TOOKANY/TACONY-FRANKFORD WATERSHED ACT 167

STORMWATER MANAGEMENT PLAN

VOLUME I - EXECUTIVE SUMMARY

FINAL REPORT
OCTOBER 10, 2008

MONTGOMERY AND PHILADELPHIA COUNTIES, PENNSYLVANIA

BLE PROJECT NO. 2004-1621-00

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PREPARED FOR:

PHILADELPHIA WATER DEPARTMENT
Office of Watersheds
1101 Market Street, 4th Floor
Philadelphia, PA 19107

PREPARED BY:

BORTON-LAWSON ENGINEERING, INC.
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VOLUME I - EXECUTIVE SUMMARY

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PLAN FORMAT

The format of the Tookany/Tacony-Frankford Watershed Stormwater Management Plan consists of Volume I, the Executive Summary, Volume II, the Plan Report, and Volume III that contains the background technical materials.

Volume I provides an overview of Act 167 and a summary of the standards and criteria developed for the plan. Volume II, the Plan Report, provides an overview of stormwater management, purpose of the study, data collection, all GIS maps, present conditions, projected land development patterns, calculation methodology, the Model Ordinance and implementation discussion.

Volume III provides supporting data, watershed modeling parameters and modeling runs, peak flows, release rates, the existing municipal ordinance matrix, and obstructions inventory. Due to large volumes of data, one copy of Volume III will be on file at both the Montgomery County Planning Commission and Philadelphia Water Department offices.

I. INTRODUCTION

This plan has been developed for the Tookany/Tacony-Frankford Watershed in Montgomery and Philadelphia Counties, Pennsylvania to comply with the requirements of the Pennsylvania Stormwater Management Act, (Act 167), of 1978. The Tookany/Tacony-Frankford system is actually a tributary of the Delaware River. In order to properly address stormwater management in the Tookany/Tacony-Frankford Watershed above the confluence with the Delaware River in Philadelphia City, it was determined that the watershed needed to be hydrologically evaluated. For the purposes of this report, when the combined counties are being formally referenced such as in section headings, the text used to refer to them will read the Tookany/Tacony-Frankford Watershed. Otherwise, they will be referenced individually when appropriate to do so.

Borton-Lawson Engineering had previously prepared a Phase I scope of study that addressed the necessary elements in completing the Stormwater Management Plan for the Tookany/Tacony-Frankford Watershed. This Phase II plan report details the analyses that were performed in order to fulfill the requirements in the scope of study.

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.

II. WATERSHED DESCRIPTION

The Tookany/Tacony-Frankford Watershed is located in Montgomery and Philadelphia Counties, and it's area is distributed fairly evenly between the two. The upper portion of the Tookany/Tacony-Frankford Watershed is located in southern Montgomery County. While in Montgomery County, the larger streams (Tookany Creek, Jenkintown Creek, Rock Creek, Mill Run, and Baeder Creek) flow through three municipalities: Abington Township, Cheltenham Township, and Jenkintown Borough. The mainstem crosses into Philadelphia County where it then becomes the only major waterbody in the lower portion of the watershed due to the high level of urbanization in the City of Philadelphia. The following table shows the municipalities in Montgomery and Philadelphia Counties that contribute runoff to the creek system:

Montgomery County	
Abington Township	Rockledge Borough
Cheltenham Township	Springfield Township
Jenkintown Borough	
Philadelphia County	
City of Philadelphia	

Although Springfield Township and Rockledge Borough are intersected by the watershed boundary, the majority of the area of these two municipalities lies outside of the watershed, and contribute only a small amount of runoff to the creek system. 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.

III. METHODOLOGY

The engineer for the project is Borton-Lawson Engineering, Inc. The plan was developed from data collected on the physical features of the watershed, such as soils, wetlands, topography, floodplains, dams and reservoirs, stream dimensions, and obstructions. Information on existing problem areas was solicited from the Watershed Planning Advisory Committee (WPAC) which consisted of representatives from the 6 municipalities as well as other interested parties including County Conservation Districts and others. Although the plan in and by itself cannot fix all existing problems, knowing where and why they exist aided the engineer in developing the subwatersheds, identifying points of interests, and understanding the hydrologic flow of the watershed as a whole. Information on existing land use and zoning was also collected. This helped the engineer to determine where and to what extent future development would take place. All of this data was compiled into a geographic information system (GIS) database.

The computer model used for the project was the Environmental Protection Agency's Stormwater Management Model (EPA SWMM 5.0). This model was chosen for the project because it can be easily adapted to an urban area, it has the ability to analyze reservoir or detention basin-routing effects, and it is accepted by the Department of Environmental Protection. To gain a realistic picture of what occurs in the Tookany/Tacony-Frankford Watershed, the model was calibrated against actual stream flow data, regression models, as well as data from the Federal Emergency Management Administration (FEMA) and the Army Corps of Engineers.

The process of determining how runoff flows throughout the watershed is a complex one. It involves running numerous scenarios through the model taking into account the location of obstructions and tributary confluences. This process produced a few large sub-basins, which were then further sub-divided. The most downstream point of each of these areas is considered a "point of interest" in which increased runoff must be analyzed for its potential impact.

Another aspect of the analysis involves modeling design storms. This term refers to assigning a frequency to a storm based on the amount of rain that falls over a 24-hour period. As the amount of rain falling over a 24-hour period increases, the frequency or chance of that storm occurring decreases. For example, 2.83 inches of rain falling over a 24-hour period is associated with the 1-year design storm, while the occurrence of 6.10 inches falling over a 24-hour period happens theoretically only every 25 years. For this study, the 1, 2, 5, 10, 25, 50, and 100-year storms were modeled.

To make implementation of the Plan viable by the municipalities, a simple, but accurate method was developed for municipal officials, engineers and developers to abide by the Plan. The watershed was divided into three (3) stormwater management districts and assigned the following proposed condition/existing condition runoff rates for each.

TABLE V-3
Stormwater Management Districts In Tookany/Tacony-Frankford Watershed

District	Proposed Condition Design Storm	(reduce to)	Existing Condition Design Storm
A	2-year		1-year
	5-year		5-year
	10-year		10-year
	25-year		25-year
	50-year		50-year
	100-year		100-year
B	2-year		1-year
	5-year		2-year
	10-year		5-year
	25-year		10-year
	50-year		25-year
	100-year		100-year
C*	Conditional Direct Discharge District		

** In District C, development sites which can discharge directly to the Tookany/Tacony-Frankford main channel or major tributaries or indirectly to the main channel through an existing stormwater drainage system (i.e., storm sewer or tributary) may do so without control of proposed conditions peak rate of runoff greater than the 5-year storm. Sites in District C will still have to comply with the groundwater recharge criteria, the water quality criteria, and streambank erosion criteria. If the proposed conditions runoff is intended to be conveyed by an existing stormwater drainage system to the main channel, assurance must be provided that such system has adequate capacity to convey the flows greater than the 2-year existing conditions peak flow or will be provided with improvements to furnish the required capacity. When adequate capacity in the downstream system does not exist and will not be provided through improvements, proposed conditions peak rate of runoff must be controlled to the existing conditions peak rate as required in District A provisions (i.e., 10-year proposed conditions flows to 10-year existing conditions flows) for the specified design storms.*

All regulated activities are required to implement water quality controls as defined by the Ordinance. Generally, they are as follows:

Montgomery County Portion of the Watershed:

The following calculation formula is to be used to determine the water quality storage volume (WQ_v) in acre-feet of storage for the Tookany/Tacony-Frankford Watershed in Montgomery County:

$$\mathbf{WQ_v = (P / 12) * (I)}$$

WQ_v = Water Quality Volume (cubic feet)
P = 1 inch
I = Proposed Impervious Area (square feet)

This volume requirement can be accomplished by the permanent volume of a wet basin or the detained volume from other BMPs. Where appropriate, wet basins shall be utilized for water quality control and shall follow the guidelines of the BMP manuals referenced in Ordinance Appendix F.

Release of water can begin at the start of the storm (i.e., the invert of the water quality orifice is at the invert of the facility). The design of the facility shall provide for protection from clogging and unwanted sedimentation.

Philadelphia County Portion of the Watershed:

The following calculation formula is to be used to determine the water quality storage volume (WQ_v) in acre-feet of storage for the Tookany/Tacony-Frankford Watershed in Philadelphia County:

$$\mathbf{WQ_v = (P / 12)*(I)}$$

WQ_v = Water quality volume (cubic feet)
P = 1 inch
I = DCIA within the limits of earth disturbance (square feet)

IV. EXEMPTIONS

Any activity that affects stormwater runoff within the Tookany/Tacony-Frankford Watershed is required to adhere to the regulations contained in the Plan. Certain land uses are exempt from the plan submission requirements of the Ordinance; however, these activities must still implement and construct stormwater management controls that are consistent with the management strategies contained in the Plan. Exemptions for land use activities include:

Montgomery County

1. Disconnected Regulated Activities (Regulated Activities that create Disconnected Impervious Areas) smaller in area than 250 sq. ft. are exempt from the peak rate control (Section 408) and drainage plan (Section 302) preparation requirements of the Model Ordinance.

2. Disconnected Regulated Activities (Regulated Activities that create Disconnected Impervious Areas) equal to or greater than 250 sq. ft. and less than 1,000 sq. ft. are exempt only from the peak rate control (Section 408) requirement of the Model Ordinance.

3. Agricultural plowing and tilling are exempt from the rate control and drainage plan preparation requirements of the Model Ordinance provided the activities are performed according to the requirements of 25 Pa. Code Chapter 102.

4. Forest management and timber operations are exempt from the rate control and Drainage plan preparation requirements of the Model Ordinance provided the activities are performed according to the requirements of 25 Pa. Code Chapter 102.

Philadelphia County Portion of the Watershed:

1. Development, including new development and redevelopment, that results in an area of Earth Disturbance less than fifteen thousand (15,000) square feet is exempt from all requirements of the Model Ordinance. However, applicants must still meet coastal water quality requirements from other programs if applicable as described in Table 105.1 of the Model Ordinance.

2. Redevelopment that results in an area of Earth Disturbance greater than or equal to fifteen thousand (15,000) sq. ft., but less than one (1) acre, is exempt from the Channel Protection/Streambank Erosion (Section 407) Requirements of the Model Ordinance.

3. Redevelopment that results in an area of Earth Disturbance greater than or equal to one (1) acre and reduces the predevelopment DCIA (Directly Connected Impervious Areas) on the site by at least 20% is exempt from the Channel Protection/Streambank Erosion (Section 407) and Flood Control/Peak Rate Control (Section 408) Requirements of the Model Ordinance.

4. Land Development, including new development or redevelopment located in Stormwater Management District ‘C’, is permitted to directly discharge for all storms greater than the 2-year recurrence interval. This can be accomplished by configuring the outlet structure not to control the larger storms or by a bypass channel that diverts only the 2-year stormwater runoff into the basin or conversely, diverts flows in excess of the 2-year storm away from the basin. The Municipality may require a downstream hydraulic impact analysis to ensure that downstream structures can pass any increase in flow, and that the increased flow will not affect the FEMA regulated water surface elevation.

A. Additional Exemption Criteria:

1. Exemptions from any provisions of the Model Ordinance shall not relieve the applicant from the requirements in Section 401 of the Model Ordinance.

2. Exemption Responsibilities - An exemption shall not relieve the Applicant from implementing such measures as are necessary to protect public health, safety, and property.

3. Drainage Problems - If a drainage problem is documented or known to exist downstream of or is expected from the proposed activity, then the Municipality may require the Applicant to comply with this entire Ordinance.

4. Emergency Exemption - Emergency maintenance work performed for the protection of public health, safety, and welfare may be exempt from the Model Ordinance. A written description of the scope and extent of any emergency work performed shall be submitted to the [*Municipality*] within two (2) calendar days of the commencement of the activity. If the [*Municipality*] finds that the work is not an emergency, then the work shall cease immediately, and the requirements of the Model Ordinance shall be addressed as applicable.

5. Even though the developer is exempt from certain portions of the Model Ordinance, he is not relieved from complying with other regulations which may apply to the project.

6. HQ and EV Streams – An exemption shall not relieve the Applicant from meeting the special requirements for watersheds draining to identified high quality (HQ) or exceptional value (EV) waters and Source Water Protection Areas (SWPA) and requirements for nonstructural project design sequencing (Ordinance Section 404).

V. NPDES REGULATIONS

New Federal regulations approved October 1999 required operators of small municipal separate storm sewer systems (MS4s) to obtain NPDES (National Pollutant Discharge Elimination System Phase II Stormwater Permitting Regulations) Phase II permits from DEP March 2003. This program affects all municipalities in “urbanized areas” of the State. This definition applies to all

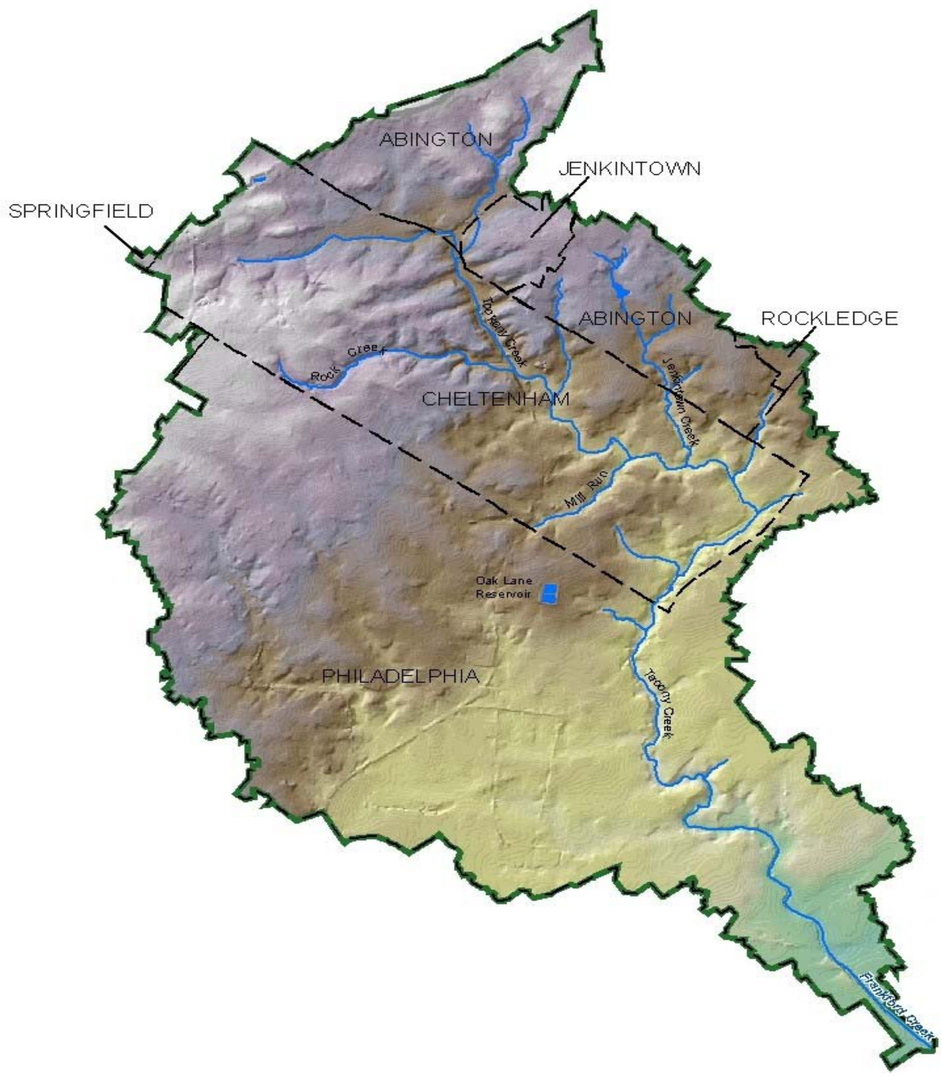
Tookany/Tacony-Frankford Watershed municipalities. Therefore, all municipalities within the Tookany/Tacony-Frankford Watershed are subject to the NPDES Phase II requirements, mandated by the Federal Clean Water Act as administered by DEP. For more information on NPDES II requirements, contact the DEP Regional Office.

VI. IMPLEMENTATION:

All municipalities within the watershed that administer their own subdivision/land development ordinances will be required to adopt the Tookany/Tacony-Frankford Watershed Stormwater Management Plan/Ordinance. The standards and criteria contained in the Model Ordinance will apply only to those portions of the municipality that are located within the boundaries of the Tookany/Tacony-Frankford Watershed. The areas outside of the watershed will still be regulated by the municipality's Subdivision/Land Development Ordinance unless otherwise written so as to apply to other areas of the municipality.

County adoption of the plan is expected to occur in June of 2008. Once this occurs, the plan will be sent to DEP to be approved. All of the municipalities will be required to adopt the Model Ordinance provisions within six (6) months of DEP approval.

TOOKANY/TACONY-FRANKFORD WATERSHED ACT 167
STORMWATER MANAGEMENT PLAN



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MONTGOMERY COUNTY COMMISSIONERS
Thomas Jay Ellis, Esq., Chairman
James R. Matthews
Ruth S. Damsker

PHILADELPHIA CITY COMMISSIONERS
Margaret Tartaglione, Chair
Joseph Duda
Edgar A. Howard

PHILADELPHIA COUNTY PLANNING COMMISSION
Thomas A. Chapman, AICP, Executive Director
Warren E. Huff, Deputy Executive Director
David Adelman
Lynette M. Brown-Sow
Patrick Eiding
Vincent Jannetti
Gloria Levin
Marcia Moore Makadon, Acting Chairperson
Stephanie W. Naidoff
Pedro Ramos

ENGINEERING CONSULTANT
Borton-Lawson Engineering, Inc.

IN CONJUNCTION WITH:
CDM INC.

TOOKANY/TACONY-FRANKFORD WATERSHED
DESIGNATED WPAC MEMBERS
As of June 30, 2008

County	WPAC Designee
Montgomery County	
Montgomery County Planning Commission	Mr. Eric Jarrell Environmental Planner
Montgomery County Conservation District	Mr. Richard Kadwill District Manager
Abington Township	Mr. Burton T. Conway Manager
Cheltenham Township	Mr. Bryan Havir Assistant Township Manager
Jenkintown Borough	Pennoni & Associates, Inc. Borough Engineer
Rockledge Township	Mr. Troy Madres Manager
City of Philadelphia	
Philadelphia Water Department	Mr. Howard Neukrug Planning and Tech. Services Director PWD Office of Watersheds
	Ms. Joanne Dahme Programs Manager PWD Office of Watershed
Philadelphia Planning Commission	Mr. Thomas Chapman Executive Director

RESOLUTION

WHEREAS, the Stormwater Management Act 167 of 1978 provides for the regulation of land and water use for flood control and stormwater management, requires the Pennsylvania Department of Environmental Protection to designate watersheds, and provides for grants to be appropriated and administered by the Department for plan preparation and implementation costs, and provides that each county will prepare and adopt a watershed stormwater management plan for each designated watershed; and

WHEREAS, the purpose of the Tookany/Tacony-Frankford Watershed Stormwater Management Plan is to protect public health and safety and to prevent or mitigate the adverse impacts related to the conveyance of excessive rates and volumes of stormwater runoff by providing for the management of stormwater runoff and control of erosion and sedimentation; and

WHEREAS, design criteria and standards of stormwater management systems and facilities within the Tookany/Tacony-Frankford Watershed shall utilize the criteria and standards as found in the watershed stormwater management plan.

NOW, THEREFORE, BE IT RESOLVED that the Philadelphia City Commissioners hereby adopt the Tookany/Tacony-Frankford Watershed Stormwater Management Plan, including all volumes, figures, appendices, Model Ordinance and forward the Plan to the Stormwater Management Section of the Pennsylvania Department of Environmental Protection for approval.

This Resolution is hereby adopted this _______day of _______, 2008 by:

PHILADELPHIA CITY COMMISSIONERS

____

Margaret Tartaglione, Chair

____

Edgar Howard

____

Joseph Duda

RESOLUTION

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WHEREAS, the Montgomery County Commissioners entered into a Memorandum of Understanding with Philadelphia County to support the development of the watershed stormwater management plan for the Tookany/Tacony-Frankford designated watershed; and

WHEREAS, the purpose of the Tookany/Tacony-Frankford Watershed Stormwater Management Plan is to protect public health and safety and to prevent or mitigate the adverse impacts related to the conveyance of excessive rates and volumes of stormwater runoff by providing for the management of stormwater runoff and control of erosion and sedimentation; and

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MONTGOMERY COUNTY COMMISSIONERS

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Thomas Jay Ellis, Esq., Chairman

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James R. Matthews

____
Ruth S. Damsker

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SECTION I

INTRODUCTION

A. Introduction

This plan has been developed for the Tookany/Tacony-Frankford Watershed in Montgomery and Philadelphia Counties, Pennsylvania to comply with the requirements of the Pennsylvania Stormwater Management Act, (Act 167), of 1978. The creek system, which is made up of the Tookany, Tacony, and Frankford Creeks, is actually a tributary of the Delaware River. In order to properly address stormwater management in the Tookany/Tacony-Frankford Watershed above the confluence with the Delaware River in Philadelphia City, it was determined that the watershed needed to be hydrologically evaluated. For the purposes of this report, when the combined counties are being formally referenced such as in section headings, the text used to refer to them will read the Tookany/Tacony-Frankford Watershed. Otherwise, they will be referenced individually when appropriate to do so.

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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.

B. Stormwater Management

Stormwater management entails bringing surface runoff caused by precipitation events under control. In past years, stormwater control was viewed only on a site-specific basis. Recently, local perspectives and policies have changed. We have realized that proper stormwater management can only be accomplished by evaluating the comprehensive picture (i.e., by analyzing what adverse impacts a development located in a watershed's headwaters may have on flooding downstream). Proper stormwater management reduces flooding, soil and streambank erosion and sedimentation, and improves the overall quality of the receiving streams.

Stormwater management requires cooperation between the state and county and local officials. It involves proper planning, engineering, construction, operation and maintenance. This entails educating the public and local officials, and it also requires program development, financing, policy revision, the development of workable criteria, and the adoption of Ordinances. The Tookany/Tacony-Frankford Watershed Stormwater Management Plan, under the Pennsylvania Stormwater Management Act (Act 167), will enable continued development to occur within the Tookany/Tacony-Frankford Watershed, utilizing both structural and non-structural measures to properly manage stormwater runoff in the watershed.

SECTION II

ACT 167

A. Stormwater Management Act 167

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. The Act requires the DEP to designate watersheds, develop guidelines for stormwater management, and model stormwater Ordinances. The designated watersheds were approved by the Environmental Quality Board July 15, 1980, and the guidelines and Model Ordinances were approved by the Legislature May 14, 1985. The Act provides for grants to be appropriated by the General Assembly and administered by DEP for 75% of the allowable costs for the preparation of a stormwater management plan. It also provides for 75% of administrative, enforcement and implementation costs incurred by any municipality or county in accordance with Chapter III - Stormwater Management Grants and Reimbursement Regulations (adopted by the Environmental Quality Board August 27, 1985).

All counties must, in consultation with its municipalities, prepare and adopt a stormwater management plan for each of its designated watersheds. The county must review and revise such plans at least every five years when funding is available. 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. These Ordinances must regulate development within the municipality in a manner consistent with the watershed stormwater plan and the provisions of the Act.

Developers are required to manage the quantity, velocity, and direction of resulting stormwater runoff in a manner that adequately protects health and property from possible injury. They must implement control measures that are consistent with the provisions of the watershed plan and the Act. The Act also provides for civil remedies for those aggrieved by inadequate management of accelerated stormwater runoff.

B. Purpose of the Study

Development in the Tookany/Tacony-Frankford Watershed causes an increase in stormwater runoff, and a reduction in groundwater recharge. A number of negative effects result from uncontrolled stormwater runoff in addition to the risk of flooding downstream. It also causes erosion and sedimentation problems, reduces stream quality, raises the temperature of the streams, and impairs the aquatic food chain. It can also reduce the base flow of streams, which is imperative for aquatic life during the drier summer months. Erosion of the streambanks caused by accelerated stream velocities due to increased runoff is already evident along multiple sections of streams in Cheltenham Township as well as Abington Township.

There is an increased statewide as well as local recognition that a sound and effective stormwater management plan requires a diversified multiple purpose plan. The plan should address the full range of hydrologic consequences resulting from development by considering tributary timing of flow volume reduction, base flow augmentation, water quality control and ecological protection rather than simply focusing on controlling site specific peak flow.

The Tookany/Tacony-Frankford study area includes parts of Montgomery County and a portion of Philadelphia County, and covers a total of 32.96 square miles or approximately 21,100 acres and discharges to the Delaware River. The creek is referred to as the Tookany Creek until it enters Philadelphia at Cheltenham Avenue; then as the Tacony Creek from the Montgomery County border until the confluence with the historic Wingohocking Creek in Juniata Park; and finally the section of stream from Juniata Park to the Delaware River is referred to as the Frankford Creek.

The watershed is highly urbanized in the lower reaches, mostly comprised of Philadelphia County. Similarly, the upper reaches of the Tookany/Tacony-Frankford study area are also highly urbanized; however, this upper portion, included mainly in Montgomery County, is characterized by a more varying mixture of land uses. The population of the entire drainage area, based on 1990 census data, is approximately 362,000 people. This yields an average population density of approximately 17 persons/acre. In addition to combined sewer overflow (CSO) discharge to Frankford Creek from the City of Philadelphia, the drainage area receives nonpoint source discharges that impact water quality. According to USGS data for the study area, the breakdown by sewer type is as follows:

- Approximately 9,800 acres are drained by combined sewers, or 47% of the drainage area;
- Approximately 9,200 acres are served by separate sewers, including areas outside of the City of Philadelphia, or 44% of the drainage area, and
- Approximately 1,900 acres are unsewered, or 9% of the drainage area.

Managing stormwater runoff on a site-specific basis does not meet the requirements of watershed based planning. The timing of flood peaks for each subbasin within a watershed contributes greatly to the flooding potential of a particular storm. Each stormwater control site within a subbasin should be managed by evaluating the comprehensive picture.

The Tookany/Tacony-Frankford Watershed Stormwater Management Plan provides reasonable regulations of development activities to control accelerated runoff and protect the health, safety and welfare of the public. The Plan includes recognition of the various rules, regulations and laws at the federal, state, county and municipal level. Once implemented, the Plan will aid in reducing costly flood damages by reducing the source and cause of local uncontrolled runoff. The Plan will make municipalities and developers more aware of comprehensive planning in stormwater control and will help maintain the quality of the creeks and their tributaries.

SECTION III

GENERAL DESCRIPTION OF WATERSHED

The Tookany/Tacony-Frankford Watershed is within the Philadelphia and Montgomery Counties, about 4-5 miles north of Center City. The watershed boundary extends into six municipalities, the City/County of Philadelphia plus five municipalities in Montgomery County. The municipalities are listed in Table III-1 and illustrated in Map III-1, the Base Map.

TABLE III-1 **Tookany/Tacony-Frankford Watershed – Municipalities**	
Montgomery County	**Area (Sq. Miles/Acres)**
1. Abington Township 2. Cheltenham Township 3. Rockledge Borough 4. Jenkintown Borough 5. Springfield Township	4.13 sq. mi./2,643 acres 8.91 sq. mi./5,702 acres 0.14 sq. mi./90 acres 0.57 sq. mi./365 acres 0.11 sq. mi./70 acres
Philadelphia County	
1. City of Philadelphia	19.1 sq. mi./12,224 acres

A. Drainage Area

The Tookany/Tacony-Frankford Watershed is roughly diamond-shaped and comprises approximately 32.96 square miles (21,094 acres). It is about 6 miles wide at its widest and about 11 miles from the northern most point to the southern most point (as measured along a curve through the center). Approximately two thirds of the watershed, 19.1 square miles (12,224 acres), is in Philadelphia County, and 13.86 square miles (8,870 acres), is in Montgomery County. Physically, the Tookany Creek, Tacony Creek and Frankford Creek are all the same stream. The stream is known as the Tookany at the northern portion of the watershed in Montgomery County and is called the Tacony where it flows in Northeast Philadelphia. South of Castor Avenue it is know as Frankford Creek. The stream system is a tributary of the Delaware River. A large portion of the watershed (almost the entire Philadelphia portion of the watershed) has no mapped surface streams. Surface water in this area originally flowed into the Wingohocking Creek. During the early part of the 20th century the Wingohocking Creek was entirely sewered and is no longer present as a flowing surface stream except at the most southern-most end where it discharges through an outfall near Juniata Park. Map III-1, the Base Map, shows the existing surface streams. As can be noted, there is a large area in the south/southwest portion of the watershed where no streams are shown. This is the former location of the Wingohocking Creek.

Being highly urban, the watershed is traversed by many roads. Interstate I-95 crosses the watershed at the southeast end, approximately 1 mile from the mouth of the creek at the confluence of the Frankford Creek with the Delaware River. US Route 1, also known as Roosevelt Boulevard, is another major thoroughfare through the watershed. It is a heavily traveled road that runs east/west through the watershed about 3.5 miles upstream from the mouth of the creek. Several major roads pass through the watershed. PA Route 611 (Broad Street) runs north/south through the center of the watershed and PA Route 73 runs east/west through the northern portion of the watershed. Other major routes include PA Route 309 and PA Route 152 in the northwest portion of the watershed. There are numerous other state and locally maintained roads throughout the watershed. Based on the GIS roads data obtained from the PennDOT, it is estimated that there are approximately 780 linear miles of mapped roads within the watershed.

TOOKANY/TACONY-FRANKFORD WATERSHED
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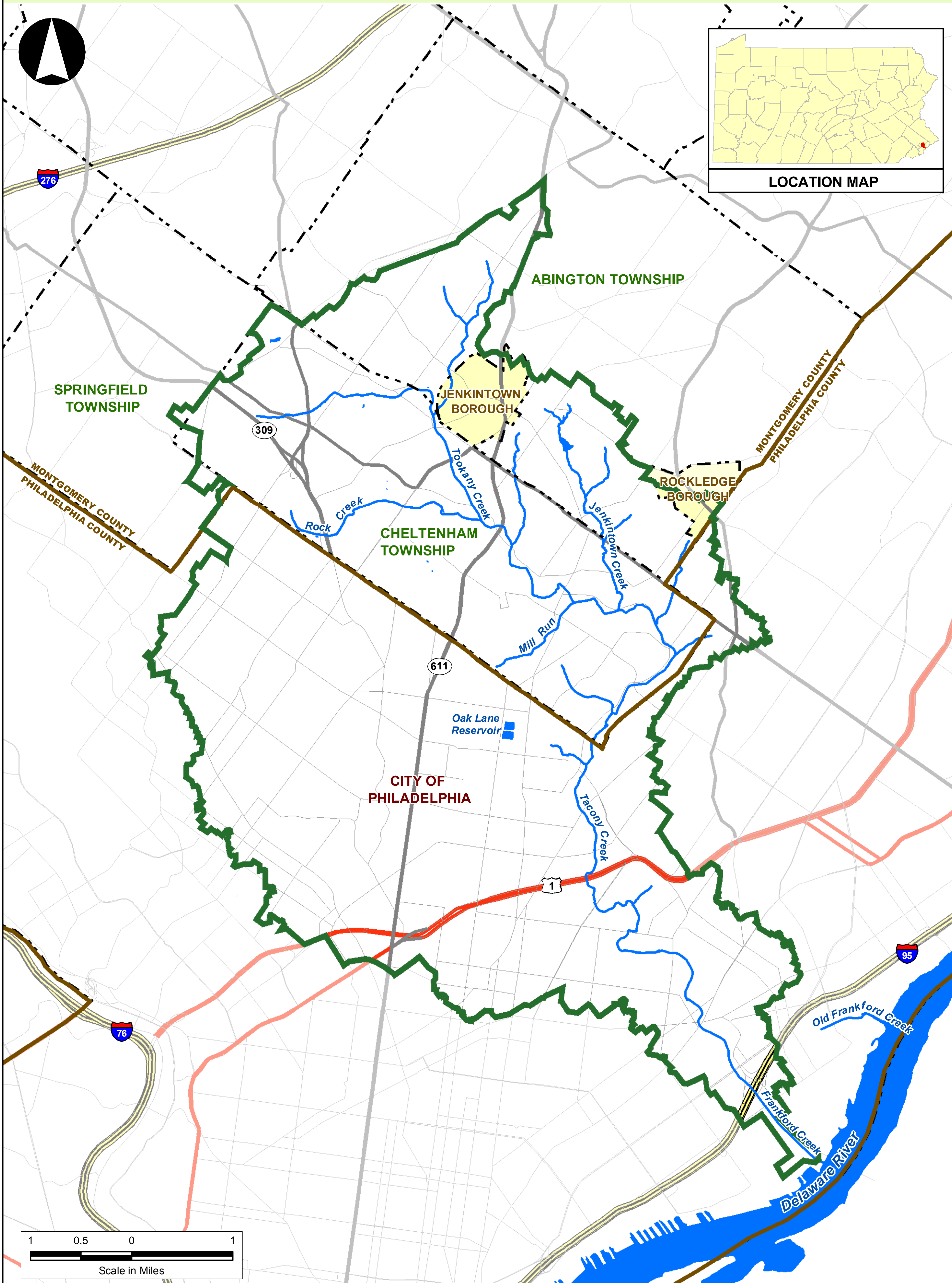

Map III-1
BASE MAP

Philadelphia PWD Water Department

Prepared For:
PHILADELPHIA WATER DEPARTMENT

Legend

- WATERSHED BOUNDARY
- COUNTY BOUNDARY
- MUNICIPAL BOUNDARIES
- BOROUGH
- STREAMS
- WATER BODIES

STATE MAINTAINED ROADS

- Interstate
- US Federal Highway
- PA State Route
- Other State Road

NOTE:
Portions of this map were generated from existing data sources as listed below. These data are shown on the maps for spatial reference only. These data did not enter into any computations or affect the reliability of the hydrologic analysis. Borton-Lawson Engineering has found some inaccuracies in some of these data and has corrected the data in locations where discrepancies were obvious, however, it was not a part of this ACT 167 Plan to correct all of the mapping data.

DATA SOURCES:
Watershed Boundary - PWD
Streams - PADEP
Water Bodies - USFWS (Derived from NWI Wetlands)
County Boundaries - PennDOT
Municipal Boundaries- PennDOT
Roads - Penn DOT

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CHECKED BY: SJD
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PROJECT #: 2004-1621-00

FILE: \\WBData\Projects\2004\1621\00\DATA\GIS\FINAL_REPORT_MAPS\ArcMap\Tookany_BaseMap.mxd

B. Data Collection

In order to evaluate the hydrologic response of the watershed, data was collected on the physical features of the watershed as follows:

1. Base Map: The base map for Geographic Information System (GIS) generated maps was generated from data received from the Pennsylvania Department of Environmental Protection (PaDEP), the Pennsylvania Department of Transportation (PennDOT) and the Philadelphia Water Department (PWD). Streams, lakes, and the watershed boundary were obtained from the PaDEP and PWD. County and municipal boundaries, roads and railroads were obtained from PennDOT and PWD. The data provided by the PWD were primarily for Philadelphia and did not include the areas in Montgomery County.

2. Elevation Data: A Digital Elevation Model (DEM) for the Tookany/Tacony-Frankford Watershed was developed from DEM data obtained from the USGS. Subwatersheds or subareas used in the watershed modeling process were derived from the DEM. Subareas, drainage courses, land slopes and lengths, and drainage element lengths and slopes could all be determined from the DEM.

3. Soils: Soil mapping data were obtained from the United States Department of Agriculture, Natural Resources Conservation Service (NRCS). Two sets of data were used, the State Soil Geographic Database (STATSGO) and the Soil Survey Geographic Database (SSURGO).

   The STATSGO data are a statewide data layer made by generalizing the detailed county soil survey data and merging them into a single layer covering the entire state. The STATSGO data were used to create the General Soils Map to give a general overview of the watershed soil characteristics.

   SSURGO is the most detailed level of soil mapping done by the NRCS. SSURGO are digital duplication of the original county soil survey maps. Each county was digitized separately to create a stand-alone, county specific GIS layer. The soil mapping units at the county boundaries were examined and edited by the NRCS to create as much continuity as possible between counties. The SSURGO soils GIS data layer shows only the boundaries of the soil mapping units. The detailed information about the individual mapping units is contained within an Access database referred to as the National Soil Information System (NASIS) database.

4. Geology: The digital geology data for the watershed was obtained from the Pennsylvania Geologic Survey (PAGS). This is a statewide GIS data layer showing geologic formation boundaries and identifying the formations. The dataset obtained from the DCNR is not intended to be used at any scale finer than 1:250,000. The geology data are displayed for the watershed at a scale larger than 1:250,000. The geology information is provided for illustrative and general information only.

The descriptions of the geologic formations were also obtained from the PAGS in the document Explanations.pdf. This PDF files contains the descriptions of geologic formation as were modified from Berg, T. M., Geyer, A. R., Edmunds, W. E., and others, compilers, 1980, *Geologic map of Pennsylvania*, Pennsylvania Geological Survey, 4th ser.,Map 1.

5. Land Cover: The existing land use map was generated by overlaying Delaware Valley Regional Planning Commission (DVRPC) land use data on year 2000 DVRPC aerial photographs.

6. Impervious Surface: The impervious surface data were derived from aerial photography conducted by Sanborn during 2004. The City of Philadelphia and watersheds that may extend beyond the city limits, were photographed and the photographs georectified and analyzed to determine areas covered by impervious surfaces such as structures, pavement and sidewalks.

7. Wetlands: Wetlands were obtained from the United States Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) in digital format and incorporated into the overall GIS. NWI maps are compiled from photointerpreted aerial photography from the National Aerial Photography Program (NAPP) 1:40,000 Scale, and the National High Altitude Photography Program (NHAP) 1:58,000 or 1:80,000 Scale. Sources dates range from the 1970's to the present. The minimum mapping unit for treeless areas is 1/4 acres, 1 to 3 acres in general. The wetlands data is provided for illustrative purposes. Other wetland areas likely exist in the watershed that are not depicted on NWI maps.

8. Floodplains: Flood hazard areas for Philadelphia and Montgomery counties were derived from the Federal Emergency Management Agency (FEMA) National Flood Insurance Program Q3 Flood Data CD, September 1996. The floodplain boundaries are considered to be a "best representation" and are not intended for engineering or insurance purposes and do not supplant on-site surveys to determine flood hazard areas. The existing developed land uses (residential, commercial, industrial, institutional, etc.) Intersected by the flood hazard areas were selected and are displayed to illustrate developed areas that may be impacted by flooding.

9. Obstructions: Bridges, culverts and pipes that convey streams and tributaries under roads, railroads and other similar infrastructure are referred to as obstructions. The obstruction locations and approximate sizes for the Tookany/Tacony-Frankford Watershed were provided by the Philadelphia Water Department in shape file format. Borton-Lawson conducted field work to determine the shape and skew of the obstructions and to measure the openings.

10. Problem Areas: Stormwater problems include flooding, erosion, sedimentation, landslides, groundwater impacts, pollution and other potential issues. Data on the location of these problems in the watershed were collected by the municipalities within the watershed with assistance from Borton-Lawson for plotting and incorporation into the watershed GIS. The municipalities were provided a topographic map of their township or borough and a set of forms. With some assistance from Borton-Lawson they identified and plotted the locations of the known problem areas on paper maps or in digital format and completed the forms

that describe the problems at each location. Borton-Lawson compiled the data from the municipalities and created a data layer to illustrate problem areas throughout the watershed.

11. <u>Stormwater Management Facilities:</u> Stormwater management facilities may include detention/infiltration basins, swales, underground storage and constructed wetlands. These types of facilities were also identified, plotted and described on forms by the municipalities. As with the problem area data, the Municipality stormwater management facilities information was compiled by Borton-Lawson and converted into GIS format. Some municipalities submitted storm sewer maps which enabled Borton-Lawson to illustrate the areas of these townships and boroughs that are served by storm drains.

12. <u>Stormwater Sewer System Outfalls:</u> Municipalities in urban areas (as defined by the US Census Bureau) are required to map the location of storm sewer outfalls as part of the PADEP Municipal Separate Storm Sewer System (MS4) program. This information was collected by the Philadelphia Water Department and provided to Borton-Lawson for inclusion in the GIS.

C. Topography and Streambed Profile

The topography of the watershed is generally level, especially in the Philadelphia portion. There is some minor relief in the upper reaches of the watershed in Montgomery County, but no significant hills. The highest point in the Tookany/Tacony-Frankford Watershed is in Abington Township with an elevation of about 433 feet above sea level USGS datum. The lowest elevations, sea level, occur along the southern portion of Frankford Creek. The average channel slope is approximately 71 feet per mile (1.34%). The Digital Elevation Model (DEM), which depicts the topographic relief of the watershed, is displayed in Map III-2.

D. Soils

The NRCS State Soil Geographic (STATSGO) data base is compiled by generalizing more detailed soils survey maps, such as a County Soils Survey. Map unit composition for a STATSGO map is determined by transecting or sampling areas on the more detailed maps and expanding the data statistically to characterize the whole map unit. A generalized soils group can consist of up to 21 different soil components; however the naming convention is typically based upon the three largest components which make up the group. In the Tookany/Tacony-Frankford Watershed, three generalized soil groups were identified. The most common soil association within the watershed is the *Chester-Glenelg-Manor Association*. This group occupies almost 29 square miles or approximately 87% of the watershed. Below is a listing of the three generalized soils groups within the watershed and a description of the three largest components. The distribution of the generalized soil groups in the Tookany/Tacony-Frankford Watershed is shown in Map III-3.

1. Hagerstown-Duffield-Clarksburg (PA058)

HAGERSTOWN	-	Typically, Hagerstown soils have a brown to dark brown silt loam Ap horizon, yellowish red clay Bt horizons, and yellowish brown clay C horizons. Well drained. Permeability is moderate. Runoff is moderate to rapid.
DUFFIELD	-	The Duffield series consists of deep and very deep, well drained soils formed in residuum from limestone bedrock. Slopes range from 0 to 35 percent. Permeability is moderate.
CLARKSBURG	-	The Clarksburg series consists of very deep, moderately well drained soils formed in colluvium, glacial till, or residuum from limestone, calcareous and noncalcareous shale, and sandstone. They are on uplands. Slope ranges from 0 to 25 percent. Permeability is slow to moderately slow.

2. Chester-Glenelg-Manor (PA061)

CHESTER	-	The Chester series consists of very deep, well drained, moderately permeable soils on uplands. They formed in materials weathered from micaceous schist. Slopes range from 0 to 65 percent.
GLENELG	-	The Glenelg series consists of very deep, well drained, moderately permeable soils on uplands formed in residuum weathered from micaceous schist. Slopes range from 0 to 55 percent.
MANOR	-	The Manor series consists of very deep, well drained to somewhat excessively drained, moderately permeable soils on uplands. They formed in materials weathered from micaceous schist. Slopes range from 0 to 65 percent.

3. Urban Land-Westbrook-Pits (PA072)

URBAN LAND	-	Urban land is a nearly level to moderately steep mixture of soils, rock, and miscellaneous manmade material. It is in industrial, commercial, and some residential areas where urban structures and works so obscure the land surface that identification of the soils is not practical. Most areas are on uplands or terraces, but some are on flood plains.
WESTBROOK	-	The Westbrook series consists of very deep, very poorly drained soils formed in organic deposits over loamy mineral material. They are in tidal marshes subject to inundation by salt water twice

		daily. Saturated hydraulic conductivity is moderately high to very high in the organic layers and low to high in the underlying mineral sediments.
PITS	-	The Pit series consists of very deep, poorly drained soils that formed in fine-textured alluvium weathered from extrusive and basic igneous rocks. Pit soils are on flood plains and in basins. Slopes range from 0 to 5 percent.

Soil properties influence the runoff generation process. The USDA Natural Resources Conservation Service (NRCS) has established a criterion determining how soils will affect runoff by placing all surface horizon soils into four Hydrologic Soil Groups (HSGs), A through D, based on infiltration rate and depth. Soils belonging to Group A are not found within the Watershed. Groups B soils are found predominantly in the City of Philadelphia. Group B is characterized as having moderate infiltration rates, and it consists primarily of moderately deep to deep, moderately well to well drained soils that exhibit a moderate rate of water transmission. Group C soils are mainly found in the Townships of Abington and Cheltenham and the Boroughs of Jenkintown and Rockledge; a minimal amount is found within the City of Philadelphia. Group C soils have slow infiltration rates when thoroughly wetted and contain fragipans, a layer that impedes downward movement of water and produces a slow rate of water transmission. Although found throughout the Watershed, the majority of Group D soils are found within Philadelphia. Group D soils are tight, low permeable soils with high runoff potential and are typically clay soils. This information was incorporated into the GIS and, from this, the watershed HSG map was developed as shown in Map III-4.

TOOKANY/TACONY-FRANKFORD WATERSHED
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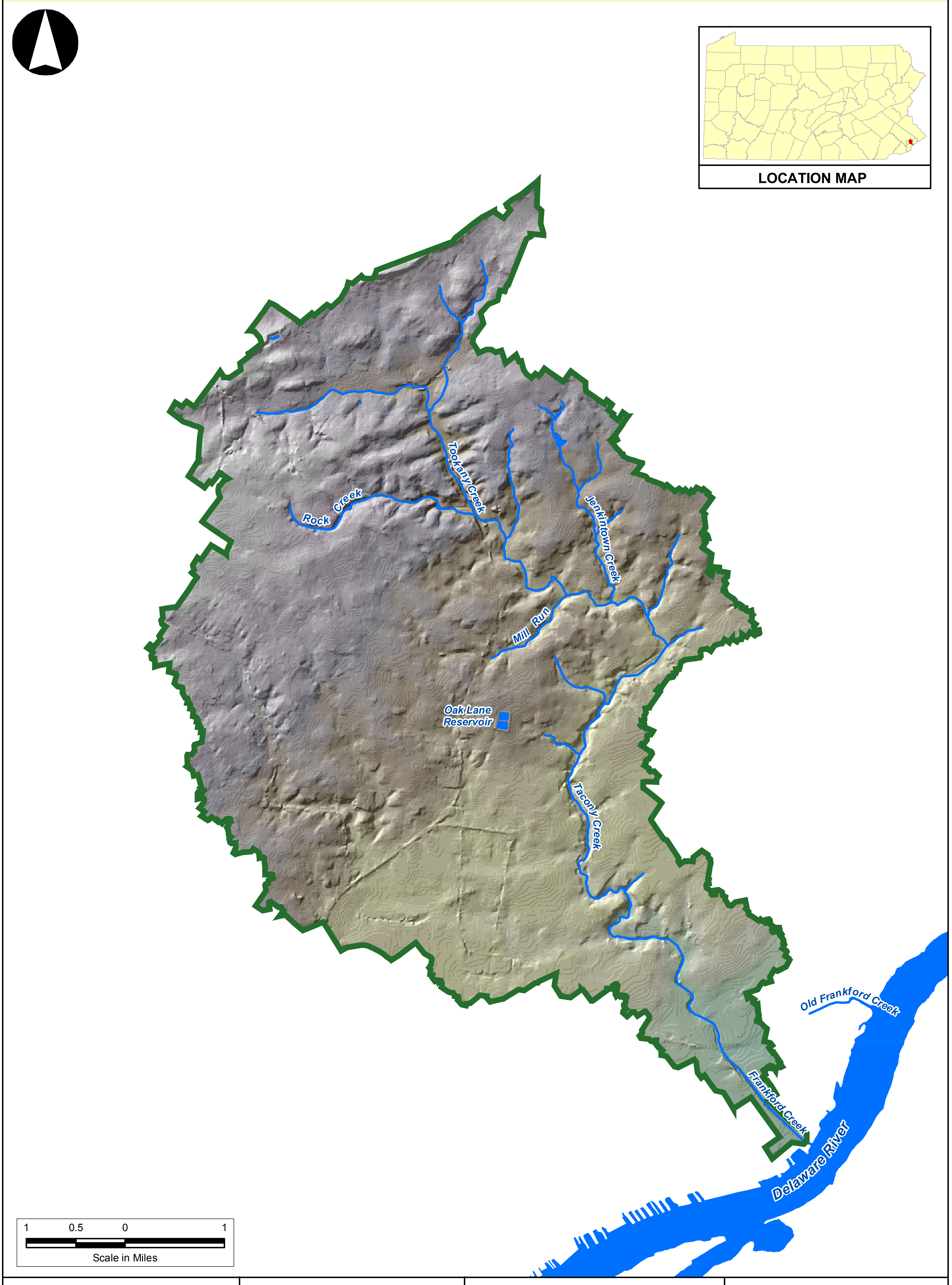

Map III-2
DIGITAL ELEVATION MODEL

Prepared For:
PHILADELPHIA WATER DEPARTMENT

Legend

- WATERSHED BOUNDARY
- STREAMS
- WATER BODIES

ELEVATION

High : 446 Feet

Low : 0 Feet

NOTE:
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DATA SOURCES:
Watershed Boundary - PWD
Streams - PADEP
Water Bodies - USFWS (Derived from NWI Wetlands)
DEM - USGS

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PREPARED BY: WSB
CHECKED BY: SJD
DATE: 6/22/2006
PROJECT #: 2004-1621-00

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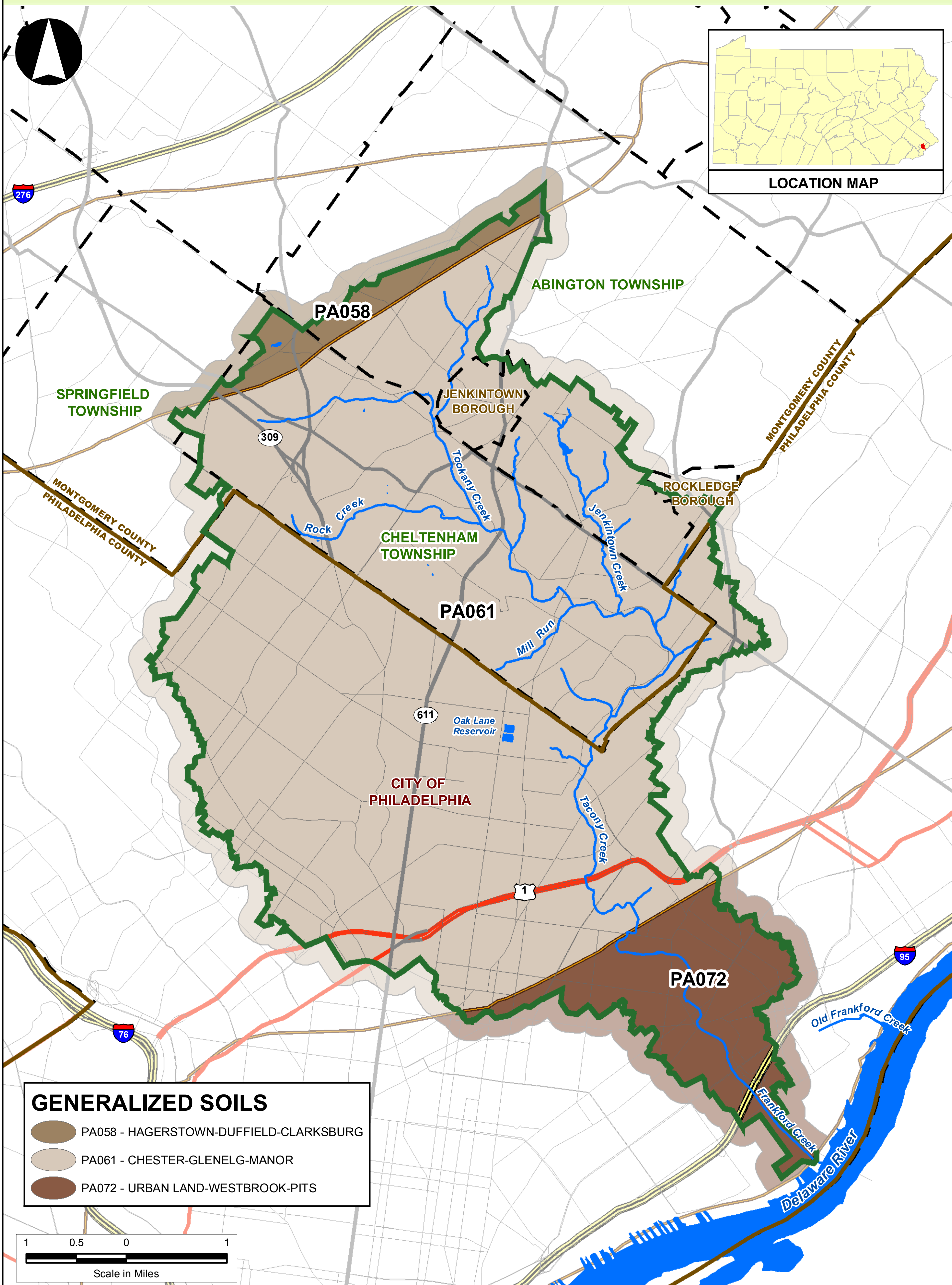

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Map III-3
GENERALIZED SOILS

Philadelphia Water Department

Prepared For:
PHILADELPHIA WATER DEPARTMENT

Legend

- WATERSHED BOUNDARY
- COUNTY BOUNDARY
- MUNICIPAL BOUNDARY
- STREAMS
- WATER BODIES
- REGIONAL SOILS

STATE MAINTAINED ROADS

- Interstate
- US Federal Highway
- PA State Route
- Other State Road

NOTE:
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DATA SOURCES:
Watershed Boundary - PWD
Streams - PADEP
Water Bodies - USFWS (Derived from NWI Wetlands)
County Boundaries - PennDOT
Municipal Boundaries- PennDOT
Roads - Penn DOT
Generalized Soils - USDA Natural Resources Conservation Service
State Soil Geographic Database (STATSGO)

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TOOKANY/TACONY-FRANKFORD WATERSHED
PHASE II - ACT 167 STORMWATER MANAGEMENT PLAN

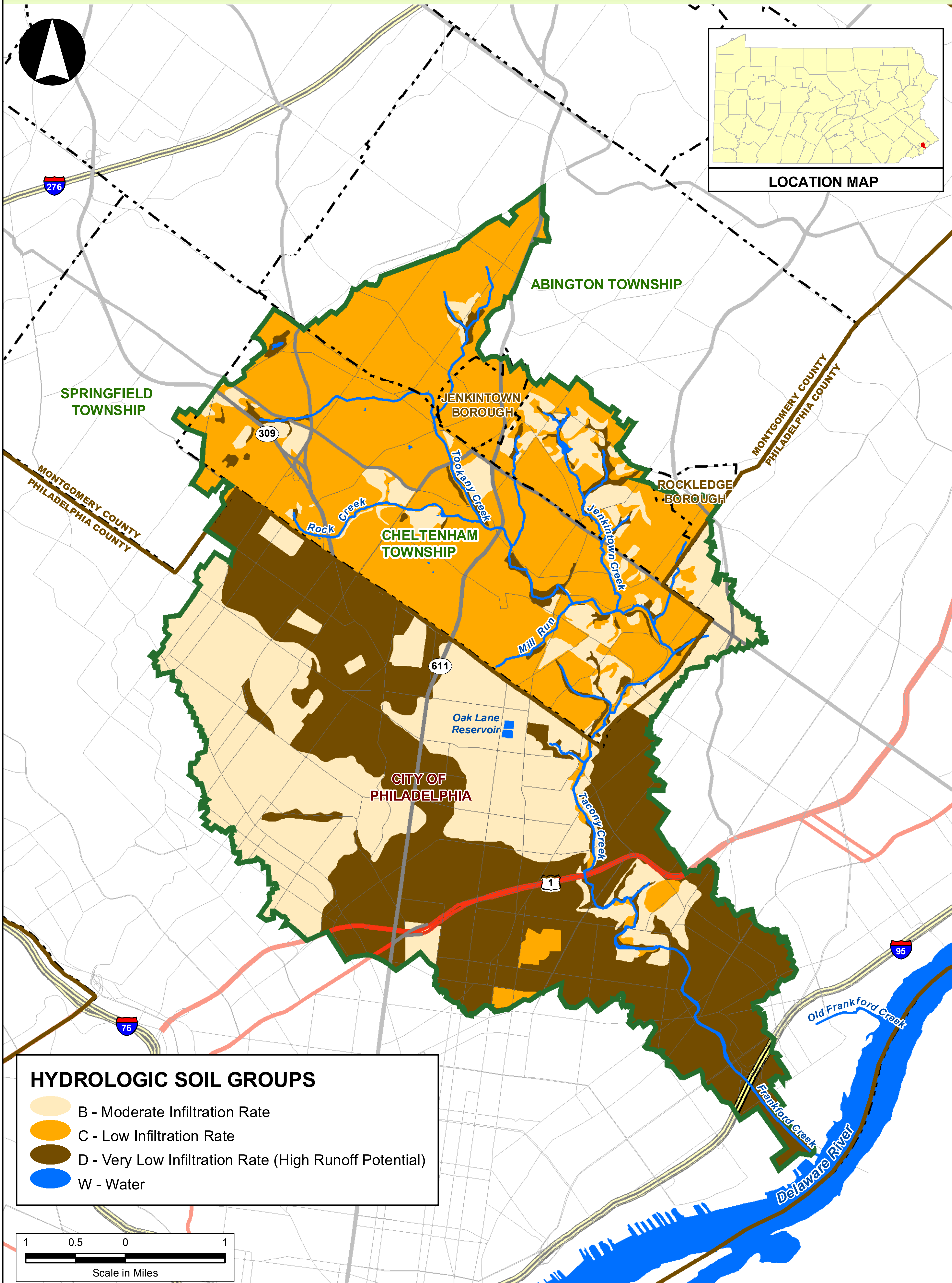

Figure III-4
HYDROLOGIC
SOIL GROUPS

Prepared For:
PHILADELPHIA
WATER
DEPARTMENT

Legend

WATERSHED BOUNDARY
COUNTY BOUNDARY
MUNICIPAL BOUNDARIES
STREAMS
WATER BODIES

STATE MAINTAINED ROADS

Interstate
US Federal Highway
PA State Route
Other State Road

NOTE:
Portions of this map were generated from existing data sources as listed below. These data are shown on the maps for spatial reference only. These data did not enter into any computations or affect the reliability of the hydrologic analysis. Borton-Lawson Engineering has found some inaccuracies in some of these data and has corrected the data in locations where discrepancies were obvious, however, it was not a part of this ACT 167 Plan to correct all of the mapping data.

