3
Abkf = 180.3
Elevation (ft)
60
55
50
45
-60
-40
-20
0
20
40
60
80
Horizontal Distance (ft)

Appendix B - Pebble Count / Bar Sample Data

X/S 1 - Riffle

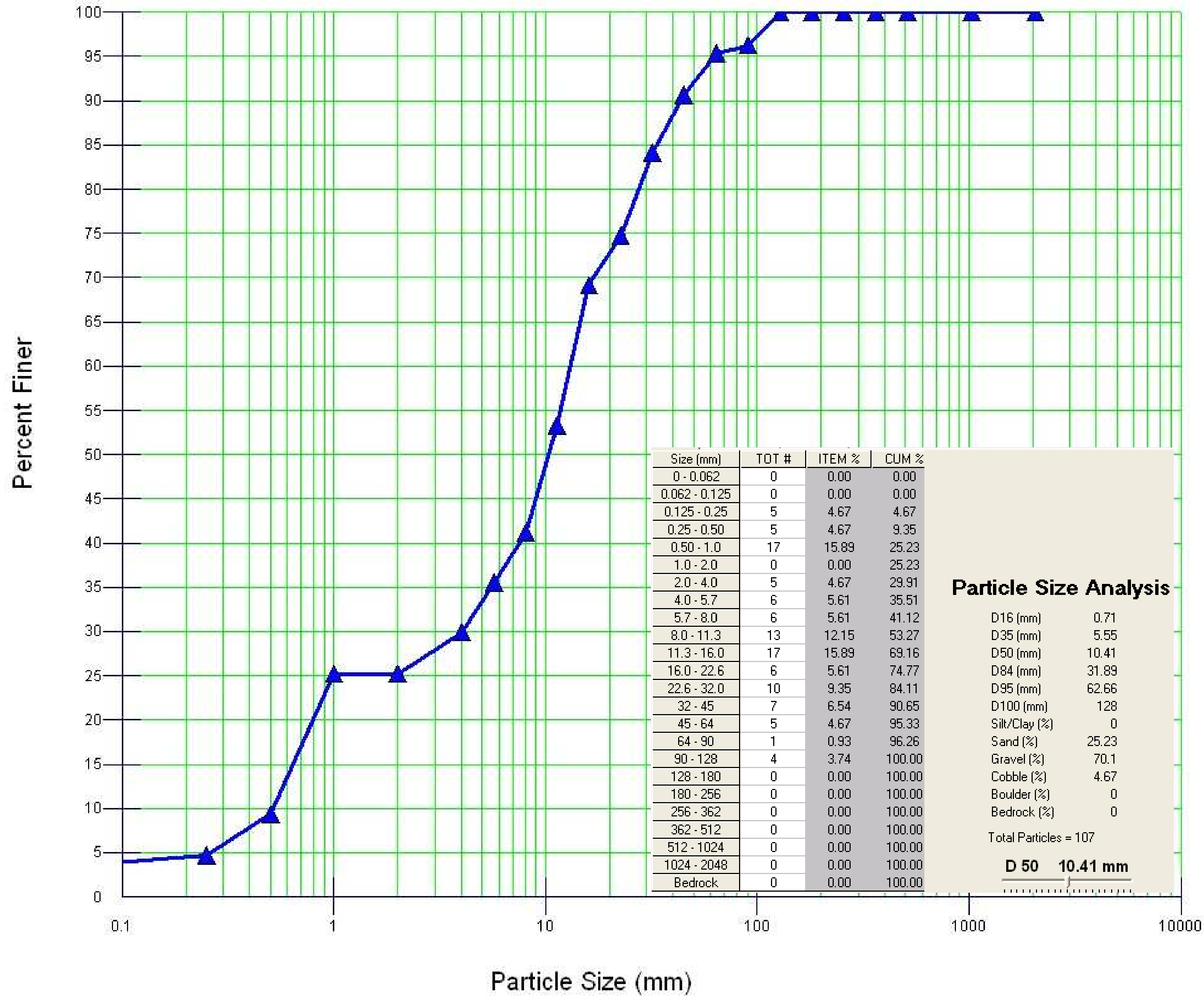


Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	0	0.00	0.00
0.25 - 0.50	0	0.00	0.00
0.50 - 1.0	4	3.96	3.96
1.0 - 2.0	0	0.00	3.96
2.0 - 4.0	1	0.99	4.95
4.0 - 5.7	2	1.98	6.93
5.7 - 8.0	5	4.95	11.88
8.0 - 11.3	5	4.95	16.83
11.3 - 16.0	4	3.96	20.79
16.0 - 22.6	9	8.91	29.70
22.6 - 32.0	13	12.87	42.57
32 - 45	11	10.89	53.47
45 - 64	13	12.87	66.34
64 - 90	11	10.89	77.23
90 - 128	6	5.94	83.17
128 - 180	13	12.87	96.04
180 - 256	4	3.96	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00



Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	12	12.00	12.00
0.25 - 0.50	11	11.00	23.00
0.50 - 1.0	20	20.00	43.00
1.0 - 2.0	0	0.00	43.00
2.0 - 4.0	11	11.00	54.00
4.0 - 5.7	13	13.00	67.00
5.7 - 8.0	12	12.00	79.00
8.0 - 11.3	17	17.00	96.00
11.3 - 16.0	3	3.00	99.00
16.0 - 22.6	1	1.00	100.00
22.6 - 32.0	0	0.00	100.00
32 - 45	0	0.00	100.00
45 - 64	0	0.00	100.00
64 - 90	0	0.00	100.00
90 - 128	0	0.00	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

X/S 3 - Glide



Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	5	4.67	4.67
0.25 - 0.50	5	4.67	9.35
0.50 - 1.0	17	15.89	25.23
1.0 - 2.0	0	0.00	25.23
2.0 - 4.0	5	4.67	29.91
4.0 - 5.7	6	5.61	35.51
5.7 - 8.0	6	5.61	41.12
8.0 - 11.3	13	12.15	53.27
11.3 - 16.0	17	15.89	69.16
16.0 - 22.6	6	5.61	74.77
22.6 - 32.0	10	9.35	84.11
32 - 45	7	6.54	90.65
45 - 64	5	4.67	95.33
64 - 90	1	0.93	96.26
90 - 128	4	3.74	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

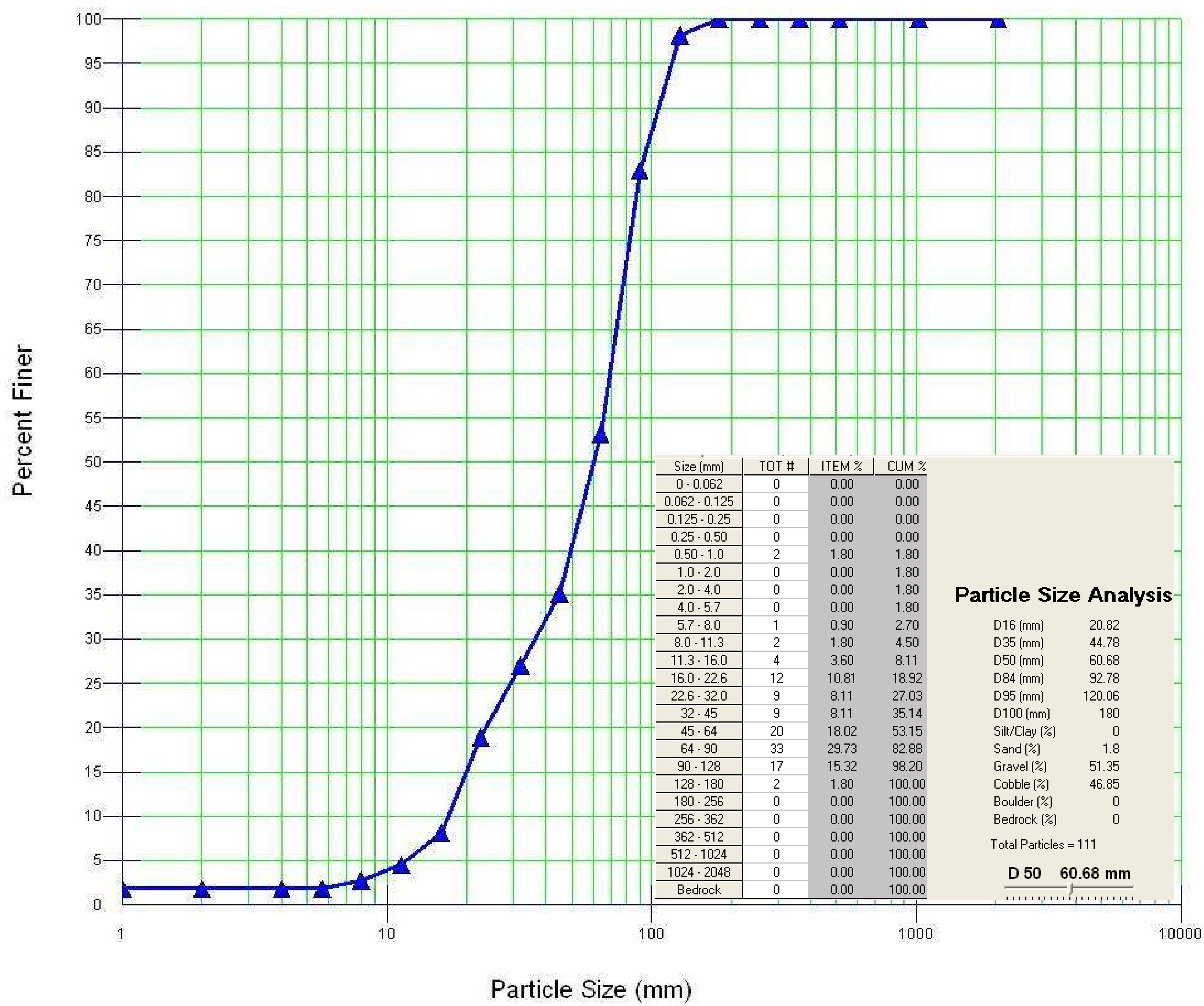
Particle Size Analysis

D16 (mm)	0.71
D35 (mm)	5.55
D50 (mm)	10.41
D84 (mm)	31.89
D95 (mm)	62.66
D100 (mm)	128
Silt/Clay (%)	0
Sand (%)	25.23
Gravel (%)	70.1
Cobble (%)	4.67
Boulder (%)	0
Bedrock (%)	0

Total Particles = 107

D 50 10.41 mm

X/S 4 - Riffle



Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	0	0.00	0.00
0.25 - 0.50	0	0.00	0.00
0.50 - 1.0	2	1.80	1.80
1.0 - 2.0	0	0.00	1.80
2.0 - 4.0	0	0.00	1.80
4.0 - 5.7	0	0.00	1.80
5.7 - 8.0	1	0.90	2.70
8.0 - 11.3	2	1.80	4.50
11.3 - 16.0	4	3.60	8.11
16.0 - 22.6	12	10.81	18.92
22.6 - 32.0	9	8.11	27.03
32 - 45	9	8.11	35.14
45 - 64	20	18.02	53.15
64 - 90	33	29.73	82.88
90 - 128	17	15.32	98.20
128 - 180	2	1.80	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

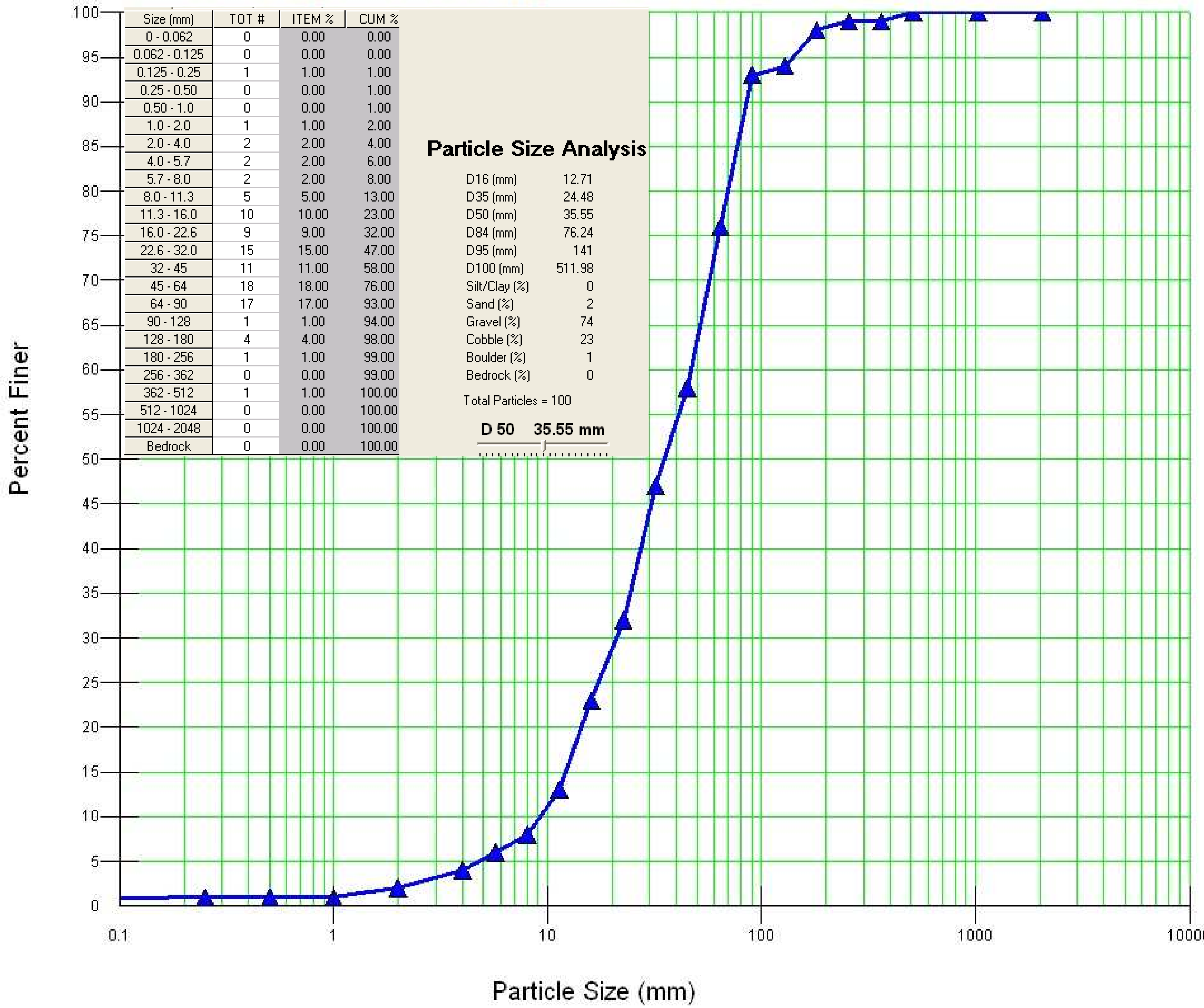
Particle Size Analysis

D16 (mm)	20.82
D35 (mm)	44.78
D50 (mm)	60.68
D84 (mm)	92.78
D95 (mm)	120.06
D100 (mm)	180
Silt/Clay (%)	0
Sand (%)	1.8
Gravel (%)	51.35
Cobble (%)	46.85
Boulder (%)	0
Bedrock (%)	0

Total Particles = 111

D 50 60.68 mm

X/S 5 - Riffle



Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	1	1.00	1.00
0.25 - 0.50	0	0.00	1.00
0.50 - 1.0	0	0.00	1.00
1.0 - 2.0	1	1.00	2.00
2.0 - 4.0	2	2.00	4.00
4.0 - 5.7	2	2.00	6.00
5.7 - 8.0	2	2.00	8.00
8.0 - 11.3	5	5.00	13.00
11.3 - 16.0	10	10.00	23.00
16.0 - 22.6	9	9.00	32.00
22.6 - 32.0	15	15.00	47.00
32 - 45	11	11.00	58.00
45 - 64	18	18.00	76.00
64 - 90	17	17.00	93.00
90 - 128	1	1.00	94.00
128 - 180	4	4.00	98.00
180 - 256	1	1.00	99.00
256 - 362	0	0.00	99.00
362 - 512	1	1.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

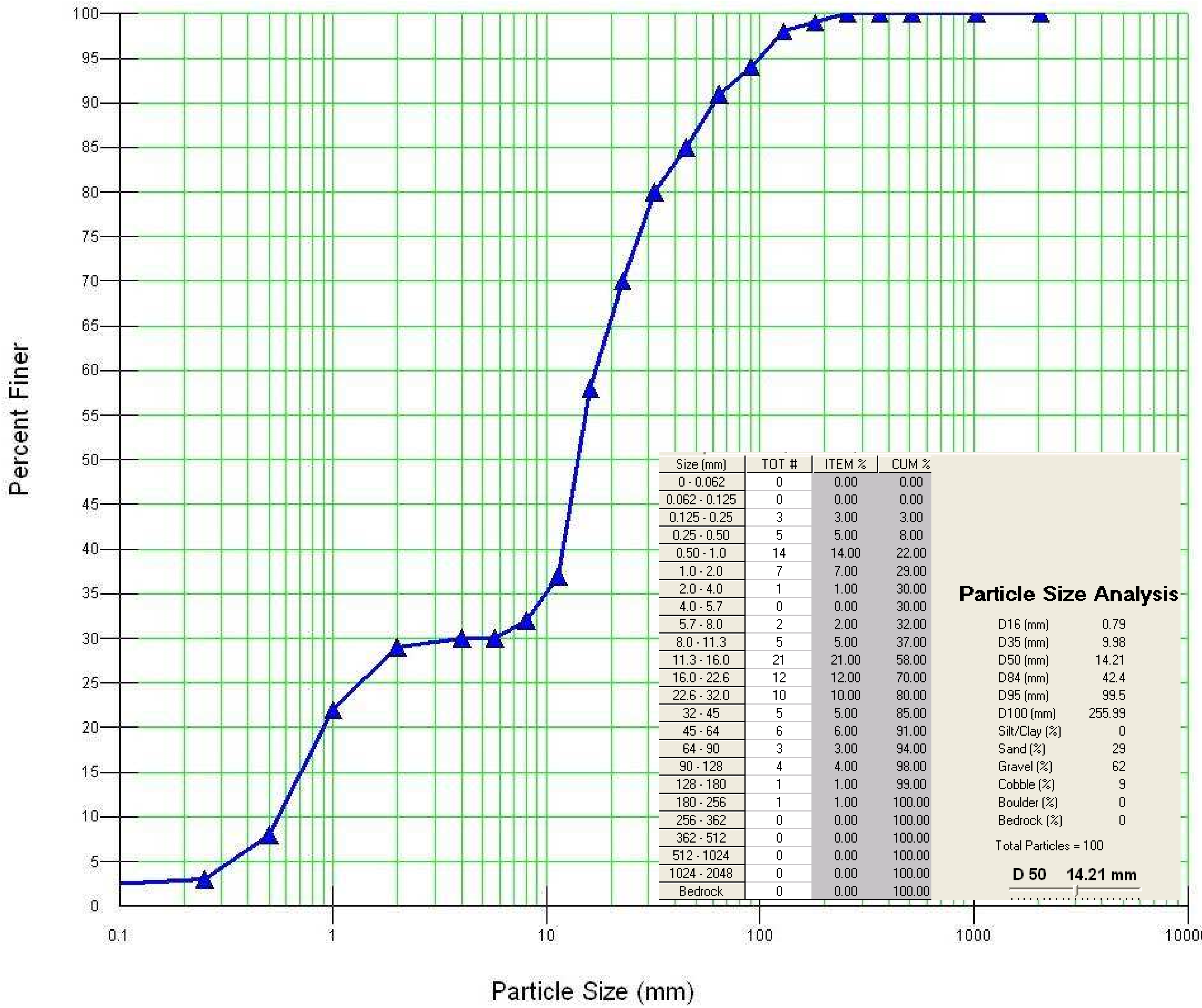
Particle Size Analysis

D16 (mm)	12.71
D35 (mm)	24.48
D50 (mm)	35.55
D84 (mm)	76.24
D95 (mm)	141
D100 (mm)	511.98
Silt/Clay (%)	0
Sand (%)	2
Gravel (%)	74
Cobble (%)	23
Boulder (%)	1
Bedrock (%)	0

Total Particles = 100

D 50 35.55 mm

X/S 6 - Run



Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	3	3.00	3.00
0.25 - 0.50	5	5.00	8.00
0.50 - 1.0	14	14.00	22.00
1.0 - 2.0	7	7.00	29.00
2.0 - 4.0	1	1.00	30.00
4.0 - 5.7	0	0.00	30.00
5.7 - 8.0	2	2.00	32.00
8.0 - 11.3	5	5.00	37.00
11.3 - 16.0	21	21.00	58.00
16.0 - 22.6	12	12.00	70.00
22.6 - 32.0	10	10.00	80.00
32 - 45	5	5.00	85.00
45 - 64	6	6.00	91.00
64 - 90	3	3.00	94.00
90 - 128	4	4.00	98.00
128 - 180	1	1.00	99.00
180 - 256	1	1.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

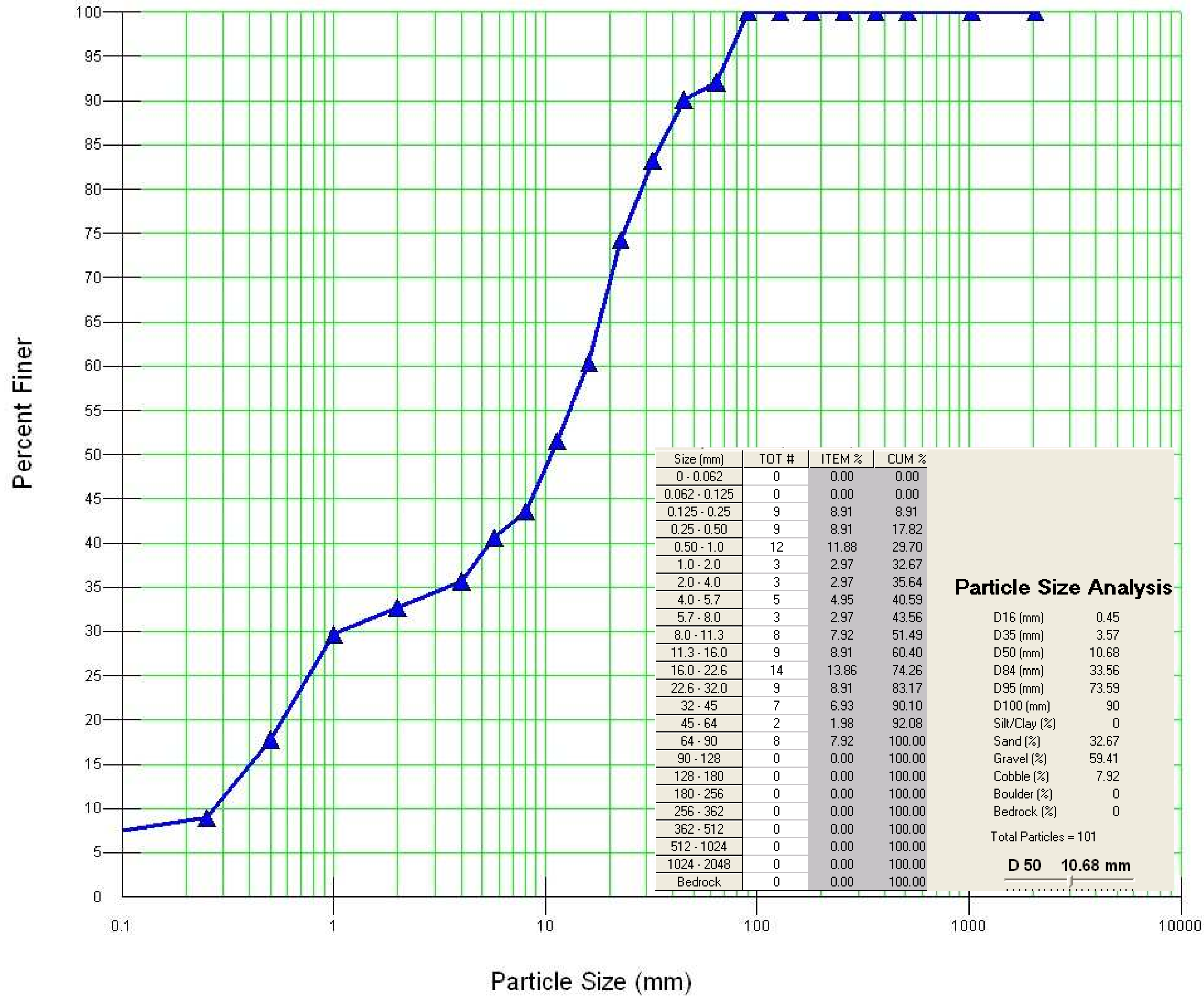
Particle Size Analysis

D16 (mm)	0.79
D35 (mm)	9.98
D50 (mm)	14.21
D84 (mm)	42.4
D95 (mm)	99.5
D100 (mm)	255.99
Silt/Clay (%)	0
Sand (%)	29
Gravel (%)	62
Cobble (%)	9
Boulder (%)	0
Bedrock (%)	0

Total Particles = 100

D 50 14.21 mm

X/S7 - Pool



Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	9	8.91	8.91
0.25 - 0.50	9	8.91	17.82
0.50 - 1.0	12	11.88	29.70
1.0 - 2.0	3	2.97	32.67
2.0 - 4.0	3	2.97	35.64
4.0 - 5.7	5	4.95	40.59
5.7 - 8.0	3	2.97	43.56
8.0 - 11.3	8	7.92	51.49
11.3 - 16.0	9	8.91	60.40
16.0 - 22.6	14	13.86	74.26
22.6 - 32.0	9	8.91	83.17
32 - 45	7	6.93	90.10
45 - 64	2	1.98	92.08
64 - 90	8	7.92	100.00
90 - 128	0	0.00	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

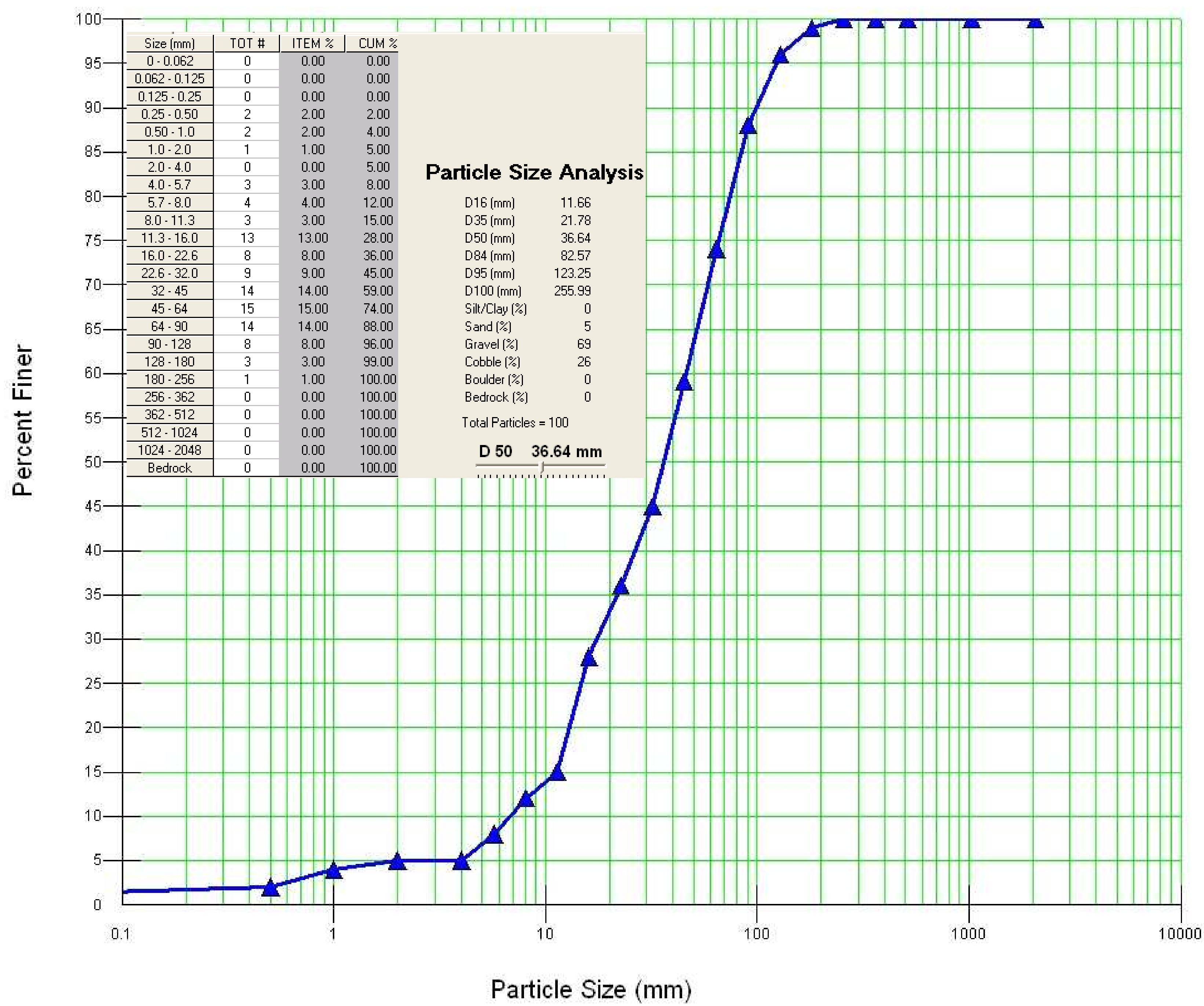
Particle Size Analysis

D16 (mm)	0.45
D35 (mm)	3.57
D50 (mm)	10.68
D84 (mm)	33.56
D95 (mm)	73.59
D100 (mm)	90
Silt/Clay (%)	0
Sand (%)	32.67
Gravel (%)	59.41
Cobble (%)	7.92
Boulder (%)	0
Bedrock (%)	0

Total Particles = 101

D 50 10.68 mm

X/S8 - Riffle



Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	0	0.00	0.00
0.25 - 0.50	2	2.00	2.00
0.50 - 1.0	2	2.00	4.00
1.0 - 2.0	1	1.00	5.00
2.0 - 4.0	0	0.00	5.00
4.0 - 5.7	3	3.00	8.00
5.7 - 8.0	4	4.00	12.00
8.0 - 11.3	3	3.00	15.00
11.3 - 16.0	13	13.00	28.00
16.0 - 22.6	8	8.00	36.00
22.6 - 32.0	9	9.00	45.00
32 - 45	14	14.00	59.00
45 - 64	15	15.00	74.00
64 - 90	14	14.00	88.00
90 - 128	8	8.00	96.00
128 - 180	3	3.00	99.00
180 - 256	1	1.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

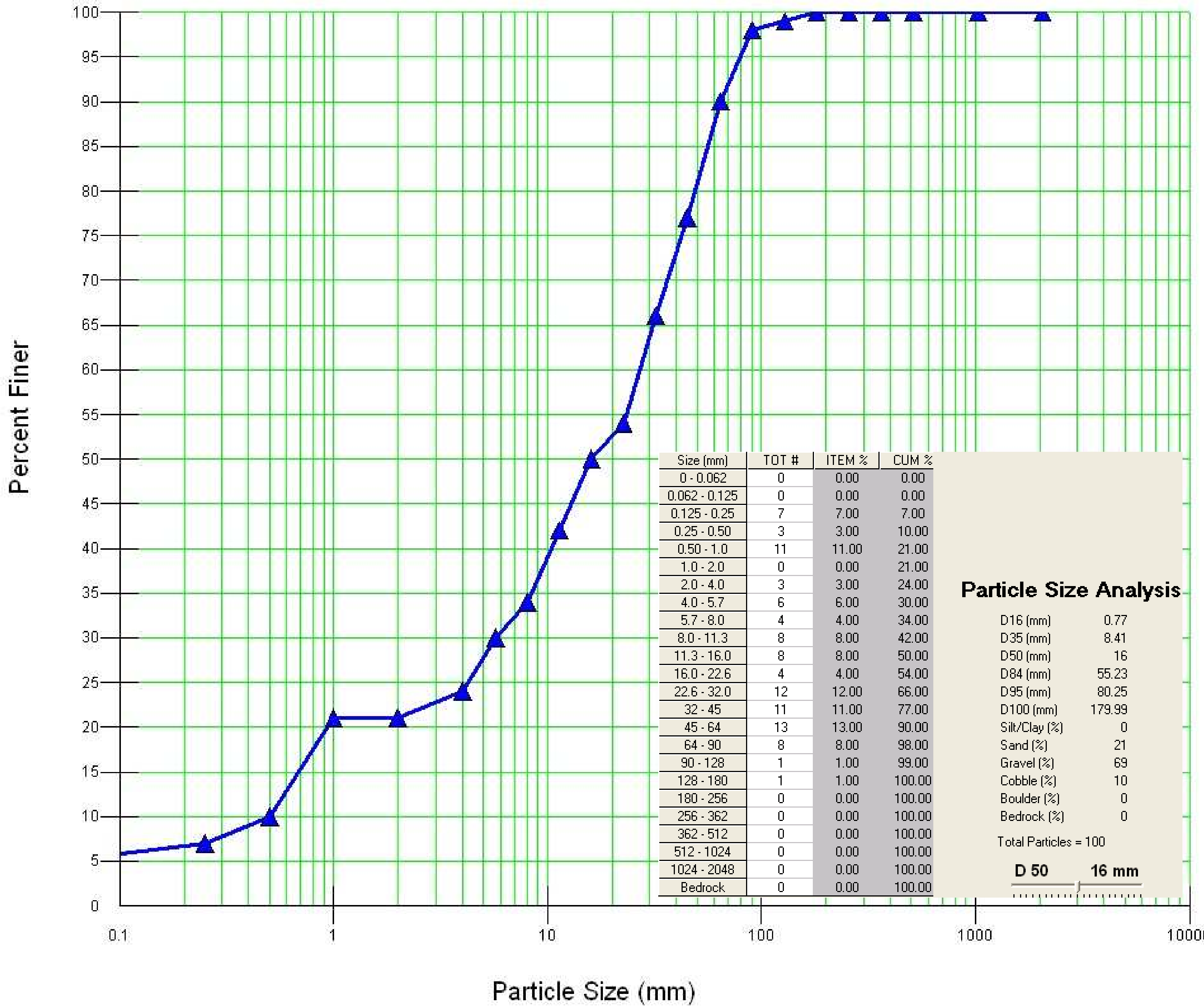
Particle Size Analysis

D16 (mm)	11.66
D35 (mm)	21.78
D50 (mm)	36.64
D84 (mm)	82.57
D95 (mm)	123.25
D100 (mm)	255.99
Silt/Clay (%)	0
Sand (%)	5
Gravel (%)	69
Cobble (%)	26
Boulder (%)	0
Bedrock (%)	0

Total Particles = 100

D 50 36.64 mm

X/S9 - Pool/Glide



Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	7	7.00	7.00
0.25 - 0.50	3	3.00	10.00
0.50 - 1.0	11	11.00	21.00
1.0 - 2.0	0	0.00	21.00
2.0 - 4.0	3	3.00	24.00
4.0 - 5.7	6	6.00	30.00
5.7 - 8.0	4	4.00	34.00
8.0 - 11.3	8	8.00	42.00
11.3 - 16.0	8	8.00	50.00
16.0 - 22.6	4	4.00	54.00
22.6 - 32.0	12	12.00	66.00
32 - 45	11	11.00	77.00
45 - 64	13	13.00	90.00
64 - 90	8	8.00	98.00
90 - 128	1	1.00	99.00
128 - 180	1	1.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

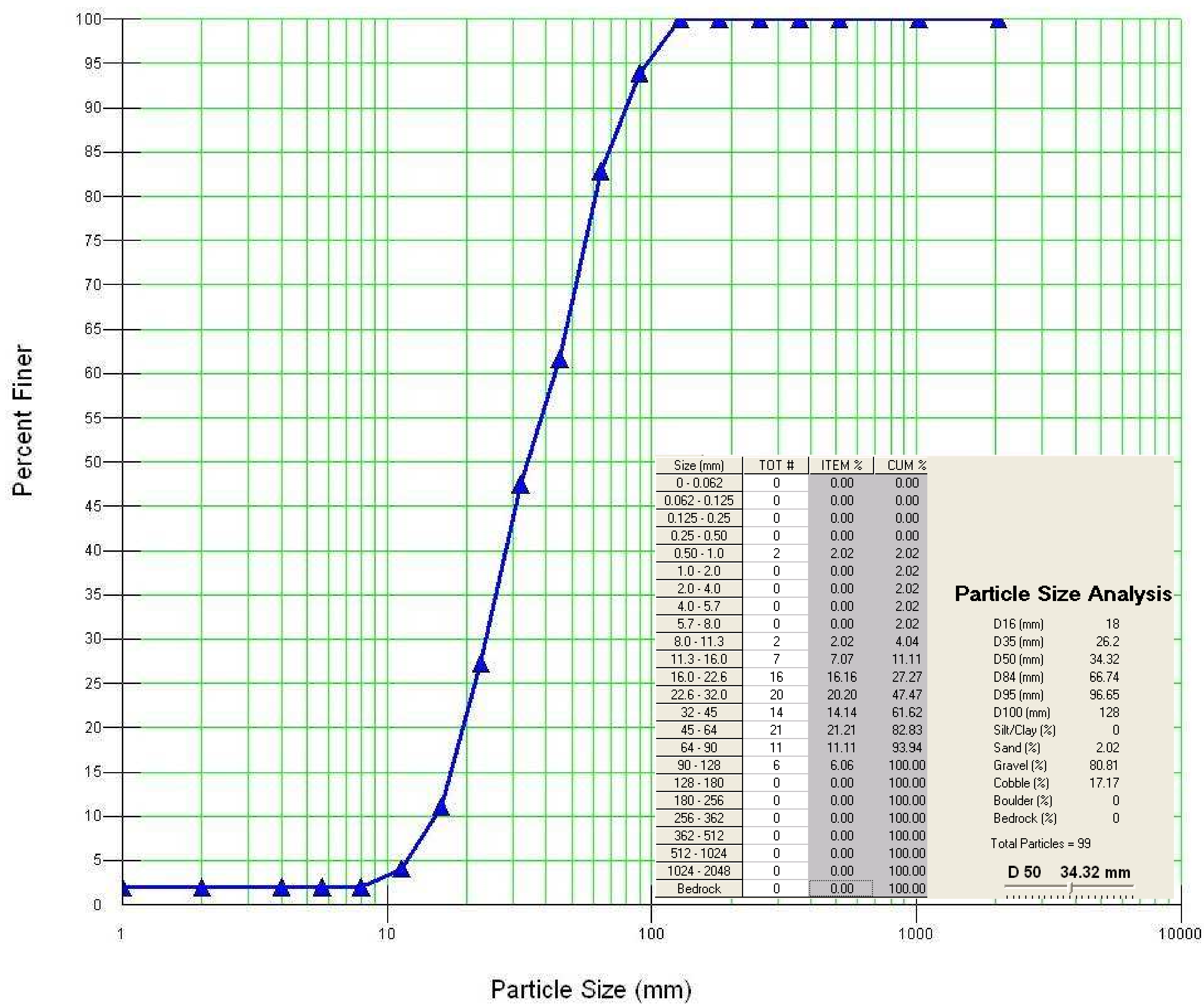
Particle Size Analysis

D16 (mm)	0.77
D35 (mm)	8.41
D50 (mm)	16
D84 (mm)	55.23
D95 (mm)	80.25
D100 (mm)	179.99
Silt/Clay (%)	0
Sand (%)	21
Gravel (%)	69
Cobble (%)	10
Boulder (%)	0
Bedrock (%)	0

Total Particles = 100

D 50 **16 mm**

X/S 10 - Riffle



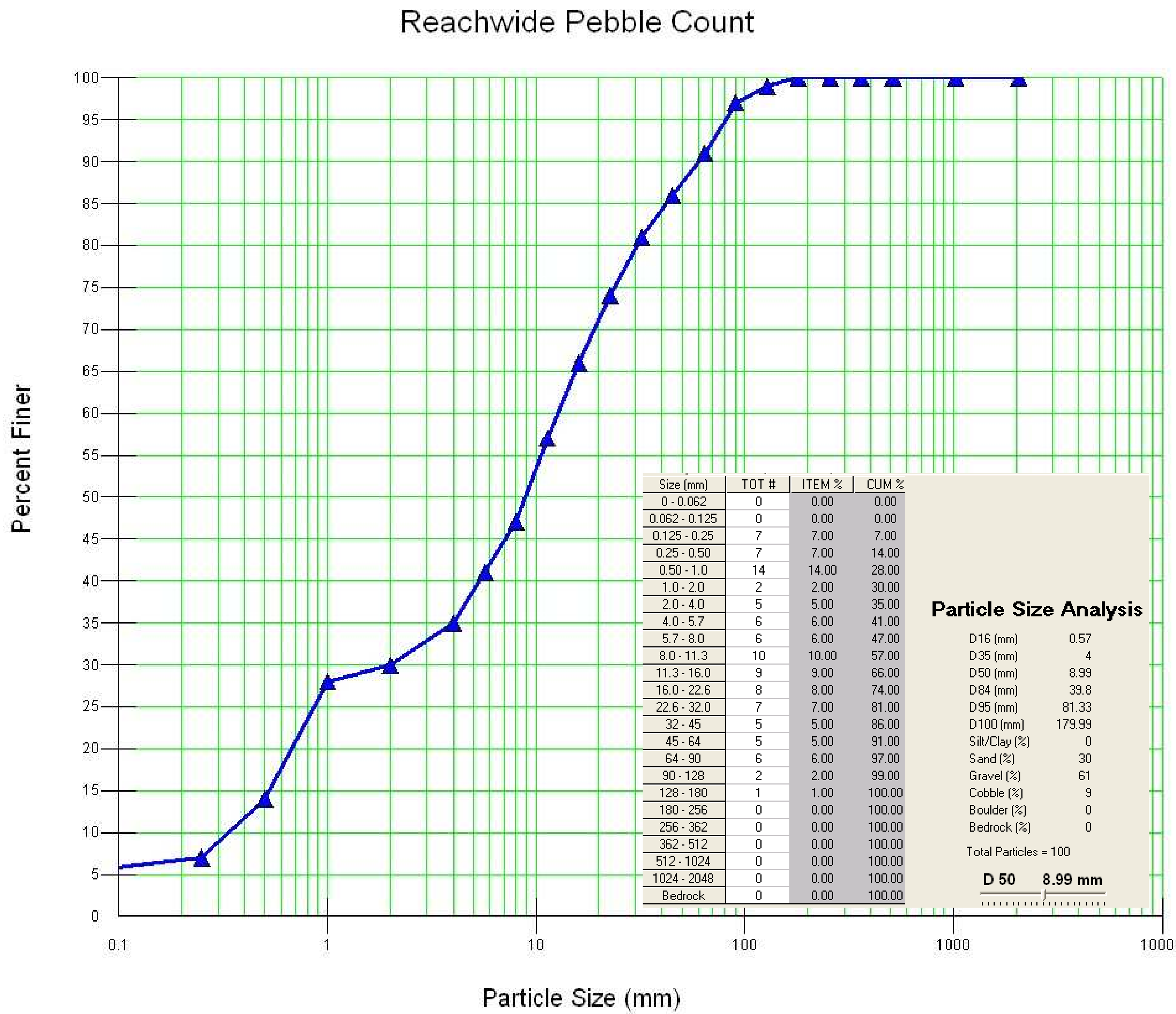
Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	0	0.00	0.00
0.25 - 0.50	0	0.00	0.00
0.50 - 1.0	2	2.02	2.02
1.0 - 2.0	0	0.00	2.02
2.0 - 4.0	0	0.00	2.02
4.0 - 5.7	0	0.00	2.02
5.7 - 8.0	0	0.00	2.02
8.0 - 11.3	2	2.02	4.04
11.3 - 16.0	7	7.07	11.11
16.0 - 22.6	16	16.16	27.27
22.6 - 32.0	20	20.20	47.47
32 - 45	14	14.14	61.62
45 - 64	21	21.21	82.83
64 - 90	11	11.11	93.94
90 - 128	6	6.06	100.00
128 - 180	0	0.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