DATA SOURCES:
Watershed Boundary - PWD
Streams - PADEP
Water Bodies - USFWS (Derived from NWI Wetlands)
County Boundaries - PennDOT
Municipal Boundaries- PennDOT
Roads - Penn DOT
Soils - USDA National Resources Conservation Service
Soil Survey Geographic (SSURGO) Database

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E. Geology

Geology plays a direct role in surface runoff in the Tookany/Tacony-Frankford Watershed because it affects its soil types within the watershed through parent material breakdown. The three major geologic formations in the Tookany/Tacony-Frankford Watershed are the Wissahickon Formation (approximately 72.5%), Pensauken and Bridgeton Formations, undifferentiated (roughly 12%) and Felsic Gneiss (about 7%). The Wissahickon Formation occupies the majority of the watershed, except for the very southern and northern portions. The Pensauken and Bridgeton Formations are found in the southern portion (Philadelphia County), while the Felsic Gneiss Formation is found in the northern portion (Montgomery County). While there is a minimal amount, 28 acres or about 0.1%, of carbonate (limestone) bearing surface geology (Conestoga Formation (OCc)) in the very upper northwest portion of the Tookany/Tacony-Frankford Watershed, there are no sinkholes listed in the DCNR Sinkhole Inventory for this area. The geologic map of the watershed can be found in Map III-5. The following descriptions of carbonate and non-carbonate geologic formations in the Watershed are modified from Berg, T. M., Geyer, A. R., Edmunds, W. E., and others, compilers, 1980, *Geologic map of Pennsylvania*, Pennsylvania Geological Survey, 4th ser., Map 1.

Limestone (Carbonate) Geologic Formation:

Conestoga Formation (OCc): Light-gray, thin-bedded, impure, contorted limestone having shale partings; conglomeratic at base; in Chester Valley, includes micaceous limestone in upper part, phyllite in middle, and alternating dolomite and limestone in lower part.

Non-Carbonate Geologic Formations:

Bryn Mawr Formation (Tbm): High-level terrace deposits; reddish-brown gravelly sand and some silt. Age uncertain.

Chickies Formation (Cch): Light-gray, hard, massive, Skolithos-bearing quartzite and quartz schist;thin, interbedded dark slate at top; conglomerate (Hellam Member) at base.

Felsic gneiss (fgp): Light, medium grained; includes rocks of probable sedimentary origin.

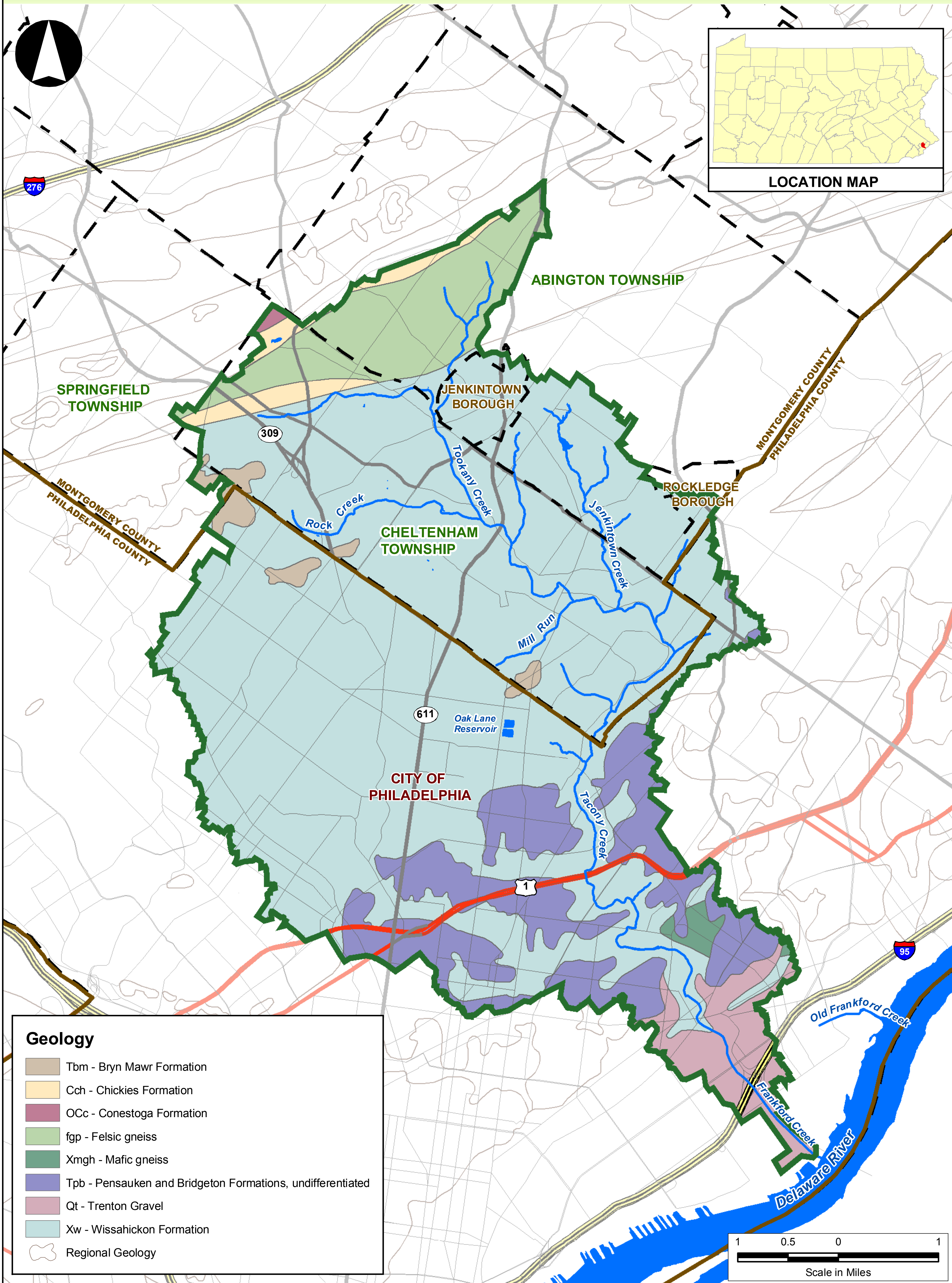
Mafic gneiss (Xmgh): Dark, medium grained; includes rocks of probable sedimentary origin; may be equivalent to "mgh" in places.

Pensauken and Bridgeton Formations, undifferentiated (Tpb): Dark-reddish-brown, cross-stratified,feldspathic quartz sand and some thin beds of fine gravel and rare layers of clay or silt.

Trenton Gravel (Qt): Gray or pale-reddish-brown, very gravelly sand interstratified with crossbedded sand and clay-silt beds; includes areas of Holocene alluvium and swamp deposits.

Wissahickon Formation (Xw): Includes oligoclase-mica schist, some hornblende gneiss, some augengneiss, and some quartz-rich and feldspar-rich members due to various degrees of granitization.

TOOKANY/TACONY-FRANKFORD WATERSHED
PHASE II - ACT 167 STORMWATER MANAGEMENT PLAN



Map III-5
GEOLOGY

Prepared For:
PHILADELPHIA WATER DEPARTMENT

Legend
WATERSHED BOUNDARY
COUNTY BOUNDARY
MUNICIPAL BOUNDARY
STREAMS
WATER BODIES
STATE MAINTAINED ROADS
Interstate
US Federal Highway
PA State Route
Other State Road

NOTE:
Portions of this map were generated from existing data sources as listed below. These data are shown on the maps for spatial reference only. These data did not enter into any computations or affect the reliability of the hydrologic analysis. Borton-Lawson Engineering has found some inaccuracies in some of these data and has corrected the data in locations where discrepancies were obvious, however, it was not a part of this ACT 167 Plan to correct all of the mapping data.

DATA SOURCES:
Watershed Boundary - PWD
Streams - PADEP
Water Bodies - USFWS (Derived from NWI Wetlands)
County Boundaries - PennDOT
Municipal Boundaries- PennDOT
Roads - Penn DOT
Bedrock Geology - PA DCNR

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F. Climate

The Tookany/Tacony-Frankford Watershed experiences a vast range of weather conditions through seasonal variations and also day to day changes in weather patterns. Both Philadelphia and Montgomery Counties are classified as somewhat humid continental climates in which the Atlantic Ocean plays a significant role in modifying the weather patterns. Changes in topography throughout the region affect local weather systems, and the change in weather between higher elevated regions and the low lying metropolitan area is rather noticeable.

The average annual temperature in the watershed is between 54 degrees F (Philadelphia) and 57 degrees F (Montgomery). It can be expected that the average summer temperature is around 77 to 80 degrees F. Extremely cold conditions are not common during the winter months due to a combination of factors including coastal low pressure systems that originate in the Carolinas and move through the area. The average winter monthly temperature is about 32 degrees F, and it can be expected that the temperature will be 32 degrees F or lower on about 100 days out of the year.

Because of the moderate conditions that exist during the winter, it is not uncommon for the watershed to experience thunderstorms throughout the entire year. In the summer, an average of 22 or so days experience thunderstorms. Average annual precipitation values are approximately 42 inches (from both rainfall and the water equivalent of melted snow). The amount of precipitation that occurs in each month does not fluctuate wildly, so this 42 inch total is distributed fairly evenly throughout the year.

Hurricanes, although not common, have been recorded to pass through the area, and have brought uncharacteristic amounts of rainfall which have resulted in flood conditions. A high monthly precipitation average for August has been recorded at 17 inches or more in correlation with the passing of hurricanes.

G. Land Cover

The Tookany/Tacony-Frankford Watershed has a long history of settlement and urbanization dating back to the early 17th century. The landscapes of the watershed vary from suburbanized to highly urbanized. Much of the southern portion of the Tookany/Tacony-Frankford Watershed lies within the City of Philadelphia. Generally speaking, the central to lower portions of the watershed can be characterized as densely developed with a high degree of urbanization. Most of the central to upper portions of the watershed can be characterized as suburbanized and/or rapidly suburbanizing.

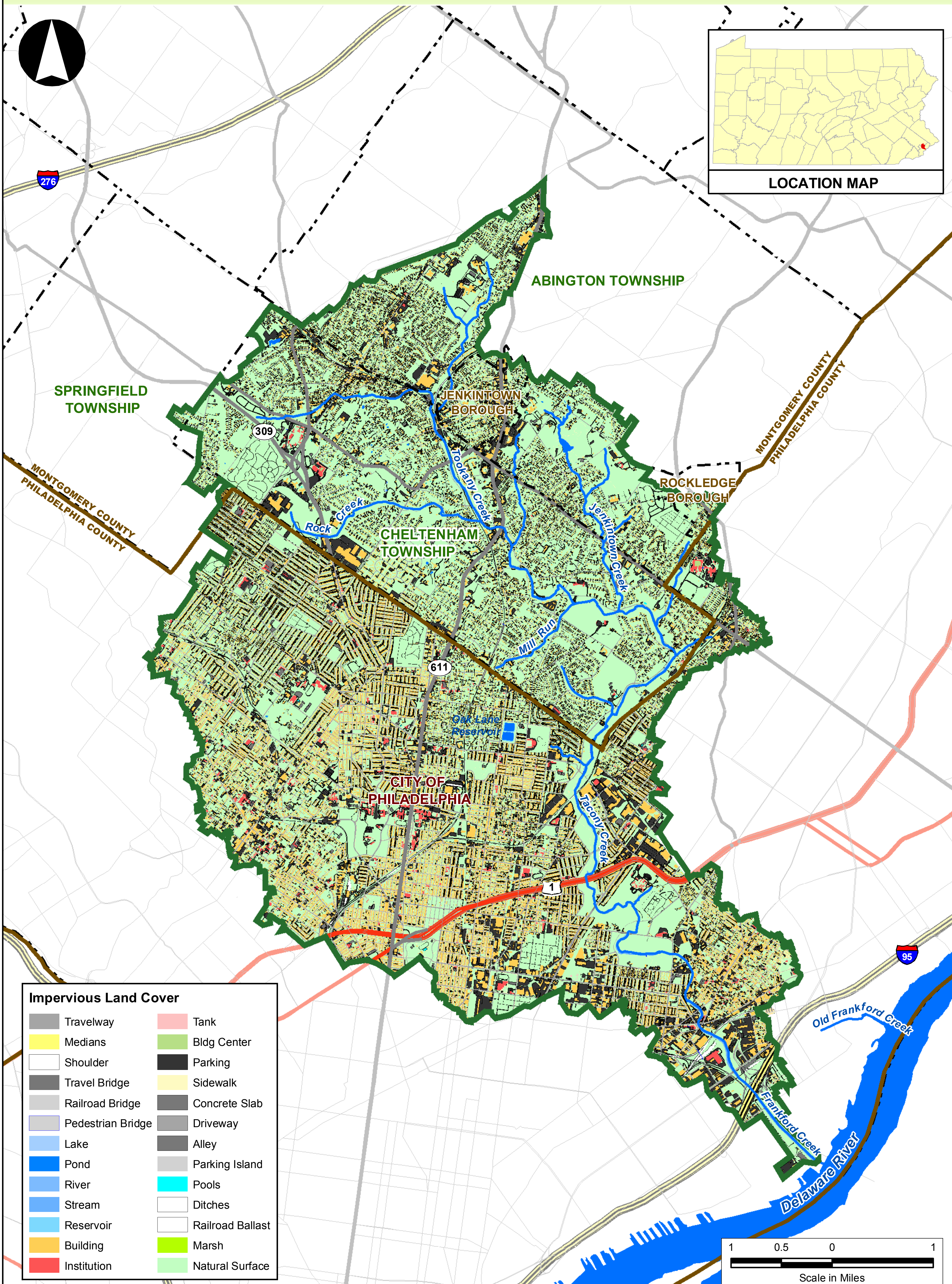
Redevelopment and infill development activities are common throughout the older urbanized areas of the watershed. The limited number of areas that remain open (i.e., large estates and stream valleys at the northern end of the watershed) are experiencing intense development pressure. The natural flow and course of the creeks and their tributaries have been significantly altered over the years. Many tributaries in the more urbanized portions of the watershed have been channelized, piped, stabilized, dredged, etc., resulting in little or no natural drainage pattern in many parts of the watershed. There are a significant number of man-made obstructions including old mills/dams and highway and railroad bridges that contribute to the alteration of natural stream flow. Much of the watershed is extensively paved and is served by storm sewer systems that discharge directly into streams with few if any quantity or quality controls. With the exception of parks and a few protected areas along tributaries at the top of the watershed, a great deal of development has taken place right up to the edge of the stream bank. This allows for little or no room for conventional riparian buffers to manage stormwater or protect the stream from water quality impacts.

While the boroughs and townships that lie within the watershed are a blend of developed and natural areas, the City of Philadelphia is urban in nature and largely developed. Overall, the predominant land cover in the watershed is classified as “natural surface” (52%). Approximately 29% of the watershed is paved, such as sidewalks, driveways, trailways, and parking. The remaining land is mostly classified as “building” and “institution”.

Map III-6 shows, in detail, the impervious land cover of the Tookany/ Tacony-Frankford Watershed, while Map III-7A depicts the generalized existing land cover. The impervious land cover data was provided by the Philadelphia Water Department and the generalized land cover was derived from the interpretation of aerial photos from 2000 by the Delaware Valley Regional Planning Commission (DVRPC). Table III-2 displays the detailed land uses by category within the watershed.

In summary, the watershed is primarily developed with large areas which have mixed commercial, residential, and industrial uses. Parts of Philadelphia and Montgomery Counties still have some forestland and agriculture. The watershed is sited within the inner-ring suburbs of Philadelphia. Therefore, any open land in this area is being developed at an incredible rate.

TOOKANY/TACONY-FRANKFORD WATERSHED
PHASE II - ACT 167 STORMWATER MANAGEMENT PLAN



Map III-6
IMPERVIOUS
LAND COVER

Legend
- WATERSHED BOUNDARY
- COUNTY BOUNDARY
- MUNICIPAL BOUNDARIES
- STREAMS
- WATER BODIES

STATE MAINTAINED ROADS
- Interstate
- US Federal Highway
- PA State Route
- Other State Road

Philadelphia PWD Water Department

Prepared For:
PHILADELPHIA
WATER
DEPARTMENT

NOTE:
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DATA SOURCES:
Watershed Boundary - PWD
Streams - PADEP
Water Bodies - USFWS (Derived from NWI Wetlands)
County Boundaries - PennDOT
Municipal Boundaries- PennDOT
Roads - Penn DOT
Land Cover - PWD

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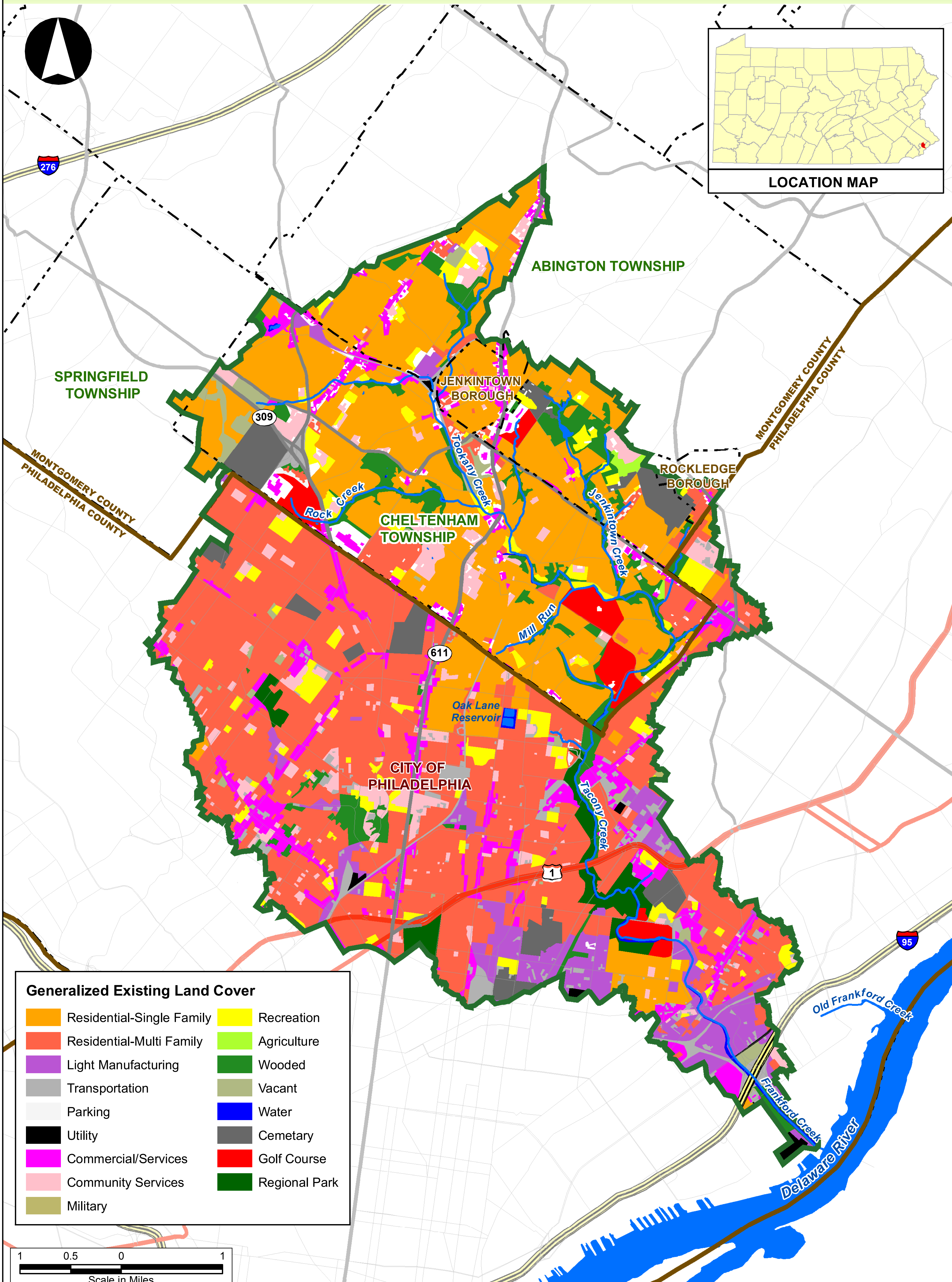
Tel: 484-821-0470

PREPARED BY: WSB
CHECKED BY: SJD
DATE: 7/6/2006
PROJECT #: 2004-1621-00

FILE: \\WBData\Projects\2004\1621\00\DATA\GIS\FINAL_REPORT_MAPS\ArcMap\Tookany_BaseMap.mxd

TOOKANY/TACONY-FRANKFORD WATERSHED
PHASE II - ACT 167 STORMWATER MANAGEMENT PLAN



Map III-7A: EXISTING LAND COVER

Prepared For:
PHILADELPHIA WATER DEPARTMENT

Philadelphia PWD Water Department

Legend

- WATERSHED BOUNDARY
- COUNTY BOUNDARY
- MUNICIPAL BOUNDARIES
- STREAMS
- WATER BODIES

STATE MAINTAINED ROADS

- Interstate
- US Federal Highway
- PA State Route
- Other State Road

NOTE:
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County Boundaries - PennDOT
Municipal Boundaries- PennDOT
Roads - Penn DOT
Land Cover - PWD

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DATE: 6/22/2006 | PROJECT #: 2004-1621-00

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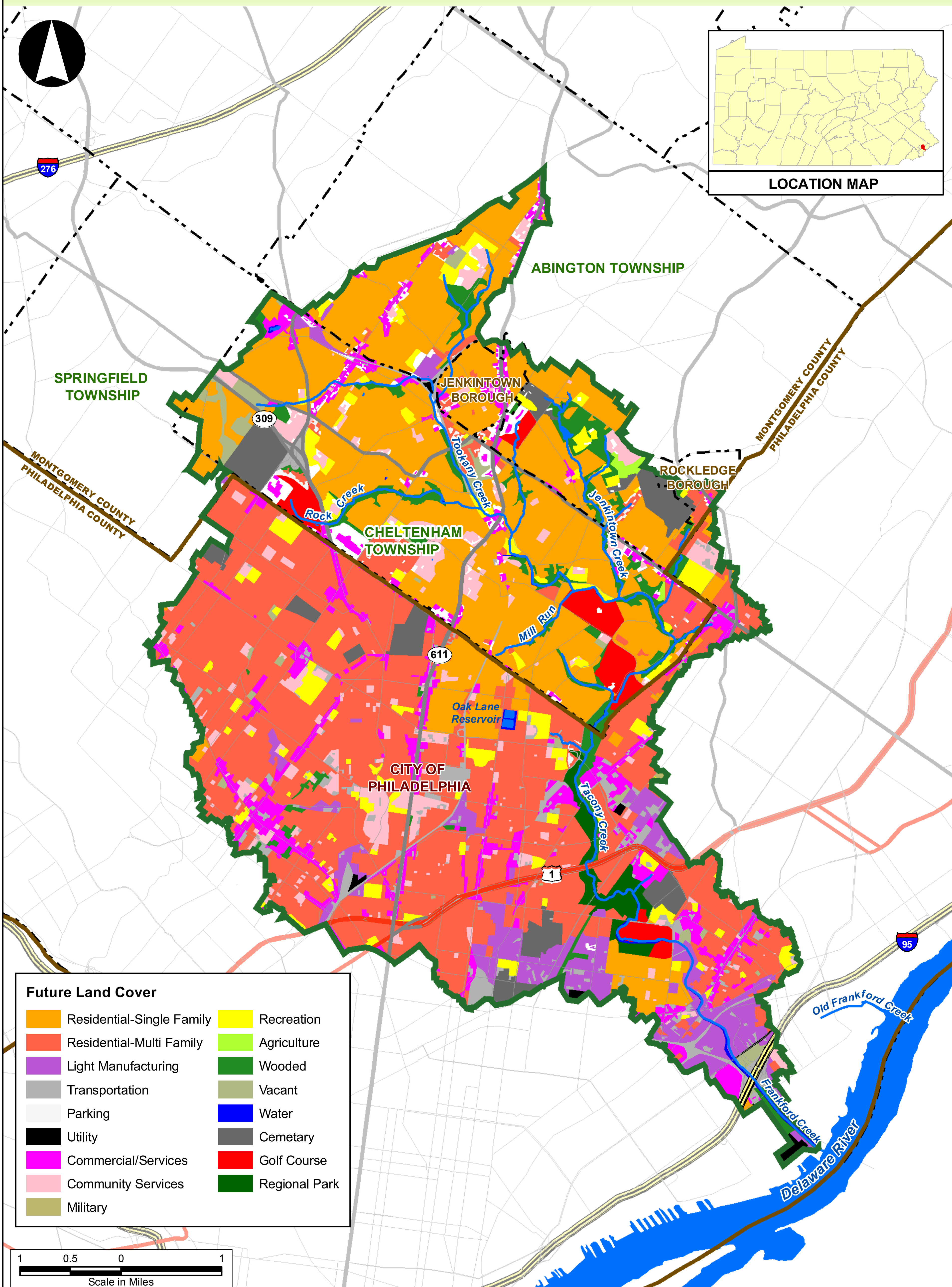
TABLE III-2
DETAILED LAND COVER STATUS BY CATEGORY

Land Use	Square Miles	Acres	Percent Area
Alley	.35	224.0	1.06
Building	5.40	3,456.0	16.35
Building Center	.01	6.4	<.01
Concrete Slab	.42	268.8	1.28
Ditches	<.01	1.5	<.01
Driveway	1.26	806.4	3.83
Institution	.29	185.6	.87
Lake	.01	6.4	<.01
Marsh	<.01	1.5	<.01
Medians	.05	32.0	.15
Natural Surface	17.05	10,912.0	51.77
Parking	2.42	1,548.8	7.35
Parking Island	.03	19.2	.01
Pedestrian Bridge	<.01	1.5	<.01
Pond	.01	6.4	.03
Pools	.03	19.2	.08
Railroad Ballast	.19	121.6	.56
Railroad Bridge	.02	12.8	.06
Reservoir	.02	12.8	.06
Shoulder	.02	12.8	.07
Sidewalk	1.33	851.2	4.03
Stream	.14	89.6	.42
Tank	<.01	1.5	<.01
Travel Bridge	.05	32.0	.16
Travelway	3.85	2,464.0	11.68
TOTAL:	**32.96**	**21,094**	**100%**

H. Land Development Patterns

Although the majority of the watershed is currently developed, there are several forested and open space areas that expected to be developed in the future. Based on current land cover patterns, the majority of new development is expected to be residential (both single and multi family). This type of development is expected to occur in the City of Philadelphia, Cheltenham Township, and Abington Township. The future land cover map is shown in Map III-7B. Existing peak flows for each calibration point in the model are shown in Table III-3.

TOOKANY/TACONY-FRANKFORD WATERSHED
PHASE II - ACT 167 STORMWATER MANAGEMENT PLAN



Map III-7B:
GENERALIZED
FUTURE LAND COVER

Prepared For:
PHILADELPHIA WATER DEPARTMENT

Legend

- WATERSHED BOUNDARY
- COUNTY BOUNDARY
- MUNICIPAL BOUNDARIES
- STREAMS
- WATER BODIES

STATE MAINTAINED ROADS

- Interstate
- US Federal Highway
- PA State Route
- Other State Road

NOTE:
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DATA SOURCES:
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Streams - PADEP
Water Bodies - USFWS (Derived from NWI Wetlands)
County Boundaries - PennDOT
Municipal Boundaries- PennDOT
Roads - Penn DOT
Future Land Cover - PWD (Modified by Borton-Lawson)

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DATE: 6/22/2006
PROJECT #: 2004-1621-00

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TABLE III-3
Present (Existing) Combined Peak Flows at the Calibration Points –
100-Year 24-Hour Storm
(Please refer to Appendix A of the Model Ordinance for Subarea Locations)

Subarea No.	Subarea Area (ac.)	Existing Peak Q (cfs)
Subcatch Z12	213.8	1363
Subcatch MS20	235.38	3304
Subcatch MS30	135.37	5401
Subcatch H8	193.18	1336
Subcatch MS36	41.21	6792
Subcatch MS44	136.56	7488
Subcatch MR10	51.25	1715
Subcatch J9	58.51	824
Subcatch J20	101.98	954
Subcatch MS52	78.56	8235
Subcatch MS50	53.76	9058
Subcatch MS74	231.63	9953
T14-N	71.78	4319
T14-P	54.8	4867
T08	65.22	3302
T14	73.8	14814
Non-MS102	13.87	9745
Non-MS122	8.06	14227
T050-015	33.43	14467

Note: The computed flow values were derived for watershed planning purposes and should not be considered regulatory values for permitting purposes. While they may be used for comparison or checking purposes, additional hydrologic computations may be needed for the design of bridges, culverts and dams.

I. Present (Existing) and Projected Development in the Flood Hazard Areas

The U.S. Department of Housing and Urban Development, Federal Insurance Administration, Federal Emergency Management Agency (FEMA) prepares Flood Insurance Studies (FISs) and floodplain mapping for the municipalities in the Tookany/Tacony-Frankford Watershed. This activity is now a responsibility of the U.S. Department of Homeland Security. Municipalities and the Pennsylvania Department of Community and Economic Development (PADCED) should be contacted as to the latest FIS before use.

There are two types of studies conducted in the FIS program: detailed and approximate. Detailed methods included hydrologic computations and detailed HEC-2 or HEC-RAS backwater computations. The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction. Areas studied by the approximate methods were areas having low development potential or minimal flood hazards.

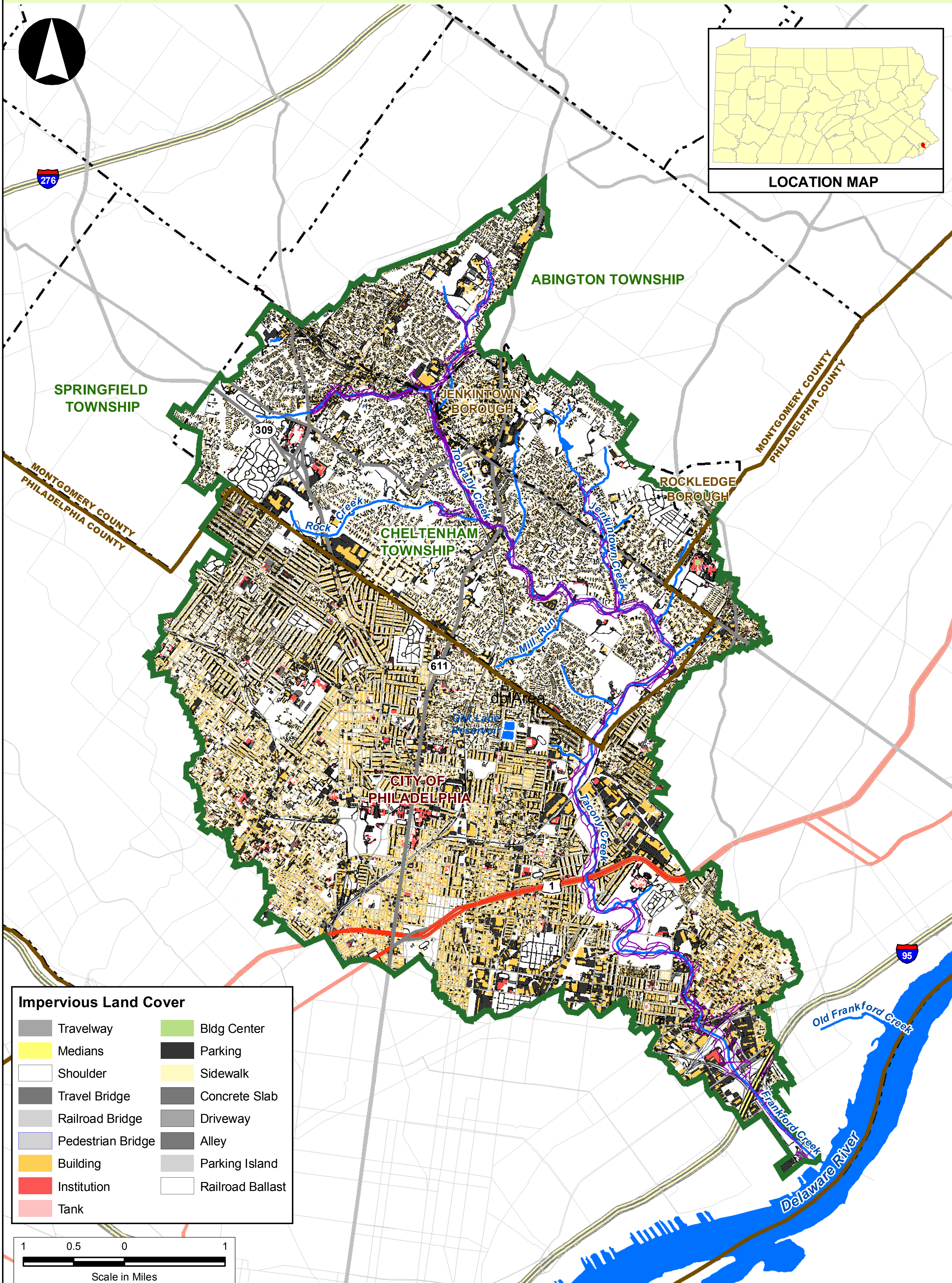
Map III-8 shows the 100-year floodplains classified as detailed and approximate as taken from the FEMA mapping for the Tookany/Tacony-Frankford Watershed. Encroachments of buildings, institutions, railroads and paved areas are shown by overlaying these areas on the floodplain in the GIS. Approximately 695 acres (3%) of the watershed are within floodplains. Of these 695 acres, 172 are developed. The remainder is considered a natural surface or water body. Table III-4 provides a summary of the total amount of developed floodplain area.

TABLE III -4
Summary of the Total Amount of Developed Floodplain Area

Existing Land Use	Acres in Floodplain	Square Miles in Floodplain
Building/ Building Center	33.7	0.05
Institutional	2.4	<0.01
Paved	123.9	0.19
Railroad	12.0	0.02
Tank	0.1	<0.01
TOTAL	**172.1**	**0.26**

The overall evaluation of the municipal questionnaires which were received shows several occurrences of stream flooding throughout the watershed during major storm events, resulting in property damages, as can be seen in Table III-5.

TOOKANY/TACONY-FRANKFORD WATERSHED
PHASE II - ACT 167 STORMWATER MANAGEMENT PLAN



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Map III-8
FLOODPLAINS AND DEVELOPMENT

Philadelphia PWD Water Department

Prepared For:
PHILADELPHIA WATER DEPARTMENT

Legend

WATERSHED BOUNDARY
FLOODPLAINS
COUNTY BOUNDARY
MUNICIPAL BOUNDARIES
STREAMS
WATER BODIES

STATE MAINTAINED ROADS

Interstate
US Federal Highway
PA State Route
Other State Road

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Streams - PADEP
Water Bodies - USFWS (Derived from NWI Wetlands)
County Boundaries - PennDOT
Municipal Boundaries- PennDOT
Roads - Penn DOT
Land Cover - PWD
Floodplains - FEMA

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PREPARED BY: WSB
DATE: 7/6/2006

CHECKED BY: SJD
PROJECT #: 2004-1621-00

Stormwater management planning is critical throughout the Tookany/Tacony-Frankford Watershed, not only in areas affected by stormwater management problems but also in those areas not experiencing stormwater related problems. In areas with stormwater related problems, flooding, which is mainly caused by larger storm events, is of major concern. The Act 167 plan can help in these areas by applying a watershed wide management plan that will help prevent existing problems from getting worse by implementing stormwater controls in upstream developing area. A heightening of stormwater problems is often characterized by either more frequent flooding problems or attainment of higher flood elevations. As cited in Section III-J, this plan shall also provide communities with information essential in evaluating and upgrading current undersized stormwater facilities. In those areas currently unaffected by stormwater problems, the Act 167 plan shall provide controls on future development to help prevent stormwater management problems from developing in areas where they do no presently occur.

One of the biggest problems in floodplain management is the increase in peak flow caused by development in the watershed. Recognizing this, the National Flood Insurance Program (NFIP) has developed a Community Rating System (CRS) to give communities credit for floodplain management activities that exceed the minimum requirements. As part of this rating system, credit points can be awarded to communities if they implement the following:

- Regulatory language (Ordinance) requiring peak rate of runoff from development to be no greater than the predevelopment runoff
- A stormwater master plan (such as this Act 167 Plan)
- State review of the stormwater management plan
- Requirement for a building's lowest floor to be elevated above flood levels
- Erosion and sediment control regulations (such as Chapter 102)
- Water quality regulations

The more credits a community can accumulate, the less its residents will have to pay for flood insurance. For further information on the community rating system, the publication *"CRS Credit for Stormwater Management,"* July 1996, published by FEMA, is available at the County Planning office.

J. Obstructions

Locations of significant waterway obstructions (i.e., culverts, bridges, etc.) were obtained by inspection of the United States Geologic Survey (USGS) topographic base map. Data on these obstructions was then obtained from the Pennsylvania Department of Transportation (PennDOT), FEMA Flood Insurance Studies, and field surveys.

The obstruction flow capacities were then compared to the peak flow at that point derived through the modeling process for each design storm frequency. The obstructions were then classified into seven categories as follows:

- Those obstructions which are able to pass the 100-year, 24-hour storm without obstructing the flow

- Those obstructions which are able to pass the 50-year, 24-hour storm and greater without obstructing the flow

- Those obstructions which are able to pass the 25-year, 24-hour storm and greater without obstructing the flow

- Those obstructions which are able to pass the 10-year, 24-hour storm and greater without obstructing the flow

- Those obstructions which are able to pass the 5-year, 24-hour storm and greater without obstructing the flow

- Those obstructions which are able to pass the 2-year, 24-hour storm and greater without obstructing the flow

- Those obstructions which are <u>NOT</u> able to pass the 2-year, 24-hour storm and greater without obstructing the flow.

The locations of all obstructions, including those that fall into the seven categories above, can be found in Map III-9. The obtained data and the obstruction flow capacities can be found in the Technical Appendix.

During the field work phase of this project, project team members noted that there were large numbers of pipes and culverts either in disrepair or clogged to a point that the flow capacity of the pipe was reduced or completely blocked. It is recommended that municipalities take advantage of the data collected and shown in Map III-9 to rank which culverts may need repair. A program should be established by the municipalities to maintain unobstructed flow on all culverts and bridges.

K. Existing Drainage Problems and Proposed Solutions

Information on drainage problems and proposed solutions was solicited from each Municipality within the Tookany/Tacony-Frankford Watershed by providing forms to each Watershed Plan Advisory Committee (WPAC) member early in the Watershed Plan study.

These problems were discussed at the WPAC meetings and varied, ranging from major regional flooding problems to minor issues that were local in nature. Many of the localized problems could be attributed to clogged or undersized inlets or small cross pipes and culverts. These small pipes typically cross roadways and other obstructions and function to convey runoff from the upstream side of an obstruction to the downstream side.

The recorded stormwater related problems were analyzed to determine if they were caused by localized (i.e., inadequately sized storm sewers) or regional (i.e., stream overbank flooding) sources. As can be seen in Map III-10, the problems can be classified generally into one of these two classes.

The localized problems are discrete problems caused by a localized situation such as inadequately sized stormwater conveyance systems, sedimentation, or uncontrolled local runoff. These problem areas may not be immediately adjacent to the stream and can be independent of the problems occurring along the creek. The other type of problem area is typically located along or adjacent to the stream and is directly affected by stormwater runoff conveyed in the stream. These problems located along the stream are typically indicative of a regional issue or a watershed-wide problem.

Twenty-one (21) problem areas were identified in this study, including several different types of problems. The type, cause, and occurrence of these problems are indicated on III-5. The categories selected in Table III-5 typically have similar causes and solutions that are discussed below. Specific solutions to each of the problems were not developed as part of this plan as they typically require an individual engineering study to characterize the problem, assess alternatives and identify the most appropriate solution based upon the needs, desires and constraints of the project stakeholders. However, generic remedies for each of the problems are discussed below.

TABLE III-5
Tookany/Tacony-Frankford Watershed Problems

Municipality	Type Of Problems	Causes Of Problems	Occurrences Of Problems	Types Of Damage
	(A)	(B)	(C)	(D)
Abington Township	1	1	-	-
Cheltenham Township	1, 2, 3	-	-	-
Jenkintown Borough	1	1, 3, 4	2	3
City of Philadelphia	-	-	-	-

N/A No problem areas reported
* No Data Collection Forms Received

Types of Problems
(A)
1. Flooding
2. Accelerated Erosion
3. Sedimentation
4. Landslide
5. Groundwater
6. Water Pollution
7. Other

Causes of Problems
(B)
1. Stormwater Volume
2. Stormwater Velocity
3. Stormwater Direction
4. Water Obstruction
5. Other

Occurrences of Problems
(C)
1. > 1 time per year
2. < 1 time per year
3. Only major flood events

Types of Damages
(D)
1. Loss of life
2. Loss of vital services
3. Property damage

TOOKANY/TACONY-FRANKFORD WATERSHED
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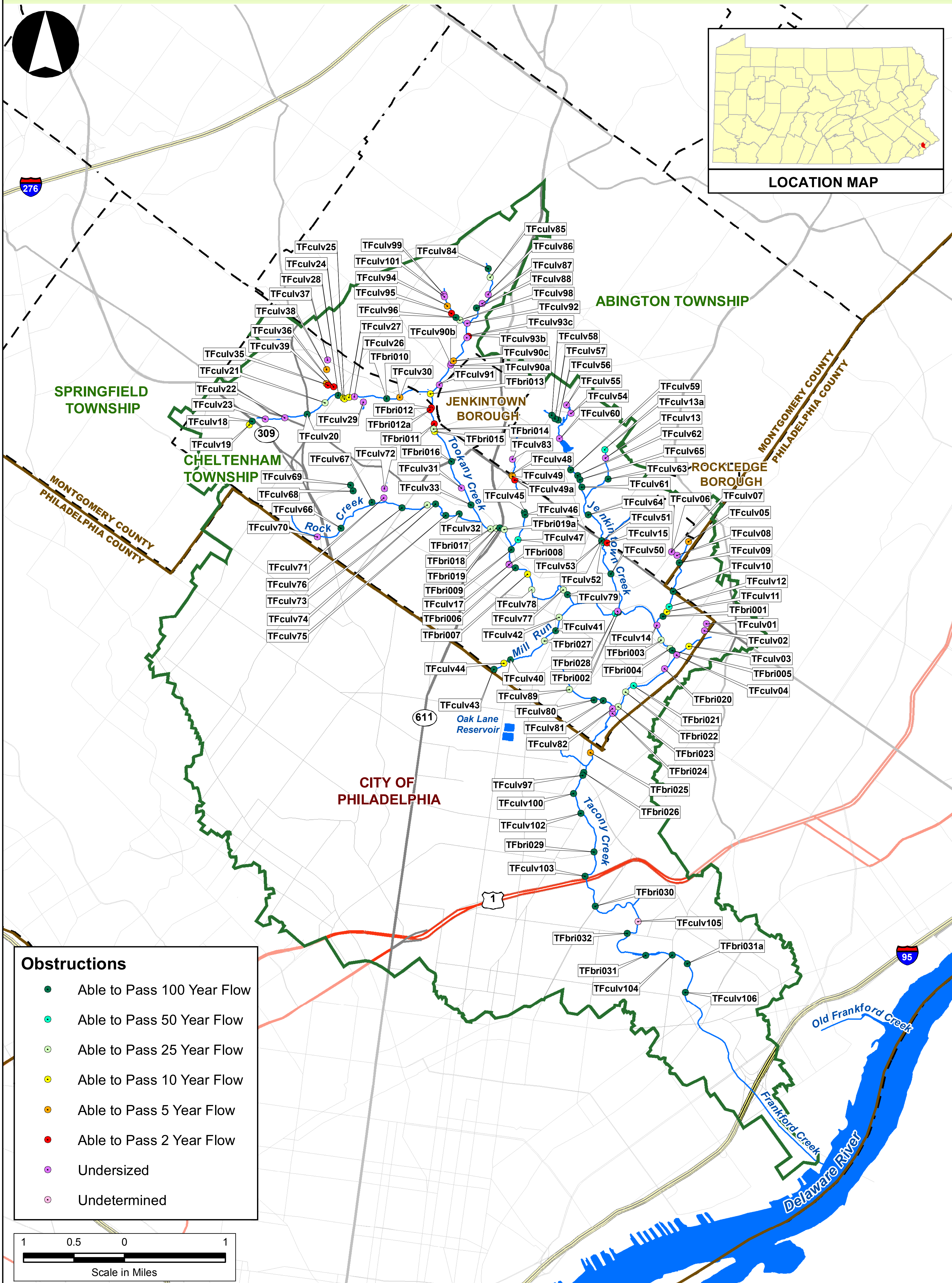

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Map III-9
OBSTRUCTIONS

Philadelphia PWD Water Department

Prepared For:
PHILADELPHIA WATER DEPARTMENT

Legend

- WATERSHED BOUNDARY
- COUNTY BOUNDARY
- MUNICIPAL BOUNDARY
- STREAMS
- WATER BODIES

STATE MAINTAINED ROADS

- Interstate
- US Federal Highway
- PA State Route
- Other State Road

NOTE:
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County Boundaries - PennDOT
Municipal Boundaries- PennDOT
Roads - Penn DOT
Obstructions - PWD (Field Verified by Borton-Lawson)

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PREPARED BY: WSB
CHECKED BY: SJD
DATE: 4/27/2006
PROJECT #: 2004-1621-00

TOOKANY/TACONY-FRANKFORD WATERSHED
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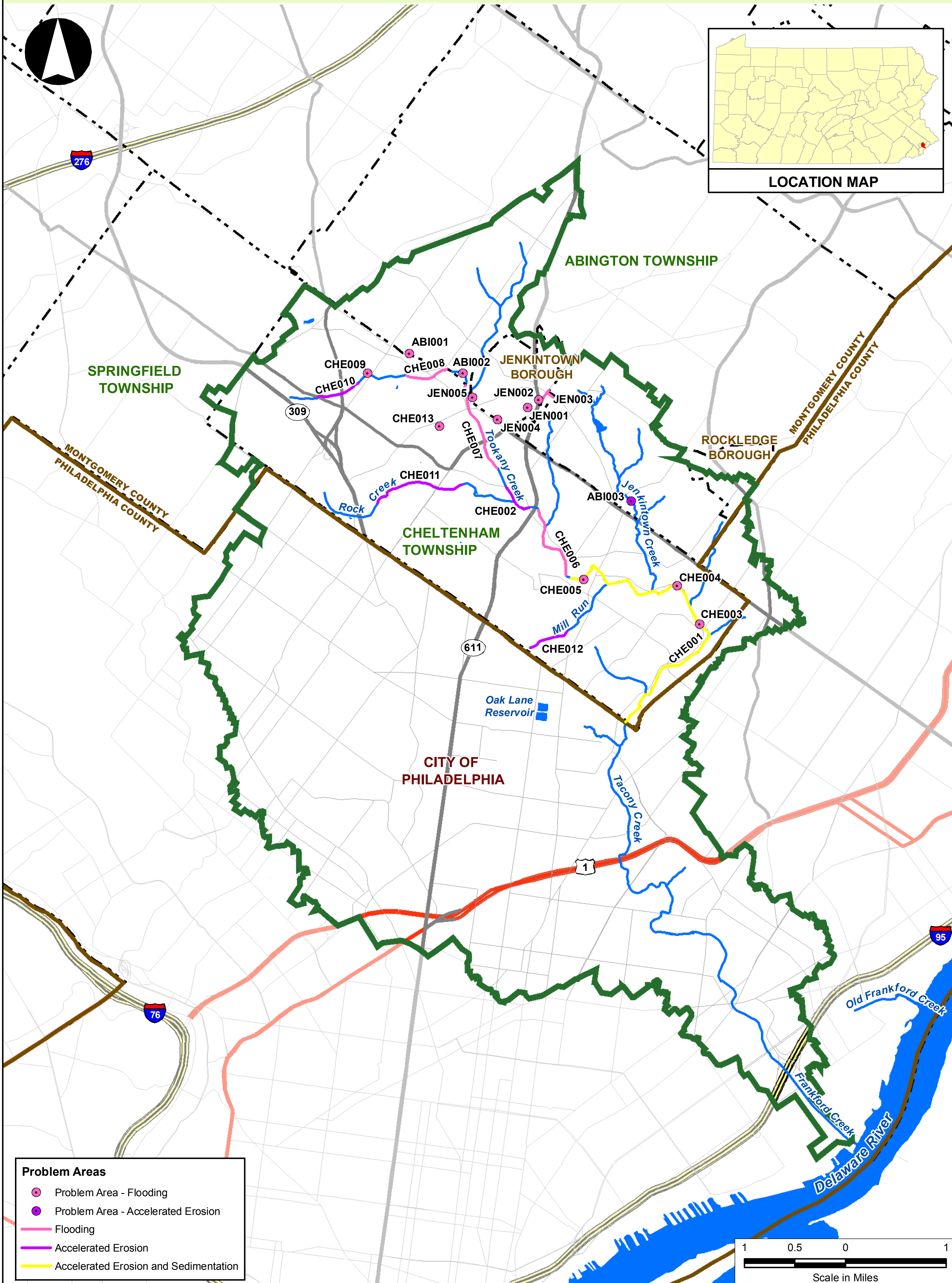

Map III- 10
PROBLEM AREAS

Philadelphia PWD Water Department

Prepared For:
PHILADELPHIA WATER DEPARTMENT

Legend

- WATERSHED BOUNDARY
- COUNTY BOUNDARY
- MUNICIPAL BOUNDARIES
- STREAMS
- WATER BODIES

STATE MAINTAINED ROADS

- Interstate
- US Federal Highway
- PA State Route
- Other State Road

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Streams - PADEP
Water Bodies - USFWS (Derived from NWI Wetlands)
County Boundaries - PennDOT
Municipal Boundaries- PennDOT
Roads - Penn DOT
Problem Areas - Municipalities

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Flooding

As discussed in Section III-I, the creeks and their tributaries have caused flooding conditions in the Tookany/Tacony-Frankford Watershed. The areas within the watershed immediately adjacent to the creeks and various low lying wetland areas are generally subject to minor flooding after rain or thaw conditions. Flooding in the watershed can be classified into two categories: 1) local flooding caused by inadequately sized storm culverts; and 2) flooding caused by the location of structures within the floodplain of the major tributaries. Of the sites identified in Table III-5, most are caused by inadequate conveyance systems in developed areas. To fix these problems municipalities must first identify and prioritize the problems based upon their severity. After the problems are prioritized to identify the most urgent problems, the Municipality should complete a hydraulic analysis to identify the causes of the problem and propose a solution. Some of the problems can be fixed with a more aggressive maintenance program to clear blockages while others may be helped through the volume control measures included in this plan. Although the volume control measures incorporated into this plan can help alleviate some of the problems, often the permanent solution to these problems requires an engineered solution which may necessitate the removal of an obstruction or the construction of flood mitigation measures such as a floodwall, regional detention, or property acquisition.

Bridges

High bed loads of streams within the watershed and corresponding gravel deposits reduce the waterway opening which in turn reduces the conveyance capacity of the bridge. As a first step gravel deposits surrounding the bridge should be removed from the opening to restore the conveyance capacity of the waterway opening. Once the capacity is restored an active maintenance schedule can be enacted to maintain the capacity of the bridges. If sedimentation is a frequent problem the size of the waterway opening can be reduced for lower stream stages to maintain the water velocity through the bridge and prevent the water from slowing and depositing sediment around the bridge. Excessive scour at select locations around a bridge or a constriction in a waterway can result in sedimentation downstream of the scour at a location where the velocity slows. In these locations often the best solution is to evaluate the cause of the scour and design counter measures to minimize the effects of the scour. An active maintenance program does not require a hydraulic study to initiate; however, any modification of the waterway opening or the channel configuration around a bridge typically involves a hydraulic study. The solution costs are typically borne by the owner of the bridge.

Erosion and Sedimentation (E & S)

The Montgomery County Conservation District and Philadelphia Water Department are responsible for administering PA Title 25, Chapter 102 (Erosion Control Regulations). These regulations address accelerated erosion and the resulting sedimentation from earthmoving activities. Permanent stabilization of exposed areas and proper stabilization of channels of conveyance will reduce erosion problems in the watershed. Improvements in the watershed can be realized by reviewing plans for new developments to make certain the methods and techniques are being specified, conducting inspections to ensure the methods specified are being installed properly and maintained and investigating and documenting any existing sources of prolonged problems. One potential solution to those areas where there are persistent problems is the application of various bioengineering techniques such as turf reinforcement mats, natural fiber rolls, reforestation with live plantings, and in particularly difficult areas armoring. A common source of funding for these problems, particularly in areas owned by the Municipality is the State's Growing Greener program.

Storm Sewers, Culverts, and Outlets

Some of the problems identified in Table III-5 are the result of inadequately sized storm culverts, and/or unstable outlets that traverse state, township, or private roads. Regular maintenance of existing sewers and culverts is typically the starting point to resolving some of these issues. In certain instances, storm sewer system appurtenances can be constructed such as trash racks, sediment basins or energy dissipators to prevent clogging of pipes. However, when routine maintenance is incapable of solving the drainage problems, the typical solution involves performing a hydrologic study to modify pipe sizes, increase the number of inlets and improve the capacity of the system. Costs are typically borne by the owner of the road.

Problems and Solutions

Stormwater related problems in the upper portion of the watershed can most likely be eliminated through an engineering analysis and application of one of the aforementioned solutions. Areas along the Tookany Creek where both erosion and sedimentation is a problem, such as those areas in the southeastern portion of Cheltenham Township, would most benefit from a solution which would investigate the cause of the erosion and/or sedimentation and then recommend a solution to stabilize the problematic channels. Therefore a detailed FGM assessment of the areas experiencing erosion and sedimentation is recommended to determine what the specific cause or causes of the problems are and to determine the best way to stabilize the channel without causing additional erosion and sedimentation. This type of an assessment is not only valuable in those areas experiencing problems, but also in stable areas, upstream and downstream of the sites in order to create a baseline evaluation for comparison with subsequent assessments near the sites. In areas where erosion is occurring, erosion-resistant materials should be placed on the banks of the channel and in certain instances the morphology or alignment of the channel altered to fully stabilize the channel. Stabilization of the eroded reaches reduces the amount of sediment available for transport downstream of the problem site and reduces the amount deposition that can occur at points where the velocity in the stream drops below the critical velocity needed to keep the materials suspended. In areas with sedimentation problems, such as in those areas upstream of a bridge or culvert where the natural channel was widened to provide additional conveyance without overtopping an embankment, alteration of the channel morphology may be needed to increase velocities to a point that does not cause erosion but yet prevents sedimentation from occurring. Typically it is ideal to use bioengineering methods to stabilize the channel and to avoid hard armoring of the stream; however, in certain locations hard armoring with rip-rap or similar materials may be necessary to provide long term stabilization. In the central portions of Cheltenham Township, where only accelerated erosion is designated as the problem, these areas represent other locations where stabilization is also needed. Modifying the channel or floodplain configuration or possibly the channel slope and lining in these areas to slow the water conveyed in the channel may also prove as a valuable means of reducing erosion.

In sections of the watershed where flooding is of a concern along extended portions of the stream, such as along the Rock Creek, Mill Run and headwater portions of the Tookany Creek in Cheltenham Township, these flooding problems may be best resolved by applying regional controls. For instance, in the Rock Creek subwatershed there appears to be several areas where a regional basin could possibly be installed to help control the amount of water conveyed by the stream. Conversely, in the Mill Run portion of the watershed there is less land area available to incorporate a regional basin to minimize flooding. In this area partial diversion of the storm flow into another nearby watercourse through the modification of storm collection systems could help reduce some of the flooding in this area. Another solution could be to construct storage features on line along the channel which could attenuate some of the flow in the creek or construct flood containment features such as earthen berms or walls along the problematic sections of the creek.

Individual problems related with flooding, which are not associated with an entire reach of the channel, such as those areas shown in southern Abington Township, northern Cheltenham Township, and Jenkintown Borough, may be due to individual obstructions and could be best resolved with the removal or modification of the obstruction to provide more conveyance. Those points representing flooding problems, which are set away from the main channel such as points CHE013 and ABI001, are probably associated with under sized or inadequate drainage facilities. Resolution of flooding problems in these areas could be accomplished by improving the drainage system, by enlarging the drainage pipes or adding additional inlets into the system.

The City of Philadelphia reported no problem areas; however, in those areas of the city where persistent stormwater issues arise, whether it is flooding, sedimentation or erosion, these issues may be resolved by completing an engineering study and applying similar solutions to those discussed in this section. Without specific information regarding the type of issue, location, extent, frequency and magnitude it is impossible to suggest a solution to the problems.

Regardless of the location, the application of the management districts and the stormwater management controls set forth in this plan will help improve the stormwater related problems throughout the watershed. Actual solutions to the watershed's problems require the development of a project specific hydraulic model to fully ascertain the scope of the problem and the magnitude of the solution needed to resolve the problem. None of the potential solutions suggested in this plan should be applied without; the development of the appropriate engineering studies needed to support the specified modifications, the demonstration of their effectiveness at resolving the problem, and the necessary approvals for the project.

L. Existing and Proposed Stormwater Collection Systems

Based on the information in the data collection forms, supplied by the municipalities through the survey, stormwater collection systems are found in all municipalities in the watershed except Rockledge Borough.

M. Existing and Proposed State, Federal and Local Flood Control Projects

According to data collected by municipalities within the watershed, there are two existing flood control projects, which include a diversion channel and levee, found along Tookany Creek in Cheltenham Township. There are no proposed flood control projects at this time.

N. Existing and Proposed Stormwater Control Facilities

There are many known private stormwater control facilities as shown in Map III-11. The cost, design, capacity, construction and operation of these private facilities cannot be projected at this time since they occur on a case by case basis as a developer buys land, submits plans, and develops the tract. Typically, the cost of such facilities is paid through the developer's financing with costs transferred to the buyer.

Although there are several storage facilities, there are no DEP designated dams within the watershed. The storage facilities were modeled in the SWMM 5.0 model to properly assess any flow attenuation that may occur through the facilities.

O. Wetlands

Wetlands were obtained from the National Wetlands Inventory Maps in digital format and incorporated into the overall GIS. Map III-12 shows the wetlands for the watershed.

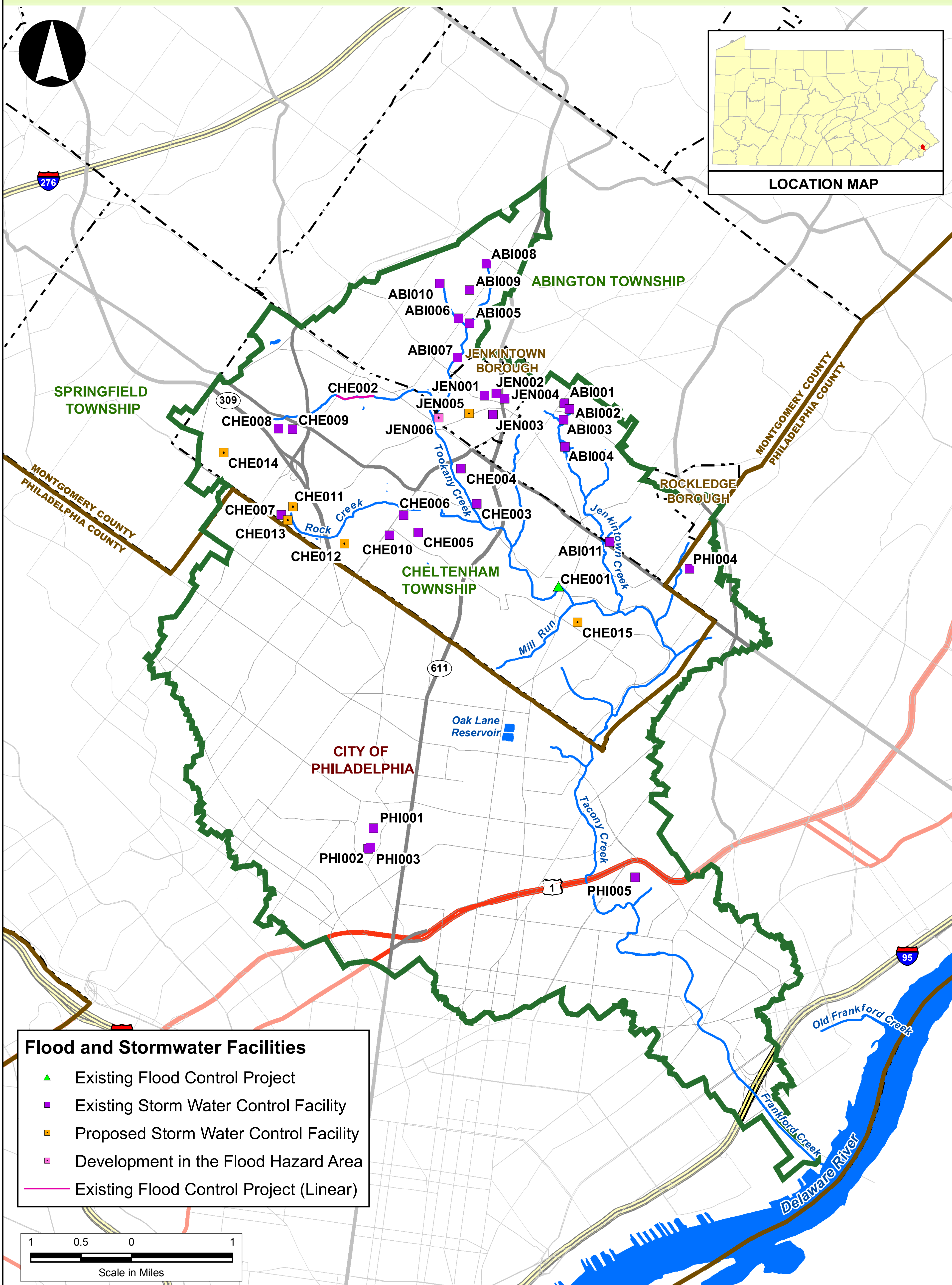
Wetlands play an important part in flood flow attenuation and pollutant filtering. Wetlands within the watershed are primarily found along the creeks' overbanks. Wetland flood flow attenuation was accounted for in the computer modeling by adjusting the stream routing time, or stream velocities, for overbank events. Wetlands should be preserved through the joint permit application process.

P. Outfalls

Mapping and documenting stormwater outfalls is one of the six Municipal Control Measures (MCMs) categories itemized in the PaDEP MS4 Stormwater Management Program Protocol to meet the requirements of the NPDES Phase II program. The objective is to detect and eliminate illicit discharges from municipal storm sewers.

Outfall locations were provided to Borton-Lawson in digital GIS shape file format by the Philadelphia Water Department. Two hundred and ninety-one (291) outfalls were identified and mapped and labeled. Map III-13 shows the outfall locations and identification numbers.

TOOKANY/TACONY-FRANKFORD WATERSHED
PHASE II - ACT 167 STORMWATER MANAGEMENT PLAN



Map III-11
FLOOD AND STORMWATER FACILITIES

Prepared For:
PHILADELPHIA WATER DEPARTMENT

Legend

- WATERSHED BOUNDARY
- COUNTY BOUNDARY
- MUNICIPAL BOUNDARIES
- STREAMS
- WATER BODIES

STATE MAINTAINED ROADS

- Interstate
- US Federal Highway
- PA State Route
- Other State Road

NOTE:
Portions of this map were generated from existing data sources as listed below. These data are shown on the maps for spatial reference only. These data did not enter into any computations or affect the reliability of the hydrologic analysis. Borton-Lawson Engineering has found some inaccuracies in some of these data and has corrected the data in locations where discrepancies were obvious, however, it was not a part of this ACT 167 Plan to correct all of the mapping data.

DATA SOURCES:
Watershed Boundary - PWD
Streams - PADEP
Water Bodies - USFWS (Derived from NWI Wetlands)
County Boundaries - PennDOT
Municipal Boundaries- PennDOT
Roads - Penn DOT
Flood & Stormwater Facilities - Municipalities

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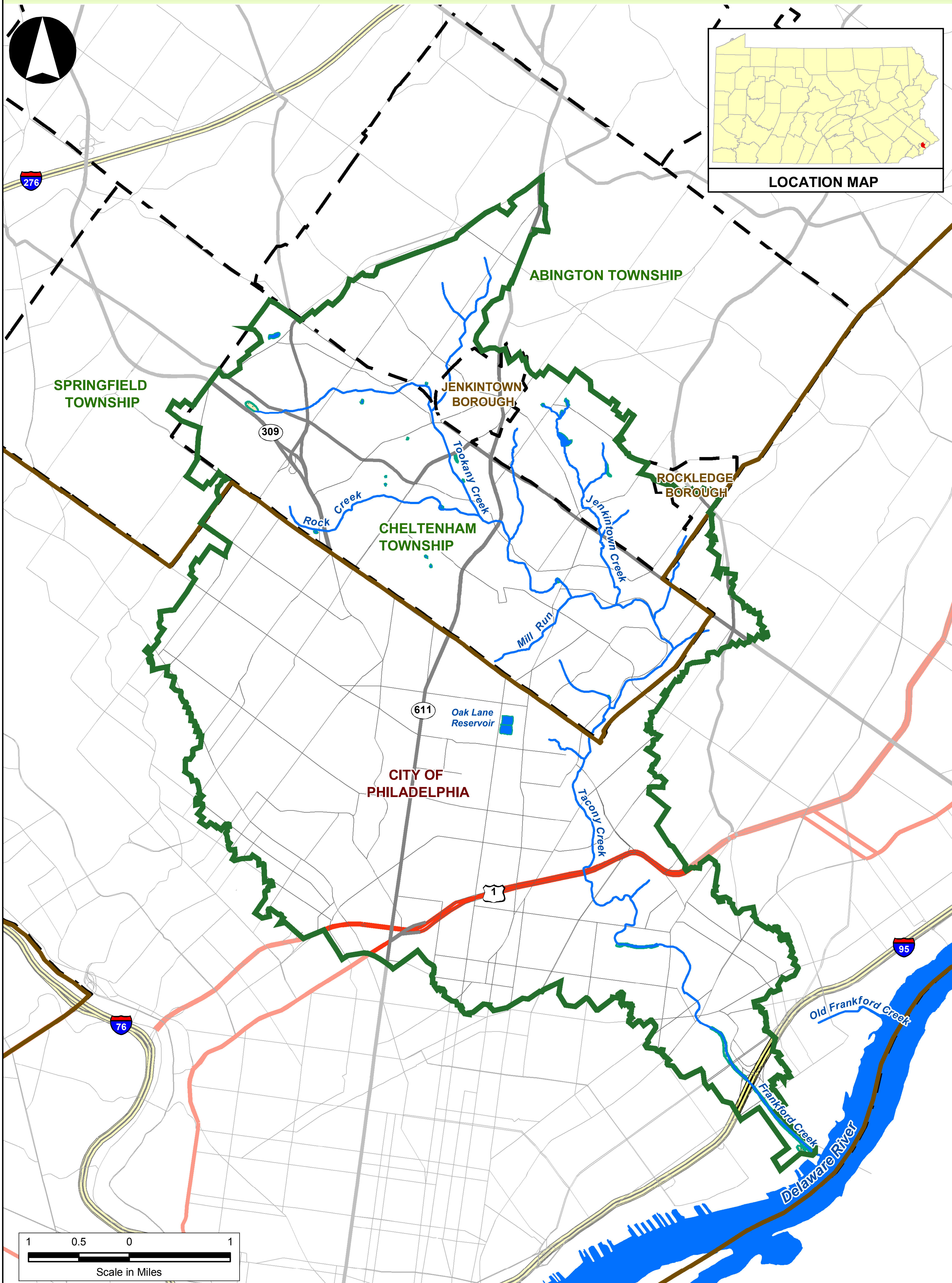
PREPARED BY: WSB
CHECKED BY: SJD
DATE: 7/6/2006
PROJECT #: 2004-1621-00

FILE: \\WBData\Projects\2004\1621\00\DATA\GIS\FINAL_REPORT_MAPS\ArcMap\Tookany_BaseMap.mxd

TOOKANY/TACONY-FRANKFORD WATERSHED
PHASE II - ACT 167 STORMWATER MANAGEMENT PLAN



Map III-12
WETLANDS

Prepared For:
PHILADELPHIA WATER DEPARTMENT

Legend

- WATERSHED BOUNDARY
- COUNTY BOUNDARY
- MUNICIPAL BOUNDARY
- STREAMS
- WATER BODIES
- WETLANDS

STATE MAINTAINED ROADS

- Interstate
- US Federal Highway
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Streams - PADEP
Water Bodies - USFWS (Derived from NWI Wetlands)
County Boundaries - PennDOT
Municipal Boundaries- PennDOT
Roads - Penn DOT
Wetlands - U.S. Fish and Wildlife Service
National Wetlands Inventory

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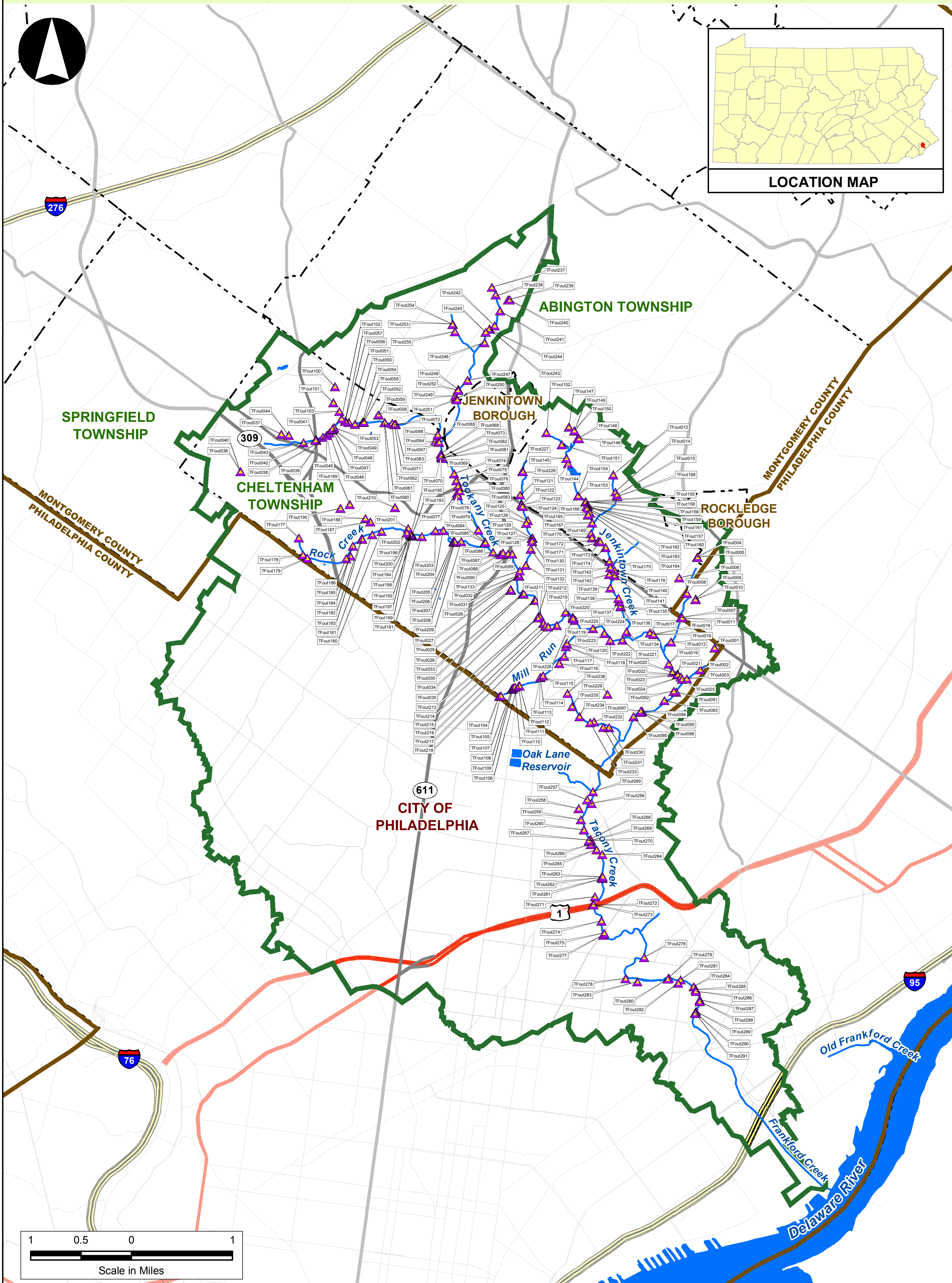

Map III-13
OUTFALLS

Prepared For:
PHILADELPHIA WATER DEPARTMENT

Philadelphia PWD Water Department

Legend

- WATERSHED BOUNDARY
- OUTFALLS
- COUNTY BOUNDARY
- MUNICIPAL BOUNDARIES
- STREAMS
- WATER BODIES

STATE MAINTAINED ROADS

- Interstate
- US Federal Highway
- PA State Route
- Other State Road

NOTE:
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Water Bodies - USFWS (Derived from NWI Wetlands)
County Boundaries - PennDOT
Municipal Boundaries- PennDOT
Roads - Penn DOT
Oufalls - PWD

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SECTION IV

WATERSHED TECHNICAL ANALYSIS

A. Watershed Modeling

An initial step in the preparation of this stormwater management plan was the selection of a stormwater simulation model to be utilized. It was necessary to select a model which:

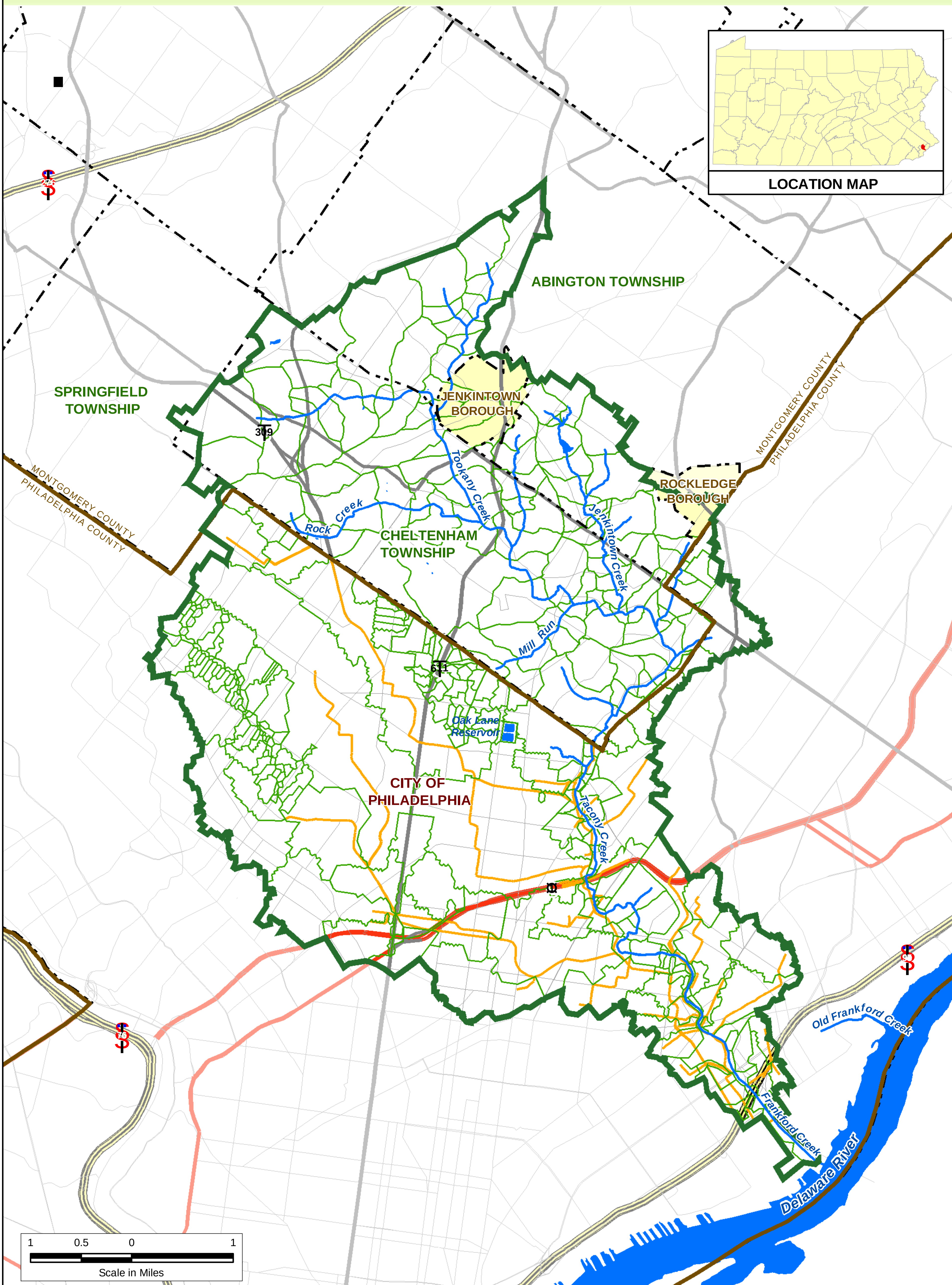
- Modeled design storms of various durations and frequencies to produce routed hydrographs which could be combined
- Was adaptable to the size of subwatersheds in this study
- Could evaluate specific physical characteristics of the rainfall-runoff process
- Did not require an excessive amount of input data yet yielded reliable results

The model decided upon was the Environmental Protection Agency's Stormwater Management Model 5.0 (SWMM 5.0) for the following reasons:

- It had been developed by the Environmental Protection Agency and CDM specifically for urban situations, and has the ability to include stormwater management facilities for modeling purposes
- Input parameters provide a flexible calibration process
- It has the ability to analyze reservoir or detention basin routing effects and location in the watershed
- It is accepted by the Pennsylvania Department of Environmental Protection

Although other models, such as HEC-HMS, may provide essentially the same results as the EPA SWMM 5.0, SWMM's ability to route stormwater through a series of conduits and junction points such as inlets and manholes make it specifically attractive for this study. The SWMM 5.0 Model generates stormwater runoff flows originating in selected subcatchments along the drainage course and provides the capability of comparing link by link contributions to the total runoff at an outfall. The model generates runoff quantities for a specified design storm based upon the physical characteristics of the subarea, and routes the runoff flow through the drainage system in relation to the hydraulic characteristics of the stream. The amount of runoff generated from each subarea is a function of its slope, percent of the subwatershed that is pervious, the depth of storage, infiltration parameters, and utilizes groundwater flow if appropriate. Percentages of impervious/pervious areas were determined from the GIS database by utilizing the data provided by PWD on impervious land use. Subwatersheds or subcatchments were delineated by PWD for their NPDES permit work. The same subcatchments were used for the Act 167 Plan for consistency. Map IV-1 displays the subcatchment delineation for Tookany/Tacony-Frankford Watershed.

TOOKANY/TACONY-FRANKFORD WATERSHED
PHASE II - ACT 167 STORMWATER MANAGEMENT PLAN



Map IV-1
SUBAREAS

Philadelphia PWD Water Department

Prepared For:
PHILADELPHIA WATER DEPARTMENT

Legend

- WATERSHED BOUNDARY
- COUNTY BOUNDARY
- MUNICIPAL BOUNDARIES
- BOROUGH
- STREAMS
- WATER BODIES
- SUBWATERSHEDS
- CSO PIPES

STATE MAINTAINED ROADS

- Interstate
- US Federal Highway
- PA State Route
- Other State Road

NOTE:
Portions of this map were generated from existing data sources as listed below. These data are shown on the maps for spatial reference only. These data did not enter into any computations or affect the reliability of the hydrologic analysis. Borton-Lawson Engineering has found some inaccuracies in some of these data and has corrected the data in locations where discrepancies were obvious, however, it was not a part of this ACT 167 Plan to correct all of the mapping data.

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Streams - PADEP
Water Bodies - USFWS (Derived from NWI Wetlands)
County Boundaries - PennDOT
Municipal Boundaries- PennDOT
Roads - Penn DOT
Subwatersheds - PWD
CSO Pipes - PWD

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B. Modeling Process

After delineating the outer Tookany/Tacony-Frankford Watershed, the watershed was further divided into subwatersheds (subcatchments in SWMM) for modeling purposes. The main considerations in the subdivision process were the location of obstructions, problem areas, the stormwater network (junctions and links) and tributary confluences. The most downstream point of each of these areas was then considered in relation to 19 points of interest. Points of interest are areas where increased runoff must be analyzed for its potential impact and were chosen at select points above and below major confluences, or at stream gages.

The reason points of interest are selected is to provide watershed runoff control through effective control of individual subarea runoff. Thus, control of stormwater runoff in the entire watershed can be achieved through stormwater management in each subbasin.

The model was calibrated and verified. Once calibrated, the watersheds were then modeled to determine the hydrologic response for the 1-, 2-, 5-, 10-, 25-, 50-, and 100-year for the 24-hour storm events. The results are shown in Volume III, Technical Appendix available at the County Office.

The modeling process addressed:

- Peak discharge values at various locations along the stream and its tributaries;
- Time to peak for the above discharges;
- Runoff contributions of individual subareas at selected downstream locations; and
- Overall watershed timing

C. Calibration

In order to simulate design storm flows for a watershed with confidence and reliability, the computer model must first be calibrated. This involves "fine tuning" the model to provide the most accurate representation of the real runoff and timing conditions of a watershed. Calibration of a model involves the adjustment of input parameters (within acceptable value ranges) to reproduce the recorded response of storm events.

When actual storm event data is available (i.e. stream flow and rain gauge data), this information can be input into the model and simulated "hydrographs" developed by the model. Hydrographs are simply a plot of time versus flow in cubic feet per second. To simulate a specific event, antecedent moisture conditions and rainfall distribution must be duplicated in the model input. Adjustments to other parameters are then made to attempt to duplicate hydrograph shapes and peak flow rates at points in the watershed where flow recordings were made. In order to utilize actual stream flow and rain gauge data for calibration, sufficient data must be available. Rain gauges must be in close proximity to the watershed so that actual rainfall conditions from these gages are representative of the actual rainfall that occurs over the watershed. Localized events, snowmelt, and unique conditions are typically not used for calibration due to their unique circumstances.

In order to maximize the accuracy of the SWMM 5.0 model, a model calibration effort was undertaken. At several essential points in the watershed, SWMM 5.0 generated flows were compared to historic event discharges from USGS gage data. PWD calibrated the SWMM model for a series of actual events. These events were small in magnitude (higher frequency storms), so the model was calibrated to match these smaller storms.

In order to calibrate the watershed model against these historic storm events, streamflow data was collected by PWD and USGS at six available stream gauges (Table IV-1) within the Tookany/Tacony-Frankford Watershed. This data was analyzed to select events which could be modeled using the SWMM 5.0 model. Typically, events which are results of isolated thunderstorm, snowmelt or a combination of rainfall/snowmelt are not ideal for modeling since many factors other than rainfall can affect results.

TABLE IV-1
USGS Stream Gauges within the
Tookany/Tacony-Frankford Watershed

USGS Gage No.:	Location	Period of Record
01467083	Tacony Creek near Jenkintown, PA.	1972-78
01467084	Rock Creek at Curtis Arboretum near Philadelphia	1971-78
01467085	Jenkintown Creek at Elkins Park, PA	1973-78
01467086	Tacony Creek at County Line, Philadelphia, PA	1965-88
01467087	Frankford Creek at Castor Ave, Philadelphia, PA	1982-2004
01467089	Frankford Creek at Torresdale Ave., Phila., PA	1965-82

Accurate rainfall data is also critical to historic event modeling. Since rainfall patterns can vary greatly throughout a watershed area, it is desirable to have many rainfall gauges located within the watershed boundary to accurately model a given storm event. The Philadelphia Water Department maintains at least five rain gauges (RG_07, RG_08, RG_13, RG_14 and RG_19) within the Tookany/Tacony-Frankford Watershed. Rainfall data from these gauges as well as three others (RG_10, RG_11 and RG_18) were used to obtain precipitation data for the watershed and calibrate the Tookany/Tacony-Frankford Watershed hydrologic model to streamflow data for historic events. The results of PWD's Log Pearson Type II streamflow analysis can be found in Table IV-2.

Table IV-2
Summary of PWD Log-Pearson Type II Frequency Analysis

USGS Gauge #	1.01	1.1	1.5	2	5	10	25	50	100
01467083	294	635	1,148	1,471	2,254	2,737	3,299	3,682	4,036
01467084	266	380	505	571	711	789	874	930	981
01467085	102	164	228	258	314	339	363	376	387
01467086	476	1,123	2,010	2,502	3,491	3,976	4,436	4,694	4,896
01467087	2,130	3,721	5,572	6,545	8,504	9,506	10,520	11,132	11,648
01467089	3,220	4,550	6,030	6,824	8,527	9,491	10,565	11,281	11,938

This calibrated model was given to Borton-Lawson for modeling purposes. In order to be confident in the results of the model results for the synthetic 1-, 2-, 5-, 10-, 25-, 50-, and 100-year storms, a Log Person Type III analysis of gage data was also performed by Borton-Lawson using the PeakFQ program. The period of record for many of the gages was short, therefore prediction of the higher frequency (1-, 2-, 5-year) storms is more accurate than the prediction for the lower frequency (25-, 50-, 100-year) storms would be. Therefore regression methods (FFA) were also performed to obtain values for the larger, less frequent storms for calibration. These results were also compared against the same results performed by PWD.

Initial "larger storm" runs (25-, 50-, 100-year storms) of the model calibrated against the actual "smaller" storms showed an over prediction against the Log Pearson Type III analysis of gage data and regression results. Therefore the model was further refined to better match the peak flows from the other methods.

FEMA Flood Insurance Studies were also referenced in areas where detailed floodplain information was available. There are several potential calibration parameters within SWMM 5.0 that pertain to both the subcatchments and conduits. In the case of subcatchments, infiltration parameters, groundwater flows, Manning's n values, and storage properties can be adjusted to better fit the model results. Links such as streams and pipe networks can be calibrated by changing the roughness coefficient and loss coefficients. These numbers could be revised with confidence, while remaining within an acceptable range of values, for similar soil and sloped subareas, to arrive at flow values from the gage data.

Design Storm Calibration Results

In order to calibrate to develop design event flood flows, the 10-, 50-, and 100-year design storms were analyzed to compare SWMM 5.0 generated flow to flows developed by the regression models as well as in the available FEMA Flood Insurance Studies. Table IV-3 compares the calibrated SWMM 5.0 model to flood flow values determined by FEMA at several locations throughout the watershed. It should be noted that regression methods oftentimes do not account for localized variables such as soils and topography. Therefore, on a subwatershed basis, the results may vary.

Results of these analyses are included in Table IV-3.

Table IV-3
Comparison of the calibrated SWMM model with other methods for the 10, 50-, and 100-year storm events (cfs)

10 year storm Methods Comparison

DA SM	Gage XX		SWMM Node	PWD Log Pearson Type III	BLE Log Pearson Type III*	BLE Regression (NFF)	BLE Regression (NFF- Urban)	FEMA FIS	Avg.**	Calibrated SWMM Value
5.25	83	MS30	MS30	2,737	2918	2240	-	-	2632	2988
1.15	84	H8	H8	789	808	688	-	-	762	731
1.17	85	J10	J10	339	358	697	-	-	465	472
16.7	86	MS74	MS76	3,976	4073	5500	8030	4,800	6595	5017
30.4	87	TF-14039	NonMS122	9,506	10570	8760	-	8,800	9409	9228
33.8	89	TF-00200	NonDel	9,491	9668	9520	-	8,800	9370	8826

* - Using PEAKFQ
** For comparative purposes only

50 year storm Methods Comparison

DA SM	Gage XX	Conduit	SWMM SubCatch	PWD Log Pearson Type III	BLE Log Pearson Type III*	BLE Regression (NFF- Rural)	BLE Regression (NFF- Urban)	FEMA FIS	Avg.**	Calibrated SWMM Value
5.25	83	MS30	MS30	3,682	4920	3340	-	-	3981	4562
1.15	84	H8	H8	930	1041	1080	-	-	1017	1134
1.17	85	J10	J10	376	463	1100	-	-	646	721
16.7	86	MS74	MS76	4,694	5670	7870	11400	8200	9458	8068
30.4	87	TF-14039	NonMS122	11,132	14560	12300	-	14500	13123	12384
33.8	89	TF-00200	NonDel	11,281	12290	13300	-	14500	12843	12400

* - Using PEAKFQ
** For comparative purposes only

100 year storm Methods Comparison

DA SM	Gage XX		SWMM Node	PWD Log Pearson Type III	BLE Log Pearson Type III*	BLE Regression (NFF)	BLE Regression (NFF- Urban)	FEMA FIS	Avg.**	Calibrated SWMM Value
5.25	83	MS30	MS30	4,036	5977	3880	-	-	4631	5389
1.15	84	H8	H8	981	1144	1280	-	-	1135	1329
1.17	85	J10	J10	387	509	1300	-	-	732	837
16.7	86	MS74	MS76	4,896	6378	9000	13400	10,000	10919	9953
30.4	87	TF-14039	NonMS122	11,648	16330	13900	-	17,500	14844	14224
33.8	89	TF-00200	NonDel	11,938	13420	15000	-	17,500	14465	14465

* - Using PEAKFQ
** For comparative purposes only

Once the SWMM model was calibrated, all storm frequencies were run to obtain the 1-, 2-, 5-, 10-, 25-, 50-, and 100-year hydrographs and peak flow at each subcatchment, node and conduit based upon the timing of the tributaries and application of the management districts.

SECTION V

STANDARDS AND CRITERIA FOR STORMWATER CONTROL

A. Watershed Level Control Philosophy

An increase in development, and in turn an increase in impervious surfaces, results not only in an increase in runoff peaks but also in runoff volume. The primary difference between on-site runoff control philosophy and the watershed level philosophy is the manner in which runoff volume is managed. Conventional on-site control philosophy has as its goal the control of runoff peaks from the site. There are numerous volume controls that can be implemented on-site such as infiltration basins, porous pavement, etc. The proposed watershed level runoff control philosophy seeks to manage the increase in runoff volumes such that the peak rates of runoff throughout the watershed are not increased. The basic goal is therefore the same for both on-site and watershed level philosophies.

B. National Pollutant Discharge Elimination System (NPDES), Phase II Requirement

Federal regulations approved in October 1999 required operators of small municipal separate storm sewer systems (MS4s) to obtain NPDES Phase II permits from DEP by March 2003. This program affects all municipalities in "urbanized areas" of the state. This definition applies to all Tookany/Tacony-Frankford Watershed municipalities as listed in Section III, Table III-1. Therefore, all municipalities within the Tookany/Tacony-Frankford Watershed are subject to the NPDES Phase II requirements mandated by the Federal Clean Water Act.

Municipalities required to implement the MS4 program must address the following six minimum control measures (MCM's):

- Public Education and Outreach
- Public Involvement/Participation
- Illicit Discharge Detection and Elimination
- Construction Site Stormwater Runoff Control
- Post-Construction Stormwater Management in New Development & Redevelopment
- Pollution Prevention/Good Housekeeping for Municipal Operations

At a minimum, municipal entities regulated under MS4 must:

- Specify BMPs and implement them to the "maximum extent practicable"
- Identify measurable goals for control measures
- Develop an implementation schedule of activities or frequency of activities, and
- Define the entity responsible for implementation

The affected municipalities must, if they already do not have one in place, develop a stormwater management program. If a Municipality has an established stormwater management program, and is subject to the provisions of the Phase II Rule, then provisions of the rule must be implemented to satisfy the federal requirements. Applicable information concerning some of the specifics of this permitting program can be found in Appendix 2 of this plan.

Adoption of the Tookany/Tacony-Frankford Watershed Stormwater Management Plan and Model Ordinance provisions will satisfy the four basic requirements noted above and, at a minimum, one of the six required elements of the NPDES II program, specifically, post-construction stormwater management in new development and redevelopment.

The NPDES program has no exemption criteria; thus, all projects within regulated municipalities will be required to comply with the additional water quality and quantity measures of the regulations. The exemption criterion of the Model Ordinance is found in Section V.J. of this Plan, and Table 105.1 and Section 106 of the Model Ordinance.

C. Standards and Criteria – Five Phased Approach

The goal of Act 167 and this stormwater management plan is to encourage planning and management of stormwater runoff that is consistent with sound water and land use practices. In addition, the Act authorized a comprehensive stormwater management program designated to preserve and restore flood carrying capacities of streams, preserve to the maximum extent practical natural stormwater runoff regimes and the natural course, current and cross sections of streams, and to protect and conserve groundwaters and groundwater recharge areas. Maintaining the existing hydrologic regime for newly developing areas in the watershed and restoring the previously functioning hydrologic regime in redeveloping areas of the watershed is the best means to accomplish this goal. The technical standards and criteria developed as a part of this task will be watershed-wide in their interpretation and/or application. To strive towards achieving this goal, and to address stream bank erosion, flooding, water quality, groundwater recharge, and stormwater management measures on development sites should consider the following five (5) objectives noted in Figure V-1:

- Maintain groundwater recharge
- Maintain or improve water quality
- Reduce channel erosion
- Manage overbank flood events
- Manage extreme flood events

Recommended standards and criteria accommodate various types of land development activities. The standards and criteria provide management practices for the implementation of stormwater control measures.

The standards and criteria also address the following:

- Identification of all areas within the watershed where different criteria apply

- Recommended Stormwater Management Districts to manage accelerated runoff from the subareas identified in item A

- Recommended design flood frequencies and computational methodologies for stormwater management measures

- A list of recommended alternate stormwater collection and control measures

- Specifications for construction and maintenance of stormwater systems

- Safety requirements for stormwater systems during and after construction

1. Groundwater Recharge

Recharging rainfall into the ground replenishes the groundwater that provides base flow to streams, (a process that keeps streams flowing during the drier summer months), and maintains groundwater for drinking water purposes. As development occurs and the impervious area increases, less rainfall reaches the groundwater systems resulting in lower base flows and smaller groundwater supplies.

Although detention basins can reduce the proposed conditions peak rate of flow to the existing conditions rate, the increased volume of runoff still gets passed downstream unless special provisions are designed into the basin to recharge this increase in runoff volume.

Thus in highly developed watersheds, it is not uncommon to see dry streams along with severely depleted groundwater drinking supplies during periods of drought. Stormwater management measures such as porous pavement with underground infiltration beds and infiltration/recharge structures or Best Management Practices (BMPs) can be designed to promote groundwater recharge. These measures are encouraged, particularly in hydrologic soil groups A and B and should be utilized wherever feasible.

It is realized, however, that due to certain soils and topographic conditions, recharge may not be feasible on every site. It will be up to the design professional, therefore, to show that this cannot be physically accomplished. If a site investigation demonstrates that a particular site is unsuitable for infiltration, the Design Professional shall be responsible for providing written documentation that is supported by field tests showing that the required volume cannot physically be infiltrated as specified in the ordinance. However, if groundwater recharge can be physically accomplished, then the volume of runoff to be infiltrated shall be determined from the equations set forth in the Model Ordinance.

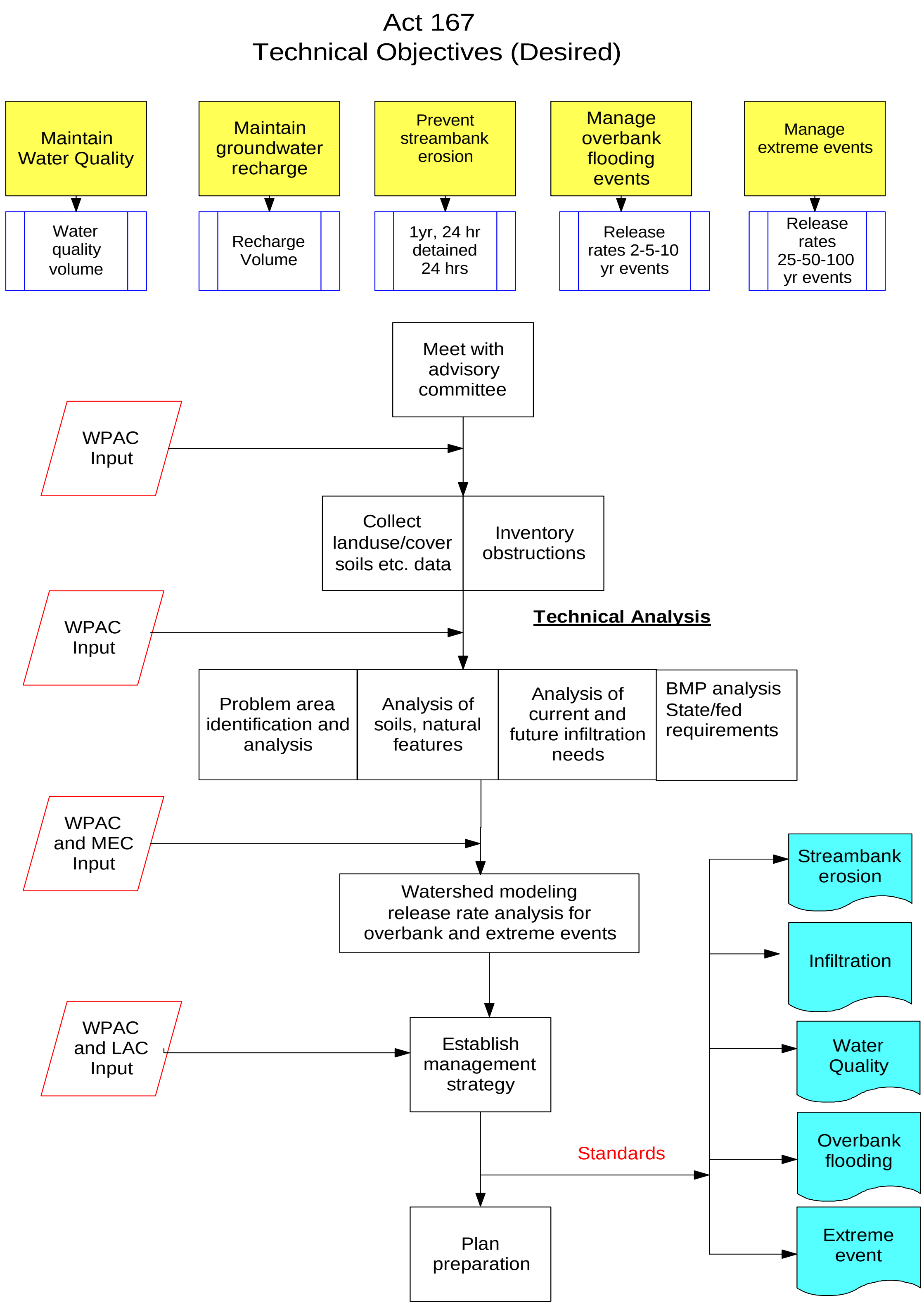

FIGURE V-1
Process Utilized Analyzing Five Comprehensive Management Objectives

Size of the Infiltration Facility

The size of the infiltration facility shall be based upon the following volume criteria:

Montgomery County Portion of the Watershed:

a. In order to preserve or restore a more natural water balance on new development and redevelopment sites, the recharge volume shall be infiltrated on site. The infiltration volume shall be equal to one (1.0) inch of rainfall (I) over all **proposed impervious surfaces**.

The recharge volume (Re_v) required would, therefore, be computed as:

$$Re_v = I * \text{impervious area (square feet)} \div 12 \text{ (inches)} = \text{cubic feet (cf)}$$

An asterisk (*) in equations denotes multiplication.

Philadelphia County Portion of the Watershed:

a. In order to preserve or restore a more natural water balance on new development and redevelopment sites, the recharge volume shall be infiltrated on site. The infiltration volume shall be equal to one (1.0) inch of rainfall (I) over all **DCIA within the limits of Earth Disturbance**.

$$Re_v = I * \text{impervious area (square feet)} \div 12 \text{ (inches)} = \text{cubic feet (cf)}$$

An asterisk (*) in equations denotes multiplication.

Soils

A detailed soils evaluation of the project site shall be required to determine the suitability of infiltration facilities. The evaluation shall be performed by a qualified design professional, and at a minimum, address soil permeability, depth to bedrock and subgrade stability. The general process for designing the infiltration BMP shall be:

a. Analyze hydrologic soil groups as well as natural and man-made features within the site to determine general areas of suitability for infiltration practices. In areas where development on fill material is under consideration, conduct geotechnical investigations of sub-grade stability; infiltration is not permitted to be ruled out without conducting these tests.

b. Provide field tests such as double ring infiltrometer or hydraulic conductivity tests (at the level of the proposed infiltration surface) to determine the appropriate hydraulic conductivity rate. Percolation tests are not recommended for design purposes.

c. Design the infiltration structure for the required retention (Re_v) volume based on field determined capacity at the level of the proposed infiltration surface.

d. If on-lot infiltration structures are proposed by the Applicant's design professional, it must be demonstrated to the Municipality that the soils are conducive to infiltrate on the lots identified.

Minimum Requirements for all Infiltration BMPs

Infiltration BMPs shall meet the following minimum requirements:

a. Infiltration BMPs intended to receive runoff from developed areas shall be selected based on suitability of soils and site conditions. A detailed soils evaluation of the project site shall be required where practicable to determine the suitability of recharge facilities. The evaluation shall be performed by a qualified design professional, and at a minimum, address soil permeability, depth to bedrock and subgrade stability.

b. Infiltration BMPs shall be constructed on soils that have a minimum depth of 24 inches between the bottom of the facility and the seasonal high water table and/or bedrock (limiting zones)

c. Infiltration BMPs shall be constructed on soils that have an infiltration rate sufficient to accept the additional stormwater load and drain completely as determined by field tests conducted by the Owner's professional designer.

d. The Infiltration BMP shall be capable of completely infiltrating the recharge volume within 3 days (72 hours).

e. Pretreatment shall be provided prior to infiltration.

Designing the Infiltration BMP

The general process for designing the infiltration BMP shall be:

a. Analyze hydrologic soil groups as well as natural and man-made features within the watershed to determine general areas of suitability for infiltration practices.

b. Provide double ring infiltrometer or hydraulic conductivity field tests at the level of the proposed recharge facility to determine the appropriate hydraulic conductivity rate.

c. Design the infiltration structure for the required storm volume based on field determined capacity at the level of the proposed infiltration surface.

d. If on-lot infiltration structures are proposed by the Applicant's design professional, it must be demonstrated to the Municipality that the soils are conducive to infiltrate on the lots identified.

In areas underlain by Karst and/or carbonate geology such as limestone, the viability and specific design standards of an infiltration BMP must be determined on a site-specific basis to avoid groundwater contamination and formation and/or expansion of sinkholes and other potentially dangerous conditions The qualified design professional shall evaluate the possibility of groundwater contamination from the proposed infiltration/recharge facility and perform a detailed hydrogeologic investigation if required by the Municipality. It is extremely important that strict erosion and sedimentation control measures be applied surrounding infiltration structures during installation to prevent the infiltrative surfaces from becoming clogged. Regardless, all waters of the Commonwealth shall be subject to the DEP's Chapter 93 Antidegradation Regulations.

Stormwater Hotspots

If a proposed site is designated as a hotspot, as defined in Table V-1, it has important implications for how stormwater is managed. First and foremost, untreated stormwater runoff from hotspots shall not be allowed to recharge into groundwater where it may contaminate water supplies. Therefore, the Re_v requirement shall NOT be applied to development sites that fit into the hotspot category (the entire WQ_v must still be treated). Second, a greater level of stormwater treatment shall be considered at hotspot sites to prevent pollutant washoff after construction. EPA's NPDES stormwater program requires some industrial sites to prepare and implement a stormwater pollution prevention plan.

While large highways (average daily traffic volume (ADT) greater than 30,000) are not designated as a stormwater hotspot, it is important to ensure that highway stormwater management plans adequately protect groundwater.

- Extreme caution shall be exercised through application of innovative design techniques to pretreat stormwater with several layers of best management practices in order to filter out contaminants before stormwater enters a proposed infiltration facility located in Source Water Protection Areas as defined by the local Municipality or Water Authority.

- Infiltration facilities shall be used in conjunction with other innovative or traditional BMPs, stormwater control facilities, and nonstructural stormwater management alternatives.

- Extreme caution shall be exercised where salt or chloride (municipal salt storage) would be a pollutant since soils do little to filter this pollutant and it may contaminate the groundwater. In these areas it is important to implement good housekeeping procedures to clean up spills immediately after they occur, store the materials out of the weather, monitor the inventory and only store the materials needed. The qualified design professional shall evaluate the possibility of groundwater contamination from the proposed infiltration facility and perform a hydrogeologic justification study if necessary.

- An impermeable liner will be required in detention basins where the possibility of groundwater contamination exists. A detailed hydrogeologic investigation may be required by the Municipality.

- The Municipality shall require the Applicant to provide safeguards against groundwater contamination for uses which may cause groundwater contamination, should there be a mishap or spill.

TABLE V-1
Classification of Stormwater Hotspots

• Vehicle salvage yards and recycling facilities	• Outdoor liquid container storage
• Vehicle fueling stations	• Outdoor loading/unloading facilities
• Vehicle service and maintenance facilities	• Public works storage areas
• Vehicle and equipment cleaning facilities	• Facilities that generate or store hazardous materials
• Fleet storage areas (bus, truck, etc.)	• Commercial container nursery
• Industrial sites (based on SIC codes outlined in the SPDES)	• Other land uses and activities as designated by an appropriate review authority
• Marinas (service and maintenance)	

The following land uses and activities are not normally considered hotspots:

- Residential streets and rural highways
- Residential development
- Institutional development
- Office developments
- Non-industrial rooftops
- Pervious areas, except golf courses and nurseries (which may need an Integrated Pest Management (IPM) Plan)

2. Water Quality

Pollutants accumulate on impervious surfaces between rainfall events or during dry weather. Pollutant concentrations in runoff from developed land, therefore, tend to be greatest at the beginning of the storm event, or during the first one half (1/2) inch to one (1.0) inch of runoff, a phenomenon commonly known as the first flush. It has also been found that approximately sixty-five percent of the rainfall events in Pennsylvania are one inch of rainfall or less, storms that essentially simulate this “first flush”. The majority of the Nonpoint Source Pollutants, therefore, are being washed into streams during this first flush. Capturing this first flush and smaller storms will, depending on the BMP design, allow the stormwater to be detained and will allow pollutants to settle out, allowing biological breakdown or uptake of these pollutants.

a. *Water Quality Standards*

The applicant shall comply with the following water quality requirements.

No regulated earth disturbance activities within the Municipality shall commence until approval by the Municipality of a plan which demonstrates compliance with State Water Quality Requirements post-construction is complete.

The BMPs shall be designed, implemented and maintained to meet State Water Quality Requirements, and any other more stringent requirements as determined by the Municipality.

To control post-construction stormwater impacts from regulated earth disturbance activities, State Water Quality Requirements can be met by BMPs, including site design, which provide for replication of pre-construction stormwater infiltration and runoff conditions, so that post-construction stormwater discharges do not degrade the physical, chemical or biological characteristics of the receiving waters. As described in the DEP Comprehensive Stormwater Management Policy (#392-0300-002, September 28, 2002), this may be achieved by the following:

1. <u>Infiltration</u>: replication of pre-construction stormwater infiltration conditions,
2. <u>Treatment</u>: use of water quality treatment BMPs to ensure filtering out of the chemical and physical pollutants from the stormwater runoff, and
3. <u>Streambank and Streambed Protection</u>: management of volume and rate of post-construction stormwater discharges to prevent physical degradation of receiving waters (e.g., from scouring).