Particle Size Analysis

D16 (mm)	18
D35 (mm)	26.2
D50 (mm)	34.32
D84 (mm)	66.74
D95 (mm)	96.65
D100 (mm)	128
Silt/Clay (%)	0
Sand (%)	2.02
Gravel (%)	80.81
Cobble (%)	17.17
Boulder (%)	0
Bedrock (%)	0

Total Particles = 99

D 50 34.32 mm



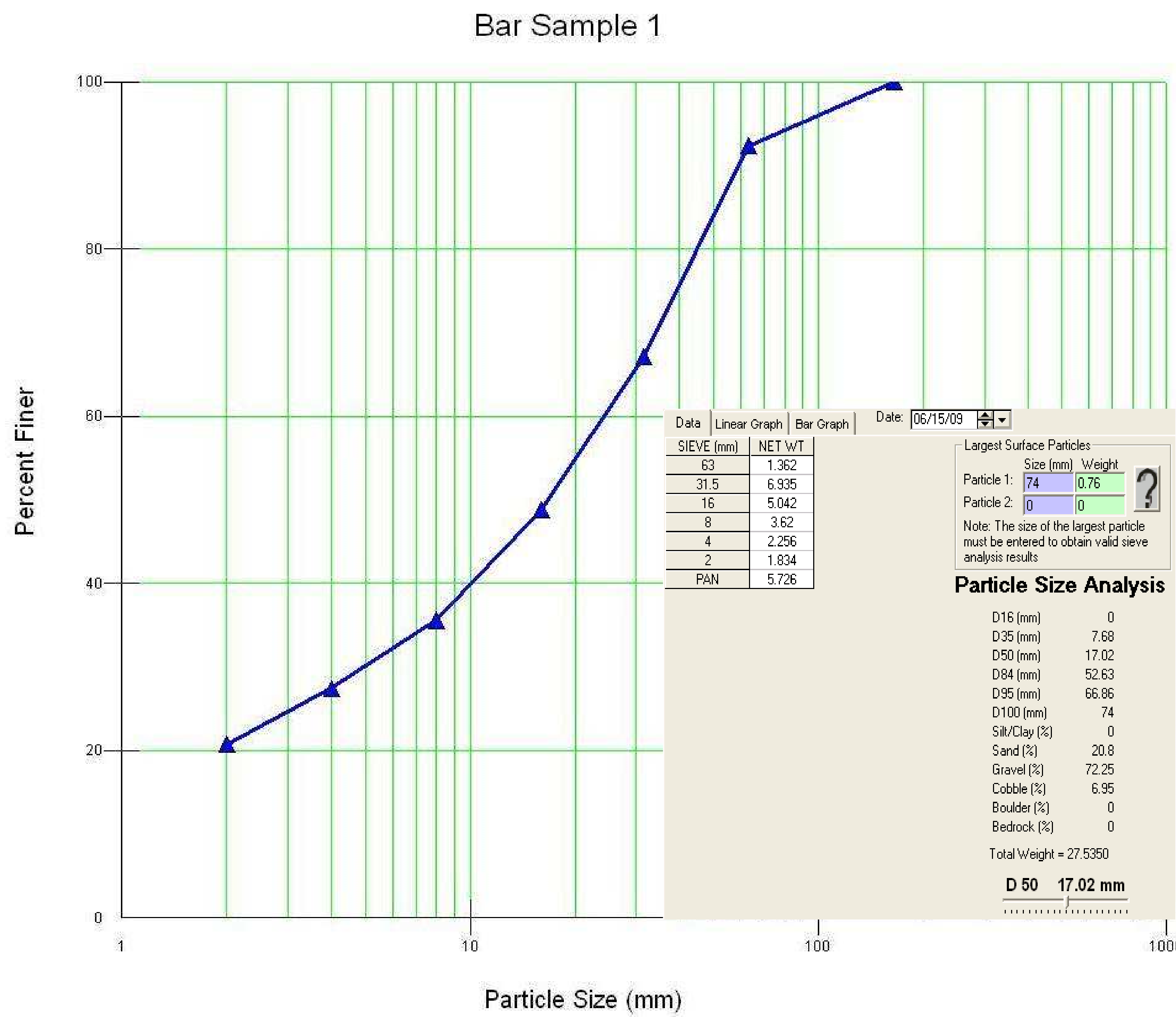
Size (mm)	TOT #	ITEM %	CUM %
0 - 0.062	0	0.00	0.00
0.062 - 0.125	0	0.00	0.00
0.125 - 0.25	7	7.00	7.00
0.25 - 0.50	7	7.00	14.00
0.50 - 1.0	14	14.00	28.00
1.0 - 2.0	2	2.00	30.00
2.0 - 4.0	5	5.00	35.00
4.0 - 5.7	6	6.00	41.00
5.7 - 8.0	6	6.00	47.00
8.0 - 11.3	10	10.00	57.00
11.3 - 16.0	9	9.00	66.00
16.0 - 22.6	8	8.00	74.00
22.6 - 32.0	7	7.00	81.00
32 - 45	5	5.00	86.00
45 - 64	5	5.00	91.00
64 - 90	6	6.00	97.00
90 - 128	2	2.00	99.00
128 - 180	1	1.00	100.00
180 - 256	0	0.00	100.00
256 - 362	0	0.00	100.00
362 - 512	0	0.00	100.00
512 - 1024	0	0.00	100.00
1024 - 2048	0	0.00	100.00
Bedrock	0	0.00	100.00

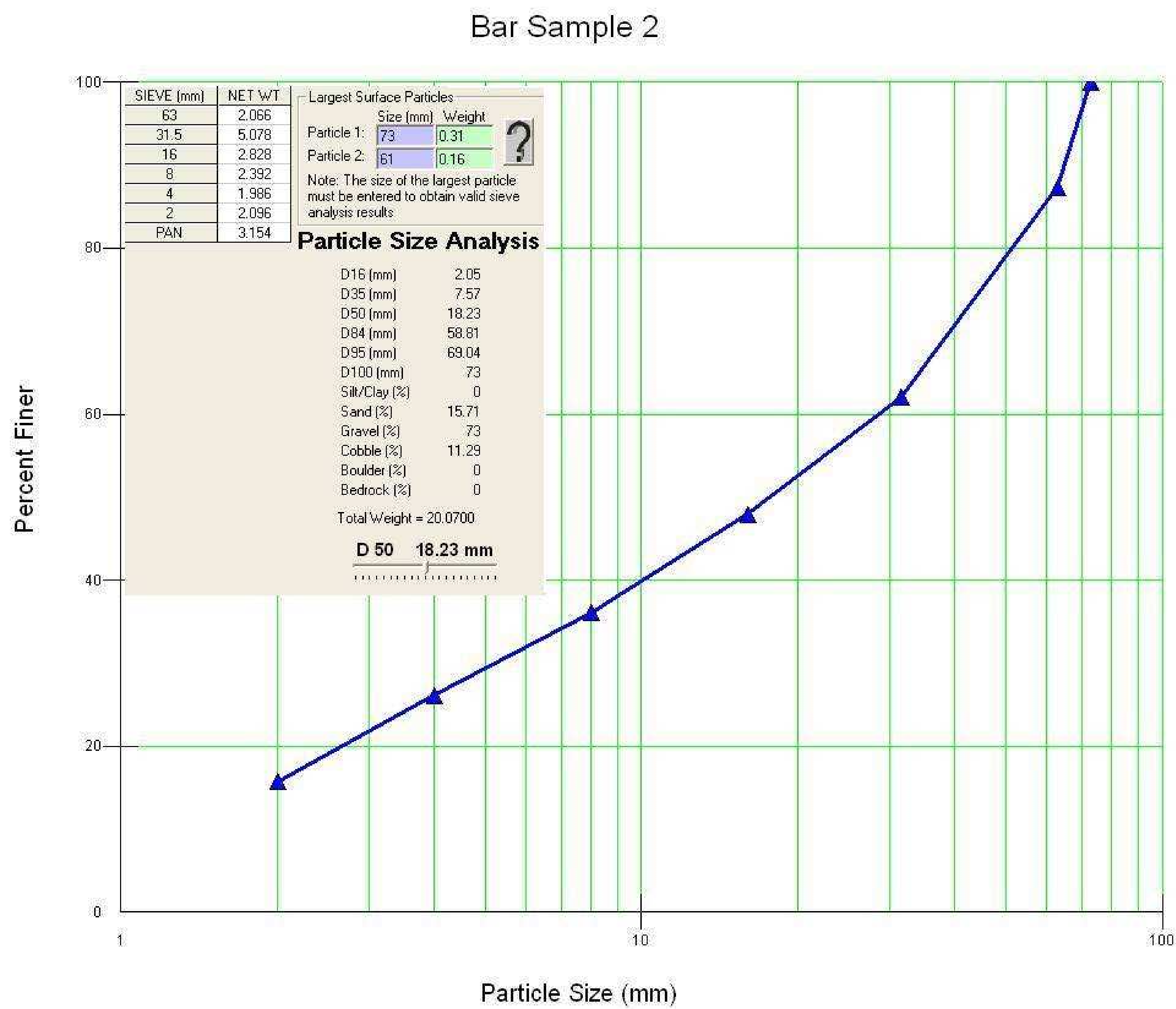
Particle Size Analysis

D16 (mm)	0.57
D35 (mm)	4
D50 (mm)	8.99
D84 (mm)	39.8
D95 (mm)	81.33
D100 (mm)	179.99
Silt/Clay (%)	0
Sand (%)	30
Gravel (%)	61
Cobble (%)	9
Boulder (%)	0
Bedrock (%)	0

Total Particles = 100

D 50 8.99 mm


Bar Sample 1
Percent Finer
0
20
40
60
80
100
1
10
100
1000
Particle Size (mm)
Data
Linear Graph
Bar Graph
Date: 06/15/09
SIEVE (mm) NET WT
63 1.362
31.5 6.935
16 5.042
8 3.62
4 2.256
2 1.834
PAN 5.726
Largest Surface Particles
Size (mm) Weight
Particle 1: 74 0.76
Particle 2: 0 0
Note: The size of the largest particle must be entered to obtain valid sieve analysis results
Particle Size Analysis
D16 (mm) 0
D35 (mm) 7.68
D50 (mm) 17.02
D84 (mm) 52.63
D95 (mm) 66.86
D100 (mm) 74
Silt/Clay (%) 0
Sand (%) 20.8
Gravel (%) 72.25
Cobble (%) 6.95
Boulder (%) 0
Bedrock (%) 0
Total Weight = 27.5350
D 50 17.02 mm


Bar Sample 2
Percent Finer
Particle Size (mm)
0
20
40
60
80
100
1
10
100
SIEVE (mm) NET WT
63 2.066
31.5 5.078
16 2.828
8 2.392
4 1.986
2 2.096
PAN 3.154
Largest Surface Particles
Size (mm) Weight
Particle 1: 73 0.31
Particle 2: 61 0.16
Note: The size of the largest particle must be entered to obtain valid sieve analysis results
Particle Size Analysis
D16 (mm) 2.05
D35 (mm) 7.57
D50 (mm) 18.23
D84 (mm) 58.81
D95 (mm) 69.04
D100 (mm) 73
Silt/Clay (%) 0
Sand (%) 15.71
Gravel (%) 73
Cobble (%) 11.29
Boulder (%) 0
Bedrock (%) 0
Total Weight = 20.0700
D 50 18.23 mm

Appendix C - BANCS Model Data

Marshall Road
Philadelphia Water Department
Office of Watersheds
BEHI Reaches

1R 0+00

June 4th, 2009

BEHI: Moderate

NBS: Very Low

Stream:	Cobbs Creek	Location:	Marshall Road
Station:	1R 0+00	Observers:	EH, RH, MM
Date:	6-4-09	Stream Type: B4c	Valley Type: V

BEHI Score (Fig. 5-19)

Study Bank Height / Bankfull Height (C)

Study Bank Height (ft) =	2.25	Bankfull Height (ft) =	2.25	(A) / (B) =	1	1

Root Depth / Study Bank Height (E)

Root Depth (ft) =	1	Study Bank Height (ft) =	2.25	(D) / (A) =	0.44	4.3

Weighted Root Density (G)

Root Density as % =	10%	(F) x (E) =	0.04	10

Bank Angle (H)

Bank Angle as *Degrees*	20	2

Surface Protection (I)

Surface Protection as % =	50%	4.4

Bank Material Adjustment:

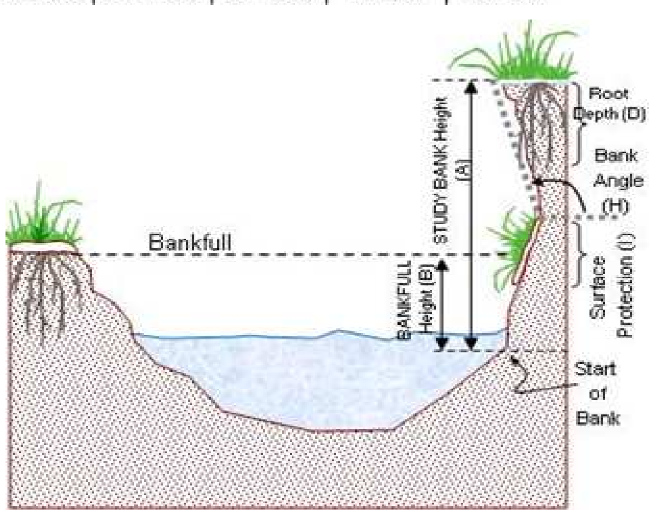
Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

Bank Material Adjustment: **0**

Stratification Adjustment: **0**

Very Low	Low	Moderate	High	Very High	Extreme
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50

Adjective Rating and **Total Score**: **Moderate** / **21.7**



Estimating Near-Bank Stress (NBS)

Stream: **Cobbs Creek** Location: **Marshall Road**

Station: **1R 0+00** Stream Type: **B4c** Valley Type: **V**

Observers: **EH, RH, MM** Date: **6-4-09**

Methods for estimating Near-Bank Stress (NBS)

(1)	Channel pattern, transverse bar or split channel/central bar creating NBS..........	Level I	Reconaissance
(2)	Ratio of radius of curvature to bankfull width (R_c / W_{bkf})......	Level II	General prediction
(3)	Ratio of pool slope to average water surface slope (S_p / S)......	Level II	General prediction
(4)	Ratio of pool slope to riffle slope (S_p / S_{rif})......	Level II	General prediction
(5)	Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})......	Level III	Detailed prediction
(6)	Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})......	Level III	Detailed prediction
(7)	Velocity profiles / Isovels / Velocity gradient......	Level IV	Validation

Level I — **(1)**

Transverse and/or central bars-short and/or discontinuous.........NBS = High / Very High

Extensive deposition (continuous, cross-channel).........NBS = Extreme

Chute cutoffs, down-valley meander migration, converging flow.........NBS = Extreme

Level II

(2)	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Dominant Near-Bank Stress
Very Low

Level III

(5)	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
	2.35	**2.75**	**0.85**	**Very Low**

(6)	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)	Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting values to a Near-Bank Stress (NBS) rating

Near-Bank Stress (NBS) ratings	Method number						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating — **Very Low**

Marshall Road
Philadelphia Water Department
Office of Watersheds
BEHI Reaches

1L 0+00

June 4th, 2009

BEHI: Very Low

NBS: High

Stream:	Cobbs Creek	**Location:**	Marshall Road
Station:	1L 0+00	**Observers:**	EH, RH, MM
Date:	6-4-09	**Stream Type:** B4c	**Valley Type:** V

BEHI Score (Fig. 5-19)

Study Bank Height / Bankfull Height (C)

Study Bank Height (ft) =	6.7	Bankfull Height (ft) =	4.1	(A) / (B) =	1.63	6.5

Root Depth / Study Bank Height (E)

Root Depth (ft) =	1	Study Bank Height (ft) =	6.7	(D) / (A) =	0.15	8

Weighted Root Density (G)

Root Density as % =	5%	(F) × (E) =	0.007	10

Bank Angle (H)

Bank Angle as *Degrees*	30	2.5

Surface Protection (I)

Surface Protection as % =	100%	0

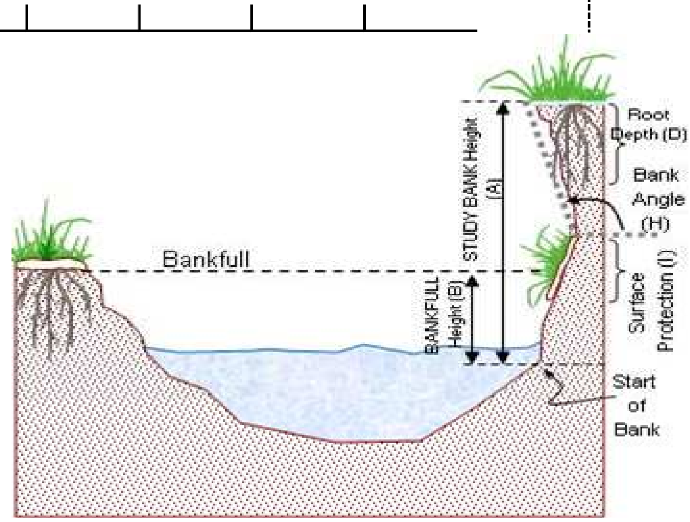
Bank Material Adjustment:

Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

Bank Material Adjustment	Boulder
Stratification Adjustment	0

Very Low	Low	Moderate	High	Very High	Extreme
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50

Adjective Rating and **Total Score**	Very Low
	27



Estimating Near-Bank Stress (NBS)

Stream: **Cobbs Creek** Location: **Marshall Road**

Station: **1L 0+00** Stream Type: **B4c** Valley Type: **V**

Observers: **EH, RH, MM** Date: **6-4-09**

Methods for estimating Near-Bank Stress (NBS)

(1)	Channel pattern, transverse bar or split channel/central bar creating NBS..........	Level I	Reconaissance
(2)	Ratio of radius of curvature to bankfull width (R_c / W_{bkf})..	Level II	General prediction
(3)	Ratio of pool slope to average water surface slope (S_p / S).....................................	Level II	General prediction
(4)	Ratio of pool slope to riffle slope (S_p / S_{rif})...	Level II	General prediction
(5)	Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf}).....................	Level III	Detailed prediction
(6)	Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf}).........................	Level III	Detailed prediction
(7)	Velocity profiles / Isovels / Velocity gradient...	Level IV	Validation

Level I — **(1)**

- Transverse and/or central bars-short and/or discontinuous.........................NBS = High / Very High
- Extensive deposition (continuous, cross-channel)...NBS = Extreme
- Chute cutoffs, down-valley meander migration, converging flow...........................NBS = Extreme

Level II

(2)	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Dominant Near-Bank Stress

High

Level III

(5)	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)

(6)	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)	Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting values to a Near-Bank Stress (NBS) rating

Near-Bank Stress (NBS) ratings	Method number						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating **High**

Marshall Road

Marshall Road
Philadelphia Water Department
Office of Watersheds
BEHI Reaches

2R 0+99

June 4th, 2009

BEHI: Very Low

NBS: Low

Stream:	Cobbs Creek	Location:	Marshall Road
Station:	2R 1+04	Observers:	EH, RH, MM
Date:	6-4-09	Stream Type: B4c	Valley Type: V

BEHI Score (Fig. 5-19)

Study Bank Height / Bankfull Height (C)

Study Bank Height (ft) =	8.5	Bankfull Height (ft) =	6.3	(A) / (B) =	1.35	5

Root Depth / Study Bank Height (E)

Root Depth (ft) =	3	Study Bank Height (ft) =	8.5	(D) / (A) =	0.35	5.2

Weighted Root Density (G)

Root Density as % =	20%	(F) × (E) =	0.07	10

Bank Angle (H)

Bank Angle as *Degrees*	44	3.2

Surface Protection (I)

Surface Protection as % =	100%	0

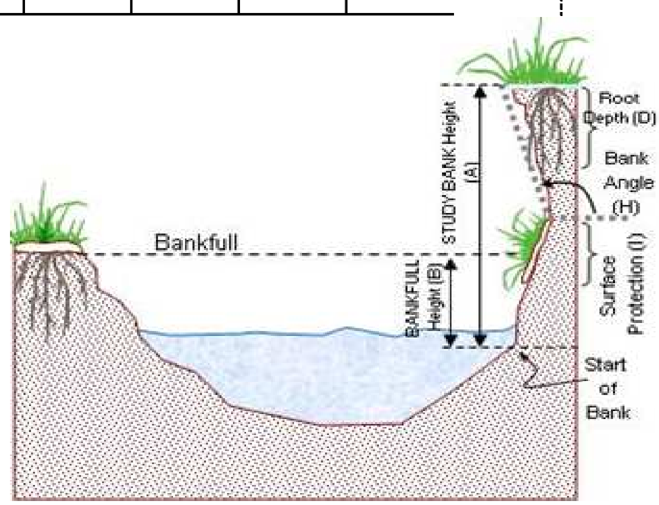
Bank Material Adjustment:

Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

Bank Material Adjustment	Boulder
Stratification Adjustment	

Very Low	Low	Moderate	High	Very High	Extreme
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50

Adjective Rating and Total Score	Very Low 23.4



Estimating Near-Bank Stress (NBS)

Stream: **Cobbs Creek**	Location: **Marshall Road**	
Station: **2R 1+04**	Stream Type: **B4c**	Valley Type: **V**
Observers: **EH, RH, MM**		Date: **6-4-09**

Methods for estimating Near-Bank Stress (NBS)

(1)	Channel pattern, transverse bar or split channel/central bar creating NBS..........	Level I	Reconaissance
(2)	Ratio of radius of curvature to bankfull width (R_c / W_{bkf})......................................	Level II	General prediction
(3)	Ratio of pool slope to average water surface slope (S_p / S)......................................	Level II	General prediction
(4)	Ratio of pool slope to riffle slope (S_p / S_{rif})......................................	Level II	General prediction
(5)	Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})......................	Level III	Detailed prediction
(6)	Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})......................	Level III	Detailed prediction
(7)	Velocity profiles / Isovels / Velocity gradient......................................	Level IV	Validation

Level I

(1)	Transverse and/or central bars-short and/or discontinuous.........................NBS = High / Very High
	Extensive deposition (continuous, cross-channel)...................................NBS = Extreme
	Chute cutoffs, down-valley meander migration, converging flow............................NBS = Extreme

Level II

(2)	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)
(3)	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)
(4)	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Dominant Near-Bank Stress
Low

Level III

(5)	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
	6.3	**4.3**	**1.47**	**Low**

(6)	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)	Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting values to a Near-Bank Stress (NBS) rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating: Low

Philadelphia Water Department

Office of Watersheds

BEHI Reaches

2L 1+22

June 4th, 2009

BEHI: Low

NBS: Very Low

Stream:	Cobbs Creek	Location:	Marshall Road
Station:	2L 1+12	Observers:	EH, RH, MM
Date:	6-4-09	Stream Type: B4c	Valley Type: V

						BEHI Score (Fig. 5-19)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	2.7	Bankfull Height (ft) =	2.7	(A) / (B) =	1	1
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	2.5	Study Bank Height (ft) =	2.7	(D) / (A) =	0.93	1.3
Weighted Root Density (G)						
		Root Density as % =	40%	(F) × (E) =	0.37	5.3
Bank Angle (H)						
				Bank Angle as *Degrees*	14	1.8
Surface Protection (I)						
				Surface Protection as % =	65%	3.2

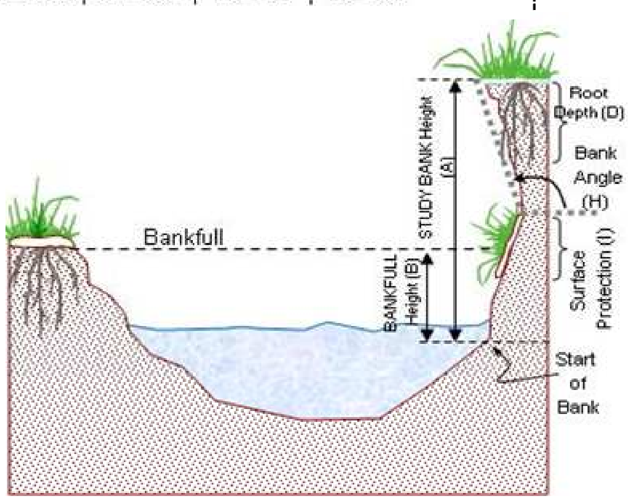
Bank Material Adjustment:

- **Bedrock** (Overall Very Low BEHI)
- **Boulders** (Overall Low BEHI)
- **Cobble** (Subtract 10 points if uniform medium to large cobble)
- **Gravel or Composite Matrix** (Add 5–10 points depending on percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt/Clay** (no adjustment)

Bank Material Adjustment	0
Stratification Adjustment	0

Very Low	Low	Moderate	High	Very High	Extreme
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50

Adjective Rating	Low
and Total Score	12.6



Estimating Near-Bank Stress (NBS)

Stream: **Cobbs Creek** Location: **Marshall Road**

Station: **2L 1+12** Stream Type: **B4c** Valley Type: **V**

Observers: **EH, RH, MM** Date: **6-4-09**

Methods for estimating Near-Bank Stress (NBS)

(1)	Channel pattern, transverse bar or split channel/central bar creating NBS..........	Level I	Reconaissance
(2)	Ratio of radius of curvature to bankfull width (R_c / W_{bkf})..	Level II	General prediction
(3)	Ratio of pool slope to average water surface slope (S_p / S)..	Level II	General prediction
(4)	Ratio of pool slope to riffle slope (S_p / S_{rif})...	Level II	General prediction
(5)	Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})......................	Level III	Detailed prediction
(6)	Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf}).........................	Level III	Detailed prediction
(7)	Velocity profiles / Isovels / Velocity gradient..	Level IV	Validation

Level I

(1)	Transverse and/or central bars-short and/or discontinuous..........................NBS = High / Very High
	Extensive deposition (continuous, cross-channel)..NBS = Extreme
	Chute cutoffs, down-valley meander migration, converging flow..........................NBS = Extreme

Level II

	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)
(2)				

	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)
(3)				

	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)
(4)				

Dominant Near-Bank Stress
Very Low

Level III

	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
(5)	**2.83**	**3.23**	**0.88**	**Very Low**

	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)
(6)								

Level IV

	Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)
(7)		

Converting values to a Near-Bank Stress (NBS) rating

Near-Bank Stress (NBS) ratings	Method number						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating **Very Low**

Marshall Road
Philadelphia Water Department
Office of Watersheds
BEHI Reaches
3R 3+02
June 4th, 2009

BEHI: Low

NBS: Low

Stream:	**Cobbs Creek**	**Location:**	**Marshall Road**
Station:	**3R 2+75**	**Observers:**	**EH, RH, MM**
Date:	**6-4-09**	**Stream Type:** **B4c**	**Valley Type:** **V**

						BEHI Score (Fig. 5-19)
Study Bank Height / Bankfull Height (C)						
Study Bank Height (ft) =	2	Bankfull Height (ft) =	2	(A) / (B) =	1	1
Root Depth / Study Bank Height (E)						
Root Depth (ft) =	1.5	Study Bank Height (ft) =	2	(D) / (A) =	0.75	2.9
Weighted Root Density (G)						
		Root Density as % =	65%	(F) × (E) =	0.49	4
Bank Angle (H)						
				Bank Angle as *Degrees*	12	1.5
Surface Protection (I)						
				Surface Protection as % =	80%	6

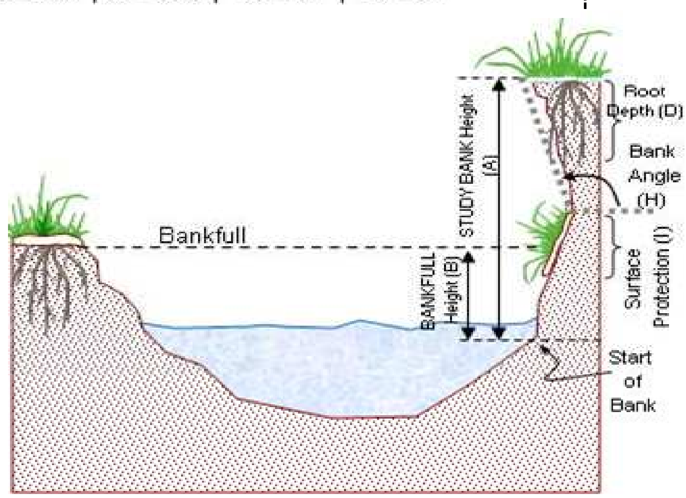
Bank Material Adjustment:

Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

Bank Material Adjustment	0
Stratification Adjustment	0

Very Low	Low	Moderate	High	Very High	Extreme
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50

Adjective Rating	Low
and Total Score	15.4



Estimating Near-Bank Stress (NBS)

Stream: **Cobbs Creek**		Location: **Marshall Road**	
Station: **3R 2+75**	Stream Type: **B4c**		Valley Type: **V**
Observers: **EH, RH, MM**			Date: **6-4-09**

Methods for estimating Near-Bank Stress (NBS)

(1)	Channel pattern, transverse bar or split channel/central bar creating NBS..........	Level I	Reconaissance
(2)	Ratio of radius of curvature to bankfull width (R_c / W_{bkf})...	Level II	General prediction
(3)	Ratio of pool slope to average water surface slope (S_p / S).....................................	Level II	General prediction
(4)	Ratio of pool slope to riffle slope (S_p / S_{rif})...	Level II	General prediction
(5)	Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})......................	Level III	Detailed prediction
(6)	Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf}).........................	Level III	Detailed prediction
(7)	Velocity profiles / Isovels / Velocity gradient..	Level IV	Validation

Level I	(1)	Transverse and/or central bars-short and/or discontinuous.........................NBS = High / Very High
		Extensive deposition (continuous, cross-channel)...NBS = Extreme
		Chute cutoffs, down-valley meander migration, converging flow..........................NBS = Extreme

Level	Method				
Level II	(2)	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)
	(3)	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)
	(4)	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)
Level III	(5)	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
		5.5	**3.7**	**1.49**	**Low**

Dominant Near-Bank Stress: **Low**

Level	Method	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)
Level III	(6)								

Level	Method	Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)
Level IV	(7)		

Converting values to a Near-Bank Stress (NBS) rating

Near-Bank Stress (NBS) ratings	Method number						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating: **Low**

Marshall Road
Philadelphia Water Department
Office of Watersheds
BEHI Reaches

3L 3+22

June 4th, 2009

BEHI: Very Low

NBS: Low

Stream:	**Cobbs Creek**	**Location:**	**Marshall Road**
Station:	**3L 3+04**	**Observers:**	**EH, RH, MM**
Date:	**6-4-09**	**Stream Type:** **B4c**	**Valley Type:** **V**

Parameter	Input 1	Value	Input 2	Value	Formula	Result	BEHI Score (Fig. 5-19)
Study Bank Height / Bankfull Height (C)	Study Bank Height (ft) =	9	Bankfull Height (ft) =	5.5	(A) / (B) =	1.64	7
Root Depth / Study Bank Height (E)	Root Depth (ft) =	3	Study Bank Height (ft) =	9	(D) / (A) =	0.33	5.5
Weighted Root Density (G)			Root Density as % =	45%	(F) × (E) =	0.15	9
Bank Angle (H)					Bank Angle as *Degrees*	30	2.6
Surface Protection (I)					Surface Protection as % =	100%	0

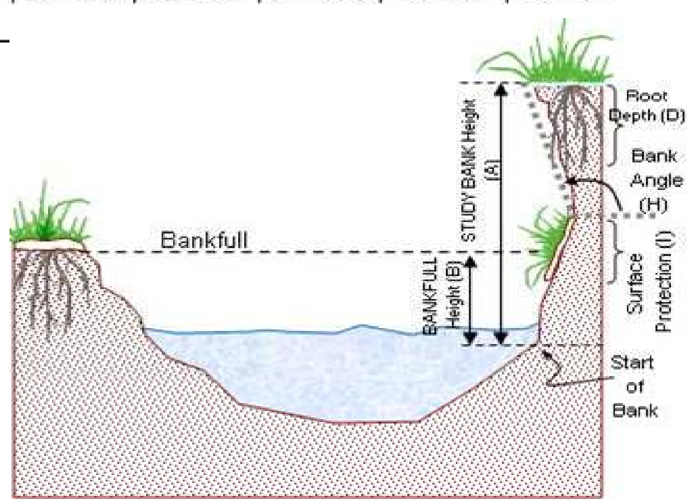
Bank Material Adjustment:

- **Bedrock** (Overall Very Low BEHI)
- **Boulders** (Overall Low BEHI)
- **Cobble** (Subtract 10 points if uniform medium to large cobble)
- **Gravel or Composite Matrix** (Add 5–10 points depending on percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt/Clay** (no adjustment)

Bank Material Adjustment	**Boulder**
Stratification Adjustment	**0**

Very Low	Low	Moderate	High	Very High	Extreme
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50

Adjective Rating and	**Very Low**
Total Score	**24.1**



Estimating Near-Bank Stress (NBS)

Stream: **Cobbs Creek**		Location: **Marshall Road**	
Station: **3L 3+04**	Stream Type: **B4c**		Valley Type: **V**
Observers: **EH, RH, MM**			Date: **6-4-09**

Methods for estimating Near-Bank Stress (NBS)

(1)	Channel pattern, transverse bar or split channel/central bar creating NBS..........	Level I	Reconaissance
(2)	Ratio of radius of curvature to bankfull width (R_c / W_{bkf})..	Level II	General prediction
(3)	Ratio of pool slope to average water surface slope (S_p / S)..	Level II	General prediction
(4)	Ratio of pool slope to riffle slope (S_p / S_{rif})..	Level II	General prediction
(5)	Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})........................	Level III	Detailed prediction
(6)	Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})........................	Level III	Detailed prediction
(7)	Velocity profiles / Isovels / Velocity gradient..	Level IV	Validation

Level I

(1)	Transverse and/or central bars-short and/or discontinuous.......................NBS = High / Very High Extensive deposition (continuous, cross-channel)...............................NBS = Extreme Chute cutoffs, down-valley meander migration, converging flow.......................NBS = Extreme

Level II

(2)	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)
(3)	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)
(4)	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Dominant Near-Bank Stress
Low

Level III

(5)	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
	5.5	**3.7**	**1.49**	**Low**

(6)	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)	Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting values to a Near-Bank Stress (NBS) rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating: Low

Marshall Road
Philadelphia Water Department
Office of Watersheds
BEHI Reaches

4R 5+62

June 4th, 2009

BEHI: Very Low

NBS: Low

Stream:	Cobbs Creek	**Location:**	Marshall Road
Station:	4R 5+33	**Observers:**	EH, RH, MM
Date:	6-4-09	**Stream Type:** B4c	**Valley Type:** V

Study Bank Height / Bankfull Height (C)

Study Bank Height (ft) =	7	Bankfull Height (ft) =	4.9	(A) / (B) =	1.43	BEHI Score (Fig. 5-19): 5

Root Depth / Study Bank Height (E)

Root Depth (ft) =	2	Study Bank Height (ft) =	7	(D) / (A) =	0.29	6

Weighted Root Density (G)

Root Density as % =	50%	(F) x (E) =	0.14	9.2

Bank Angle (H)

Bank Angle as *Degrees*	46	3.2

Surface Protection (I)

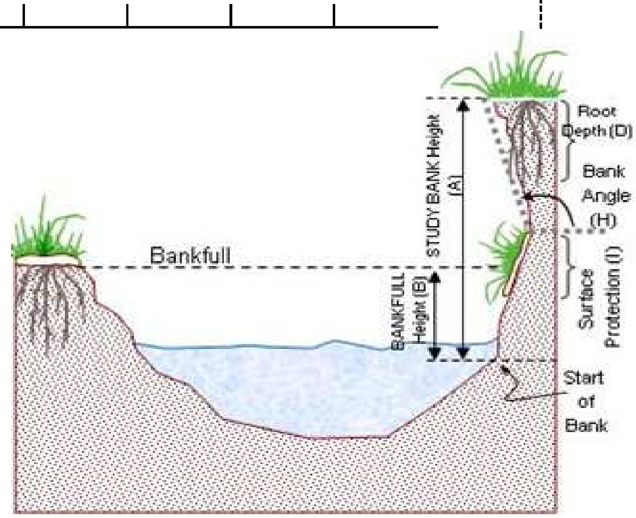
Surface Protection as % =	100%	0

Bank Material Adjustment:
- **Bedrock** (Overall Very Low BEHI)
- **Boulders** (Overall Low BEHI)
- **Cobble** (Subtract 10 points if uniform medium to large cobble)
- **Gravel or Composite Matrix** (Add 5–10 points depending on percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt/Clay** (no adjustment)

Bank Material Adjustment	Boulder
Stratification Adjustment	0

Very Low	Low	Moderate	High	Very High	Extreme
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50

Adjective Rating	Very Low
and Total Score	23.4



Estimating Near-Bank Stress (NBS)

Stream: **Cobbs Creek**		Location: **Marshall Road**	
Station: **4R 5+33**		Stream Type: **B4c**	Valley Type: **V**
Observers: **EH, RH, MM**			Date: **6-4-09**

Methods for estimating Near-Bank Stress (NBS)

(1)	Channel pattern, transverse bar or split channel/central bar creating NBS..........	Level I	Reconaissance
(2)	Ratio of radius of curvature to bankfull width (R_c / W_{bkf})..	Level II	General prediction
(3)	Ratio of pool slope to average water surface slope (S_p / S)..	Level II	General prediction
(4)	Ratio of pool slope to riffle slope (S_p / S_{rif})..	Level II	General prediction
(5)	Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})......................	Level III	Detailed prediction
(6)	Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})........................	Level III	Detailed prediction
(7)	Velocity profiles / Isovels / Velocity gradient..	Level IV	Validation

Level I

(1)	Transverse and/or central bars-short and/or discontinuous..........................NBS = High / Very High
	Extensive deposition (continuous, cross-channel)..NBS = Extreme
	Chute cutoffs, down-valley meander migration, converging flow..........................NBS = Extreme

Level II

	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)
(2)				

	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)
(3)				

	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)
(4)				

Dominant Near-Bank Stress
Low

Level III

	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
(5)	**4.9**	**3.9**	**1.26**	**Low**

	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)
(6)								

Level IV

	Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)
(7)		

Converting values to a Near-Bank Stress (NBS) rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating: Low

Philadelphia Water Department
Office of Watersheds
BEHI Reaches
4L 5+50
June 4th, 2009

BEHI: Low

NBS: Moderate

Stream:	Cobbs Creek	Location:	Marshall Road
Station:	4L 5+27	Observers:	EH, RH, MM
Date:	6-4-09	Stream Type: B4c	Valley Type: V

BEHI Score (Fig. 5-19)

Study Bank Height / Bankfull Height (C)

Study Bank Height (ft) =	3.5	Bankfull Height (ft) =	3.5	(A) / (B) =	1	1

Root Depth / Study Bank Height (E)

Root Depth (ft) =	1.5	Study Bank Height (ft) =	3.5	(D) / (A) =	0.43	3.7

Weighted Root Density (G)

Root Density as % =	35%	(F) × (E) =	0.15	9

Bank Angle (H)

Bank Angle as *Degrees*	37	2.7

Surface Protection (I)

Surface Protection as % =	75%	2.6

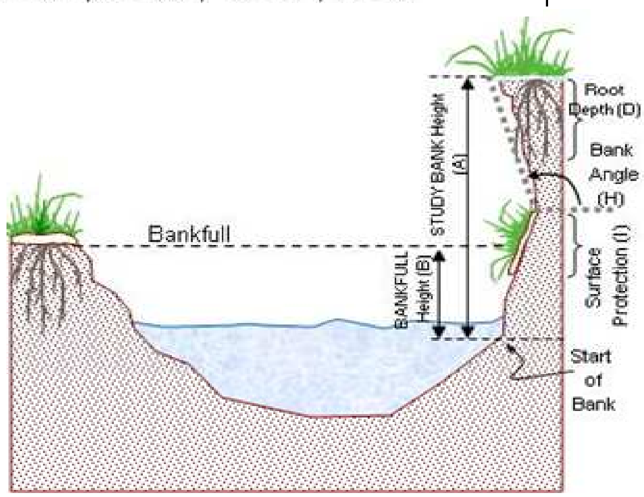
Bank Material Adjustment:

Bedrock (Overall Very Low BEHI)
Boulders (Overall Low BEHI)
Cobble (Subtract 10 points if uniform medium to large cobble)
Gravel or Composite Matrix (Add 5–10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt/Clay (no adjustment)

Bank Material Adjustment	0
Stratification Adjustment	0

Very Low	Low	Moderate	High	Very High	Extreme
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50

Adjective Rating	Low
and Total Score	19.0



Estimating Near-Bank Stress (NBS)

Stream: **Cobbs Creek**		Location: **Marshall Road**	
Station: **4L 5+27**		Stream Type: **B4c**	Valley Type: **V**
Observers: **EH, RH, MM**			Date: **6-4-09**

Methods for estimating Near-Bank Stress (NBS)

(1)	Channel pattern, transverse bar or split channel/central bar creating NBS..........	Level I	Reconaissance
(2)	Ratio of radius of curvature to bankfull width (R_c / W_{bkf})...	Level II	General prediction
(3)	Ratio of pool slope to average water surface slope (S_p / S)......................................	Level II	General prediction
(4)	Ratio of pool slope to riffle slope (S_p / S_{rif})...	Level II	General prediction
(5)	Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf}).....................	Level III	Detailed prediction
(6)	Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf}).........................	Level III	Detailed prediction
(7)	Velocity profiles / Isovels / Velocity gradient...	Level IV	Validation

Level I

(1)	Transverse and/or central bars-short and/or discontinuous..........................NBS = High / Very High
	Extensive deposition (continuous, cross-channel)......................................NBS = Extreme
	Chute cutoffs, down-valley meander migration, converging flow..........................NBS = Extreme

Level II

(2)	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)
(3)	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)
(4)	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Dominant Near-Bank Stress
Moderate

Level III

(5)	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
	6.1	**4**	**1.53**	**Moderate**

(6)	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)	Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting values to a Near-Bank Stress (NBS) rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating: Moderate

Philadelphia Water Department
Office of Watersheds
BEHI Reaches

5R 7+51

June 4th, 2009

BEHI: Very Low

NBS: Low

Stream:	**Cobbs Creek**		**Location:**	**Marshall Road**	
Station:	**5R 6+91**		**Observers:**	**EH, RH, MM**	
Date:	**6-4-09**	**Stream Type: B4c**	**Valley Type:**	**V**	

BEHI Score (Fig. 5-19)

Study Bank Height / Bankfull Height (C)

Study Bank Height (ft) =	3.6	Bankfull Height (ft) =	3.6	(A) / (B) =	1	1

Root Depth / Study Bank Height (E)

Root Depth (ft) =	3	Study Bank Height (ft) =	3.6	(D) / (A) =	0.83	2.2

Weighted Root Density (G)

Root Density as % =	85%	(F) × (E) =	0.71	2.7

Bank Angle (H)

Bank Angle as *Degrees*	15	1.8

Surface Protection (I)

Surface Protection as % =	90%	1

Bank Material Adjustment:

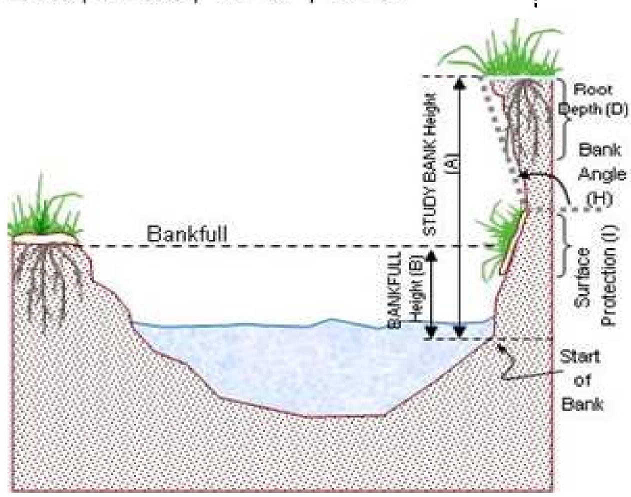
- **Bedrock** (Overall Very Low BEHI)
- **Boulders** (Overall Low BEHI)
- **Cobble** (Subtract 10 points if uniform medium to large cobble)
- **Gravel or Composite Matrix** (Add 5–10 points depending on percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt/Clay** (no adjustment)