To achieve the water quality goal, the following criterion is established:

Developed areas will provide adequate storage and treatment facilities necessary to capture and treat stormwater runoff specifically for water quality purposes. The Recharge Volume computed when calculating the groundwater recharge/infiltration volume may be incorporated as a component of the Water Quality Volume (WQ_v). If the required Recharge Volume is less than the required Water Quality Volume, only that portion of the Water Quality Volume exceeding the Recharge Volume may be treated by methods other than recharge/infiltration BMPs.

This volume requirement can be accomplished by the permanent volume of a wet basin or the detained volume from other BMPs. Where appropriate, wet basins shall be utilized for water quality control and shall follow the guidelines of the BMP manuals referenced in Ordinance Appendix F.

Release of water can begin at the start of the storm (i.e., the invert of the water quality orifice is at the invert of the facility). The design of the facility shall provide for protection from clogging and unwanted sedimentation.

Montgomery County Portion of the Watershed:

The required Water Quality Volume (WQ_v) is the storage capacity needed to capture and to treat a portion of stormwater runoff from the developed areas of the site produced from 1 inch of rainfall. The following calculation formula is to be used to determine the water quality storage volume, (WQ_v), in acre-feet of storage for the Tookany/Tacony-Frankford Watershed in Montgomery County:

Eqn. V-2

$$WQ_v=(P / 12)*(I)$$

WQ_v = Water Quality Volume (cubic-feet)
P = 1 inch
I = Proposed Impervious Surfaces (square feet)

Philadelphia County Portion of the Watershed:

The following calculation formula is to be used to determine the water quality storage volume (WQ_v) in acre-feet of storage for the Tookany/Tacony-Frankford Watershed in Philadelphia County:

Eqn. V-3

$$WQ_v = (P / 12)*(I)$$

WQ_v = Water quality volume (cubic feet)
P = 1 inch
I = DCIA within the limits of earth disturbance (square feet)

To accomplish the above, the Applicant shall submit original and innovative designs to the Municipal Engineer for review and approval. Such designs may achieve the water quality objectives through a combination of different BMPs.

Evidence of any necessary permit(s) for regulated earth disturbance activities from the appropriate DEP regional office must be provided to the Municipality. The issuance of an NPDES Construction Permit (or permit coverage under the statewide General Permit (PAG-2) satisfies the requirements of Ordinance Section 406.A.

The WQ_v shall be utilized to size water quality BMPs. Design of these BMPs shall be in accordance with design specifications outlined in the *Pennsylvania Stormwater Best Management Practices Manual* (Document Number 363-0300-002, December 30, 2006) or other applicable manuals. The following factors shall be considered when evaluating the suitability of BMPs used to control water quality at a given development site:

1. Total contributing drainage area.
2. Permeability and infiltration rate of the site soils.
3. Slope and depth to bedrock.
4. Seasonal high water table.
5. Proximity to building foundations and wellheads.
6. Erodibility of soils.
7. Land availability and configuration of the topography.
8. Peak discharge and required volume control.
9. Stream bank erosion.
10. Efficiency of the BMPs to mitigate potential water quality problems.
11. The volume of runoff that will be effectively treated.
12. The nature of the pollutant being removed.
13. Maintenance requirements.
14. Creation/protection of aquatic and wildlife habitat.
15. Recreational value.
16. Enhancement of aesthetic and property value.

b. *Buffers*

Maintaining or restoring natural buffers has many stormwater related benefits (see Table V-2) including aiding in groundwater recharge, improving water quality of runoff and protecting streambanks from erosion. Therefore, if a perennial or intermittent stream passes through the site, the applicant shall create a stream buffer extending a minimum of fifty (50) feet to either side of the top-of-bank of the channel. The buffer area shall be maintained with and encouraged to use appropriate native vegetation (Refer to Appendix B of the Pennsylvania *Stormwater Best Management Practices Manual* for plant lists). If the applicable rear or side yard setback is less than fifty (50) feet, the buffer width may be reduced to twenty-five (25) percent of the setback to a minimum of ten (10) feet. If an existing buffer is legally prescribed (i.e. deed, covenant, easement, etc.) and it exceeds the requirements of this Ordinance, the existing buffer shall be maintained. [Note: The Municipality may select a smaller buffer width (above) if desired, but the selected buffer may not be less than ten (10) feet]. This does not include lakes or wetlands.

TABLE V-2
Twenty Benefits Of Buffers

1. Reduce watershed impervious area.
2. Maintain distance from impervious cover.
3. Help prevents small drainage problems and complaints.
4. Stream "right-of-way" allows for lateral movement.
5. Land area may provide effective flood water storage.
6. Protection from streambank erosion.
7. Increase property values.
8. Increased pollutant removal.
9. Foundation for present or future greenways.
10. Provide food and habitat for wildlife.
11. Mitigate stream warming.
12. Protection of associated wetlands.
13. Prevent disturbance to steep slopes.
14. Preserve important terrestrial habitat.
15. Corridors for conservation.
16. Essential habitat for amphibians.
17. Fewer barriers to fish migration.
18. Discourage excessive storm drain enclosures/channel hardening.
19. Provide space for stormwater ponds.
20. Allowance for future restoration.

3. Stream Bank Erosion

As storm flows increase, velocities in the stream also increase thus exacerbating stream bank erosion problems. The greatest stream velocities and therefore, the greatest amount of streambank erosion typically occurs during near- bank full and bank full flow events. In most watersheds bank full flow has been found to equate to approximately the 1.5-year storm. Therefore, controls to keep stream flows to below approximately the 1.5-year storm flow, or near the 1-year storm flow, would aide in minimizing stream bank erosion. Furthermore, allowing this volume to discharge from the control facility over a minimum 24- hours would reduce discharge velocities during near bank full and bank full flows. Streambank erosion criteria based upon the above discussion were therefore incorporated into the standards and criteria and Model Ordinance (Section 407). This same management criterion also improves the water quality from stormwater runoff. Therefore applying the groundwater recharge in Section V.1 above and the water quality criteria in Section V.2 will also help the stream bank erosion problems.

Montgomery County Portion of the Watershed:

In addition to the control of water quality volume (in order to minimize the impact of stormwater runoff on downstream streambank erosion), the primary requirement is to design a BMP to detain the proposed conditions 2-year, 24-hour design storm to the existing conditions 1-year flow using the SCS Type II distribution. Additionally, provisions shall be made (such as adding a small orifice at the bottom of the outlet structure) so that the proposed conditions 1-year storm takes a minimum of 24 hours to drain from the facility from a point where the maximum volume of water from the 1-year storm is captured (i.e., the maximum water surface elevation is achieved in the facility). Release of water can begin at the start of the storm (i.e., the invert of the water quality orifice is at the invert of the facility).

The minimum orifice size in the outlet structure to the BMP shall be three (3) inches in diameter where possible, and a trash rack shall be installed to prevent clogging. On sites with small contributing drainage areas to this BMP that do not provide enough runoff volume to allow a 24 hour attenuation with the 3 inch orifice, the calculations shall be submitted showing this condition. Orifice sizes less than 3 inches can be utilized provided that the design will prevent clogging of the intake.

In “Conditional Direct Discharge Districts” (District C) only - (See Section 408), the objective is not to attenuate the storms greater than the 2-year recurrence interval. This can be accomplished by configuring the outlet structure not to control the larger storms, or by a bypass channel that diverts only the 2-year stormwater runoff into the basin or conversely, diverts flows in excess of the 2-year storm away from the basin.

<u>Philadelphia County Portion of the Watershed:</u>

Applicants shall adhere to the following Stream Bank Erosion/Channel Protection Requirements:

A. To meet the requirement, Stormwater Management Practices shall retain or detain the runoff from all Direct Connected Impervious Area (DCIA) within the limits of Earth Disturbance from a 1-year, 24-hour Natural Resources Conservation Service (NRCS) Type II design storm in the proposed site condition such that the runoff takes a minimum of 24 hours and a maximum of 72 hours to drain from the facility.

B. Redevelopment sites with less than one (1) acre of Earth Disturbance or redevelopment sites that demonstrate a 20% reduction in DCIA from predevelopment conditions are exempt from this requirement.

C. The infiltration and water quality volumes may be incorporated into the channel protection portion of the design provided the design meets all requirements concurrently.

4. <u>Overbank Events</u>

Flooding and stormwater problems are caused by excess stormwater quantity. Storm events which result in water exceeding the natural bank of a stream are termed as “overbank” events and are typically defined as an expected frequency of occurrence. Based upon the realization that most bankfull events occur at approximately the 1.5 to 2-year event, events greater than the 2-year storm result in overbank flooding. These “overbank” events typically range from the 2-year to 10-year events. Management of these “overbank” events requires a detailed knowledge of the interrelationship between all contributing areas of a watershed. Analysis of peak runoff, timing of runoff, and duration of runoff from the various areas of a watershed is critical for establishing these criteria. The result of this analysis is the Management District Concept, discussed in Section V.D.

5. <u>Extreme Events</u>

"Extreme" flooding events are separated from "overbank" flooding events by the severity of damage which is incurred. Typically, events such as the 25-, 50- and 100-year events are labeled as "extreme" events.

While some overbank and extreme flooding events are inevitable, the goal is to control the frequency of occurrence for such events such that the level of overbank flooding is the same over time so that damages to existing conditions infrastructure are not exacerbated by upstream development. Therefore, different management criteria are given for these "overbank" and "extreme" event floods.

It must be recognized that there is a difference between the meanings of storm and flood when considering 5-year storms and 5-year floods. Although a certain quantity of rain may classify a rainfall event as a 5-year storm, this does not mean that same amount of rain will result in a 5-year flood. For example, if the event would occur during a drought, a 5-year storm may result in only a 2-year flood because of the capacity of the soil and ground to absorb water. However, if the same event occurred on top of a snow melt, then a 10-year flood may occur because of the extra water volume present in the melting snow.

Similarly, the term "5-year flood" does not mean that this event will occur once every five years. Nor does it mean that once a 5-year event occurs, it will be another five years until that event may occur again. A 5-year event refers to the probability that the event will occur in any given year, which is the inverse of the frequency event. Therefore, a 5-year event has a 20% probability of occurring in any given year.

D. Management District Concept (For Overbank and Extreme Events)

Many Act 167 plans were based upon the release rate concept where each subarea of the watershed was assigned a release rate (as a percent value). For any development scenario, the post-development runoff rate must meet a percent (release rate) of the predevelopment runoff rate. These release rates were developed by analyzing the individual subarea contribution to the overall watershed runoff. This plan equates release rates to equivalent design storms and places the subareas in separate management districts. The management district concept uses the same idea as the release rate concept; however, it displays the final criteria by grouping subareas into "management districts" rather than assigning a release rate to each individual subarea. Each management district contains specific criteria which are to be met in order to address "overbank" and "extreme" design events.

Figure V-3 shows a simplified version of how various subarea hydrographs would contribute to the peak flow at a particular point of interest (POI). As can be seen from Figure V-2, hydrograph "A" peaks after the point of interest hydrograph. In this case, standard detention or reducing post development flows to existing conditions rates would attenuate the flows past A's peak, which would not influence the peak of the POI. A development site in subarea B would contribute flow at a time between the start and end of that subarea's hydrograph. Standard detention would attenuate flow to a point where it is increasing flow at the POI; therefore, stormwater management controls would need to reduce the outflow to a higher frequency (smaller) storm. Flows in subarea C enter and exit the stream system before the peak flow occurred at the POI; therefore, if possible, it would be advantageous not to detain these flows. Subareas A, B, and C on the sample would fall into districts A, B, and C as shown on Appendix A of the Model Ordinance. Development of the design storm criteria was based upon downstream obstruction capacities and problem areas identified in the study, as well as the overall goal of maintaining the existing condition's flow at all points in the watershed in the future.

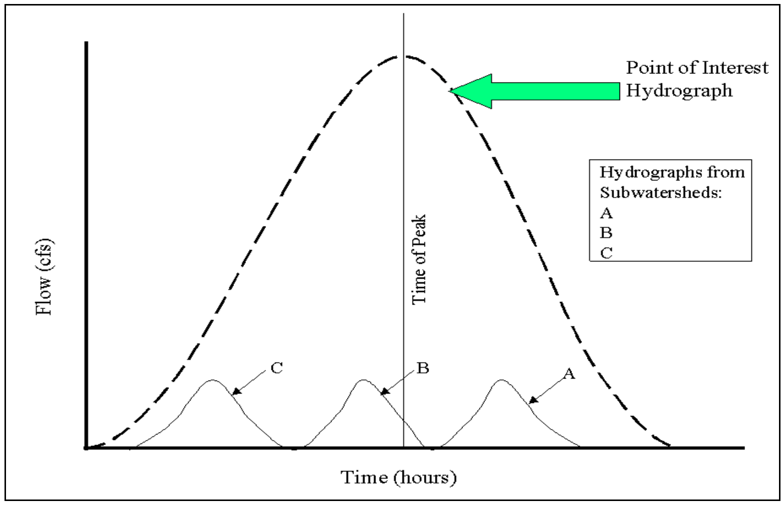

FIGURE V-3

Relative Timing of Subwatershed Hydrographs

A major goal was to determine where in the watershed stormwater detention was appropriate for new development and, just as importantly, where detention was not appropriate. It was also important to determine to what extent stormwater detention would be required in individual subareas as described above. Table V-3 shows how the peak rate of post-development runoff would have to be reduced to the peak rate of predevelopment runoff for the design storms specified.

A major goal of the Tookany/Tacony-Frankford Watershed Act 167 Plan was to determine where in the watershed stormwater detention was appropriate for new development and, just as importantly, where detention was not appropriate. It was also important to determine to what extent stormwater detention would be required in individual subareas as described above. On the table below, the peak rate of proposed conditions runoff would have to be reduced to the peak rate of existing conditions runoff for the design storms specified below. Individual subareas would fall into one of three districts:

TABLE V-3
Stormwater Management Districts In The Tookany/Tacony-Frankford Watershed

District	Proposed Condition Design Storm	(reduce to)	Existing Condition Design Storm
A	2-year		1-year
	5-year		5-year
	10-year		10-year
	25-year		25-year
	50-year		50-year
	100-year		100-year
B	2-year		1-year
	5-year		2-year
	10-year		5-year
	25-year		10-year
	50-year		25-year
	100-year		100-year
C *	Conditional Direct Discharge District		

** In District C, development sites which can discharge directly to the Tookany/Tacony-Frankford main channel or major tributaries or indirectly to the main channel through an existing stormwater drainage system (i.e., storm sewer or tributary) may do so without control of proposed conditions peak rate of runoff greater than the 5-year storm. Sites in District C will still have to comply with the groundwater recharge criteria, the water quality criteria, and streambank erosion criteria. If the proposed conditions runoff is intended to be conveyed by an existing stormwater drainage system to the main channel, assurance must be provided that such system has adequate capacity to convey the flows greater than the 2-year existing conditions peak flow or will be provided with improvements to furnish the required capacity. When adequate capacity in the downstream system does not exist and will not be provided through improvements, the proposed conditions peak rate of runoff must be controlled to the existing conditions peak rate as required in District A provisions (i.e., 10-year post-development flows to 10-year existing conditions flows) for the specified design storms.*

As in District C, development in those subareas designated on Appendix A- Stormwater Management District Map of the Model Ordinance must convey the generated stormwater runoff to a stream or watercourse in a safe manner. **The conveyance must manage the quantity, velocity and direction of resulting stormwater runoff in a manner that adequately protects health and property from possible injury pursuant to Act 167, does not overtax existing conditions drainage facilities and does not cause erosion or sedimentation.** Acceptable velocities shall be based upon criteria contained in the DEP *Erosion and Sediment Pollution Control Program Manual.* **The proposed conditions flow that is greater than existing conditions flow can only be released if it would not aggravate a significant obstruction or existing conditions problem area or overload existing conditions storm sewer networks.** If it would, proper stormwater management, obstruction replacement or standard detention would be required. Additionally, any flow from the 50-year storm not carried by downstream drainage facilities must be addressed and where necessary, additional controls must be installed to assure collection of this water by control facilities where required by the stormwater design.

When discharging greater than existing conditions peak flow rates, proper analysis of channel capacity downstream of a development site is essential to insure that the goal of not creating any new problem areas or aggravating existing conditions drainage problem areas is achieved. The analysis must include the assumption of complete build-out of the tributary areas to the channel being evaluated based upon the latest zoning revision after plan adoption. The analysis must also analyze the future conditions assuming that stormwater detention on development sites is not implemented. This is required to evaluate the impacts that proposed development conditions have on flows. In addition, stormwater control measures consistent with the Plan must be assumed in analyzing projected development upstream of the point of evaluation.

E. Redevelopment

This Plan did not want to create a disincentive to redevelop existing urbanized areas. The stormwater management criteria are based upon meeting the existing conditions flow for a specified design storm. Since existing conditions includes any impervious area existing at the site at the time of the proposed development, the criteria, by default, relaxes the stormwater quantity peak rate of flow by allowing them to match existing conditions for the design storm specified in the management district. However, to promote redevelopment to consider adding additional open space and properly managing stormwater runoff in the redevelopment design, in lieu of meeting the stormwater peak rate control criteria established in Section V.D, the applicant may choose to reduce the total impervious surface on the site by at least twenty percent (20%); based upon a comparison of existing impervious surface to proposed impervious surface as stated in Section 408.G of the Model Ordinance.

F. Process to Accomplish Standards and Criteria

Table V-4 provides a process to accomplish the required standards and criteria, on a priority basis, looking at means other than detention to promote recharge, improve water quality and prevent streambank erosion and to reduce proposed conditions peak flows to the required existing conditions rate.

TABLE V-4
Process to Achieve the Standards and Criteria
in Order of Required Consideration
(Ultimate Goal - Match Existing Conditions Hydrograph)

1. Maximize use of Nonstructural Stormwater Management Alternatives
   - Minimize disturbance of natural features
   - Minimize grading
   - Minimize impervious surfaces, consider pervious surfaces
   - Break up large impervious surfaces
2. Satisfy groundwater recharge (infiltration) objective
3. Satisfy water quality
4. Satisfy streambank erosion requirements
5. Apply BMPs near the source of the runoff
6. Satisfy the runoff peak attenuation objective considering all measures other than detention basins
7. After satisfying the above requirements, incorporate dual purpose detention measures, if necessary, to attenuate peaks. Dual purpose detention is recommended, e.g., recycling water, wetlands basins, water storage for fire flow, etc.

The sources in the Reference Section of this Plan should be consulted to aid the design engineer in BMP selection and design.

The required standards and criteria developed are summarized in Table V-5 while recommended standards and criteria can be found in Table V-6. The ultimate goal would be to match the predevelopment hydrograph, not just the predevelopment peak. Nonstructural stormwater management measures (also referred to as conservation design or low impact development, LID) should be evaluated to help achieve this goal. Conservation design focuses on preserving the areas most beneficial to environmental conservation, and developing on the areas most suitable to development. This typically includes development of an opportunity and constraints map. Conservation design measures are discussed in more detail in Section V-E. Section V of the *Pennsylvania Stormwater Best Management Practices Manual* should also be consulted to achieve these goals.

TABLE V-5
Required Criteria & Standards in the Tookany/Tacony-Frankford Watershed

Required Standard	Benefit
Stormwater Management A, B, and C Management Districts	No increase in runoff on a watershed wide basis, stormwater attenuation.
Recharge/Infiltration/Retention All development proposed should investigate the implementation of infiltration or retention structures for the stormwater control measures as opposed to surface detention (in all Hydrologic Soils Groups) and adhere to the recharge requirements of the Model Ordinance. This also pertains to the portions of the watershed that have storm sewers. Recharge structures installed prior to tapping into the storm sewers are recommended where soils and physical conditions permit. Impacts on subsurface mine pools and Karst areas should be evaluated before recommending this type of practice.	Groundwater/stream base flow recharge, flow attenuation.
Water Quality Provide adequate storage and treatment facilities necessary to capture and treat the Water Quality Volume (WQ_v).	Allows pollutants to settle thus providing improved water quality.
Calculations Methodology Parameters must be obtained from the Model Ordinance.	Calculations for consistent stormwater management.
Existing Storm Sewers or Culverts Discharge into existing sewer networks or culverts will be based on system capacity or design storm(s), whichever is more restrictive.	Preserve sewer/culvert capacity thereby reducing Operation and Maintenance and replacement costs.
Discharge of Accelerated Runoff Only excess accelerated stormwater runoff (after all criteria has been met) shall be safely discharged into existing drainage patterns and storm sewers without adversely affecting properties or causing channel scouring and erosion.	Safe conveyance, continued surface and groundwater quality, flow attenuation.
Inappropriate Outlets If outlet from stormwater conveyance systems from a development site to a stream, tributary, stabilized channel, or storm sewer is not possible, runoff shall be collected in a BMP and discharged at a nonerosive rate. Outlets discharging onto adjacent property owner(s)' properties must have adjacent property owner(s)' written permission.	Safe conveyance, continued surface and groundwater quality, flow attenuation.
District C Those subareas shown on the Appendix A map in the Model Ordinance as being in District C shall safely discharge runoff directly into an existing conveyance system with no detention or attenuation of greater than the 5-year storm.	Allows excess runoff to exit watershed system prior to peak while still meeting water quality and groundwater recharge goals.
Wetlands Refer wetland impacts to state agency for review.	Infiltration, surface and groundwater recharge, stream base flow, water quality, flow attenuation, detention.

Note: *See the Model Ordinance for more detailed standards and criteria.*

TABLE V-6
Recommended Criteria & Standards in the Tookany/Tacony-Frankford Watershed

Recommended Standard	**Benefit**
Erosion and Sediment Pollution Control Network with administrative and regulatory agencies to sequence and control earth disturbance sites to maintain and protect areas designated for recharge or leave areas of native vegetation intact.	Infiltration, structure integrity, surface water quality, safe conveyance, stream, culvert, and channel capacity.
Floodplains Those floodplains in which the floodplain stores floodwaters shall not be filled or covered with impervious surface so as to not reduce the storage capacity.	Natural stormwater detention/flood control downstream.
Roof Drains, Residential/Commercial Prevent all roof drains from discharging into storm sewers, roadside ditches, or channels. Discharge to lawn; recharge basin or storage facilities for re-use.	Promotes infiltration, flow attenuation, and increases runoff time of concentration, flow attenuation.
Pervious Surfaces The use of pervious materials will be encouraged for parking surfaces and sidewalks. Compaction of soils is discouraged and natural or undisturbed areas onsite are encouraged in order to keep open space pervious. Aquifer or groundwater recharge beds are encouraged.	Infiltration, groundwater recharge.
Structures Concentrate on locating facilities within areas conducive to recharge and accommodate recharge to meet management district requirements. No stormwater structures are allowed in floodplains that would reduce the storage volume.	Infiltration, groundwater recharge, stream base flow.
Steep Slopes Regulate activities in critical slope areas where management of stormwater by structure is inappropriate. Slopes should be vegetated with native vegetation.	Stream base flow, flow attenuation, conveyance integrity, surface water quality.
Stream Bank Protection Reduce 2-year post-development flow to 1-year predevelopment flow. Green Roof	Reduces the number of erosive storms thereby reducing stream bank erosion.
Construct rooftop gardens	Flow attenuation and small storm retention
Riparian Buffer Width that is recommended is 50 feet measured from the top of bank on both sides of the stream.	Water quality, flood drainage reduction, habitat enhancement erosion reduction.

Note: *See the Model Ordinance for more detailed standards and criteria.*

G. Alternative Runoff Control Techniques

Each developer must not allow the runoff from his site to exceed the applicable release rate applied to the subwatershed where the site is located. This runoff control can be obtained in a number of different ways. The following tables indicate an overview of general measures that can be applied to reduce or delay stormwater runoff as well as the advantages and disadvantages for several types of runoff control measures. It will be up to the developer or the developer's engineer to select the technique that is the most appropriate to the type of project and physical characteristics of the site.

In determining what measures or combination of measures to install, the following parameters should be considered:

- Soil characteristics (hydrologic soil group, etc.)
- Subsurface conditions (high water table, bedrock, etc.)
- Topography (steepness of slope, etc.)
- Existing drainage patterns
- Economics
- Advantages and disadvantages of each technique

Some runoff control techniques are "structural" stormwater management controls meaning that they are physical facilities for runoff abatement. Others are "non-structural" controls, referring to land use management techniques geared toward minimizing storm runoff impacts through control of the type and extent of new development throughout the study area. The Tookany/Tacony-Frankford Watershed Stormwater Management Plan is based on the assumption that new development of various types will occur throughout the study area (except as regulated by floodplain regulations) and that structural controls may be required to minimize the runoff implications of the new development.

1. Nonstructural Runoff Controls

Non-structural methods of controlling stormwater runoff quantity and quality, such as innovative site planning, impervious area and grading reduction, protection of natural depression areas, temporary ponding on site and other techniques are recommended. Non-structural BMPs are increasingly recognized as a critical feature of stormwater BMP plans, particularly with respect to site design. In most cases, non-structural BMPs shall be combined with structural BMPs to meet all stormwater requirements. The key benefit of non-structural BMPs is that they can reduce the generation of stormwater from the site thereby reducing the size and cost of structural BMPs. In addition, they can provide partial removal of many pollutants. The non-structural BMPs have been classified into broad categories including, but not limited to:

- Natural area conservation
- Limiting disturbed areas

- Conservation design

A more detailed discussion on nonstructural Stormwater BMPs can be found in Ordinance Appendix E.

Table V-7
Nonstructural Stormwater Best Management Practices

Nonstructural Stormwater Measure	Description
Natural Area Conservation	Conservation of natural areas such as forest, wetlands, or other sensitive areas in a protected easement thereby retaining their existing conditions hydrologic and water quality characteristics.
Disconnection of Rooftop Runoff	Rooftop runoff is disconnected and then directed over an undisturbed area where it may either infiltrate into the soil or filter over it. This is typically obtained by grading the site to promote overland flow or by providing bioretention on single-family residential lots.
Disconnection of Non-Rooftop Runoff	Disconnect surface impervious cover by directing it to undisturbed areas where it is either infiltrated or filtered though the soil
Stream Buffer	Stream buffer effectively treats stormwater runoff. Effective treatment constitutes capturing runoff from pervious and impervious areas adjacent to the buffer and treating the runoff through overland flow across an undisturbed grass or forested area.
Grass Channel (Open Section Roads)	Open grass channels are used to reduce the volume of runoff and pollutants during smaller storms.
Environmentally Sensitive Rural Development	Environmental site design techniques are applied to low density or rural residential development.

2. <u>Structural Runoff Controls:</u>

Structural controls for managing storm runoff can be categorized as either volume controls or rate controls. Volume controls are designed to prevent a certain amount of the total rainfall from becoming runoff by providing an opportunity for the rainfall to infiltrate into the ground. Greater opportunity for infiltration can be provided by minimizing the amount of impervious cover associated with development, by draining impervious areas over undisturbed areas or into specific infiltration devices, and by using grassed swales or channels to convey runoff in lieu of storm sewer systems. Rate controls are designed to regulate the peak discharge of runoff by providing temporary storage of runoff which otherwise would leave the site at an unacceptable peak value. Rate controls, much more so than volume controls, are adaptable to regional considerations for controlling much larger watershed areas than one development site.

a. *Innovative BMPs*: The use of traditional and innovative best management practices (BMPs) is encouraged to meet the recharge, water quality and quantity criteria established in this Plan. *The Pennsylvania Handbook of Best Management Practices for Developing Areas* prepared by the Pennsylvania Association of Conservation

Districts, Inc., (Spring, 1998), BMP Manuals referenced in Section VIII or the *Pennsylvania Stormwater Best Management Practices Manual*, should be used for design and maintenance of these practices/facilities.

b. *Temperature Sensitive BMPs*: Runoff from blacktop during hot summer months can provide a "slug" of warm water into the streams, which could affect trout. Therefore, for areas within defined Special Protection subwatersheds which include Exceptional Value (EV) and High Quality (HQ) waters, the temperature and quality of stormwater entering streams shall be maintained through the use of temperature sensitive BMPs and stormwater conveyance systems. Temperature sensitive BMPs are simply those BMPs which help reduce the temperature of the discharge of the BMP, typically by shading or by providing temporary underground storage. A list of some temperature sensitive BMPs and the source for further information on them can be found in Table V-8.

TABLE V-8
Temperature Sensitive BMPs

To minimize temperature increases caused by new development in watersheds Stormwater BMP designs should:
• Provide shading for pools and channels (particularly south side) • Maintain existing forested buffers • Bypass available base flow and/or springflow • Utilize underground storage where possible • Utilize recharge

c. *Quantity Control*: Proposed conditions development runoff from a site must not exceed the applicable existing conditions rate applied to the subwatershed where the site is located. This runoff control can be obtained in a number of different ways. The following tables indicate an overview of general measures that can be applied to reduce or delay stormwater runoff as well as the advantages and disadvantages for several types of runoff control measures. The applicant must select the technique that is the most appropriate to the type of project and physical characteristics of the site. Best Management Practices can be utilized to manage water quality, groundwater, recharge, streambank erosion and quantity (peak and volume). The runoff control(s) most applicable to a development site may vary widely depending upon site characteristics such as:

- Type of development proposed
- Soil characteristics (hydrologic soil group, etc.)
- Subsurface conditions (high water table, bedrock, etc.)
- Topography (steepness of slope, etc.)
- Existing drainage patterns
- Economics
- Advantages and disadvantages of each technique

- Applicable performance standard

The use of traditional and innovative Best Management Practices (BMPs) is encouraged to meet the recharge, water quality and quantity criteria established in this Plan. The *Pennsylvania Stormwater Best Management Practies Manual,* or the *Pennsylvania Handbook of Best Management Practices for Developing Areas* prepared by the Pennsylvania Association of Conservation Districts, Inc., Spring, 1998 should be referenced for design and maintenance of these practices/facilities.

Table V-9 provides possible on-site stormwater control methods while Table V-10 explains the advantages and limitations of various on-site stormwater control methods. Table V-11 explains the suitability of control measures in the Tookany/Tacony-Frankford Watershed.

TABLE V-9
Possible On-Site Stormwater Control Methods

Area	**Reducing Runoff**	**Delaying Runoff**
Large Flat Roof	1. Cistern storage 2. Rooftop gardens 3. Pool storage or fountain storage	1. Ponding on roof by constricted downspouts
Parking Lots	1. Porous pavement a. Gravel parking lots b. Porous or punctured asphalt 2. Concrete vaults and cisterns beneath parking lots in high value areas 3. Vegetated ponding areas round parking lots 4. Gravel trenches	1. Grassy strips on parking lots 2. Grassed waterways draining parking lot 3. Ponding and detention measures for impervious areas a. Rippled pavement b. Depressions c. Basins
Residential	1. Cisterns for individual homes or groups of homes. 2. Gravel driveways (porous). 3. Contoured landscape. 4. Groundwater recharge: a. Perforated pipe b. Gravel (sand) c. Trench d. Porous pipe e. Dry wells 5. Vegetated depressions.	1. Reservoir or detention basin 2. Planting a high delaying grass (high roughness) 3. Gravel driveways 4. Grassy gutters or channels 5. Increased length of travel of runoff by means of gutters, diversions, etc
General	1. Gravel alleys 2. Porous sidewalks 3. Mulched planters	1. Gravel alleys

Source: *Urban Hydrology for Small Watersheds. Technical Release No. 55.*

TABLE V-10
Advantages and Limitations of Various
On-Site Stormwater Control Methods

BIORETENTION FACILITY	
Advantages:	
1.	If designed properly, has shown ability to remove significant amounts of dissolved heavy metals, phosphorous, TSS, and fine sediments.
2.	Requires relatively little engineering design in comparison to other stormwater management facilities (e.g. sand filters).
3.	Provides groundwater recharge when the runoff is allowed to infiltrate into the subsurface.
4.	Enhances the appearance of parking lots and provides shade and wind breaks, absorbs noise, and improves an area's landscape.
5.	Maintenance on a bioretention facility is limited to the removal of leaves from the bioretention area each fall.
6.	The vegetation recommended for use in bioretention facilities is generally hardier than the species typically used in parking lot landscapes. This is a particular advantage in urban areas where plants often fare poorly due to poor soils and air pollution.
Limitations:	
1.	Low removal of nitrates.
2.	Not applicable on steep, unstable slopes or landslide areas (slopes greater than 20 percent).
3.	Requires relatively large areas.
4.	Not appropriate at locations where the water table is within 6 feet of the ground surface and where the surrounding soil stratum is unstable.
5.	Clogging may be a problem, particularly if the BMP receives runoff with high sediment loads.
CATCH BASIN INSERTS	
Advantages:	
1.	Provides moderate removal of larger particles and debris as pretreatment.
2.	Low installation costs.
3.	Units can be installed in existing traditional stormwater infrastructure.
4.	Ease of installation
5.	Requires no additional land area.
Limitations:	
1.	Vulnerable to accumulated sediments being resuspended at low flow rates.
2.	Severe clogging potential if exposed soil surfaces exist upstream.
3.	Maintenance and inspection of catch basin inserts may be required before and after each rainfall event, excessive cleaning, and maintenance.
4.	Available head to meet design criteria.
5.	Dissolved pollutants are not captured by filter media.
6.	Limited pollutant removal capabilities.
CISTERNS	
Advantages:	
1.	Low installation cost.
2.	Requires little space for installation.
3.	Reduces amount of stormwater runoff
4.	Conserves water usage.
Limitations:	
1.	Limited amount of stormwater runoff can be captured.
2.	Restricted to structure runoff.
3.	Aesthetically unpleasing.

TABLE V-10 (CONT))

CONSTRUCTED WETLANDS	
Advantages:	
1.	Artificial wetlands offer natural aesthetic qualities, wildlife habitat, erosion control, and pollutant removal.
2.	Artificial wetlands can offer good treatment following treatment by other BMPs, such as wet ponds, that rely upon settling of larger sediment particles (Urbonas, 1992). They are useful for large basins when used in conjunction with other BMPs.
3.	Wetlands that are permanently flooded are less sensitive to polluted water inflows because the ecosystem does not depend upon the polluted water inflow.
4.	Can provide uptake of soluble pollutants such as phosphorous, through plant uptake.
5.	Can be used as a regional facility.
Limitations:	
1.	Although the use of natural wetlands may be more cost effective than the use of an artificial wetland; environmental, permitting and legal issues may make it difficult to use natural wetlands for this purpose.
2.	Wetlands require a continuous base flow.
3.	If not properly maintained, wetlands can accumulate salts and scum which can be flushed out by large storm flows.
4.	Regular maintenance, including plant harvesting, is required to provide nutrient removal.
5.	Frequent sediment removal is required to maintain the proper functioning of the wetland.
6.	A greater amount of space is required for a wetland system than is required for an extended/dry detention basin treating the same amount of area.
7.	Although artificial wetlands are designed to act as nutrient sinks, on occasion, the wetland may periodically become a nutrient source.
8.	Wetlands that are not permanently flooded are more likely to be affected by drastic changes in inflow of polluted water.
9.	Cannot be used on steep unstable slopes or densely populated areas.
10.	Threat of mosquitoes.
11.	Hydraulic capacity may be reduced with plant overgrowth.
DRY WELLS	
Advantages:	
1.	Recommended in Residential Areas
2.	Requires minimal space to install.
3.	Low installation costs.
4.	Reduces amount of runoff.
5.	Provides groundwater recharge.
6.	Can serve small impervious areas like rooftops.
7.	Helps to disconnect impervious surfaces.
Limitations:	
1.	Offers little pretreatment which may cause clogging.
2.	Dry wells should not be installed where hazardous or toxic materials are used, handled, stored or where a spill of such materials would drain into the dry well.
3.	Risk of groundwater contamination in very coarse soils may require groundwater monitoring.
4.	Not suitable on fill sites or steep slopes.
5.	Must have a minimum of 3 to 4 feet between the bottom of the dry well and the seasonal high water table.
6.	Dry wells service a limited drainage area, typically only rooftop runoff.
7.	Dry wells must be located at least 10 feet away, on the down slope side of the structure, from building foundations to prevent seepage.

TABLE V-10 (CONT)

DRY WELLS (cont):	
Limitations:	
8.	Stormwater runoff carrying bacteria, sediment, fertilizer, pesticides, and other chemicals may flow directly into the groundwater.
9.	Loss of infiltrative capacity and high maintenance cost in fine soils.
10.	Low removal of dissolved pollutants in very coarse soils.
11.	Soils must be permeable.
12.	Not recommended for use with commercial rooftops unless adequacy of pretreatment is assured.
EXTENDED / DRY DETENTION BASINS OR UNDERGROUND TANKS	
Advantages:	
1.	Modest removal efficiencies for the larger particulate fraction of pollutants.
2.	Removal of sediment and buoyant materials. Nutrients, heavy metals, toxic materials, and oxygen-demanding particles are also removed with sediment substances associated with the particles.
3.	Can be designed for combined flood control and stormwater quality control.
4.	Requires less capital cost and land area when compared to wet pond BMP.
5.	Downstream channel protection when properly designed and maintained.
Limitations:	
1.	Require sufficient area and hydraulic head to function properly.
2.	Generally not effective in removing dissolved and finer particulate size pollutants from stormwater.
3.	Some constraints other than the existing topography include, but are not limited to, the location of existing and proposed utilities, depth to bedrock, location and number of existing trees, and wetlands.
4.	Extended/dry detention basins have moderate to high maintenance requirements.
5.	Sediments can be resuspended if allowed to accumulate over time and escape through the hydraulic control to downstream channels and streams.
6.	Some environmental concerns with using extended/dry detention basins include potential impact on wetlands, wildlife habitat, aquatic biota, and downstream water quality.
7.	May create mosquito breeding conditions and other nuisances.
INFILTRATION BASINS	
Advantages:	
1.	High removal capability for particulate pollutants and moderate removal for soluble pollutants.
2.	Groundwater recharge helps to maintain dry-weather flows in streams.
3.	Can minimize increases in runoff volume.
4.	When properly designed and maintained, it can replicate pre-development hydrology more closely than other BMP options.
5.	Basins provide more habitat value than other infiltration systems.
Limitations:	
1.	High failure rate due to clogging and high maintenance burden.
2.	Low removal of dissolved pollutants in very coarse soils.
3.	Not suitable on fill slopes or steep slopes.
4.	Risk of groundwater contamination in very coarse soils may require groundwater monitoring.
5.	Should not be used if significant upstream sediment load exists.
6.	Slope of contributing watershed needs to be less than 20 percent.
7.	Not recommended for discharge to a sole source aquifer.
8.	Cannot be located within 100 feet of drinking water wells.
9.	Metal and petroleum hydrocarbons could accumulate in soils to potentially toxic levels.
10.	Relatively large land requirement.
11.	Only feasible where soil is permeable and there is sufficient depth to bedrock and water table.
12.	Need to be located a minimum of 10 feet down gradient and 100 feet up gradient from building foundations because of seepage problems.

TABLE V-10 (CONT)

INFILTRATION TRENCHES	
Advantages:	
1.	Provides groundwater recharge.
2.	Trenches fit into small areas.
3.	Good pollutant removal capabilities.
4.	Can minimize increases in runoff volume.
5.	Can fit into medians, perimeters, and other unused areas of a development site.
6.	Helps replicate pre-development hydrology and increases dry weather base flow.
Limitations:	
1.	Slope of contributing watershed needs to be less than 20 percent.
2.	Soil should have infiltration rate greater than 0.3 inches per hour and clay content less than 30 percent.
3.	Drainage area should be between 1 to 10 acres.
4.	The bottom of infiltration trench should be at least 4 feet above the underlying bedrock and the seasonal high water table.
5.	High failure rates of conventional trenches and high maintenance burden.
6.	Low removal of dissolved pollutants in very coarse soils.
7.	Not suitable on fill slopes or steep slopes.
8.	Risk of groundwater contamination in very coarse soils may require groundwater monitoring.
9.	Cannot be located within 100 feet of drinking water wells.
10.	Need to be located a minimum of 10 feet down gradient and 100 feet up gradient from building foundations because of seepage problems.
11.	Should not be used if upstream sediment load cannot be controlled prior to entry into the trench.
12.	Metals and petroleum hydrocarbons could accumulate in soils to potentially toxic levels.
MEDIA FILTRATION	
Advantages:	
1.	May require less space than other treatment control BMPs and can be located underground.
2.	Does not require continuous base flow.
3.	Suitable for individual developments and small tributary areas up to 100 acres.
4.	Does not require vegetation.
5.	Useful in watersheds where concerns over groundwater quality or site conditions prevent use of infiltration.
6.	High pollutant removal capability.
7.	Can be used in highly urbanized settings.
8.	Can be designed for a variety of soils.
9.	Ideal for aquifer regions.
Limitations:	
1.	Given that the amount of available space can be a limitation that warrants the consideration of a sand filter BMP, designing one for a large drainage area where there is room for more conventional structures may not be practical.
2.	Available head to meet design criteria.
3.	Requires frequent maintenance to prevent clogging.
4.	Not effective at removing liquid and dissolved pollutants.
5.	Severe clogging potential if exposed soil surfaces exist upstream.
6.	Sand filters may need to be placed offline to protect it during extreme storm events.

TABLE V-10 (CONT)

POROUS PAVEMENT	
Advantages:	
1.	Porous pavements operate in a similar fashion to infiltration trenches and thus provide similar water quality benefits, including reductions in fine-grained sediments, nutrients, organic matter, and trace metals.
2.	In addition to water quality benefits, porous pavements also provide significant reductions in surface runoff with up to 90 percent of rainfall retained within the BMP (Schueler, 1992).
3.	An added benefit provided by the on-site infiltration is the extent to which the stormwater runoff is able to contribute to groundwater recharge.
4.	Reduces pavement ponding.
Limitations:	
1.	Only applicable for low-traffic volume areas.
2.	To maintain effectiveness, porous pavements require frequent maintenance.
3.	Porous pavements are not intended to remove sediments.
4.	Easily clogged by sediments if not situated properly.
5.	Porous pavements are limited to treating small areas (0.25 to 10 acres).
6.	Contributing drainage area slopes should be 5 percent or less to limit the amount of sediments that could potentially lead to clogging of the porous pavement.
7.	On average, porous pavements clog within 5 years.
8.	Underlying soil strata must have an adequate infiltration capacity of at least 0.3 inches per hour but preferably 0.50 in/hr or more. Adequate soil permeability should extend for a depth of at least 4 feet.
9.	The bottom of the reservoir layer should be at least 4 feet above the seasonally high water table. Porous pavements should be no closer than 100 feet from drinking wells and 100 feet upgradient and 10 feet down gradient from building foundations. Due to the risk of groundwater contamination, porous pavements should not be used for gas stations or other areas with a relatively high potential for chemical spills. Similarly, special consideration should be given to the use of porous pavements in wellhead protection areas serviced by sole source aquifers.
10.	The porous pavement should not be located where run-on from adjacent areas can introduce sediments to the pavement surface. Similarly, areas subject to wind-blown sediment loads should be avoided.
11.	Extended rain can reduce the pavement’s load bearing capacity.
12.	More expensive than traditional paving surfaces.
STORM DRAIN INSERTS	
Advantages:	
1.	Low installation costs.
2.	Prefabricated for different standard storm drain designs.
3.	Require minimal space to install.
Limitations:	
1.	Some devices may be vulnerable to accumulated sediments being resuspended during heavy storms.
2.	Can only handle limited amounts of sediment and debris.
3.	Maintenance and inspection of storm drain inserts are required before and after each rainfall event.
4.	High maintenance costs.
5.	Hydraulic losses.

TABLE V-10 (CONT)

VEGETATED FILTER STRIPS	
Advantages:	
1.	Lowers runoff velocity (Schueler, 1987).
2.	Slightly reduces runoff volume (Schueler, 1987).
3.	Slightly reduces watershed imperviousness (Schueler, 1987).
4.	Slightly contributes to groundwater recharge (Schueler, 1987).
5.	Aesthetic benefit of vegetated “open spaces” (Colorado Department of Transportation, 1992).
6.	Preserves the character of riparian zones, prevents erosion along streambanks, and provides excellent urban wildlife habitat (Schueler, 1992).
Limitations:	
1.	Filter strips cannot treat high velocity flows, and do not provide enough storage or infiltration to effectively reduce peak discharges to predevelopment levels for design storms (Schueler, 1992). This lack of quantity control dictates use in rural or low-density development.
2.	Requires slope less than 5%.
3.	Requires low to fair permeability of natural subsoil.
4.	Large land requirement.
5.	Often concentrates water, which significantly reduces effectiveness.
6.	Pollutant removal is unreliable in urban settings.
VEGETATED SWALE	
Advantages:	
1.	Relatively easy to design, install and maintain.
2.	Vegetated areas that would normally be included in the site layout, if designed for appropriate flow patterns, may be used as a vegetated swale.
3.	Relatively inexpensive.
4.	Vegetation is usually pleasing to residents.
Limitations:	
1.	Irrigation may be necessary to maintain vegetative cover.
2.	Potential for mosquito breeding areas.
3.	Possibility of erosion and channelization over time.
4.	Requires dry soils with good drainage and high infiltration rates for better pollutant removal.
WET PONDS	
Advantages:	
1.	Wet ponds have recreational and aesthetic benefits due to the incorporation of permanent pools in the design.
2.	Wet ponds offer flood control benefits in addition to water quality benefits.
3.	Wet ponds can be used to handle a maximum drainage area of 10 mi^2.
4.	High pollutant removal efficiencies for sediment, total phosphorus, and total nitrogen are achievable when the volume of the permanent pool is at least three times the water quality volume (the volume to be treated).
5.	A wet pond removes pollutants from water by both physical and biological processes, thus they are more effective at removing pollutants than extended/dry detention basins.
6.	Creation of aquatic and terrestrial habitat.
1.	Wet ponds may be feasible for stormwater runoff in residential or commercial areas with a combined drainage area greater than 20 acres but no less than 10 acres.
2.	An adequate source of water must be available to ensure a permanent pool throughout the entire year.
3.	If the wet pond is not properly maintained or the pond becomes stagnant; floating debris, scum, algal blooms, unpleasant odors, and insects may appear.

TABLE V-10 (CONT)

WET PONDS (cont)	
Limitations:	
1.	Sediment removal is necessary every 5 to 10 years.
2.	Heavy storms may cause mixing and subsequent resuspension of solids.
3.	Evaporation and lowering of the water level can cause concentrated levels of salt and algae to increase.
4.	Cannot be placed on steep unstable slopes.
5.	Pending volume and depth, pond designs may require approval from State Division of Dams Safety.
Note: *Advantages / Limitations adapted from Los Angeles County Development Planning for Stormwater Management Manual, September 2002.*	

TABLE V-11
Suitability of Different Control Measures in the Tookany/Tacony-Frankford Watershed

1.	**Cisterns and Covered Ponds:** Recommended in industrial parks where water could be utilized for fire protection; costs vary on size of cistern and material used; low maintenance costs (usually requires periodic sediment removal). Also may be used in existing or newly developed residential areas.
2.	**Rooftop Gardens:** Recommended in this watershed.
3.	**Surface Pond Storage:** Recommended where pond sites exist or on more porous soils (A and B) for groundwater recharge; relatively inexpensive to install and maintain; helps entrap sediment to improve the water quality of the receiving stream.
4.	**Ponding on Roof, Constricted Downspouts:** Possible on large buildings; required structure modifications usually expensive; low maintenance costs unless leaks occur.
5.	**Increased Roof Roughness:** Possible for industrial, commercial, and public buildings; relative effectiveness minimal on a watershed wide basis; moderate installation costs; little maintenance costs.
6.	**Porous Pavement:** Highly recommended where possible, especially in A and B soils and large parking facilities; promotes groundwater recharge; moderate in expense compared to typical paving; low maintenance costs.
7.	**Grassed Channels and Vegetated Strips:** Recommended wherever possible throughout the watershed to slow velocity and reduce erosion; minimal slopes recommended; could entrap sediment to improve water quality; low installation and maintenance costs; promotes infiltration.
8.	**Ponding and Detention on Pavement:** Recommended in entire watershed except in "Conditional Direct Discharge" areas; very inexpensive with low maintenance costs; freezing should be considered.
9.	**Reservoirs or Detention Basin:** Recommended in entire watershed except in "Conditional Direct Discharge" areas; moderate installation and maintenance costs.
10.	**Groundwater Recharge:** Recommended throughout the watershed particularly in Hydrologic Soil Group A and B.
11.	**High Delay Grass and Routing Flow Over Lawns:** Recommended in entire watershed; delays runoff, entraps sediment, reduces velocities, reduces erosion potential; relatively inexpensive installation and maintenance costs.

H. Sub-Regional (Combined Site) Storage

Traditionally, the approach to stormwater management has been to control the runoff on an individual site basis. However, there is a growing commitment to finding cost-effective comprehensive control techniques that both preserve and protect the natural drainage system. In other words, two developers developing sites adjacent to each other could pool their capital resources to provide for a community stormwater storage facility in the most hydrologic advantageous location.

The goal should be the development and use of the most cost-effective and environmentally sensitive stormwater runoff controls. These controls will significantly improve the capability and flexibility of land developers and communities to control runoff consistent with the Tookany/Tacony-Frankford Watershed Stormwater Management Plan.

An advantage to combining efforts is to increase the opportunity to utilize stormwater control facilities to meet other community needs. For example, certain stormwater control facilities could be designed so that recreational facilities such as ball fields, open space, volleyball, etc. could be incorporated. Natural or artificial ponds and lakes could serve both recreational and stormwater management objectives.

To take this concept a step further, there is also the possibility that the stormwater could be managed "off-site"; that is, in a location off the property(s) in question. These stormwater management facilities could be constructed in an offsite location more hydrologically advantageous to the watershed. These facilities could be publicly owned detention, retention, lake, pond, or other physical facilities to serve multiple developments. The design and release rate would need to be consistent with the Plan.

I. Regional Detention Facilities

One option in watershed-wide storm management is to control runoff using regional facilities. Developers could pool their capital to build a regional detention basin at a strategic location in place of installing a basin on each individual site. However, due to the urbanization that exists throughout the watershed, there are not any feasible locations for regional detention facilities.

J. Stormwater Quantity Control Exemption

1. Exemptions for Land Use Activities

<u>Montgomery County Portion of the Watershed:</u>

1. Disconnected Regulated Activities smaller in area than 250 sq. ft. are exempt from the peak rate control and drainage plan preparation requirement of the Model Ordinance.

2. Disconnected Regulated Activities equal to or greater than 250 sq. ft. and less than 1,000 sq. ft. are exempt only from the peak rate control requirement of the Model Ordinance.

3. Agricultural plowing and tilling are exempt from the rate control and drainage plan preparation requirements of the Model Ordinance provided the activities are performed according to the requirements of 25 Pa. Code Chapter 102.

4. Forest management and timber operations are exempt from the rate control and drainage plan preparation requirements of the Model Ordinance provided the activities are performed according to the requirements of 25 Pa. Code Chapter 102.

5. Exemptions from any provisions of the Model Ordinance shall not relieve the applicant from the requirements in Section 401 of the Model Ordinance.

Table V-12 shows the exemption criteria for the Philadelphia County portion of the watershed.

Philadelphia County Portion of the Watershed:

1. Development, including new development and redevelopment, that results in an area of Earth Disturbance less than fifteen thousand (15,000) sq. ft. is exempt from all requirements of the Model Ordinance. However, applicants must still meet coastal water quality requirements from other programs if applicable as outlined in Table V-12 below which corresponds to Table 105.1 of the Model Ordinance.

2. Redevelopment that results in an area of Earth Disturbance greater than or equal to fifteen thousand (15,000) sq. ft., but less than one (1) acre, is exempt from the Channel Protection/Streambank Erosion Requirements (Section 407) of the Model Ordinance.

3. Redevelopment that results in an area of Earth Disturbance greater than or equal to one (1) acre and reduces the predevelopment DCIA on the site by at least 20% is exempt from the Channel Protection/Streambank Erosion (Section 407) and Flood Control/Peak Rate Control (Section 408) Requirements of the Model Ordinance.

TABLE V-12
Ordinance Applicability for the Philadelphia County Portion of the Watershed

Ordinance Article or Section	Type of Project	Earth Disturbance Associated with Development		
		0-15,000 sq. ft.	15,000 sq. ft.-1 acre	> 1 acre
Article III Drainage Plan Requirements	New Development	N/A**	Yes	Yes
	Redevelopment	N/A**	Yes	Yes
Section 404 Nonstructural Project Design Requirements	New Development	N/A**	Yes	Yes
	Redevelopment	N/A**	Yes	Yes
Section 406 Water Quality Requirements	New Development	N/A**	Yes	Yes
	Redevelopment	N/A**	Yes	Yes
Section 407 Channel Protection / Streambank Erosion Requirements	New Development	N/A**	Yes	Yes
	Redevelopment	N/A**	Exempt	Yes (Alternate Criteria)
Section 408 Flood Control / Stormwater Peak Rate Control and Management Districts Requirements	New Development	N/A**	Yes	Yes
	Redevelopment	N/A**	Yes (Alternate Criteria)	Yes (Alternate Criteria)

Yes (Alternate Criteria) – Redevelopment disturbing more than one acre which reduces the DCIA from predevelopment conditions by at least 20% is exempt from the Channel Protection Requirements of this Ordinance, and redevelopment greater than or equal to 15,000 square feet which reduces the DCIA from predevelopment conditions by at least 20% are exempt from the Flood Control Requirements of this Ordinance (See Section 106, Philadelphia County Portion of the Watershed, for further details).

N/A – Not Applicable, development project is not subject to requirements of indicated Regulations section. Voluntary controls are encouraged.

Exempt – Development project is not subject to requirements of indicated Regulations section.

** – If the proposed development results in stormwater discharge that exceeds stormwater system capacity, increases the FEMA regulated water surface elevation, causes a combined sewer overflow, or degrades receiving waters, the design specifications presented in these Regulations may be applied to proposed development activities as warranted to protect public health, safety, or property.

A. Additional Exemption Criteria:

1. Exemption Responsibilities - An exemption shall not relieve the Applicant from implementing such measures as are necessary to protect public health, safety, and property.

2. Drainage Problems - If a drainage problem is documented or known to exist downstream of or is expected from the proposed activity, then the Municipality may require the Applicant to comply with the entire Model Ordinance.

3. Emergency Exemption - Emergency maintenance work performed for the protection of public health, safety, and welfare may be exempt from the Model Ordinance. A written description of the scope and extent of any emergency work performed shall be submitted to the [*Municipality*] within two (2) calendar days of the commencement of the activity. If the [*Municipality*] finds that the work is not an emergency, then the work shall cease immediately, and the requirements of the Model Ordinance shall be addressed as applicable.

4. Even though the developer is exempt from certain portions of the Model Ordinance, he is not relieved from complying with other regulations which may apply to the project.

5. HQ and EV Streams – An exemption shall not relieve the Applicant from meeting the special requirements for watersheds draining to identified high quality (HQ) or exceptional value (EV) waters and Source Water Protection Areas (SWPA) and requirements for nonstructural project design sequencing (Ordinance Section 404).