Bank Material Adjustment: 0

Stratification Adjustment: 0

Very Low	Low	Moderate	High	Very High	Extreme
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50

Adjective Rating and Total Score: Very Low — 8.7



Estimating Near-Bank Stress (NBS)

Stream: **Cobbs Creek** Location: **Marshall Road**

Station: **5R 6+91** Stream Type: **B4c** Valley Type: **V**

Observers: **EH, RH, MM** Date: **6-4-09**

Methods for estimating Near-Bank Stress (NBS)

(1)	Channel pattern, transverse bar or split channel/central bar creating NBS..........	Level I	Reconaissance
(2)	Ratio of radius of curvature to bankfull width (R_c / W_{bkf})..	Level II	General prediction
(3)	Ratio of pool slope to average water surface slope (S_p / S)......................................	Level II	General prediction
(4)	Ratio of pool slope to riffle slope (S_p / S_{rif})...	Level II	General prediction
(5)	Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf})......................	Level III	Detailed prediction
(6)	Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})........................	Level III	Detailed prediction
(7)	Velocity profiles / Isovels / Velocity gradient..	Level IV	Validation

Level I

(1)
- Transverse and/or central bars-short and/or discontinuous..........................NBS = High / Very High
- Extensive deposition (continuous, cross-channel)......................................NBS = Extreme
- Chute cutoffs, down-valley meander migration, converging flow.............................NBS = Extreme

Level II

(2)	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)

(3)	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)

(4)	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)

Dominant Near-Bank Stress
Low

Level III

(5)	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
	3.5	**3.2**	**1.1**	**Low**

(6)	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)

Level IV

(7)	Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)

Converting values to a Near-Bank Stress (NBS) rating

Near-Bank Stress (NBS) ratings	Method number (1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating **Low**

Philadelphia Water Department
Office of Watersheds
BEHI Reaches

5L 7+51

June 4th, 2009

BEHI: Very Low

NBS: Low

Stream:	Cobbs Creek		Location:	Marshall Road
Station:	5L 6+99		Observers:	EH, RH, MM
Date:	6-4-09	Stream Type: B4c	Valley Type:	V

BEHI Score (Fig. 5-19)

Study Bank Height / Bankfull Height (C)

Study Bank Height (ft) =	5	Bankfull Height (ft) =	3.9	(A) / (B) =	1.28	5.2

Root Depth / Study Bank Height (E)

Root Depth (ft) =	3	Study Bank Height (ft) =	5	(D) / (A) =	0.6	3.5

Weighted Root Density (G)

Root Density as % =	50%	(F) × (E) =	0.3	5.5

Bank Angle (H)

Bank Angle as Degrees	48	3.8

Surface Protection (I)

Surface Protection as % =	90%	1

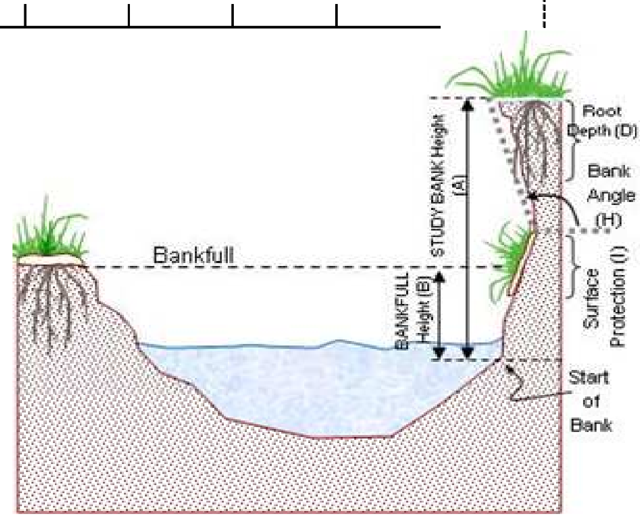
Bank Material Adjustment:

- **Bedrock** (Overall Very Low BEHI)
- **Boulders** (Overall Low BEHI)
- **Cobble** (Subtract 10 points if uniform medium to large cobble)
- **Gravel or Composite Matrix** (Add 5–10 points depending on percentage of bank material that is composed of sand)
- **Sand** (Add 10 points)
- **Silt/Clay** (no adjustment)

Bank Material Adjustment	Boulder
Stratification Adjustment	0

Very Low	Low	Moderate	High	Very High	Extreme
5 – 9.5	10 – 19.5	20 – 29.5	30 – 39.5	40 – 45	46 – 50

Adjective Rating and Total Score	Very Low	19



Estimating Near-Bank Stress (NBS)

Stream: **Cobbs Creek**	Location: **Marshall Road**		
Station: **5L 6+99**	Stream Type: **B4c**	Valley Type: **V**	
Observers: **EH, RH, MM**		Date: **6-4-09**	

Methods for estimating Near-Bank Stress (NBS)

(1)	Channel pattern, transverse bar or split channel/central bar creating NBS..........	Level I	Reconaissance
(2)	Ratio of radius of curvature to bankfull width (R_c / W_{bkf})..	Level II	General prediction
(3)	Ratio of pool slope to average water surface slope (S_p / S)..	Level II	General prediction
(4)	Ratio of pool slope to riffle slope (S_p / S_{rif})..	Level II	General prediction
(5)	Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkf}).....................	Level III	Detailed prediction
(6)	Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkf})........................	Level III	Detailed prediction
(7)	Velocity profiles / Isovels / Velocity gradient..	Level IV	Validation

Level I

(1)	Transverse and/or central bars-short and/or discontinuous..........................NBS = High / Very High
	Extensive deposition (continuous, cross-channel)...NBS = Extreme
	Chute cutoffs, down-valley meander migration, converging flow...........................NBS = Extreme

Level II

	Radius of Curvature R_c (ft)	Bankfull Width W_{bkf} (ft)	*Ratio* R_c / W_{bkf}	Near-Bank Stress (NBS)
(2)				

	Pool Slope S_p	Average Slope S	*Ratio* S_p / S	Near-Bank Stress (NBS)
(3)				

	Pool Slope S_p	Riffle Slope S_{rif}	*Ratio* S_p / S_{rif}	Near-Bank Stress (NBS)
(4)				

Dominant Near-Bank Stress
Low

Level III

	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkf} (ft)	*Ratio* d_{nb} / d_{bkf}	Near-Bank Stress (NBS)
(5)	**5**	**4.3**	**1.16**	**Low**

	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft^2)	Mean Depth d_{bkf} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkf} (lb/ft^2)	Ratio τ_{nb} / τ_{bkf}	Near-Bank Stress (NBS)
(6)								

Level IV

	Velocity Gradient (ft / sec / ft)	Near-Bank Stress (NBS)
(7)		

Converting values to a Near-Bank Stress (NBS) rating

Near-Bank Stress (NBS) ratings	Method number						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60
High	See	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40

Overall Near-Bank Stress (NBS) rating | **Low**

Appendix D - Bank Pin Data

Marshall Road
Philadelphia Water Department
Office of Watersheds
Bank Pin Locations

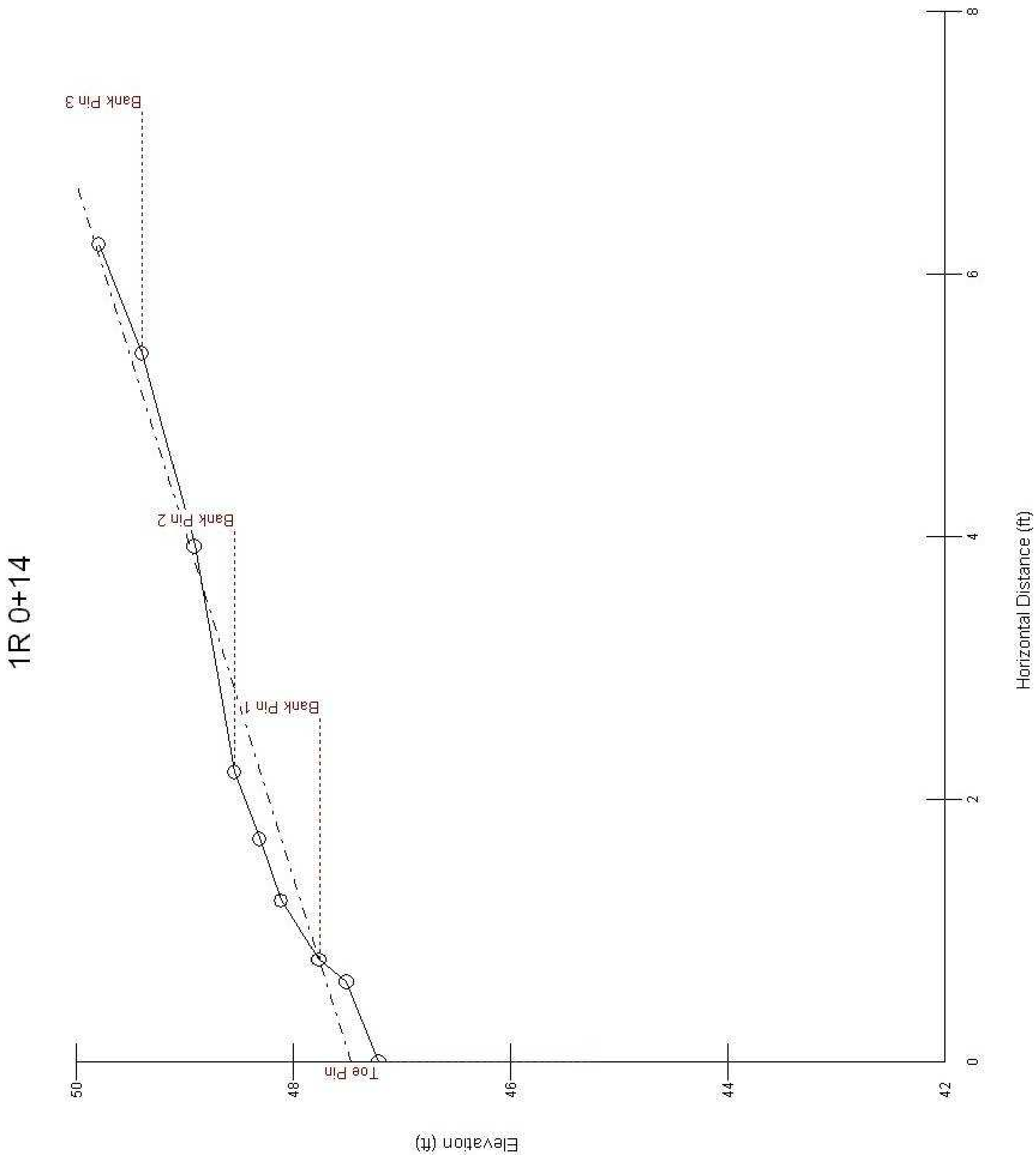
1R 0+14

June 4th, 2009

Bank Pin Site

Upstream

Downstream


1R 0+14
Elevation (ft)
Horizontal Distance (ft)
Toe Pin
Bank Pin 1
Bank Pin 2
Bank Pin 3
50
48
46
44
42
0
2
4
6
8

Marshall Road

Philadelphia Water Department

Office of Watersheds

Bank Pin Locations

1L 1+09

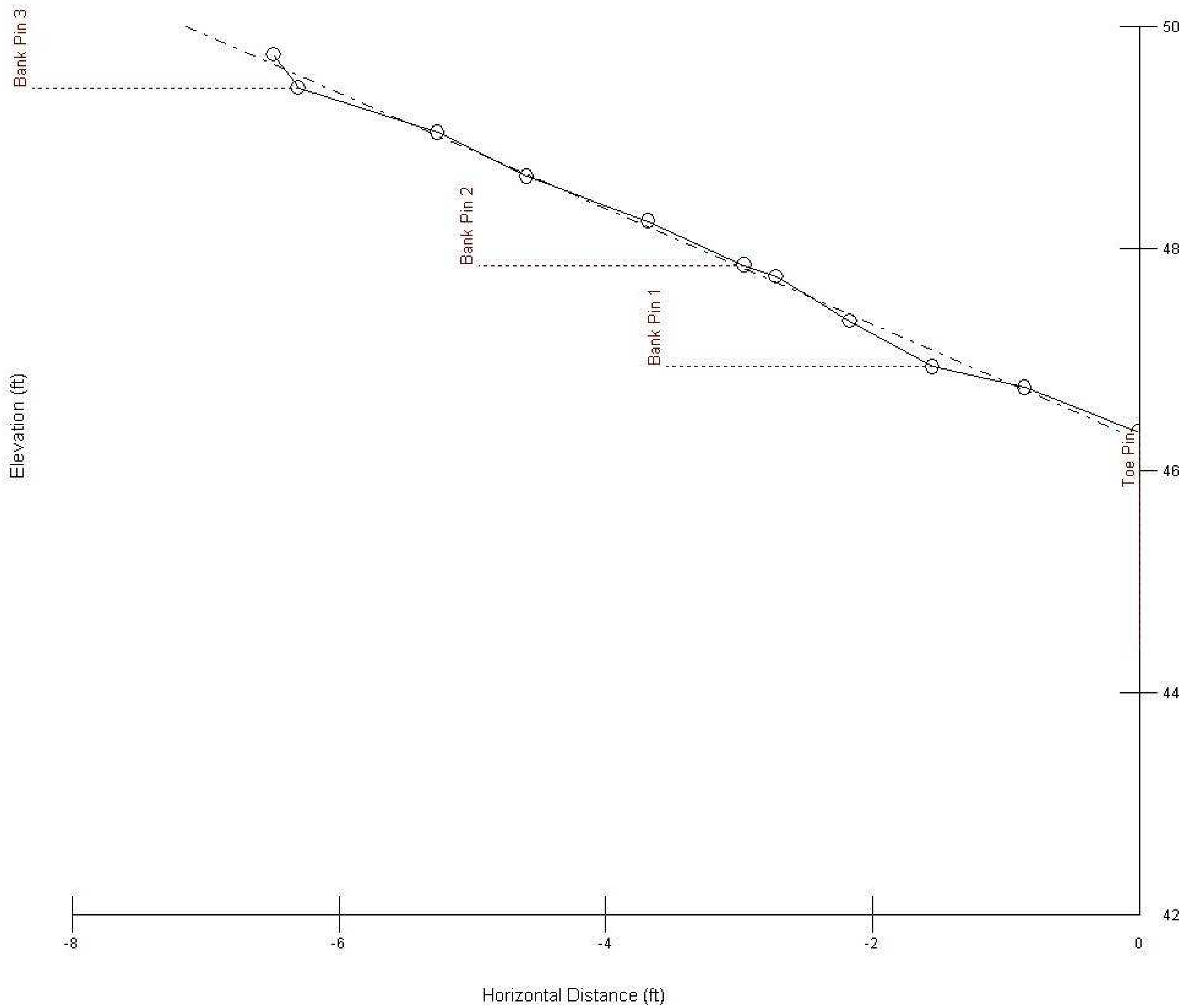
June 4th, 2009

Bank Pin Site

Upstream

Downstream

1L 1+09

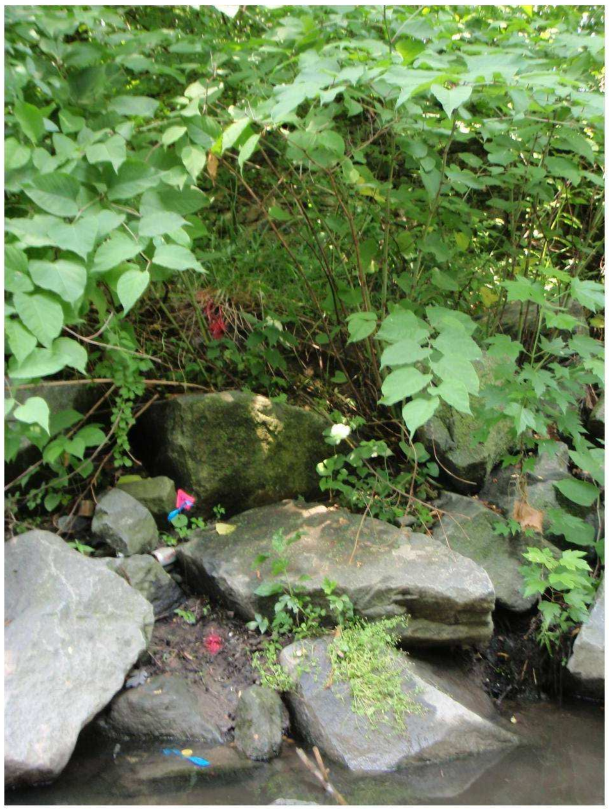


Bank Pin 3
Bank Pin 2
Bank Pin 1
Toe Pin
Elevation (ft)
50
48
46
44
42
-8
-6
-4
-2
0
Horizontal Distance (ft)

Marshall Road
Philadelphia Water Department
Office of Watersheds
Bank Pin Locations

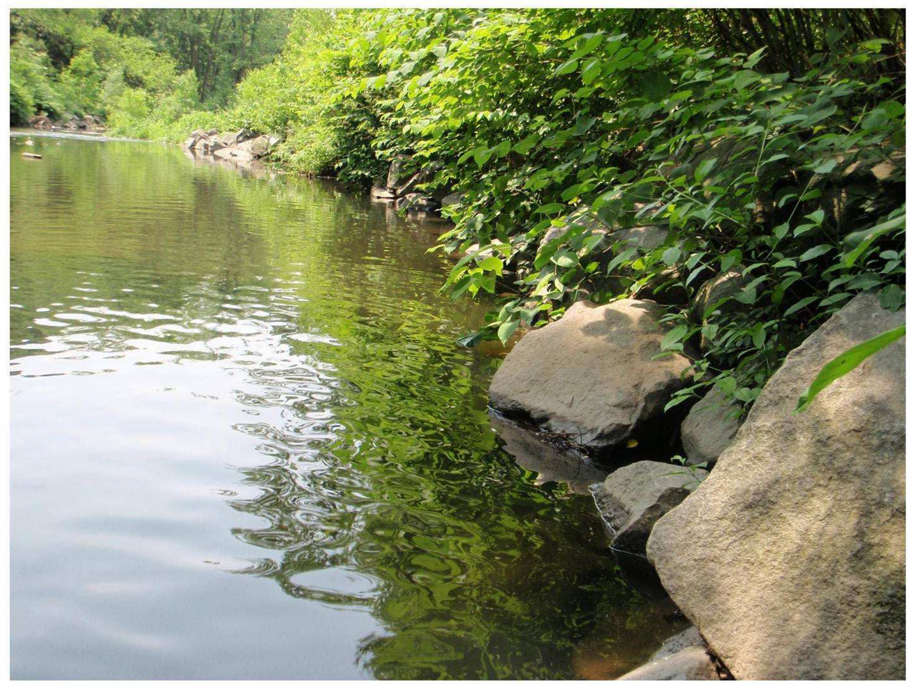
2R 1+58

June 4th, 2009



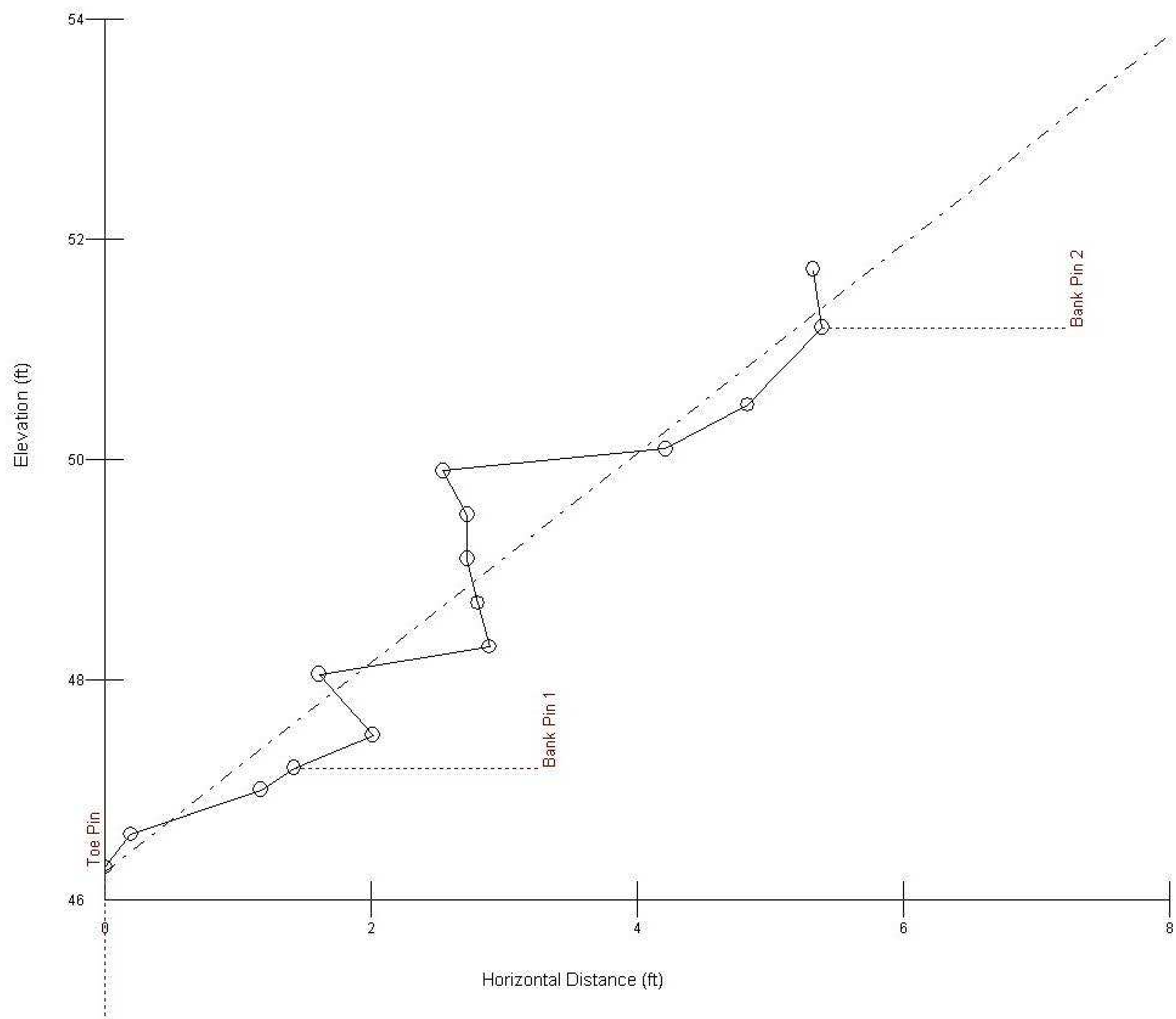
Bank Pin Site

Upstream



Downstream

2R 1+58



Elevation (ft)
54
52
50
48
46
Toe Pin
Bank Pin 1
Bank Pin 2
0
2
4
6
8
Horizontal Distance (ft)

Marshall Road
Philadelphia Water Department
Office of Watersheds
Bank Pin Locations

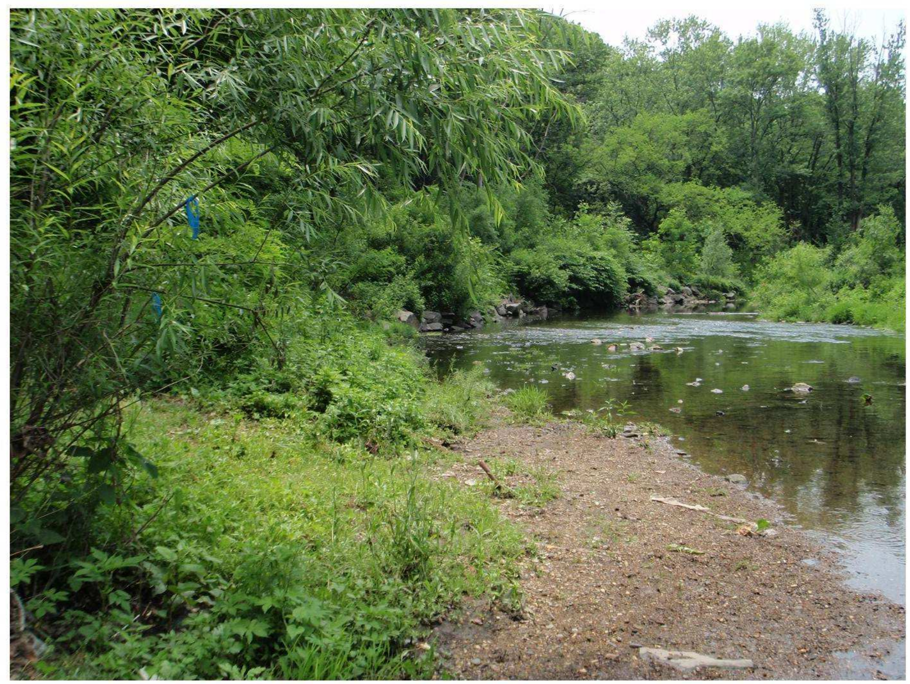
2L 2+41

June 4th, 2009

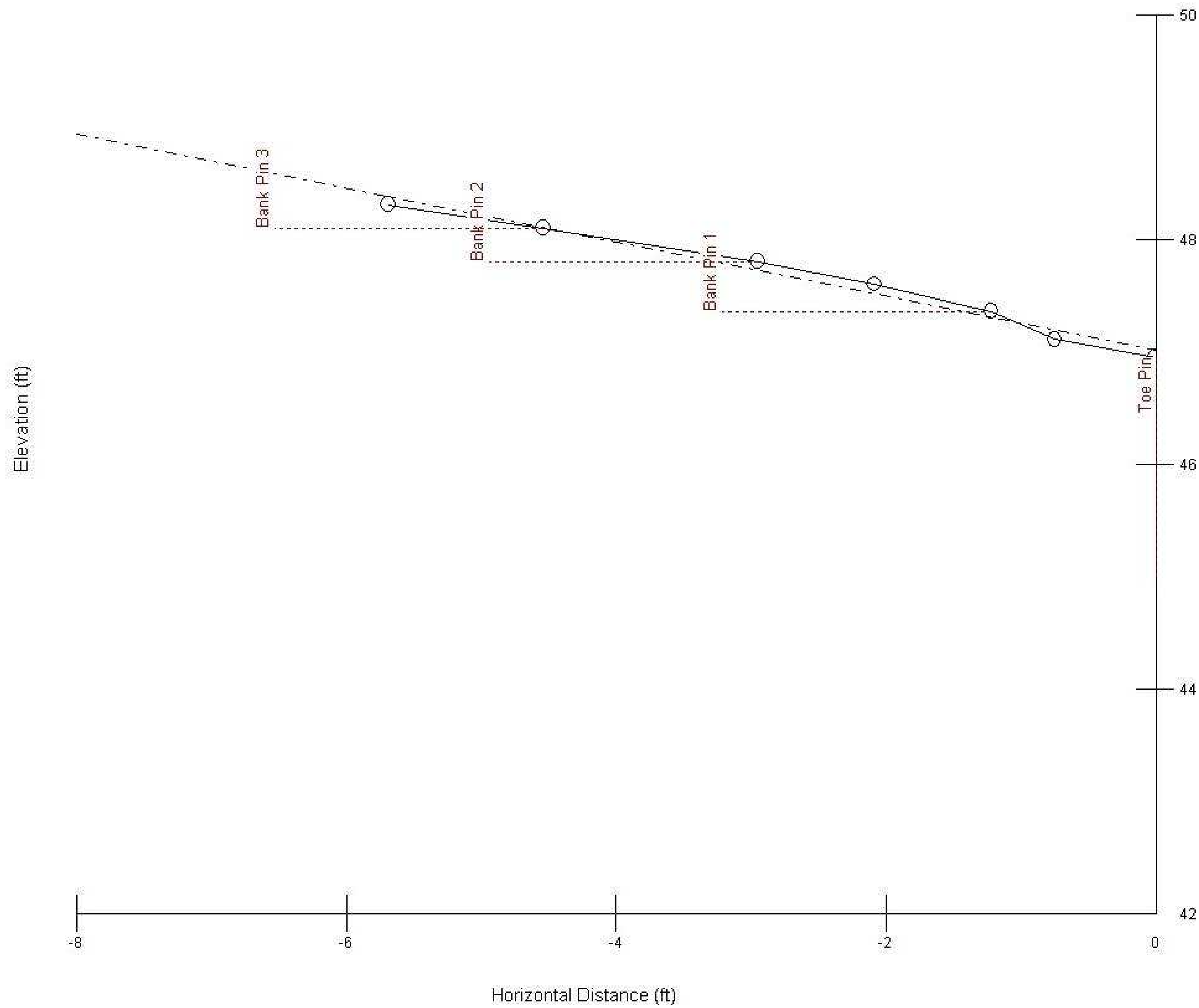
Bank Pin Site

Upstream

Downstream



2L 2+41



50
48
46
44
42
Bank Pin 3
Bank Pin 2
Bank Pin 1
Toe Pin
Elevation (ft)
-8
-6
-4
-2
0
Horizontal Distance (ft)

Marshall Road
Philadelphia Water Department
Office of Watersheds
Bank Pin Locations

3R 3+93

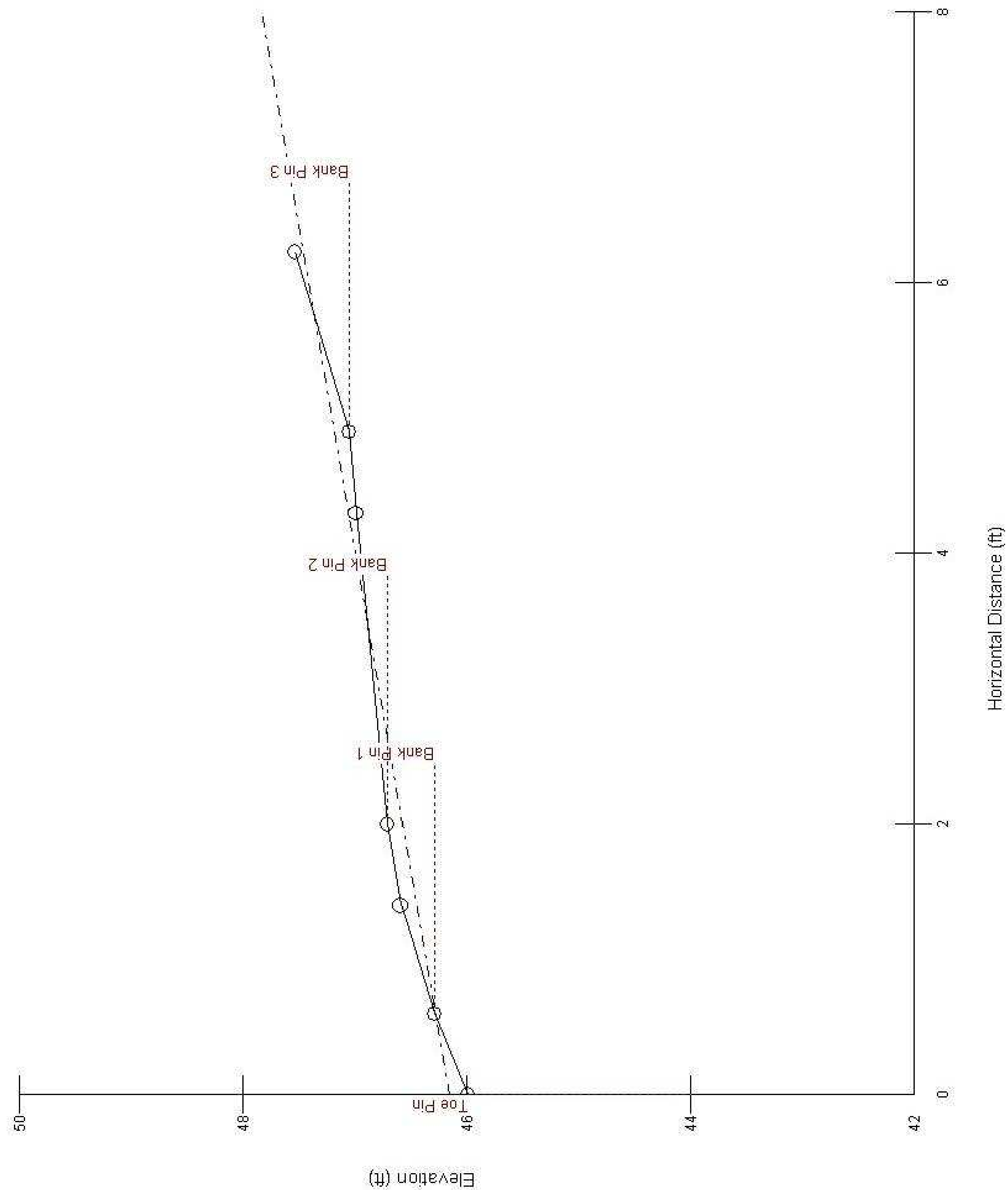
June 4th, 2009

Bank Pin Site

Upstream

Downstream

3R 4+50

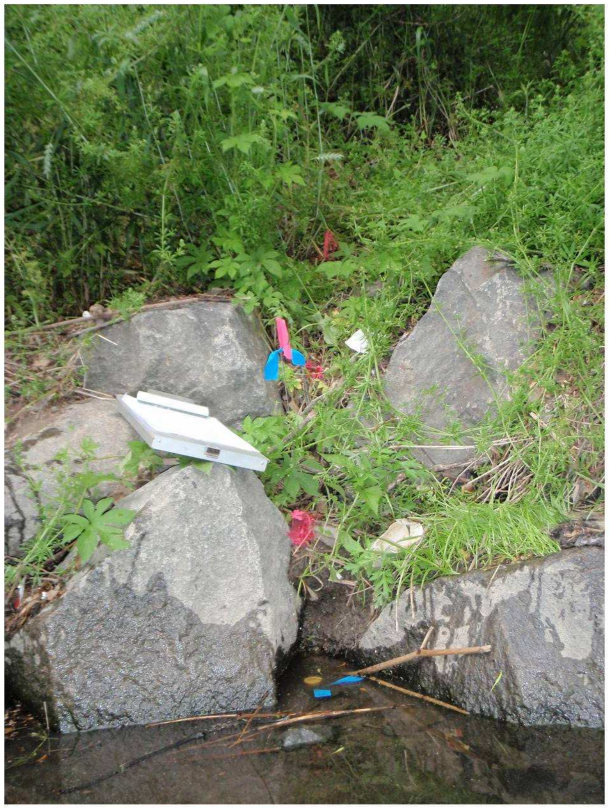


Bank Pin 3
Bank Pin 2
Bank Pin 1
Toe Pin
Elevation (ft)
Horizontal Distance (ft)
50
48
46
44
42
0
2
4
6
8

Marshall Road
Philadelphia Water Department
Office of Watersheds
Bank Pin Locations

3L 3+93

June 4th, 2009

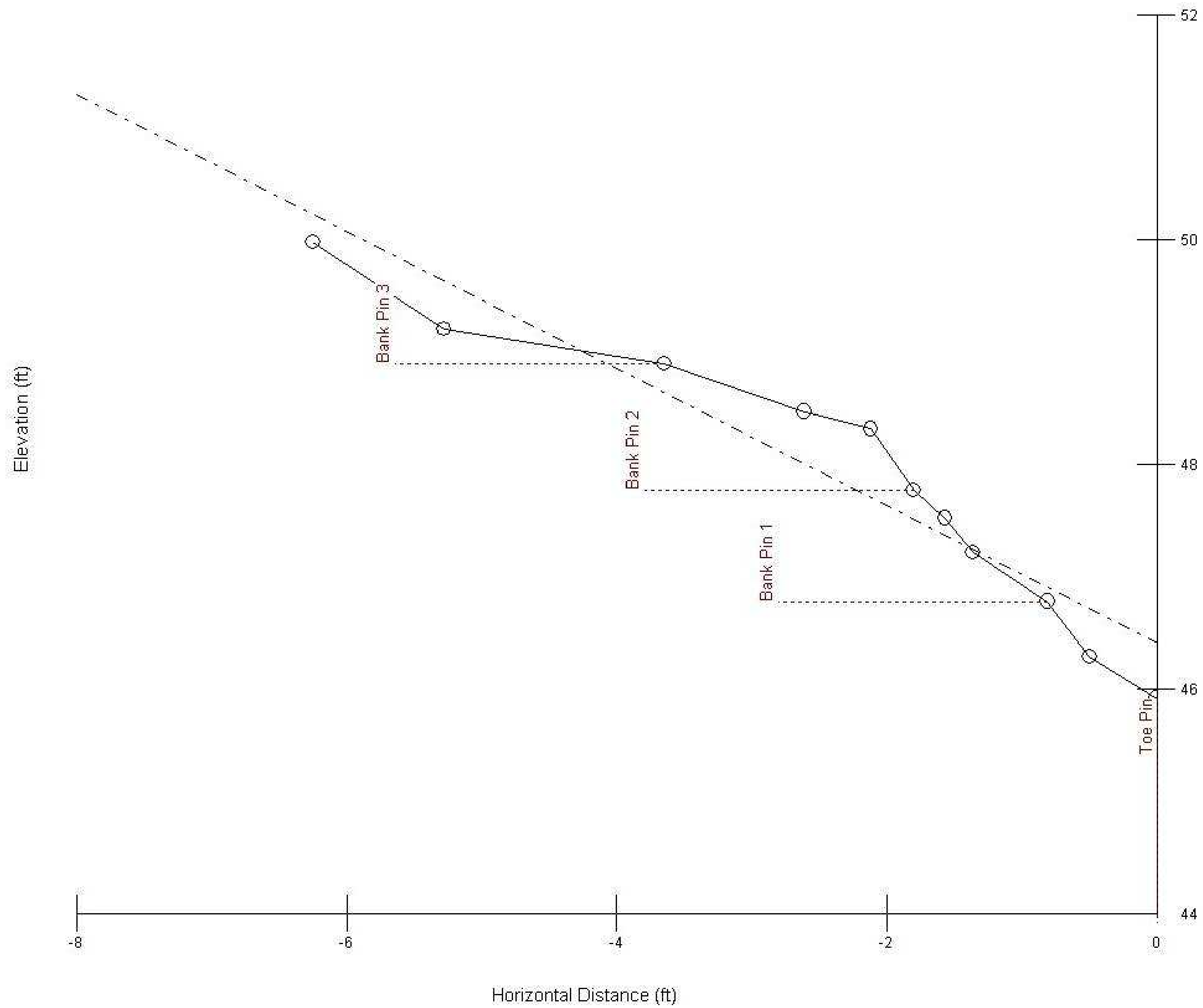


Bank Pin Site

Upstream

Downstream

3L 3+93



52
50
48
46
44
Elevation (ft)
Bank Pin 3
Bank Pin 2
Bank Pin 1
Toe Pin
-8
-6
-4
-2
0
Horizontal Distance (ft)

Marshall Road

Philadelphia Water Department

Office of Watersheds

Bank Pin Locations

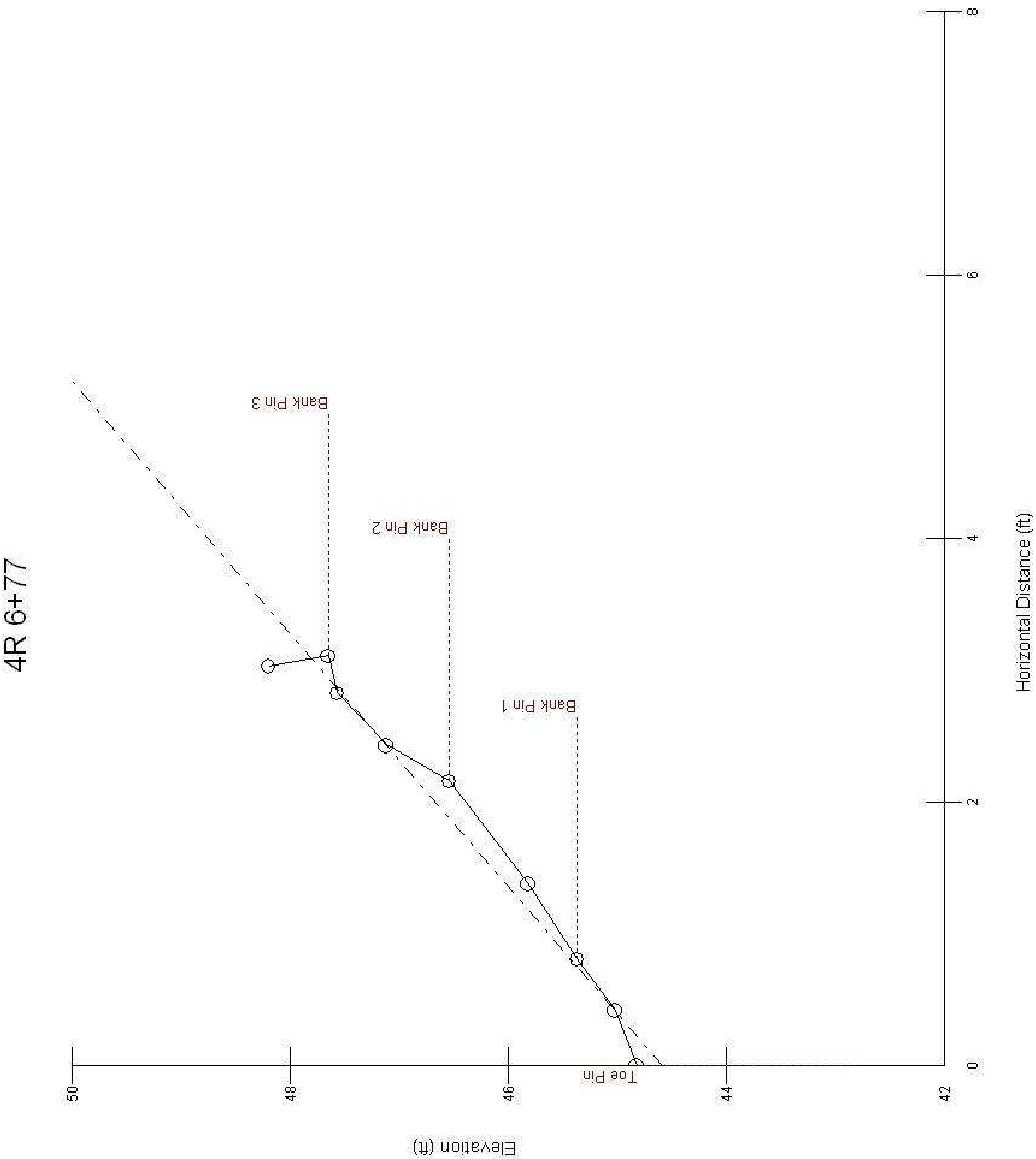
4R 6+77

June 4th, 2009

Bank Pin Site

Upstream

Downstream



4R 6+77
Bank Pin 3
Bank Pin 2
Bank Pin 1
Toe Pin
Elevation (ft)
42
44
46
48
50
Horizontal Distance (ft)
0
2
4
6
8

Marshall Road
Philadelphia Water Department
Office of Watersheds
Bank Pin Locations