SECTION VI

MUNICIPAL ORDINANCE INTRODUCTION

Municipalities within the Commonwealth of Pennsylvania are empowered to regulate land use activities that affect runoff by the authority of the Act of October 4, 1978, 32 P.S., P.L. 864 (Act 167) Section 680.1 et seq., as amended, The "Stormwater Management Act." Act 167 requires that:

- Counties prepare a watershed stormwater management plan in conformance with the requirements of Act 167 for each watershed within their boundaries.
- The plans evaluate present and future runoff within the watershed and make technical recommendations for the control and management of runoff from new development (both quantity and quality).
- Municipalities implement the plan via a Stormwater Ordinance developed as part of the plan.
- Developers control the quantity and quality of runoff from new development (including redevelopment) in accordance with each Municipality's implementing Ordinance.

The Stormwater Management Act emphasizes locally administered stormwater programs with the watershed municipalities taking the lead role. Implementation and enforcement of the watershed plan standards and criteria will require the municipalities to adopt the appropriate Ordinance provisions Ordinances that address subdivision and land development. As part of the preparation of the Tookany/Tacony-Frankford Watershed Stormwater Management Plan, a Model Municipal Ordinance has been prepared that will implement the Plan provisions presented in the Ordinance as a single purpose Ordinance that could be adopted by each Municipality with minor changes to fulfill the needs of a particular Municipality. This could be adopted essentially "as is" (with some modification) by the municipalities. Provisions would also be required in the Subdivision and Land Development Ordinance to ensure that activities regulated by the Ordinance were appropriately referenced.

In addition to adopting the Ordinance itself, the municipalities would also have to revise their existing subdivision, land development, and zoning Ordinances to incorporate the necessary linking provisions. These linking provisions would refer to any applicable regulated activities within the watershed to the single purpose Ordinance. Key provisions of the Model Stormwater Ordinance include the drainage standards and criteria, performance standards for stormwater management, and maintenance provisions for stormwater facilities.

Finally, the Model Stormwater Ordinances should be understandable, applied fairly and uniformly throughout the watershed, and should not discourage creative solutions to stormwater management problems. It would be desirable for the municipalities to adopt a uniform regulatory approach for the Tookany/Tacony-Frankford Watershed.

The implementation of the runoff control strategy for development will be through municipal adoption of the appropriate Ordinance provisions. The "Tookany/Tacony-Frankford Watershed Act

167 Stormwater Management Ordinance" will not completely replace the existing storm drainage Ordinance provisions currently in effect in the municipalities. The reasons for this are as follows:

- Not all of the municipalities in the Tookany/Tacony-Frankford Watershed are completely within the watershed. For those portions of the Municipality outside Tookany/Tacony-Frankford Watershed, the existing Ordinance provisions would still apply.
- Permanent and temporary stormwater control facilities are regulated by the Act 167 Ordinance. Stormwater management and erosion and sedimentation control during construction would continue to be regulated under the existing Stormwater Ordinance and Chapter 102 Erosion and Sediment and Pollution Controls, Title 25 of DEP Regulations.
- The Act 167 Ordinance contains only those minimum stormwater runoff control criterion and standards which are necessary or desirable from a total watershed perspective. Additional stormwater management design criteria (i.e., inlet spacing, inlet type, collection system details, etc.) which should be based on sound engineering practice should be regulated under the current Ordinance provisions or as part of the general responsibilities of the municipal engineer.

The following Model Ordinance has been developed specifically for municipalities within the Tookany/Tacony-Frankford Watershed in order to implement the Tookany/Tacony-Frankford Watershed Stormwater Management Plan which includes the Tookany/Tacony-Frankford Integrated Watershed Management Plan (TTF-IWMP). Municipalities may elect to either create a single-purpose Stormwater Ordinance (recommended) or amend existing subdivision or zoning Ordinances to implement the associated stormwater management plan.

All of the provisions within this Model Ordinance (unless specifically designated as optional) are required to be part of the Municipal Stormwater Ordinance or other Ordinances implementing the requirements of the stormwater management plan.

Organization:

This Ordinance contains the following eight articles, each with specific provisions.

Article I - General Provisions: This article includes general administrative provisions including applicable land areas and regulated activities. This article also includes the stormwater management exemption criteria.

Article II - Definitions: This article provides a list of common terms and associated definitions used throughout the Ordinance.

Article III - Drainage Plan Requirements: This article lists the specific requirements for submittal, content, and review of drainage plans required by the Ordinance.

Article IV - Stormwater Management: This article represents the technical provisions for stormwater management within the Tookany/Tacony-Frankford Watershed and includes the stormwater management district implementation provisions, water quality requirements, design criteria, calculation methods, and erosion and sedimentation requirements.

Article V - Inspections: This article describes inspection procedures for permanent stormwater management and water quality facilities.

Article VI - Fees and Expenses: This article contains the provisions for a municipal review fee.

Article VII - Maintenance Responsibilities: This article outlines the applicants' responsibilities for operation and maintenance of stormwater management facilities.

Article VIII - Prohibitions: This article, required by NPDES Phase II, prohibits the discharge of non stormwater flows to any municipal separate storm sewer system with the exception of certain activities found not to contribute pollution to surface waters.

Article IX - Enforcement and Penalties: This article describes municipal enforcement procedures, remedies, and the appeals process.

Appendices: This section of the Ordinance contains nine technical support appendices necessary to implement the Ordinance provisions.

Please note that the plan and associated Ordinance provisions were developed under the authority of and in strict conformance with the requirements of Act 167. These documents were prepared in consultation with a WPAC comprised of designated representatives from each of the watershed municipalities, County Planning and Conservation District staff. Proposed Ordinance provisions were reviewed and accepted by a majority of the voting members (noted above) who attended the meetings.

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. These Ordinances must regulate development within the Municipality in a manner consistent with the watershed stormwater plan and the provisions of the Act.

The following amendment is required for municipalities that issue an occupancy permit:

- An Occupancy Permit shall not be secured or issued unless the provisions of the Tookany/Tacony-Frankford Watershed Stormwater Management Ordinance have been followed. The Occupancy Permit shall be required for each lot owner and/or developer of all major and minor subdivisions and land development in the Municipality

For municipalities without an Occupancy Permit, they may want to adopt the above draft and include other regulatory items in the occupancy permit requirement for their own use.

ORDINANCE REQUIREMENTS:

The following Ordinance provisions must be retained when a Municipality either elects to create a single-purpose stormwater Ordinance or amends existing subdivision or zoning Ordinances to implement the stormwater management plan.

- Article I - General Provisions
- Article II - Definitions
- Article III - Drainage Plan Requirements – Section 302
- Article IV - Design Criteria for Stormwater Management Facilities Sections 401, 402, 403, 404, 405, 406, 407, 408 (except G and H), 409, 410
- Article V - Inspections (language may be modified by Municipality)
- Article VII - Maintenance (language may be modified by Municipality)
- Article VIII - Prohibitions
- Article IX - Enforcement and Penalties (only when enacting a single-purpose Ordinance)

The following Ordinance provisions are optional, <u>but recommended to be retained</u>:

- Section 408. G-H
- Section 709. Municipal Stormwater Control and BMP Operation and Maintenance Fund
- Article VI - Fees and Expenses

All other provisions are optional and may be modified to be consistent with other Municipal Ordinances related to land development.

NOTE: If a Municipality chooses to use the Model Ordinance to implement the stormwater management plan, it is recommended that the Ordinance be submitted to the municipal solicitor, engineer, and DEP for review prior to enactment.

NPDES Requirements

Federal regulations approved October 1999 required operators of small municipal separate storm sewer systems (MS4s) to obtain NPDES Phase II permits from DEP by March 2003. (NPDES II is an acronym for the National Pollutant Discharge Elimination System Phase II Stormwater Permitting Regulations.) This program affects all municipalities in “urbanized areas” of the state. This definition applies to all Tookany/Tacony-Frankford Watershed municipalities. Therefore, all municipalities within the Tookany/Tacony-Frankford Watershed will be subject to the NPDES Phase II requirements mandated by the Federal Clean Water Act as administered by DEP. For more information on NPDES II requirements, contact the DEP Regional Office.

Implementation

In order to aid the municipalities and developers in the implementation process, flow charts have been developed as shown in Ordinance Appendix.

Administration

Due to difference in administration of the building permit process in Philadelphia County, the applicability requirements for the Philadelphia portion of the watershed will be based upon earth disturbance as opposed to the amount of proposed impervious area. Table 105.1a summarizes the applicability requirements for the municipalities in Philadelphia and Montgomery Counties. Table 105.1b summarizes the applicability requirements for the City of Philadelphia.

SECTION VII

PRIORITIES FOR IMPLEMENTATION

The Tookany/Tacony-Frankford Watershed Stormwater Management Plan preparation process is complete with Montgomery and Philadelphia Counties' adoption of the draft Plan and submission of the final Plan to DEP for approval. This sets in motion the mandatory schedule of adoption of Ordinances needed to implement stormwater management criteria. Tookany/Tacony-Frankford Watershed municipalities had six months from DEP approval to adopt the necessary Ordinance provisions.

A. DEP Approval of the Plan

Upon adoption of the Watershed Plan by Montgomery and Philadelphia Counties, the Plan was submitted to DEP for approval. A draft of the Stormwater Management Plan and draft Model Ordinance was sent to DEP prior to adoption of the Plan. The DEP review process involves determination that all of the activities specified in the Scope of Study have been completed. The DEP also reviewed the Plan for consistency with municipal floodplain management plans, State programs that regulate dams, encroachments and other water obstructions, and State and Federal flood control programs. The review process also ensures that the Plan is compatible with other watershed stormwater plans in the basin, and that the Plan is consistent with the policies of Act 167.

B. Publishing the Final Plan

Upon DEP approval, the Philadelphia Water Department published and provided, at minimum, two copies of the Plan to each Municipality. The Plan includes this report, appendices, figures, and the Model Ordinance.

C. Municipal Adoption of Ordinance to Implement the Plan

The essential ingredient for implementation of the Stormwater Management Plan is the adoption of the necessary Ordinance provisions by the Tookany/Tacony-Frankford Watershed municipalities. Provided as part of the Plan is the <u>Act 167 Stormwater Management Plan Model Ordinance</u> which is a single purpose stormwater Ordinance that could be adopted by each Municipality essentially "as is" to implement the Plan. The single purpose Ordinance was chosen for ease of incorporation into the existing structure of Municipal Ordinances. All that is required of any Municipality would be to adopt the Ordinance itself and adopt the necessary provisions for tying into the existing subdivision and land development Ordinance and zoning Ordinance as outlined in the Municipal Ordinance Matrix in the Appendix. The tying provisions would simply refer any applicable regulated activities within the Tookany/Tacony-Frankford Watershed from the other Ordinances to the single purpose Ordinance. It is recommended that the delineation of the watershed subareas and the stormwater management criteria assigned to each subarea be enacted as part of each Municipality's zoning or subdivision Ordinance. This way the requirements for management of stormwater will be applicable to all changes in land use and not limited to activities that are subject to subdivision and land development regulations.

D. Level of Government Involvement in Stormwater Management

The existing institutional arrangements for the management of stormwater include federal, state, and county governments, as well as every Municipality within the watershed.

In the absence of a single entity with responsibility for all aspects of stormwater management within a watershed, it is clear that the "management" that occurs is primarily a function of a multiple permitting process where a developer attempts to satisfy the requirements of all of the permitting agencies. Each public agency has established its own regulations based on its own objectives and legislative mandates as well as its own technical standards according to its particular stormwater concerns.

The minimum objectives of this Plan and the minimum mandates of Act 167 can be accomplished without significant modification of existing institutional arrangements. Actions must be taken at the municipal level. Participation by the county in the technical review of stormwater management plans is necessary. In addition, there must be maintenance and operation of the computer model (as necessary), and compilation of data required for periodically updating the Plan. In addition, upon adoption of the Plan, all future public facilities, facilities for the provision of public utility services, and facilities owned or financed by state funds will have to be consistent with the Plan, even though they might not otherwise be subject to municipal regulation.

The primary municipal level activity will be the adoption or amendment of development regulations to incorporate watershed stormwater management standards. Act 167 requires that this be accomplished within six months of the Plan's adoption and approval. Model Ordinance provisions will be distributed to all of the watershed municipalities. The Montgomery and Philadelphia County Planning Commissions will be available upon request to assist municipalities in the adoption of the Model Ordinance provisions to fit particular Municipal Ordinance structures.

The primary county level activity will be the establishment of review procedures. The Model Ordinance calls for review of stormwater management plans for development sites and Erosion and Sediment Pollution Control Plans by the Montgomery and Philadelphia County Conservation Districts respectively. Evidence that the appropriate state and federal agencies responsible for administering wetland regulatory programs have been contacted for land development sites containing regulated wetlands is also required. The purpose is to ensure that plan standards have been applied appropriately and that downstream impacts have been adequately addressed. Procedures and capabilities for performing the review function exist within the governmental agencies.

The counties will also be responsible for the maintenance of data for performance of review and of "no-harm" evaluation. The materials prepared by consultants during the plan preparation process that are needed in the development of site specific stormwater management plans, including data needed to perform the "no-harm" evaluation, must be maintained in a place and form that is accessible to users.

E. County-Wide Coordination

There are possible situations of stormwater management functions and concerns, which may not be adequately addressed within the structure of the existing institutional arrangements or by the adoption and enforcement of new regulations at the municipal level, as outlined above.

For example, the construction of regional storage facilities may offer an economic and technically sound alternative to the construction of individual, on-site detention basins. There is, however, no organization now that is capable of implementing such a concept. To do so would require a multi-municipal entity capable of planning, financing, constructing, operating, and maintaining the shared storage facilities in a manner similar to the management required for the collection, treatment, and disposal of sanitary wastes.

The Tookany/Tacony-Frankford Watershed is a drainage system. All of its parts are interrelated. What happens upstream affects what happens downstream, and what happens downstream places limitations on what happens upstream. If runoff is not controlled in upstream communities, downstream communities will flood. However, if in a downstream community, the capacity of a drainage channel can be safely increased, more upstream runoff may be released, thus reducing somewhat the cost of required upstream control facilities.

The reduced storm frequency standard proposed in this Plan is the primary standard for managing stormwater on a watershed basis and is a very simple concept that can be implemented on a property-by-property basis. But the same technical tool that allowed the modeling of rainfall routing throughout the watershed and the development of a usable standard for property-level control, is also capable of testing numerous, technically feasible solutions that would work for combinations of properties and for combinations of subareas. Some of these potential solutions may be preferable to those that would result from the application of release rates to individual properties.

There are, of course, ways to work out agreements on a case-by-case basis to permit the accomplishment of almost any objective, whether a public or a private undertaking. However, as the number of stormwater detention and control facilities increases during future years, continuing maintenance to ensure the integrity of structures and their performance will become very important. A proliferation of "special agreements" to handle special situations may make future accountability very difficult.

An ideal structure for the management of stormwater on a watershed basis would be an entity, a regional stormwater management board, capable of dealing with all interrelated elements of the system to achieve the following:

- The best possible technical solutions in the most effective manner;
- The efficient and competent review of stormwater management components of development plans;
- The continued maintenance and proper functioning of all elements of the system;
- The repair and replacement of system components as necessary;
- Continuing monitoring and evaluation of the performance of the drainage system;
- Updating and revision of system requirements and standards as necessary;

- Responsible financial management including an equitable apportionment of operating and capital costs among the system's users and beneficiaries.

It is clear that not all of these objectives can be achieved on a watershed basis through municipal implementation of the stormwater plan, but that the existence of an intermunicipal entity capable of continuous action at the system or watershed level is required.

An optimum management system would be an entity capable of performing similar functions for multiple watersheds. There are a variety of models for such an entity, ranging from assigning new responsibilities to a coordinated team of existing county departments to the creation of a regional stormwater management board to include stormwater functions. Further, under any management system, some of the elements in the process could be contracted out to a private vendor.

The essential concept is that stormwater can be managed like a public utility and that the costs for planning, construction, operation and maintenance, monitoring and evaluation can be equitably shared by all of the system's users.

A basic assumption underlying the concept of user financing of stormwater management is that damage caused by existing and potential stormwater runoff without controls is intolerable. Therefore, it is in the public interest to undertake stormwater management immediately, and such management should not be delayed until federal and state funding is available.

Based on stormwater management experience elsewhere, users (including beneficiaries) can finance the full cost of stormwater management inexpensively and equitably. The cost to each user is calculated based on user's property characteristics. Because this method is based on a formula, it has the advantage of being objective in its application.

F. Correction of Existing Drainage Problems

The development of the watershed plan has provided a framework for the correction of existing drainage problems, a logical first step in the process of implementation of a stormwater management Ordinance. It will prevent the worsening of existing drainage problems and prevent the creation of new drainage problems as well. The step-by-step outline below is by no means a mandatory action to be taken by the municipalities with watershed plan adoption options; it is just one method of solving problems uniformly throughout the watershed in order to solve current runoff situations.

1. Prioritize a list of storm drainage problems within the municipalities based on frequency of occurrence, potential for injury, as well as damage history.
2. Develop a detailed engineering evaluation to determine the exact nature of the top priority drainage problems within the municipalities in order to determine solutions cost estimates and a recommended course of municipal action.
3. Incorporate implementation of recommended solutions regarding stormwater runoff in the annual municipal capital or maintenance budget.

G. Culvert Replacement

The General Procedures for Municipalities to determine size of replacement culverts using Act 167 data is as follows:

1. Determine the location and Municipality of obstruction on the Obstruction Map and obtain the obstruction number.
2. From Section 105.161 of DEP's Chapter 105, determine the design storm frequency.
3. From "Municipal Stream Obstruction Data" tables, locate the Municipality and Obstruction number. Locate the flow value (cfs) for the design storm frequency determined in #2 above.
4. Have the culvert sized for this design flow and obtain any necessary approvals/permits.

Note: Any culverts/stream crossings not identified on the Obstruction Map need to have storm flows computed for sizing purposes (i.e.: Those culverts which were not measured due to lack of maintenance and therefore the inability to determine the actual size of the obstruction).

H. PennVEST Funding

One way in which the completion and implementation of this plan can be of assistance in addressing storm drainage problems is by opening the avenue of funding assistance through the PennVEST program. The PennVEST Act of 1988, as amended, provides low interest loans to governmental entities for the construction, improvement or rehabilitation of stormwater projects including the transports, storage and infiltration of stormwater and best management practices to address Nonpoint Source Pollution associated with stormwater.

In order to qualify for a loan under PennVEST, the Municipality or county:

1. Must be located in a watershed for which there is an existing county adopted and DEP approved stormwater plan with enacted stormwater Ordinances consistent with the plan, or
2. Must have enacted a stormwater control Ordinance consistent with the Stormwater Management Act.

I. Landowner's/Developer's Responsibilities

Any landowner and any person engaged in the alteration or development of land that may affect stormwater runoff characteristics shall implement such measures consistent with the provisions of the applicable watershed stormwater plan as are reasonably necessary to prevent injury to health, safety or other property. Such measures shall include such actions as are required:

1. To assure the maximum rate of stormwater runoff is no greater after development than prior to development activities; or
2. To manage the quantity, velocity and direction of resulting stormwater runoff in a manner that otherwise adequately protects health and property from possible injury.

Many developers throughout the state, after realizing the natural resource, public safety and potential economic advantages of proper stormwater management, are constructing development consistent with natural resources protection.

SECTION VIII

PLAN REVIEW ADOPTION AND UPDATING PROCEDURES

A. County Adoption

Prior to plan completion, Philadelphia and Montgomery Counties transmitted a sample of the proposed Stormwater Ordinance for review to affected municipal planning commissions, local governing bodies, the Watershed Plan Advisory Committee and other interested parties. Philadelphia and Montgomery Counties then transmitted a draft plan which included the draft Ordinance for review to the municipal planning commission and the governing body of each involved Municipality, the County Planning Department or Commission and the Watershed Plan Advisory Committee by official correspondence. This review included an evaluation of the plan's consistency with other plans and programs affecting the watershed. The reviews and comments will be submitted to the county by official correspondence. The county will receive, tabulate, and respond to the comments and will revise the Plan as necessary.

Philadelphia and Montgomery Counties held public meetings. A notice for the hearing was published two weeks prior to the hearing date. The meeting notice contained a summary of the principal provisions of the Plan and stated where copies of the Plan could be examined or obtained within each Municipality. The comments received at the public hearing were reviewed by the county and appropriate modifications to the Plan were made.

The Plan was passed as a resolution by the County Commissioners for the purpose of adoption. The resolution included references to the volumes, figures, appendices and Model Ordinance. The County resolution was recorded in the minutes of a regular meeting of the Montgomery and Philadelphia County Commissioners.

Philadelphia and Montgomery Counties then submitted to the Department of Environmental Protection: a letter of transmittal and three copies of the adopted plan, the review by each affected municipal planning agency and local governing body and the County Planning Department, public hearing notice and minutes, and the resolution of adoption of the Plan by each County. The letter of transmittal stated that Philadelphia and Montgomery Counties have complied with all procedures outlined in Act 167 and requested that the Department of Environmental Protection approve the adopted plan.

B. Provisions for Plan Revision

Section 5 of the Stormwater Management Act requires that the stormwater management plan be updated at least every five years. This requirement considers the changes in land use, obstructions, flood control projects, floodplain identification, and management objectives or policy that may take place within the watershed.

It will be necessary to collect and manage the required data in a consistent manner and preferably store it in a central location. This is not only to prepare an updated plan, but also, if required, to make interim runs on the runoff simulation model to analyze the impact of a proposed major development or a proposed major stormwater management facility.

The following recommendations are the minimum requirements to maintain an effective technical position for periodically reviewing and revising the Plan.

1. It is recommended that the Philadelphia and Montgomery County Board of Commissioners authorize the County Planning Department to undertake the task of organizing stormwater management plans and supporting data submitted for review. The Planning Department should also assume responsibility for periodically reviewing, revising, and updating the stormwater management plan.
2. It is recommended that the Philadelphia and Montgomery County Planning Departments prepare a workable program for the identification, collection and management of the required data. The program should not be limited to the cooperative efforts of the constituent member municipalities within the Tookany/Tacony-Frankford Watershed, but should also include both state and county agencies concerned with stormwater management.
3. It is recommended that the Watershed Plan Advisory Committee convene biannually or as needed to review the Stormwater Management Plan and determine if the Plan is adequate for minimizing the runoff impacts of new development. At a minimum, the information (to be reviewed by the Committee) will be as follows:
    a. Development activity data as monitored by the Philadelphia and Montgomery County Planning Commission.
    b. Information regarding additional storm drainage problem areas as provided by the municipal representatives to the Advisory Committee.
    c. Zoning and Subdivision amendments within the watershed.
    d. Impacts associated with any regional or subregional detention alternatives implemented in the watershed.
    e. Adequacy of the administrative aspects of regulated activity review.
    f. Additional hydrologic data available through preparation of the Stormwater Management Plan for the Tookany/Tacony-Frankford Watershed.

The Committee will review the above data and make recommendations to the County for revisions to the Tookany/Tacony-Frankford Watershed Stormwater Management Plan. Philadelphia and Montgomery Counties will review the recommendations of the Watershed Plan Advisory Committee and determine if revisions are to be made. A revised Plan would be subject to the same rules of adoption as the original Plan. Should the County determine that no revisions to the Plan are required for a period of five consecutive years, the County will adopt a resolution stating that the Plan has been reviewed and been found satisfactory to meet the requirements of Act 167. The resolution will then be forwarded to the Department of Environmental Protection.

SECTION IX

FORMATION OF THE TOOKANY/TACONY-FRANKFORD WATERSHED ADVISORY COMMITTEE

The meeting was held by the Committee during the preparation and adoption of the detailed Watershed Stormwater Management Plan.

Advisory Committee meetings and their purposes were as follows:

Meeting	Date	Purpose
1	12/15/2004	Introduction to Stormwater Management; Reviewed Act 167; Distributed data collection forms; NPDES coordination, coordination with other study initiatives; Watershed characteristics.
2	1/18/2005	Watershed characteristics, reviewed coordination with other study initiatives; discussed data collection forms - progress report; reviewed GIS mapping efforts; reviewed infill / redevelopment issues and BMPs; reviewed Fluvial Geomorphology study; sample Act 167 Plan.
3	4/15/2006	Reviewed Goals and Act 167 NPDES Ordinance; discussed status of project and mapping; reviewed municipal data collection efforts and status; discussed timeline and milestones.
4	1/24/2007	Update on municipal data collection forms; discussed current modeling efforts; reviewed comments on existing NPDES/ SW ordinance; revised timeline for work completion.
5	10/24/2007	Update on municipal data collection forms, discussed current modeling efforts; discussed criteria to be included in the SW ordinance; revised timeline for work completion.

SECTION X

REFERENCES

1. USDA, Soil Conservation Service (sic Natural Resources Conservation Service), Soil Survey of Montgomery County, PA (1963) Revised (1972).

2. USDA, Soil Conservation Service (sic Natural Resources Conservation Service), Soil Survey of Philadelphia County, PA (1963) Revised (1972).

3. Federal Emergency Management Agency, Flood Insurance Study – Montgomery County, Pennsylvania, October 19, 2001.

4. Federal Emergency Management Agency, Flood Insurance Study – Philadelphia County, Pennsylvania, January 17, 2007.

5. Maryland Department of the Environment, Maryland Stormwater Design Manual, Volume I & II.

6. Department of Environmental Protection, Pennsylvania Stormwater Best Management Practices Manual, December 2006.

PLAN APPENDIX 1

PUBLIC COMMENTS
&
RESPONSES

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Bureau of Watershed Management
MEMORANDUM
From Barry A. Newman, M.S., P.E.

To: PWD	Subject
cc:	Comments on
Date: 8/31/2007	July 18, 2007 Draft Tookany-Frankford
Page: 1 of 3	Act 167 Stormwater Management Plan

The subject documents were received electronically on July 23, 2007. Our comments are limited to a cursory review of only the following:

- o Volume I, Executive Summary,
- o Municipal Handbook,
- o Appendix 3, Model Ordinance, and
- o Appendix 4, NPDES.

We did not review Volume II, Plan Contents. The documents taken together are referred to as the Plan.

MAJOR COMMENTS

Some portions of the Plan are inconsistent with the requirements of Act 167. Any portion of the Plan inconsistent with Act 167, or other regulatory or statutory requirements, must be revised to eliminate the inconsistency. The following comments provide examples of sections that must be revised.

1. In Volume I, Section III, Methodology, the Stormwater Management District C, Conditional Direct Discharge District, is inconsistent with the requirement of Section 13(1) of Act 167 which requires in part that the maximum rate of storm water runoff after development can be no greater than prior to development.

2. Volume I, Section I, Introduction, of the Plan states that, "The main objective of a stormwater management plan is to control stormwater runoff from new development …." Section II, Methodology, states, "… the plan is not geared toward solving existing problems." These statements are not supported in Act 167 and they contradict Section 3 of the Act which includes in the statement of purpose to "restore the flood carrying capacity of Commonwealth streams" and to "preserve to the maximum extent practicable natural storm water runoff regimes and natural course, current and cross-section of water of the Commonwealth; and to protect and conserve ground waters and ground-water recharge areas." Section 5(c)(2) of the Act requires the Plan to "consider and be consistent with other existing municipal, county, regional, and State environmental and land use plans." Many of these plans involve efforts to solve existing problems; therefore, the draft Plan is inconsistent if it is not also solving existing problems.

3. Volume 1, Section III, Methodology, discusses exemptions. Activities or land alterations that may affect stormwater runoff must be regulated by the ordinance. This must include any activity that may affect the quality of stormwater runoff. Certain activities, such as minor gardening can be exempt from the requirement to submit a drainage plan; however, regulation of the activity

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Bureau of Watershed Management

MEMORANDUM

From Barry A. Newman, M.S., P.E.

To: PWD	Subject
cc:	Comments on
Date: 8/31/2007	July 18, 2007 Draft Tookany-Frankford
Page: 2 of 3	Act 167 Stormwater Management Plan

for protection of public health and safety and protection of property needs to continue.

4. Volume II, Appendix 3, Model Ordinance. Following DEP's draft model ordinance more closely is recommended.

Section 104, Statutory Authority. Subsections B and C contain irrelevant citations.

Section 105, Applicability, The ordinance could be applied across an entire municipality. Areas not included in a detailed hydrologic analysis, if any, could be shown at 100% on the release rate map if one is used.

Section 106, Exemptions. Any exemption from all requirements of this Ordinance is not acceptable. The Maintenance Exemption is not acceptable. Paragraphs B.5 (both of them), B6, and B7 should be deleted.

Article II, Definitions, should follow DEP's draft model ordinance. Agricultural Activities, Alteration, Bankfull, BMP, Conservation District (Philadelphia does not have one), Design Professional, Penn State Runoff Model (was it used in this study), Regulated Earth Disturbance Activity, Road Maintenance, State Water Quality Requirements, Stream, should be verified with the definitions in DEP's draft model ordinance, the Clean Streams Law, or Chapters 92, 102 and 105 of DEP's regulations.

Article III, Section 304 A through I should be deleted. Mostly these sections have the municipality regulating itself.

Section 304.J should apply only to construction authorization. The portion of a permit that applies to maintenance of facilities already constructed cannot be rescinded or revoked.

The following provision should be added to the ordinance: "The Municipality may, after consultation with DEP, approve measures for meeting the State Water Quality Requirements other than those in this Ordinance, provided that they meet the minimum requirements of, and do not conflict with, State law including but not limited to the Clean Streams Law." Any inconsistent content in the draft ordinance should be deleted.

Delete Section 402.

GENERAL COMMENTS

1. The references in the Municipal Handbook are out-of-date. DEP's Stormwater BMP Manual should be included. Also more recent publications such as EPA's Watershed Handbook and EPA's National Management Measures to Control Non-Point Source Pollution from Urban Areas could be included.
2. Volume II, Appendix 3, Model Ordinance, "Municipal Engineer" should be replaced by "Municipality."

Section 401.D should be deleted.

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
Bureau of Watershed Management
MEMORANDUM
From Barry A. Newman, M.S., P.E.

To: PWD	Subject
cc:	Comments on
Date: 8/31/2007	July 18, 2007 Draft Tookany-Frankford
Page: 3 of 3	Act 167 Stormwater Management Plan

Section 401.E should be replaced by Section 301.G from DEP's draft model ordinance.

All references to other regulations, e.g. 401.H and I, should be deleted. Section 108 of DEP's draft model ordinance could be inserted into the ordinance.

The meanings of Section 401.K, P, and R are unclear.

Section 404 is unclear.

Delete Section 408.G through I (Note: Section J cross-references itself).

Section 709 is too complex and too prescriptive and it requires an inflation rate and a discount rate which are not specified. A periodic stormwater use fee would be simpler.

Section 801 uses wording from an early version of DEP's draft model wording. The wording from the current version of DEP's model should be used.

In the Appendixes to the ordinance, technical content should be consistent with DEP's BMP Manual. For example, PDT-IDF has been superseded by NOAA Atlas 14. The purpose of including the Alternating Block Method is unclear.

The purpose of Appendix H is unclear.

The references should include DEP's Stormwater BMP Manual.

Process and procedure guidance in the ordinance should be deleted. The ordinance should provide the required performance standards.

If you have any questions, please contact Barry A. Newman, M.S., P.E., 717-772-5661, at your convenience.

P:\BWM\Waterways Wetland Erosion Control Division\StormwaterPlanningandManagement\!ProjectFiles\PhiladelphiaCounty\TACONY-FRANKFORD\P2\Plan\2007-07-23-Draft\CommentMemo-2007-09-04a.doc

September 28, 2007

Mr. Barry Newman
Pennsylvania Department of Environmental Protection
Bureau of Watershed Management
Rachel Carson State Office Building
400 Market Street, 10h Floor
Harrisburg, PA 17105

RE: Tookany/Tacony-Frankford Watershed Act 167 - Response to Comments on Volume II

BL No.: 2004-1621-00

Dear Mr. Newman:

The purpose of this letter is to document our responses to comments provided by Mr. Barry Newman, P.E. of the PADEP to the pre-draft version of the Tookany/Tacony-Frankford Watershed Stormwater Act 167 Plan. Mr Newman's comments were provided in a 3 page memo to the Philadelphia Water Department dated August 31, 2007. A general description of Mr. Newman's comment followed by our reply is listed below.

1. **Comment 1 – Volume I, Section III Methodology, Applicability of the Direct Discharge District**

    a. This is a new interpretation by DEP. The 1982 Allegheny County Pilot plan approved by DEP, that was given to Counties as the procedure to use on how Act 167 Plans should be completed interpreted that "no greater discharge" meant on a watershed-wide basis, taking into account the accumulated flows in the stream, not just leaving the site. *It stated: "When Section 13 is read in conjunction with other portions of the Act, it becomes apparent that the intent of the Act is to apply the standard to protect persons and property downstream of the site being altered and not immediately adjacent to the site. In other words, Section 13 is not spatially limited; it applies not only as the runoff leaves the site, but as far as its impacts can be reasonably determined. ... Section 3 indicates that the Act was intended to manage runoff at the watershed level." "Section 13(2) permits changes in runoff characteristics, including increased runoff rates, provided they do not cause harm." "In most instances, it seems that deciding when*

Section 13(2) permits increased runoff rates can be done only within the context of a watershed plan. The watershed plan should identify those areas where increasing runoff rates will not cause harm or will be beneficial. Thus, the watershed plans will result in a more defined and, therefore, a more usable, Section 13(2). It appears that DEP is now in a quandry, since many plans had been approved by DEP with the "Conditional Direct Discharge" or similar provisions, and therefore DEP would be noncompliant with their own Act. We will await DEP's official decision.

2. **Comment 2 – Volume I, Section I Introduction, Resolution of existing drainage problems by the plan**

    a. The respective sections of the manual were revised to be consistent with Act 167.

3. **Comment 3 - Volume I, Section IV Exemptions**

    a. This section of Volume I was revised to indicate that even though certain activities may be exempt from preparing a stormwater management plan they are still considered a regulated activity which is regulated by the plan and must have controls in place to manage stormwater runoff.

4. **Volume II, Appendix 3, Model Ordinance**

    a. The model ordinance was updated with similar language as provided in the DEP draft model ordinance dated June 28, 2007.
    b. ***Section 104, Statutory Authority*** - Irrelevant citations pertaining to sections 104.B and 104.C were removed from this section.
    c. ***Section 105, Applicability*** - Applying the standard across the entire municipality is at the discretion of the individual municipalities adopting the ordinance.
    d. ***Section 106, Exemptions*** – The model ordinance only allows for exemptions from plan submission and peak rate control for activities meeting the specified area limitations. Sections 106.B5, B.6 and B.7 were deleted. The maintenance exemption was removed.
    e. ***Article II, Section 202, Definitions*** – The definitions were revised to be consistent with those definitions contained in the latest version of the PADEP Model Ordinance. In certain instances the definitions from the PADEP Model Ordinance were inserted verbatim into the chapter in other instances the definitions contained in the draft version were retained because they were believed to be more descriptive.

f. ***Article III, Section 304, Drainage Plan Review*** – This section was retained in the model ordinance as it describes the procedures used to review the drainage plan and ensure it is consistent with the plan.
g. ***Article III, Section 304.J*** – This section was revised to indicate that only construction permits will be revoked. The wording supplied by the PADEP pertaining to meeting State Water Quality Requirements was added to Article I, Section 109.
h. ***Article III, Section 402 Permit Requirements by Other Governmental Entities*** – The list of other possible permits that an applicant may need to obtain for a project was deleted and the section revised to indicate that compliance with the ordinance does not relieve the applicant from obtaining all necessary permits for the project.

5. **General Comment 1 - References in the Municipal Handbook** – The suggested references were added to the Municipal Handbook.

6. **General Comment 2 - Volume II Appendix 3, Model Ordinance** – References to the municipal engineer were replaced with municipality in those sections deemed appropriate.

   a. ***Section 401.D*** - The portion of this section which was considered potentially objectionable to the PADEP was deleted from the ordinance.
   b. ***Section 301.E*** – This portion of the Model Ordinance was removed and replaced with Section 301.G from the PADEP Model Ordinance.
   c. ***Section 401.H and I*** – The respective sections were deleted from the Model Ordinance.
   d. ***Section 108 from the PADEP Model ordinance*** – The wording from this section was added to section 402 of the Model Ordinance.
   e. ***Sections 401.K,P and R*** – Additional wording was added to the respective sections to clarify the intent of the unclear sections.
   f. ***Section 404*** – Portions of this section were reworded to clarify its intent.
   g. ***Section 408.G-I*** – As directed the respective sections dealing with No Harm and the Hardship option were deleted.
   h. ***Section 709*** – The methodology used to calculate the potential payment to a maintenance fund was revised and retained in lieu of a fee schedule. Although a fee schedule is simpler it would require routine updates. The individual municipalities may replace this section with a fee schedule if desired.

i. ***Section 801*** – The wording in this section of the Model Ordinance was replaced with the wording from the PADEP Model Ordinance.

j. ***Model Ordinance Appendices*** – The model ordinance Appendix were revised to be consist

   i. ***Consistency of Technical Content with PADEP Stormwater BMP Manual*** – The Model Ordinance was developed to be consistent with the technical content contained in the PA BMP Manual. If you are aware of any discrepancies please provide specific references.

   ii. ***Use of PDT-IDF Curves*** – The example in Appendix F has been revised to indicate that the figures contained in the Appendix are for demonstration purposes only and the readers of the ordinance should use the latest version of the PDT-IDF curves developed by PennDOT and based on the NOAA Atlas 14 data. This data is not presently available to the design community but will likely be available upon completion of this project.

   iii. ***Purpose of the Alternating Block Method*** - The alternating block method is given to provide the user of the ordinance a way of taking available data and manipulating it to develop useful stormwater data necessary for stormwater management computations.

   iv. ***Appendix H*** - The purpose of this Appendix is to provide readers of the ordinance with information related to West-Nile virus and the propensity of stormwater management features for becoming a breeding ground for mosquitoes.

   v. ***Appendix G, References*** – The PA Stormwater BMP Manual was added to the list of references for the Model Ordinance.

   vi. ***Process and Procedure Guidance*** – Specific sections

All of the comments provided to our office by the PADEP were addressed in the draft version of the Tookany/Tacony Frankford Stormwater Act 167 Plan.

Sincerely,

Leonard J. Smith, P.E.
Lehigh Valley Office

LJS:asw

Amber S. Wallace

From: Marc.Cammarata@phila.gov
Sent: Friday, August 31, 2007 2:55 PM
To: Paul A. DeBarry
Cc: Chris.Carter@phila.gov; Joanne.Dahme@phila.gov
Subject: TTF Act 167 Comments on Volume II - Plan Contents

i'm getting there - slow and steady review.
Volume II comments through Section IV.
more to come

II-2 - 2nd and 3rd Paragraphs
Replace Tacony-Frankford with Tookany/Tacony-Frankford

III-1 - A. Drainage Area - 1st paragraph
Replace steam with stream

III-2
Replace PADOT with PennDOT

III-4 - B.1. (twice)
Replace PADOT with PennDOT

III-5 9. Obstructions
Replace Tacony with Tookany/Tacony-Frankford

III-21 I. Present...
Replace FIS studies with FIS

III-23 Numerous sentences in this paragraph are really confusing - the message here is lost
...currently unaffected by stormwater or stormwater problems?
...address future more frequent flooding
... shall provide controls on future ... preventing future stormwater runoff problems.

III-23 J. Obstructions
Replace PADOT with PennDOT

III-24 K. Existing..
2nd Paragraph
What is a cross pipe?
3rd Paragraph
The sentence staring with "One is those is..." doesn't make sense.

III-28 Table of Watershed Problems
I know that we insisted that we didn't have any 'Problem Areas' but we put them in a table like this, it makes me laugh.
We obviously have accelerated erosion, sedimentation, and i am sure the Park floods occasionally. How do we document specific problem areas for a severely degraded and impaired stream?

III-29 N. Existing...
2nd Paragraph
Replace "are not any DEP designated dams" with there "are no DEP designated dams"

IV-3 B. Modeling Process
1st Paragraph - 3rd sentence
storm were network???, storm water network?

IV-4
3rd Paragraph
What do you mean there are no rain gages within the TTF Watershed boundary? The PWD maintains RG_07, RG_08, RG_13, RG_14, and RG_19
Rain Gage Zip file is attached.

IV-6 Last Paragraph
The sentence does not make sense.

marc

Marc J Cammarata, P.E.
Environmental Projects Engineer
Office of Watersheds - PWD
www.phillyriverinfo.org
215.685.4948
marc.cammarata@phila.gov

September 28, 2007

Mr. Marc Cammarata
Philadelphia Water Department
Office of Watersheds
1101 Market Street, 4th Floor
Philadelphia, PA 19107

RE: Tookany/Tacony-Frankford Watershed Act 167 - Response to Comments on Volume II

BL No.: 2004-1621-00

Dear Mr. Cammarata:

We have reviewed the comments from the Philadelphia Water Department (PWD) pertaining to the pre-draft version of the Tookany/Tacony-Frankford Watershed Act 167 Plan which were provided in an email to our office dated August 31, 2007 and authored by you. We have made the following revisions to the plan based upon your comments:

1. **Page II-2, 2nd and 3rd Paragraphs – Replace Tacony-Frankford with Tookany/Tacony-Frankford.**

    a. The change was made as indicated.

2. **Page III-1, Section A. Drainage Area, 1st paragraph – Replace steam with stream.**

    a. The change was made as indicated.

3. **Page III-2 – Replace PADOT with PennDOT.**

    a. The change was made as indicated.

4. **Page III-4, Section B.1. (twice) – Replace PADOT with PennDOT.**

    a. The change was made as indicated.

5. **Page III-5, Number 9, Obstructions – Replace Tacony with Tookany/Tacony-Frankford.**

a. The change was made as indicated.

6. **Page III-21, Section I. – Replace FIS studies with FIS.**

    a. The change was made as indicated.

7. **Page III-23 – Numerous sentences in this paragraph are really confusing. The message here is lost:**
    - ...currently unaffected by stormwater or stormwater problems?
    - ...address future more frequent flooding
    - ...shall provide controls on future...preventing future stormwater runoff problems.

    a. The paragraph was revised to clarify its intent.

8. **Page III-23, Section J., Obstructions – Replace PADOT with PennDOT.**

    a. The change was made as indicated.

9. **Page III-24, Section K., 2nd Paragraph – What is a cross pipe?**

    a. The sentence was revised to provide a description of a cross pipe.

10. **Page III-24, Section K., 3rd Paragraph – The sentence staring with "One is those is..." doesn't make sense.**

    a. The paragraph was revised to clarify its intent.

11. **Page III-28, Table of Watershed Problems – I know that we insisted that we didn't have any 'Problem Areas' but we put them in a table like this, it makes me laugh. We obviously have accelerated erosion, sedimentation, and I am sure the Park floods occasionally. How do we document specific problem areas for a severely degraded and impaired stream?**

    a. Specific problem areas are typically addressed in Table III-6. For a severely degraded stream a section or table listing the problems could be added to the plan documenting the stream's condition; however this information was not included in the plan.

12. **Page III-29, Section N., 2nd Paragraph – Replace "are not any DEP designated dams" with there "are no DEP designated dams."**

    a. The change was made as indicated.

13. Page IV-3, Section B., 1st Paragraph, 3rd sentence – Storm were network???, storm water network?

   a. The change was made as indicated.

14. Page IV-4, 3rd Paragraph – What do you mean there are no rain gages within the TTF Watershed boundary? The PWD maintains RG_07, RG_08, RG_13, RG_14, and RG_19. Rain Gage Zip file is attached.

   a. Eight gages were used in the model. The gages used in the model were indicated in the plan.

15. Page IV-6, Last Paragraph – The sentence does not make sense.

   a. The sentence was revised to clarify its intent.

All of the comments contained in PWD email were addressed in the draft version of the Tookany/Tacony Frankford Stormwater Act 167 Plan.

Sincerely,

Leonard J. Smith, P.E.
Lehigh Valley Office

LJS:asw

Pennsylvania Department of Environmental Protection

Rachel Carson State Office Building
P.O. Box 8775
Harrisburg, PA 17105-8775

September 8, 2008

Bureau of Watershed Management 717-787-6827

CERTIFIED MAIL NO. 7099 3220 0003 4528 0729

Ms. Joanne Dahme
Philadelphia Water Department
1101 Market Street
ARAMARK Tower - 5th Floor
Philadelphia, PA 19107

Mr. Kenneth Hughes
Montgomery County Planning Commission
Montgomery County Courthouse
P.O. Box 311
Norristown, PA 19404-0311

Re: Draft Stormwater Management Plan for
Tookany/Tacony-Frankford Watershed
Philadelphia and Montgomery Counties

Dear Ms. Dahme and Mr. Hughes:

The Department of Environmental Protection (DEP) has reviewed the draft Stormwater Management Plan (SMP) submitted on May 21, 2008 for the Tookany/Tacony-Frankford (TTF) watershed located in Philadelphia and Montgomery Counties. A conference call was held on August 25, 2008 to discuss issues with the plan. Responses during the conference call are listed below. In addition, DEP reviewed the December 2005 Tookany/Tacony-Frankford Integrated Watershed Management Plan (TTF IWMP) and has provided comments below. The SMP is not consistent with Act 167 or the Phase II Tacony-Frankford designated watershed grant agreement for the following reasons:

Stormwater Management Act

- The plan does not fully comply with Section 5 of the Stormwater Management Act. The following portions of (b) in Section 5 are not addressed in the SMP:

    1. (4) An analysis of present and projected development in flood hazard areas, and its sensitivity to damages from future flooding or increased runoff. Map III-8 indicates development within the floodplain, however, there is no sensitivity

analysis from future flooding or increased runoff in the plan. The TTF IWMP satisfies this portion of the Act.

2. (5) A survey of existing drainage problems and proposed solutions. The survey in the report is complete, but there needs to be tangible solutions with recommended locations and a timeframe for when the solutions will be implemented. There is wording in the solutions section (i.e., could, may, would) that suggests the solutions will not be implemented. On page III-30, it states that "actual solutions to the watershed's problems require the development of a project-specific hydraulic model to fully ascertain the scope of the problem and the magnitude of the solution needed to resolve the problem". The model in the plan provides a good basis to identify locations throughout the watershed where drainage solutions are to be implemented. In addition, consideration of modification to the landform as a long-term solution to the drainage problems, as suggested on page III-29 of the plan, may further impair the stream by causing increased erosion and sedimentation. The TTF IWMP satisfies this portion of the Act.

3. (7) An assessment of alternative runoff control techniques and their efficiency in the particular watershed. This assessment is not completed in the plan, however, the TTF IWMP satisfies this portion of the Act.

4. (9) A designation of those areas to be served by storm water collection and control facilities within a ten-year period, an estimate of the design capacity and costs of such facilities, a schedule and proposed methods of financing the development, construction and operation of such facilities, and an identification of the existing and proposed institutional arrangements to implement and operate the facilities. This section is not addressed in the plan, however, the TTF IWMP satisfies this portion of the Act.

5. (11) Criteria and standards for the control of storm water runoff from existing and new development which are necessary to minimize dangers to property and life and carry out the purposes of this act. Five (5) standards are discussed in Section V.C of the plan: maintain groundwater recharge, maintain or improve Water Quality (WQ), reduce channel erosion, manage overbank flood events, and manage extreme flood events. To maintain groundwater recharge, the plan suggests applying the Maryland Method. This method is not consistent with the PADEP manual. Please suggest a different method to maintain groundwater recharge that is consistent with the Best Management Practices (BMP) manual. Secondly, please ensure that all Waters of the Commonwealth are subject to Chapter 93 Antidegradation regulations, not just High Quality or Exceptional Value designated surface water. Thirdly, please define how extreme caution shall be exercised in highway SMPs as is discussed on page V-8 of the plan. Lastly, please explain how a Conditional Direct Discharge District described on page V-17 will satisfy Section 13 of the SM Act, which requires the maximum

rate of stormwater runoff is no greater after development than prior to development activities.

6. (12) Priorities for implementation of action within each plan – Section VII.F outlines prioritizing a list of storm drainage problems. The TTF IWMP satisfies this portion of the Act.

Model Ordinance

- The following portions of the model ordinance within the SMP must be addressed:

  1. State Water Quality requirements are not referenced in Article III.
  2. Impervious, volume control, or rate control language are not used in Article III.

Specific plan comments

- Please change Natural to National on page III-23 of the plan.

Phase II Tookany/Tacony-Frankford Watershed grant agreement

- The following items of the grant agreement must be addressed:

  1. Stage A on page 16 – 1. Data collection, 7. Stormwater collection and control facilities, and 13. Engineering and planning facilities related to stormwater. The TTF IWMP satisfies this portion of the Act.

  2. A.2 Watershed Characterization on page 18 – determine ranges of hydraulic geometry relationships based on bankfull discharges; stream survey (cruise 25 miles) to characterize measured reach morphology, disturbance, channel stability, and qualitative habitat assessment on the habitat evaluation field form using digital photos at strategic points; 5 cross sections/mile (photos); bank pins and scour chains (30 pins and 10 chains); stream rankings; and protection and restoration strategies for existing and potential stream impacts. The TTF IWMP satisfies this portion of the Act.

  3. A.3 on page 20 – municipal ordinance review. The TTF IWMP satisfies this portion of the Act.

  4. Page 26 – B.6 does not address f, g, h, i, j, k, l, m, n, o, p, and q and may address b, d, and k. The TTF IWMP satisfies this portion of the Act.

5. D.1 on page 31 – 1. Land use runoff impacts, stormwater collection system runoff impacts, available runoff control techniques, and their efficiencies in watershed, 5. Recommendations for solutions to existing drainage problems, and 6. Recommendations for new drainage facilities. The TTF IWMP satisfies this portion of the Act.

Clearly, the TTF IWMP satisfies many of the Act 167 requirements listed in this letter. It is imperative that the TTF IWMP be included by reference in the model ordinance and included as an addendum to the SMP that was submitted to DEP. Please respond to the remaining comments, add the appropriate language to the model ordinance, and include the TTF IWMP as an addendum to the SMP.

We have not performed a technical review of the engineering analysis. We expect to complete the technical review by the end of September. We will notify you of the technical review results in a separate letter.

Thank you for your cooperation in working with DEP toward managing stormwater in Philadelphia and Montgomery Counties. If you need additional information or have any questions, please call me at (717) 772-5628.

Sincerely,

Jennifer Kehler

Jennifer Kehler
Water Program Specialist
Stormwater Planning & Management
Division of Waterways, Wetlands, and
Stormwater Management

Barry A. Newman

Barry A. Newman, M.S., P.E.
Chief, Stormwater Planning & Management
Division of Waterways, Wetlands, and
Stormwater Management

cc: Mr. Jarrell, MCPC

October 6, 2008

Jennifer Kehler
Pennsylvania Department of Environmental Protection
Rachel Carson State Office Building
P.O. Box 8775
Harrisburg, PA 17105-8775

RE: Tookany/Tacony-Frankford Watershed Stormwater Management Plan Response to DEP Comments dated September 8th, 2008, Received on September 23, 2008

BL No.: 2006-1922-01

Dear Ms. Kehler:

This letter is in response to the review comments provided by Jennifer Kehler and Barry Newman of the Pennsylvania Department of Environmental Protection, dated September 8, 2008.

We have received your comments to the Tookany/Tacony-Frankford (TTF) Watershed Act 167 Plan, Model Ordinance, and grant agreement dated September 8, 2008. The review was very thorough and helpful. The majority of comments in your review letter stated that the Tookany/Tacony-Frankford Integrated Watershed Management Plan (TTF-IWMP) satisfied portions of the Act that were referred to. Therefore, the TTF-IWMP was included in the Tookany/Tacony-Frankford Watershed Act 167 Plan, further referred to as the Plan, and as an Appendix. It was also referenced in the Model Ordinance. Based on your review comments, the following changes have been made to the Model Ordinance:

1. The TTF IWMP has now been included as part of the Plan and is found in Plan Appendix 4 to address this comment.

2. The TTF IWMP has now been included as part of the Plan and is found in Plan Appendix 4 to address this comment.

3. The TTF IWMP has now been included as part of the Plan and is found in Plan Appendix 4 to address this comment.

4. The TTF IWMP has now been included as part of the Plan and is found in Plan Appendix 4 to address this comment.

The Maryland method has been removed from Section V.C in the groundwater recharge section of the Model Ordinance. The groundwater recharge for Montgomery County and Philadelphia County is consistent with Section 303.2.b of the DEP Model Ordinance. Also the water quality volume for Montgomery County has been changed to be "1 inch over all proposed impervious surfaces" which is consistent with Section 303.2.B of the DEP Model Ordinance. WQ_v for Philadelphia County is also consistent with Section 302.2.b.

The wording has been changed on page V-7 to say "All waters of the Commonwealth shall be subject to the DEP's Chapter 93 Antidegradation Regulations".

On page V-8 Bullet 1 and 3 under the sentence which is about large highways, the wording has been changed to say "Extreme caution shall be exercised through innovative design techniques to properly filter contaminants associated with highways" and "Extreme caution shall be exercised through innovative design techniques..." Corresponding text in model ordinance for this has also been updated.

The Conditional Direct Discharge District criteria was discussed in the February 1, 2008 11 a.m. conference call between PWD (Joanne Dahme, Mark Camaratta, Chris Carter), its consultants (Jim Smullen, CDM; Paul DeBarry, BLE) and DEP (Barry Newman). The district does require that the maximum rate of stormwater runoff is no greater after development than prior to development activities for up through the 5-year storm and must meet infiltration, water quality volume, and streambank erosion requirements, meeting the requirements of the Act. Due to its location of this area in relation to the mouth of the watershed, PWD suggested this area safely release the larger storm peak flows so as to not hold back the water form when the watershed peaked. It was agreed upon in that meeting and language developed during that meeting stating that if " *** – If the proposed development results in stormwater discharge that exceeds stormwater system capacity, increases the FEMA regulated water surface elevation, causes a combined sewer overflow, or degrades receiving waters, the design specifications presented in these Regulations may be applied to proposed development activities as warranted to protect public health, safety, or property.*" were added to Table 105.1 of the Model Ordinance and "*The Municipality may require a downstream hydraulic impact analysis to ensure that downstream structures can pass any increase in flow, and that the increased flow will not affect the FEMA regulated water surface elevation*" were added to Section 106.A – Philadelphia Portion No. 4 of the Model Ordinance, Section 13 of the SM Act would be satisfied. This language also then satisfies Section 13 (2) of the SM Act which states that "***or*** *(2) to manage the quantity, velocity, and direction of resulting storm water runoff in a manner which otherwise adequately protects health, and property from possible injury".* Table 408 of the Model Ordinance also states "*When adequate capacity in the downstream system does not exist and will not be provided through improvements, the proposed conditions peak rate of runoff must be controlled to the existing conditions peak rate as required in District A provisions (i.e., 10-year proposed conditions flows to 10-year existing conditions flows) for the specified design storms."*

5. The TTF IWMP has now been included as part of the Plan and is found in Plan Appendix 4 to address this comment.

Model Ordinance

1. Article III of the TTF Model Ordinance is Drainage Plan requirements and Article IV is Stormwater Management. The suggested language "Meet State Water Quality Requirements as defined in Article II, and any more stringent requirements set forth by the Municipality" has therefore been added to Section 401 N.