4L 5+62

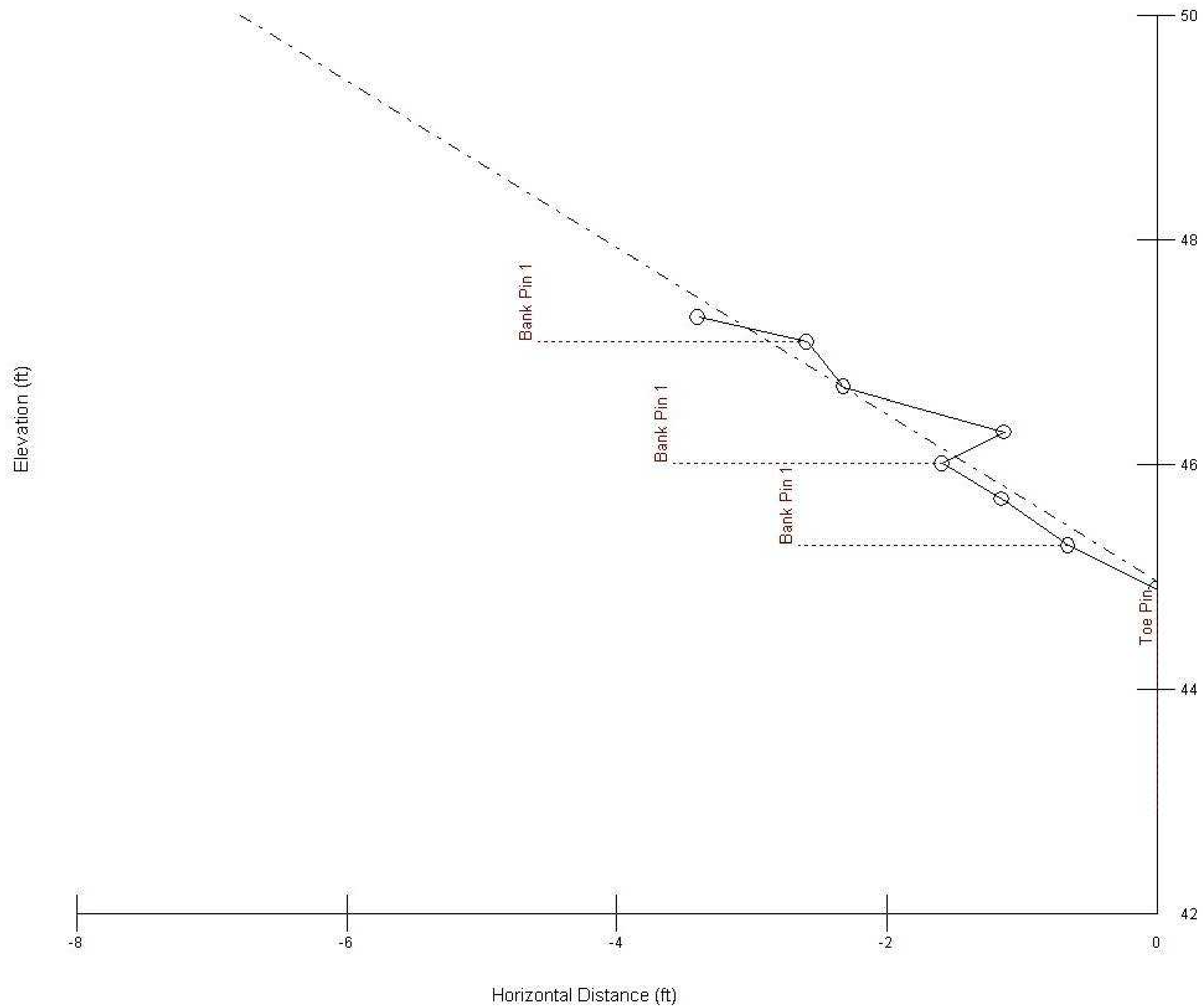
June 4th, 2009

Bank Pin Site

Upstream

Downstream

4L 5+62



Elevation (ft)
Horizontal Distance (ft)
Bank Pin 1
Bank Pin 1
Bank Pin 1
Toe Pin
50
48
46
44
42
-8
-6
-4
-2
0

Marshall Road
Philadelphia Water Department
Office of Watersheds
Bank Pin Locations

5R 8+30

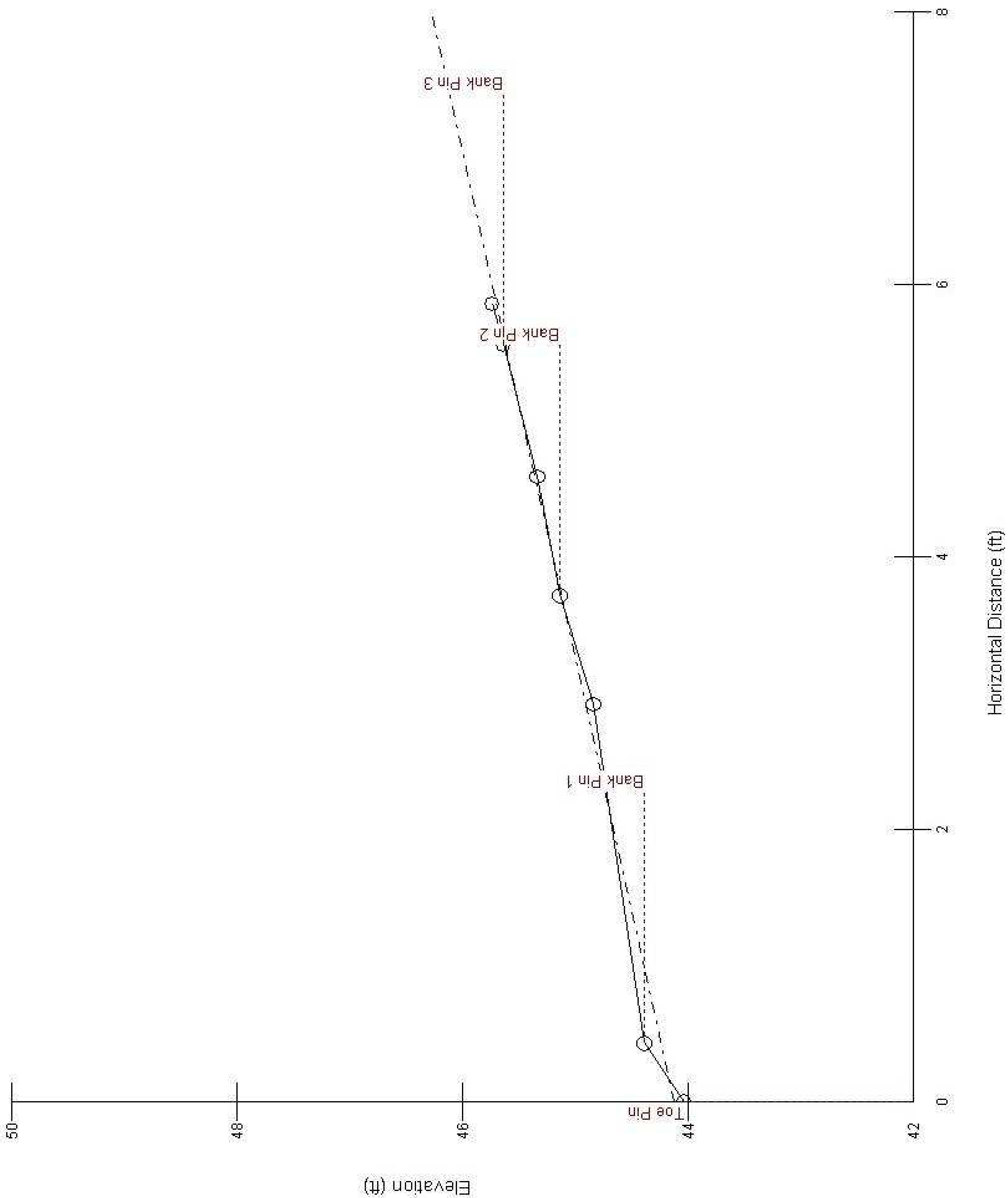
June 4th, 2009

Bank Pin Site

Upstream

Downstream

5R 8+30



Elevation (ft)
Horizontal Distance (ft)
50
48
46
44
42
0
2
4
6
8
Toe Pin
Bank Pin 1
Bank Pin 2
Bank Pin 3

Marshall Road
Philadelphia Water Department
Office of Watersheds
Bank Pin Locations

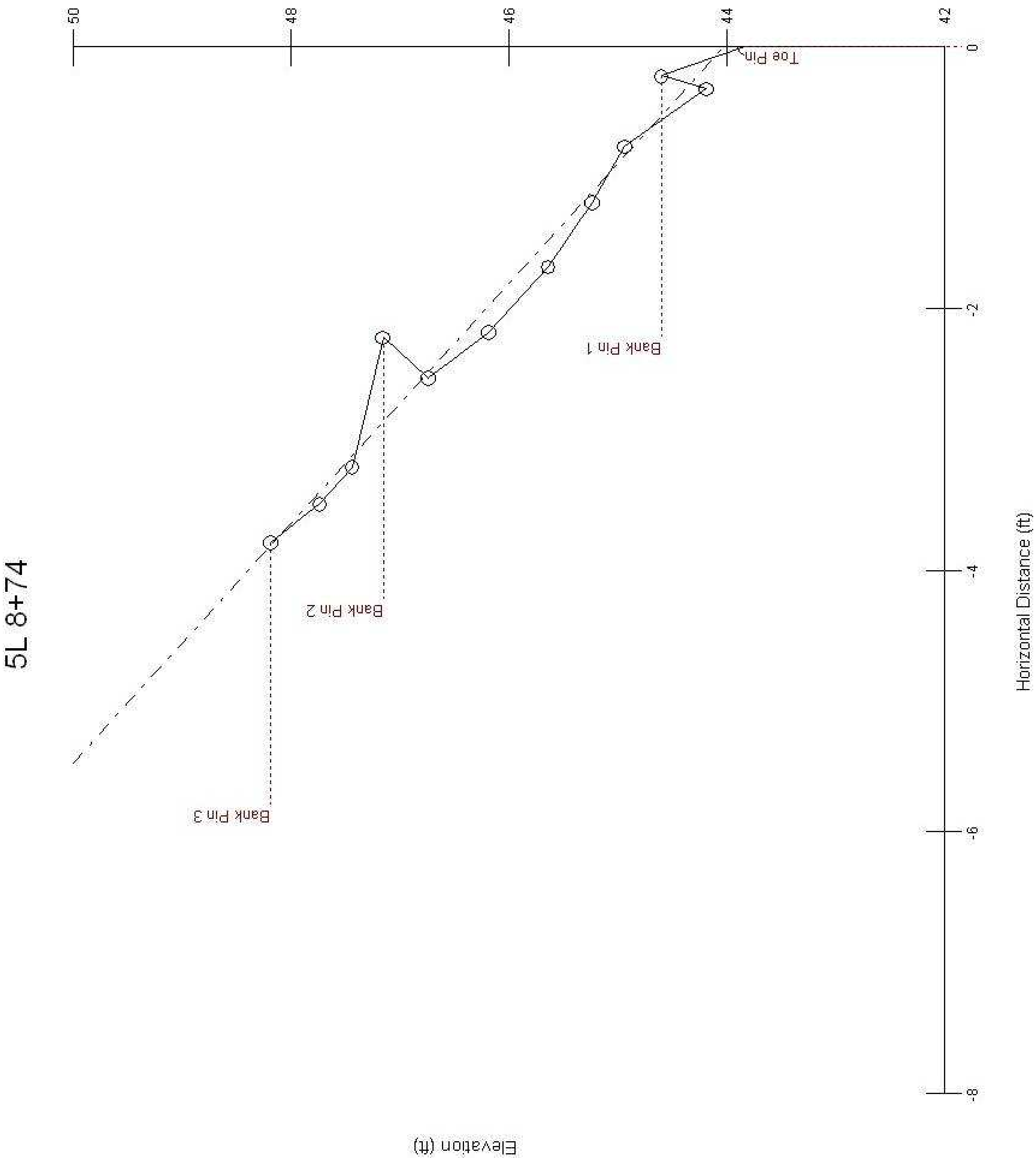
5L 8+30

June 4th, 2009

Bank Pin Site

Upstream

Downstream


5L 8+74
Elevation (ft)
Horizontal Distance (ft)
50
48
46
44
42
0
-2
-4
-6
-8
Toe Pin
Bank Pin 1
Bank Pin 2
Bank Pin 3

Appendix E – Stream Stability Data

Point / Side BAR-BULK MATERIALS SAMPLE DATA: Size Distribution Analysis — Observers: RH, EH, MM, GB

Stream: Cobbs Creek — Location: Marshall Road-Bar Sample Composite — Date: 6-04-09

	0 ↔ 2		2 ↔ 4		4 ↔ 8		8 ↔ 16		16 ↔ 32		32 ↔ 64		64 ↔ 128		128 ↔ 256		256 ↔ 512	
	Catch Pan or BUCKET		Sieve SIZE		Sieve SIZE		Sieve SIZE		Sieve SIZE		Sieve SIZE mm		Sieve SIZE mm		Sieve SIZE mm		Sieve SIZE	
	Tare weight 1.25		Tare weight 0.458		Tare weight 0.494		Tare weight 0.510		Tare weight 0.530		Tare weight 0.552		Tare weight 0.547		Tare weight ------------		Tare weight ------------	
	Sample weights		Sample weights		Sample weights		Sample weights		Sample weights		Sample weights		Sample weights		Sample weights		Sample weights	
	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net	Total	Net
1	1.966	0.716	0.65	0.192	0.752	0.258	0.94	0.43	1.05	0.52	2.248	1.696	2.12	1.573			4.16	4.16
2	1.67	0.42	0.822	0.364	0.924	0.43	1.286	0.776	1.906	1.376	1.83	1.278	1.066	0.519				
3	2.012	0.762	0.724	0.266	0.826	0.332	1.01	0.5	1.042	0.512	0.906	0.354	1.366	0.819				
4	2.17	0.92	0.916	0.458	1.058	0.564	1.404	0.894	1.164	0.634	1.862	1.31	2.104	1.557				
5	2.352	1.102	0.676	0.218	0.74	0.246	0.862	0.352	1.46	0.93	2.116	1.564						
6	2.068	0.818	0.8	0.342	0.92	0.426	1.178	0.668	1.6	1.07	1.28	0.728						
7	2.458	1.208	1.102	0.644	1.058	0.564	1.204	0.694	1.288	0.758	3.92	3.368						
8	2.154	0.904	0.8	0.342	0.834	0.34	0.926	0.416	1.324	0.794	2.286	1.734						
9	1.786	0.536	0.944	0.486	1.012	0.518	1.248	0.738	1.436	0.906	0.606	0.054						
10	1.994	0.744	1.082	0.624	1.058	0.564	1.054	0.544	0.9	0.37	0.63	0.078						
11	2.22	0.97																
12																		
13																		
14																		
15																		
Net wt. total		9.1		3.936		4.242		6.012		7.87		12.164		4.468		0		4.16
% Grand total		17.52%		7.58%		8.17%		11.57%		15.15%		23.41%		8.60%		0.00%		8.01%
Accum. % ≤		17.52%	→	25.09%	→	33.26%	→	44.83%	→	59.98%	→	83.39%	→	91.99%	→	91.99%	→	100%

Sub Total: 51.952

add surface material weights to grand total

No.	Dia.	WT.
1	74	0.758
2	73	0.31

GRAND TOTAL SAMPLE WEIGHT: 53.020

Figure D.1 Sieve Analysis Worksheet for Composite Gravel Bar Sample

Stream:	**Cobbs Creek**		Stream Type: **B4c**	
Location:	**Marshall Road Bar Composite**		Valley Type: **V**	
Observers:	**EH,RH,MR,GB**		Date: **6/04/09**	
Enter required information				
34	D_{50}	Riffle bed material D_{50} (mm)		
20.8	$\hat{D}_{50}$	Bar sample D_{50} (mm)		
0.239	D_{max}	Largest particle from bar sample (ft)	**73**	**(mm)** 304.8 mm/ft
0.0035	**S**	Existing bankfull water surface slope (ft/ft)		
2.53	**d**	Existing bankfull mean depth (ft)		
1.65	γ_s	Submerged specific weight of sediment		
Select the appropriate equation and calculate critical dimensionless shear stress				
1.63	$D_{50}/\hat{D}_{50}$	Range: 3 – 7	Use EQUATION 1: $\tau^* = 0.0834\ (\quad)^{-0.872}$	
2.15	D_{max}/D_{50}	Range: 1.3 – 3.0	Use EQUATION 2: $\tau^* = 0.0384\ (D_{max}/D_{50})^{-0.887}$	
0.01950	τ^*	Bankfull Dimensionless Shear Stress	EQUATION USED:Equation 2	
Calculate bankfull mean depth required for entrainment of largest particle in bar sample				
2.20	**d**	Required bankfull mean depth (ft)	$d = (t^*\ \gamma s\ D_{max})/S$	
	Check:	(Stable) Aggrading Degrading		
Calculate bankfull water surface slope required for entrainment of largest particle in bar sample				
0.003039	**S**	Required bankfull water surface slope (ft/ft)	$S = (t^*\ \gamma s\ D_{max})/d$	
	Check:	(Stable) Aggrading Degrading		
Sediment competence using dimensional shear stress				
0.5526	Bankfull shear stress $\tau = \gamma dS$ (lbs/ft^2) (substitute hydraulic radius, R, with mean depth, d)			
42.02	Moveable particle size (mm) at bankfull shear stress **(Figure 5-54)**			
Use Leopold et. al (1964) Power-Trendline from Figure 5-54 to get shear stress value				
1.0514	Predicted shear stress required to initiate movement of D_{max} (mm) **(Figure 5-54)**			
4.81	Predicted mean depth required to initiate movement of D_{max} (mm)		$d = (t)/\gamma S$	
0.0067	Predicted slope required to initiate movement of D_{max} (mm)			

Figure D.3 Stream Competency Analysis Worksheet for Composite Bar Sample

Appendix F –Historic Biomonitoring Data

Table F.1 - 2002 Macroinvertebrate Species List- Site DCC455

Order	Family	Genus	Total	Tolerance value
Diptera	Chironomidae	spp	119	6
Tricoptera	Hydropsychidae	Hydropsyche	42	5
Tricoptera	Hydropsychidae	Cheumatopsyche	21	6
Isopoda	Asselidae	Caecidotea	17	6
Oligochaeta	Lumbriculidae	spp	10	8
Amphipoda	Crangonicitidae	Crangonyx	2	6
Diptera	Tipulidae	Antocha	2	3
Diptera	Tipulidae	Tipula	2	4
Coleoptera	Elmidae	Stenelmis	1	5
Neritacea	Ancylidae	spp	1	7
Gastropoda	Lymnaeidae	spp	1	7

Table F.2 - 2002 Macroinvertebrate Species List - Site DCC490

Order	Family	Genus	Total	Tolerance value
Isopoda	Asselidae	Caecidotea	213	6
Diptera	Chironomidae	spp	94	6
Tricoptera	Hydropsychidae	Hydropsyche	87	4
Tricoptera	Hydropsychidae	Cheumatopsyche	23	6
Neritacea	Ancylidae	spp	16	7
Bivalvia	Corbiculidae	Corbicula	13	4
Oligochaeta	Lumbriculidae	spp	5	8
Diptera	Simulidae	Twinnia	3	6
Diptera	Thaumalidae	Thaumalea	1	6
Diptera	Tipulidae	Antocha	1	3
Coleoptera	Dystiscidae	Agabetes	1	5
Gastropoda	Planorbidae	spp	1	6
Gastropoda	Lymnaeidae	spp	1	7
Diptera	Psychodidae	spp	1	10

Table F.3 - 2002 Macroinvertebrate Species List - French Creek Reference Reach

Order	Family	Genus	Total	Tolerance value
Tricoptera	Hydropsychidae	Hydropsyche	108	5
Tricoptera	Hydropsychidae	Cheumatopsyche	84	6
Tricoptera	Philopotamatidae	Chimarra	22	4
Tricoptera	Glossosamatidae	Glossosoma	10	0
Tricoptera	Philopotamatidae	Dolophiloides	2	0
Plecoptera	Capniidae	Alocapnia	47	3
Plecoptera	Taeniopterygidae	Taeniopteryx	24	2
Plecoptera	Perlidae	Acroneuria	16	0
Plecoptera	Nemouridae	Prostoia	4	2
Oligochaeta	Lumbriculidae	spp	3	8
Megaloptera	Corydalidae	Corydalus	4	4
Gastropoda	Ancylidae	spp	10	7
Gastropoda	Plueroceridae	spp	6	7
Gastropoda	Pysidae	spp	1	8
Ephemeroptera	Isonychidae	Isonychia	64	3
Ephemeroptera	Baetidae	Baetis	28	6
Ephemeroptera	Heptigeniidae	Stenonema	17	3
Diptera	Chironomidae	spp	86	6
Diptera	Tipulidae	Tipula	8	4
Diptera	Simulidae	Simulium	2	6
Diptera	Tipulidae	Antocha	1	3
Diptera	Emphididae	Hemerodromia	1	6
Coleoptera	Elmidae	Stenelmis	35	5
Bivalvia	Corbiculidae	Corbicula	3	4
Anisoptera	Gomphidae	Progomphus	1	5
Acariformes	Oxidae	Oxus	2	4

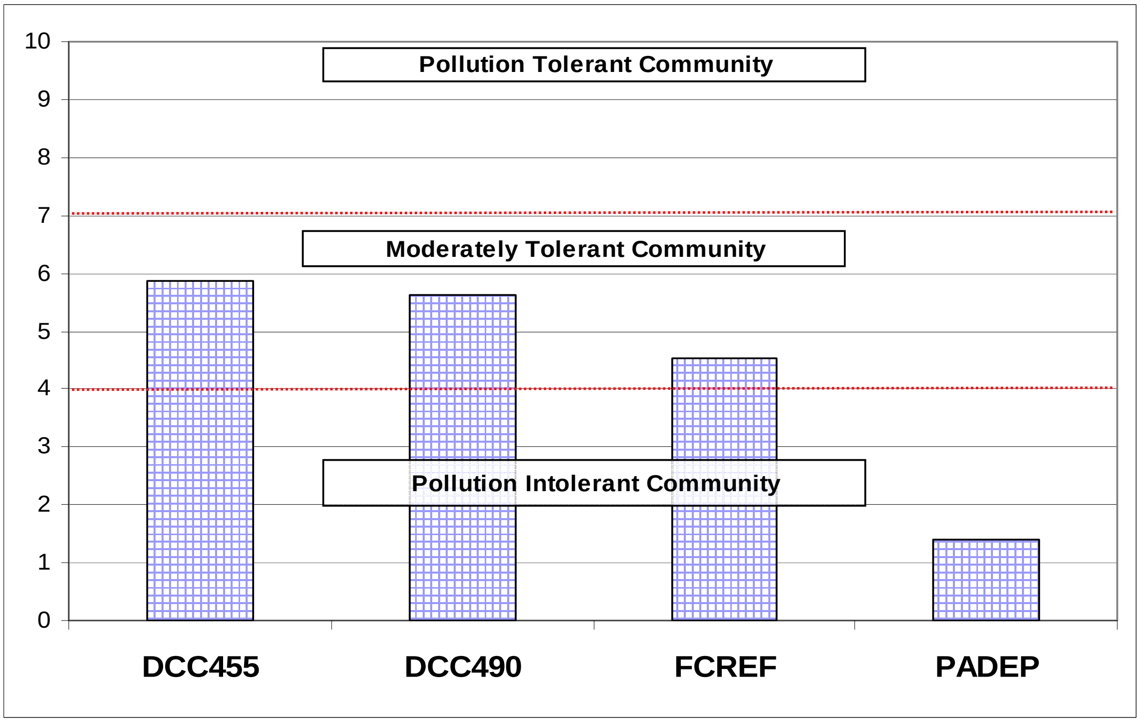


Figure F.1 – Hilsenhoff Biotic Index Score Comparison for Marshall Roads Sites, French Creek Reference Reach and PADEP Standard Reference

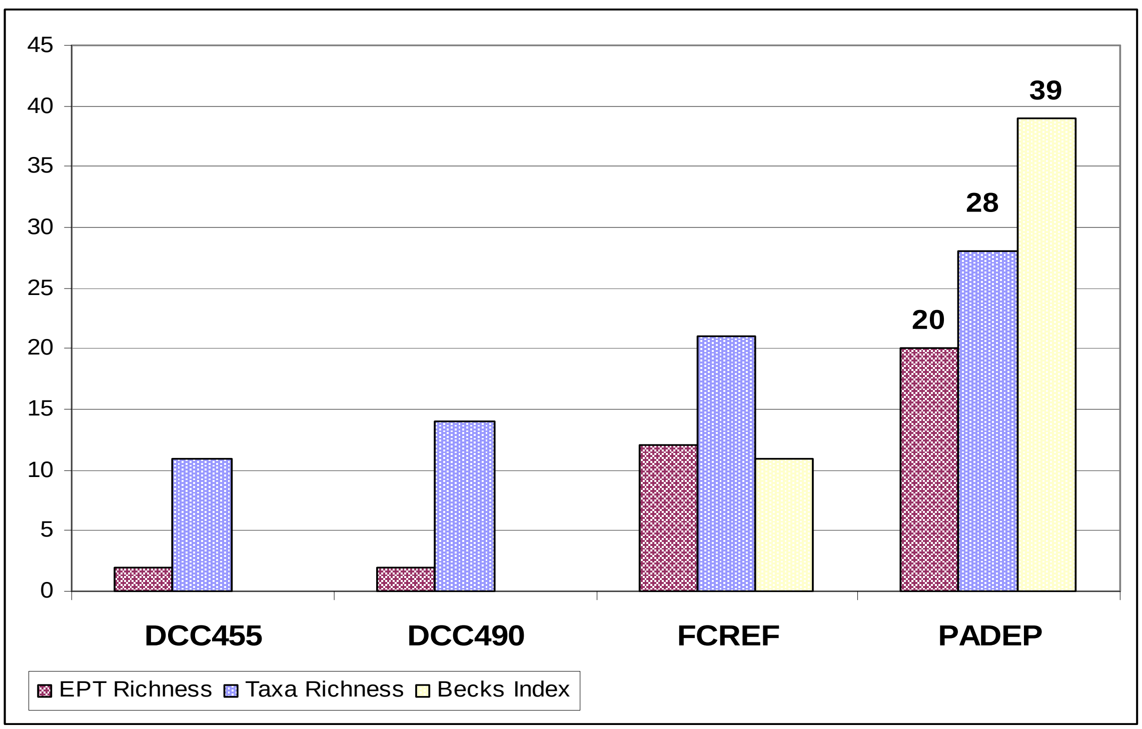


Figure F.2 –PADEP ICE Metric Score Comparison for Marshall Roads Sites, French Creek Reference Reach and PADEP Standard Reference

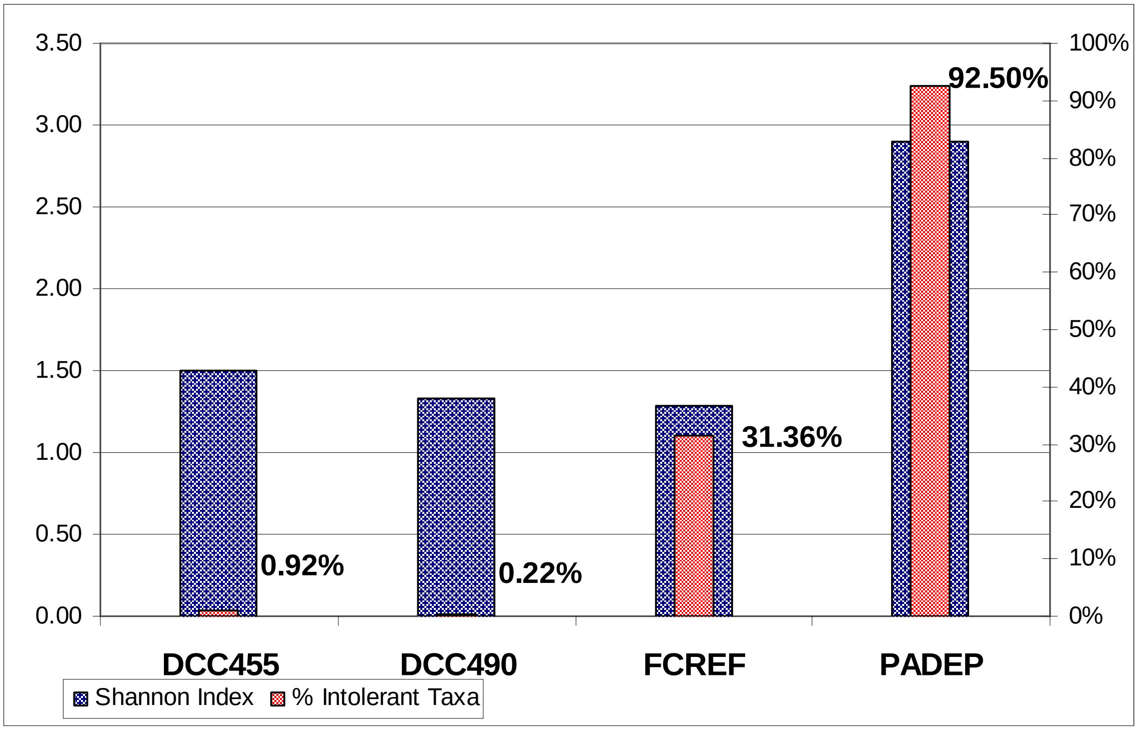


Figure F.3 –PADEP ICE Metric Score Comparison for Marshall Roads Sites, French Creek Reference Reach and PADEP Standard Reference

Historic Fish Data

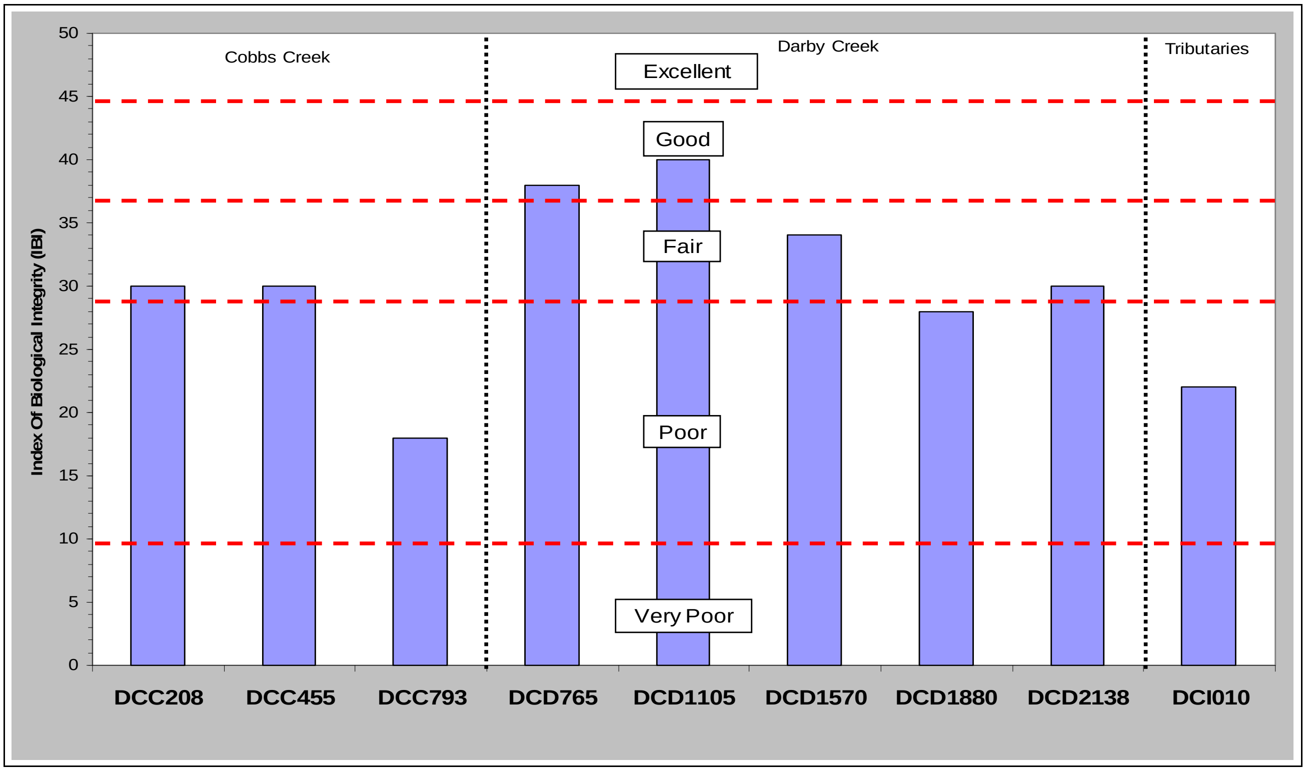


Figure F.4 –IBI Metric Score Comparison for Sites in Darby Creek and Cobbs Creek (2003)

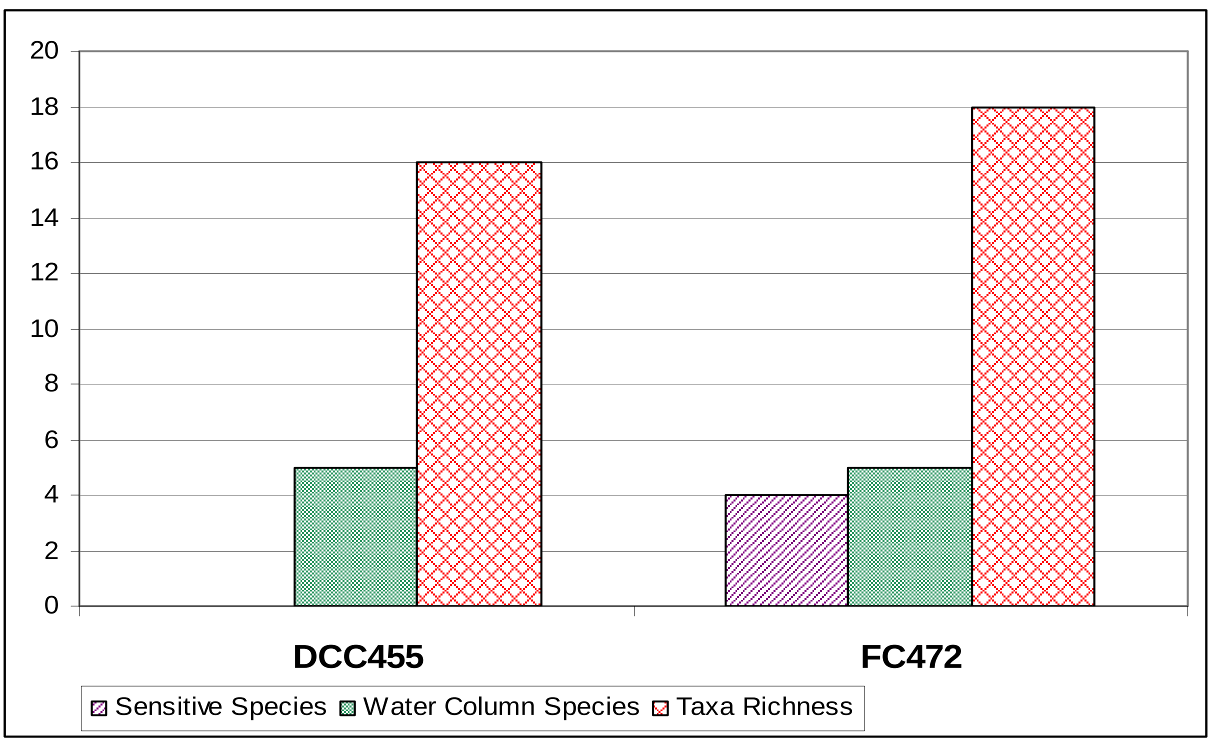


Figure F.5 –IBI Metric Score Comparison for DCC455 (Marshall Road) and French Creek Reference Reach

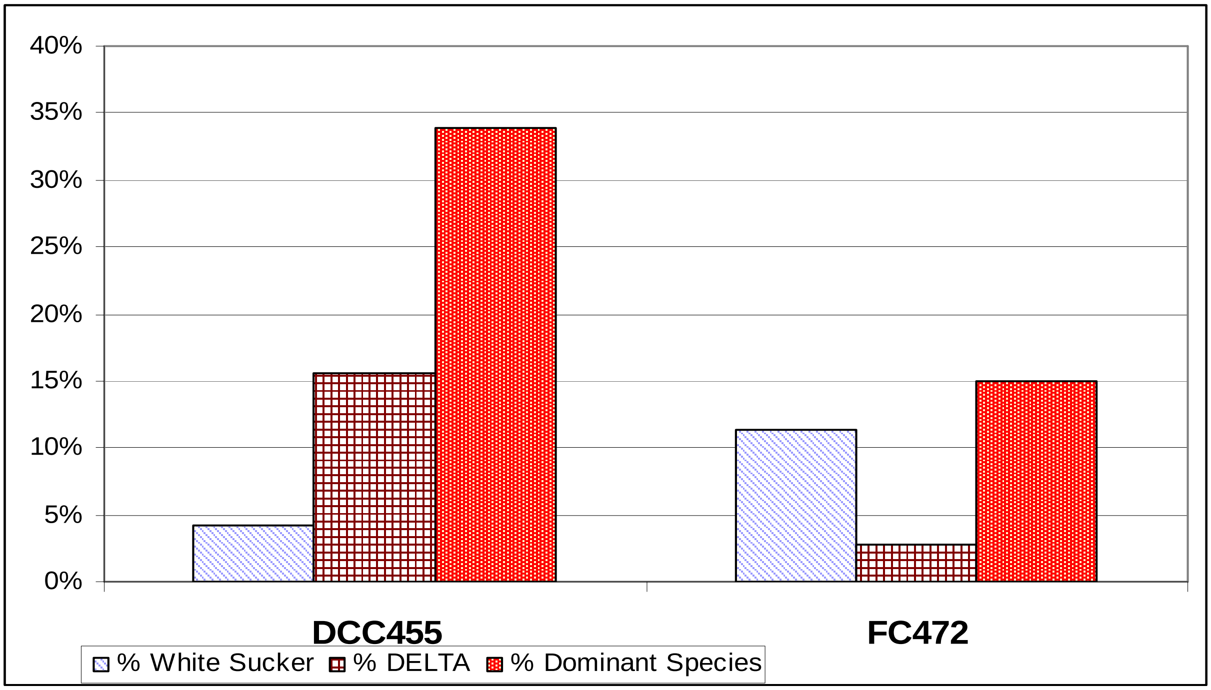


Figure F.6 –IBI Metric Score Comparison for DCC455 (Marshall Road) and French Creek Reference Reach

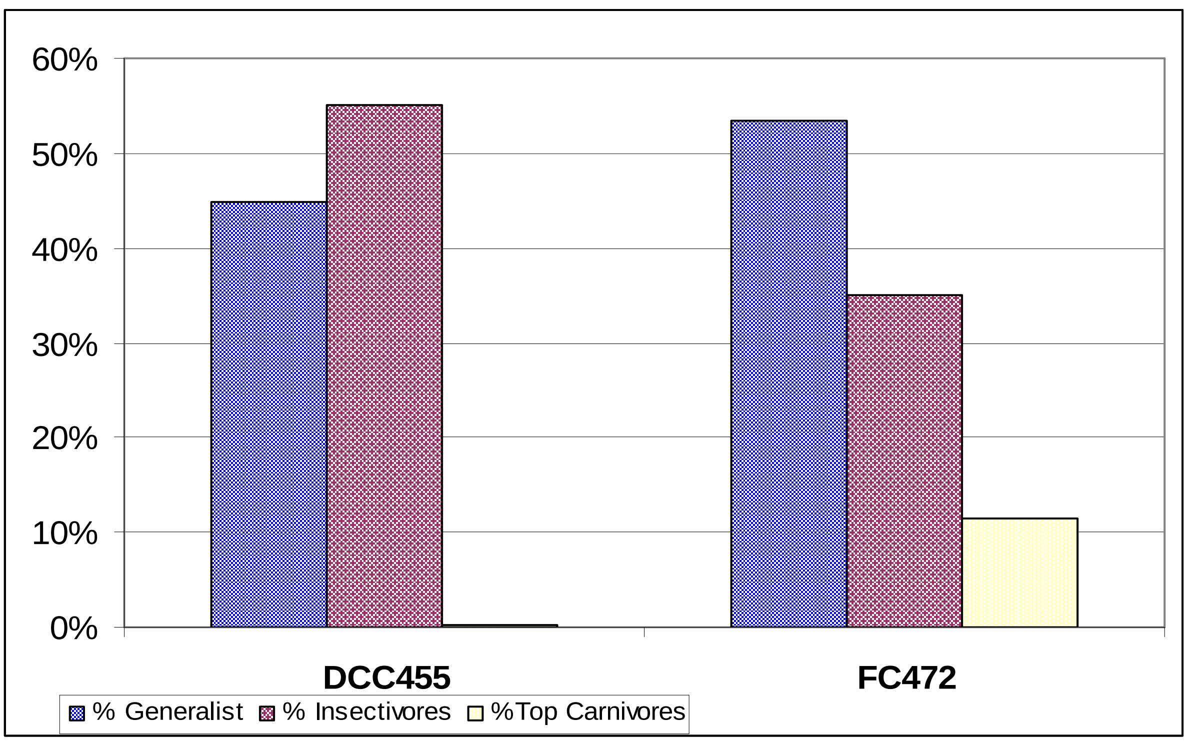


Figure F.7 –IBI Metric Score Comparison for DCC455 (Marshall Road) and French Creek Reference Reach

APPENDIX N –
NLNA CISTERN WATER TESTING
LANCASTER LABORATORIES LAB RESULTS

2425 New Holland Pike, PO Box 12425, Lancaster, PA 17605-2425 • 717-656-2300 Fax: 717-656-2681 • www.lancasterlabs.com

ANALYTICAL RESULTS

Prepared by:	Prepared for:
Lancaster Laboratories 2425 New Holland Pike Lancaster, PA 17605-2425	NLNA 833 North 5th Street Philadelphia PA 19123

May 10, 2010

Project: NLNA - Cistern Water Testing

Submittal Date: 04/26/2010
Group Number: 1191887
State of Sample Origin: PA

Client Sample Description	Lancaster Labs (LLI) #
Grab Water Sample	5963667

The specific methodologies used in obtaining the enclosed analytical results are indicated on the Laboratory Sample Analysis Record.

ELECTRONIC COPY TO   Philadelphia Water Department   Attn: Susan Patterson

Questions? Contact Environmental Client Services

Respectfully Submitted,

Diane L. Lockard
Principal Microbiologist Group Leader

Sample Description: Grab Water Sample
NLNA - Cistern Water Testing

LLI Sample # PW 5963667
LLI Group # 1191887
Account # 01907

Project Name: NLNA - Cistern Water Testing

Collected: 04/26/2010 08:05 by SP
through 04/26/2010 08:20
Submitted: 04/26/2010 15:30
Reported: 05/10/2010 19:50
Discard: 05/25/2010

NLNA
833 North 5th Street
Philadelphia PA 19123

NLNAG

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Limit of Quantitation	Dilution Factor
GC Extractable TPH	**SW-846 8015B modified**		**mg/l**	**mg/l**	
08093	TPH by GC/FID water C8-C40	n.a.	< 0.58	0.58	1
Metals	**EPA 200.7 rev 4.4**		**mg/l**	**mg/l**	
07049	Cadmium	7440-43-9	< 0.0050	0.0050	1
	The EPA has set a maximum contaminant level of 0.005 mg/l for cadmium.				
01750	Calcium	7440-70-2	16.5	0.200	1
07051	Chromium	7440-47-3	< 0.0150	0.0150	1
	The EPA has set a maximum contaminant level of 0.1 mg/l for chromium. The state of Pennsylvania has set a maximum contaminant level of 0.05 mg/l for chromium.				
	EPA 200.8 rev 5.4		**mg/l**	**mg/l**	
06025	Arsenic	7440-38-2	0.0063	0.0020	1
	The EPA has set a maximum contaminant level of 0.01 mg/l for arsenic.				
06035	Lead	7439-92-1	0.0022	0.0010	1
	The action level for lead in the lead and copper rule is 0.015 mg/l. Because health effects are possible, especially in young children, EPA guidance recommends that corrective action be taken when the action level is met or exceeded.				
	EPA 245.1 rev 3		**mg/l**	**mg/l**	
00259	Mercury	7439-97-6	< 0.00020	0.00020	1
	The EPA has set a maximum contaminant level of 0.002 mg/l for mercury.				
Wet Chemistry	**EPA 365.1**		**mg/l**	**mg/l**	
00227	Total Phosphorus as P (water)	7723-14-0	0.22	0.10	1
	EPA 410.4		**mg/l**	**mg/l**	
04001	Chemical Oxygen Demand	n.a.	69.1	50.0	1
	SM20 2320 B		**mg/l as CaCO3**	**mg/l as CaCO3**	
00202	Alkalinity to pH 4.5	n.a.	220	2.0	1
00201	Alkalinity to pH 8.3	n.a.	13.5	2.0	1
	SM20 4500 H/B		**Std. Units**	**Std. Units**	
00200	pH	n.a.	8.9	0.010	1
	pH is a measure of hydrogen ion activity. An acceptable range for pH in drinking water is 6.5 - 8.5. This parameter is not generally considered to be directly health related. In combination with solids, alkalinity and calcium levels, pH can give an indication of whether the water is corrosive to plumbing.				
	SM20 4500 NH3 D		**mg/l**	**mg/l**	
06914	Ammonia-Nitrogen Distilled	7664-41-7	0.18	0.15	1
Microbiology	**SM20 9223 B**		**/100ml**	**/100ml**	

Sample Description: Grab Water Sample
NLNA - Cistern Water Testing

LLI Sample # PW 5963667
LLI Group # 1191887
Account # 01907

Project Name: NLNA - Cistern Water Testing

Collected: 04/26/2010 08:05 by SP
through 04/26/2010 08:20
Submitted: 04/26/2010 15:30
Reported: 05/10/2010 19:50
Discard: 05/25/2010

NLNA
833 North 5th Street
Philadelphia PA 19123

NLNAG

CAT No.	Analysis Name	CAS Number	As Received Result	As Received Limit of Quantitation	Dilution Factor
Microbiology	**SM20 9223 B**		**/100ml**	**/100ml**	
08161	Tot Coli/E. coli (Quanti-tray)	n.a.	See Below		n.a.

*****BACTERIOLOGICALLY CONTAMINATED****

The water this test result represents is NOT considered bacteriologically safe to drink according to standards established by the Environmental Protection Agency (EPA). It is the presence of coliform bacteria, and not the number, that is significant. If the source of your water supply is a well, we recommend that you disinfect your well and retest the water prior to consuming it. If you need information on disinfecting your well, please contact us to receive our pamphlet, "Information and General Procedures for Testing Your Water". If the well has already been disinfected, you should contact a water treatment company or your plumber for permanent options. We recommend that you retest your well water every 6 to 12 months to verify that it continues to be bacteriologically safe.

Total Coliform > 200.5 /100ml
E. coli < 1.0 /100ml

General Sample Comments

PA DEP Lab Certification ID 36-00037, Expiration Date: 1/31/11

All QC is compliant unless otherwise noted. Please refer to the Quality Control Summary for overall QC performance data and associated samples.

Laboratory Sample Analysis Record

CAT No.	Analysis Name	Method	Trial#	Batch#	Analysis Date and Time	Analyst	Dilution Factor
08093	TPH by GC/FID water C8-C40	SW-846 8015B modified	1	101170030A	04/29/2010 13:56	Heather E Williams	1
07003	Extraction - DRO (Waters)	SW-846 3510C	1	101170030A	04/28/2010 09:35	Karen R Rettew	1
07049	Cadmium	EPA 200.7 rev 4.4	1	101195716003	05/03/2010 07:30	Joanne M Gates	1
01750	Calcium	EPA 200.7 rev 4.4	1	101195716003	05/03/2010 07:30	Joanne M Gates	1
07051	Chromium	EPA 200.7 rev 4.4	1	101195716003	05/03/2010 07:30	Joanne M Gates	1
06025	Arsenic	EPA 200.8 rev 5.4	1	101267050001A	05/10/2010 14:48	Choon Y Tian	1
06035	Lead	EPA 200.8 rev 5.4	1	101267050001A	05/10/2010 14:48	Choon Y Tian	1
00259	Mercury	EPA 245.1 rev 3	1	101185714002	04/29/2010 19:33	Nelli S Markaryan	1
05716	EPA 600 ICP Digest (tot rec)	EPA 200.7 rev 4.4	1	101195716003	05/02/2010 09:20	James L Mertz	1
07050	ICP/MS EPA-600 Digest	EPA 200.8 rev 5.4	1	101267050001	05/06/2010 14:02	James L Mertz	1
05714	PW/WW Hg Digest	EPA 245.1 rev 3	1	101185714002	04/29/2010 09:50	Denise K Conners	1
00227	Total Phosphorus as P (water)	EPA 365.1	1	10117109101A	04/28/2010 18:01	Joseph E McKenzie	1
08263	Total Phos as P Prep (water)	EPA 365.1	1	10117109101A	04/27/2010 12:00	Nancy J Shoop	1
04001	Chemical Oxygen Demand	EPA 410.4	1	10124400101B	05/04/2010 07:13	Susan A Engle	1
00202	Alkalinity to pH 4.5	SM20 2320 B	1	10124020201A	05/04/2010 12:25	Geraldine C Smith	1
00201	Alkalinity to pH 8.3	SM20 2320 B	1	10124020201A	05/04/2010 12:25	Geraldine C Smith	1
00200	pH	SM20 4500 H/B	1	10116020001B	04/26/2010 22:00	Luz M Groff	1

Sample Description: Grab Water Sample
NLNA - Cistern Water Testing

LLI Sample # PW 5963667
LLI Group # 1191887
Account # 01907

Project Name: NLNA - Cistern Water Testing

Collected: 04/26/2010 08:05 by SP
through 04/26/2010 08:20
Submitted: 04/26/2010 15:30
Reported: 05/10/2010 19:50
Discard: 05/25/2010

NLNA
833 North 5th Street
Philadelphia PA 19123

NLNAG

Laboratory Sample Analysis Record

CAT No.	Analysis Name	Method	Trial#	Batch#	Analysis Date and Time	Analyst	Dilution Factor
06914	Ammonia-Nitrogen Distilled	SM20 4500 NH3 D	1	10123691401A	05/04/2010 08:50	Michele L Graham	1
04219	Ammonia Distillation	SM20 4500 NH3 B	1	10123691401A	05/03/2010 07:45	Michele L Graham	1
08161	Tot Coli/E. coli (Quanti-tray)	SM20 9223 B	1	042610LMH	04/27/2010 20:55	Keith A Hoover	n.a.

Quality Control Summary

Client Name: NLNA　　　　　Group Number: 1191887
Reported: 05/10/10 at 07:50 PM

Matrix QC may not be reported if site-specific QC samples were not submitted. In these situations, to demonstrate precision and accuracy at a batch level, a LCS/LCSD was performed, unless otherwise specified in the method.

Laboratory Compliance Quality Control

Analysis Name	Blank Result	Blank LOQ	Report Units	LCS %REC	LCSD %REC	LCS/LCSD Limits	RPD	RPD Max
Batch number: 101170030A	Sample number(s): 5963667							
TPH by GC/FID water C8-C40	< 0.60	0.60	mg/l	86	81	60-120	6	20
Batch number: 101185714002	Sample number(s): 5963667							
Mercury	< 0.00020	0.00020	mg/l	112		85-115		
Batch number: 101195716003	Sample number(s): 5963667							
Cadmium	< 0.0050	0.0050	mg/l	91		85-115		
Calcium	< 0.200	0.200	mg/l	102		85-115		
Chromium	< 0.0150	0.0150	mg/l	98		85-115		
Batch number: 101267050001A	Sample number(s): 5963667							
Arsenic	< 0.0020	0.0020	mg/l	100		85-115		
Lead	< 0.0010	0.0010	mg/l	111		85-115		
Batch number: 10117109101A	Sample number(s): 5963667							
Total Phosphorus as P (water)	< 0.10	0.10	mg/l	98		90-110		
Batch number: 10116020001B	Sample number(s): 5963667							
pH				100		99-101		
Batch number: 10123691401A	Sample number(s): 5963667							
Ammonia-Nitrogen Distilled	< 0.15	0.15	mg/l	96	95	81-116	2	5
Batch number: 10124020201A	Sample number(s): 5963667							
Alkalinity to pH 4.5	< 2.0	2.0	mg/l as CaCO3	100		98-103		
Batch number: 10124400101B	Sample number(s): 5963667							
Chemical Oxygen Demand				100		94-110		

Sample Matrix Quality Control

Unspiked (UNSPK) = the sample used in conjunction with the matrix spike
Background (BKG) = the sample used in conjunction with the duplicate

Analysis Name	MS %REC	MSD %REC	MS/MSD Limits	RPD	RPD MAX	BKG Conc	DUP Conc	DUP RPD	Dup RPD Max
Batch number: 101185714002	Sample number(s): 5963667 UNSPK: 5963667 BKG: 5963667								
Mercury	116		80-120			< 0.00020	< 0.00020	0 (1)	20
Batch number: 101195716003	Sample number(s): 5963667 UNSPK: P962699 BKG: P962699								
Cadmium	97		83-116			< 0.0050	< 0.0050	0 (1)	20

*- Outside of specification
(1) The result for one or both determinations was less than five times the LOQ.
(2) The unspiked result was more than four times the spike added.

Quality Control Summary

Client Name: NLNA Group Number: 1191887
Reported: 05/10/10 at 07:50 PM

Sample Matrix Quality Control

Unspiked (UNSPK) = the sample used in conjunction with the matrix spike
Background (BKG) = the sample used in conjunction with the duplicate

Analysis Name	MS %REC	MSD %REC	MS/MSD Limits	RPD	RPD MAX	BKG Conc	DUP Conc	DUP RPD	Dup RPD Max
Calcium	35 (2)		78-125			38.9	37.4	4	20
Chromium	97		81-120			< 0.0150	< 0.0150	0 (1)	20
Batch number: 101267050001A	Sample number(s): 5963667 UNSPK: 5963667 BKG: 5963667								
Arsenic	103		70-130			0.0063	0.0068	8 (1)	20
Lead	108		75-124			0.0022	0.0023	6 (1)	20
Batch number: 10117109101A	Sample number(s): 5963667 UNSPK: P963545 BKG: P963545								
Total Phosphorus as P (water)	92		90-110			< 0.10	< 0.10	0 (1)	3
Batch number: 10116020001B	Sample number(s): 5963667 BKG: P963560								
pH						7.7	7.6	0	1
Batch number: 10123691401A	Sample number(s): 5963667 BKG: P967815								
Ammonia-Nitrogen Distilled						33.6	33.1	2	20
Batch number: 10124020201A	Sample number(s): 5963667 UNSPK: 5963667 BKG: 5963667								
Alkalinity to pH 4.5	100		73-121			220	222	1	5
Alkalinity to pH 8.3						13.5	13.5	0	5
Batch number: 10124400101B	Sample number(s): 5963667 UNSPK: P964788 BKG: P964788								
Chemical Oxygen Demand	90		90-110			3,070	3,160	3	5

Surrogate Quality Control

Surrogate recoveries which are outside of the QC window are confirmed
unless attributed to dilution or otherwise noted on the Analysis Report.

Analysis Name: TPH by GC/FID water C8-C40
Batch number: 101170030A

	Chlorobenzene	Orthoterphenyl
5963667	76	84
Blank	79	85
LCS	76	92
LCSD	73	86
Limits:	28-152	52-131

*- Outside of specification
(1) The result for one or both determinations was less than five times the LOQ.
(2) The unspiked result was more than four times the spike added.

Lancaster Laboratories
Explanation of Symbols and Abbreviations

The following defines common symbols and abbreviations used in reporting technical data:

N.D.	none detected	**BMQL**	Below Minimum Quantitation Level
TNTC	Too Numerous To Count	**MPN**	Most Probable Number
IU	International Units	**CP Units**	cobalt-chloroplatinate units
umhos/cm	micromhos/cm	**NTU**	nephelometric turbidity units
C	degrees Celsius	**F**	degrees Fahrenheit
Cal	(diet) calories	**lb.**	pound(s)
meq	milliequivalents	**kg**	kilogram(s)
g	gram(s)	**mg**	milligram(s)
ug	microgram(s)	**l**	liter(s)
ml	milliliter(s)	**ul**	microliter(s)
m3	cubic meter(s)	**fib >5 um/ml**	fibers greater than 5 microns in length per ml

< less than – The number following the sign is the <u>limit of quantitation</u>, the smallest amount of analyte which can be reliably determined using this specific test.

> greater than

ppm parts per million – One ppm is equivalent to one milligram per kilogram (mg/kg), or one gram per million grams. For aqueous liquids, ppm is usually taken to be equivalent to milligrams per liter (mg/l), because one liter of water has a weight very close to a kilogram. For gases or vapors, one ppm is equivalent to one microliter of gas per liter of gas.

ppb parts per billion

Dry weight basis Results printed under this heading have been adjusted for moisture content. This increases the analyte weight concentration to approximate the value present in a similar sample without moisture.

U.S. EPA data qualifiers:

Organic Qualifiers

A	TIC is a possible aldol-condensation product
B	Analyte was also detected in the blank
C	Pesticide result confirmed by GC/MS
D	Compound quatitated on a diluted sample
E	Concentration exceeds the calibration range of the instrument
J	Estimated value
N	Presumptive evidence of a compound (TICs only)
P	Concentration difference between primary and confirmation columns >25%
U	Compound was not detected
X,Y,Z	Defined in case narrative

Inorganic Qualifiers

B	Value is <CRDL, but ≥IDL
E	Estimated due to interference
M	Duplicate injection precision not met
N	Spike amount not within control limits
S	Method of standard additions (MSA) used for calculation
U	Compound was not detected
W	Post digestion spike out of control limits
*****	Duplicate analysis not within control limits
+	Correlation coefficient for MSA <0.995

Analytical test results for methods listed on the laboratories' accreditation scope meet all requirements of NELAC unless otherwise noted under the individual analysis.

Tests results relate only to the sample tested. Clients should be aware that a critical step in a chemical or microbiological analysis is the collection of the sample. Unless the sample analyzed is truly representative of the bulk of material involved, the test results will be meaningless. If you have questions regarding the proper techniques of collecting samples, please contact us. We cannot be held responsible for sample integrity, however, unless sampling has been performed by a member of our staff. This report shall not be reproduced except in full, without the written approval of the laboratory.

WARRANTY AND LIMITS OF LIABILITY – In accepting analytical work, we warrant the accuracy of test results for the sample as submitted. THE FOREGOING EXPRESS WARRANTY IS EXCLUSIVE AND IS GIVEN IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED. WE DISCLAIM ANY OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING A WARRANTY OF FITNESS FOR PARTICULAR PURPOSE AND WARRANTY OF MERCHANTABILITY. IN NO EVENT SHALL LANCASTER LABORATORIES BE LIABLE FOR INDIRECT, SPECIAL, CONSEQUENTIAL, OR INCIDENTAL DAMAGES INCLUDING, BUT NOT LIMITED TO, DAMAGES FOR LOSS OF PROFIT OR GOODWILL REGARDLESS OF (A) THE NEGLIGENCE (EITHER SOLE OR CONCURRENT) OF LANCASTER LABORATORIES AND (B) WHETHER LANCASTER LABORATORIES HAS BEEN INFORMED OF THE POSSIBILITY OF SUCH DAMAGES. We accept no legal responsibility for the purposes for which the client uses the test results. No purchase order or other order for work shall be accepted by Lancaster Laboratories which includes any conditions that vary from the Standard Terms and Conditions of Lancaster Laboratories and we hereby object to any conflicting terms contained in any acceptance or order submitted by client.

APPENDIX O – DEFECTIVE LATERALS GROUP FY2010 ANNUAL REPORT

Defective Connections Group

Fiscal Year 2010 Annual Report

Reggie Williams

I. BACKGROUND INFORMATION

A. Phase I Stormwater Regulations

In 1990, the Environmental Protection Agency (EPA) promulgated Stormwater Regulations that required National Pollutant Discharge Elimination System (NPDES) permits for stormwater discharges from large (populations in excess of 250,000) and medium-sized (populations between 100,000 and 250,000) municipalities with separate storm sewer systems, (MS4)[1]. The City of Philadelphia with a 1990 population of 1.4 million is one of the two NPDES Stormwater Phase I permittees in Pennsylvania. The other permittee is the City of Allentown.

B. NPDES Permit for Stormwater

The City of Philadelphia received its first NPDES Stormwater Permit under the 1990 Federal Regulations as issued by the PA DEP in September 1995. This permit had a 5-year term that expired in September 2000. Among other requirements, the permit required the city to reduce stormwater based pollution of the natural streams, creeks and rivers, from (1) residential and commercial areas, (2) construction sites (3) industrial sites and (4) defective lateral connections.

The renewal of the NPDES Stormwater Permit that expired in September 2000 has been approved by the PA DEP. The new permit provides for the same scope and requirements for the Defective Laterals Detection and Abatement Program as the previous permit and incorporates some provisions from the Consent Order and Agreement (COA) of July 1998 although the COA was successfully completed on March 18, 2004.

With the Water Department's internal reorganization and creation of the Office of Watersheds (OOW), the responsibilities numbered (1) through (3) above, along with the periodic reporting thereon was transferred to the OOW. The Defective Connections group continues to pursue the 4th objective of NPDES Permit, namely the detection of defective laterals that cause sanitary wastewater to be carried to the local streams and rivers. The Plumbing Repair Programs unit is responsible for abating the defective laterals detected.

II. DEFECTIVE LATERALS DETECTION AND ABATEMENT PROGRAM

A. Scope of Investigations

The MS4 impacts the areas of the city where there are two separate sewers in the street. The sanitary sewer system, which consists of a network of pipes of smaller diameter, carries domestic wastewater to the City's three Water Pollution Control Plants located in the Northeast, Southeast and Southwest. The storm sewer system consists of pipes of larger diameter but significantly shorter lengths and transports the stormwater to the nearest natural waterways. In general, the relatively newer sections of the city in the northeast, northwest and southwest are served by a MS4.

[1] Municipal Separate Storm Sewer System

Due to problems generally attributed to improper installation or lack of oversight during construction, sanitary wastewater from some properties can be transported into the storm sewers and from there, to the streams and rivers. This intrusion of sanitary wastewater causes pollution of the streams and rivers, which are the source of city's water supply. The polluted streams and rivers also endanger the physical health and safety of residents and users of the streams. The NPDES Permit requires the city to identify and abate the plumbing connections (defective laterals) that cause the sanitary wastewater to drain into the streams.

The investigations of stream pollution are triggered by the presence of a dry weather discharge from the storm sewer outfalls into the streams. There are over 400 stormwater outfalls in city's MS4 system of which some 200 have exhibited some dry weather flow.

It should be mentioned however, that not all dry weather discharge from an outfall comes from sanitary wastewater incursion; some may come from underground natural streams or from groundwater inflow. Additional testing of chemical and biochemical composition of samples collected from the outfalls determines whether or not stream pollution may be caused by defective laterals.

B. Outfall Sampling

A systematic sampling of the quality of dry weather flow from the 200 plus outfalls was performed in 1991 as part of the NPDES permit application process. This program attempted to document the amount of flow (gph) and in many cases, fecal coliform count (number of fecal colonies per ml of water). The outfall sampling results were updated in 1998 when additional observations of fluoride levels (mg/l) were included to provide some indication of the origin of water seen in the outfalls. This is based on the fact that the natural water coming from streams or ground water seepage does not contain any significant fluorides, but the City water contains 1.0 mg/l of fluorides.

The more likely outcomes of fluoride and fecal count analyses are interpreted as follows:

i. **High fluoride level with high fecal count:** possible intrusion of sanitary wastewater into the storm sewer
ii. **Low fluoride level with high fecal count:** possible transport of surface contamination in the non-domestic discharge
iii. **High fluoride with low fecal count**: possible water main leak

The Leak Detection unit is alerted when the condition listed at (iii) above is encountered.

As a part of the MS4 permit, all stormwater outfalls are to be inspected once every five years. If there is dry-weather flow present then the outfall is to be sampled and tested for fecal presence and fluoride levels. In addition, the priority outfalls of the watersheds where the current detection and abatement efforts are concentrated are to be sampled on a quarterly basis. Outfall inspections and sampling are handled by the Industrial Waste unit.

During FY2010, 44 outfall inspections were conducted and 44 samples were taken due to observed dry-weather flow as part of the Permit Inspection program. During FY2010, 237 outfall inspections were conducted and 121 samples were taken due to observed dry-weather flow as part of the Quarterly Priority Outfall Sampling program. This work was completed by the Industrial Waste unit.

C. Field Screening

The object of field screening is to identify the areas in a watershed that are suspected of contributing to stream pollution through defective laterals. The field screening begins systematically at an outfall that shows a contaminated dry weather flow[2].

Proceeding upstream from the outfall, the storm sewer manholes are successively opened and observed for the presence of flow. The term "**flow**" has been widened to include "**wet**" stormwater manholes on the assumption that the wetness was caused by earlier active flow. These observations are continued upstream along a specified sewer line and stop when a stormwater manhole no longer exhibits any flow or wetness. The field screening is then continued along another tributary sewer and eventually through the entire watershed of the outfall.

D. Identification of Defective Laterals

1) Dye Tests

Dye testing is a process by which a cross-connected lateral at a property that carries sanitary wastewater to a storm sewer is identified.

(a) Initial Dye Test

Before a test is conducted, the fresh air inlets (FAIs) located at the curbside of the property are identified as being sanitary and storm FAIs. The dye test protocol adopted by the City requires the presence of two properly functioning FAIs for successful initial tests. If one or no FAI is seen at a property or one or both of the FAIs are clogged or damaged, the initial dye test is aborted with a notation "**Inconclusive**".

During the initial dye test, a water-soluble fluorescent dye is placed in the fresh air inlets (FAIs) and/or the area drains. The dye is then washed down with water.

In the case of a **"Camera Assisted Dye Test"** the emergence of the dye is observed in the **storm sewer** by a closed circuit television camera positioned in the storm sewer in front of the stormwater lateral connection of the property. Possible observations include:

(i) Green dye placed in storm FAI is seen in the storm sewer
(ii) Green dye paced in storm FAI is not seen in the storm sewer
(iii) Red dye placed in the sanitary FAI is seen in the storm sewer
(iv) Red dye placed in the sanitary FAI is not seen in the storm sewer.

The above observations are interpreted as follows:

1) Combination of (i) and (ii): **Proper connection**
2) Combination of (i) and (iii): **Probable cross connection**
3) Combination of (ii) and (iv): **Inconclusive result**
4) Combination of (ii) and (iii): **Probable cross connection**

[2] A dry weather flow is defined as one that is detected after an elapse of 72 hours of a continuous dry spell from the previous rainfall event.

In certain cases, the use of the closed circuit television camera is not possible. In such cases, the initial tests are conducted manually.

In a **"Manual Dye Test"**, a green dye placed in the storm FAI is drained and observed in the **storm sewer**. At the same time, a red dye is placed and drained in the sanitary FAI and observed in the **sanitary sewer**. If the green dye appears in the sanitary sewer, irrespective of the red dye's appearance in the storm sewer, the conclusion arrived at is "**Proper Connection**". If the green dye is not seen in the sanitary sewer, the test is repeated by placing and draining more dye from the sanitary FAI and observing its emergence in the **storm sewer**. This result signifies the presence of a "**Cross Connection**". All other combinations of observations in the Manual Dye Test are held to be "**Inconclusive**".

The initial dye tests, whether conducted manually or by a camera are intended to be least intrusive to the water customers. During these initial tests, no entry into the home is involved. In order to provide water for dye tests at the FAIs, field crews use portable water equipment. The Defective Connections group has two vehicles (Econoline vans) each retrofitted with 200 gallon water supply tanks.

(b) Confirmation Dye Test

A confirmation dye test is conducted in case of an Inconclusive test or a Possible cross connection. This test is conducted after a second notification to the customer has been sent. This test is **intrusive**; admission inside the home is required to conduct the complete test.

The confirmation dye test is conducted **manually** by placing and flushing the fluorescent dye in household plumbing fixtures, such as a toilet. The emergence of the dye is then observed in the **sanitary sewer**.

If the dye does appear in the sanitary sewer, it is concluded that the property tested has a "**Proper Connection**." If on the other hand the dye from the household plumbing does not appear in the sanitary sewer, then and only then an observation is made in the storm sewer. The presence of the dye in the storm sewer confirms the existence of a "**Cross Connection.**"[3]

(c) Notices of Defect (NOD)

When a confirmation dye test indicates that there exists a cross connection at the subject property, the property owner is advised that if the property qualifies as a residential property (with no more than 4 units in one of which the owner has his/her residence), the city will make repairs to the defective lateral(s) at no cost to the property owner. If later on it is discovered that the property does not fall within this category, the customer is informed by a follow up notice of his responsibility to repair the defect at their cost.

The Plumbing Repair Programs unit handles customer communications and is responsible for the abatement of these defects.

2) Customer Notifications

[3] This step was modified in CY2001 to conduct the tests from **all** plumbing fixtures, including any in the basement in order to identify the existence of an internal cross connection, where all fixtures but one are properly connected to the sanitary sewer, with one offending connection to the storm sewer.

(a) Initial Notification

The identification of the defective laterals begins after delineating the parts of a watershed suspected of contributing dry weather flow to the MS4 system, after field screening. All property holders in the specified area receive an initial notification letter, generated through the Oracle-based DLS computer program. The notification provides an introduction of the program and requests the customer's cooperation in enabling dye tests at their property. A dye test is conducted after an initial notification is sent out to a customer. There are three possible outcomes of a dye test:

(i) A test is conducted and no cross connection is found. In this case, a result of "No Cross Connection" is entered in the database and the case is closed.

(ii) A test is conducted and it is concluded that there might exist a cross connection that results in the transport of sanitary wastewater into the storm sewer. This condition requires additional tests to confirm the existence of a cross connection.

(iii) A test cannot be conducted due to any of a variety of reasons, such as FAIs were not conclusively identified, were clogged, etc. This situation also warrants additional tests to conclude whether or not a cross connection exists.

(b) Confirmation Notification

In either of case (ii) or (iii) above, a follow up notification is sent out to the customer, informing them of the results of the previous attempt and requesting them to be available at a specified date for additional "Confirmation" tests at their property. Of course, if the date provided by the City is not suitable to the customer, they can schedule an alternative appointment that suit them.

Dye tests are then conducted at the property from within the customer's premises as described earlier. The results of the tests, (a) a Proper Connection or (b) a Cross Connection, are entered in the DLS computer program.

(c) Water Shutoff Notification

Not all dye tests are completed as a result of confirmation notifications. Some customers ignore the scheduled date and fail to make an alternative appointment. In such cases an informatory note is left at the property and a follow up attempt for tests is made. If this also results in no test, another notification is sent out informing the customer that if they do not make a firm appointment by a specified date (usually within two calendar weeks of the notification date), their water service would be turned off by the Customer Service unit. Of course if the customers do respond and make an appointment for dye tests, the service shutoff is withdrawn and tests are completed as soon as possible.

(d) Miscellaneous Closures

In some cases, where there was no response to dye test requests or water service shutoff notifications due to properties being vacant or abandoned, the cases were closed with a notation "**Miscellaneous Closure**". A miscellaneous closure is activated because of any of the following reasons:

- No active water service to the premises

- Property abandoned, empty or unoccupied
- No billing to the property per Revenue Department
- No sewer connection

From time to time, the miscellaneously closed accounts are revisited. If we find that the reason that caused the account to be originally closed is no longer valid, a dye test is conducted and the property is then re-classified according to the test results.

III. PRIORITY OUTFALLS

During FY2010, the emphasis of the Defective Laterals Detection and Abatement program has been on outfalls at the top of the Priority Outfall List. The Priority Outfall List ranks all outfalls sampled with dry-weather flow based on a preset formula that includes the fecal coliform results, the estimated volume of flow, whether the outfall discharges to a drinking water source water, and a complaint factor. The Priority Outfall List is periodically updated based on the results of the (Permit) Outfall Inspection and Sampling Program described earlier.

IV. SUMMARY OF DYE TESTS AND ABATEMENTS

Table 1 provides a summary of the work performed in detecting and abating defective laterals. It shows the cumulative numbers since the inception of the project, and the progress that was attained during FY2010.

==

Table 1.
Updated Progress on Dye Tests in Philadelphia MS4 Area

	Since Inception of the Program	During Fiscal 2010
Dye Tests Initiated	40,986	3,666
No Cross Connections Found	38,909	3,522
Cross Connections Identified	1,068	58
Completed Tests	39,977	3,580
Abatements Completed	1,036	47

Of the 47 abatements above, 42 were residential properties. The cost for these abatements was $ 280,970.50. Additionally, 5 commercial properties were abated at a cost of $ 6,069.00.

V. MISCELLANEOUS

Estimates of Pollution Removed

The following data provides a rough measure of the effectiveness of the Defective Connections group's positive contribution to improving the local environment:

- Number of Cross Connections Abated
  Since Inception of the Program 1,036

During FY2010 47

- Estimated gallons of Polluted Water Prevented from entering the stormwater outfalls[4]
  Since Inception of the Program 145.6 million gallons per year
  During FY2010 6.6 million gallons per year

VI. STAFF LEVELS

Because of the high priority assigned to the Defective Connections group, the availability of manpower is extremely important. The sanctioned personnel for the unit is as follows:

One **Water Customer Services Supervisor**

Two **Field Representative Supervisors**

Four **Science Technicians**
One position vacant (since 10/12/07)

Eight **Utility Representatives**
One position vacant (since 8/1/08)
One position vacant (since 10/17/08)
One position vacant (since 8/31/07)

One **Clerk Typist II**

The above field and office staffs are organized under the Water Customer Services Supervisor. This position is responsible for all aspects of the unit. The two Field Representative Supervisors are each responsible for two field crews, four crews in all. Each crew is led by a Science Technician and has two Utility Representatives.

In addition to the field staff, the Defective Connections group has the following position which provides general support:

Clerk Typist II: The CT II handles the intricacies of the DLS database, creation of various correspondences related to dye tests, and follows-up with the field staff.

The CT II also handles a variety of communications with the customers, makes appointments, and follows-up with delinquent customers. They also maintain the record of water shutoff warnings and miscellaneous closures.

At the end of FY2010, 12 of the 16 approved positions in the Defective Connections group were filled.

[4] Based on an average use of 110 gallons per capita per day, over a family size of 3.5 persons.

APPENDIX P – MONOSHONE WATERSHED QUARTERLY WATER QUALITY UPDATES

Philadelphia PWD Water Department

The Monoshone Watershed

Quarterly Water Quality Update

Issue No. 1 May 2009

Caring About Philadelphia's Water Resources

The City of Philadelphia cares greatly about the streams that define its neighborhoods. We recognize that streams are critical human habitats, in addition to ecosystems that support aquatic life.

The Philadelphia Water Department (PWD) initiated a number of pollution prevention programs in the Monoshone Watershed in 1999. Since then, we have seen reductions in the levels of bacteria that indicate the presence of sewage at the seven stormwater outfalls that drain into the Monoshone Creek.

Much of this work is supported by local environmental organizations such as the Senior Environment Corps (SEC) and Chestnut Hill College (CHC). As a result of this partnership, PWD is publishing a quarterly water quality update to share bacteria sampling results at Outfall 5 and at a point downstream on the Monoshone, just south of RittenhouseTown.

This report is the first of those quarterly issues.

What is a WATERSHED?

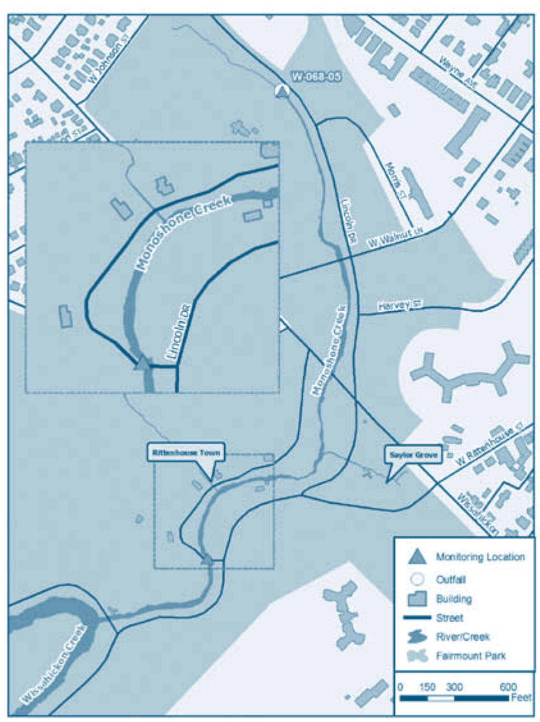
A watershed is the land surrounding a system of rivers (or streams or creeks), or a particular river, that, when it rains, sheds the runoff into that waterway. Everything you do impacts your watershed. Runoff from garden fertilizers, hazardous substances like used motor oil, and trash dumped into one area of a river bank can pollute water many miles downstream. Protecting and preserving our watersheds helps protect our water resources.

About the Monoshone Creek Watershed

PWD is working to protect the Monoshone Creek Watershed. One way we are doing this is through a number of programs focused on the basic problems of separate sewer systems in urban areas. This is a system in which one sewer collection system is dedicated to sanitary collection, such as waste from bathrooms and kitchens, and the other is dedicated to stormwater runoff collection, such as the rainwater that goes into the storm drains.

The Challenges of a Separate Sewer System

Separate storm sewers systems drain directly to waterways such as rivers, creeks, and streams. Urban environments can be challenging for these storm sewers, as the stormwater runoff can contain litter, gasoline, oils, fertilizers, animal wastes, and other pollutants that are washed from our lawns and streets into storm drains. In addition, high volumes of stormwater runoff are delivered to streams during intense rain storms, which harm stream habitats for fish and other wildlife.



Overview of the Monoshone Watershed: This map shows the Monoshone Creek and the locations of the Water Department's stormwater outfalls along the creek. Outfall Number 5, which receives the largest volume of stormwater runoff due to the size of the drainage area, is the location where PWD takes its quarterly fecal coliform sample. At the same time, a sample will be taken just south of Historic RittenhouseTown.

(Continued on page 2)

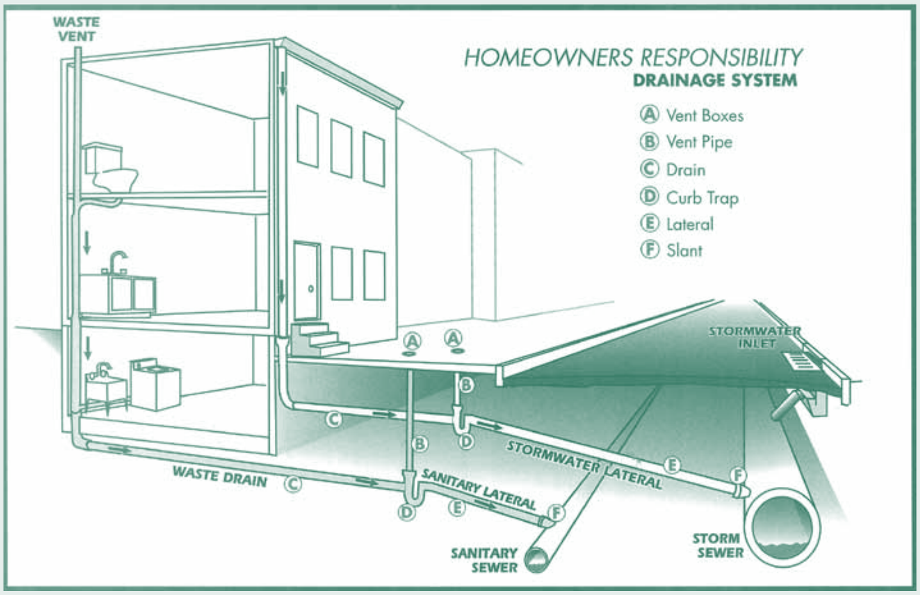
(Continued from page 1)

Our projects in the Monoshone Creek Watershed include the inspection and repair of defective sewer lateral pipes; the relining of the sanitary sewer under Lincoln Drive; stream channel restoration; the creation of the Saylor Grove Treatment Wetland demonstration project; and the initiation of the Wissahickon Watershed Partnership.

All of these projects are designed to help control stormwater runoff and stop pollutants from getting into our waterways.

For the Monoshone Creek and our other stream systems throughout the City – the Cobbs, the Tacony, the Wissahickon, the Pennypack and the Poquessing – this restoration will take some time. Each stream system has its own challenges.

In an urban environment, it is impossible to clean a river or stream to the point where there is no bacteria in that waterway. Animal wastes and other urban pollutants that are picked up by rainfall will always be a factor. Our challenge is to work with the City of Philadelphia and our community partners to achieve streams that are healthy for fish and wildlife, and are a joy to see and touch. That is a vision that the City champions.



The diagram above depicts a home plumbing system. The homeowner's responsibility for maintenance and repair includes all internal plumbing and fixtures, and extends to the items labelled "A" through "F." PWD is responsible for the sanitary sewers and storm sewers, as well as the stormwater inlets.

LONG TERM BACTERIA TRENDS MEASURED AS FECAL COLIFORM AT OUTFALL 5

Outfall 5 Lincoln & Morris	Date	Fluoride (milligrams per liter)	Fecal Count (# per 100 milligrams)
2007			
Outfall 5	3/26/07	0.33	2,000
Outfall 5	5/16/07	0.46	2,300
Outfall 5	9/17/07	0.97	3,800
Outfall 5	10/22/07	0.69	22,000
2008			
Outfall 5	3/13/08	0.12	360
Outfall 5	4/23/08	0.35	3,000
Outfall 5	9/15/08	0.57	138,000
Outfall 5	12/3/08	0.53	191,000

As the sampling above results illustrate, fecal coliform numbers are often in the low thousands which means we all still have much work to do. But at the same time, we have witnessed a marked improvement from sampling results taken a decade ago. Often, a high result is an indicator that there is a problem within the City's sewer or a property lateral(s), resulting in sewage entering the creek. PWD inspects the sewers in this area to track down and repair potential problems

Strategies For a Healthy Future

Meeting the challenges we face is a step-by-step process. In order to have success tomorrow, we need to put a number of small programs in place today. These programs will result in consistent, incremental improvements.

Revitalized, healthy streams will become a reality through the many approaches that the City has embraced. These strategies look at traditional pollutant sources such as property sewer lines and aging infrastructure, and how we can repair and maintain these to prevent pollution. Our strategies also include innovative programs that make green, sustainable development part of our everyday city planning.

Looking at the Numbers: What We Do on the Land Impacts Our Water

Bacteria sampling measures the levels of fecal coliform per 100 milliliters.

Fecal Coliform are bacteria that indicate the presence of sewage. The water quality standard is 200 fecal coliforms/100 ml – an extremely difficult goal to consistenly meet in urban streams. Typical sources of high fecal coliform counts in the Monoshone Creek include stormwater runoff, improperly connected house laterals, clogged sewer pipes, and leaking septic systems.

Fecal coliform bacteria are used as an indicator of the presence of sewage in streams and rivers.

Fluoride is a naturally occurring element, but high levels can indicate that treated water is finding its way into the creek. A fluoride concentration above 0.5 milligrams per liter may be an indicator of a leaking lateral(s), a sewer problem, or a leaking water service line or main.

PWD and the PA Department of Environmental Protection (PA DEP) measure water quality improvements over the long term. Our goal is to ensure that bacteria levels continue to decline as we put watershed protection programs in place and alter the way the urban landscape impacts our waterways. This topic will be covered in our next issue.

Responding to Emergency Events

PWD investigates and responds to incidents such as accidental spills, illegal dumping activities and sewer emergency repairs. These emergencies may result in large spikes in bacteria volumes. When high bacteria sampling results are discovered, they indicate to PWD that something unusual is happening in the drainage area, or that there may be a problem with a property lateral or with the City's sewer collection system.

The following sewage causing events and PWD follow up actions took place between September 2007 and December 2008. These events are related to the periodic spikes in high fecal counts in the Monoshone Creek:

September 2007: A choke in the manhole at Walnut and Kingsley Street resulted in a backup through the manhole and into the street. PWD's Sewer Maintenance Unit flushed and cleaned the manhole and sewer.

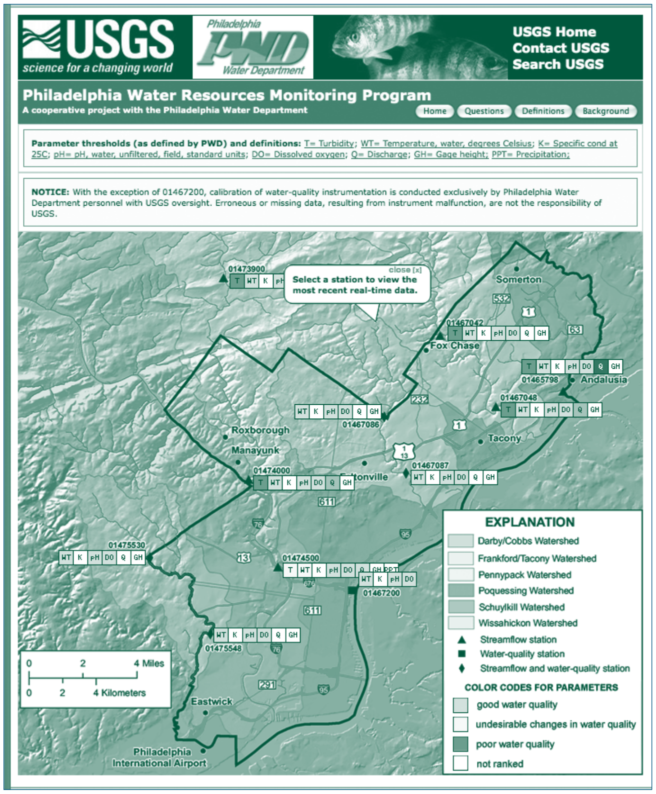
December 2007: A choke in the manhole at Walnut and Kingsley Street resulted in a backup through the manhole and into the street. PWD's Sewer Maintenance Unit flushed and cleaned the manhole and sewer.

September 2008: The sanitary lateral from the Park building in Blue Bell Park was found to be connected to the storm sewer, resulting in periodic sewage flows into the creek. PWD Sewer Maintenance cleaned the area. Fairmount Park made the necessary repairs and connected the building's sanitary lateral to the sanitary sewer.

December 2008: PWD's Industrial Waste Unit investigated an apparent discharge into the outfall by Saylor's Grove. The source of the discharge was traced to improper oil/grease disposal practices by the Burger King restaurant on Chelten Avenue. The practice was brought to the attention of the restaurant and district managers. PWD is continuing to monitor the outfall to ensure this practice doesn't happen again.

A number of these events were reported to the PWD by the public. We appreciate and rely on the public to call our hotline number at 215-685-6300 whenever they see a sewage or water leak on the street or in a stream.

Welcome to the Philadelphia Water Department's "Water Resources Monitoring Program" website (see below). The link is: http://pa.water.usgs.gov/pwd/



PWD has entered into a cooperative agreement with the United States Geological Survey (USGS) to develop a long-term monitoring system for our watersheds.

As you can see on the above map, which is displayed on the front page of the project website, each station, including Schuylkill at Fairmount Dam, has water quality information which includes Dissolved Oxygen, pH, Conductivity, Water Temperature and, in some instances, Turbidity.

This program was instituted as part of our comprehensive watershed monitoring program and will continue as an integral component of PWD's Storm Water and Combined Sewer Overflow (CSO) permits' monitoring requirements, as well as our Source Water Protection Program.

Under the agreement, PWD assumes the responsibilities of the water quality instrumentation while USGS continues to perform the operations and maintenance on the stations.

With this data, PWD will track spatial (upstream vs. downstream) patterns in water quality as well as temporal (day vs. night, historical, and interannual variation) patterns.

This will allow us to determine changes in water quality and quantity as we progress with the implementation of our integrated watershed management plans, as well as serving as a barometer for changes in global climate and sea level changes.

Next Issue: Information on PWD's Low Impact Development Green Infrastructure Program will be featured. This issue will appear in September, 2009.

For More Information:

PWD's Annual Stormwater and Combined Sewer Overflow (CSO) Annual Report and other watershed management and comprehensive characterization reports can be found at: www.phillyriverinfo.org.

For up to date information on the recreational water quality of the Schuylkill River, go to http://www.phillyrivercast.org/.

Here's What You Can Do:

Join a watershed partnership. For information, go to: www.phillyriverinfo.org.

Visit the Fairmount Water Works Interpretive Center, both on line at www.fairmountwaterworks.org, or in person at 640 Water Works Drive in Philadelphia.

Philadelphia PWD Water Department

The Monoshone Watershed

Quarterly Water Quality Update

Issue No. 2 September 2009

Separate and Combined Sewer Systems

In many of Philadelphia's homes, sanitary sewage and stormwater travel together through a combined sanitary/storm sewer system for treatment at one of the City's three sewage treatment plants, where it is cleaned before it is discharged to the Delaware River.

In some areas of Philadelphia, such as the Wissahickon Creek Watershed, stormwater from downspouts, yards and streets is piped to separate storm sewers and released into local streams. This stormwater runoff is not treated before it is released.