2. These items are addressed in Article IV.

Specific Plan Comments

1. "Natural" has been changed to "national" on Page III-23 of the Plan.

Phase II Tookany/Tacony-Frankford Watershed Grant Agreement

1. 1 through 5. For all items of this section, the TTF IWMP has been included in Plan Appendix 4 to address these issues.

Your review letter has been very helpful and will be included as an Appendix to the Plan. We thank you for your input and look forward to the successful implementation of the TTF Act 167 Plan and Model Ordinance.

Sincerely,

Joanne Dahme
Philadelphia Water Department

c: Paul A. DeBarry, Borton-Lawson

PLAN APPENDIX 2

MODEL ORDINANCE

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TOOKANY/TACONY-FRANKFORD WATERSHED
MODEL ACT 167 and NPDES STORMWATER
MANAGEMENT ORDINANCE

OCTOBER 10, 2008

PLEASE HAVE YOUR SOLICITOR REVIEW THE ENCLOSED ORDINANCE AND CHECK THE APPLICABILITY OF ALL SECTIONS TO YOUR MUNICIPALITY

If you have any questions, please call
Chris Carter, Philadelphia Water Department, at 215-685-6245

[Note: According to DEP requirements, this Model Ordinance must include specific text taken directly from the NPDES II Model Ordinance (effective August 2, 2003). Provisions grayed out in this Model Ordinance are direct language from the NPDES Model Ordinance. This shading is for your information only and should be removed before adopting the ordinance.]

MUNICIPAL ORDINANCE INTRODUCTION

Municipalities within the Commonwealth of Pennsylvania are empowered to regulate land use activities that affect runoff by the authority of the Act of October 4, 1978, 32 P.S., P.L. 864 (Act 167) Section 680.1 et seq., as amended, The "Stormwater Management Act." Act 167 requires that:

- Counties prepare a watershed stormwater management plan in conformance with the requirements of Act 167 for each watershed within their boundaries.
- The plans evaluate present and future runoff within the watershed and make technical recommendations for the control and management of runoff from new development (both quantity and quality).
- Municipalities implement the plan via a Stormwater Ordinance developed as part of the plan.
- Developers control the quantity and quality of runoff from new development (including redevelopment) in accordance with each Municipality's implementing Ordinance.

The Stormwater Management Act emphasizes locally administered stormwater programs with the watershed municipalities taking the lead role. Implementation and enforcement of the watershed plan standards and criteria will require the municipalities to adopt the appropriate Ordinance provisions Ordinances that address subdivision and land development. As part of the preparation of the Tookany/Tacony-Frankford Watershed Stormwater Management Plan, a Model Municipal Ordinance has been prepared that will implement the Plan provisions presented in the Ordinance as a single purpose Ordinance that could be adopted by each Municipality with minor changes to fulfill the needs of a particular Municipality. This could be adopted essentially "as is" (with some modification) by the municipalities. Provisions would also be required in the Subdivision and Land Development Ordinance to ensure that activities regulated by the Ordinance were appropriately referenced.

In addition to adopting the Ordinance itself, the municipalities would also have to revise their existing subdivision, land development, and zoning Ordinances to incorporate the necessary linking provisions. These linking provisions would refer to any applicable regulated activities within the watershed to the single purpose Ordinance. Key provisions of the Model Stormwater Ordinance include the drainage standards and criteria, performance standards for stormwater management, and maintenance provisions for stormwater facilities.

Finally, the Model Stormwater Ordinances should be understandable, applied fairly and uniformly throughout the watershed, and should not discourage creative solutions to stormwater management problems. It would be desirable for the municipalities to adopt a uniform regulatory approach for the Tookany/Tacony-Frankford Watershed.

The implementation of the runoff control strategy for development will be through municipal adoption of the appropriate Ordinance provisions. The "Tookany/Tacony-Frankford Watershed Act 167 Stormwater Management Ordinance" will not completely replace the existing storm drainage Ordinance provisions currently in effect in the municipalities. The reasons for this are as follows:

- Not all of the municipalities in the Tookany/Tacony-Frankford Watershed are completely within the watershed. For those portions of the Municipality outside Tookany/Tacony-Frankford Watershed, the existing Ordinance provisions would still apply.
- Permanent and temporary stormwater control facilities are regulated by the Act 167 Ordinance. Stormwater management and erosion and sedimentation control during construction would continue to be regulated under the existing Stormwater Ordinance and Chapter 102 Erosion and Sediment and Pollution Controls, Title 25 of DEP Regulations.
- The Act 167 Ordinance contains only those minimum stormwater runoff control criterion and standards which are necessary or desirable from a total watershed perspective. Additional stormwater management design criteria (i.e., inlet spacing, inlet type, collection system details, etc.) which should be based on sound engineering practice should be regulated under the current Ordinance provisions or as part of the general responsibilities of the municipal engineer.

The following Model Ordinance has been developed specifically for municipalities within the Tookany/Tacony-Frankford Watershed in order to implement the Tookany/Tacony-Frankford Watershed Stormwater Management Plan which includes the Tookany/Tacony-Frankford Integrated Watershed Management Plan (TTF-IWMP). Municipalities may elect to either create a single-purpose Stormwater Ordinance (recommended) or amend existing subdivision or zoning Ordinances to implement the associated stormwater management plan.

All of the provisions within this Model Ordinance (unless specifically designated as optional) are required to be part of the Municipal Stormwater Ordinance or other Ordinances implementing the requirements of the stormwater management plan.

Organization:

This Ordinance contains the following eight articles, each with specific provisions.

Article I - General Provisions: This article includes general administrative provisions including applicable land areas and regulated activities. This article also includes the stormwater management exemption criteria.

Article II - Definitions: This article provides a list of common terms and associated definitions used throughout the Ordinance.

Article III - Drainage Plan Requirements: This article lists the specific requirements for submittal, content, and review of drainage plans required by the Ordinance.

Article IV - Stormwater Management: This article represents the technical provisions for stormwater management within the Tookany/Tacony-Frankford Watershed and includes the stormwater management district implementation provisions, water quality requirements, design criteria, calculation methods, and erosion and sedimentation requirements.

Article V - Inspections: This article describes inspection procedures for permanent stormwater management and water quality facilities.

Article VI - Fees and Expenses: This article contains the provisions for a municipal review fee.

Article VII - Maintenance Responsibilities: This article outlines the applicants' responsibilities for operation and maintenance of stormwater management facilities.

Article VIII - Prohibitions: This article, required by NPDES Phase II, prohibits the discharge of non stormwater flows to any municipal separate storm sewer system with the exception of certain activities found not to contribute pollution to surface waters.

Article IX - Enforcement and Penalties: This article describes municipal enforcement procedures, remedies, and the appeals process.

Appendices: This section of the Ordinance contains nine technical support appendices necessary to implement the Ordinance provisions.

Please note that the plan and associated Ordinance provisions were developed under the authority of and in strict conformance with the requirements of Act 167. These documents were prepared in consultation with a WPAC comprised of designated representatives from each of the watershed municipalities, County Planning and Conservation District staff. Proposed Ordinance provisions were reviewed and accepted by a majority of the voting members (noted above) who attended the meetings.

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. These Ordinances must regulate development within the Municipality in a manner consistent with the watershed stormwater plan and the provisions of the Act.

The following amendment is required for municipalities that issue an occupancy permit:

- An Occupancy Permit shall not be secured or issued unless the provisions of the Tookany/Tacony-Frankford Watershed Stormwater Management Ordinance have been followed. The Occupancy Permit shall be required for each lot owner and/or developer of all major and minor subdivisions and land development in the Municipality

For municipalities without an Occupancy Permit, they may want to adopt the above draft and include other regulatory items in the occupancy permit requirement for their own use.

ORDINANCE REQUIREMENTS:

The following Ordinance provisions <u>must be retained</u> when a Municipality either elects to create a single-purpose stormwater Ordinance or amends existing subdivision or zoning Ordinances to implement the stormwater management plan.

- Article I - General Provisions
- Article II - Definitions
- Article III - Drainage Plan Requirements – Section 302

- Article IV - Design Criteria for Stormwater Management Facilities Sections 401, 402, 403, 404, 405, 406, 407, 408 (except G and H), 409, 410
- Article V - Inspections (language may be modified by Municipality)
- Article VII - Maintenance (language may be modified by Municipality)
- Article VIII - Prohibitions
- Article IX - Enforcement and Penalties (only when enacting a single-purpose Ordinance)

The following Ordinance provisions are optional, but recommended to be retained:

- Section 408. G-H
- Section 709. Municipal Stormwater Control and BMP Operation and Maintenance Fund
- Article VI - Fees and Expenses

All other provisions are optional and may be modified to be consistent with other Municipal Ordinances related to land development.

NOTE: If a Municipality chooses to use the Model Ordinance to implement the stormwater management plan, it is recommended that the Ordinance be submitted to the municipal solicitor, engineer, and DEP for review prior to enactment.

NPDES Requirements

Federal regulations approved October 1999 required operators of small municipal separate storm sewer systems (MS4s) to obtain NPDES Phase II permits from DEP by March 2003. (NPDES II is an acronym for the National Pollutant Discharge Elimination System Phase II Stormwater Permitting Regulations.) This program affects all municipalities in “urbanized areas” of the state. This definition applies to all Tookany/Tacony-Frankford Watershed municipalities. Therefore, all municipalities within the Tookany/Tacony-Frankford Watershed will be subject to the NPDES Phase II requirements mandated by the Federal Clean Water Act as administered by DEP. For more information on NPDES II requirements, contact the DEP Regional Office.

Implementation

In order to aid the municipalities and developers in the implementation process, flow charts have been developed as shown in Ordinance Appendix.

Administration

Due to difference in administration of the building permit process in Philadelphia County, the applicability requirements for the Philadelphia portion of the watershed will be based upon earth disturbance as opposed to the amount of proposed impervious area. Table 105.1a summarizes the applicability requirements for the municipalities in Philadelphia and Montgomery Counties. Table 105.1b summarizes the applicability requirements for the City of Philadelphia.

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TOOKANY/TACONY-FRANKFORD WATERSHED STORMWATER MANAGEMENT ORDINANCE

Implementing the Requirements of the Tookany/Tacony-Frankford Watershed Stormwater Management Plan

ORDINANCE NO.________ OF __________

_[*Municipality*], __[*County*] _ COUNTY,

PENNSYLVANIA

Adopted at a Public Meeting held on

_________________, 20__

ARTICLE I- GENERAL PROVISIONS

Section 101. Short Title

This Ordinance shall be known as the “Tookany/Tacony-Frankford Watershed Stormwater Management Ordinance” and may sometimes be cited as the Tookany/Tacony-Frankford Watershed Stormwater Management Ordinance.

Section 102. Statement of Findings

The governing body of the Municipality finds that:

A. Inadequate management of accelerated runoff of stormwater resulting from development throughout a watershed increases flows and velocities, contributes to erosion and sedimentation, overtaxes the carrying capacity of streams and storm sewers, greatly increases the cost of public facilities to carry and control stormwater, undermines flood plain management and flood control efforts in downstream communities, reduces groundwater recharge, threatens public health and safety, and increases non-point source pollution of water resources.

B. A comprehensive program of stormwater management, including reasonable regulation of development and activities causing accelerated runoff, is fundamental to the public health, safety and welfare and the protection of people of the Commonwealth, their resources and the environment.

C. Stormwater is an important water resource, which provides groundwater recharge for water supplies and base flow of streams, which also protects and maintains surface water quality.

D. Inadequate planning and management of stormwater runoff resulting from land development throughout a watershed can also harm surface water resources by changing the natural hydrologic patterns, accelerating stream flows (which increase scour and erosion of stream beds and stream banks, thereby elevating sedimentation), destroying aquatic habitat, and elevating aquatic pollutant concentrations and loadings such as sediments, nutrients, heavy metals, and pathogens. Groundwater resources are also impacted through loss of recharge.

E. Federal and state regulations require certain municipalities to implement a program of stormwater controls. These municipalities are required to obtain a permit for stormwater discharges from their separate storm sewer systems under the NPDES.

F. Impacts from stormwater runoff can be minimized by using project designs that maintain the natural hydrologic regime and sustain high water quality, groundwater recharge, stream baseflow, and aquatic ecosystems. The most cost-effective and environmentally advantageous way to manage stormwater runoff is through nonstructural project design that minimizes impervious surfaces and sprawl, avoids sensitive areas (i.e., stream buffers, floodplains, steep slopes), and considers topography and soils to maintain the natural hydrologic regime.

G. Public education on the control of pollution from stormwater is an essential component in successfully addressing stormwater.

H. Nonstormwater discharges to municipal separate storm sewer systems can contribute to pollution of waters of the Commonwealth by the Municipality.

Section 103. Purpose

The purpose of this Ordinance is to promote the public health, safety, and welfare within the Tookany/Tacony-Frankford Watershed by maintaining the natural hydrologic regime and by minimizing the harms and maximizing the benefits described in Section 102 of this Ordinance, through provisions designed to:

A. Meet legal water quality requirements under state law, including regulations at 25 Pa. Code Chapter 93 to protect, maintain, reclaim and restore the existing and designated uses of the waters of this Commonwealth.

B. Conserve the natural drainage systems as much as possible.

C. Manage stormwater runoff close to their source.

D. Provide procedures and performance standards for watershed-wide stormwater planning and management

E. Maintain groundwater recharge, to prevent degradation of surface and groundwater quality and to otherwise protect water resources.

F. Prevent scour and erosion of stream banks and stream beds.

G. Provide proper operation and maintenance of all permanent Stormwater Management (SWM) Best Management Practices (BMPs) that are implemented within the Municipality.

H. Provide standards to meet NPDES permit requirements.

I. Promote alternative project designs and layouts that minimize the impacts on surface and groundwater.

J. Promote nonstructural best management practices (BMPs).

K. Minimize increases in runoff stormwater volume.

L. Minimize impervious surfaces.

M. Provide review procedures and performance standards for stormwater planning and management.

N. Utilize and preserve existing natural drainage systems as much as possible.

O. Maintain existing baseflows and quality of streams and watercourses, where possible.

P. Address the quality and quantity of stormwater discharges from the development site.

Q. Implement an illegal discharge detection and elimination program that addresses non-stormwater discharges into the Municipality's separate storm sewer system.

R. Preserve the flood-carrying capacity of streams.

Section 104. Statutory Authority

The Municipality is empowered to regulate land use activities that affect runoff and surface and groundwater quality and quantity by the authority of:

A. Primary Authority.

The Act of October 4, 1978, P.L. 864 (Act 167), 32 P.S. Section 680.1, et seq., as amended, the "Storm Water Management Act" and the (appropriate municipal code).

B. Secondary Authority.

The authority of the Act of July 31, 1968, P.L. 805, No. 247, The Pennsylvania Municipalities Planning Code, as amended.

Section 105. Applicability/Regulated Activities

All Regulated Activities and all activities that may affect stormwater runoff, including Land Development and Earth Disturbance Activity, are subject to regulation by this Ordinance. In addition, all applicable development in Philadelphia County must comply with the City of Philadelphia's stormwater regulations. These regulations are available online at: http://www.phillyriverinfo.org/programs/subprogrammain.aspx?Id=Regulations. In addition, the user must comply with the latest version of "Stormwater Management Guidance Manual" (currently Version 2.0), prepared by the Philadelphia Water Department Office of Watersheds. This manual is available online at http://www.phillyriverinfo.org/PWDDevelopmentReview/RequirementsLibrary.aspx?. The site contains several checklists which have been developed to assist the user in complying with these regulations.

TABLE 105.1
ORDINANCE APPLICABILITY FOR THE PHILADELPHIA COUNTY PORTION OF THE WATERSHED

Ordinance Article or Section	Type of Project	Earth Disturbance Associated with Development		
		0-15,000 sq. ft.	15,000 sq. ft.-1 acre	> 1 acre
Article III Drainage Plan Requirements	New Development	N/A**	Yes	Yes
	Redevelopment	N/A**	Yes	Yes
Section 404 Nonstructural Project Design Requirements	New Development	N/A**	Yes	Yes
	Redevelopment	N/A**	Yes	Yes
Section 406 Water Quality Requirements	New Development	N/A**	Yes	Yes
	Redevelopment	N/A**	Yes	Yes
Section 407 Channel Protection / Streambank Erosion Requirements	New Development	N/A**	Yes	Yes
	Redevelopment	N/A**	Exempt	Yes (Alternate Criteria)
Section 408 Flood Control / Stormwater Peak Rate Control and Management Districts Requirements	New Development	N/A**	Yes	Yes
	Redevelopment	N/A**	Yes (Alternate Criteria)	Yes (Alternate Criteria)

Yes (Alternate Criteria) – Redevelopment disturbing more than one acre which reduces the DCIA from predevelopment conditions by at least 20% is exempt from the Channel Protection Requirements of this Ordinance, and redevelopment greater than or equal to 15,000 square feet which reduces the DCIA from predevelopment conditions by at least 20% are exempt from the Flood Control Requirements of this Ordinance (See Section 106, Philadelphia County Portion of the Watershed, for further details).

N/A – Not Applicable, development project is not subject to requirements of indicated Regulations section. Voluntary controls are encouraged.

Exempt – Development project is not subject to requirements of indicated Regulations section.

** – If the proposed development results in stormwater discharge that exceeds stormwater system capacity, increases the FEMA regulated water surface elevation, causes a combined sewer overflow, or degrades receiving waters, the design specifications presented in these Regulations may be applied to proposed development activities as warranted to protect public health, safety, or property.

Section 106. Exemptions

A. Exemptions for Land Use Activities

Note: Philadelphia County and Montgomery County will follow different Exemption Criteria.

Montgomery County Portion of the Watershed:

1. Disconnected Regulated Activities (Regulated Activities that create Disconnected Impervious Areas) smaller in area than 250 sq. ft. are exempt from the peak rate control (Section 408) and drainage plan (Section 302) preparation requirements of this Ordinance.

2. Disconnected Regulated Activities (Regulated Activities that create Disconnected Impervious Areas) equal to or greater than 250 sq. ft. and less than 1,000 sq. ft. are exempt only from the peak rate control (Section 408) requirement of this Ordinance.

3. Agricultural plowing and tilling are exempt from the rate control and drainage plan preparation requirements of this Ordinance provided the activities are performed according to the requirements of 25 Pa. Code Chapter 102.

4. Forest management and timber operations are exempt from the rate control and Drainage plan preparation requirements of this Ordinance provided the activities are performed according to the requirements of 25 Pa. Code Chapter 102.

Philadelphia County Portion of the Watershed:

1. Development, including new development and redevelopment, that results in an area of Earth Disturbance less than fifteen thousand (15,000) square feet is exempt from all requirements of this Ordinance. However, applicants must still meet coastal water quality requirements from other programs if applicable as described in Table 105.1.

2. Redevelopment that results in an area of Earth Disturbance greater than or equal to fifteen thousand (15,000) sq. ft., but less than one (1) acre, is exempt from the Channel Protection/Streambank Erosion (Section 407) Requirements of this Ordinance.

3. Redevelopment that results in an area of Earth Disturbance greater than or equal to one (1) acre and reduces the predevelopment DCIA (Directly Connected Impervious Areas) on the site by at least 20% is exempt from the Channel Protection/Streambank Erosion (Section 407) and Flood Control/Peak Rate Control (Section 408) Requirements of this Ordinance.

4. Land Development, including new development or redevelopment located in Stormwater Management District 'C', is permitted to directly discharge for all storms greater than the 2-year recurrence interval. This can be accomplished by configuring the outlet structure not to control the larger storms or by a bypass channel that diverts only the 2-year stormwater runoff into the basin or conversely, diverts flows in excess of the 2-year storm away from the basin. The Municipality may require a downstream hydraulic impact analysis to ensure that downstream structures can pass any increase in flow, and that the increased flow will not affect the FEMA regulated water surface elevation.

B. Additional Exemption Criteria:

1. Exemptions from any provisions of this Ordinance shall not relieve the applicant from the requirements in Section 401 of this Ordinance.

2. Exemption Responsibilities - An exemption shall not relieve the Applicant from implementing such measures as are necessary to protect public health, safety, and property.

3. Drainage Problems - If a drainage problem is documented or known to exist downstream of or is expected from the proposed activity, then the Municipality may require the Applicant to comply with this entire Ordinance.

4. Emergency Exemption - Emergency maintenance work performed for the protection of public health, safety, and welfare may be exempt from this Ordinance. A written description of the scope and extent of any emergency work performed shall be submitted to the [*Municipality*] within two (2) calendar days of the commencement of the activity. If the [*Municipality*] finds that the work is not an emergency, then the work shall cease immediately, and the requirements of this Ordinance shall be addressed as applicable.

5. Even though the developer is exempt from certain portions of this Ordinance, he is not relieved from complying with other regulations which may apply to the project.

6. HQ and EV Streams – An exemption shall not relieve the Applicant from meeting the special requirements for watersheds draining to identified high quality (HQ) or exceptional value (EV) waters and Source Water Protection Areas (SWPA) and requirements for nonstructural project design sequencing (Ordinance Section 404).

Section 107. Repealer

Any Ordinance or Ordinance provision of the Municipality inconsistent with any of the provisions of this Ordinance is hereby repealed to the extent of the inconsistency only.

Section 108. Severability

In the event that a court of competent jurisdiction declares any section or provision of this Ordinance invalid, such decision shall not affect the validity of any of the remaining provisions of this Ordinance.

Section 109. Compatibility with Other Ordinances or Legal Requirements

Approvals issued pursuant to this Ordinance do not relieve the Applicant of the responsibility to secure required permits or approvals for activities regulated by any other applicable code, rule, act, or Ordinance.

To the extent that this Ordinance imposes more rigorous or stringent requirements for stormwater management, the specific requirements contained in this Ordinance shall be followed.

The Municipality may after consultation with the DEP, approve measures for meeting the State Water Quality Requirements other than those in this Ordinance, provided that they meet the minimum requirements of, and do not conflict with, State law including but not limited to the Clean Streams Law.

Nothing in this Ordinance shall be construed to affect any of the Municipality's requirements regarding stormwater matters that do not conflict with the provisions of this Ordinance, such as local stormwater management design criteria (e.g., inlet spacing, inlet type, collection system design and details, outlet structure design, etc.). Conflicting provisions in other municipal Ordinances or regulations shall be construed to retain the requirements of this Ordinance addressing state water quality requirements.

ARTICLE II-DEFINITIONS

Section 201. Interpretation

For the purposes of this Ordinance, certain terms and words used herein shall be interpreted as follows:

A. Words used in the present tense include the future tense; the singular number includes the plural, and the plural number includes the singular; words of masculine gender include feminine gender; and words of feminine gender include masculine gender.

B. The word "includes" or "including" shall not limit the term to the specific example, but is intended to extend its meaning to all other instances of like kind and character.

C. The words "shall" and "must" are mandatory; the words "may" and "should" are permissive.

D. The word "person" includes an individual, firm, association, organization, partnership, trust, company, corporation, unit of government, or any other similar entity.

E. The words "used" or "occupied" include the words "intended, designed, maintained, or arranged to be used, occupied, or maintained."

Section 202. Definitions

Accelerated Erosion – The removal of the surface of the land through the combined action of man's activity and the natural processes of a rate greater than that which would occur because of natural process alone.

Agricultural Activities – The work of producing crops and raising livestock including tillage, plowing, disking, harrowing, pasturing, mushroom growing, nursery, and sod operations and installation of conservation measures. Construction of new buildings or impervious area is not considered an agricultural activity.

Alteration – As applied to land, a change in topography as a result of the moving of soil and rock from one location or position to another; also the changing of surface conditions by causing the surface to be more or less impervious; land disturbance.

Applicant – A landowner, developer or other person who has filed an application to the Municipality for approval to engage in any Regulated Activity at a project site in the Municipality.

As-built Drawings – Engineering or site drawings maintained by the contractor as he constructs the project and upon which he documents the actual locations of the building components and changes to the original contract documents. These documents, or a copy of same, are turned over to the Municipality at the completion of the project.

Bankfull – The channel at the top-of-bank or point from where water begins to overflow onto a floodplain.

Baseflow – Portion of stream discharge derived from groundwater; the sustained discharge that does not result from direct runoff or from water diversions, reservoir releases, piped discharges, or other human activities.

Bioretention – A stormwater retention area that utilizes woody and herbaceous plants and soils to remove pollutants before infiltration occurs.

BMP (Best Management Practice) – Activities, facilities, designs, measures or procedures used to manage stormwater impacts from Regulated Activities, to meet State Water Quality Requirements, to promote groundwater recharge and to otherwise meet the purposes of this Ordinance. Stormwater BMPs are commonly grouped into one of two broad categories or measures: "structural" or "non-structural." In this Ordinance, non-structural BMPs or measures refer to operational and/or behavior-related practices that attempt to minimize the contact of pollutants with stormwater runoff whereas structural BMPs or measures are those that consist of a physical device or practice that is installed to capture and treat stormwater runoff. Structural BMPs include, but are not limited to, a wide variety of practices and devices, from large-scale retention ponds and constructed wetlands, to small-scale underground treatment systems, infiltration facilities, filter strips, low impact design, bioretention, wet ponds, permeable paving, grassed swales, riparian or forested buffers, sand filters, detention basins, and manufactured devices. Structural Stormwater BMPs are permanent appurtenances to the project site.

Buffer – The area of land immediately adjacent to any stream, measured perpendicular to and horizontally from the top-of-bank on both sides of a stream (see Top-of-bank).

Channel – An open drainage feature through which stormwater flows. Channels include, but shall not be limited to, natural and man-made drainageways, swales, streams, ditches, canals, and pipes flowing partly full.

Channel Erosion – The widening, deepening, or headward cutting of channels and waterways caused by stormwater runoff or bankfull flows.

Cistern – An underground reservoir or tank for storing rainwater.

Conservation District – A conservation district, as defined in section 3(c) of the Conservation District Law (3 P. S. § 851(c)), which has the authority under a delegation agreement executed with the Department to administer and enforce all or a portion of the erosion and sediment control program in this Commonwealth..

Conveyance – A facility or structure used for the transportation or transmission of something from one place to another.

Culvert – A structure with its appurtenant works which carries water under or through an embankment or fill.

Dam – A man-made barrier, together with its appurtenant works, constructed for the purpose of impounding or storing water or another fluid or semifluid. A dam may include a refuse bank, fill, or structure for highway, railroad, or other purposes which impounds or may impound water or another fluid or semifluid.

DEP - The Pennsylvania Department of Environmental Protection.

Department – The Pennsylvania Department of Environmental Protection.

Designee – The agent of the [*County Name*] County Planning [*Commission or Department*], [*County Name*] County Conservation District, and/or agent of the Governing Body involved with the administration, review, or enforcement of any provisions of this Ordinance by contract or memorandum of understanding.

Design Professional (Qualified) – A Pennsylvania Registered Professional Engineer trained to develop stormwater management plans.

Design Storm – The magnitude and temporal distribution of precipitation from a storm event measured in probability of occurrence (e.g., a 5-year storm) and duration (e.g., twenty-four (24) hours), used in the design and evaluation of stormwater management systems. Also see Return Period.

Detention - The volume of runoff that is captured and released into the waters of this Commonwealth at a controlled rate.

Detention Basin – An impoundment designed to collect and retard stormwater runoff by temporarily storing the runoff and releasing it at a predetermined rate. Detention basins are designed to drain completely soon after a rainfall event and become dry until the next rainfall event.

Developer – A person who seeks to undertake any regulated earth disturbance activities at a project site in the Municipality.

Development – Any human-induced change to improved or unimproved real estate, whether public or private, including, but not limited to, land development, construction, installation, or expansion of a building or other structure, land division, street construction, and site alteration such as embankments, dredging, grubbing, grading, paving, parking or storage facilities, excavation, filling, stockpiling, or clearing. As used in this Ordinance, development encompasses both new development and redevelopment.

Development Site (Site) **–** The specific tract or parcel of land where any regulated activity set forth in Section 105 is planned, conducted, or maintained. See also Project Site.

Diameter at Breast Height (DBH) **–** The outside bark diameter at breast height which is defined as four and one half (4.5) feet (1.37m) above the forest floor on the uphill side of the tree.

Diffused Drainage Discharge – Drainage discharge that is not confined to a single point location or channel, including sheet flow or shallow concentrated flow.

Directly Connected Impervious Area (DCIA) – An impervious or impermeable surface which is directly connected to a stormwater drainage or conveyance system, leading to direct runoff, decreased infiltration, decreased filtration, and decreased time of concentration.

Discharge – 1. (verb) To release water from a project, site, aquifer, drainage basin, or other point of interest; 2. (noun) The rate and volume of flow of water such as in a stream, generally expressed in cubic feet per second (see Peak Discharge).

Discharge Point – The point of discharge for a stormwater facility.

Disconnected Impervious Area (DIA) – An impervious or impermeable surface which is disconnected from any stormwater drainage or conveyance system and is redirected or directed to a pervious area which allows for infiltration, filtration, and increased time of concentration.

Disturbed Areas – An unstabilized land area where an earth disturbance activity is occurring or has occurred.

Ditch – A man-made waterway constructed for irrigation or stormwater conveyance purposes.

Downslope Property Line – That portion of the property line of the lot, tract, or parcels of land being developed, located such that overland or pipe flow from the project site would be directed towards it by gravity.

Drainage Conveyance Facility – A stormwater management facility designed to transport stormwater runoff that includes channels, swales, pipes, conduits, culverts, and storm sewers.

Drainage Easement – A right granted by a landowner to a grantee allowing the use of private land for stormwater management purposes.

Drainage Permit – A permit issued by the Municipality after the drainage plan has been approved.

Drainage Plan – The documentation of the stormwater management system, if any, to be used for a given development site, the contents of which are established in Section 302.

Earth Disturbance (ED)– A construction or other human activity which disturbs the surface of land including, but not limited to, clearing and grubbing, grading, excavations, embankments, land development, agricultural plowing or tilling, timber harvesting activities, road maintenance activities, mineral extraction, and the moving, depositing, stockpiling, or storing of soil, rock, or earth materials.

Emergency Spillway – A conveyance area that is used to pass peak discharge greater than the maximum design storm controlled by the stormwater facility.

Encroachment – A structure or activity that changes, expands, or diminishes the course, current, or cross-section of a watercourse, floodway, or body of water.

Erosion – The natural process by which the surface of the land is worn away by water, wind or chemical action.

Erosion and Sediment Control Plan – A plan that is designed to minimize accelerated erosion and sedimentation. Said plan must be submitted to and approved by the appropriate Conservation District before construction can begin.

Exceptional Value Waters – Surface waters of high quality which satisfy Pennsylvania Code Title 25 Environmental Protection, Chapter 93, Water Quality Standards, §93.4b(b) (relating to anti-degradation).

Existing Conditions – The dominant land cover during the 5-year period immediately preceding a proposed Regulated Activity. If the initial condition of the site is undeveloped land, the land use shall be considered as "meadow" unless the natural land cover is proven to generate a lower curve number or Rational "c" value, such as forested lands.

FEMA – Federal Emergency Management Agency.

Flood – A temporary condition of partial or complete inundation of land areas from the overflow of streams, rivers, and other waters of this Commonwealth.

Floodplain – Any land area susceptible to inundation by water from any natural source or delineated by applicable FEMA maps and studies as being a special flood hazard area. Included are lands adjoining a river or stream that have been or may be expected to be inundated by a 100-year flood. Also included are areas that comprise Group 13 Soils, as listed in Appendix A of the Pennsylvania DEP Technical Manual for Sewage Enforcement Officers (as amended or replaced from time to time by PADEP).

Floodway – The channel of a watercourse and those portions of the adjoining floodplains which are reasonably required to carry and discharge the 100-year frequency flood. Unless otherwise specified, the boundary of the floodway is as indicated on maps and flood insurance studies provided by the Federal Emergency Management Agency (FEMA). In an area where no FEMA maps or studies have defined the boundary of the 100-year frequency floodway, it is assumed, absent evidence to the contrary, that the floodway extends from the stream to fifty (50) feet from the top-of-bank.

Fluvial Geomorphology – The study of landforms associated with river channels and the processes that form them.

Forest Management/Timber Operations – Planning and associated activities necessary for the management of forest lands. These include timber inventory and preparation of forest management plans, silvicultural treatment, cutting budgets, logging road design and construction, timber harvesting, and reforestation.

Freeboard – A vertical distance between the elevation of the design high-water and the top of a dam, levee, tank, basin, swale, or diversion berm. The space is required as a safety margin in a pond or basin.

Grade – 1. (noun) A slope, usually of a road, channel, or natural ground specified in percent and shown on plans as specified herein. 2. (verb) To finish the surface of a roadbed, the top of an embankment, or the bottom of an excavation.

Grassed Waterway – A natural or man-made waterway, usually broad and shallow, covered with erosion-resistant grasses used to convey surface water.

Groundwater – Water beneath the earth's surface that supplies wells and springs and is often between saturated soil and rock.

Groundwater Recharge – The replenishment of existing natural underground water supplies from rain or overland flow.

HEC-HMS – The U.S. Army Corps of Engineers, Hydrologic Engineering Center (HEC) - Hydrologic Modeling System (HMS). This model was used to model the Tookany/Tacony-Frankford Watershed during the Act 167 plan development and was the basis for the standards and criteria of this Ordinance.

High Quality Waters – Surface waters having quality which exceeds levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water by satisfying Pennsylvania Code Title 25 Environmental Protection, Chapter 93, Water Quality Standards, § 93.4b(a).

Hotspots – Areas where land use or activities generate highly contaminated runoff, with concentrations of pollutants in excess of those typically found in stormwater.

Hydrograph – A graph representing the discharge of water versus time for a selected point in the drainage system.

Hydrologic Regime – The hydrologic cycle or balance that sustains quality and quantity of stormwater, baseflow, storage, and groundwater supplies under natural conditions.

Hydrologic Soil Group (HSG) – Infiltration rates of soils vary widely and are affected by subsurface permeability as well as surface intake rates. Soils are classified into four HSG's (A, B, C, and D) according to their minimum infiltration rate, which is obtained for bare soil after prolonged wetting. The NRCS defines the four groups and provides a list of most of the soils in the United States and their group classification. The soils in the area of the development site may be identified from a soil survey report that can be obtained from local NRCS offices or conservation district offices. Soils become less pervious as the HSG varies from A to D (NRCS).

Impervious Surface – A surface that prevents the infiltration of water into the ground. Impervious surfaces (or areas) shall include, but not be limited to, roofs, additional indoor living spaces, patios, garages, storage sheds and similar structures, and any new streets or sidewalks. Decks, parking areas, and driveway areas are not counted as impervious areas if they do not prevent infiltration.

Impoundment – A retention or detention basin designed to retain stormwater runoff and release it at a controlled rate.

Infill – Development that occurs on smaller parcels that remain undeveloped but are within or in very close proximity to urban or densely developed areas. Infill development usually relies on existing infrastructure and does not require an extension of water, sewer, or other public utilities.

Infiltration – Movement of surface water into the soil, where it is absorbed by plant roots, evaporated into the atmosphere, or percolated downward to recharge groundwater.

Infiltration basin - A shallow impoundment that is designed to infiltrate Stormwater into the soil. Infiltration basins are believed to have a high pollutant removal efficiency, and can also help recharge the groundwater, thus restoring low flows to stream systems. Infiltration basins can be problematic at many sites because of stringent soils requirements. In addition, some studies have relatively high failure rates compared with other Stormwater treatment practices.

Infiltration Structures – A structure designed to direct runoff into the underground water (e.g., French drains, seepage pits, or seepage trenches).

Inflow – The flow entering the stormwater management facility and/or BMP.

Inlet – The upstream end of any structure through which water may flow.

Intermittent Stream – A stream that flows only part of the time. Flow generally occurs for several weeks or months in response to seasonal precipitation or groundwater discharge.

Invert – The lowest surface, the floor or bottom of a culvert, drain, sewer, channel, basin, BMP, or orifice.

Karst - A type of topography or landscape characterized by surface depressions, sinkholes, rock pinnacles/uneven bedrock surface, underground drainage and caves. Karst is formed on carbonate rocks, such as limestone or dolomite.

Land Development – Any of the following activities:

(i) The improvement of one (1) lot or two (2) or more contiguous lots, tracts, or parcels of land for any purpose involving:

a. A group of two (2) or more residential or nonresidential buildings, whether proposed initially or cumulatively, or a single nonresidential building on a lot or lots regardless of the number of occupants or tenure, or

b. The division or allocation of land or space, whether initially or cumulatively, between or among two (2) or more existing or prospective occupants by means of, or for the purpose of, streets, common areas, leaseholds, condominiums, building groups, or other features;

(ii) A subdivision of land;

(iii) Development in accordance with Section 503(1.1) of the PA Municipalities Planning Code.

Limiting Zone – A soil horizon or condition in the soil profile or underlying strata that includes one of the following:

(i) A seasonal high water table, whether perched or regional, determined by direct observation of the water table or indicated by soil mottling.

(ii) A rock with open joints, fracture or solution channels, or masses of loose rock fragments, including gravel, with insufficient fine soil to fill the voids between the fragments.

(iii) A rock formation, other stratum, or soil condition that is so slowly permeable that it effectively limits downward passage of water.

Lot – A designated parcel, tract, or area of land established by a plat or otherwise as permitted by law and to be used, developed, or built upon as a unit.

Main Stem (Main Channel) – Any stream segment or other runoff conveyance used as a reach in the Tookany/Tacony-Frankford Watershed hydrologic model.

Manning Equation (Manning Formula) – A method for calculation of velocity of flow (e.g., feet per second) and flow rate (e.g., cubic feet per second) in open channels based upon channel shape, roughness, depth of flow, and slope. “Open channels” may include closed conduits so long as the flow is not under pressure.

Maximum Design Storm – The maximum (largest) design storm that is controlled by the stormwater facility.

Municipal Engineer – A professional engineer licensed as such in the Commonwealth of Pennsylvania, duly appointed as the Engineer for a Municipality, planning agency, or joint planning commission.

Municipality – [*Municipal Name*], [*County Name*] County, Pennsylvania.

Natural Condition – Pre-development condition.

Natural Hydrologic Regime – See Hydrologic Regime.

Natural Recharge Area – Undisturbed surface area or depression where stormwater collects and a portion of which infiltrates and replenishes the underground and groundwater.

Nonpoint Source Pollution – Pollution that enters a waterbody from diffuse origins in the watershed and does not result from discernible, confined, or discrete conveyances.

Nonstormwater Discharges – Water flowing in stormwater collection facilities, such as pipes or swales, which is not the result of a rainfall event or snowmelt.

Nonstructural Best Management Practice (BMPs) – Methods of controlling stormwater runoff quantity and quality, such as innovative site planning, impervious area and grading reduction, protection of natural depression areas, temporary ponding on site, and other techniques.

NPDES – National Pollutant Discharge Elimination System, the federal government's system for issuance of permits under the Clean Water Act, which is delegated to DEP in Pennsylvania.

NRCS – Natural Resource Conservation Service (previously SCS).

Open Channel – A conveyance channel that is not enclosed.

Outfall – "Point source" as described in 40 CFR § 122.2 at the point where the Municipality's storm sewer system discharges to surface waters of the Commonwealth.

Outflow – The flow exiting the stormwater management facility and/or BMP.

Outlet – Points of water disposal to a stream, river, lake, tidewater, or artificial drain.

Parent Tract – The parcel of land from which a land development or subdivision originates, determined from the date of municipal adoption of this Ordinance.

Parking Lot Storage – Involves the use of parking areas as temporary impoundments with controlled release rates during rainstorms.

Peak Discharge – The maximum rate of stormwater runoff from a specific storm event.

Penn State Runoff Model – The computer-based hydrologic model developed at Pennsylvania State University.

Pipe – A culvert, closed conduit, or similar structure (including appurtenances) that conveys stormwater.

Planning Commission – The Planning Commission of [*Municipal Name*].

Point Source – Any discernible, confined, and discrete conveyance including, but not limited to, any pipe, ditch, channel, tunnel, or conduit from which stormwater is or may be discharged, as defined in state regulations at 25 Pennsylvania Code § 92.1.

Post-construction – Period after construction during which disturbed areas are stabilized, stormwater controls are in place and functioning, and all proposed improvements in the approved land development plan are completed.

Pre-construction – Prior to commencing construction activities.

Pre-development Condition – Undeveloped/natural condition.

Pretreatment – Techniques employed in stormwater BMPs to provide storage or filtering to trap coarse materials and other pollutants before they enter the system, but not necessarily designed to meet the water quality volume requirements of Section 406.

Project Site – The specific area of land where any regulated activities in the Municipality are planned, conducted, or maintained.

Qualified Professional - Any person licensed by the Pennsylvania Department of State or otherwise qualified by law to perform the work required by the Ordinance.

Rational Formula – A rainfall-runoff relation used to estimate peak flow.

Reach – Any stream segment or other runoff conveyance used in the Tookany/Tacony-Frankford Watershed hydrologic model.

Recharge – The replenishment of groundwater through the infiltration of rainfall, other surface waters, or land application of water or treated wastewater.

Reconstruction – Demolition and subsequent rebuilding of impervious surface.

Record Drawings – Original documents revised to suit the as-built conditions and subsequently provided by the Engineer to the client. The Engineer reviews the contractor's as-builts against his/her own records for completeness, then either turns these over to the client or transfers the information to a set of reproducibles, in both cases for the client's permanent records.

Redevelopment – Any development that requires demolition or removal of existing structures or impervious surfaces at a site and replacement with new impervious surfaces. Maintenance activities such as top-layer grinding and re-paving are not considered to be redevelopment. Interior remodeling projects and tenant improvements are also not considered to be redevelopment.

Regulated Activities – Any Earth Disturbances Activities or any activities that involve the alteration or development of land in a manner that may affect stormwater runoff.

Regulated Earth Disturbance Activity – Defined under NPDES Phase II regulations as earth disturbance activity of one (1) acre or more with a point source discharge to surface waters or the Municipality's storm sewer system or five (5) acres or more regardless with or without a point source discharge. This includes earth disturbance on any portion of, part, or during any stage of a larger common plan of development.

Release Rate – The percentage of existing conditions peak rate of runoff from a site or subarea to which the proposed conditions peak rate of runoff must be reduced to protect downstream areas.

Repaving – Replacement of the impervious surface that does not involve reconstruction of an existing paved (impervious) surface.

Replacement Paving – Reconstruction of and full replacement of an existing paved (impervious) surface.

Retention/Removed Runoff - The volume of runoff that is captured and not released directly into the surface waters of this Commonwealth during or after a storm event.

Return Period – The average interval, in years, within which a storm event of a given magnitude can be expected to recur. For example, the 25-year return period rainfall would be expected to recur on the average of once every twenty-five (25) years.

Riser – A vertical pipe extending from the bottom of a pond that is used to control the discharge rate from the pond for a specified design storm.

Road Maintenance – Earth disturbance activities within the existing road cross-section, such as grading and repairing existing unpaved road surfaces, cutting road banks, cleaning or clearing drainage ditches, and other similar activities.

Roof Drains – A drainage conduit or pipe that collects water runoff from a roof and leads it away from the structure.

Rooftop Detention – The temporary ponding and gradual release of stormwater falling directly onto flat roof surfaces using controlled-flow roof drains in building designs.

Runoff – Any part of precipitation that flows over the land surface.

SALDO – Subdivision and land development Ordinance.

Sediment - Soils or other materials transported by surface water as a product of erosion.

Sediment Basin – A barrier, dam, or retention or detention basin located and designed in such a way as to retain rock, sand, gravel, silt, or other material transported by water during construction.

Sediment Pollution – The placement, discharge, or any other introduction of sediment into the waters of the Commonwealth.

Sedimentation – The process by which mineral or organic matter is accumulated or deposited by the movement of water or air.

Seepage Pit/Seepage Trench – An area of excavated earth filled with loose stone or similar coarse material into which surface water is directed for infiltration into the underground water.

Separate Storm Sewer System – A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains) primarily used for collecting and conveying stormwater runoff.

Shallow Concentrated Flow – Stormwater runoff flowing in shallow, defined ruts prior to entering a defined channel or waterway.

Sheet Flow – A flow process associated with broad, shallow water movement on sloping ground surfaces that is not channelized or concentrated.

Soil Cover Complex Method – A method of runoff computation developed by NRCS that is based on relating soil type and land use/cover to a runoff parameter called curve number (CN).

Source Water Protection Areas (SWPA) – The zone through which contaminants, if present, are likely to migrate and reach a drinking water well or surface water intake.

Spillway – A conveyance that is used to pass the peak discharge of the maximum design storm that is controlled by the stormwater facility.

State Water Quality Requirements – As defined under state regulations -- protection of *designated* and *existing* uses (see 25 Pennsylvania Code Chapters 93 and 96)--including:

A. Each stream segment in Pennsylvania has a "designated use," such as "cold water fishery" or "potable water supply," which is listed in Chapter 93. These uses must be protected and maintained under state regulations.

B. "Existing uses" are those attained as of November 1975, regardless of whether they have been designated in Chapter 93. Regulated earth disturbance activities must be designed to protect and maintain existing uses and maintain the level of water quality necessary to protect those uses in all streams and to protect and maintain water quality in special protection streams.

C. Water quality involves the chemical, biological, and physical characteristics of surface water bodies. After regulated earth disturbance activities are complete, these characteristics can be impacted by the addition of pollutants such as sediment and changes in habitat through increased flow volumes and/or rates as a result of changes in land surface area from those activities. Therefore, permanent discharges to surface waters must be managed to protect the stream bank, stream bed, and structural integrity of the waterway to prevent these impacts.

Storage Indication Method – A reservoir routing procedure based on solution of the continuity equation (inflow minus outflow equals the change in storage) with outflow defined as a function of storage volume and depth.

Storm Frequency – The number of times that a given storm "event" occurs or is exceeded on the average in a stated period of years (see Return Period).

Storm Sewer – A system of pipes and/or open channels that conveys intercepted runoff and stormwater from other sources but excludes domestic sewage and industrial wastes.

Stormwater – Drainage runoff from the surface of the land resulting from precipitation or snow or ice melt.

Stormwater Management District – Those subareas of a watershed in which some type of detention is required to meet the plan requirements and the goals of Act 167.

Stormwater Management Facility – Any structure, natural or man-made, that, due to its condition, design, or construction, conveys, stores, or otherwise affects stormwater runoff quality, rate, or quantity. Typical stormwater management facilities include, but are not limited to, detention and infiltration basins, open channels, storm sewers, pipes, and infiltration structures.

Stormwater Management Plan – The watershed plan, known as the "Tookany/Tacony-Frankford Watershed Act 167 Stormwater Management Plan," for managing those land use activities that will influence stormwater runoff quality and quantity and that would impact the Tookany/Tacony-Frankford Watershed adopted by Montgomery and Philadelphia Counties as required by the Act of October 4, 1978, P.L. 864 (Act 167).

Stormwater Management Site Plan – The plan prepared by the Applicant or his representative indicating how stormwater runoff will be managed at the particular site of interest according to this Ordinance.

Stream – A natural watercourse.

Stream Buffer – The land area adjacent to each side of a stream essential to maintaining water quality (see Buffer).

Stream Enclosure – A bridge, culvert, or other structure in excess of one hundred (100) feet in length upstream to downstream which encloses a regulated water of the Commonwealth.

Subarea (Subwatershed) – The smallest drainage unit of a watershed for which stormwater management criteria have been established in the stormwater management plan.

Subdivision – The division or redivision of a lot, tract, or parcel of land by any means into two (2) or more lots, tracts, parcels, or other divisions of land including changes in existing lot lines for the purpose, whether immediate or future, of lease, partition by the court for distribution to heirs or devisees, transfer of ownership, or building or lot development; provided, however, that the subdivision by lease of land for agricultural purposes into parcels of more than ten (10) acres not involving any new street or easement of access or any residential dwelling shall be exempted. As defined in The Pennsylvania Municipalities Planning Code, Act of July 31, 1968, P.L. 805, No. 247.

Surface Waters of the Commonwealth – Any and all rivers, streams, creeks, rivulets, ditches, watercourses, storm sewers, lakes, dammed water, wetlands, ponds, springs, and all other bodies or channels of conveyance of surface waters, or parts thereof, whether natural or artificial, within or on the boundaries of the Commonwealth.

Swale – A low-lying stretch of land that gathers or carries surface water runoff.

Timber Operations – See Forest Management.

Time-of-concentration (Tc) – The time required for surface runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed. This time is the combined total of overland flow time and flow time in pipes or channels, if any.

Top-of-bank – Highest point of elevation in a stream channel cross-section at which a rising water level just begins to flow out of the channel and over the floodplain.

Undeveloped Condition – Natural condition (see also Pre-development Condition).

USDA - United States Department of Agriculture.

Vernal Pond – Seasonal depressional wetlands that are covered by shallow water for variable periods from winter to spring but may be completely dry for most of the summer and fall.

Watercourse – A channel or conveyance of surface water having a defined bed and banks, whether natural or artificial, with perennial or intermittent flow.

Waters of the Commonwealth – Rivers, streams, creeks, rivulets, impoundments, ditches, watercourses, storm sewers, lakes, dammed water, wetlands, ponds, springs and other bodies or channels of conveyance of surface and underground water, or parts thereof, whether natural or artificial, within or on the boundaries of this Commonwealth.

Watershed – Region or area drained by a river, watercourse or other surface water of the Commonwealth.

Wellhead – 1. A structure built over a well, 2. The source of water for a well.

Wellhead Protection Area – The surface and subsurface area surrounding a water supply well, well field, or spring supplying a public water system through which contaminants are reasonably likely to move toward and reach the water source.

Wet Basin – Pond for urban runoff management that is designed to detain urban runoff and always contains water.

Wetland – Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, fens, and similar areas.

Woods – A natural groundcover with more than one (1) viable tree of a DBH of six (6) inches or greater per fifteen hundred (1,500) square feet which existed within three (3) years of application; a cover condition for which SCS curve numbers have been assigned or to which equivalent Rational Method runoff coefficients have been assigned.

ARTICLE III-DRAINAGE PLAN REQUIREMENTS

Section 301. General Requirements

For any of the activities regulated by this Ordinance, the preliminary or final approval of subdivision and/or land development plans, the issuance of any building or occupancy permit, or the commencement of any earth disturbance activity may not proceed until the Property Owner or Applicant or his/her agent has received written approval of a drainage plan from the Municipality and an adequate erosion and sediment control plan review by the Conservation District.

Section 302. Drainage Plan Contents

The drainage plan shall consist of a general description of the project including sequencing items described in Section 404, calculations, maps, and plans. A note on the maps shall refer to the associated computations and erosion and sediment control plan by title and date. The cover sheet of the computations and erosion and sediment control plan shall refer to the associated maps by title and date. All drainage plan materials shall be submitted to the Municipality in a format that is clear, concise, legible, neat, and well organized; otherwise, the drainage plan shall not be accepted for review and shall be returned to the Applicant.

The following items shall be included in the drainage plan:

A. General

1. General description of the project including those areas described in Section 404.B.
2. General description of proposed permanent stormwater management techniques, including construction specifications of the materials to be used for stormwater management facilities.
3. Complete hydrologic, hydraulic, and structural computations for all stormwater management facilities.
4. An erosion and sediment control plan, including all reviews and letters of adequacy from the Conservation District.
5. A general description of proposed nonpoint source pollution controls.
6. The Drainage Plan Application and completed fee schedule form and associated fee (Ordinance Appendix C-1).
7. The Drainage Plan Checklist (Appendix C-2).

B. Maps

Map(s) of the project area shall be submitted on 24-inch x 36-inch sheets and/or shall be prepared in a form that meets the requirements for recording at the offices of the Recorder of Deeds of [*County Name*] County. If the SALDO has more stringent criteria than this Ordinance, then the more stringent criteria shall apply. The contents of the map(s) shall include, but not be limited to:

1. The location of the project relative to highways, municipal boundaries, or other identifiable landmarks.

2. Existing contours at intervals of two (2) feet. In areas of slopes greater than [___] percent, 5-foot contour intervals may be used.

3. Existing streams, lakes, ponds, or other waters of the Commonwealth within the project area.

4. Other physical features including flood hazard boundaries, stream buffers, existing drainage courses, areas of natural vegetation to be preserved, and the total extent of the upstream area draining through the site.

5. The locations of all existing and proposed utilities, sanitary sewers, and water lines within fifty (50) feet of property lines.

6. An overlay showing soil names and boundaries.

7. Limits of earth disturbance, including the type and amount of impervious area that would be added.

8. Proposed structures, roads, paved areas, and buildings.

9. Final contours at intervals of two (2) feet. In areas of steep slopes (greater than [___] percent), 5-foot contour intervals may be used.

10. The name of the development, the name and address of the owner of the property, and the name of the individual or firm preparing the plan.

11. The date of submission.

12. A graphic and written scale of one (1) inch equals no more than fifty (50) feet; for tracts of twenty (20) acres or more, the scale shall be one (1) inch equals no more than one hundred (100) feet.

13. A north arrow.

14. The total tract boundary and size with distances marked to the nearest foot and bearings to the nearest degree.

15. Existing and proposed land use(s).

16. A key map showing all existing man-made features beyond the property boundary that would be affected by the project.

17. Location of all open channels.

18. Overland drainage patterns and swales.

19. A 15-foot wide access easement around all stormwater management facilities that would provide ingress to and egress from a public right-of-way.

20. The location of all erosion and sediment control facilities.

21. A note on the plan indicating the location and responsibility for maintenance of stormwater management facilities that would be located off site. All off-site facilities shall meet the performance standards and design criteria specified in this Ordinance.

22. A statement, signed by the Applicant, acknowledging that any revision to the approved drainage plan must be approved by the Municipality, and that a revised erosion and sediment control plan must be submitted to the Conservation District for a determination of adequacy.

23. The following signature block for the Design Engineer:

    "I, (Design Engineer), on this date (date of signature), hereby certify that the drainage plan meets all design standards and criteria of the Tookany/Tacony-Frankford Watershed Act 167 Stormwater Management Ordinance."

C. Supplemental Information to be Submitted to the Municipality

1. A written description of the following information shall be submitted by the Applicant and shall include:

    a. The overall stormwater management concept for the project designed in accordance with Section 404.
    b. Stormwater runoff computations as specified in this Ordinance.
    c. Stormwater management techniques to be applied both during and after development.
    d. Expected project time schedule.
    e. Development stages or project phases, if so proposed.
    f. An operations and maintenance plan in accordance with Section 702 of this Ordinance.

2. An erosion and sediment control plan.

3. A description of the effect of the project (in terms of runoff volumes and peak flows) on adjacent properties and on any existing municipal stormwater collection system that may receive runoff from the project site.

4. An Approved Highway Occupancy Permit from the Pennsylvania Department of Transportation (PennDOT) District office when utilization of a PennDOT storm drainage system is proposed.

D. Stormwater Management Facilities

1. All stormwater management facilities must be located on a plan and described in detail.

2. When infiltration measures such as seepage pits, beds, or trenches are used, the locations of existing and proposed septic tank infiltration areas and wells must be shown.

3. All calculations, assumptions, and criteria used in the design of the stormwater management facilities must be shown.

Section 303. Plan Submission

The Municipality shall require receipt of a complete drainage plan, as specified in this Ordinance.