Homes that are serviced by separate storm sewers also have a separate drainage system for their sanitary sewage, which is collected in the sanitary sewer and sent to a treatment plant.

In some homes, the pipes (called laterals) leading to these two systems may be leaking or improperly connected. In this situation, sanitary sewage may enter stormwater sewers and may be released untreated into local waterways.

Laterals that are improperly connected (also known as crossed laterals or cross connections) and laterals that are leaking due to deterioration are known as defective laterals.

PWD (Philadelphia Water Department) funds the correction of the crossed laterals in its effort to improve stream water quality with minimal public impact.

Introduction

Welcome to PWD's Second Quarterly Water Quality Update for the Monoshone Creek. Following our May 2009 issue, we received a number of inquiries concerning the periodic high levels of fecal coliform that were measured at Outfall Five. Part of the problem of placing these high levels in some context — to determine if such high levels are a chronic problem and representative of the typical quality of the flow from Outfall 5 into the Monoshone — was the lack of a large sampling pool. As we shared in our last update, PWD is required to perform four quarterly samples at its priority stormwater outfalls and test all 404 of its stormwater outfalls within a five year period.

(Continued on page 2)

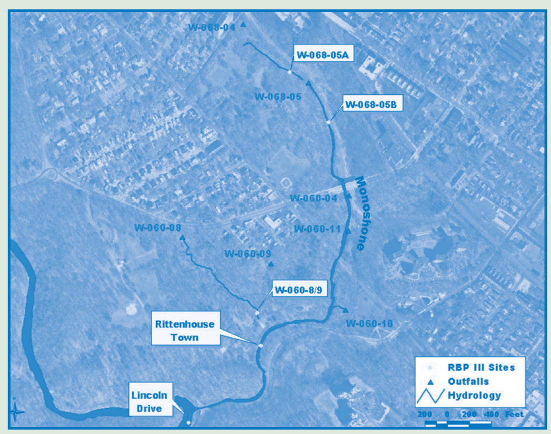
Challenges

Separate storm sewers can be beneficial to our rivers and streams as they often contain underground streams, providing essential base flow to our waterways.

But urban environments also present some challenges, as the quality of stormwater runoff can be tainted by litter, gasoline, oils, fertilizers, animal wastes and other pollutants that are washed from our lawns and streets into storm drains.

In addition, high volumes of stormwater runoff are delivered to streams during intense rain storms, which impacts stream habitats. The programs that PWD has instituted in the Monoshone Creek Watershed are programs focused on the inherent problems of separate sewer systems in urban areas.

Monoshone Watershed



Aerial View of the Monoshone Watershed:

The above aerial photograph shows the Monoshone Creek and the locations of the Water Department's stormwater outfalls along the creek. Outfall Number 5, which receives the largest volume of stormwater runoff due to the size of the drainage area, is the location where PWD takes its quarterly fecal coliform sample.

(Continued from page 1)

Summary of Fecal Coliform Results

Stormwater Outfall Monitoring Program

Data from project initiation (May '09) to present.

MONOSHONE CREEK Outfall #5 (ST068050)	
Sample Date	**Fecal Coliform (# per 100 milligrams)**
5/12/09	720
5/19/09	4,000
5/26/09	1,700
5/26/09	4,900
6/02/09	3,000
6/22/09	3,000
6/24/09	4,800
7/06/09	11,000
7/15/09	1,100
7/27/09	78000
8/17/09	26000
8/26/09	560000*
9/02/09	9400

*As the sampling above illustrates, fecal coliform numbers are often in the low thousands, which means we all still have work to do. But, at the same time, we have witnessed a marked improvement from sampling results taken a decade ago. Often, a high result – such as the one obtained on 8/26/09 – is an indicator that there is a problem within the City's sewer or a property lateral(s), resulting in sewage entering the creek. PWD inspects the sewers in this area to track down and repair potential problems. We did not find a problem in our system and therefore believe it is related to a private property problem.

MONOSHONE CREEK -- Downstream Site (MONO250)	
Sample Date	**Fecal Coliform (# per 100 milligrams)**
5/12/09	400
5/19/09	300
5/26/09	1,000
6/02/09	180
7/06/09	900
7/15/09	200
8/17/09	700
8/26/09	540
9/02/09	500

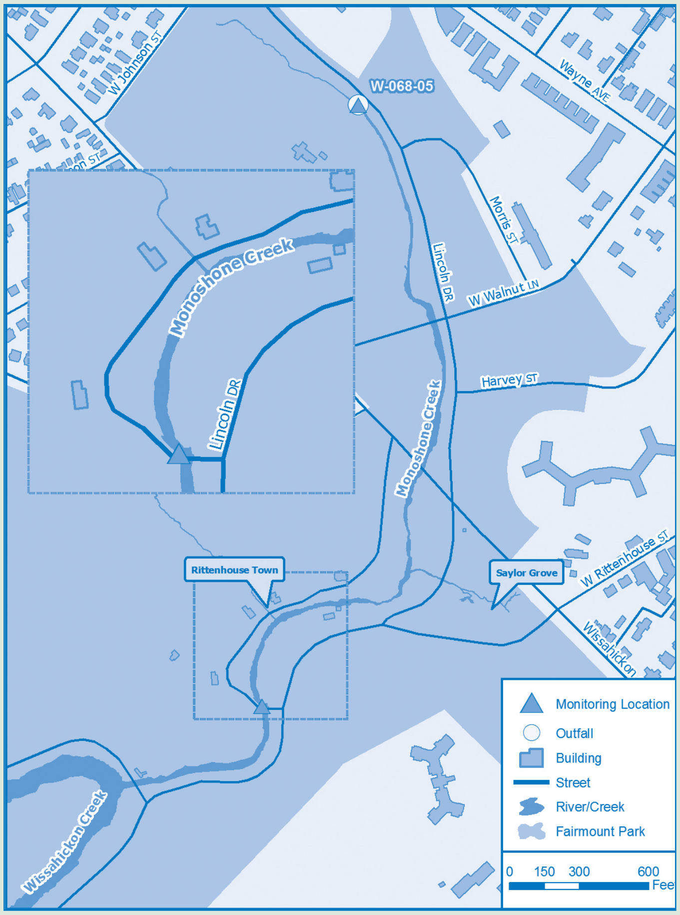
Pilot Monitoring Program

We felt that additional samples were needed at Outfall 5 to give us a better picture of typical water quality at this outfall. We also wanted to determine if PWD crews could make a more timely response if sampling showed that a pollution-causing event was happening somewhere in the Outfall 5 drainage area.

To address these issues, this past May we initiated a pilot sampling program, geared to collect samples at both Outfall 5 and a location downstream of RittenhouseTown, above the confluence of the Monoshone and Wissahickon creeks. Originally, we were going to collect samples on a weekly basis, three times a month, during dry weather (no rainfall within a 72 hour period), as the sampling goal was to determine the quality of the stream flow within Outfall 5 untainted by polluted stormwater runoff. Because this summer was a fairly wet one, we did not collect as many samples as we had hoped. However, we did accumulate a fair number of samples at both locations and plan to continue this sampling program into the future.

Pilot Monitoring Program Results

The good news: fecal coliform results, beginning in May 2009, illustrate a consistently fair water quality for an urban stream like the Monoshone, and sampling results are even better in the creek itself by the time the stream travels past RittenhouseTown. These results are comparable to fecal counts found in all of the streams in the urban Southeast PA Region.



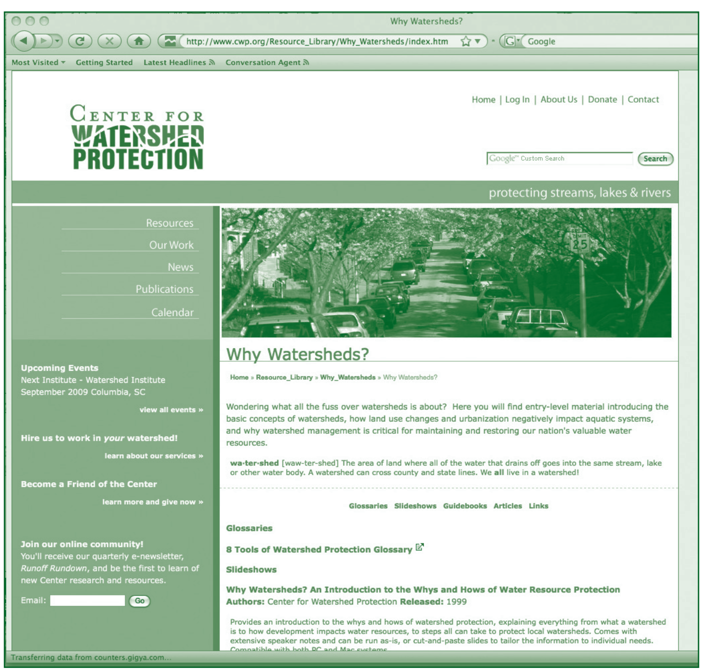
Overview of the Monoshone Watershed:

This map shows the Monoshone Creek and the locations of the Water Department's stormwater outfalls along the creek. Outfall Number 5, which receives the largest volume of stormwater runoff due to the size of the drainage area, is the location where PWD takes its quarterly fecal coliform sample. At the same time, a sample is taken just south of Historic RittenhouseTown.

FACT:

The Monoshone Watershed drains approximately 1,100 acres, of which 40 percent is impervious.

Information from the Center for Watershed Protection on Impervious Surfaces and their Impact on Stream Water Quality



Research has revealed that imperviousness is a powerful and important indicator of future stream quality and that significant degradation occurs at relatively low levels of development. The strong relationship between imperviousness and stream quality presents a serious challenge for urban watershed managers. It underscores the difficulty in maintaining urban stream quality in the face of development. At the same time, imperviousness represents a common currency that can be measured and managed by planners, engineers and landscape architects alike. It links activities of the individual development site with its cumulative impact at the watershed scale. With further research, impervious cover can serve as an important foundation for more effective land use planning decisions.

For the entire article, go to the Center for Watershed Protection's Website at: http://www.cwp.org/Resource_Library/Why_Watersheds/index.htm.

Long Term Plan

PWD will continue to invest in its long term plans to address water quality problems in its streams and rivers through its integrated watershed management approach, seeking opportunities to slowly redevelop the City so that it manages stormwater in an environmentally beneficial way. Additional information about the Department's strategy can be found in its recent report titled, *Green City, Clean Watershed*, submitted to the PA DEP and EPA on September 1. The entire report, and a public summary, are currently on line at www.phillywatersheds.org/ltcpu.

Aeration

How it works

As a stream flows over rocks and riffles, oxygen gets introduced into the water, which improves the ability of beneficial microbes in the stream to break down and remove bacteria and excess nutrients.

In some urban streams, this process does not occur due to a lack of riffles or excessive amounts of sediment deposition, which decreases the flow of oxygen through the streambed.

This in turn decreases the amount of oxygen available to stream insects and the fish that use them as a food source. It also promotes the presence of anaerobic bacteria. These microbes break down nutrients and the waste products of other organisms (more slowly), but the by-product of this anaerobic process (similar to fermentation of beer or lactic acid production in a runner's legs) is the creation of methane gas, nitrates, hydrogen sulfide (swamp gas) and other chemicals that are harmful or toxic to stream organisms.

That is why aerators are used in man-made ponds and detention basins. Adding oxygen, artificially or naturally, improves water's ability to self-cleanse.

We are also continuing to investigate pollution sources to the Monoshone that include: defective laterals, spills, improper disposal of wastes, and other sources that can impact the Monoshone Creek.

Investigations

When we received the high fecal count at Outfall Five on August 26, we dispatched a Sewer Maintenance crew to check the outfall and sewers in the immediate area for the source of pollution.

However, although only a day had passed since the sample was taken and tested, and the crew notified, when the crew reached the site, the outfall no longer showed apparent contamination. This is a constant challenge in a separate sewer system - contamination can happen anywhere in the system, at any time. It is not necessarily a constant.

Moving forward, PWD will be assessing health facilities, businesses and other non-residential properties to ensure that proper use of storm and area drains are taking place. We will also be identifying sections of the watershed that have septic systems and private sewers.

Next Issue:

Update on Pilot Sampling Program

For More Information:

PWD's Annual Stormwater and Combined Sewer Overflow (CSO) Annual Report and other watershed management and comprehensive characterization reports can be found at: www.phillyriverinfo.org.

For up to date information on the recreational water quality of the Schuylkill River, go to http://www.phillyrivercast.org/.

Here's What You Can Do:

Join a watershed partnership. For information, go to: www.phillyriverinfo.org.

Visit the Fairmount Water Works Interpretive Center, both online at www.fairmountwaterworks.org, or in person at 640 Water Works Drive in Philadelphia.

What is a WATERSHED?

A watershed is the land surrounding a system of rivers (or streams or creeks), or a particular river, that, when it rains, sheds the runoff into that waterway. Everything you do impacts your watershed. Runoff from garden fertilizers, hazardous substances like used motor oil, and trash dumped into one area of a river bank can pollute water many miles downstream. Protecting and preserving our watersheds helps protect our water resources.

Philadelphia Water Department

The Monoshone Watershed

Quarterly Water Quality Update

Issue No. 3 February 2010

Introduction

Welcome to the Philadelphia Water Department's (PWD) Third Quarterly Water Quality Update for the Monoshone Creek. This issue provides updates on our Saylor Grove Treatment Wetland, and more detailed sampling information.

Saylor Grove Site Facts

- Saylor Grove Park is approximately 3.2 acres. The Saylor Grove Wetland makes up about one-third of the park.
- Saylor Grove Wetland drains approximately 156 acres of stormwater runoff from Germantown. The wetland is designed to drain the stormwater within 24 hours.
- Saylor Grove Wetland will filter a significant portion of the estimated 70 million gallons of stormwater per year.
- The wetland will remove approximately 13 tons of total suspended solids from the Monoshone Creek per year.
- The first 0.7 inches of every rainfall event will be sent to and treated at the wetland. According to the long-term historical record of the airport's rainfall data, 70% of all storms make up 0.7 inches or less of rainfall.
- The wetland will improve flow variability of the Monoshone Creek.
- The wetland will increase biodiversity (vegetation and animals).
- Approximately 3,000 trees, shrubs, and herbaceous plugs have been planted.

Saylor Grove Treatment Wetland: What has been happening there?

The Saylor Grove Treatment Wetland had been treating stormwater runoff from a drainage area of approximately 156 acres for over three years now. During this time, the wetland bottom has seen an accumulation of a large amount of sediment and some organic matter that settled as the water was retained in the basin. This sediment buildup has reduced the volume of water that the wetland can hold and treat, which created the need for the dredging operation of the pond. We expected this to happen, as both detention basins and man-made treatment wetlands require periodic dredging in order to allow them to continue to operate in an optimal manner. (The sediment collected in the treatment wetland is sediment that does not make its way to the Monoshone Creek).

(continued on page 2)

Separate and Combined Sewer Systems

In many of Philadelphia's homes, sanitary sewage and stormwater travel together through a combined sanitary/storm sewer system for treatment at one of the City's three sewage treatment plants, where it is cleaned before it is discharged to the Delaware River.

In some areas of Philadelphia, such as the Wissahickon Creek Watershed, stormwater from downspouts, yards and streets is piped to separate storm sewers and released into local streams. This stormwater runoff is not treated before it is released.

Homes that are serviced by separate storm sewers also have a separate drainage system for their sanitary sewage, which is collected in the sanitary sewer and sent to a treatment plant.

In some homes, the pipes (called laterals) leading to these two systems may be leaking or improperly connected. In this situation, sanitary sewage may enter stormwater sewers and may be released untreated into local waterways.

Laterals that are improperly connected (also known as crossed laterals or cross connections) and laterals that are leaking due to deterioration are known as defective laterals.

PWD funds the correction of the crossed laterals in its effort to improve stream water quality with minimal public impact.

(Saylor Grove *from page 1)*

PWD has done a topographic survey of the wetland, using the as-built elevations versus the survey gathered prior to the dredging to determine the amount of sediment that had built-up throughout the wetland and that would have to be removed to get the wetland back to the as-built elevations and volume. This information will give us the sense as to how often the wetland should be dredged as a component of its long-term operation and maintenance.

In order to effectively dredge the site, the wetland was drained so that the material removed would have a larger solid content. During the work, a survey was done to confirm that the appropriate elevations were achieved in a particular area prior to moving on. The forebay pond area was dug to about three feet in the deepest part and graded, while the channel areas around the left and right sides of the island were excavated up to two feet. The northeast area of the wetland was left undisturbed due to the existence of vegetation that we wanted to preserve and the 48-inch stormwater pipe that runs beneath the wetland. Currently, PWD is testing the removed material to determine its characteristics and content, including moisture content, organic vs. inorganic composition, nutrients such as nitrogen and phosphorus, and chemical constituents. With this knowledge, we will gain a better understanding of just how effective the wetland has been in treating stormwater runoff, as this wetland is serving as a model for similar projects in the Wissahickon Creek Watershed.

Why we use Fecal Coliform as an Indicator

Fecal coliform bacteria indicate fecal contamination and the potential presence of human pathogens (microorganisms that can make people sick). The fecal coliform test is used because it is reliable, relatively simple to perform, and provides results quickly and inexpensively compared to tests for specific pathogens. One of the disadvantages of the fecal coliform test is that these bacteria are found in feces of many different kinds of warm-blooded animals, not just in sanitary flow. Although not ideal, fecal coliform is presently regulated by PADEP water quality standards and used by PWD for screening sources of potential pollution in streams and dry weather flow from stormwater outfalls.

When performing a fecal coliform test, lab scientists do not actually count individual bacteria themselves, but count the colonies that grow from a single bacterium. A sample of water is passed through a very fine filter which is then placed in a petri dish containing a food source and a selective indicator chemical. If bacteria are able to consume the food source and multiply, the chemical indicator changes color. Each color spot on the petri dish is considered one "colony forming unit" (CFU).

PWD lab scientists need to be able to test for bacteria in samples that range from very pure (drinking water) to polluted (stormwater), so they may use a much smaller subsample of water when testing stormwater and multiply the number of colonies counted by the amount that the sample was diluted. This is why the precision of the results decreases as bacteria concentration increases. With the large dilution factors applied for testing a stormwater sample, each spot on the plate can represent 1000 bacteria (or more) in the final sample result.

Summary of Fecal Coliform Results

Stormwater Outfall Monitoring Program

Data from project initiation (May '09) to present.

MONOSHONE CREEK Outfall #5 (ST068050)

Sample Date	Fecal Coliform (# per 100 milliliters)
05/12/09	720
05/19/09	4,000
05/26/09	1,700
05/26/09	4,900
06/02/09	3,000
06/22/09	3,000
06/24/09	4,800
07/06/09	11,000
07/15/09	1,100
07/27/09	78,000
08/17/09	26,000
08/26/09	560,000*
09/02/09	9,400
09/08/09	5,100
09/21/09	7,600
09/21/09	1,100
10/06/09	4,900
10/14/09	7,270
10/27/09	12,300
11/09/09	5,000
11/18/09	7,545
11/30/09	45,000
12/29/09	200
12/29/09	210
12/30/09	280
01/05/10	964
01/12/10	4,600

MONOSHONE CREEK -- Downstream Site (MONO250) RITTENHOUSETOWN SITE

Sample Date	Fecal Coliform (# per 100 milliliters)
05/12/09	400
05/19/09	300
05/26/09	1,000
06/02/09	180
07/06/09	900
07/15/09	200
08/17/09	700
08/26/09	540
09/02/09	500
09/08/09	800
09/21/09	1,100
10/06/09	800
10/14/09	200
11/09/09	100
11/18/09	100
11/30/09	300
12/30/09	150
01/05/10	10
01/12/10	45

*As the sampling above illustrates, fecal coliform numbers are often in the low thousands, which means we all still have work to do. But, at the same time, we have witnessed a marked improvement from sampling results taken a decade ago. Often, a high result – such as the one obtained on 8/26/09 – is an indicator that there is a problem within the City's sewer or a property lateral(s), resulting in sewage entering the creek. PWD inspects the sewers in this area to track down and repair potential problems. We did not find a problem in our system and therefore believe it was related to a private property problem.

Water is considered safe for recreation (immersing oneself in the water) when it tests below 200 colonies per 100 milliliters of sample. The Monoshone, as is true with other urban streams, rarely consistently meets that target as bacteria sources include sewage leaks, wildlife and stormwater runoff. That is why it is important to wash your hands or other parts of your body that come into contact with waterways when fishing or hiking just as you would do when gardening in your backyard.

Why does fecal coliform bacteria concentration decrease in the Monoshone from Outfall 5 to RittenhouseTown?

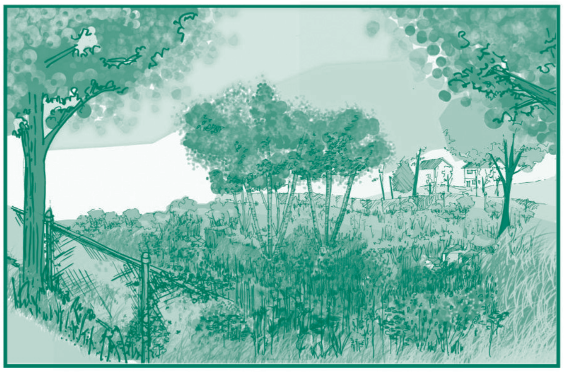
Indicator bacteria generally grow best under conditions similar to the gut of warm-blooded animals. Once exposed to the environment, these bacteria may die or become otherwise injured such that they do not produce colonies in laboratory tests. Bacteria may die from natural causes, such as being eaten by other organisms, or changes in water chemistry, temperature, and sunlight exposure. Urban stormwater may also contain pollutants that are toxic or injurious to bacteria.

Dilution by other sources of water with smaller concentrations of indicator bacteria causes the overall bacteria concentration to decrease. There are several sources of flow to the Monoshone Creek between outfall 5 and the MONO250 RittenhouseTown monitoring site.

Bacteria, and particles to which bacteria are attached, settle out of the water column. Indicator bacteria in sediments generally die and are consumed by decomposers. However, some bacteria may be re-suspended during subsequent storm events, or rarely, even multiply within sediments under favorable conditions.

Additional Stormwater Treatment Wetlands to be Constructed in the Wissahickon Creek Watershed

The Saylor Grove Stormwater Treatment Wetland served as a working model for two new treatment wetlands planned to begin construction this spring - the Cathedral Road and Wises Mill Stormwater Treatment Wetlands. PWD and its partners are very excited about the opportunity to treat polluted stormwater runoff before it flows into these important tributaries of the Wissahickon Creek.



PWD and the Fairmount Park Commission are working together to design a stormwater treatment wetland at the headwaters of Cathedral Run. Cathedral Run is a small first order tributary to the Wissahickon Creek. The stream originates from springs downstream of Courtesy Stables and then travels approximately 2,500 ft through a wooded section of Fairmount Park before entering Wissahickon Creek. The stream is relatively steep with an average gradient of 8.5%; however, the downstream half of the tributary is visibly steeper than the upstream reach.

The watershed is highly developed with 31% impervious cover and 361 homes. The natural drainage area is 116 acres; however two outfalls collect stormwater from an additional 40 acres. Base flow is low and was measured to be 0.06 cfs during August 2005. One outfall (W-076-01) located at the headwaters of the tributary drains approximately 91 acres of residential and commercial property.

The stormwater wetland will be designed to achieve the following goals:

- Reduce downstream sediment loading
- Improve the flow variability of storm related flows on Cathedral Run
- Increase base flow
- Improve diversity of in-stream biological community
- Maintain and enhance recreational use/aesthetics
- Reduce shear stress in channel
- Ensure wetland drains within 72 hours

Schuylkill Soundings Presents:

Freshwater Mussel Restoration Program
A Project of the Partnership for the Delaware Estuary

Wednesday, February 17, 2010 • 6:00 pm to 8:00 pm
Fairmount Water Works Interpretive Center

Please RSVP by February 15. For reservations or information, please call 215-685-0723. Visit us at 640 Water Works Drive, Phila PA 19130 or online at www.fairmountwaterworks.org.

Next Issue:

PWD will be reaching out to its environmental and citizen partners to initiate a Stormwater Troopers program –– an event in which PWD and community partners saturate the neighborhood that drains into Outfall 5 to raise awareness of defective laterals and other problems that can contribute to the pollution of the Monoshone Creek.

For More Information:

PWD's Annual Stormwater and Combined Sewer Overflow (CSO) Annual Report and other watershed management and comprehensive characterization reports can be found at: www.phillywatersheds.org.

For up to date information on the recreational water quality of the Schuylkill River, go to http://www.phillyrivercast.org/.

Here's What You Can Do:

Join a watershed partnership. For information, go to: www.phillyriverinfo.org.

Visit the Fairmount Water Works Interpretive Center, both online at www.fairmountwaterworks.org, or in person at 640 Water Works Drive in Philadelphia.

What is a WATERSHED?

A watershed is the land surrounding a system of rivers (or streams or creeks), or a particular river, that, when it rains, sheds the runoff into that waterway. Everything you do impacts your watershed. Runoff from garden fertilizers, hazardous substances like used motor oil, and trash dumped into one area of a river bank can pollute water many miles downstream. Protecting and preserving our watersheds helps protect our water resources.

Philadelphia Water Department

The Monoshone Watershed

Quarterly Water Quality Update

Issue No. 4 July 2010

Introduction

Welcome to PWD's Fourth Quarterly Water Quality Update for the Monoshone Creek.

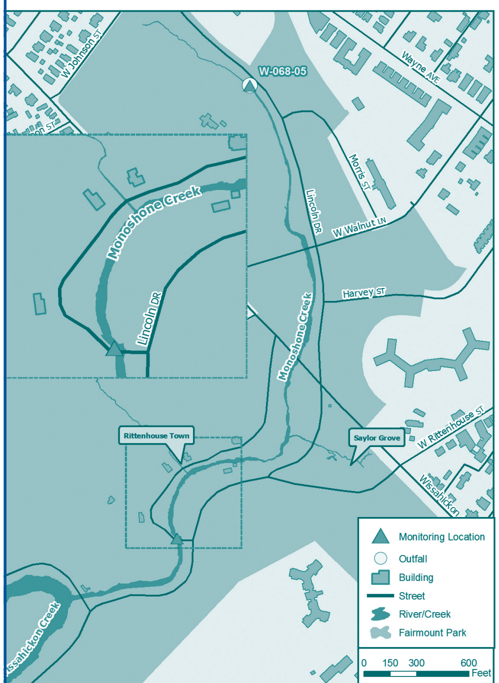
As you may remember, we initiated a pilot sampling program in May 2009, geared to collected samples at Outfall 5 and a location downstream of RittenhouseTown, above the confluence of the Monoshone and Wissahickon creeks.

Samples are collected on a weekly basis, three times a month, during dry weather (no rainfall within a 72 hour period) as the sampling goal is to determine the quality of the stream flow within Outfall 5 untainted by polluted stormwater runoff.

During some months, we did not collect as many samples as we had hoped due to lots of rain. However, in this report, we have a full year of data to share, which reflects the water quality of the Monoshone Creek during all four seasons.

Pilot Monitoring Program Results

We still believe that the news on water quality is generally good for an urban stream like the Monoshone, and sampling results prove consistently better in the creek itself by the time the stream travels past RittenhouseTown. These results are comparable to fecal counts found in all of the streams in the built out, Southeast PA Region. But we still find some outliers in this data, and our goal has been to track down and resolve the sources of this bacteria.



Overview of the Monoshone Watershed:

This map shows the Monoshone Creek and the locations of the Water Department's stormwater outfalls along the creek. Outfall Number 5, which receives the largest volume of stormwater runoff due to the size of the drainage area, is the location where PWD takes its quarterly fecal coliform sample. At the same time, a sample is taken just south of Historic RittenhouseTown.

Summary of Fecal Coliform Results

Stormwater Outfall Monitoring Program
Data from project initiation (May '09) to present.

MONOSHONE CREEK -- Downstream Site (MONO250) RITTENHOUSETOWN SITE	
Sample Date	Fecal Coliform (# per 100 milliliters)
05/12/09	400
05/19/09	300
05/26/09	1,000
06/02/09	180
07/06/09	900
07/15/09	200
08/17/09	700
08/26/09	540
09/02/09	500
09/08/09	800
09/21/09	1,100
10/06/09	800
10/14/09	200
11/09/09	100
11/18/09	100
11/30/09	300
12/30/09	150
01/05/10	10
01/12/10	45
01/26/10	no sampling
03/02/10	no sampling
03/10/10	209
04/06/10	100
04/20/10	10
05/11/10	60
06/08/10	200

(continued on page 2)

(Pilot Monitoring *continued from page 1*)

MONOSHONE CREEK Outfall #5 (ST068050)	
Sample Date	Fecal Coliform (# per 100 milliliters)
05/12/09	720
05/19/09	4,000
05/26/09	1,700
05/26/09	4,900
06/02/09	3,000
06/22/09	3,000
06/24/09	4,800
07/06/09	11,000
07/15/09	1,100
07/27/09	78,000
08/17/09	26,000
08/26/09	560,000*
09/02/09	9,400
09/08/09	5,100
09/21/09	7,600
09/21/09	1,100
10/06/09	4,900
10/14/09	7,270
10/27/09	12,300
11/09/09	5,000
11/18/09	7,545
11/30/09	45,000
12/29/09	200
12/29/09	210
12/30/09	280
01/05/10	964
01/12/10	4,600
03/10/10	5,500
04/06/10	11,000
04/20/10	3,600
05/11/10	2,200
06/08/10	2,400

*As the sampling above illustrates, fecal coliform numbers are often in the low thousands, which means we all still have work to do. But, at the same time, we have witnessed a marked improvement from sampling results taken a decade ago. Often, a high result – such as the one obtained on 8/26/09 – is an indicator that there is a problem within the City's sewer or a property lateral(s), resulting in sewage entering the creek. PWD inspects the sewers in this area to track down and repair potential problems. We did not find a problem in our system and therefore believe it was related to a private property problem.

Defective Laterals and Private Sewers

We shared in the past that identifying the sources of sewage in our stormwater sewer pipes may begin at the outfall – the end of the stormwater sewer that empties into the Monoshone Creek – but that is only the beginning of the journey.

We have been focusing on Outfall 5, which receives the stormwater flow from homes, businesses and streets spread over a 630-acre area. We know that sewage from properties enters the city's storm sewers from two chronic sources: leaking property sewer and storm laterals and from property laterals that are connected to the wrong sewer.

As we noted in past updates, the Monoshone Creek Watershed is a separate sewer area, which means there is a sanitary sewer pipe and a stormwater sewer pipe in every block. Every property has a lateral pipe connection to the sanitary sewer which drains your household plumbing fixtures (sinks, showers, toilets, washers) and a stormwater lateral pipe which captures your roof and yard runoff for delivery to the storm sewer. The laterals pipes are often installed side by side. Over the years they age and deteriorate and sometimes allow the flow from the one pipe into the other.

But our efforts now are targeted at identifying the lateral pipes that are "crossed" or connected to the wrong sewer. Even though these are the property owner's responsibility, PWD will pay for the correction of these crossed laterals as a component of its program.

Since 1999, PWD has inspected approximately 2,400 properties out of the 4,100 homes in the Monoshone Creek Watershed in its quest to find the crossed lateral connections that result in a continuous sewage contribution to the Monoshone Creek. Properties are investigated only after evidence has determined that they may have defective laterals. As a result of these inspections, 92 properties were found to have crossed lateral connections.

Most recently, we are now working on 14 blocks in the outfall 5 drainage area that are blocks with private sewers – sewers that are not owned or maintained by PWD but connect into our system. These sewers are "combined" sewers – sewers that collect both household sanitary wastes and stormwater into one sewer. Our testing over the next month will determine whether or not the entire block sewer is connected to the appropriate city sewer.

Philadelphia Water Department

The ARAMARK Tower
1101 Market Street
Philadelphia, Pennsylvania 19107-2994

BERNARD BRUNWASSER
Commissioner

June 3, 2010

Dear Resident:

Within the next week or two, the Water Department will be inspecting the sewer system in your neighborhood. These inspections are aimed at insuring proper configuration of your drainage system. Due to State and Federal regulatory requirements, the Water Department is required to investigate these conditions.

The Water Department personnel will be performing these tests from the street. However, there may be situations where we need to access your property in order to complete these tests. If such situations arise, we will send you a follow-up letter.

Thank you for your attention and cooperation in this matter. Should you have any questions, please feel free to contact me at 215-685-6255.

Very truly yours,

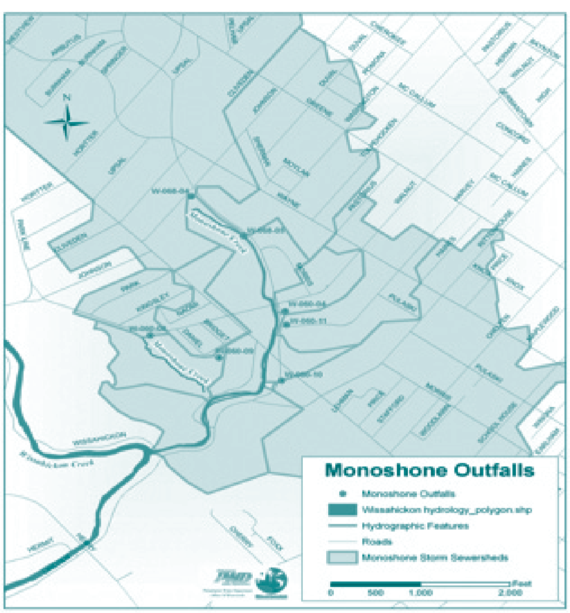
Project Manager

An Equal Opportunity Employer

This letter (right) will go out to residents on the private sewer blocks in the area to let them know about the inspections PWD will be performing to determine if there are crossed laterals in the neighborhood. The majority of the Monoshone drainage area has already completed defective lateral testing at the block level.

The map (below) shows the outfalls in the Monoshone Creek area.

The PWD worker (below left) is placing a CCTV (Closed Circuit Television) video camera into the sewer in order to see if there are crossed laterals in the system.



What are the Challenges of the Defective Lateral Program?

It is like looking for a needle in a haystack because:

- A block may not appear “wet” if no one is using their plumbing
- Once a block is established as wet, extremely time consuming to test every property on block (often 40 – 60 houses)
- If tests results are not clear, must get into property to dye test plumbing fixtures on all floors – letters to customers and appointments. Can result in an average of 4 – 5 internal tests per day
- Vast majority of sewage infiltration is from broken, leaking laterals

Update on Saylor Grove

Recently we found a plant that we hadn't discovered before at the Saylor Grove Stormwater Treatment Wetland. The plant was identified as an American bur reed, and there are a cluster of them on the pond banks. It is a native stalk like plant that has a lithe beauty and attracts birds and insects such as butterflies. The best habitat for these plants is shallow waters and mud banks. In addition, Fairmount Park and PWD have recently completed a seeding of the area that was disturbed during the dredging of the forebay section of the pond. The area was planted with 19 pounds of native seeds. Birds spotted at the wetland during a recent stroll included red-winged blackbirds and goldfinches.

Schuylkill Soundings at the Fairmount Water Works Interpretive Center Presents:

July 21 at 5:30 p.m.: Joan Blaustein and Tom Witmer, Parks and Rec, present "Models of Ecological Restoration in Philadelphia"

August 18 at 5:30 p.m.: Adam Levine presents "The City's Hidden Streams"

To reserve, contact emilie.hickerson@phila.gov. Visit us at 640 Water Works Drive, Phila PA 19130 or online at www.fairmountwaterworks.org. On Twitter: @FWWIC.

Next Issue:

Our next issue will include the results of the defective lateral testing completed on the 14 private sewer blocks.

For More Information:

PWD's Annual Stormwater and Combined Sewer Overflow (CSO) Annual Report and other watershed management and comprehensive characterization reports can be found at: www.phillywatersheds.org.

For up to date information on the recreational water quality of the Schuylkill River, go to http://www.phillyrivercast.org/.

Here's What You Can Do:

Join a watershed partnership. For information, go to: www.phillyriverinfo.org.

Visit the Fairmount Water Works Interpretive Center, both online at www.fairmountwaterworks.org, or in person at 640 Water Works Drive in Philadelphia.

What is a WATERSHED?

A watershed is the land surrounding a system of rivers (or streams or creeks), or a particular river, that, when it rains, sheds the runoff into that waterway. Everything you do impacts your watershed. Runoff from garden fertilizers, hazardous substances like used motor oil, and trash dumped into one area of a river bank can pollute water many miles downstream. Protecting and preserving our watersheds helps protect our water resources.

APPENDIX Q –
DEFECTIVE LATERALS GROUP
QUARTERLY REPORTS

STORM WATER MANAGEMENT PROGRAM
NPDES PERMIT NO. PA0054712

DEFECTIVE LATERAL CONNECTION STATUS REPORT
(Covering Period from July 1, 2009 to September 30, 2009)

Submitted to

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER QUALITY MANAGEMENT

By

CITY OF PHILADELPHIA
PHILADELPHIA, PA

November 13, 2009

DLC Program Update
3rd Quarter 2009

I. INTRODUCTION

This Defective Lateral Connection Status Report is submitted to the Pennsylvania Department of Environmental Protection (PADEP) as part of the reporting requirements of the City of Philadelphia NPDES Storm Water Management Permit No. PA 0054712. The report covers the three-month period beginning July 1, 2009 and ending September 30, 2009.

The body of this report will describe the recent activities of the City during the past quarter within the Priority Outfall areas and at other significant outfalls on the Stormwater Priority Outfall List. Additionally, goals for the next quarter will be listed.

Table 1 provides a summary of the program with respect to Complete tests, Cross-connections identified, and Abatements performed. Table 2 provides a listing of all laboratory analyses of samples taken at stormwater outfalls or within the stormwater system during the previous quarter. Table 3 provides a listing of properties with cross-connections outstanding greater than 120 days. Finally, Table 4 provides a listing of reported spills to the stormwater system or receiving streams.

II. PAST QUARTER REVIEW

A. Priority Outfalls

1. 7th & Cheltenham Outfall (T-088-01)

DLC program activities have performed 2,829 Complete tests in this sewershed, identifying 132 Cross-connections, all but 1 of which have been Abated.

Six (6) sites intercepting flow from 5 targeted areas are listed below.

1. CFD-01 Plymouth St., west of Pittsville St.
2. CFD-02 Pittsville St., south of Plymouth St.
3. CFD-03 Elston St., east of Bouvier St.
4. CFD-04 Ashley St., west of Bouvier St.
5. CFD-05 Cheltenham Ave., east of 19th St.
6. CFD-06 Verbena St., south of Cheltenham Ave.

The number of inspections, blockages cleared and discharges noted during this quarter are listed below.

Flap Gate	Inspections	Blockages	Discharges
CFD-01	13	1	0
CFD-02	15	3	0
CFD-03	13	0	0
CFD-04	11	0	0
CFD-05	12	0	0
CFD-06	10	0	0

The most recent fecal sample value was 77000 fecal colonies per 100 ml. at the outfall on September 21, 2009.

2. Monastery Ave. Outfall (W-060-01)

DLC program activities have performed 611 Complete tests in this sewershed, identifying 16 Cross-connections, all of which have been Abated.

Two (2) sites intercepting flow are listed below.

1. MFD-01 Jannette St., west of Monastery Ave.
2. MFD-02 Green La., north of Lawnton St.

The number of inspections, blockages cleared and discharges noted during this quarter are listed below.

Flap Gate	Inspections	Blockages	Discharges
MFD-01	11	0	0
MFD-02	11	0	0

The most recent fecal sample value was 23000 fecal colonies per 100 ml. at the outfall on September 21, 2009.

3. Monoshone Creek Outfalls (W-060-04, W-060-08, W-060-09, W-060-10, W-060-11, W-068-04 and W-068-05)

DLC program activities have performed 2,742 Complete tests in these sewershed areas, identifying 92 Cross-connections, all of which have been Abated. The majority of the efforts have been in the W-068-05 sewershed area which is by far the largest in terms of drainage area and properties served.

The most recent fecal sample value was 1100 fecal colonies per 100 ml. at the W-068-05 outfall on September 21, 2009.

4. Manayunk Canal Outfalls (S-051-06, S-058-01, S-059-01 through S-059-11)

DLC program activities have performed 2,444 Complete tests in these sewershed areas, identifying 59 Cross-connections, all of which have been Abated. The majority of the efforts have been in the S-059-04 sewershed area.

The most recent fecal sample value was 2100 fecal colonies per 100 ml. at the S-058-01 outfall, 360 fecal colonies per 100 ml. at the S-059-01 outfall, 23000 fecal colonies per 100 ml. at the S-059-02 outfall, 1800 fecal colonies per 100 ml. at the S-059-03 outfall, 730 fecal colonies per 100 ml. at the S-059-04 outfall, 180 fecal colonies per 100 ml. at the S-059-05 outfall, 900 fecal colonies per 100 ml. at the S-059-09 outfall, all on September 21, 2009.

B. Other Outfalls

1. Sandyford Run Outfall (P-090-02)

One (1) site intercepting flow is listed below.

1. PFD-01 Sandyford Run

The number of inspections, blockages cleared and discharges noted during this quarter are listed below.

Flap Gate	Inspections	Blockages	Discharges
PFD-01	7	1	0

2. A current summary of additional outfalls from the Stormwater Priority Outfall List that the City has performed complete testing or abatements at this quarter is as follows.

Outfall #	Complete Tests	Cross-Connections	Abatements
D-092-05	0	0	1
P-091-11	28	1	0
P-099-03	0	0	1
P-100-01	15	0	0
P-100-19	(2)	0	0
P-100-21	2	0	0
P-104-06	143	3	2
P-104-07	452	7	2
P-105-01	63	2	7
P-105-06	0	0	1
P-112-01	32	1	1
P-113-01	10	0	0
Q-101-05	89	0	0
Q-101-17	118	3	3

Outfall #	Complete Tests	Cross-Connections	Abatements
Q-106-04	(113)	(2)	(2)
Q-106-09	45	2	2
Q-106-11	(5)	(1)	(1)
Q-107-02	0	0	1
Q-110-07	13	0	0
Q-110-16	(13)	0	0
Q-114-06	17	0	0
S-046-06	0	0	8
T-080-02	0	0	1
T-089-04	14	0	0
W-086-01	0	0	1

III. NEXT QUARTER GOALS

A. Priority Outfalls

1. 7th & Cheltenham Outfall (T-088-01)

Goals for the Quarter

- Continue to monitor the operation of the diversion apparatuses.
- Continue sampling at the priority outfall with dry-weather flow.

2. Monastery Ave. Outfall (W-060-01)

Goals for the Quarter

- Continue to monitor the operation of the diversion apparatuses.
- Continue sampling at the priority outfall with dry-weather flow.

3. Monoshone Creek Outfalls (W-060-04, W-060-08, W-060-09, W-060-10, W-060-11, W-068-04 and W-068-05)

Goals for the Quarter

- Continue sampling at outfall W-068-05 with dry-weather flow.

4. Manayunk Canal Outfalls (S-051-06, S-058-01, S-059-01 through S-059-11)

Goals for the Quarter

- Continue sampling at the priority outfalls with dry-weather flow.

B. Other Outfalls

1. Sandyford Run Outfall (P-090-02)

Goals for the Quarter

- Continue to monitor the operation of the diversion apparatus.

2. Continue to perform outstanding abatements of identified cross-connections within the following outfalls.

- D-092-05
- P-091-11
- P-100-08
- P-101-02
- P-104-06
- P-104-07
- P-105-01
- P-105-06
- P-04
- Q-101-03
- Q-101-09
- Q-110-18
- Q-115-12
- S-046-06
- S-051-08
- S-052-04
- T-088-01
- T-089-04
- W-086-01
- W-086-02

3. Continue to perform property testing within the following outfalls.

- P-091-10
- P-091-11
- P-100-01
- Q-101-05
- Q-110-12
- Q-117-01
- Q-106-09

Table 1
DLC Program Summary
July 1, 2009 to September 30, 2009

Complete Tests:

- 37,305 Complete tests have been performed under the DLC program
- **908 Complete tests were performed this past quarter**
- 28 Complete tests were performed in outfall P-091-11
- 15 Complete tests were performed in outfall P-100-01
- (2) Complete tests were performed in outfall P-100-19
- 2 Complete tests were performed in outfall P-100-21
- 143 Complete tests were performed in outfall P-104-06
- 452 Complete tests were performed in outfall P-104-07
- 63 Complete tests were performed in outfall P-105-01
- 32 Complete tests were performed in outfall P-112-01
- 10 Complete tests were performed in outfall P-113-01
- 89 Complete tests were performed in outfall Q-101-05
- 118 Complete tests were performed in outfall Q-101-17
- (113) Complete tests were performed in outfall Q-106-04
- 45 Complete tests were performed in outfall Q-106-09
- (5) Complete tests were performed in outfall Q-106-11
- 13 Complete tests were performed in outfall Q-110-07
- (13) Complete tests were performed in outfall Q-110-16
- 17 Complete tests were performed in outfall Q-114-06
- 14 Complete tests were performed in outfall T-089-04

Cross-Connections Found:

- 1,026 Cross-connections have been identified under the DLC program
- **16 Cross-connections were identified this past quarter**
- 1 Cross-connection was identified in outfall P-091-11
- 3 Cross-connections were identified in outfall P-104-06
- 7 Cross-connections were identified in outfall P-104-07
- 2 Cross-connections were identified in outfall P-105-01
- 1 Cross-connection was identified in outfall P-112-01
- 3 Cross-connections were identified in outfall Q-101-17
- (2) Cross-connections were identified in outfall Q-106-04
- 2 Cross-connections were identified in outfall Q-106-09
- (1) Cross-connection was identified in outfall Q-106-11

Abatements:

- 968 Abatements have been performed under the DLC program
- **28 Abatements were performed this past quarter**
- 1 Abatement was performed in outfall D-092-05
- 1 Abatement was performed in outfall P-099-03
- 2 Abatements were performed in outfall P-104-06
- 2 Abatements were performed in outfall P-104-07
- 7 Abatements were performed in outfall P-105-01
- 1 Abatement was performed in outfall P-105-06
- 1 Abatement was performed in outfall P-112-01
- 3 Abatements were performed in outfall Q-101-17
- (2) Abatements were performed in outfall Q-106-04
- 2 Abatements were performed in outfall Q-106-09
- (1) Abatement was performed in outfall Q-106-11
- 1 Abatement was performed in outfall Q-107-02
- 8 Abatements were performed in outfall S-046-06
- 1 Abatement was performed in outfall T-080-02
- 1 Abatement was performed in outfall W-086-01

Outfall/Manhole Screening and Sampling:

- 11 outfall inspections were made as part of the Priority Outfall sampling program this past quarter
- 11 outfall samples were taken due to observed dry-weather flow during the above inspections

- 66 outfall inspections were made as part of the Permit Inspection Program sampling program this past quarter
- 44 outfall samples were taken due to observed dry-weather flow during the above inspections

Table 2
Lab Analysis of Water at Outfalls and/or in the Storm Sewers
July 1, 2009 to September 30, 2009

A. Priority Outfalls

Outfall	Date	Time	Location	Sewer Size (in)	Flow (gph)	Fluoride (mg/l)	Fecal Count (# per 100 ml)	Comments
S-058-01	9/21/2009	11:05	Outfall: Domino Lane	54		0.29	2100	
S-059-01	9/21/2009	11:25	Outfall: Parker	60		0.20	360	
S-059-02	9/21/2009	11:40	Outfall: Fountain	42		0.12	23000	
S-059-03	9/21/2009	11:50	Outfall: Wright	42		0.15	1800	
S-059-04	9/21/2009	12:00	Outfall: Leverington	51		0.31	730	
S-059-05	9/21/2009	12:05	Outfall: Leverington (east)	4'-0"x2'-8"		0.36	180	
S-059-09	9/21/2009	12:25	Outfall: Green Lane	36		n/a	900	
T-088-01	9/21/2009	11:40	Outfall: 7th & Cheltenham	84		0.19	77000	
T-088-01	9/21/2009	11:45	Outfall: 7th & Cheltenham @ Bridge	84		0.25	88000	
W-060-01	9/21/2009	10:30	Outfall: Monastery Lane	5'-0"x4'x4"		0.14	23000	
W-068-05	9/21/2009	10:55	Outfall: Lincoln & Morris	90		0.33	1100	

B. Permit Inspection Program

Outfall	Date	Time	Location	Sewer Size (in)	Flow (gph)	Fluoride (mg/l)	Fecal Count (# per 100 ml)	Comments
Q-106-18	8/13/2009	9:20	Outfall: Inwood & Waldemire	30	360	0.25	81000	
Q-106-20	8/13/2009	9:00	Outfall: Oakhill & Waldemire	18	N/F	n/a	n/a	
Q-106-13	8/17/2009	11:10	Outfall: W Red Lion & Waldemire	42	N/F	n/a	n/a	
Q-106-14	8/17/2009	11:00	Outfall: W Red Lion & Waldemire	30	N/F	n/a	n/a	
Q-106-15	8/17/2009	11:05	Outfall: W Red Lion & Waldemire	42	240	0.31	100	Takes the flow on east side of Red Lion
Q-106-16	8/17/2009	11:25	Outfall: Green Acres & Waldemire	30	N/F	n/a	n/a	
Q-106-17	8/17/2009	11:45	Outfall: Rayland & Helmer	36	30	0.35	5700	Partially submerged, may contain creek water
Q-106-19	8/17/2009	10:25	Outfall: Dorchester & Waldemere	24	<30	0.35	<100	Pipe cracked and submerged, sampled from manhole @ intersection IFO 3801 Dorchester St.
Q-106-05	8/24/2009	11:15	Outfall: Chesterfield & Berea	42	240	0.14	18000	
Q-106-06	8/24/2009	11:30	Outfall: Chesterfield & Berea	27	30	0.18	4800	
Q-106-07	8/25/2009	10:20	Outfall: E of Chesterfield & Berea	21	<30	0.24	3300	
Q-106-08	8/25/2009	10:35	Outfall: SE of Keswick Rd. & S. Keswick Pl.	27	240	0.15	6700	
Q-106-09	8/25/2009	10:45	Outfall: NE of Churchill & Wessex	24	<30	0.31	200000	
Q-106-10	8/25/2009	11:10	Outfall: SW Morrell & Ashfield	21	60	0.22	26000	Half submerged into creek
Q-106-11	8/26/2009	10:20	M/H: on Morrell Ave. at Intersection with Ashfield Rd.		N/F	n/a	n/a	
Q-106-22	8/26/2009	10:35	M/H: on Ashfield Rd. at Intersection with Morrell Ave.		60	0.19	2400	Manhole IFO apartment leasing office parking lot

Table 2
Lab Analysis of Water at Outfalls and/or in the Storm Sewers
July 1, 2009 to September 30, 2009

Outfall	Date	Time	Location	Sewer Size (in)	Flow (gph)	Fluoride (mg/l)	Fecal Count (# per 100 ml)	Comments
Q-106-21	8/26/2009	11:00	Outfall: E of Morrell & Calera	66	180	0.29	25000	
Q-106-12	8/26/2009	11:25	Outfall: SE Morrell & Ashfield	30	180	0.58	>200000	
Q-101-19	8/26/2009	11:44	Outfall: Vale & Crestmont	36	240	0.11	73000	
Q-101-18	8/26/2009	12:00	M/H: Morrell Ave. & Crestmont Ave.		N/F	n/a	n/a	
Q-101-17	8/26/2009	12:10	M/H: Morrell Ave. & Crestmont Ave.		N/F	n/a	n/a	
Q-121-01	8/27/2009	11:25	Outfall: Ina & Stevens	54	<30	0.10	29000	
Q-121-02	8/27/2009	11:40	Outfall: Kovats & Poquessing Creek Dr.	48	<30	0.17	1100	
Q-121-03	8/27/2009	12:15	Outfall: Liberty & Poquessing Creek Dr.	36	N/F	n/a	n/a	
Q-121-04	8/27/2009	12:25	Outfall: Poquessing Creek Ln. & Poquessing Creek Dr.	36	60	0.36	60000	
Q-121-05	8/27/2009	12:40	Outfall: Milford & Poquessing Creek Dr.	42	30	0.20	5100	
Q-121-06	8/27/2009	13:05	Outfall: Carter & Poquessing Creek Dr.	30	180	0.17	100	
Q-120-01	8/31/2009	9:55	Outfall: Denise & Depue	18	180	0.24	90000	
Q-120-02	8/31/2009	10:20	Outfall: S of Bustleton & Petoni	66	60	0.21	6700	
Q-120-03	8/31/2009	10:35	Outfall: Bustleton & Station	54	<30	0.10	3100	
Q-120-04	8/31/2009	11:00	Outfall: Bustleton & Station	24	60	0.24	300	
Q-110-09	9/3/2009	8:25	Outfall: S of Academy & Comly Rd. (N)	36	N/F	n/a	n/a	
Q-110-08	9/3/2009	8:30	Outfall: S of Academy & Comly Rd. (S)	42	N/F	n/a	n/a	
Q-114-01	9/3/2009	8:50	Outfall: Byberry & Evans (E)	21	N/F	n/a	n/a	
Q-120-05	9/3/2009	10:20	Outfall: NE of County Line & Overhill	36	<30	0.16	200	
Q-120-06	9/3/2009	10:45	Outfall: Poquessing Ave. & Station	27	N/F	n/a	n/a	
Q-120-07	9/3/2009	11:05	Outfall: NW of Trevose & Maple	24	N/F	n/a	n/a	
Q-120-08	9/3/2009	11:25	Outfall: NW of Trevose & Edison	60	30	0.13	1700	Half submerged into creek
Q-120-09	9/3/2009	11:30	Outfall: NW of Trevose & Edison	27	30	0.12	1800	Half submerged into creek
Q-120-10	9/3/2009	12:00	Outfall: NW of Trevose & Southampton	36	30	0.12	1000	
Q-110-21	9/8/2009	10:05	Outfall: SW of Norcom & Charter	66	N/F	n/a	n/a	
Q-110-01	9/8/2009	10:10	Outfall: SW of Charter & Norcom	36	240	0.12	<100	
Q-110-02	9/8/2009	10:40	Outfall: SW of Decataur & Darnell	42	N/F	n/a	n/a	
Q-110-03	9/8/2009	10:42	Outfall: SW of Decataur & Darnell	42	N/F	n/a	n/a	
Q-110-04	9/8/2009	10:57	Outfall: S of Decataur & Darnell	42	600	1.10	<100	
Q-110-05	9/8/2009	11:35	Outfall: N of Drummond & Red Lion	66	N/F	n/a	n/a	
Q-110-06	9/8/2009	11:58	Outfall: NW of Academy & Amity	54	120	0.15	3900	
Q-110-07	9/8/2009	12:20	Outfall: N of Academy & Chalfont	30	120	0.11	200	
Q-110-10	9/8/2009	12:50	Outfall: SW Comly Rd. & Tara	36	N/F	n/a	n/a	
Q-110-11	9/8/2009	13:05	Outfall: NE of Comly Rd. & Tara	60	30	1.06	>200000	
Q-110-13	9/9/2009	10:00	Outfall: S of Academy & Newberry	36	<60	0.25	1000	
Q-110-14	9/9/2009	10:10	Outfall: S of Academy & Newberry	54	120	0.30	3500	
Q-110-12	9/9/2009	10:35	M/H: IFO 3642 Salina Rd.		N/F	n/a	n/a	
Q-110-15	9/9/2009	10:55	Outfall: N of Waldemire & Bryne	60	120	0.19	2000	

Table 2
Lab Analysis of Water at Outfalls and/or in the Storm Sewers
July 1, 2009 to September 30, 2009

Outfall	Date	Time	Location	Sewer Size (in)	Flow (gph)	Fluoride (mg/l)	Fecal Count (# per 100 ml)	Comments
Q-110-16	9/9/2009	11:15	Outfall: E of Chalfont & Keswick	36	180	0.12	400	
Q-110-17	9/9/2009	11:32	Outfall: S of Waldemire & Chalfont	60	120	0.21	1000	
Q-110-18	9/9/2009	11:43	Outfall: W of Waldemire & Millbrook	36	60	0.24	600	
Q-110-19	9/9/2009	12:07	Outfall: E of Helmer & Keswick	21	N/F	n/a	n/a	
Q-110-20	9/9/2009	12:10	Outfall: SE of Helmer & Keswick	54	N/F	n/a	n/a	
Q-117-01	9/15/2009	10:15	Outfall: W Byberry & Audubon	27	300	0.24	<100	
Q-117-02	9/15/2009	10:34	Outfall: Carosel Station Condos	7'-0"x6'-6"	120	0.22	38000	
Q-117-03	9/15/2009	10:40	Outfall: Carosel Station Condos	42	N/F	n/a	n/a	
Q-118-01	9/22/2009	9:45	Outfall: NE of Roosevelt & Hornig	36	60	0.34	100	
Q-118-02	9/22/2009	10:20	Outfall: SE of Hornig & Roosevelt	42	<30	0.48	545	
Q-118-03	9/22/2009	10:45	Outfall: W McNulty & Southampton	42	30	0.50	100	
Q-118-05	9/22/2009	11:25	Outfall: Byberry & Evans	27	300	0.16	100	
Q-118-06	9/22/2009	12:45	Outfall: Woodhaven & Evans	42	300	0.12	<100	
Q-117-05	9/22/2009	1:35	Outfall: SE Byberry & Trina	48	120	0.17	20000	
Q-109-06	9/30/2009	11:15	Outfall: Red Lion & Roosevelt	66	240	0.17	10363	
Q-109-07	9/30/2009	11:50	Outfall: Roosevelt & Red Lion	36	120	0.12	5100	
Q-114-03	9/30/2009	12:15	Outfall: Comly Rd. & Nestor	42	60	0.14	80	

Table 3
Residential Cross Connections Not Abated Within 120 Days

A. Properties Abated & Confirmed Prior to Reporting:

Address				Outfall Code	Complete Date	Admin. Action	Abatement Confirmation Date	Comments
00107		Village	La	Q-107-02	01-25-2006		08-05-2009	Dye tests are in dispute. H/O claims that there is no cross. Reinspection is pending.
01249		Poquessing Crk	Dr	Q-121-02	02-09-2006		05-11-2009	Completed and abated
03319	N	Bailey	St	S-046-06	06-16-2006		05-04-2009	Non bill status, may be vacant
00425	W	Abbottsford	Ave	S-046-06	06-24-2006		05-04-2009	Inspection pending
03264	N	Marston	St	S-046-06	12-15-2006		06-16-2009	
08103		Ardleigh	St	W-086-01	05-14-2007		05-13-2009	
00230	E	Willow Grove	Ave	W-086-01	08-27-2007		05-23-2009	
03619		Glenn	St	Q-106-03	01-19-2008		06-17-2009	
01709		Rachael	St	P-105-06	01-26-2008		05-27-2009	
09231		Milnor	St	D-092-05	04-24-2008		05-06-2009	
05934		Newtown	Ave	T-080-02	05-03-2008		05-04-2009	
01733		Bergen	St	P-099-03	08-30-2008		05-11-2009	
01721		Foxchase	Rd	P-099-03	09-04-2008		06-03-2009	
03013		Secane	Pl	Q-115-01	09-17-2008		05-08-2009	
00244		Stearly	St	T-080-02	09-25-2008		05-11-2009	
01810		Tustin	St	P-099-03	10-06-2008		05-19-2009	
03528		Carey	Rd	Q-110-16	11-15-2008		06-01-2009	
10900		Carey	Pl	Q-110-16	11-17-2008		05-05-2009	
03628		Sussex	La	Q-106-04	12-27-2008		05-11-2009	
07404		Lawndale	Ave	T-089-04	01-27-2009		06-01-2009	

B. Properties Active As Of Reporting:

Address				Outfall Code	Complete Date	Admin. Action	Comments
03513		Indian Queen	La	S-052-04	06-10-2004		Was never referred to Program. Dye tests were never confirmed.
09328		Ditman	St	Q-101-09	02-11-2006		Inspection completed, repairs pending.
03126	N	29th	St	S-046-06	04-20-2006		Inspection pending

Table 3
Residential Cross Connections Not Abated Within 120 Days

Address				Outfall Code	Complete Date	Admin. Action	Comments
03111	N	29th	St	S-046-06	04-24-2006		Inspection pending
03231	N	29th	St	S-046-06	05-16-2006		Problems with inspection. Reinspection requested.
02615	W	Allegheny	Ave	S-046-06	05-31-2006		Inspection pending.
05400		Archer	St	S-046-06	06-15-2006		Property in non bill status, may be vacant. Sold to a bank
00531		Hansberry	St	S-046-06	08-30-2006		Bad address, letters were returned
05054		Mc Kean	Ave	S-046-06	09-26-2006		Inspection pending
03136	N	Patton	St	S-046-06	10-21-2006		Inspection pending
09326		Neil	Rd	P-105-06	03-15-2008		
09390		Neil	Rd	P-105-06	05-31-2008		
01050		Lakeside	Ave	T-088-01	10-18-2008		
00813		Cottman	Ave	T-089-04	10-20-2008		
03786		Bandon	Dr	Q-115-12	01-07-2009		
07723		Hasbrook	Ave	T-089-04	02-04-2009		
07236		Rising Sun	Ave	T-089-04	02-18-2009		
07344		Palmetto	St	T-089-04	02-23-2009		
00245		Pensdale	St	S-051-08	03-09-2009		
07350	E	Tabor	Rd	T-089-04	04-09-2009		
07323	E	Tabor	Rd	T-089-04	04-11-2009		
02922	W	Allegheny	Ave	S-046-06	04-11-2009		
09408		Hilspach	St	P-105-01	04-25-2009		
07314		Lawndale	Ave	T-089-04	05-07-2009		

Table 4

Spills to Storm Sewers and/or Receiving Waters

July 1, 2009 to September 30, 2009

Date	Outfall	Address	Source Code	Material Involved	Completion Date	Remarks
08/03/09		River Road and Nixon Street Schuylkill River	3011	Surface water	08/03/09	Industrial Waste unit investigated a possible discharge at Smith's Run. No active sewage discharge observed. The source of the brown colored flow was traced to the Wingdance pond in the Schuylkill Environmental Center.
08/16/09	S-052-05	5101 Rochelle Avenue Schuylkill River	3009	Sewage	08/16/09	Sewer Maintenance unit flushed 8" diameter sanitary sewer to relieve choke at manhole #S052-05-S0030 causing approximate 20 gpm discharge. Sewage flowed over ground from the manhole to inlet #92386.
08/26/09	Q-120-02	13360 Philmont Avenue Poquessing Creek	3009	Sewage	08/26/09	Sewer Maintenance unit flushed 10" diameter sanitary sewer to relieve choke causing approximate 7 gpm discharge.
08/27/09	T-088-01	7th Street and Cheltenham Avenue Tacony Creek	3009	Sewage	08/27/09	Industrial Waste unit investigated a possible discharge from the outfall. No active sewage discharge observed.
08/30/09		4200 Monument Road		Sewage	08/30/09	Sewer Maintenance unit found sewage flowing from a manhole over the street to inlet #74468 and back into the combined sewer system. Investigation revealed that a section of the 27" diameter combined sewer had collapsed. Bypass pumping was used until temporary repairs were completed. Finally, approximately 160' of sewer pipe was replaced.
09/28/09		Smith Playground / Fairmount Park 1400 Fountain Green Drive and Kelly Drive Schuylkill River	3011	Sewage	09/29/09	Industrial Waste unit investigated a report of sewage flowing over embankment. The source was traced to the playground restroom. Fairmount Park representative notified. Customer Service unit to serve NOD (notice of defect).

Source Codes:

3009 - Spill to Storm Sewer

3011 - Spill to Receiving Stream

STORM WATER MANAGEMENT PROGRAM
NPDES PERMIT NO. PA0054712

DEFECTIVE LATERAL CONNECTION STATUS REPORT
(Covering Period from October 1, 2009 to December 31, 2009)

Submitted to

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER QUALITY MANAGEMENT

By

CITY OF PHILADELPHIA
PHILADELPHIA, PA

February 12, 2010

DLC Program Update
4th Quarter 2009

I. INTRODUCTION

This Defective Lateral Connection Status Report is submitted to the Pennsylvania Department of Environmental Protection (PADEP) as part of the reporting requirements of the City of Philadelphia NPDES Storm Water Management Permit No. PA 0054712. The report covers the three-month period beginning October 1, 2009 and ending December 31, 2009.

The body of this report will describe the recent activities of the City during the past quarter within the Priority Outfall areas and at other significant outfalls on the Stormwater Priority Outfall List. Additionally, goals for the next quarter will be listed.

Table 1 provides a summary of the program with respect to Complete tests, Cross-connections identified, and Abatements performed. Table 2 provides a listing of all laboratory analyses of samples taken at stormwater outfalls or within the stormwater system during the previous quarter. Table 3 provides a listing of properties with cross-connections outstanding greater than 120 days. Finally, Table 4 provides a listing of reported spills to the stormwater system or receiving streams.

II. PAST QUARTER REVIEW

A. Priority Outfalls

1. 7th & Cheltenham Outfall (T-088-01)

DLC program activities have performed 2,829 Complete tests in this sewershed, identifying 132 Cross-connections, all but 1 of which have been Abated.

Six (6) sites intercepting flow from 5 targeted areas are listed below.

1. CFD-01 Plymouth St., west of Pittsville St.
2. CFD-02 Pittsville St., south of Plymouth St.
3. CFD-03 Elston St., east of Bouvier St.
4. CFD-04 Ashley St., west of Bouvier St.
5. CFD-05 Cheltenham Ave., east of 19th St.
6. CFD-06 Verbena St., south of Cheltenham Ave.

The number of inspections, blockages cleared and discharges noted during this quarter are listed below.

Flap Gate	Inspections	Blockages	Discharges
CFD-01	12	0	0
CFD-02	12	0	0
CFD-03	13	0	0
CFD-04	12	0	0
CFD-05	12	0	0
CFD-06	12	0	0

The most recent fecal sample value was 1000 fecal colonies per 100 ml. at the outfall on December 29, 2009.

2. Monastery Ave. Outfall (W-060-01)

DLC program activities have performed 611 Complete tests in this sewershed, identifying 16 Cross-connections, all of which have been Abated.

Two (2) sites intercepting flow are listed below.

1. MFD-01 Jannette St., west of Monastery Ave.
2. MFD-02 Green La., north of Lawnton St.

The number of inspections, blockages cleared and discharges noted during this quarter are listed below.

Flap Gate	Inspections	Blockages	Discharges
MFD-01	12	0	0
MFD-02	12	0	0

The most recent fecal sample value was 50 fecal colonies per 100 ml. at the outfall on December 29, 2009.

3. Monoshone Creek Outfalls (W-060-04, W-060-08, W-060-09, W-060-10, W-060-11, W-068-04 and W-068-05)

DLC program activities have performed 2,742 Complete tests in these sewershed areas, identifying 92 Cross-connections, all of which have been Abated. The majority of the efforts have been in the W-068-05 sewershed area which is by far the largest in terms of drainage area and properties served.

The most recent fecal sample value was 200 fecal colonies per 100 ml. at the W-068-05 outfall on December 29, 2009.

4. Manayunk Canal Outfalls (S-051-06, S-058-01, S-059-01 through S-059-11)

DLC program activities have performed 2,444 Complete tests in these sewershed areas, identifying 59 Cross-connections, all of which have been Abated. The majority of the efforts have been in the S-059-04 sewershed area.

The most recent fecal sample value was <100 fecal colonies per 100 ml. at the S-058-01 outfall, <100 fecal colonies per 100 ml. at the S-059-01 outfall, 49000 fecal colonies per 100 ml. at the S-059-02 outfall, 6600 fecal colonies per 100 ml. at the S-059-03 outfall, 15000 fecal colonies per 100 ml. at the S-059-04 outfall, 1800 fecal colonies per 100 ml. at the S-059-05 outfall, <100 fecal colonies per 100 ml. at the S-059-09 outfall, all on December 28, 2009.

B. Other Outfalls

1. Sandyford Run Outfall (P-090-02)

One (1) site intercepting flow is listed below.

1. PFD-01 Sandyford Run

The number of inspections, blockages cleared and discharges noted during this quarter are listed below.

Flap Gate	Inspections	Blockages	Discharges
PFD-01	6	0	0

2. Franklin and Hasbrook Outfall (T-089-04)

A Sanitary Diversion Valve (SDV) was installed over the existing east 3'-0" x 6'-6" twin concrete storm water sewers in Franklin Avenue and activated on October 29, 2009. The new SDV diverts all existing dry weather sanitary flow from the storm sewer that previously drained into Outfall T-089-04, to the existing sanitary sewer located under it.

One (1) site intercepting flow is listed below.

1. CFD-01 Franklin and Hasbrook

The number of inspections, blockages cleared and discharges noted during this quarter are listed below.

Flap Gate	Inspections	Blockages	Discharges
CFD-01	39	0	0

3. A current summary of additional outfalls from the Stormwater Priority Outfall List that the City has performed complete testing or abatements at this quarter is as follows.

Outfall #	Complete Tests	Cross-Connections	Abatements
P-091-10	185	2	0
P-091-11	3	0	0
P-100-01	36	1	0
P-100-05	13	0	0
P-100-21	14	0	0
P-104-07	20	1	3
P-105-01	5	0	0
P-105-06	0	0	1
P-108-16	63	0	0
P-112-01	3	0	0
Q-101-05	284	8	3
Q-106-09	1	0	0
Q-106-16	48	0	0
Q-110-07	46	0	0
Q-110-12	51	0	0
Q-114-12	1	1	1
Q-115-12	0	0	1
Q-117-01	8	1	0
Q-117-03	75	0	0
S-046-06	0	0	3
S-051-08	0	0	1
T-089-04	0	0	2

III. NEXT QUARTER GOALS

A. Priority Outfalls

1. 7th & Cheltenham Outfall (T-088-01)

Goals for the Quarter

- Continue to monitor the operation of the diversion apparatuses.
- Continue sampling at the priority outfall with dry-weather flow.

2. Monastery Ave. Outfall (W-060-01)

Goals for the Quarter

- Continue to monitor the operation of the diversion apparatuses.
- Continue sampling at the priority outfall with dry-weather flow.

3. Monoshone Creek Outfalls (W-060-04, W-060-08, W-060-09, W-060-10, W-060-11, W-068-04 and W-068-05)

Goals for the Quarter
- Continue sampling at outfall W-068-05 with dry-weather flow.

4. Manayunk Canal Outfalls (S-051-06, S-058-01, S-059-01 through S-059-11)

Goals for the Quarter
- Continue sampling at the priority outfalls with dry-weather flow.

B. Other Outfalls

1. Sandyford Run Outfall (P-090-02)

Goals for the Quarter
- Continue to monitor the operation of the diversion apparatus.

2. Franklin and Hasbrook Outfall (T-089-04)

Goals for the Quarter
- Continue to monitor the operation of the diversion apparatus.

3. Continue to perform outstanding abatements of identified cross-connections within the following outfalls.

- D-092-05
- P-091-10
- P-091-11
- P-100-01
- P-100-08
- P-101-02
- P-104-06
- P-104-07
- P-105-01
- P-105-06
- P-04
- Q-101-03
- Q-101-05
- Q-101-09
- Q-110-18
- Q-117-01
- S-046-06
- S-052-04
- T-088-01
- T-089-04
- W-086-01

- W-086-02

4. Continue to perform property testing within the following outfalls.

- P-091-06
- P-091-10
- P-100-01
- P-100-08
- P-100-21
- P-101-05
- P-108-16
- Q-110-07

Table 1
DLC Program Summary
October 1, 2009 to December 31, 2009

Complete Tests:

- 38,161 Complete tests have been performed under the DLC program
- **856 Complete tests were performed this past quarter**
- 185 Complete tests were performed in outfall P-091-10
- 3 Complete tests were performed in outfall P-091-11
- 36 Complete tests were performed in outfall P-100-01
- 13 Complete tests were performed in outfall P-100-05
- 14 Complete tests were performed in outfall P-100-21
- 20 Complete tests were performed in outfall P-104-07
- 5 Complete tests were performed in outfall P-105-01
- 63 Complete tests were performed in outfall P-108-16
- 3 Complete tests were performed in outfall P-112-01
- 284 Complete tests were performed in outfall Q-101-05
- 1 Complete test was performed in outfall Q-106-09
- 48 Complete tests were performed in outfall Q-106-16
- 46 Complete tests were performed in outfall Q-110-07
- 51 Complete tests were performed in outfall Q-110-12
- 1 Complete test was performed in outfall Q-114-12
- 8 Complete tests were performed in outfall Q-117-01
- 75 Complete tests were performed in outfall Q-117-03

Cross-Connections Found:

- 1,040 Cross-connections have been identified under the DLC program
- **14 Cross-connections were identified this past quarter**
- 2 Cross-connections were identified in outfall P-091-10
- 1 Cross-connection was identified in outfall P-100-01
- 1 Cross-connection was identified in outfall P-104-07
- 8 Cross-connections were identified in outfall Q-101-05
- 1 Cross-connection was identified in outfall Q-114-12
- 1 Cross-connections was identified in outfall Q-117-01

Abatements:

- 983 Abatements have been performed under the DLC program
- **15 Abatements were performed this past quarter**
- 3 Abatements were performed in outfall P-104-07
- 1 Abatement was performed in outfall P-105-06
- 3 Abatements were performed in outfall Q-101-05
- 1 Abatement was performed in outfall Q-114-12
- 1 Abatement was performed in outfall Q-115-12
- 3 Abatements were performed in outfall S-046-06
- 1 Abatement was performed in outfall S-051-08
- 2 Abatements were performed in outfall T-089-04

Outfall/Manhole Screening and Sampling:

- 11 outfall inspections were made as part of the Priority Outfall sampling program this past quarter
- 11 outfall samples were taken due to observed dry-weather flow during the above inspections

- 68 outfall inspections were made as part of the Permit Inspection Program sampling program this past quarter
- 22 outfall samples were taken due to observed dry-weather flow during the above inspections

Table 2
Lab Analysis of Water at Outfalls and/or in the Storm Sewers
October 1, 2009 to December 31, 2009

Outfall	Date	Time	Location	Sewer Size (in)	Flow (gph)	Fluoride (mg/l)	Fecal Count (# per 100 ml)	Comments
A. Priority Outfalls								
S-058-01	12/28/2009	9:40	Outfall: Domino Lane	54		0.21	<100	
S-059-01	12/28/2009	9:55	Outfall: Parker	60		<0.2	<100	
S-059-02	12/28/2009	10:05	Outfall: Fountain	42		<0.2	49000	
S-059-03	12/28/2009	10:10	Outfall: Wright	42		<0.2	6600	
S-059-04	12/28/2009	10:25	Outfall: Leverington	51		0.29	15000	
S-059-05	12/28/2009	10:30	Outfall: Leverington (east)	4'-0"x2'-8"		0.29	1800	
S-059-09	12/28/2009	10:40	Outfall: Green Lane	36		0.87	<100	
T-088-01	12/29/2009	10:20	Outfall: 7th & Cheltenham	84		<0.2	1000	
T-088-01	12/29/2009	10:25	Outfall: 7th & Cheltenham @ Bridge	84		<0.2	390	
W-068-05	12/29/2009	11:05	Outfall: Lincoln & Morris	90		0.32	200	
W-060-01	12/29/2009	11:30	Outfall: Monastery Lane	5'-0'x4'-4"		<0.2	50	
B. Permit Inspection Program								
Q-115-01	10/5/2009	9:55	Outfall: NE of Dunks Ferry & Secane	54	N/F	n/a	n/a	
Q-115-10	10/5/2009	10:10	Outfall: S of Medford & Vinton	36	N/F	n/a	n/a	
Q-115-14	10/5/2009	10:12	Outfall: S of Medford & Vinton	36	N/F	n/a	n/a	
Q-115-12	10/5/2009	10:30	Outfall: W of Nanton & Canby	72	600	0.26	74000	Greyish scum on bottom of channel
Q-115-08	10/5/2009	11:05	Outfall: NE of Academy & Torrey	36	N/F	n/a	n/a	
Q-115-13	10/5/2009	11:10	Outfall: NE of Academy & Torrey	27	N/F	n/a	n/a	
Q-115-07	10/5/2009	11:15	Outfall: NW of Academy & Torrey	24	30	0.37	>200000	
Q-115-06	10/5/2009	11:30	Outfall: W of Academy & Torrey	30	N/F	n/a	n/a	
Q-115-05	10/5/2009	11:35	Outfall: NW of Academy & Medford	27	N/F	n/a	n/a	
Q-115-03	10/5/2009	11:40	Outfall: SE of Ancona & Medford	24	N/F	n/a	n/a	
Q-115-02	10/5/2009	11:45	Outfall: NE of Medford & Ancona	30	N/F	n/a	n/a	
Q-115-15	10/5/2009	11:50	Outfall: NE of Medford & Ancona	18	N/F	n/a	n/a	
Q-115-04	10/5/2009	11:55	Outfall: Ancona & Tyronne	36	N/F	n/a	n/a	
Q-115-09	10/6/2009	11:15	Outfall: SE of Cabell & Lester	66	N/F	n/a	n/a	
Q-115-11	10/6/2009	11:35	Outfall: E of Vinton & Teton	42	N/F	n/a	n/a	
Q-115-16	10/6/2009	12:15	Outfall: N of Duffy & Galdi	18	N/F	n/a	n/a	
Q-115-17	10/13/2009	10:20	Outfall: NW of McCarthy & Cliffe	24	N/F	n/a	n/a	
Q-115-18	10/13/2009	10:30	Outfall: NW Knights & McCarthy	18	N/F	n/a	n/a	
Q-114-04	10/13/2009	11:30	Outfall: SW of Comly & Caroline	54	300	0.57	1209	Oil sheen on pooling area

Table 2
Lab Analysis of Water at Outfalls and/or in the Storm Sewers
October 1, 2009 to December 31, 2009

Outfall	Date	Time	Location	Sewer Size (in)	Flow (gph)	Fluoride (mg/l)	Fecal Count (# per 100 ml)	Comments
Q-114-17	10/13/2009	12:05	Outfall: SW of Norcom & Comly	27	N/F	n/a	n/a	
Q-114-05	10/13/2009	12:10	Outfall: SW of Norcom & Comly	48	N/F	n/a	n/a	
Q-114-06	10/14/2009	8:50	Outfall: NW Comly & Thorton	54	N/F	n/a	n/a	
Q-114-07	10/14/2009	9:20	Outfall: NW Woodhaven & Thorton	66	30	0.32	200	Sampled from creek IFO outfall
Q-114-08	10/14/2009	9:55	Outfall: Intersection of Woodhaven & Thorton	42	N/F	n/a	n/a	
Q-114-09	10/14/2009	11:15	Outfall: Intersection of Woodhaven & Thorton	42	N/F	n/a	n/a	
Q-114-10	10/14/2009	10:37	Outfall: Intersection of River & Waterview Lane	36	N/F	n/a	n/a	Outfall is almost completely filled with dirt and vegetation
Q-114-11	10/14/2009	11:08	Outfall: SE of Woodhaven & Riverside	42	30	0.26	<100	
Q-114-13	10/14/2009	12:05	Outfall: SW of Woodhaven & Tyrone	30	N/F	n/a	n/a	
Q-119-01	10/21/2009	9:40	Outfall: NE NcNulty & Townsend	84	60	<0.1	100	Creek water is flowing into outfall
Q-119-02	10/21/2009	10:25	Outfall: Maureen & Mechanicsville	18	N/F	n/a	n/a	
Q-114-12	10/21/2009	11:15	Outfall: S of Woodhaven & Medford	54	120	<0.1	100	
Q-114-14	10/21/2009	11:40	Outfall: NW of Academy & Brandon	21	N/F	n/a	n/a	
Q-114-18	10/21/2009	12:10	Outfall: NW Thorton & Townsend	48	N/F	n/a	n/a	
Q-107-01	10/22/2009	10:45	Outfall: SE of Greenmount & Telfair	54	N/F	n/a	n/a	Lots of sediment and vegetation building up in outfall
Q-107-02	10/22/2009	11:20	Outfall: SE of Deerpath & Parkdale	7'-0"x8'-8"	3600	0.31	53000	
Q-107-03	10/22/2009	11:35	Outfall: E of Deerpath & Parkview	24	NF	n/a	n/a	
Q-101-20	11/3/2009	9:40	Outfall: SE of Outlook & Lansford	54	300	0.88	<100	
Q-101-03	11/3/2009	10:00	Outfall: N of Academy & Holme	5'-6"x8'-8"	600	0.55	9364	
Q-101-04	11/3/2009	10:30	Outfall: NE of Pearson & Crispin	42	N/F	n/a	n/a	
Q-101-13	11/3/2009	11:30	Outfall: N of Brook & Stevenson	18	120	0.34	85000	
Q-101-14	11/3/2009	11:40	Outfall: N of Brook & Constance	18	N/F	n/a	n/a	
Q-101-15	11/3/2009	11:45	Outfall: N of Brook & Carteret	18	N/F	n/a	n/a	
Q-101-16	11/3/2009	11:55	Outfall: N of Brook & Rowena	18	30	0.24	104000	
Q-107-04	11/9/2009	10:35	Outfall: E of Dimarco & Lawnbrook	27	N/F	n/a	n/a	
Q-107-05	11/9/2009	11:00	Outfall: SE of Dimarco & Green Dale	42	180	0.36	24000	
Q-107-06	11/9/2009	11:55	Outfall: SE of Orchard & Cresmont	42	N/F	n/a	n/a	
Q-107-07	11/10/2009	11:10	Outfall: N of Knights & Frankford	54	30	0.15	1400	
Q-102-01	11/10/2009	11:25	Outfall: NE of Frankford & Hegerman	36	N/F	n/a	n/a	
Q-106-03	11/16/2009	10:20	Outfall: SE of Berea & Glenn	54	N/F	n/a	n/a	
Q-106-04	11/16/2009	10:40	Outfall: SE of Berea & Glenn	42	600	1.04	>20000	Heavy flow, part of outfall pipe broken off, fallen in creek
Q-110-08	11/16/2009	11:05	Outfall: S of Academy & Comly	42	N/F	n/a	n/a	
Q-110-09	11/16/2009	11:10	Outfall: S of Academy & Comly	36	N/F	n/a	n/a	
Q-110-01	11/16/2009	11:30	Outfall: SW of Charter & Norcom	36	360	0.20	300	
Q-110-21	11/16/2009	11:38	Outfall: SW of Norcom & Charter	66	N/F	n/a	n/a	

Table 2
Lab Analysis of Water at Outfalls and/or in the Storm Sewers
October 1, 2009 to December 31, 2009

Outfall	Date	Time	Location	Sewer Size (in)	Flow (gph)	Fluoride (mg/l)	Fecal Count (# per 100 ml)	Comments
Q-120-11	11/17/2009	11:15	Outfall: SE Philmont & Lukens	60	60	0.21	<100	
Q-120-12	11/17/2009	11:30	Outfall: Laura Lane & Laura Place	18	30	0.92	<100	
Q-120-13	11/17/2009	11:35	Outfall: W of Bustleton on Laura Lane	21	30	0.45	<100	
Q-120-14	11/17/2009	11:45	Outfall: W of Bustleton on Laura Lane	18	N/F	n/a	n/a	
Q-109-06	11/23/2009	11:30	Outfall: Red Lion & Roosevelt	66	30	<0.2	<100	
Q-114-16	11/23/2009	11:55	Outfall: Roosevelt & Bennett	30	N/F	n/a	n/a	Excessive algae in culvert
Q-114-15	11/23/2009	11:56	Outfall: Roosevelt & Bennett	30	N/F	n/a	n/a	Excessive algae in culvert
Q-114-02	11/23/2009	12:03	Outfall: Bennett & Roosevelt	42	N/F	n/a	n/a	
T-056-01	12/2/2009	11:35	Outfall: Ashland & Adams	36	120	0.38	100	Sampled from manhole on Ashland Street
T-063-02	12/2/2009	12:05	Outfall: S of I & Wyoming	36	N/F	n/a	n/a	Observation from manhole on Maple Lane
T-063-03	12/2/2009	12:20	Outfall: S of Caster & Wyoming	21	N/F	n/a	n/a	Damp but no flow
T-055-01	12/2/2009	12:40	Outfall: Deal & Kensington	24	N/F	n/a	n/a	Damp but no flow
Q-113-09	12/8/2009	10:25	Outfall: NE of Northeast & Tomlinson	4'-0"x7'-7"	360	0.14	6700	
Q-113-11	12/8/2009	11:45	Outfall: W of Roosevelt & Bennett	36	N/F	n/a	n/a	

Table 3
Residential Cross Connections Not Abated Within 120 Days

A. Properties Abated & Confirmed Prior to Reporting:

Address			Outfall Code	Complete Date	Admin. Action	Abatement Confirmation Date	Comments
00107	Village	La	Q-107-02	01-25-2006		08-05-2009	Dye tests are in dispute. H/O claims that there is no cross. Reinspection is pending.
07344	Palmetto	St	T-089-04	02-23-2009		08-05-2009	

B. Properties Active As Of Reporting:

Address				Outfall Code	Complete Date	Admin. Action	Comments
03513		Indian Queen	La	S-052-04	06-10-2004		Was never referred to Program. Dye tests were never confirmed.
09328		Ditman	St	Q-101-09	02-11-2006		Inspection completed, repairs pending.
03126	N	29th	St	S-046-06	04-20-2006		Inspection pending
02615	W	Allegheny	Ave	S-046-06	05-31-2006		Inspection pending.
05400		Archer	St	S-046-06	06-15-2006		Property in non bill status, may be vacant. Sold to a bank
05054		Mc Kean	Ave	S-046-06	09-26-2006		Inspection pending
09390		Neil	Rd	P-105-06	05-31-2008		
00813		Cottman	Ave	T-089-04	10-20-2008		
07350	E	Tabor	Rd	T-089-04	04-09-2009		
07323	E	Tabor	Rd	T-089-04	04-11-2009		
02922	W	Allegheny	Ave	S-046-06	04-11-2009		
09408		Hilspach	St	P-105-01	04-25-2009		
09514		Clark	St	P-105-01	06-19-2009		
01108		Rising Sun	Pl	P-104-06	07-17-2009		
01112		Bloomfield	Ave	P-104-06	07-29-2009		
00803		Bergen	St	P-104-07	08-12-2009		
00806		Arnold	St	P-104-07	08-15-2009		
08511		Bridle	Rd	P-104-07	08-31-2009		

Table 4

Spills to Storm Sewers and/or Receiving Waters

October 1, 2009 to December 31, 2009

Date	Outfall	Address	Source Code	Material Involved	Completion Date	Remarks
10/09/09	P-113-04	10666 Halstead Street Paul's Run	3009	Sewage	10/09/09	Sewer Maintenance unit flushed 10" diameter sanitary sewer to relieve choke causing approximate 1 gpm discharge.
10/13/09	S-058-01	300 Domino Lane Manayunk Canal	3011	Sewage	10/13/09	Sewer Maintenance unit flushed 10" diameter sanitary sewer to relieve choke causing minor discharge.
11/18/09	P-090-02	1300 Rhawn Street Sandy Run	3009	Sewage	11/18/09	Sewer Maintenance unit flushed 10" diameter sanitary sewer to relieve choke causing approximate 1 gpm discharge.
12/26/09	S-059-04	300 Leverington Avenue Manayunk Canal	3011	Sewage	12/28/09	Sewer Maintenance unit found choked 10" diameter sanitary sewer causing approximate 5 gpm discharge from FAI at 337 Leverington Avenue during rain. Sewage flowed along gutter to storm inlet. Bypass pumping initiated while contractor excavated sewer to remove stuck flusher hose and clear debris.
12/28/09		201 Cottman Avenue		Sewage	12/28/09	Sewer Maintenance unit flushed 12" diameter sanitary sewer to relieve choke causing approximate 2 gpm discharge thru manhole #THL-B0675 to street causing icing condition.

Source Codes:

3009 - Spill to Storm Sewer

3011 - Spill to Receiving Stream

STORM WATER MANAGEMENT PROGRAM
NPDES PERMIT NO. PA0054712

DEFECTIVE LATERAL CONNECTION STATUS REPORT
(Covering Period from January 1, 2010 to March 31, 2010)

Submitted to

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER QUALITY MANAGEMENT

By

CITY OF PHILADELPHIA
PHILADELPHIA, PA

May 14, 2010

DLC Program Update
1st Quarter 2010

I. INTRODUCTION

This Defective Lateral Connection Status Report is submitted to the Pennsylvania Department of Environmental Protection (PADEP) as part of the reporting requirements of the City of Philadelphia NPDES Storm Water Management Permit No. PA 0054712. The report covers the three-month period beginning January 1, 2010 and ending March 31, 2010.