A. Proof of application or documentation of required permit(s) or approvals for the programs listed below shall be part of the plan:

1. NPDES Permit for Stormwater Discharges from Construction Activities

2. DEP Joint Permit Application

3. PennDOT Highway Occupancy Permit

4. Chapter 105 (Dam Safety and Waterway Management)

5. Chapter 106 (Floodplain Management)

6. Any other permit under applicable state or federal regulations

B. The plan shall be coordinated with the state and federal permit process and the municipal SALDO review process. The process implementing the provisions in this Ordinance is illustrated in Appendices B-1 and B-2.

C. For projects that require SALDO approval, the drainage plan shall be submitted by the Applicant as part of the preliminary plan submission where applicable for the regulated activity.

D. For regulated activities that do not require SALDO approval, see Section 301, General Requirements.

E. Six (6) copies of the drainage plan shall be submitted and distributed as follows:

1. Two (2) copies to the Municipality accompanied by the requisite municipal review fee, as specified in this Ordinance.

2. Two (2) copies to the County Conservation District.

3. One (1) copy to the municipal Engineer.

4. One (1) copy to the County Planning Commission/Department.

F. Any submissions to the agencies listed above that are found to be incomplete shall not be accepted for review and shall be returned to the Applicant with a notification in writing of the specific manner in which the submission is incomplete.

Section 304. Drainage Plan Review

A. The Municipality shall review the drainage plan for consistency with the adopted Tookany/Tacony-Frankford Watershed Act 167 Stormwater Management Plan. Any drainage plans found incomplete shall not be accepted for review and shall be returned to the Applicant.

B. The Municipality shall review the drainage plan for any subdivision or land development against the municipal SALDO provisions not otherwise superseded by this Ordinance.

C. The Conservation District, in accordance with established criteria and procedures, shall review the drainage plan for consistency with stormwater management and erosion and sediment pollution control requirements and provide comments to the Municipality. Such comments shall be considered by the Municipality prior to final approval of the drainage plan.

D. For activities regulated by this Ordinance, the Municipality shall notify the Applicant in writing, within [___] calendar days, whether the drainage plan is consistent with the stormwater management plan.

1. If the Municipality determines that the drainage plan is consistent with the stormwater management plan, the Municipality shall forward a letter of consistency to the municipal Secretary who will then forward a copy to the Applicant.

2. If the Municipality determines that the drainage plan is inconsistent or noncompliant with the stormwater management plan, the Municipality shall forward a letter to the municipal Secretary with a copy to the Applicant citing the reason(s) and specific Ordinance sections for the inconsistency or noncompliance. Inconsistency or noncompliance may be due to inadequate information to make a reasonable judgment as to compliance with the stormwater management plan. Any drainage plans that are inconsistent or noncompliant may be revised by the Applicant and resubmitted when consistent with this

Ordinance. The municipal Secretary shall then notify the Applicant of the Municipality's findings. Any inconsistent or noncompliant drainage plans may be revised by the Applicant and resubmitted consistent with this Ordinance.

E. For regulated activities specified in Section 105 of this Ordinance that require a building permit, the Municipality shall notify the municipal Building Permit Officer in writing, within a time frame consistent with the municipal Building Code and/or municipal SALDO, whether the drainage plan is consistent with the stormwater management plan. The municipal Building Permit Officer shall forward a copy of the consistency/inconsistency letter to the Applicant. Any drainage plan deemed inconsistent may be revised by the Applicant and resubmitted consistent with this Ordinance.

F. For regulated activities under this Ordinance that require an NPDES Permit Application, the Applicant shall forward a copy of the Municipality's letter stating that the drainage plan is consistent with the stormwater management plan to the Conservation District. DEP and the Conservation District may consider the Municipality's review comments in determining whether to issue a permit.

G. The Municipality shall not grant preliminary or final approval to any subdivision or land development for regulated activities specified in Section 105 of this Ordinance if the drainage plan has been found by the Municipality to be inconsistent with the stormwater management plan. All required permits from DEP must be obtained prior to approval of any subdivision or land development.

H. No building permits for any regulated activity specified in Section 105 of this Ordinance shall be approved by the Municipality if the drainage plan has been found to be inconsistent with the stormwater management plan, as determined by the Municipality and Conservation District (or City of Philadelphia designated agency), or without considering the comments of the Municipality and Conservation District (or City of Philadelphia designated agency). All required permits from DEP must be obtained prior to issuance of a building permit.

I. The Applicant shall be responsible for completing record drawings of all stormwater management facilities included in the approved drainage plan. The record drawings and an explanation of any discrepancies with the design plans shall be submitted to the Municipality for final approval. In no case shall the Municipality approve the record drawings until the Municipality receives a copy of an approved Declaration of Adequacy and/or Highway Occupancy Permit from the PennDOT District office; and a NPDES Permit, and/or any other applicable permits or approvals from DEP or the Conservation District. The above permits and approvals must be based on the record drawings.

J. The Municipality's approval of a drainage plan shall be valid for a period not to exceed [*recommended 5*] years commencing on the date that the Municipality signs the approved drainage plan. If stormwater management facilities included in the approved drainage plan have not been constructed, or if constructed, record drawings of these facilities have not been approved within this [____] year time period, then the Municipality may consider the drainage plan inconsistent or noncompliant and may revoke all permits related to construction authorization. Drainage plans that are determined to be inconsistent or noncompliant by the Municipality shall be resubmitted in accordance with Section 306 of this Ordinance.

Section 305. Modification of Plans

A. A modification to a submitted drainage plan under review by the Municipality for a development site that involves the following shall require a resubmission to the Municipality of a modified drainage plan consistent with Section 303 of this Ordinance and be subject to review as specified in Section 304 of this Ordinance:

1. Change in stormwater management facilities or techniques,
2. Relocation or redesign of stormwater management facilities, or
3. Is necessary because soil or other conditions are not as stated on the drainage plan as determined by the Municipality.

B. A modification to an already approved or inconsistent or noncompliant drainage plan shall be submitted to the Municipality, accompanied by the applicable municipal review and inspection fee. A modification to a drainage plan for which a formal action has not been taken by the Municipality shall be submitted to the Municipality accompanied by the applicable municipal review and inspection fee.

Section 306. Resubmission of Inconsistent or Noncompliant Drainage Plans

An inconsistent or noncompliant drainage plan may be resubmitted with the revisions addressing the municipality's concerns documented in writing. It must be addressed to the municipal Secretary in accordance with Section 303 of this Ordinance, distributed accordingly, and be subject to review as specified in Section 304 of this Ordinance. The applicable municipal review and inspection fee must accompany a resubmission of an inconsistent or noncompliant drainage plan.

ARTICLE IV - STORMWATER MANAGEMENT

Section 401. General Requirements

A. Applicants proposing regulated activities in the Tookany/Tacony-Frankford Watershed which do not fall under the exemption criteria shown in Section 106 shall submit a drainage plan consistent with the Tookany/Tacony-Frankford Watershed Stormwater Management Plan to the Municipality for review. The stormwater management criteria of this Ordinance shall apply to the total proposed development even if development is to take place in stages.

B. The Applicant is required to find practicable alternatives to the surface discharge of stormwater, the creation of impervious surfaces, and the degradation of waters of the Commonwealth and must maintain as much as possible the natural hydrologic regime.

C. The drainage plan must be designed consistent with the sequencing provisions of Section 404 to ensure maintenance of the natural hydrologic regime, to promote groundwater recharge, and to protect groundwater and surface water quality and quantity. The drainage plan designer must proceed sequentially in accordance with Article IV of this Ordinance.

D. Stormwater drainage systems shall be designed to permit unimpeded flow along natural watercourses.

E. Stormwater flows onto adjacent property shall not be created, increased, decreased, relocated, or otherwise altered without permission of the adjacent property owner(s). Such stormwater flows shall be subject to the requirements of this Ordinance.

F. Areas of existing diffused drainage discharge, whether proposed to be concentrated or maintained as diffused drainage areas, shall be subject to any applicable discharge criteria in the general direction of existing discharge, except as otherwise provided by this Ordinance. If diffused drainage discharge is proposed to be concentrated and discharged onto adjacent property, the Applicant must document that adequate downstream conveyance facilities exist to safely transport the concentrated discharge or otherwise prove that no erosion, sedimentation, flooding, or other impacts will result from the concentrated discharge.

G. Where a development site is traversed by existing streams, drainage easements shall be provided conforming to the line of such streams. The terms of the easement shall conform to the stream buffer requirements contained in Section 406.F of this Ordinance.

H. Minimization of impervious surfaces and infiltration of runoff through seepage beds, infiltration trenches, etc., is encouraged where soil conditions permit in order to reduce the size or eliminate the need for detention facilities or other structural BMPs.

I. All stormwater runoff shall be treated for water quality prior to discharge to surface water or groundwater. BMPs selected for treatment of stormwater should incorporate pretreatment features (i.e. sediment forebays, filter strips) to help remove nonpoint source pollutants at the beginning of the treatment or management processes before conveying it into other stormwater management devices (i.e. ponds, stormwater wetlands, infiltration facilities).

J. All regulated activities within the Municipality shall be designed, implemented, operated, and maintained to meet the purposes of this Ordinance, through these two elements:

1. Erosion and sediment control during earth disturbance activities (e.g., during construction), and

2. Water quality protection measures after completion of earth disturbance activities (i.e., after construction), including operations and maintenance.

K. No regulated earth disturbance activities within the Municipality shall commence until the requirements of this Ordinance are met.

L. Post-construction water quality protection shall be addressed as required by Section 406.

M. Operations and maintenance of permanent stormwater BMPs shall be addressed as required by Article VII.

N. Meet State Water Quality as defined in Article II, and any more stringent requirements set forth by the Municipality.

O. Techniques described in Appendix D (Low Impact Development) of this Ordinance shall be considered because they reduce the costs of complying with the requirements of this Ordinance and the state water quality requirements.

P. In selecting the appropriate BMPs or combinations thereof, the Applicant shall consider the following items before selecting a BMP or combination of BMPs which are most appropriate for the site, its contributing drainage area, the characteristics of the stormwater runoff and the receiving waterway:

1. Total contributing area.
2. Permeability and infiltration rate of the site's soils.
3. Slope and depth to bedrock.
4. Seasonal high water table.
5. Proximity to building foundations and wellheads.
6. Erodibility of soils.
7. Land availability and configuration of the topography.
8. Peak discharge and required volume control.
9. Stream bank erosion.
10. Efficiency of the BMPs to mitigate potential water quality problems.
11. The volume of runoff that will be effectively treated.
12. The nature of the pollutant being removed.
13. Maintenance requirements.
14. Creation/protection of aquatic and wildlife habitat.

15. Recreational value.

Q. The applicant may meet the stormwater management criteria through off-site stormwater management measures as long as the proposed measures are in the same subwatershed as shown in Ordinance Appendix A.

Section 402. Permit Requirements by Other Governmental Entities

Approvals issued and actions taken under this Ordinance do not relieve the Applicant of the responsibility to secure required permits or approvals for activities regulated by any other code, law, regulation or ordinance.

Section 403. Erosion and Sediment Control During Regulated Earth Disturbance Activities

A. No Regulated Earth Disturbance Activities within the Municipality shall commence until the Municipality receives an approval from the Conservation District of an erosion and sediment control plan for construction activities.

B. DEP has regulations that require an erosion and sediment control plan for any earth disturbance activity of five thousand (5,000) square feet or more, under 25 Pennsylvania Code § 102.4(b).

C. In addition, under 25 Pennsylvania Code Chapter 92, a DEP "NPDES Construction Activities" Permit is required for regulated earth disturbance activities.

D. Evidence of any necessary permit(s) for regulated earth disturbance activities from the appropriate DEP regional office or County Conservation District must be provided to the Municipality. The issuance of an NPDES Construction Permit (or permit coverage under the statewide General Permit (PAG-2)) satisfies the requirements of subsection 403.A. [*]

[This sentence is optional -- if the Municipality has additional or more stringent requirements than those in state regulations, then this sentence should not be used.]*

E. A copy of the erosion and sediment control plan and any required permit, as required by DEP regulations, shall be available on the project site at all times.

F. Additional erosion and sediment control design standards and criteria are recommended to be applied where infiltration BMPs are proposed. They shall include the following:

1. Areas proposed for infiltration BMPs shall be protected from sedimentation and compaction during the construction phase to maintain maximum infiltration capacity.

2. Infiltration BMPs shall not be constructed nor receive runoff until the entire drainage area contributory to the infiltration BMP has achieved final stabilization.

Section 404. Nonstructural Project Design (Sequencing to Minimize Stormwater Impacts)

A. The design of all regulated activities shall include the following to minimize stormwater impacts.

1. The Applicant shall find practicable alternatives to discharging stormwater to surface waters, such as those listed in Appendix E, Table E-4; the creation of impervious surfaces; and the degradation of waters of the Commonwealth. Applicants shall maintain as much as possible the natural hydrologic regime of the site.

2. An alternative is considered practicable if upon consideration of existing technology, logistics, overall project purposes, and other municipal requirements, the alternative is available and capable of implementation.

3. Unless otherwise demonstrated, all nonstructural alternatives are presumed to have less adverse impact on quantity and quality of waters of the Commonwealth than structural stormwater BMPs.

B. The Applicant shall demonstrate that stormwater controls for regulated activities were designed in the following sequence. The goal of the sequence is to minimize the increases in stormwater runoff and impacts to water quality resulting from the proposed regulated activity:

1. Prepare an Existing Resource and Site Analysis Map (ERSAM) showing environmentally sensitive areas including, but not limited to, steep slopes, ponds, lakes, streams, wetlands, hydric soils, vernal pools, stream buffers, flood plains and hydrologic soil groups. Land development, existing recharge areas, and any other requirements specifically outlined in the municipal SALDO shall also be included.

2. Establish a stream buffer according to Section 406.F.

3. Prepare a preliminary project layout avoiding sensitive areas identified in Section 404.B.1.

4. Identify site-specific existing conditions which may impact the stormwater management controls for the project such as drainage areas, discharge points, recharge areas, and hydrologic soil groups A and B (areas conducive to infiltration).

5. Evaluate nonstructural stormwater management alternatives to minimize the impact of construction activities upon stormwater runoff:

   a. Minimize earth disturbance.

   b. Minimize impervious surfaces.

   c. Break up large impervious surfaces.

6. Satisfy the groundwater recharge (infiltration) objective (Section 405) and provide for stormwater pretreatment devices to aid in the removal of nonpoint source pollutants prior to infiltration.

7. Provide for water quality protection in accordance with Section 406 water quality requirements.

8. Provide stream bank erosion protection in accordance with Section 407 stream bank erosion requirements.

9. Determine what management district the site falls (Ordinance Appendix A) and conduct an existing conditions runoff analysis.

10. Prepare final project design to maintain existing conditions drainage areas and discharge points, to minimize earth disturbance and impervious surfaces, and, to the maximum extent possible, to ensure that the remaining site development has no surface or point discharge.

11. Conduct a proposed conditions runoff analysis based on the final design that meets the management district requirements (Section 408).

12. Manage any remaining runoff prior to discharge through detention, bioretention, direct discharge, or other structural stormwater management control.

Section 405. Groundwater Recharge

Note: Philadelphia County and Montgomery County will follow different Groundwater Recharge criteria.

Maximizing the groundwater recharge capacity of the area being developed is required. Design of the infiltration facilities shall consider groundwater recharge to compensate for the reduction in the recharge that occurs when the ground surface is disturbed or impervious surface is created. It is recommended that roof runoff be directed to infiltration BMPs that may be designed to compensate for the runoff from parking areas. These measures are required to be consistent with Section 103 and to take advantage of utilizing any existing recharge areas.

Infiltration may not be feasible on every site due to site-specific limitations such as soil type. If it cannot be physically accomplished, then the design professional shall be responsible to show that this cannot be **physically** accomplished. If it can be physically accomplished, then the volume of runoff to be infiltrated shall be determined from Section 405.A.2. If soil investigation reports demonstrate that the soil is unsuitable for infiltration, the Design Professional shall be responsible for providing written documentation showing that the required volume cannot physically be infiltrated within the required time period.

A. Infiltration BMPs shall meet the following minimum requirements:

1. Infiltration BMPs intended to receive runoff from developed areas shall be selected based on suitability of soils and site conditions and shall be constructed on soils that have the following characteristics:

    a. A minimum depth of twenty-four (24) inches between the bottom of the BMP and the top of the limiting zone.

    b. An infiltration rate sufficient to accept the additional stormwater load and dewater completely as determined by field tests conducted by the Applicant's design professional.

    c. The infiltration facility shall be capable of completely infiltrating the recharge (infiltration) volume (Re_v) within three (3) days (72 hours).

    d. Pretreatment shall be provided prior to infiltration.

    e. The Design Professional is required to follow the Hotspot Investigation, Subsurface Stability, and Suitability of Infiltration procedures in the PA BMP Manual to determine whether the proposed infiltration on the Development Site is appropriate.

2. The size of the infiltration facility shall be based upon the following volume criteria:

<u>Montgomery County Portion of the Watershed:</u>

a. In order to preserve or restore a more natural water balance on new development and redevelopment sites, the recharge volume shall be infiltrated on site. The recharge volume shall be equal to one (1.0) inch of rainfall (I) over all **proposed impervious surfaces**.

The recharge volume (Re_v) required would, therefore, be computed as:

$$\mathbf{Re_v = I * impervious\ area\ (square\ feet) \div 12\ (inches) = cubic\ feet\ (cf)}$$

An asterisk (*) in equations denotes multiplication.

<u>Philadelphia County Portion of the Watershed:</u>

a. In order to preserve or restore a more natural water balance on new development and redevelopment sites, the recharge volume shall be infiltrated on site. The recharge volume shall be equal to one (1.0) inch of rainfall over all **DCIA within the limits of Earth Disturbance**.

Re_v = I * impervious area (square feet) ÷ 12 (inches) = cubic feet (cf)

An asterisk (*) in equations denotes multiplication.

B. Soils - A detailed soils evaluation of the project site shall be required to determine the suitability of infiltration facilities. The evaluation shall be performed by a qualified design professional and at a minimum address soil permeability, depth to bedrock, and subgrade stability. The general process for designing the infiltration BMP shall be:

1. Analyze hydrologic soil groups as well as natural and man-made features within the site to determine general areas of suitability for infiltration practices. In areas where development on fill material is under consideration, conduct geotechnical investigations of sub-grade stability; infiltration may not be ruled out without conducting these tests.

2. Provide field tests such as double ring infiltrometer or hydraulic conductivity tests (at the level of the proposed infiltration surface) to determine the appropriate hydraulic conductivity rate. Percolation tests are not recommended for design purposes.

3. Design the infiltration structure for the required retention (Re_v) volume based on field determined capacity at the level of the proposed infiltration surface.

4. If on-lot infiltration structures are proposed by the Applicant's design professional, it must be demonstrated to the Municipality that the soils are conducive to infiltrate on the lots identified.

C. Stormwater Hotspots – Below is a list of examples of designated hotspots. If a site is designated as a hotspot, it has important implications for how stormwater is managed. First and foremost, untreated stormwater runoff from hotspots shall not be allowed to recharge into groundwater where it may contaminate water supplies. Therefore, the Re_v requirement shall NOT be applied to development sites that fit into the hotspot category (the entire WQ_v must still be treated). Second, a greater level of stormwater treatment shall be considered at hotspot sites to prevent pollutant washoff after construction. The Environmental Protection Agency's (EPA) NPDES stormwater program requires some industrial sites to prepare and implement a stormwater pollution prevention plan.

Examples of hotspots:

- Vehicle salvage yards and recycling facilities
- Vehicle fueling stations
- Vehicle service and maintenance facilities
- Vehicle and equipment cleaning facilities
- Fleet storage areas (bus, truck, etc.)
- Industrial sites based on Standard Industrial Codes
- Marinas (service and maintenance)
- Outdoor liquid container storage

- Outdoor loading/unloading facilities
- Public works storage areas
- Facilities that generate or store hazardous materials
- Commercial container nursery
- Other land uses and activities as designated by an appropriate review authority

The following land uses and activities are not normally considered hotspots:

- Residential streets and rural highways
- Residential development
- Institutional development
- Office developments
- Nonindustrial rooftops
- Pervious areas, except golf courses and nurseries (which may need an integrated pest management (IPM) plan).

While large highways (average daily traffic volume (ADT) greater than thirty thousand (30,000) are not designated as stormwater hotspots, it is important to ensure that highway stormwater management plans adequately protect groundwater.

D. Extreme caution shall be exercised through innovative design techniques to properly filter contaminants where infiltration is proposed in Source Water Protection Areas (SWPAs) as defined by the local Municipality or Water Authority.

E. Infiltration facilities shall be used in conjunction with other innovative or traditional BMPs, stormwater control facilities, and nonstructural stormwater management alternatives.

F. Extreme caution shall be exercised through innovative design techniques where salt or chloride (municipal salt storage) would be a pollutant since soils do little to filter this pollutant, and it may contaminate the groundwater. The qualified design professional shall evaluate the possibility of groundwater contamination from the proposed infiltration facility and perform a hydrogeologic justification study if necessary.

G. An impermeable liner will be required in detention basins where the possibility of groundwater contamination exists. A detailed hydrogeologic investigation may be required by the Municipality.

H. The Municipality shall require the Applicant to provide safeguards against groundwater contamination for land uses that may cause groundwater contamination should there be a mishap or spill.

Section 406. Water Quality Requirements

Note: Philadelphia County and Montgomery County will follow different Water Quality Requirements.

The Applicant shall comply with the following water quality requirements of this Article.

A. No regulated earth disturbance activities within the Municipality shall commence until approval by the Municipality of a plan which demonstrates compliance with post-construction state water quality requirements.

B. The BMPs shall be designed, implemented, and maintained to meet state water quality requirements and any other more stringent requirements as determined by the Municipality.

C. To control post-construction stormwater impacts from regulated earth disturbance activities, state water quality requirements can be met by BMPs, including site design, which provide for replication of pre-construction stormwater infiltration and runoff conditions so that post-construction stormwater discharges do not degrade the physical, chemical, or biological characteristics of the receiving waters. As described in the DEP Comprehensive Stormwater Management Policy (#392-0300-002, September 28, 2002), this may be achieved by the following:

    1. Infiltration: replication of pre-construction stormwater infiltration conditions,
    2. Treatment: use of water quality treatment BMPs to ensure filtering out of the chemical and physical pollutants from the stormwater runoff, and
    3. Stream bank and Stream bed Protection: management of volume and rate of post-construction stormwater discharges to prevent physical degradation of receiving waters (e.g., from scouring).

D. Developed areas shall provide adequate storage and treatment facilities necessary to capture and treat stormwater runoff. The recharge volume computed under Section 405 may be a component of the water quality volume if the Applicant chooses to manage both components in a single facility. If the recharge volume is less than the water quality volume, the remaining water quality volume may be captured and treated by methods other than infiltration BMPs. The required water quality volume (WQ_v) is the storage capacity needed to capture and treat a portion of stormwater runoff from the developed areas of the site.

Montgomery County Portion of the Watershed:

The following calculation formula is to be used to determine the water quality storage volume (WQ_v) in acre-feet of storage for the Tookany/Tacony-Frankford Watershed in Montgomery County:

$$\mathbf{WQ_v = (P / 12) * (I)}$$

WQ_v = Water Quality Volume (cubic feet)
P = 1 inch
I = Proposed Impervious Area (square feet)

This volume requirement can be accomplished by the permanent volume of a wet basin or the detained volume from other BMPs. Where appropriate, wet basins shall be utilized for water quality control and shall follow the guidelines of the BMP manuals referenced in Ordinance Appendix F.

Release of water can begin at the start of the storm (i.e., the invert of the water quality orifice is at the invert of the facility). The design of the facility shall provide for protection from clogging and unwanted sedimentation.

Philadelphia County Portion of the Watershed:

The following calculation formula is to be used to determine the water quality storage volume (WQ_v) in acre-feet of storage for the Tookany/Tacony-Frankford Watershed in Philadelphia County:

$$\boxed{\mathbf{WQ_v = (P / 12)*(I)}}$$

WQ_v = Water quality volume (cubic feet)
P = 1 inch
I = DCIA within the limits of earth disturbance (square feet)

E. To accomplish the above, the Applicant shall submit original and innovative designs to the Municipality for review and approval. Such designs may achieve the water quality objectives through a combination of different BMPs.

F. If a perennial or intermittent stream passes through the site, the Applicant shall create a stream buffer extending a minimum of fifty (50) feet to either side of the top-of-bank of the channel. The buffer area shall be maintained with and encouraged to use appropriate native vegetation (refer to Appendix B of the Pennsylvania Stormwater Best Management Practices Manual for plant lists). If the applicable rear or side yard setback is less than fifty (50) feet, the buffer width may be reduced to twenty-five (25) percent of the setback to a minimum of ten (10) feet. If an existing buffer is legally prescribed (i.e., deed, covenant, easement, etc.) and it exceeds the requirements of this Ordinance, the existing buffer shall be maintained. *[Note: The Municipality may select a smaller buffer width (above) if desired, but the selected buffer may not be less than ten (10) feet]*. This does not include lakes or wetlands.

G. Evidence of any necessary permit(s) for regulated earth disturbance activities from the appropriate DEP regional office must be provided to the Municipality. The issuance of an

NPDES Construction Permit (or permit coverage under the statewide General Permit (PAG-2)) satisfies the requirements of subsection 406.A. [*]

*[***** This sentence above is optional -- if the Municipality has additional or more stringent requirements than those in state regulations, then this sentence should not be used.]*

Section 407. Stream Bank Erosion Requirements (Channel Protection)

Note: Philadelphia County and Montgomery County will follow different Stream Bank Erosion Requirements.

Montgomery County Portion of the Watershed:

Applicants shall adhere to the following Stream Bank Erosion/Channel Protection Requirements:

A. In addition to the control of water quality volume (in order to minimize the impact of stormwater runoff on downstream stream bank erosion), the primary requirement is to design a BMP to detain the proposed conditions 2-year, 24-hour design storm to the existing conditions 1-year flow using the SCS Type II distribution. Additionally, provisions shall be made (such as adding a small orifice at the bottom of the outlet structure) so that the proposed conditions 1-year storm takes a minimum of twenty-four (24) hours to drain from the facility from a point where the maximum volume of water from the 1-year storm is captured (i.e., the maximum water surface elevation is achieved in the facility). Release of water can begin at the start of the storm (i.e., the invert of the water quality orifice is at the invert of the facility).

B. The minimum orifice size in the outlet structure to the BMP shall be three (3) inches in diameter where possible, and a trash rack shall be installed to prevent clogging. On sites with small drainage areas contributing to this BMP that do not provide enough runoff volume to allow a 24-hour attenuation with the 3-inch orifice, the calculations shall be submitted showing this condition. Orifice sizes less than three (3) inches can be utilized, provided that the design will prevent clogging of the intake.

C. In “Conditional Direct Discharge Districts” (District C) only (see Section 408), the objective is not to attenuate the storms greater than the 2-year recurrence interval. This can be accomplished by configuring the outlet structure not to control the larger storms or by a bypass channel that diverts only the 2-year stormwater runoff into the basin or conversely, diverts flows in excess of the 2-year storm away from the basin.

Philadelphia County Portion of the Watershed:

Applicants shall adhere to the following Stream Bank Erosion/Channel Protection Requirements:

A. To meet the requirement, Stormwater Management Practices shall retain or detain the runoff from all DCIA within the limits of Earth Disturbance from a 1-year, 24-hour Natural Resources Conservation Service (NRCS) Type II design storm in the proposed site condition such that the runoff takes a minimum of 24 hours and a maximum of 72 hours to drain from the facility.

B. Redevelopment sites with less than one (1) acre of Earth Disturbance or redevelopment sites that demonstrate a 20% reduction in DCIA from predevelopment conditions are exempt from this requirement.

C. The infiltration and water quality volumes may be incorporated into the channel protection portion of the design provided the design meets all requirements concurrently.

Section 408. Stormwater Peak Rate Control and Management Districts

A. The Tookany/Tacony-Frankford Watershed has been divided into stormwater management districts as shown on the Management District Map in Model Ordinance Appendix A.

In addition to the requirements specified in Table 408.1 below, the erosion and sedimentation control (Section 403), the nonstructural project design (Section 404), the groundwater recharge (Section 405), the water quality (Section 406), and the stream bank erosion (Section 407) requirements shall be implemented.

Standards for managing runoff from each subarea in the Tookany/Tacony-Frankford Watershed for the 2-, 5-, 10-, 25-, 50-, and 100-year design storms are shown in Table 408.1. Development sites located in each of the management districts must control proposed conditions runoff rates to existing conditions runoff rates for the design storms in accordance with Table 408.1.

TABLE 408.1

PEAK RATE CONTROL STANDARDS BY STORMWATER MANAGEMENT DISTRICT IN THE TOOKANY/TACONY-FRANKFORD WATERSHED

District	Proposed Condition Design Storm (reduce to)	Existing Condition Design Storm
A	2-year	1-year
	5-year	5-year
	10-year	10-year
	25-year	25-year
	50-year	50-year
	100-year	100-year
B	2-year	1-year
	5-year	2-year
	10-year	5-year
	25-year	10-year
	50-year	25-year
	100-year	100-year
C*	Conditional Direct Discharge District	

**In District C, development sites that can discharge directly to the Tookany/Tacony-Frankford Watershed main channel, major tributaries, or indirectly to the main channel through an existing stormwater drainage system (i.e., storm sewer or tributary) may do so without control of the proposed conditions peak rate of runoff greater than the 5-year storm. Sites in District C will still have to comply with the groundwater recharge criteria, the water quality criteria, and stream bank erosion criteria. If the proposed conditions runoff is intended to be conveyed by an existing stormwater drainage system to the main channel, assurance must be provided that such system has adequate capacity to convey the flows greater than the 2-year existing conditions peak flow or will be provided with improvements to furnish the required capacity. When adequate capacity in the downstream system does not exist and will not be provided through improvements, the proposed conditions peak rate of runoff must be controlled to the existing conditions peak rate as required in District A provisions (i.e., 10-year proposed conditions flows to 10-year existing conditions flows) for the specified design storms.*

B. General - Proposed conditions rates of runoff from any regulated activity shall not exceed the peak release rates of runoff from existing conditions for the design storms specified on the Stormwater Management District Watershed Map (Ordinance Appendix A) and this section of the Ordinance.

C. District Boundaries - The boundaries of the stormwater management districts are shown on an official map that is available for inspection at the municipal and County Planning offices. A copy of the official map at a reduced scale is included in Ordinance Appendix A. The exact location of the stormwater management district boundaries as they apply to a given development site shall be determined by mapping the boundaries using the 2-foot topographic contours (or most accurate data required) provided as part of the drainage plan.

D. Sites Located in More than One (1) District - For a proposed development site located within two (2) or more stormwater management district category subareas, the peak discharge rate from any subarea shall meet the management district criteria for which the discharge is located. The calculated peak discharges shall apply regardless of whether the grading plan changes the drainage area by subarea. An exception to the above may be granted if discharges from multiple subareas recombine in proximity to the discharge site. In this case, peak discharge in any direction may follow Management District A criteria, provided that the overall site discharge meets the management district criteria for which the discharge is located.

E. Off-site Areas - Off-site areas that drain through a proposed development site are not subject to release rate criteria when determining allowable peak runoff rates. However, on-site drainage facilities shall be designed to safely convey off-site flows through the development site.

F. Site Areas - Where the site area to be impacted by a proposed development activity differs significantly from the total site area, only the proposed impact area utilizing stormwater management measures shall be subject to the management district criteria. In other words, unimpacted areas bypassing the stormwater management facilities would not be subject to the management district criteria.

G. Alternate Criteria for Redevelopment Sites - For redevelopment sites, one of the following minimum design parameters shall be accomplished, whichever is most appropriate for the given site conditions as determined by [*Municipality*];

1. Meet the full requirements specified by Table 408.1 and Sections 408.A through 408.F, and Section 408.H.

   or

2. Reduce the total impervious surface on the site by at least twenty (20) percent based upon a comparison of existing impervious surface to proposed impervious surface.

The following article provisions are optional. Please see box below.

H. "Downstream Hydraulic Capacity Analysis" - Any downstream hydraulic capacity analysis conducted in accordance with this Ordinance shall use the following criteria for determining adequacy for accepting increased peak flow rates:

1. Natural or man-made channels or swales must be able to convey the increased runoff associated with a 2-year return period event within their banks at velocities consistent with protection of the channels from erosion. Acceptable velocities shall be based upon criteria included in the DEP *Erosion and Sediment Pollution Control Program Manual*.

2. Natural or man-made channels or swales must be able to convey increased 25-year return period runoff without creating any hazard to persons or property.

3. Culverts, bridges, storm sewers, or any other facilities which need to pass or convey flows from the tributary area must be designed in accordance with DEP Chapter 105 regulations (if applicable) and, at minimum, pass the increased 25-year return period runoff.

Section 409. Calculation Methodology

A. Stormwater runoff from all development sites with a drainage area of greater than 200 acres shall be calculated using a generally accepted calculation technique that is based on the NRCS soil cover complex method. Table 409-1 summarizes acceptable computation methods and the method selected by the design professional shall be based on the individual limitations and suitability of each method for a particular site. The Municipality may allow the use of the Rational Method to estimate peak discharges from drainage areas that contain less than 200 acres. The Soil Complex Method shall be used for drainage areas greater than 200 acres.

TABLE 409.1
Acceptable Computation Methodologies For
Stormwater Management Plans

METHOD	METHOD DEVELOPED BY	APPLICABILITY
TR-20 (or commercial computer package based on TR-20)	USDA NRCS	Applicable where use of full hydrology computer model is desirable or necessary.
TR-55 (or commercial computer package based on TR-55)	USDA NRCS	Applicable for land development plans within limitations described in TR-55.
HEC-1 / HEC-HMS	US Army Corps of Engineers	Applicable where use of full hydrologic computer model is desirable or necessary.
PSRM	Penn State University	Applicable where use of a hydrologic computer model is desirable or necessary; simpler than TR-20 or HEC-1.
Rational Method or commercial computer package based on Rational Method)	Emil Kuichling(1889)	For sites less than 200 acres and with time of concentration less than 60 minutes (tc< 60 min), or as approved by the Municipality and/or Municipal Engineer
Other Methods	Varies	Other computation methodologies approved by the Municipality and/or Municipal Engineer.

**Note: Successors to the above methods are also acceptable. These successors include WinTR55 for TR-55 and WinTR20 for TR-20*

B. All calculations consistent with this Ordinance using the soil cover complex method shall use the appropriate design rainfall depths for the various return period storms according to the region in which they are located as presented in Table B-1 in Appendix B of this Ordinance. If a hydrologic computer model such as PSRM or HEC-1 / HEC-HMS is used for stormwater runoff calculations, then the duration of rainfall shall be 24 hours. The rainfall distribution should reference to NOAA Atlas 14.

C. For the purposes of existing conditions flow rate determination, undeveloped land shall be considered as "meadow" in good condition, unless the natural ground cover generates a lower curve number or Rational 'C' value (i.e., forest), as listed in Table E-1 or E-2 in Appendix E of this Ordinance.

D. All calculations using the Rational Method shall use rainfall intensities consistent with appropriate times-of-concentration for overland flow and return periods from the NOAA Atlas 14 Precipitation-Frequency Atlas of the United States (2004, revised 2006). Times-of-concentration for overland flow shall be calculated using the methodology presented in

Chapter 3 of Urban Hydrology for Small Watersheds, NRCS, TR-55 (as amended or replaced from time to time by NRCS). Times-of-concentration for channel and pipe flow shall be computed using Manning's equation.

E. Runoff Curve Numbers (CN) for both existing and proposed conditions to be used in the soil cover complex method shall be obtained from Table E-1 in Appendix E of this Ordinance.

F. Runoff coefficients (c) for both existing and proposed conditions for use in the Rational method shall be obtained from Table E-2 in Appendix E of this Ordinance.

G. Where uniform flow is anticipated, the Manning equation shall be used for hydraulic computations, and to determine the capacity of open channels, pipes, and storm sewers. Values for Manning's roughness coefficient (n) shall be consistent with Table E-3 in Appendix B of the Ordinance.

H. Outlet structures for stormwater management facilities shall be designed to meet the performance standards of this Ordinance using any generally accepted hydraulic analysis technique or method.

I. The design of any stormwater detention facilities intended to meet the performance standards of this Ordinance shall be verified by routing the design storm hydrograph through these facilities using the Storage-Indication Method. For drainage areas greater than 200 acres in size, the design storm hydrograph shall be computed using a calculation method that produces a full hydrograph (i.e. TR-20, TR-55, HEC-1, PSRM). The Municipality may approve the use of any generally accepted full hydrograph approximation technique that shall use a total runoff volume that is consistent with the volume from a method that produces a full hydrograph.

Section 410. Other Requirements

A. Any stormwater facility located on state highway rights-of-way shall be subject to approval by PennDOT.

B. All wet basin designs shall incorporate biologic controls consistent with the West Nile Guidance found in Appendix H.

C. Any stormwater management facility (i.e., detention basin) required or regulated by this Ordinance designed to store runoff and requiring a berm or earthen embankment shall be designed to provide an emergency spillway to handle flow up to and including the 100-year proposed conditions. The height of embankment must provide a minimum [*<u>recommended 1.0 foot</u>*] of freeboard above the maximum pool elevation computed when the facility functions for the 100-year proposed conditions inflow. Should any stormwater management facility require a dam safety permit under DEP Chapter 105, the facility shall be designed in accordance with Chapter 105 and meet the regulations of Chapter 105 concerning dam safety. Chapter 105 may be required to pass storms larger than the 100-year event.

D. Any facilities that constitute water obstructions (e.g., culverts, bridges, outfalls, or stream enclosures) and any work involving wetlands governed by DEP Chapter 105 regulations (as amended or replaced from time to time by DEP) shall be designed in accordance with Chapter 105 and will require a permit from DEP.

E. Any other drainage conveyance facility that does not fall under Chapter 105 regulations must be able to convey, without damage to the drainage structure or roadway, runoff from the 25-year design storm with a minimum one (1.0) foot of freeboard measured below the lowest point along the top of the roadway. Any facility that constitutes a dam as defined in DEP Chapter 105 regulations may require a permit under dam safety regulations. Any facility located within a PennDOT right-of-way must meet PennDOT minimum design standards and permit submission requirements.

F. Any drainage conveyance facility and/or channel not governed by Chapter 105 regulations must be able to convey, without damage to the drainage structure or roadway, runoff from the 25-year design storm. Conveyance facilities to or exiting from stormwater management facilities (i.e., detention basins) shall be designed to convey the design flow to or from that structure. Roadway crossings located within designated floodplain areas must be able to convey runoff from a 100-year design storm. Any facility located within a PennDOT right-of-way must meet PennDOT minimum design standards and permit submission requirements.

G. Storm sewers must be able to convey proposed conditions runoff from a [*5-, 10-, or 25-*] year design storm without surcharging inlets, where appropriate.

H. Adequate erosion protection shall be provided along all open channels and at all points of discharge.

I. The design of all stormwater management facilities shall incorporate sound engineering principles and practices. The Municipality reserves the right to disapprove any design that would result in construction in or continuation of a stormwater problem area.

ARTICLE V-INSPECTIONS

Section 501. Inspections

A. The Municipality or his municipal designee shall inspect all phases of the installation of the permanent BMPs and/or stormwater management facilities as deemed appropriate by the Municipality.

B. During any stage of the work, if the Municipality or his municipal designee determines that the permanent BMPs and/or stormwater management facilities are not being installed in accordance with the approved stormwater management plan, the Municipality shall revoke any existing permits or other approvals and issue a cease and desist order until a revised drainage plan is submitted and approved, as specified in this Ordinance, and until the deficiencies are corrected.

C. A final inspection of all BMPs and/or stormwater management facilities shall be conducted by the Municipality or his municipal designee to confirm compliance with the approved drainage plan prior to the issuance of any occupancy permit.

ARTICLE VI-FEES AND EXPENSES

Section 601. Municipality Drainage Plan Review and Inspection Fee

Fees shall be established by the Municipality to defray plan review and construction inspection costs incurred by the Municipality. All fees shall be paid by the Applicant at the time of drainage plan submission. A review and inspection fee schedule shall be established by resolution of the municipal Governing Body based on the size of the regulated activity and based on the Municipality’s costs for reviewing drainage plans and conducting inspections pursuant to Section 501. The Municipality shall periodically update the review and inspection fee schedule to ensure that review costs are adequately reimbursed.

Section 602. Expenses Covered by Fees

The fees required by this Ordinance shall at a minimum cover:

A. Administrative costs.

B. The review of the drainage plan by the Municipality.

C. The site inspections.

D. The inspection of stormwater management facilities and drainage improvements during construction.

E. The final inspection upon completion of the stormwater management facilities and drainage improvements presented in the drainage plan.

F. Any additional work required to enforce any permit provisions regulated by this Ordinance, correct violations, and assure proper completion of stipulated remedial actions.

ARTICLE VII-MAINTENANCE RESPONSIBILITIES

Section 701. Performance Guarantee

A. For subdivisions and land developments the Applicant shall provide a financial guarantee to the Municipality for the timely installation and proper construction of all stormwater management controls as:

1. Required by the approved drainage plan equal to or greater than the full construction cost of the required controls, or

2. The amount and method of payment provided for in the SALDO.

B. For other regulated activities, the Municipality may require a financial guarantee from the Applicant.

Section 702. Responsibilities for Operations and Maintenance of Stormwater Controls and BMPs

A. No regulated earth disturbance activities within the Municipality shall commence until approval by the Municipality of a stormwater control and BMP operations and maintenance plan that describes how the permanent (e.g., post-construction) stormwater controls and BMPs will be properly operated and maintained.

B. The following items shall be included in the stormwater control and BMP operations and maintenance plan:

1. Map(s) of the project area, in a form that meets the requirements for recording at the offices of the Recorder of Deeds of ________________________County, shall be submitted on_______-inch x-_______inch sheets. The contents of the map(s) shall include, but not be limited to:

    a. Clear identification of the location and nature of permanent stormwater controls and BMPs,
    b. The location of the project site relative to highways, municipal boundaries or other identifiable landmarks,
    c. Existing and final contours at intervals of two (2) feet, or others as appropriate,
    d. Existing streams, lakes, ponds, or other bodies of water within the project site area,
    e. Other physical features including flood hazard boundaries, sinkholes, streams, existing drainage courses, and areas of natural vegetation to be preserved,
    f. The locations of all existing and proposed utilities, sanitary sewers, and water lines within fifty (50) feet of property lines of the project site,
    g. Proposed final changes to the land surface and vegetative cover, including the type and amount of impervious area that would be added,
    h. Proposed final structures, roads, paved areas, and buildings, and

i. A 15-foot wide access easement around all stormwater controls and BMPs that would provide ingress to and egress from a public right-of-way.

2. A description of how each permanent stormwater control and BMP will be operated and maintained, and the identity and contact information associated with the person(s) responsible for operations and maintenance,

3. The name of the project site, the name and address of the owner of the property, and the name of the individual or firm preparing the plan, and

4. A statement, signed by the landowner, acknowledging that the stormwater controls and BMPs are fixtures that can be altered or removed only after approval by the Municipality.

C. The stormwater control and BMP operations and maintenance plan for the project site shall establish responsibilities for the continuing operation and maintenance of all permanent stormwater controls and BMPs, as follows:

1. If a plan includes structures or lots which are to be separately owned and in which streets, sewers, and other public improvements are to be dedicated to the Municipality, stormwater controls and BMPs may also be dedicated to and maintained by the Municipality;

2. If a plan includes operations and maintenance by a single ownership or if sewers and other public improvements are to be privately owned and maintained, then the operation and maintenance of stormwater controls and BMPs shall be the responsibility of the owner or private management entity.

D. The Municipality shall make the final determination on the continuing operations and maintenance responsibilities. The Municipality reserves the right to accept or reject the operations and maintenance responsibility for any or all of the stormwater controls and BMPs.

Section 703. Municipal Review of a Stormwater Control and BMP Operations and Maintenance Plan

A. The Municipality shall review the stormwater control and BMP operations and maintenance plan for consistency with the purposes and requirements of this Ordinance and any permits issued by DEP.

B. The Municipality shall notify the Applicant in writing whether or not the stormwater control and BMP operations and maintenance plan is approved.

C. The Municipality may require a “record drawing” of all stormwater controls and BMPs and an explanation of any discrepancies with the operations and maintenance plan.

Section 704. Adherence to an Approved Stormwater Control and BMP Operations and Maintenance Plan

It shall be unlawful to alter or remove any permanent stormwater control and BMP required by an approved stormwater control and BMP operations and maintenance plan or to allow the property to remain in a condition which does not conform to an approved stormwater control and BMP operations and maintenance plan.

Section 705. Operations and Maintenance Agreement for Privately Owned Stormwater Controls and BMPs

A. The Applicant shall sign an operations and maintenance agreement with the Municipality covering all stormwater controls and BMPs that are to be privately owned. The maintenance agreement shall be transferred with transfer of ownership. The agreement shall be substantially the same as the agreement in Appendix I of this Ordinance.

B. Other items may be included in the agreement where determined necessary to guarantee the satisfactory operation and maintenance of all permanent stormwater controls and BMPs. The agreement shall be subject to the review and approval of the Municipality.

Section 706. Stormwater Management Easements

A. Stormwater management easements are required for all areas used for off-site stormwater control, unless a waiver is granted by the Municipality.

B. Stormwater management easements shall be provided by the Applicant or property owner if necessary for access for inspections and maintenance or the preservation of stormwater runoff conveyance, infiltration, and detention areas and other stormwater of the easement shall be specified in any agreement under Section 705.

Section 707. Maintenance Agreement for Privately Owned Stormwater Facilities

A. Prior to final approval of the site's drainage plan, the Applicant shall sign and record the maintenance agreement contained in Appendix I which is attached and made part hereof covering all stormwater control facilities that are to be privately owned.

B. Other items may be included in the agreement where determined necessary to guarantee the satisfactory maintenance of all facilities. The maintenance agreement shall be subject to the review and approval of the municipal Solicitor and Governing Body.

Section 708. Recording of an Approved Stormwater Control and BMP Operations and Maintenance Plan and Related Agreements

A. The owner of any land upon which permanent stormwater controls and BMPs will be placed, constructed, or implemented, as described in the stormwater control and BMP operations and maintenance plan, shall record the following documents in the Office of the Recorder of

Deeds for ____________ County, within fifteen (15) days of approval of the stormwater control and BMP operations and maintenance plan by the Municipality:

1. The operations and maintenance plan, or a summary thereof,
2. Operations and maintenance agreements under Section 705, and
3. Easements under Section 706.

B. The Municipality may suspend or revoke any approvals granted for the project site upon discovery of failure on the part of the owner to comply with this section.

Section 709. Municipal Stormwater Control and BMP Operation and Maintenance Fund

A. Persons installing stormwater controls or BMPs shall be required to pay a specified amount to the Municipal Stormwater Control and BMP Operation and Maintenance Fund to help defray costs of periodic inspections and maintenance expenses. The amount of the deposit shall be determined as follows:

1. If the stormwater control or BMP is to be privately owned and maintained, the deposit shall cover the cost of periodic inspections performed by the Municipality for a period of ten (10) years, as estimated by the Municipality. After that period of time, inspections will be performed at the expense of the Municipality.

2. If the stormwater control or BMP is to be owned and maintained by the Municipality, the Municipality may require persons installing stormwater controls or BMPs to pay a specified amount to the Municipal Stormwater Control and BMP Operation and Maintenance Fund to help defray costs of operations and maintenance activities. The deposit shall cover the estimated costs for maintenance and inspections for ten (10) years. The Municipality will establish the estimated costs utilizing information submitted by the Applicant.

3. The amount of the deposit to the fund shall be converted to present worth of the annual series values. The municipal Engineer shall determine the present worth equivalents, which shall be subject to the approval of the Governing Body.

B. If a stormwater control or BMP is proposed also serves as a recreational facility (e.g., ball field or lake), the Municipality may adjust, reduce or waive the amount of the maintenance fund deposit based upon the value of the land for public recreational purpose.

C. If at some future time, a stormwater control or BMP (whether publicly or privately owned) is eliminated due to the installation of storm sewers or other storage facility, the unused portion of the maintenance fund deposit will be applied to the cost of abandoning the facility and connecting to the storm sewer system or other facility. Any amount of the deposit remaining after the costs of abandonment are paid will be returned to the depositor.

ARTICLE VIII- PROHIBITIONS

Section 801. Prohibited Discharges

A. Any drain or conveyance, whether on the surface or subsurface, which allows any non-stormwater discharge including sewage, process wastewater, and wash water to enter the waters of this Commonwealth is prohibited.

B. No person shall allow, or cause to allow, discharges into surface waters of this Commonwealth which are not composed entirely of stormwater, except (1) as provided in subsection C below, and (2) discharges allowed under a state or federal permit.

C. The following discharges are authorized unless they are determined to be significant contributors to pollution to the waters of this Commonwealth:

- Discharges from fire fighting activities	- Flows from riparian habitats and wetlands
- Potable water sources including water line flushing	- Uncontaminated water from foundations or from footing drains
- Irrigation drainage	- Lawn watering
- Air conditioning condensate	- Dechlorinated swimming pool discharges
- Springs	- Uncontaminated groundwater
- Water from crawl space pumps	- Water from individual residential car washing
- Pavement wash waters where spills or leaks of toxic or hazardous materials have not occurred (unless all spill material has been removed) and where detergents are not used	- Routine external building wash down (which does not use detergents or other compounds)

D. In the event that the Municipality or DEP determines that any of the discharges identified in Subsection C, significantly contribute to pollution of the waters of this Commonwealth, the Municipality or DEP will notify the responsible person(s) to cease the discharge.

Section 802. Prohibited Connections

A. The following connections are prohibited, except as provided in Section 801.B above:

1. Any drain or conveyance, whether on the surface or subsurface, which allows any non-stormwater discharge including sewage, process wastewater, and wash water to enter the separate storm sewer system and any connections to the storm drain system from indoor drains and sinks; and

2. Any drain or conveyance connected from a commercial or industrial land use to the separate storm sewer system which has not been documented in plans, maps, or equivalent records and approved by the Municipality.

Section 803. Roof Drains

A. Roof drains shall not be connected to streets, sanitary or storm sewers, or roadside ditches in order to promote overland flow and infiltration/percolation of stormwater where advantageous to do so.

B. When it is more advantageous to connect directly to streets or storm sewers, connections of roof drains to streets or roadside ditches may be permitted on a case by case basis as determined by the Municipality.

C. Roof drains shall discharge to infiltration areas or vegetative BMPs to the maximum extent practicable.

Section 804. Alteration of BMPs

A. No person shall modify, remove, fill, landscape, or alter any existing stormwater control or BMP unless it is part of an approved maintenance program without the written approval of the Municipality.

B. No person shall place any structure, fill, landscaping, or vegetation into a stormwater control or BMP or within a drainage easement which would limit or alter the functioning of the stormwater control or BMP without the written approval of the Municipality.

ARTICLE IX - ENFORCEMENT AND PENALTIES

Section 901. Right-of-Entry

A. Upon presentation of proper credentials, duly authorized representatives of the Municipality may enter at reasonable times upon any property within the Municipality to inspect the implementation, condition, or operation and maintenance of the stormwater controls or BMPs in regard to any aspect governed by this Ordinance.

B. Stormwater control and BMP owners and operators shall allow persons working on behalf of the Municipality ready access to all parts of the premises for the purposes of determining compliance with this Ordinance.

C. Persons working on behalf of the Municipality shall have the right to temporarily locate on any stormwater control or BMP in the Municipality such devices as are necessary to conduct monitoring and/or sampling of the discharges from such stormwater control or BMP.

D. Unreasonable delays in allowing the Municipality access to a stormwater control or BMP is a violation of this Article.

Section 902. Public Nuisance

A. The violation of any provision of this Ordinance is hereby deemed a public nuisance.

B. Each day that a violation continues shall constitute a separate violation.

Section 903. Enforcement Generally

A. Whenever the Municipality finds that a person has violated a prohibition or failed to meet a requirement of this Ordinance, the Municipality may order compliance by written notice to the responsible person. Such notice may, without limitation, require the following remedies:

1. Performance of monitoring, analyses, and reporting;

2. Elimination of prohibited connections or discharges;

3. Cessation of any violating discharges, practices, or operations;

4. Abatement or remediation of stormwater pollution or contamination hazards and the restoration of any affected property;

5. Payment of a fine to cover administrative and remediation costs;

6. Implementation of stormwater controls and BMPs; and

7. Operation and maintenance of stormwater controls and BMPs.

B. Such notification shall set forth the nature of the violation(s) and establish a time limit for correction of these violations(s). Said notice may further advise that, if applicable, should the violator fail to take the required action within the established deadline, the work will be done by the Municipality or designee, and the expense thereof shall be charged to the violator.

C. Failure to comply within the time specified shall also subject such person to the penalty provisions of this Ordinance. All such penalties shall be deemed cumulative and shall not prevent the Municipality from pursuing any and all other remedies available in law or equity.

Section 904. Suspension and Revocation of Permits and Approvals

A. Any building, land development, or other permit or approval issued by the Municipality may be suspended or revoked by the Municipality for:

1. Noncompliance with or failure to implement any provision of the permit;

2. A violation of any provision of this Ordinance; or

3. The creation of any condition or the commission of any act during construction or development which constitutes or creates a hazard or nuisance, pollution, or which endangers the life, health, or property of others.

B. A suspended permit or approval shall be reinstated by the Municipality when:

1. The Municipality or designee has inspected and approved the corrections to the stormwater controls and BMPs or the elimination of the hazard or nuisance, and/or

2. The Municipality is satisfied that the violation of the Ordinance, law, or rule and regulation has been corrected.

C. A permit or approval that has been revoked by the Municipality cannot be reinstated. The Applicant may apply for a new permit under the procedures outlined in this Ordinance.

Section 905. Penalties

A. Any person violating the provisions of this Ordinance shall be subject to a fine of not less than $ ________ nor more than $ ________ for each violation, recoverable with costs. Each day that the violation continues shall constitute a separate offense and the applicable fines are cumulative.

B. In addition, the Municipality, through its Solicitor, may institute injunctive, mandamus, or any other appropriate action or proceeding at law or in equity for the enforcement of this Ordinance. Any court of competent jurisdiction shall have the right to issue restraining orders, temporary or permanent injunctions, mandamus, or other appropriate forms of remedy or relief.

Section 906. Notification

In the event that a person fails to comply with the requirements of this Ordinance or fails to conform to the requirements of any permit issued hereunder, the Municipality shall provide written notification of the violation. Such notification shall state the nature of the violation(s) and establish a time limit for correction of these violation(s). Failure to comply within the time specified shall subject such person to the penalty provisions of this Ordinance. All such penalties shall be deemed cumulative and shall not prevent the Municipality from pursuing any and all remedies. It shall be the responsibility of the owner of the real property on which any regulated activity is proposed to occur, is occurring, or has occurred to comply with the terms and conditions of this Ordinance.

Section 907. Enforcement

The municipal Governing Body is hereby authorized and directed to enforce all of the provisions of this Ordinance. All inspections regarding compliance with the drainage plan shall be the responsibility of the municipal Engineer or other qualified persons designated by the Municipality.

A. A set of design plans approved by the Municipality shall be on file at the site throughout the duration of the construction activity. Periodic inspections may be made by the Municipality or designee during construction.