The body of this report will describe the recent activities of the City during the past quarter within the Priority Outfall areas and at other significant outfalls on the Stormwater Priority Outfall List. Additionally, goals for the next quarter will be listed.

Table 1 provides a summary of the program with respect to Complete tests, Cross-connections identified, and Abatements performed. Table 2 provides a listing of all laboratory analyses of samples taken at stormwater outfalls or within the stormwater system during the previous quarter. Table 3 provides a listing of properties with cross-connections outstanding greater than 120 days. Finally, Table 4 provides a listing of reported spills to the stormwater system or receiving streams.

II. PAST QUARTER REVIEW

A. Priority Outfalls

1. 7th & Cheltenham Outfall (T-088-01)

DLC program activities have performed 2,829 Complete tests in this sewershed, identifying 132 Cross-connections, all but 1 of which have been Abated.

Six (6) sites intercepting flow from 5 targeted areas are listed below.

1. CFD-01 Plymouth St., west of Pittsville St.
2. CFD-02 Pittsville St., south of Plymouth St.
3. CFD-03 Elston St., east of Bouvier St.
4. CFD-04 Ashley St., west of Bouvier St.
5. CFD-05 Cheltenham Ave., east of 19th St.
6. CFD-06 Verbena St., south of Cheltenham Ave.

The number of inspections, blockages cleared and discharges noted during this quarter are listed below.

Flap Gate	Inspections	Blockages	Discharges
CFD-01	8	4	0
CFD-02	11	5	0
CFD-03	10	2	0
CFD-04	9	2	0
CFD-05	11	1	0
CFD-06	9	0	0

The most recent fecal sample value was 480 fecal colonies per 100 ml. at the outfall on March 25, 2010.

2. Monastery Ave. Outfall (W-060-01)

DLC program activities have performed 611 Complete tests in this sewershed, identifying 16 Cross-connections, all of which have been Abated.

Two (2) sites intercepting flow are listed below.

1. MFD-01 Jannette St., west of Monastery Ave.
2. MFD-02 Green La., north of Lawnton St.

The number of inspections, blockages cleared and discharges noted during this quarter are listed below.

Flap Gate	Inspections	Blockages	Discharges
MFD-01	8	2	0
MFD-02	8	1	0

The most recent fecal sample value was 90 fecal colonies per 100 ml. at the outfall on March 25, 2010.

3. Monoshone Creek Outfalls (W-060-04, W-060-08, W-060-09, W-060-10, W-060-11, W-068-04 and W-068-05)

DLC program activities have performed 2,742 Complete tests in these sewershed areas, identifying 92 Cross-connections, all of which have been Abated. The majority of the efforts have been in the W-068-05 sewershed area which is by far the largest in terms of drainage area and properties served.

The most recent fecal sample value was 4100 fecal colonies per 100 ml. at the W-068-05 outfall on March 25, 2010.

4. Manayunk Canal Outfalls (S-051-06, S-058-01, S-059-01 through S-059-11)

DLC program activities have performed 2,444 Complete tests in these sewershed areas, identifying 59 Cross-connections, all of which have been Abated. The majority of the efforts have been in the S-059-04 sewershed area.

The most recent fecal sample value was 10 fecal colonies per 100 ml. at the S-058-01 outfall, 945 fecal colonies per 100 ml. at the S-059-01 outfall, 5900 fecal colonies per 100 ml. at the S-059-02 outfall, 145 fecal colonies per 100 ml. at the S-059-03 outfall, 9600 fecal colonies per 100 ml. at the S-059-04 outfall, 100 fecal colonies per 100 ml. at the S-059-05 outfall, 10 fecal colonies per 100 ml. at the S-059-09 outfall, all on March 10, 2010.

B. Other Outfalls

1. Sandyford Run Outfall (P-090-02)

One (1) site intercepting flow is listed below.

1. PFD-01 Sandyford Run

The number of inspections, blockages cleared and discharges noted during this quarter are listed below.

Flap Gate	Inspections	Blockages	Discharges
PFD-01	10	1	0

2. Franklin and Hasbrook Outfall (T-089-04)

A Sanitary Diversion Valve (SDV) was installed over the existing east 3'-0" x 6'-6" twin concrete storm water sewers in Franklin Avenue and activated on October 29, 2009. The new SDV diverts all existing dry weather sanitary flow from the storm sewer that previously drained into Outfall T-089-04, to the existing sanitary sewer located under it.

One (1) site intercepting flow is listed below.

1. CFD-01 Franklin and Hasbrook

The number of inspections, blockages cleared and discharges noted during this quarter are listed below.

Flap Gate	Inspections	Blockages	Discharges
CFD-01	60	3	0

3. A current summary of additional outfalls from the Stormwater Priority Outfall List that the City has performed complete testing or abatements at this quarter is as follows.

Outfall #	Complete Tests	Cross-Connections	Abatements
P-083-03	1	0	0
P-091-06	51	0	0
P-091-10	23	1	0
P-100-01	5	1	2
P-100-05	30	1	1
P-100-08	481	4	1
P-100-21	30	1	0
P-103-03	42	0	0
P-104-07	0	0	1
P-108-16	26	1	1
P-112-04	69	0	0
P-113-01	10	0	0
Q-101-05	3	0	3
Q-101-17	88	1	0
Q-106-16	1	0	0
Q-110-07	1	0	0
Q-114-06	6	0	0
Q-117-01	0	0	1
Q-117-03	7	0	0

III. NEXT QUARTER GOALS

A. Priority Outfalls

1. 7th & Cheltenham Outfall (T-088-01)

Goals for the Quarter

- Continue to monitor the operation of the diversion apparatuses.
- Continue sampling at the priority outfall with dry-weather flow.

2. Monastery Ave. Outfall (W-060-01)

Goals for the Quarter

- Continue to monitor the operation of the diversion apparatuses.
- Continue sampling at the priority outfall with dry-weather flow.

3. Monoshone Creek Outfalls (W-060-04, W-060-08, W-060-09, W-060-10, W-060-11, W-068-04 and W-068-05)

Goals for the Quarter

- Continue sampling at outfall W-068-05 with dry-weather flow.

4. Manayunk Canal Outfalls (S-051-06, S-058-01, S-059-01 through S-059-11)

Goals for the Quarter

- Continue sampling at the priority outfalls with dry-weather flow.

B. Other Outfalls

1. Sandyford Run Outfall (P-090-02)

Goals for the Quarter

- Continue to monitor the operation of the diversion apparatus.

2. Franklin and Hasbrook Outfall (T-089-04)

Goals for the Quarter

- Continue to monitor the operation of the diversion apparatus.

3. Continue to perform outstanding abatements of identified cross-connections within the following outfalls.

- D-092-05
- P-091-10
- P-091-11
- P-100-08
- P-100-21
- P-101-02
- P-104-06
- P-104-07
- P-105-01
- P-105-06
- P-04
- Q-101-03
- Q-101-05
- Q-101-09
- Q-101-17
- Q-110-18
- S-046-06
- S-052-04
- T-088-01
- T-089-04
- W-086-01
- W-086-02

4. Continue to perform property testing within the following outfalls.

- P-091-06
- P-091-10
- P-100-08
- P-112-04
- Q-114-06

Table 1
DLC Program Summary
January 1, 2010 to March 31, 2010

Complete Tests:

- 39,035 Complete tests have been performed under the DLC program
- **874 Complete tests were performed this past quarter**
- 1 Complete test was performed in outfall P-083-03
- 51 Complete tests were performed in outfall P-091-06
- 23 Complete tests were performed in outfall P-091-10
- 5 Complete tests were performed in outfall P-100-01
- 30 Complete tests were performed in outfall P-100-05
- 481 Complete tests were performed in outfall P-100-08
- 30 Complete tests were performed in outfall P-100-21
- 42 Complete tests were performed in outfall P-103-03
- 26 Complete tests were performed in outfall P-108-16
- 69 Complete tests were performed in outfall P-112-04
- 10 Complete tests were performed in outfall P-113-01
- 3 Complete tests were performed in outfall Q-101-05
- 88 Complete tests were performed in outfall Q-101-17
- 1 Complete test was performed in outfall Q-106-16
- 1 Complete test was performed in outfall Q-110-07
- 6 Complete tests were performed in outfall Q-114-06
- 7 Complete tests were performed in outfall Q-117-03

Cross-Connections Found:

- 1,050 Cross-connections have been identified under the DLC program
- **10 Cross-connections were identified this past quarter**
- 1 Cross-connection was identified in outfall P-091-10
- 1 Cross-connection was identified in outfall P-100-01
- 1 Cross-connection was identified in outfall P-100-05
- 4 Cross-connections were identified in outfall P-100-08
- 1 Cross-connection was identified in outfall P-100-21
- 1 Cross-connection was identified in outfall P-108-16
- 1 Cross-connection was identified in outfall Q-101-17

Abatements:

- 993 Abatements have been performed under the DLC program
- **10 Abatements were performed this past quarter**
- 2 Abatements were performed in outfall P-100-01
- 1 Abatement was performed in outfall P-100-05
- 1 Abatement was performed in outfall P-100-08
- 1 Abatement was performed in outfall P-104-07
- 1 Abatement was performed in outfall P-108-16
- 3 Abatements were performed in outfall Q-101-05
- 1 Abatement was performed in outfall Q-117-01

Outfall/Manhole Screening and Sampling:

- 11 outfall inspections were made as part of the Priority Outfall sampling program this past quarter
- 11 outfall samples were taken due to observed dry-weather flow during the above inspections

- 1 outfall inspection was made as part of the Permit Inspection Program sampling program this past quarter
- 1 outfall sample was taken due to observed dry-weather flow during the above inspections

Table 2
Lab Analysis of Water at Outfalls and/or in the Storm Sewers
January 1, 2010 to March 31, 2010

Outfall	Date	Time	Location	Sewer Size (in)	Flow (gph)	Fluoride (mg/l)	Fecal Count (# per 100 ml)	Comments
A. Priority Outfalls								
S-058-01	3/10/2010	9:35	Outfall: Domino Lane	54		0.25	10	
S-059-01	3/10/2010	9:55	Outfall: Parker	60		<0.2	945	
S-059-02	3/10/2010	10:05	Outfall: Fountain	42		0.26	5900	
S-059-03	3/10/2010	10:20	Outfall: Wright	42		<0.2	145	
S-059-04	3/10/2010	10:35	Outfall: Leverington	51		0.35	9600	
S-059-05	3/10/2010	10:40	Outfall: Leverington (east)	4'-0"x2'-8"		0.34	100	
S-059-09	3/10/2010	10:55	Outfall: Green Lane	36		0.94	10	
T-088-01	3/25/2010	12:05	Outfall: 7th & Cheltenham	84		0.20	480	
T-088-01	3/25/2010	12:20	Outfall: 7th & Cheltenham @ Bridge	84		0.18	580	
W-068-05	3/25/2010	11:30	Outfall: Lincoln & Morris	90		0.28	4100	
W-060-01	3/25/2010	11:00	Outfall: Monastery Lane	5'-0'x4'-4"		0.14	90	
B. Permit Inspection Program								
Q-102-02	1/19/2010	8:40	Outfall: St. Denis & Hegerman	48	180	0.89	150	

Table 3
Residential Cross Connections Not Abated Within 120 Days

A. Properties Abated & Confirmed Prior to Reporting:

Address			Outfall Code	Complete Date	Admin. Action	Abatement Confirmation Date	Comments
03508	Primrose	Rd	Q-101-05	10-23-2009		03-24-2010	
03434	Grant	Ave	Q-101-05	10-28-2009		03-08-2010	

B. Properties Active As Of Reporting:

Address				Outfall Code	Complete Date	Admin. Action	Comments
03513		Indian Queen	La	S-052-04	06-10-2004		Was never referred to Program. Dye tests were never confirmed.
09328		Ditman	St	Q-101-09	02-11-2006		Inspection completed, repairs pending.
03126	N	29th	St	S-046-06	04-20-2006		Inspection pending
02615	W	Allegheny	Ave	S-046-06	05-31-2006		Inspection pending.
05400		Archer	St	S-046-06	06-15-2006		Property in non bill status, may be vacant. Sold to a bank
05054		Mc Kean	Ave	S-046-06	09-26-2006		Inspection pending
09390		Neil	Rd	P-105-06	05-31-2008		
00813		Cottman	Ave	T-089-04	10-20-2008		
07350	E	Tabor	Rd	T-089-04	04-09-2009		
07323	E	Tabor	Rd	T-089-04	04-11-2009		
02922	W	Allegheny	Ave	S-046-06	04-11-2009		
09408		Hilspach	St	P-105-01	04-25-2009		
09514		Clark	St	P-105-01	06-19-2009		
01108		Rising Sun	Pl	P-104-06	07-17-2009		
01112		Bloomfield	Ave	P-104-06	07-29-2009		
00803		Bergen	St	P-104-07	08-12-2009		
08511		Bridle	Rd	P-104-07	08-31-2009		
03165		Draper	St	P-091-11	09-19-2009		
03552		Grant	Ave	Q-101-05	10-23-2009		
08053		Cresco	Ave	P-091-10	11-23-2009		
03301		Welsh	Rd	P-091-10	11-23-2009		

Table 4

Spills to Storm Sewers and/or Receiving Waters

January 1, 2010 to March 31, 2010

Date	Outfall	Address	Source Code	Material Involved	Completion Date	Remarks
01/19/10	P-105-13	9900 Haldeman Avenue Wooden Bridge Run	3009	Sewage	01/19/10	Sewer Maintenance unit flushed 10" diameter sanitary sewer to relieve choke causing approximate 1 gpm discharge.
01/28/10	P-101-02	9300 Annapolis Road Wooden Bridge Run	3011	Sewage	01/28/10	Sewer Maintenance unit flushed 10" diameter sanitary sewer to relieve choke causing approximate 3 gpm discharge.
03/03/10		State Road and Pennypack Street		Sewage	03/03/10	Sewer Maintenance unit found approximate 3 gpm sewage leak from manhole #BCF-0020 on 42" diameter force main. Sewage flowed over grass to gutter. Issue referred to J. Butler, Chief Operating Officer, Bucks County Water and Sewer Authority for investigation and correction.
03/23/10	Q-110-01	11301 Norcom Road Walton's Run	3009	Sewage	03/23/10	Sewer Maintenance unit flushed 10" diameter sanitary sewer to relieve choke causing approximate 3 gpm discharge.
03/24/10	W-068-05	W. Duval and Greene Streets Monoshone Creek	3011	Sewage	03/24/10	Sewer Maintenance unit removed debris from manhole invert on Duval Street and flushed 12" diameter sanitary sewer on Greene Street to relieve chokes causing approximate 3 gpm discharge.
03/30/10	F-09	Erie and Torresdale Avenues Tacony Creek	3011	Sewage / Wet Weather CSO	03/30/10	Industrial Waste unit investigated a reported sewage discharge during wet weather. No choked sewers found. Observed normal wet weather discharge from F-09 CSO chamber.

Source Codes:

3009 - Spill to Storm Sewer

3011 - Spill to Receiving Stream

STORM WATER MANAGEMENT PROGRAM
NPDES PERMIT NO. PA0054712

DEFECTIVE LATERAL CONNECTION STATUS REPORT
(Covering Period from April 1, 2010 to June 30, 2010)

Submitted to

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER QUALITY MANAGEMENT

By

CITY OF PHILADELPHIA
PHILADELPHIA, PA

August 13, 2010

DLC Program Update
2nd Quarter 2010

I. INTRODUCTION

This Defective Lateral Connection Status Report is submitted to the Pennsylvania Department of Environmental Protection (PADEP) as part of the reporting requirements of the City of Philadelphia NPDES Storm Water Management Permit No. PA 0054712. The report covers the three-month period beginning April 1, 2010 and ending June 30, 2010.

The body of this report will describe the recent activities of the City during the past quarter within the Priority Outfall areas and at other significant outfalls on the Stormwater Priority Outfall List. Additionally, goals for the next quarter will be listed.

Table 1 provides a summary of the program with respect to Complete tests, Cross-connections identified, and Abatements performed. Table 2 provides a listing of all laboratory analyses of samples taken at stormwater outfalls or within the stormwater system during the previous quarter. Table 3 provides a listing of properties with cross-connections outstanding greater than 120 days. Finally, Table 4 provides a listing of reported spills to the stormwater system or receiving streams.

II. PAST QUARTER REVIEW

A. Priority Outfalls

1. 7th & Cheltenham Outfall (T-088-01)

DLC program activities have performed 2,829 Complete tests in this sewershed, identifying 132 Cross-connections, all but 1 of which have been Abated.

Six (6) sites intercepting flow from 5 targeted areas are listed below.

1. CFD-01 Plymouth St. west of Pittsville St.
2. CFD-02 Pittsville St. south of Plymouth St.
3. CFD-03 Elston St. east of Bouvier St.
4. CFD-04 Ashley St. west of Bouvier St.
5. CFD-05 Cheltenham Ave. east of 19th St.
6. CFD-06 Verbena St. south of Cheltenham Ave.

The number of inspections, blockages cleared and discharges noted during this quarter are listed below.

Flap Gate	Inspections	Blockages	Discharges
CFD-01	11	5	0
CFD-02	9	5	0
CFD-03	9	2	0
CFD-04	9	1	0
CFD-05	8	2	0
CFD-06	9	0	0

The most recent fecal sample value was 12300 fecal colonies per 100 ml. at the outfall on June 3, 2010.

2. Monastery Ave. Outfall (W-060-01)

DLC program activities have performed 611 Complete tests in this sewershed, identifying 16 Cross-connections, all of which have been Abated.

Two (2) sites intercepting flow are listed below.

1. MFD-01 Jannette St. west of Monastery Ave.
2. MFD-02 Green La. north of Lawnton St.

The number of inspections, blockages cleared and discharges noted during this quarter are listed below.

Flap Gate	Inspections	Blockages	Discharges
MFD-01	9	0	0
MFD-02	9	0	0

The most recent fecal sample value was 700 fecal colonies per 100 ml. at the outfall on June 3, 2010.

3. Monoshone Creek Outfalls (W-060-04, W-060-08, W-060-09, W-060-10, W-060-11, W-068-04 and W-068-05)

DLC program activities have performed 2,742 Complete tests in these sewershed areas, identifying 92 Cross-connections, all of which have been Abated. The majority of the efforts have been in the W-068-05 sewershed area which is by far the largest in terms of drainage area and properties served.

The most recent fecal sample value was >20000 fecal colonies per 100 ml. at the W-068-05 outfall on June 3, 2010.

4. Manayunk Canal Outfalls (S-051-06, S-058-01, S-059-01 through S-059-11)

DLC program activities have performed 2,444 Complete tests in these sewershed areas, identifying 59 Cross-connections, all of which have been Abated. The majority of the efforts have been in the S-059-04 sewershed area.

The most recent fecal sample value was 1000 fecal colonies per 100 ml. at the S-058-01 outfall, 2000 fecal colonies per 100 ml. at the S-059-01 outfall, 42000 fecal colonies per 100 ml. at the S-059-02 outfall, 31000 fecal colonies per 100 ml. at the S-059-03 outfall, >200000 fecal colonies per 100 ml. at the S-059-04 outfall, 8500 fecal colonies per 100 ml. at the S-059-05 outfall, 600 fecal colonies per 100 ml. at the S-059-09 outfall, all on June 16, 2010.

B. Other Outfalls

1. Sandyford Run Outfall (P-090-02)

One (1) site intercepting flow is listed below.

1. PFD-01 Sandyford Run (Brous and Lexington Aves.)

The number of inspections, blockages cleared and discharges noted during this quarter are listed below.

Flap Gate	Inspections	Blockages	Discharges
PFD-01	12	0	0

2. Franklin and Hasbrook Outfall (T-089-04)

A Sanitary Diversion Valve (SDV) was installed over the existing east 3'-0" x 6'-6" twin concrete storm water sewers in Franklin Avenue and activated on October 29, 2009. The new SDV diverts all existing dry weather sanitary flow from the storm sewer that previously drained into Outfall T-089-04, to the existing sanitary sewer located under it.

One (1) site intercepting flow is listed below.

1. CFD-01 Franklin and Hasbrook Aves.

The number of inspections, blockages cleared and discharges noted during this quarter are listed below.

Flap Gate	Inspections	Blockages	Discharges
CFD-01	61	0	0

3. A current summary of additional outfalls from the Stormwater Priority Outfall List that the City has performed complete testing or abatements at this quarter is as follows.

Outfall #	Complete Tests	Cross-Connections	Abatements
P-091-01	91	2	0
P-091-06	590	8	1
P-091-08	64	3	0
P-091-10	16	1	0
P-100-08	15	1	3
P-101-01	11	0	0
P-103-01	8	0	0
P-103-03	11	0	0
P-108-14	66	0	0
P-112-04	39	3	2
P-113-01	22	0	0
Q-101-05	0	0	2
Q-101-10	4	0	0
Q-101-17	2	0	1
Q-114-06	1	0	0
W-077-01	6	1	0

III. NEXT QUARTER GOALS

A. Priority Outfalls

1. 7th & Cheltenham Outfall (T-088-01)

Goals for the Quarter

- Continue to monitor the operation of the diversion apparatuses.
- Continue sampling at the priority outfall with dry-weather flow.

2. Monastery Ave. Outfall (W-060-01)

Goals for the Quarter

- Continue to monitor the operation of the diversion apparatuses.
- Continue sampling at the priority outfall with dry-weather flow.

3. Monoshone Creek Outfalls (W-060-04, W-060-08, W-060-09, W-060-10, W-060-11, W-068-04 and W-068-05)

Goals for the Quarter

- Continue sampling at outfall W-068-05 with dry-weather flow.

4. Manayunk Canal Outfalls (S-051-06, S-058-01, S-059-01 through S-059-11)

Goals for the Quarter

- Continue sampling at the priority outfalls with dry-weather flow.

B. Other Outfalls

1. Sandyford Run Outfall (P-090-02)

Goals for the Quarter

- Continue to monitor the operation of the diversion apparatus.

2. Franklin and Hasbrook Outfall (T-089-04)

Goals for the Quarter

- Continue to monitor the operation of the diversion apparatus.

3. Continue to perform abatements of identified cross-connections within the following outfalls.

- D-092-05
- P-091-01
- P-091-06
- P-091-08
- P-091-10
- P-091-11
- P-100-08
- P-100-21
- P-101-02
- P-104-06
- P-104-07
- P-105-01
- P-105-06
- P-112-04
- P-04
- Q-101-03
- Q-101-09
- Q-110-18
- S-046-06
- S-052-04
- T-088-01
- T-089-04
- W-077-01
- W-086-01
- W-086-02

4. Continue to perform property testing within the following outfalls.

- P-091-01
- P-101-01
- P-108-14
- Q-110-15
- Q-113-09
- Q-121-05

Table 1
DLC Program Summary
April 1, 2010 to June 30, 2010

Complete Tests:

- 39,981 Complete tests have been performed under the DLC program
- **946 Complete tests were performed this past quarter**
- 91 Complete tests were performed in outfall P-091-01
- 590 Complete tests were performed in outfall P-091-06
- 64 Complete tests were performed in outfall P-091-08
- 16 Complete tests were performed in outfall P-091-10
- 15 Complete tests were performed in outfall P-100-08
- 11 Complete tests were performed in outfall P-101-01
- 8 Complete tests were performed in outfall P-103-01
- 11 Complete tests were performed in outfall P-103-03
- 66 Complete tests were performed in outfall P-108-14
- 39 Complete tests were performed in outfall P-112-04
- 22 Complete tests were performed in outfall P-113-01
- 4 Complete tests were performed in outfall Q-101-10
- 2 Complete tests were performed in outfall Q-101-17
- 1 Complete test was performed in outfall Q-114-06
- 6 Complete tests were performed in outfall W-077-01

Cross-Connections Found:

- 1,069 Cross-connections have been identified under the DLC program
- **19 Cross-connections were identified this past quarter**
- 2 Cross-connections were identified in outfall P-091-01
- 8 Cross-connections were identified in outfall P-091-06
- 3 Cross-connections were identified in outfall P-091-08
- 1 Cross-connection was identified in outfall P-091-10
- 1 Cross-connection was identified in outfall P-100-08
- 3 Cross-connections were identified in outfall P-112-04
- 1 Cross-connection was identified in outfall W-077-01

Abatements:

- 1,002 Abatements have been performed under the DLC program
- **9 Abatements were performed this past quarter**
- 1 Abatement was performed in outfall P-091-06
- 3 Abatements were performed in outfall P-100-08
- 2 Abatements were performed in outfall P-112-04
- 2 Abatements were performed in outfall Q-101-05
- 1 Abatement was performed in outfall Q-101-17

Outfall/Manhole Screening and Sampling:

- 11 outfall inspections were made as part of the Priority Outfall Inspection Program this past quarter
- 11 outfall samples were taken due to observed dry-weather flow during the above inspections

- 102 outfall inspections were made as part of the Permit Inspection Program this past quarter
- 54 outfall samples were taken due to observed dry-weather flow during the above inspections

Table 2
Lab Analysis of Water at Outfalls and/or in the Storm Sewers
April 1, 2010 to June 30, 2010

Outfall	Date	Time	Location	Sewer Size (in)	Flow (gph)	Fluoride (mg/l)	Fecal Count (# per 100 ml)	Comments
A. Priority Outfalls								
T-088-01	6/3/2010	9:35	Outfall: 7th & Cheltenham	84		0.25	12300	
T-088-01	6/3/2010	9:40	Outfall: 7th & Cheltenham @ Bridge	84		0.22	11000	
W-060-01	6/3/2010	11:20	Outfall: Monastery Lane	5'-0"x4'-4"		0.20	700	
W-068-05	6/3/2010	10:25	Outfall: Lincoln & Morris	90		0.38	>20000	
S-058-01	6/16/2010	10:05	Outfall: Domino Lane	54		0.34	1000	
S-059-01	6/16/2010	10:20	Outfall: Parker	60		<.2	2000	
S-059-02	6/16/2010	10:35	Outfall: Fountain	42		0.23	42000	
S-059-03	6/16/2010	10:45	Outfall: Wright	42		<.2	31000	
S-059-04	6/16/2010	10:55	Outfall: Leverington	51		0.26	>200000	
S-059-05	6/16/2010	11:00	Outfall: Leverington (east)	4'-0"x2'-8"		0.31	8500	
S-059-09	6/16/2010	11:15	Outfall: Green Lane	36		1.06	600	
B. Permit Inspection Program								
A-004-01	6/8/2010	13:15	Outfall: Lindbergh & Chelwynde	Unk	NF	N/A	N/A	
P-082-02	6/21/2010	11:15	Manhole: Holmesburg Ave & Mill St	48	350	0.32	86000	MH on Mill Street above CSO
P-082-01	6/21/2010	12:00	Outfall: Enfield between Torresdale & Cottage	27	NF	N/A	N/A	Observed from Manhole on Cottage Street
P-083-04	4/7/2010	10:15	Outfall: SE of State Rd & Ashburner	102	600	<0.2	27	OF submerged in creek
P-083-03	4/7/2010	10:25	Outfall: State Rd & Ashburner	9'-0"x11'-1"	600	0.27	580	
P-083-01	4/7/2010	10:45	Outfall: NE of State Rd & Rhawn	18	30	<0.2	64	
P-083-02	4/7/2010	10:55	Outfall: NE of State Rd & Rhawn	18	NF	N/A	N/A	
P-090-02	4/12/2010	10:30	Outfall: S of Brous & Roosevelt Blvd	156	60	0.35	400	
P-090-01	4/12/2010	10:40	Outfall: S of Brous & Roosevelt Blvd	42	300	0.10	<10	
P-091-01	5/27/2010	10:20	Outfall: NE of Sandyford Ave & Brous St	36	120	0.60	>200000	
P-091-02	6/21/2010	10:00	Outfall: N of Sandyford & Ryan Aves	42	60	2.65	100	
P-091-03	6/21/2010	10:10	Outfall: NE of Sandyford & Ryan Aves	27	NF	N/A	N/A	
P-091-04	6/21/2010	10:35	Outfall: SE of Rhawn St & Lexington Ave	36	NF	N/A	N/A	
P-091-05	6/22/2010	10:00	Outfall: NW of Winchester Ave & Albion	42	NF	N/A	N/A	
P-091-07	6/22/2010	10:15	Outfall: W of Holme & Winchester Aves	54	600	0.77	<100	OF submerged in creek
P-091-06	6/22/2010	10:25	Outfall: W of Holme & Winchester Aves	3'-0"x7'-7"	1200	<0.2	400	OF submerged in creek
P-091-10	6/22/2010	11:20	Outfall: NW of Welsh Rd & Rowland Ave	42	180	0.72	67000	

Table 2
Lab Analysis of Water at Outfalls and/or in the Storm Sewers
April 1, 2010 to June 30, 2010

Outfall	Date	Time	Location	Sewer Size (in)	Flow (gph)	Fluoride (mg/l)	Fecal Count (# per 100 ml)	Comments
P-091-09	6/22/2010	11:40	Outfall: NW of Welsh Rd & Rowland Ave	36	360	0.87	636	
P-091-08	6/28/2010	9:50	Outfall: NW of Rowland & Hartel Aves	54	120	0.41	<100	
P-091-11	6/28/2010	10:45	Outfall: E of Wintrop & Draper Sts	30	180	0.67	<100	
P-091-12	6/28/2010	11:30	Outfall: SE of Narvon & Arthur Sts	30	30	0.32	1000	
P-091-13	6/28/2010	11:45	Outfall: SE of Longford St & Holme Ave	21	NF	N/A	N/A	
P-092-01	4/8/2010	10:30	Outfall: NW of Pennypack & Crispin St	18	NF	N/A	N/A	Observation from MH
P-092-02	4/8/2010	10:40	Outfall: NW of Pennypack & Crispin St	20	NF	N/A	N/A	Observation from MH
P-092-04	4/12/2010	11:05	Outfall: NE Pennypack & Crispin St	18	30	0.12	<10	
P-092-03	4/12/2010	11:15	Outfall: NE Pennypack & Crispin St	18	30	0.12	<10	
P-099-01	6/29/2010	10:50	Outfall: NE of Tabor Ave & Stanwood St	5'-0"x6'-6"	180	0.14	>200000	
P-099-03	6/29/2010	11:20	Outfall: SE of Tustin & Bustleton Aves	7'-0"x6'-6"	180	0.49	>200000	
P-099-04	6/29/2010	11:45	Outfall: SW of Evarts & Tolbut Sts	36	NF	N/A	N/A	
P-099-05	6/29/2010	12:10	Outfall: NE of Horrocks & Strahle Sts	42	120	0.46	7000	
P-100-05	4/13/2010	10:10	Outfall: NW of Winchester Ave & Tolbut St	36	NF	N/A	N/A	
P-100-06	4/13/2010	10:15	Outfall: S Sperry & Macon Sts	21	NF	N/A	N/A	
P-100-07	4/13/2010	10:25	Outfall: SE of Sperry & Danbury Sts	24	15	0.22	845	
P-100-01	4/28/2010	10:00	Outfall: W of Woodward & Winchester Ave	42	120	<0.2	480	
P-100-04	4/28/2010	10:15	Outfall: S of Winchester & Blue Grass Rd	48	30	0.47	10	
P-100-08	4/28/2010	10:20	Outfall: SE Maxwell & Danbury Sts	72	120	0.32	>20000	
P-100-10	4/28/2010	10:45	Outfall: NE of Ashton Rd & Jenny Place	21	30	<0.2	5800	
P-100-12	4/28/2010	10:46	Outfall: NE of Ashton Rd & Jenny Place	15	NF	N/A	N/A	
P-100-11	4/28/2010	10:47	Outfall: NE of Ashton Rd & Jenny Place	42	NF	N/A	N/A	
P-100-09	4/28/2010	10:50	Outfall: N of Ashton Rd & Jenny Place	15	NF	N/A	N/A	
P-100-02	4/29/2010	10:24	Outfall: S of Roosevelt Blvd & Winchester	42	NF	N/A	N/A	
P-100-03	4/29/2010	10:29	Outfall: S of Roosevelt Blvd & Winchester	30	NF	N/A	N/A	
P-100-19	4/29/2010	10:45	Outfall: NW of Willits & Cloverly	24	NF	N/A	N/A	
P-100-18	4/29/2010	10:50	Outfall: NW of Willits & Cloverly	15	15	0.14	>20000	
P-100-17	4/29/2010	10:55	Outfall: NW of Willits & Cloverly	27	30	0.60	2900	
P-100-24	5/5/2010	10:00	Outfall: SE of Angus & Woodbridge Rds	27	60	0.48	9500	
P-100-25	5/5/2010	10:15	Outfall: Annapolis & Cloverly	21	30	0.57	6300	
P-100-13	5/6/2010	10:30	Outfall: Holme Ave & Longford St	18	NF	N/A	N/A	
P-100-14	5/6/2010	10:40	Outfall: W of Holme Ave & Longford St	42	NF	N/A	N/A	OF halfway submerged
P-100-15	5/6/2010	11:50	Outfall: W of Cloverly Rd & Arlan Ave	30	NF	N/A	N/A	
P-100-21	5/6/2010	12:30	Outfall: W of Woodenbridge & Cloverly Rds	27	NF	N/A	N/A	
P-100-16	5/10/2010	11:20	Outfall: SE of Maxwell, Tolbut & Tremont	54	120	<0.2	3000	
P-100-20	5/10/2010	11:40	Outfall: NE of Ryerson Rd & Ryerson Pl	30	NF	N/A	N/A	
P-100-23	5/11/2010	10:00	Outfall: S of Ashton & Angus Rds	36	120	0.68	>20000	
P-100-22	5/11/2010	10:30	Outfall: SW of Angus Rd & Angus Pl	18	NF	N/A	N/A	
P-101-02	6/22/2010	10:35	Outfall: NW of Annapolis & Brookdale Rds	42	60	0.29	26000	Sampled in ponded channel

Table 2
Lab Analysis of Water at Outfalls and/or in the Storm Sewers
April 1, 2010 to June 30, 2010

Outfall	Date	Time	Location	Sewer Size (in)	Flow (gph)	Fluoride (mg/l)	Fecal Count (# per 100 ml)	Comments
P-101-01	6/22/2010	10:45	Outfall: E of Woodbridge & Saxton Rds	24	NF	N/A	N/A	
P-103-02	5/11/2010	11:00	Outfall: S of Pine & Shady Ln	18	NF	N/A	N/A	
P-103-01	5/11/2010	11:05	Outfall: N of Pine & Shady Ln	42	120	<0.2	460	
P-103-03	5/11/2010	11:30	Outfall: N of Hoffnagle St & Rockwell Ave	42	NF	N/A	N/A	
P-104-01	4/19/2010	11:00	Outfall: SW of Pine Rd & Longmeadow Ln	21	NF	N/A	N/A	
P-104-02	4/19/2010	11:15	Outfall: SW of Pine Rd & Longmeadow Ln	42	NF	N/A	N/A	
P-104-03	4/21/2010	10:00	Outfall: S of Verree & Meeting House Rds	42		0.20	10	
P-104-04	4/23/2010	10:00	Outfall: Intersection Verree & Meeting House	24	NF	N/A	N/A	
P-104-05	4/23/2010	10:35	Outfall: NW of Norvelt Dr & Hoven Rd	30	60	<0.2	5100	
P-104-06	4/23/2010	11:00	Outfall: SE of MeetingHouse & Verree Rds	48	120	<0.2	10	
P-104-07	4/23/2010	11:15	Outfall: SE of Tustin & Rising Sun Aves	66	NF	N/A	N/A	
P-105-01	4/29/2010	10:50	Outfall: SE of Roosevelt Blvd & Goodnaw St	102	300	0.15	4000	
P-105-02	4/29/2010	12:00	Outfall: N of Winchester & Old Bustleton Aves	60	240	0.25	1560	
P-105-03	4/30/2010	10:37	Outfall: Roosevelt Blvd & Grant Ave	4'-0"x7'-7"	NF	N/A	N/A	
P-105-04	4/30/2010	11:00	Outfall: Blue Grass & Welsh Rds	30	NF	N/A	N/A	
P-105-05	4/30/2010	11:05	Outfall: NE of Blue Grass & Welsh	30	NF	N/A	N/A	
P-105-06	5/5/2010	11:15	Outfall: Old Bustleton Ave & Gregg St	6'-0"x9'-9"	600	<0.2	3500	
P-106-02	5/10/2010	10:38	Outfall: NE of Ashton & Saxton Rds	36	30	<0.2	162	
P-106-01	5/10/2010	11:00	Outfall: Ashton Rd & Grant Ave	60	300	<0.2	<10	
P-108-01	5/20/2010	9:45	Outfall: W of Bloomfield & Jennifer	36	NF	N/A	N/A	
P-108-02	5/20/2010	9:50	Outfall: W of Bloomfield & Jennifer	18	NF	N/A	N/A	
P-108-04	5/20/2010	10:15	Outfall: SW of Kings Oak Lane	30	60	0.90	<10	
P-108-05	5/20/2010	10:35	Outfall: SE of Greycourt & Pocasett	27	60	<0.2	9	
P-108-07	5/20/2010	10:50	Outfall: E of Alberger & Darlington	36	30	<0.2	1130	
P-108-06	5/20/2010	10:55	Outfall: E of Alberger & Darlington	27	NF	N/A	N/A	
P-108-12	5/20/2010	11:15	Outfall: E of Bloomfield & Veree	36	NF	N/A	N/A	
P-108-13	5/20/2010	11:20	Outfall: E of Bloomfield & Veree	36	15	<0.2	135	
P-108-10	6/30/2010	11:15	Outfall: W of Pecan & Stratford Drives	18	60	<0.2	400	
P-108-14	6/30/2010	11:50	Outfall: NE of Verree & Marchman Rds	66	NF	N/A	N/A	
P-109-03	6/30/2010	10:40	Outfall: S of Bustleton Ave & Norwalk Rd	24	30	0.23	4100	
P-109-05	6/30/2010	10:50	Outfall: Norwalk Rd & Wally Ave	42	NF	N/A	N/A	
P-112-02	4/21/2010	9:30	Outfall: SE of Welsh & Darlington Rds	48	NF	N/A	N/A	
P-112-01	4/21/2010	9:35	Outfall: SE of Welsh & Darlington Rds	42	1	<0.1	20	
P-112-03	4/21/2010	10:00	Outfall: NE of Laramie & Kismet Rds	8'-0"X8'-8"	220	0.18	50	
P-112-05	4/21/2010	10:15	Outfall: E of Laramie & Kismet Rds	21	NF	N/A	N/A	
P-112-04	4/21/2010	10:20	Outfall: E of Laramie & Kismet Rds.	66	200	<0.2	2700	

Table 2
Lab Analysis of Water at Outfalls and/or in the Storm Sewers
April 1, 2010 to June 30, 2010

Outfall	Date	Time	Location	Sewer Size (in)	Flow (gph)	Fluoride (mg/l)	Fecal Count (# per 100 ml)	Comments
Q-101-09	5/26/2010	10:20	Outfall: E of Ditman & Eden Sts	7'-0"x9'-9"	240	0.38	77000	
Q-101-06	5/26/2010	10:45	Outfall: E of Grant Ave & Fordham Rd	21	NF	N/A	N/A	
Q-101-05	5/26/2010	10:50	Outfall: E of Grant Ave & Fordham Rd	54	360	0.26	3900	
Q-101-08	5/26/2010	11:10	Outfall: NW of Grant Ave & Leon St	21	NF	N/A	N/A	
Q-101-07	5/26/2010	11:20	Outfall: NW of Grant Ave & Leon St	36	120	<0.2	4900	
Q-101-10	5/26/2010	11:35	Outfall: Torresdale Ave & Fitler St	27	60	0.82	560	
Q-101-12	6/29/2010	9:45	Outfall: SE of Grant & Torresdale Aves	18	NF	N/A	N/A	
Q-102-03	6/28/2010	10:05	Outfall: SE of Tulip & Stevenson Sts	48	NF	N/A	N/A	
Q-102-04	6/28/2010	10:30	Outfall: N of Grant Ave & James St	30	NF	N/A	N/A	
Q-115-19	6/28/2010	9:30	Outfall: NE of Dunksferry & Mechanicsville	84	NF	N/A	N/A	

Table 3
Residential Cross Connections Not Abated Within 120 Days

A. Properties Abated & Confirmed Prior to Reporting:

Address			Outfall Code	Complete Date	Admin. Action	Abatement Confirmation Date	Comments
03508	Primrose	Rd	Q-101-05	10-23-2009		03-24-2010	
03552	Grant	Ave	Q-101-05	10-23-2009		04-23-2010	
03434	Grant	Ave	Q-101-05	10-28-2009		03-08-2010	
03523	Primrose	Rd	Q-101-05	12-05-2009		04-05-2010	

B. Properties Active As Of Reporting:

Address				Outfall Code	Complete Date	Admin. Action	Comments
03513		Indian Queen	La	S-052-04	06-10-2004		Was never referred to Program. Dye tests were never confirmed.
09328		Ditman	St	Q-101-09	02-11-2006		Inspection completed, repairs pending.
03126	N	29th	St	S-046-06	04-20-2006		Inspection pending
02615	W	Allegheny	Ave	S-046-06	05-31-2006		Inspection pending.
05400		Archer	St	S-046-06	06-15-2006		Property in non bill status, may be vacant. Sold to a bank
05054		Mc Kean	Ave	S-046-06	09-26-2006		Inspection pending
09390		Neil	Rd	P-105-06	05-31-2008		
00813		Cottman	Ave	T-089-04	10-20-2008		
07350	E	Tabor	Rd	T-089-04	04-09-2009		
07323	E	Tabor	Rd	T-089-04	04-11-2009		
02922	W	Allegheny	Ave	S-046-06	04-11-2009		
09408		Hilspach	St	P-105-01	04-25-2009		
09514		Clark	St	P-105-01	06-19-2009		
01108		Rising Sun	Pl	P-104-06	07-17-2009		
01112		Bloomfield	Ave	P-104-06	07-29-2009		
00803		Bergen	St	P-104-07	08-12-2009		
08511		Bridle	Rd	P-104-07	08-31-2009		
03165		Draper	St	P-091-11	09-19-2009		
08053		Cresco	Ave	P-091-10	11-23-2009		

Table 3
Residential Cross Connections Not Abated Within 120 Days

Address			Outfall Code	Complete Date	Admin. Action	Comments
03301	Welsh	Rd	P-091-10	11-23-2009		
08062	Crispin	St	P-091-10	01-09-2010		
09317	Cloverly	Rd	P-100-21	01-14-2010		

Table 4

Spills to Storm Sewers and/or Receiving Waters

April 1, 2010 to June 30, 2010

Date	Outfall	Address	Source Code	Material Involved	Completion Date	Remarks
04/06/10	T-088-01	7th Street and Cheltenham Avenue Tacony Creek	3009	Sewage	04/06/10	Industrial Waste unit investigated an apparent short duration discharge from the outfall. No source identified.
04/26/10	S-046-09	Ford Road Wastewater Pumping Station / 3800 Ford Road Unnamed tributary of Schuylkill River	3011	Sewage / Wet Weather Flow	04/26/10	Flow Control unit investigated station alarm during a storm. Found electronic control equipment damaged by apparent lightning strike. Pump station operated manually, ending wet well overflow estimated at 8,465 gph, until repairs were made
06/05/10	P-112-04	9725 Laramie Street Darlington Run	3011	Sewage	06/05/10	Sewer Maintenance unit flushed 12" diameter sanitary sewer to relieve choke causing approximate 1 gpm discharge from manhole #P112-03-S0010.
06/19/10	S-052-05	Ridge and Manayunk Avenues Schuylkill River	3009	Sewage	07/03/10	Sewer Maintenance unit operated bypass pumping to relieve approximate 7 gpm discharge while repairs were made to the 8" diameter sanitary sewer.

Source Codes:

3009 - Spill to Storm Sewer

3011 - Spill to Receiving Stream