B. It shall be unlawful for any person, firm, or corporation to undertake any regulated activity under Section 104 on any property except as provided for in the approved drainage plan and pursuant to the requirements of this Ordinance. It shall be unlawful to alter or remove any control structure required by the drainage plan pursuant to this Ordinance or to allow the property to remain in a condition which does not conform to the approved drainage plan.

C. At the completion of the project and as a prerequisite for the release of the performance guarantee, the owner or his representatives shall:

1. Provide a certification of completion from an engineer, architect, surveyor, or other qualified person verifying that all permanent facilities have been constructed according to the plans and specifications and approved revisions thereto.

2. Provide a set of as-built (record) drawings.

D. After receipt of the certification by the Municipality, a final inspection shall be conducted by the Municipality or designated representative to certify compliance with this Ordinance.

E. Prior to revocation or suspension of a permit and at the request of the Applicant, the Governing Body will schedule a hearing to discuss the noncompliance if there is no immediate danger to life, public health, or property. The expense of a hearing shall be the Applicant's responsibility.

F. Occupancy Permit

An occupancy permit shall not be issued unless the certification of completion pursuant to Section 907.C.1 has been secured. The occupancy permit shall be required for each lot owner and/or Applicant for all subdivisions and land developments in the Municipality.

Section 908. Appeals

A. Any person aggrieved by any action of the [*Municipal Name*] or its designee may appeal to [*the Municipality's Governing Body*] within thirty (30) days of that action.

B. Any person aggrieved by any decision of [*the Municipality's Governing Body*] may appeal to the County Court of Common Pleas in the County where the activity has taken place within thirty (30) days of the municipal decision.

ENACTED and ORDAINED at a regular meeting of the ____________________ ____________________________ on the _____ of ______________________, 20__. This Ordinance shall take effect immediately.

____
[Name]

____
[Title]

____
[Name]

____
[Title]

____
[Name]

____
[Title]

____
[Name]

____
[Title]

____
[Name]

____
[Title]

ATTEST:

____
Secretary

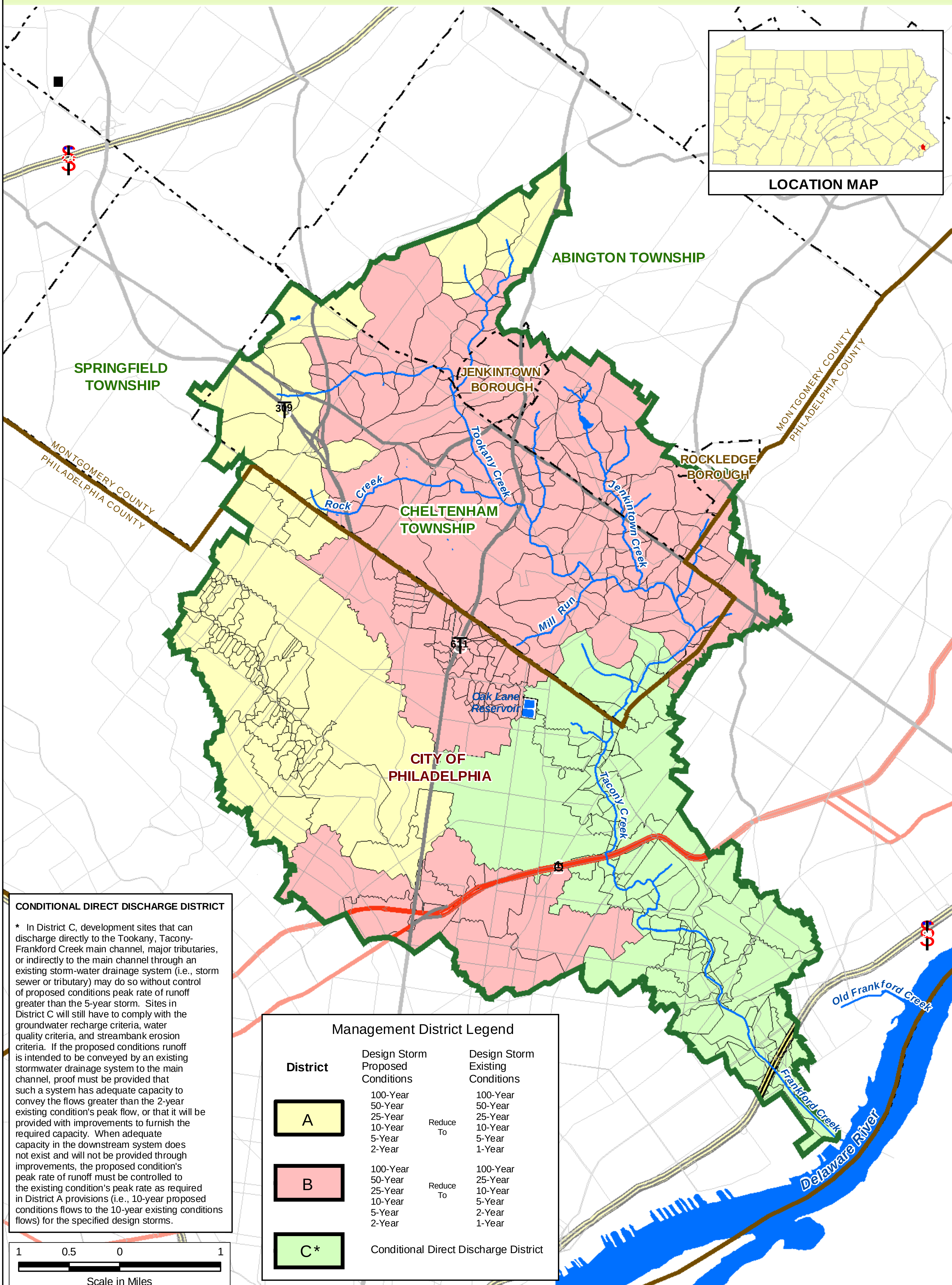
I hereby certify that the foregoing Ordinance was advertised in the ____ on __________, 20__, a newspaper of general circulation in the Municipality and was duly enacted and approved as set forth at a regular meeting of the Municipality's Governing Body held on _____________, 20__.

____
Secretary

ORDINANCE APPENDIX A

STORMWATER MANAGEMENT DISTRICT WATERSHED MAP

TOOKANY/TACONY-FRANKFORD WATERSHED
PHASE II - ACT 167 STORMWATER MANAGEMENT PLAN



CONDITIONAL DIRECT DISCHARGE DISTRICT

* In District C, development sites that can discharge directly to the Tookany, Tacony-Frankford Creek main channel, major tributaries, or indirectly to the main channel through an existing storm-water drainage system (i.e., storm sewer or tributary) may do so without control of proposed conditions peak rate of runoff greater than the 5-year storm. Sites in District C will still have to comply with the groundwater recharge criteria, water quality criteria, and streambank erosion criteria. If the proposed conditions runoff is intended to be conveyed by an existing stormwater drainage system to the main channel, proof must be provided that such a system has adequate capacity to convey the flows greater than the 2-year existing condition's peak flow, or that it will be provided with improvements to furnish the required capacity. When adequate capacity in the downstream system does not exist and will not be provided through improvements, the proposed condition's peak rate of runoff must be controlled to the existing condition's peak rate as required in District A provisions (i.e., 10-year proposed conditions flows to the 10-year existing conditions flows) for the specified design storms.

1 0.5 0 1

Scale in Miles

Management District Legend

District	Design Storm Proposed Conditions		Design Storm Existing Conditions
A	100-Year 50-Year 25-Year 10-Year 5-Year 2-Year	Reduce To	100-Year 50-Year 25-Year 10-Year 5-Year 1-Year
B	100-Year 50-Year 25-Year 10-Year 5-Year 2-Year	Reduce To	100-Year 25-Year 10-Year 5-Year 2-Year 1-Year
C*	Conditional Direct Discharge District		

Model Ordinance Appendix A MANAGEMENT DISTRICTS

Philadelphia PWD Water Department

Prepared For: PHILADELPHIA WATER DEPARTMENT

Legend

- WATERSHED BOUNDARY
- SUBWATERSHEDS
- COUNTY BOUNDARY
- MUNICIPAL BOUNDARIES
- STREAMS
- WATER BODIES

STATE MAINTAINED ROADS

- Interstate
- US Federal Highway
- PA State Route
- Other State Road

NOTE:
Portions of this map were generated from existing data sources as listed below. These data are shown on the maps for spatial reference only. These data did not enter into any computations or affect the reliability of the hydrologic analysis. Borton-Lawson Engineering has found some inaccuracies in some of these data and has corrected the data in locations where discrepancies were obvious, however, it was not a part of this ACT 167 Plan to correct all of the mapping data.

DATA SOURCES:
Watershed Boundary - PWD
Streams - PADEP
Water Bodies - USFWS (Derived from NWI Wetlands)
County Boundaries - PennDOT
Municipal Boundaries- PennDOT
Roads - Penn DOT
Subwatersheds - PWD
Management Districts - Borton-Lawson

Borton Lawson Engineering

Northeast Pennsylvania
613 Baltimore Drive
Wilkes-Barre, PA 18702
Tel: 570-821-1999

Lehigh Valley
3893 Adler Place
Bethlehem, PA 18017
Tel: 484-821-0470

PREPARED BY: SJD CHECKED BY: SAV

DATE: 7/6/2006 PROJECT #: 2004-1621-00

FILE: \\WBDataProjects\2004\162100\DATA\GIS\FINAL_REPORT_MAPS\ArcMap\Appendix_Mgmt_Districts.mxd

ORDINANCE APPENDIX B - 1

SAMPLE DRAINAGE PLAN APPLICATION

SAMPLE DRAINAGE PLAN APPLICATION

(To be attached to the "land subdivision plan or development plan review application" or "minor land subdivision plan review application")

Application is hereby made for review of the Stormwater Management Plan and related data as submitted herewith in accordance with the ___________________________Stormwater Management Ordinance.

________________Final Plan ________________Preliminary Plan __________Sketch Plan

Date of Submission ________________________Submission No.__________________________

1. Name of subdivision or development____

2. Name of Applicant __________________________________ Telephone No.______________

   (if corporation, list the corporation's name and the names of two officers of the corporation)
   ____Officer 1
   ____Officer 2

   Address____
   Zip____

   Applicant's interest in subdivision or development
   (if other than property owner, give owner's name and address)

3. Name of property owner ______________________________Telephone No._______________

   Address____
   Zip____

4. Name of engineer or surveyor _________________________Telephone No._______________

   Address____
   Zip____

5. Type of subdivision or development proposed:

____ Single-family Lots	____ Townhouses	____ Commercial (Multi-lot)
____ Two-family Lots	____ Garden Apartments	____ Commercial (One Lot)
____ Multi-family Lots	____ Mobile Home Park	____ Industrial (Multi-lot)
____ Cluster Type Lots	____ Campground	____ Industrial (One Lot)
____ Planned Residential Development	____ Other (____________________________)	

6. Linear feet of new road proposed____ L.F.

7. Area of proposed and existing impervious area on the entire tract.

   a. Existing (to remain) _______________ S.F. _______________% of property
   b. Proposed _______________ S.F. _______________% of property

8. Stormwater

   a. Does the peak rate of runoff from proposed conditions exceed that flow which occurred for existing conditions for the designated design storm?_______________________

   b. Design storm utilized (on-site conveyance systems) (24 hr.)______________________
      No. of Subarea______________________________
      Watershed Name____________________________

      Explain:____
      ____
      ____

   c. Does the submission and/or district meet the criteria for the applicable management district?
      ____

   d. Number of subarea(s) from Ordinance Appendix A of the Tookany/Tacony-Frankford Watershed Stormwater Management Plan_____________________________________

   e. Type of proposed runoff control____

   f. Does the proposed stormwater control criteria meet the requirements/guidelines of the Stormwater Ordinance?____

      If not, what variances/waivers are requested?______________________________________
      ____

      Reasons____

   g. Does the plan meet the requirements of Article III of the Stormwater Ordinance?_____

      If not, what variances/waivers are requested?____________________________________

      Reasons why ____
      ____

   h. Was TR-55, June 1986, utilized in determining the time of concentration?_____________
      ____

i. What hydrologic method was used in the stormwater computations?__________________
____

j. Is a hydraulic routing through the stormwater control structure submitted?_____________
____

k. Is a construction schedule or staging attached?________________________________

l. Is a recommended maintenance program attached?_____________________________

9. Erosion and Sediment Pollution Control (E&S):

a. Has the stormwater management and E&S plan, supporting documentation, and narrative been submitted to the _______[*County Name*]___County Conservation District?______

b. Total area of earth disturbance ______________________________________S.F.

10. Wetlands

a. Have the wetlands been delineated by someone trained in wetland delineation?_________

b. Have the wetland lines been verified by a state or federal permitting authority?______

c. Have the wetland lines been surveyed?_______________________________________

d. Total acreage of wetland within the property __________________________________

e. Total acreage of wetland disturbed____

f. Supporting documentation____

11. Filing

a. Has the required fee been submitted?____

Amount____

b. Has the proposed schedule of construction inspection to be performed by the Applicant's engineer been submitted?____

c. Name of individual who will be making the inspections_________________________

d. General comments about stormwater management at the development________________
____
____

CERTIFICATE OF OWNERSHIP AND ACKNOWLEDGMENT OF APPLICATION:

COMMONWEALTH OF PENNSYLVANIA
COUNTY OF____[*County Name*]___.

On this the _________ day of _________________, 20_____, before me, the undersigned officer, personally appeared ________________________who, being duly sworn according to law, deposes and says that __________________________________are owners of the property described in this application and that the application was made with ____________________________ knowledge and/or direction and does hereby agree with the said application and to the submission of the same.

____Property Owner

My Commission Expires____20__________
Notary Public____

THE UNDERSIGNED HEREBY CERTIFIES THAT TO THE BEST OF HIS KNOWLEDGE AND BELIEF THE INFORMATION AND STATEMENTS GIVEN ABOVE ARE TRUE AND CORRECT.

SIGNATURE OF APPLICANT____

//

(Information Below This Line To Be Completed By The Municipality)

____________________________ (Name of) Municipality official submission receipt:

Date complete application received ________________plan number________________________

Fees _______________ date fees paid ______________ received by________________________

Official submission receipt date ____

Received by______________________________

____
Municipality

PROPOSED SCHEDULE OF FEES

[It is recommended that Municipalities adopt a fee schedule independent of the Ordinance so that fee schedules can be adjusted as need arises without having to go through the Ordinance revision public hearing process.]

Subdivision name______________________________Submittal No.___________________________

Owner _______________________________________Date___________________________________

Engineer____

1. Filing fee $____________

2. Proposed land use
   - 2a. Subdivision, campgrounds, mobile home parks, and multi-family dwelling where the units are located in the same local watershed $____________
   - 2b. Multi-family dwelling where the designated open space is located in a different local watershed from the proposed units $____________
   - 2c. Commercial/industrial $____________
   - 2d. Other $____________

3. Relative amount of earth disturbance
   - 3a. Residential
     - road <500 l.f. $____________
     - road 500-2,640 l.f. $____________
     - road >2,640 l.f. $____________
   - 3b. Commercial/industrial and other
     - impervious area <3,500 s.f. $____________
     - impervious area 3,500-43,560 s.f. $____________
     - impervious area >43,560 s.f. $____________

4. Relative size of project
   - 4a. Total tract area
     - <1 ac. $____________
     - 1-5 ac. $____________
     - 5-25 ac. $____________
     - 25-100 ac. $____________
     - 100-200 ac. $____________
     - >200 ac. $____________

5. Stormwater control measures
   - 5a. Detention basins and other controls which require a review of hydraulic routings $____________

($ per control)

5b. Other control facilities which require storage volume calculations but no hydraulic routings ($ per control) $___________

6. Site inspection ($ per inspection) $___________

Total $___________

All subsequent reviews shall be 25% of the amount of the initial review fee unless a new application is required as per Section 306 of the Stormwater Ordinance. A new fee shall be submitted with each revision in accordance with this schedule.

ORDINANCE APPENDIX B – 2

DRAINAGE PLAN CHECKLIST

Montgomery County Conservation District
143 Level Road
Collegeville, PA 19426
Phone: 610-489-4506
Fax: 610-489-9795

Project: ____________________
Municipality: ____________________
Engineer: ____________________
Submittal No: ____________________
Date: ____________________
Project ID: ____________________ (for County use ONLY)

ARTICLE I: GENERAL PROVISIONS

Reference: Section 105 Applicability/Regulated Activities

1. Is the Proposed Project within the Tookany/Tacony-Frankford Watershed? ☐ Yes ☐ No
2. Does the Proposed Project meet the definition of a "Regulated Activity"? ☐ Yes ☐ No

STOP – If you have checked NO for either of the above questions, you are not required to submit a Stormwater Management Plan under the Tookany/Tacony-Frankford Watershed Stormwater Management Ordinance.

ARTICLE I: GENERAL PROVISIONS

Reference: Section 106 Exemptions

Note: Parent Tract refers to the total parcel configuration on June 30,2008 and includes any subdivision of lands which may have occurred after than date.

Parent Tract Area: ___________ acres

Total Existing Impervious Area (as of June 30, 2008): ___________ acres
Total New Impervious Area (all Phases): ___________ acres

Parcel IS Exempt ☐ Parcel IS NOT Exempt ☐

ARTICLE IV: STORMWATER MANAGEMENT

Reference: Section 404 Nonstructural Project Design

1. Has an Existing Resource and Site Analysis Map (ERSAM) been prepared?

   ☐ Yes ☐ No, Explain ____________________

ARTICLE IV: STORMWATER MANAGMENT (Continued)

2. Are any of the following Environmentally Sensitive areas identified on site?

Steep Slopes	☐ Yes	☐ No	☐ Unknown
Ponds / Lakes / Vernal Pools	☐ Yes	☐ No	☐ Unknown
Streams	☐ Yes	☐ No	☐ Unknown
Wetlands	☐ Yes	☐ No	☐ Unknown
Hydric Soils	☐ Yes	☐ No	☐ Unknown
Flood plains	☐ Yes	☐ No	☐ Unknown
Stream Buffer Zones	☐ Yes	☐ No	☐ Unknown
Hydrologic Soil Groups A or B	☐ Yes	☐ No	☐ Unknown
Recharge Areas	☐ Yes	☐ No	☐ Unknown
Others: ____________	☐ Yes	☐ No	☐ Unknown

3. Does the site layout plan avoid Environmentally Sensitive Areas identified on site?

☐ Yes ☐ No, Explain ____________

4. Has a stream buffer been established per Section 406.G.?

☐ Yes ☐ No, Explain ____________

ARTICLE IV: STORMWATER MANAGEMENT

Reference: Section 405 Groundwater Recharge

1. Is the proposed activity considered a "Stormwater Hotspot"? ☐ Yes ☐ No
2. Have provisions been installed to promote groundwater recharge on site?

   ☐ Yes ☐ No, Explain ____________

3. Total Recharge Volume Required:__________ cubic feet
4. How is the Required Recharge Volume being addressed?

☐ Infiltration Trench	☐ Dry Swales
☐ Infiltration Basin	☐ Other: ____________
☐ Bioretention	

ARTICLE IV: STORMWATER MANAGEMENT

Reference: Section 406 Water Quality Requirements

1. Have provisions been installed to address stormwater runoff water quality on site?

   ☐ Yes ☐ No, Explain ____

   ____

   ____

2. Total Water Quality Volume Required: __________ acre feet

3. Is the site in a Special Protection watershed which includes Exceptional Value (EV) of High Quality (HQ) waters? ☐ Yes ☐ No

4. How is the Required Water Quality Volume being addressed?

   ☐ Wet Detention Basin ☐ Sand Filter
   ☐ Extended Dry Detention Basin ☐ Constructed Wetlands
   ☐ Bioretention ☐ Other: ____________________

ARTICLE IV: STORMWATER MANAGMENT

Reference: Section 407 Streambank Erosion Requirements

1. Has the 2-year proposed conditions flow been reduced to the 1-year existing conditions flow?

   ☐ Yes ☐ No, Explain ____

   ____

   ____

2. Does the proposed conditions 1-year storm drain over a minimum 24-hour period?

   ☐ Yes ☐ No, Explain ____

   ____

   ____

ARTICLE IV: STORMWATER MANAGEMENT

Reference: Section 408 Stormwater Peak Rate Control and Management Districts

1. In which of the following Stormwater Management District(s) is the site located?

   ☐ A ☐ C
   ☐ B

2. Does the Proposed Conditions Runoff meet the Criteria established in Table 408.1?

   ☐ Yes ☐ No, if you answered Yes proceed next page.

ARTICLE IV: STORMWATER MANAGEMENT

Reference: Section 409 Calculation Methodology

1. Which method(s) are utilized in the site stormwater management plan for computing stormwater runoff rates and volumes?

   ☐ TR-20 ☐ PSRM
   ☐ TR-55 ☐ Rational Method
   ☐ HEC-1 / HEC-HMS ☐ Other:__________________

2. Was NOAA Atlas 14 utilized in rainfall determination?

   ☐ Yes ☐ No, Explain ____

3. Was Table E-2 (Runoff Curve Numbers) or Table E-3 in the Appendix F (Rational Runoff Coefficients) utilized in calculations for runoff?

   ☐ Yes ☐ No, Explain ____

4. For any proposed stormwater detention facility, were the appropriate design storms routed through the facility using the Storage-Indication Method?

   ☐ Yes ☐ No, Explain ____

ARTICLE IV: STORMWATER MANAGEMENT

Reference: Section 410 Other Requirements

1. Is this project subject to PENNDOT approval?

   ☐ Yes ☐ No

   a. If "YES" have these plans been forwarded to PENNDOT for review?

      ☐ Yes ☐ No, Explain ____________________________________

2. Have proposed wet detention basins incorporated biologic control consistent with the West Nile Guidelines presented in Appendix G?

   ☐ Yes ☐ No ☐ Not Applicable

3. Are any proposed stormwater facilities subject to PADEP Chapter 105 permitting?

   ☐ Yes ☐ No

   a. If "YES" have these plans been forwarded to PADEP for review?

      ☐ Yes ☐ No, Explain ____________________________________

ARTICLE VII: MAINTENANCE RESPONSIBLITIES

Reference: Section 702 Responsibilities for Operations and Maintenance of Stormwater Controls/BMPs

1. Has a Stormwater Control and BMP Operations and Maintenance Plan been approved by the Municipality?

   ☐ Yes ☐ No, Explain ____

   ____

2. Who shall assume responsibility for implementing the Stormwater Control and BMP Operations and Maintenance Plan?

   ☐ Municipality ☐ Homeowner Association
   ☐ Private Owner ☐ Other _______________

Philadelphia Water Department
ARAMark Tower – 5th Floor
1101 Market Street
Philadelphia, PA 19107
Phone: 215-685-4944
Fax: 215-685-6043

Project: ____

Engineer: ____

Submittal No: __________________

Date: ______________________

Project ID: ___________________ (for County use ONLY)

ARTICLE I: GENERAL PROVISIONS

Reference: Section 105 Applicability/Regulated Activities

1. Is the Proposed Project within the Tookany/Tacony-Frankford Watershed? ☐ Yes ☐ No
2. Does the Proposed Project meet the definition of a "Regulated Activity"? ☐ Yes ☐ No

STOP – If you have checked NO for either of the above questions, you are not required to submit a Stormwater Management Plan under the Tookany/Tacony-Frankford Watershed Stormwater Management Ordinance.

ARTICLE I: GENERAL PROVISIONS

Reference: Section 106 Exemptions

Note: Parent Tract refers to the total parcel configuration on June 30,2008 and includes any subdivision of lands which may have occurred after than date.

Parent Tract Area: __________ acres

Total Existing Impervious Area (as of June 30, 2008): __________ acres
Total New Impervious Area (all Phases): __________ acres

Parcel IS Exempt ☐ Parcel IS NOT Exempt ☐

ARTICLE IV: STORMWATER MANAGEMENT

Reference: Section 404 Nonstructural Project Design

1. Has an Existing Resource and Site Analysis Map (ERSAM) been prepared?

   ☐ Yes ☐ No, Explain ____

ARTICLE IV: STORMWATER MANAGMENT (Continued)

2. Are any of the following Environmentally Sensitive areas identified on site?

Steep Slopes	☐ Yes	☐ No	☐ Unknown
Ponds / Lakes / Vernal Pools	☐ Yes	☐ No	☐ Unknown
Streams	☐ Yes	☐ No	☐ Unknown
Wetlands	☐ Yes	☐ No	☐ Unknown
Hydric Soils	☐ Yes	☐ No	☐ Unknown
Flood plains	☐ Yes	☐ No	☐ Unknown
Stream Buffer Zones	☐ Yes	☐ No	☐ Unknown
Hydrologic Soil Groups A or B	☐ Yes	☐ No	☐ Unknown
Recharge Areas	☐ Yes	☐ No	☐ Unknown
Others: ____________________	☐ Yes	☐ No	☐ Unknown

3. Does the site layout plan avoid Environmentally Sensitive Areas identified on site?

☐ Yes ☐ No, Explain ____

4. Has a stream buffer been established per Section 406.G.?

☐ Yes ☐ No, Explain ____

ARTICLE IV: STORMWATER MANAGEMENT

Reference: Section 405 Groundwater Recharge

1. Is the proposed activity considered a "Stormwater Hotspot"? ☐ Yes ☐ No

2. Have provisions been installed to promote groundwater recharge on site?

☐ Yes ☐ No, Explain ____

3. Total Recharge Volume Required:__________ cubic feet

4. How is the Required Recharge Volume being addressed?

☐ Infiltration Trench	☐ Dry Swales
☐ Infiltration Basin	☐ Other: ____________________
☐ Bioretention	

ARTICLE IV: STORMWATER MANAGEMENT

Reference: Section 406 Water Quality Requirements

1. Have provisions been installed to address stormwater runoff water quality on site?

   ☐ Yes ☐ No, Explain ____
   ____
   ____

2. Total Water Quality Volume Required: __________ acre feet

3. Is the site in a Special Protection watershed which includes Exceptional Value (EV) of High Quality (HQ) waters? ☐ Yes ☐ No

4. How is the Required Water Quality Volume being addressed?

☐ Wet Detention Basin	☐ Sand Filter
☐ Extended Dry Detention Basin	☐ Constructed Wetlands
☐ Bioretention	☐ Other: ____________________

ARTICLE IV: STORMWATER MANAGMENT

Reference: Section 407 Streambank Erosion Requirements

1. Has the 2-year proposed conditions flow been reduced to the 1-year existing conditions flow?

   ☐ Yes ☐ No, Explain ____
   ____
   ____

2. Does the proposed conditions 1-year storm drain over a minimum 24-hour period?

   ☐ Yes ☐ No, Explain ____
   ____
   ____

ARTICLE IV: STORMWATER MANAGEMENT

Reference: Section 408 Stormwater Peak Rate Control and Management Districts

1. In which of the following Stormwater Management District(s) is the site located?

☐ A	☐ C
☐ B	

2. Does the Proposed Conditions Runoff meet the Criteria established in Table 408.1?

   ☐ Yes ☐ No, if you answered Yes proceed next page.

ARTICLE IV: STORMWATER MANAGEMENT

Reference: Section 409 Calculation Methodology

1. Which method(s) are utilized in the site stormwater management plan for computing stormwater runoff rates and volumes?

   ☐ TR-20 ☐ PSRM
   ☐ TR-55 ☐ Rational Method
   ☐ HEC-1 / HEC-HMS ☐ Other:___________________

2. Were Table F-1 or Figure F-4 in Appendix F utilized in rainfall determination?

   ☐ Yes ☐ No, Explain ____
   ____
   ____

3. Were Table F-2 (Runoff Curve Numbers) or Table F-3 in the Appendix F (Rational Runoff Coefficients) utilized in calculations for runoff?

   ☐ Yes ☐ No, Explain ____
   ____
   ____

4. For any proposed stormwater detention facility, were the appropriate design storms routed through the facility using the Storage-Indication Method?

   ☐ Yes ☐ No, Explain ____
   ____
   ____

Reference: Section 410 Other Requirements

1. Is this project subject to PENNDOT approval?

   ☐ Yes ☐ No

   a. If "YES" have these plans been forwarded to PENNDOT for review?

      ☐ Yes ☐ No, Explain ____
      ____

2. Have proposed wet detention basins incorporated biologic control consistent with the West Nile Guidelines presented in Appendix H?

   ☐ Yes ☐ No ☐ Not Applicable

3. Are any proposed stormwater facilities subject to PADEP Chapter 105 permitting?

   ☐ Yes ☐ No

a. If “YES” have these plans been forwarded to PADEP for review?

☐ Yes ☐ No, Explain ____

____

ARTICLE VII: MAINTENANCE RESPONSIBLITIES

Reference: Section 702 Responsibilities for Operations and Maintenance of Stormwater Controls/BMPs

1. Has a Stormwater Control and BMP Operations and Maintenance Plan been approved by the Municipality?

   ☐ Yes ☐ No, Explain ____

   ____

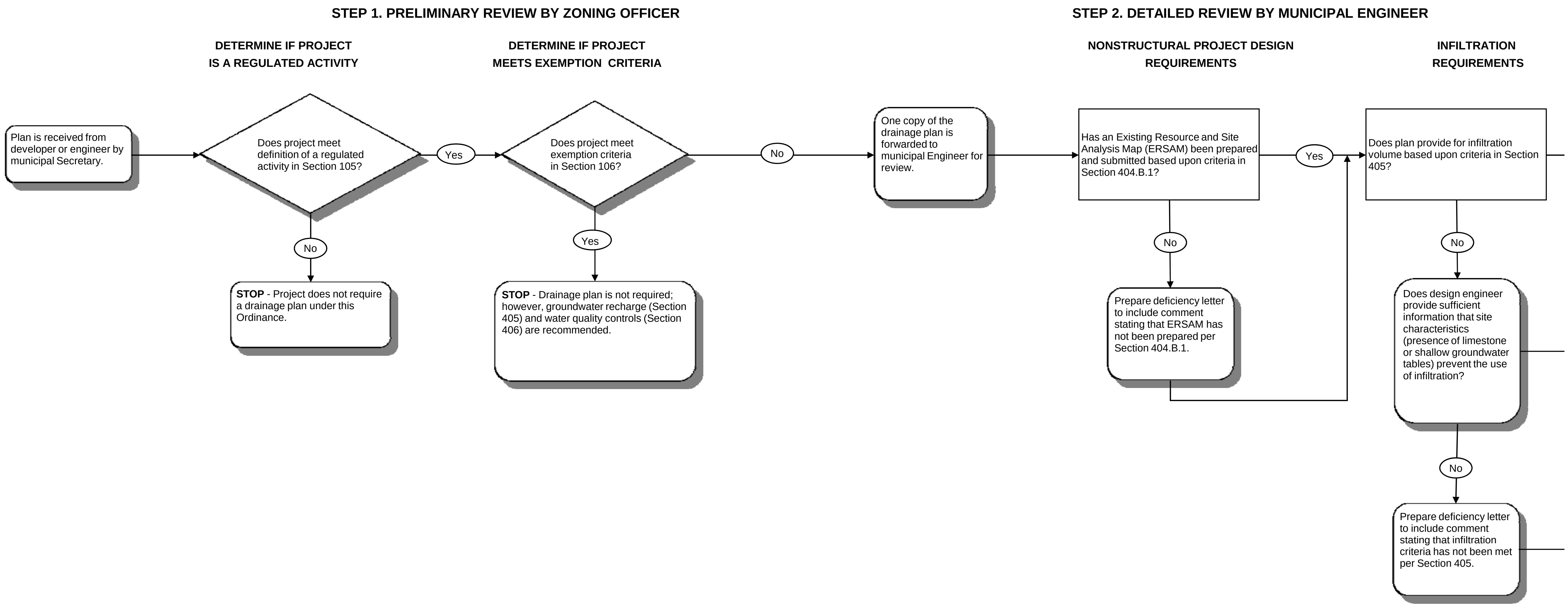
2. Who shall assume responsibility for implementing the Stormwater Control and BMP Operations and Maintenance Plan?

   ☐ Municipality ☐ Homeowner Association
   ☐ Private Owner ☐ Other ______________

ORDINANCE APPENDIX C

IMPLEMENTATION FLOW CHARTS

TOOKANY/TACONY-FRANKFORD WATERSHED
STORMWATER MANAGEMENT
Water Quality and Quantity Control Drainage Plan
Municipal Review Procedure

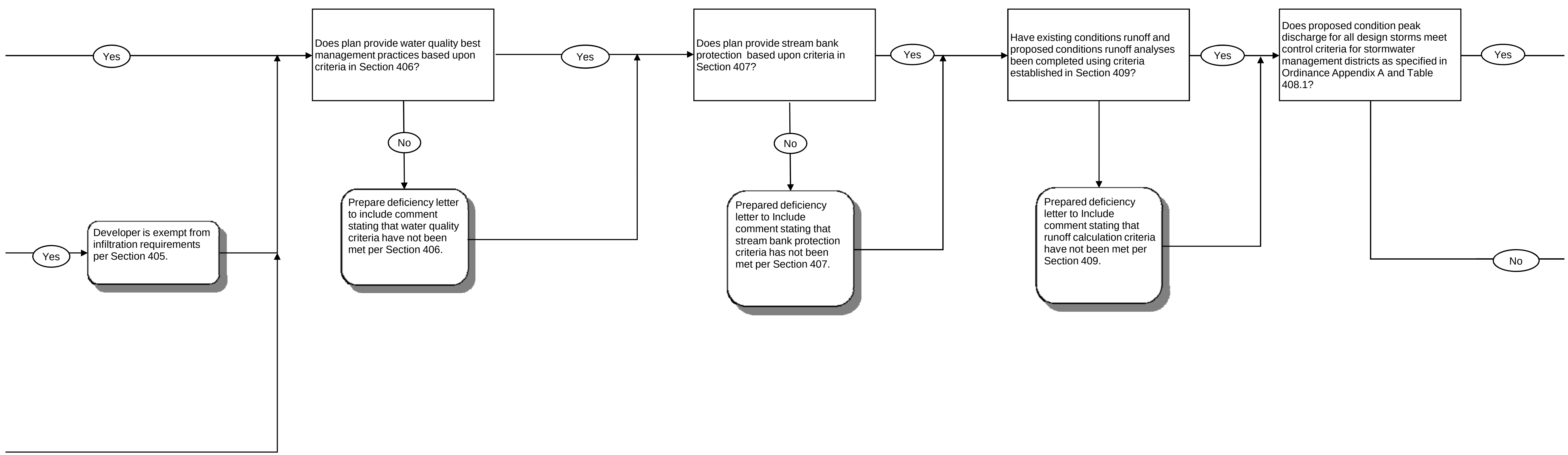


TOOKANY/TACONY-FRANKFORD WATERSHED
STORMWATER MANAGEMENT
Water Quality and Quantity Control Drainage Plan
Municipal Review Procedure

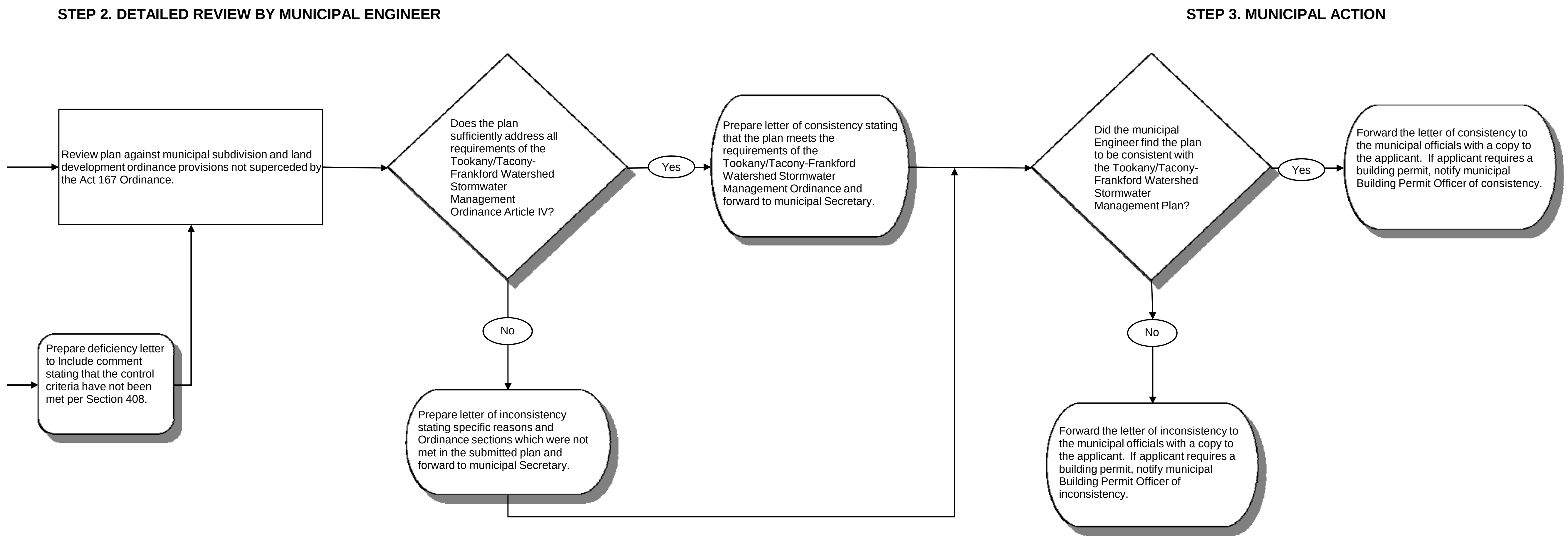
STEP 2. DETAILED REVIEW BY MUNICIPAL ENGINEER

WATER QUALITY REQUIREMENTS

STREAMBANK EROSION REQUIREMENTS



TOOKANY/TACONY-FRANKFORD WATERSHED
STORMWATER MANAGEMENT
Water Quality and Quantity Control Drainage Plan
Municipal Review Procedure



ORDINANCE APPENDIX D

LOW IMPACT DEVELOPMENT (LID) PRACTICES

LOW IMPACT DEVELOPMENT (LID) PRACTICES

ALTERNATIVE APPROACH FOR MANAGING STORMWATER RUNOFF

Natural hydrologic conditions can be altered radically by poorly planned development practices such as introducing unnecessary impervious surfaces, destroying existing drainage swales, constructing unnecessary storm sewers, and changing local topography. A traditional drainage approach of development has been to remove runoff from a site as quickly as possible and capture it in a detention basin. This approach leads ultimately to the degradation of water quality as well as expenditure of additional resources for detaining and managing concentrated runoff at some downstream location.

The recommended alternative approach is to promote practices that will minimize proposed conditions runoff rates and volumes, which will minimize needs for artificial conveyance and storage facilities. To simulate pre-development hydrologic conditions, infiltration is often necessary to offset the loss of infiltration by creation of impervious surfaces. The ability of the ground to infiltrate depends upon the soil types and its conditions.

Preserving natural hydrologic conditions requires careful alternative site design considerations. Site design practices include preserving natural drainage features, minimizing impervious surface area, reducing the hydraulic connectivity of impervious surfaces, and protecting natural depression storage. A well-designed site will contain a mix of all of those features. The following describes various techniques to achieve the alternative approach:

- **Preserving Natural Drainage Features**. Protecting natural drainage features, particularly vegetated drainage swales and channels, is desirable because of their ability to infiltrate and attenuate flows and to filter pollutants. However, this objective is often not accomplished in land development. In fact, commonly held drainage philosophy encourages just the opposite pattern -- streets and adjacent storm sewers are typically located in the natural headwater valleys and swales, thereby replacing natural drainage functions with a completely impervious system. As a result, runoff and pollutants generated from impervious surfaces flow directly into storm sewers with no opportunity for attenuation, infiltration, or filtration. Developments designed to fit site topography also minimize the amount of grading on site.

- **Protecting Natural Depression Storage Areas**. Depressional storage areas either have no surface outlet or drain very slowly following a storm event. They can be commonly seen as ponded areas in farm fields during the wet season or after large runoff events. Traditional development practices eliminate these depressions by filling or draining, thereby obliterating their ability to reduce surface runoff volumes and trap pollutants. The volume and release rate characteristics of depressions should be protected in the design of the development site. The depressions can be protected by simply avoiding the depression or by incorporating its storage as additional capacity in required detention facilities.

- **Avoiding Introduction of Impervious Areas**. Careful site planning should consider reducing impervious coverage to the maximum extent possible. Building footprints, sidewalks, driveways, and other features producing impervious surfaces should be evaluated to minimize impacts on runoff.

- **Reducing the Hydraulic Connectivity of Impervious Surfaces**. Impervious surfaces are significantly less of a problem if they are not directly connected to an impervious conveyance system (such as a storm sewer). Two basic ways to reduce hydraulic connectivity are routing of roof runoff over lawns and reducing the use of storm sewers. Site grading should promote increasing travel time of stormwater runoff and should help reduce concentration of runoff to a single point in the development.

- **Routing Roof Runoff Over Lawns**. Roof runoff can be easily routed over lawns in most site designs. The practice discourages direct connection of downspouts to storm sewers or parking lots. The practice also discourages sloping driveways and parking lots to the street. By routing roof drains and crowning the driveway to run off to the lawn, the lawn is essentially used as a filter strip.

- **Reducing the Use of Storm Sewers**. By reducing use of storm sewers for draining streets, parking lots, and back yards, the potential for accelerating runoff from the development can be greatly reduced. The practice requires greater use of swales and may not be practical for some development sites, especially if there are concerns for areas that do not drain in a "reasonable" time. The practice requires educating local citizens and public works officials who expect runoff to disappear shortly after a rainfall event.

- **Reducing Street Widths**. Street widths can be reduced by either eliminating on-street parking or by reducing roadway widths. Municipal planners and traffic designers should encourage narrower neighborhood streets which ultimately could lower maintenance.

- **Limiting Sidewalks to One Side of the Street**. A sidewalk on one side of the street may suffice in low-traffic neighborhoods. The lost sidewalk could be replaced with bicycle/recreational trails that follow back-of-lot lines. Where appropriate, backyard trails should be constructed using pervious materials.

- **Using Permeable Paving Materials**. These materials include permeable interlocking concrete paving blocks or porous bituminous concrete. Such materials should be considered as alternatives to conventional pavement surfaces, especially for low use surfaces such as driveways, overflow parking lots, and emergency access roads.

- **Reducing Building Setbacks**. Reducing building setbacks reduces impervious cover associated with driveway and entry walks and is most readily accomplished along low-traffic streets where traffic noise is not a problem.

- **Constructing Cluster Developments**. Cluster developments can also reduce the amount of impervious area for a given number of lots. The biggest savings occurs with street length, which also will reduce costs of the development. Cluster development groups the construction activity in less-sensitive areas without substantially affecting the gross density of development.

In summary, a careful consideration of the existing topography and implementation of a combination of the above mentioned techniques may avoid construction of costly stormwater control measures. Benefits include reduced potential for downstream flooding and water quality degradation of receiving streams/water bodies, enhancement of aesthetics, and reduction of development costs. Other benefits include more stable baseflows in receiving streams, improved groundwater recharge, reduced flood flows, reduced pollutant loads, and reduced costs for conveyance and storage.

ORDINANCE APPENDIX E

STORMWATER MANAGEMENT DESIGN CRITERIA

TABLE E-1
RUNOFF CURVE NUMBERS
Source: NRCS (SCS) TR-55

TABLE E-2
RATIONAL RUNOFF COEFFICIENTS

TABLE E-3
MANNING ROUGHNESS COEFFICIENTS

TABLE E-4
NONSTRUCTURAL STORMWATER MANAGEMENT MEASURES

FIGURE E-1
RECOMMENDATION CHART FOR INFILTRATION STORMWATER MANAGEMENT BMPS IN CARBONATE AREAS

TABLE E-1
Runoff Curve Numbers
(From NRCS (SCS) TR-55)

LAND USE DESCRIPTION		HYDROLOGIC SOIL GROUP A	B	C	D
Open Space		44	65	77	82
Meadow / Orchard		30	58	71	78
Agricultural		59	71	79	83
Forest		36	60	73	79
Commercial	(85% Impervious)	89	92	94	95
Industrial	(72% Impervious)	81	88	91	93
Institutional	(50% Impervious)	71	82	88	90
Residential					
Average Lot Size	% impervious				
1/8 acre or less*	65	77	85	90	92
1/8 - 1/3 acre	34	59	74	82	87
1/3 - 1 acre	23	53	69	80	85
1 - 4 acres	12	46	66	78	82
Farmstead		59	74	82	86
Smooth Surfaces (Concrete, Asphalt, Gravel or Bare Compacted Soil)		98	98	98	98
Water		98	98	98	98
Mining/Newly Graded Areas (Pervious Areas Only)		77	86	91	94

* Includes Multi-Family Housing unless justified lower density can be provided.
Note: Existing site conditions of bare earth or fallow ground shall be considered as meadow when choosing a CN value.

TABLE E-2
RATIONAL RUNOFF COEFFICIENTS

By Hydrologic Soils Group and Overland Slope (%)

	A			B			C			D		
Land Use	0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+
Cultivated Land	0.08[a]	0.13	0.16	0.11	0.15	0.21	0.14	0.19	0.26	0.18	0.23	0.31
	0.14[b]	0.18	0.22	0.16	0.21	0.28	0.20	0.25	0.34	0.24	0.29	0.41
Pasture	0.12	0.20	0.30	0.18	0.28	0.37	0.24	0.34	0.44	0.30	0.40	0.50
	0.15	0.25	0.37	0.23	0.34	0.45	0.30	0.42	0.52	0.37	0.50	0.62
Meadow	0.10	0.16	0.25	0.14	0.22	0.30	0.20	0.28	0.36	0.24	0.30	0.40
	0.14	0.22	0.30	0.20	0.28	0.37	0.26	0.35	0.44	0.30	0.40	0.50
Forest	0.05	0.08	0.11	0.08	0.11	0.14	0.10	0.13	0.16	0.12	0.16	0.20
	0.08	0.11	0.14	0.10	0.14	0.18	0.12	0.16	0.20	0.15	0.20	0.25
Residential												
Lot Size 1/8 Acre	0.25	0.28	0.31	0.27	0.30	0.25	0.30	0.33	0.38	0.33	0.36	0.42
	0.33	0.37	0.40	0.35	0.39	0.44	0.38	0.42	0.49	0.41	0.45	0.54
Lot Size 1/4 Acre	0.22	0.26	0.29	0.24	0.29	0.33	0.27	0.31	0.36	0.30	0.34	0.40
	0.30	0.34	0.37	0.33	0.37	0.42	0.36	0.40	0.47	0.38	0.42	0.52
Lot Size 1/3 Acre	0.19	0.23	0.26	0.22	0.26	0.30	0.25	0.29	0.34	0.28	0.32	0.39
	0.28	0.32	0.35	0.30	0.35	0.39	0.33	0.38	0.45	0.36	0.40	0.50
Lot Size 1/2 Acre	0.16	0.20	0.24	0.19	0.23	0.28	0.22	0.27	0.32	0.26	0.30	0.37
	0.25	0.29	0.32	0.28	0.32	0.36	0.31	0.35	0.42	0.34	0.38	0.48
Lot Size 1 Acre	0.14	0.19	0.22	0.17	0.21	0.26	0.20	0.25	0.31	0.24	0.29	0.35
	0.22	0.26	0.29	0.24	0.28	0.34	0.28	0.32	0.40	0.31	0.35	0.46
Industrial	0.67	0.68	0.68	0.68	0.68	0.69	0.68	0.69	0.69	0.69	0.69	0.70
	0.85	0.85	0.86	0.85	0.86	0.86	0.86	0.86	0.87	0.86	0.86	0.88
Commercial	0.71	0.71	0.72	0.71	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
	0.88	0.88	0.89	0.89	0.89	0.89	0.89	0.89	0.90	0.89	0.89	0.90
Streets	0.70	0.71	0.71	0.71	0.72	0.74	0.72	0.73	0.76	0.73	0.75	0.78
	0.76	0.77	0.79	0.80	0.82	0.84	0.84	0.85	0.89	0.89	0.91	0.95
Open Space	0.05	0.10	0.14	0.08	0.13	0.19	0.12	0.17	0.24	0.16	0.21	0.28
	0.11	0.16	0.20	0.14	0.19	0.26	0.18	0.23	0.32	0.22	0.27	0.39
Parking	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87
	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97

[a] Runoff coefficients for storm recurrence intervals less than 25 years.

[b] Runoff coefficients for storm recurrence intervals of 25 years or more.

Source : Rawls, W.J., S.L. Wong and R.H. McCuen, 1981, "Comparison of Urban Flood Frequency Procedures", Preliminary Draft, U.S. Department of Agriculture, Soil Conservation Service, Baltimore, MD.

TABLE E-3

Roughness Coefficients (Manning's "n") For Overland Flow
(U.S. Army Corps Of Engineers, HEC-1 Users Manual)

Surface Description	n		
Dense Growth	0.4	-	0.5
Pasture	0.3	-	0.4
Lawns	0.2	-	0.3
Bluegrass Sod	0.2	-	0.5
Short Grass Prairie	0.1	-	0.2
Sparse Vegetation	0.05	-	0.13
Bare Clay-Loam Soil (eroded)	0.01	-	0.03
Concrete/Asphalt - very shallow depths			
(less than 1/4 inch)	0.10	-	0.15
- small depths			
(1/4 inch to several inches)	0.05	-	0.10

Roughness Coefficients (Manning's "n") For Channel Flow

Reach Description	n
Natural stream, clean, straight, no rifts or pools	0.03
Natural stream, clean, winding, some pools or shoals	0.04
Natural stream, winding, pools, shoals, stony with some weeds	0.05
Natural stream, sluggish deep pools and weeds	0.07
Natural stream or swale, very weedy or with timber underbrush	0.10
Concrete pipe, culvert or channel	0.012
Corrugated metal pipe	0.012-0.027(1)
High Density Polyethylene (HDPE) Pipe	
Corrugated	0.021-0.029(2)
Smooth Lined	0.012-0.020(2)

(1) Depending upon type, coating and diameter
(2) Values recommended by the American Concrete Pipe Association, check Manufacturer's recommended value.

TABLE E-4

NONSTRUCTURAL STORMWATER MANAGEMENT MEASURES

Nonstructural Stormwater Measure	**Description**
Natural Area Conservation	Conservation of natural areas such as forest, wetlands, or other sensitive areas in a protected easement, thereby retaining their existing hydrologic and water quality characteristics.
Disconnection of Rooftop Runoff	Rooftop runoff is disconnected and then directed over a pervious area where it may either infiltrate into the soil or filter over it. This is typically obtained by grading the site to promote overland flow or by providing bioretention on single-family residential lots.
Disconnection of Nonrooftop Runoff	Disconnect surface impervious cover by directing it to pervious areas where it is either infiltrated or filtered through the soil.
Buffers	Buffers effectively treat stormwater runoff. Effective treatment constitutes capturing runoff from pervious and impervious areas adjacent to the buffer and treating the runoff through overland flow across a grassy or forested area.
Grass Channel (Open Section Roads)	Open grass channels are used to reduce the volume of runoff and pollutants during smaller storms.
Environmentally Sensitive Rural Development	Environmental site design techniques are applied to low-density or rural residential development.

Source: Maryland Department of the Environment, “Maryland Stormwater Design Manual,” Baltimore, MD, 2000

FIGURE E-1
Recommendation Chart for Infiltration Stormwater Management BMP's in Carbonate Bedrock

SITE RISK FACTORS	Geology Type	CARBONATE BEDROCK																											
	Effective Soil Thickness	Less than 2 Feet	2 to 4 Feet									Over 4 Feet to 8 Feet									Over 8 Feet								
	Special Geologic Features*	Low/Med/High Buffer	Low Buffer			Medium Buffer			High Buffer			Low Buffer			Medium Buffer			High Buffer			Low Buffer			Medium Buffer			High Buffer		
SITE INVESTIGATION RECOMMENDED		(Unacceptable)	Preliminary			Preliminary			Preliminary			Preliminary			Preliminary			Preliminary			Preliminary			Preliminary			Preliminary		
DESIGN FACTORS	Infiltration Loading Rates (% Increase)**	(Unacceptable)	0-100%	100-300%	300-500%	0-100%	100-300%	300-500%	0-100%	100-300%	300-500%	0-100%	100-300%	300-500%	0-100%	100-300%	300-500%	0-100%	100-300%	300-500%	0-100%	100-300%	300-500%	0-100%	100-300%	300-500%	0-100%	100-300%	300-500%
PROGRAM SUMMARY GUIDANCE ***						1	1				1	2								1	2					1			

RECOMMENDED

NOT RECOMMENDED

* Special Geologic Feature Buffer widths are as follows:

Low Buffer is less than 50 feet

Medium Buffer is 50 feet to 100 feet

High Buffer is greater than 100 feet

** Rates greater than 500% not recommended.

*** Assumes adequately permeable soils and lack of natural constraints as required for all infiltration systems.

1 Infiltration systems may be allowed at the determination of the Engineer and/or Geologist, provided that a Detailed Site Investigation is undertaken which confirms nature of rock, location of Special Geologic Features, and adequacy of the buffer between the SGF and the proposed stormwater system(s).

2 In these Special Geologic Features: Low Buffer situations, infiltration systems may be allowed at the determination of the Engineer and/or Geologist, provided that a Detailed Site Investigation is undertaken and a 25 foot buffer from SGFs is maintained.

Source: Little Lehigh Creek Watershed ACT 167 – Stormwater Management Ordinance. May 2004

ORDINANCE APPENDIX F

REFERENCES

REFERENCES

<u>BMP Manuals</u>

California
California Stormwater BMP Handbook: New Development and Redevelopment (January 2003) – separate file available at **http://www.cabmphandbooks.org/Development.asp**

Georgia
Georgia Stormwater Management Manual Volume 2: Technical Handbook (August 2001)-separate file **(http://www.georgiastormwater.com/)**

Maryland
2000 Maryland Stormwater Design Manual –
http://www.mde.state.md.us/Programs/Waterprograms/SedimentandStormwater/stormwater design/index.asp

Massachusetts
Stormwater Management, Volume Two: Stormwater Technical Handbook (Massachusetts, 1997) – separate file available at **http://www.state.ma.us/dep/brp/stormwtr/stormpub.htm**

Minnesota
Minnesota Urban Small Sites BMP Manual: Stormwater Best Management Practices for Cold Climates (July 2001) – **http://www.metrocouncil.org/environment/Watershed/BMP/manual.htm**

New Jersey
Revised Manual for New Jersey: Best Management Practices for Control of Nonpoint Source Pollution from Stormwater (Fifth Draft May 2000) –
http://www.state.nj.us/dep/watershedmgt/bmpmanual.htm

New York
New York State Stormwater Management Design Manual (2001) –
http://www.dec.state.ny.us/website/dow/swmanual/swmanual.html

Pennsylvania
Pennsylvania Association of Conservation Districts, Pennsylvania Handbook of Best Management Practices for Developing Areas, November 14, 1997.

Pennsylvania
Pennsylvania Stormwater Best Management Practices Manual, December 2006
http://www.depweb.state.pa.us/watershedmgmt/cwp/view.asp?a=1437&Q=518682&PM=1

Washington
Stormwater Management Manual for Western Washington (August 2001) – **http://www.ecy.wa.gov/programs/wq/stormwater/manual.html**

Federal
Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring (FHWA) – **http://www.fhwa.dot.gov/environment/ultraurb/3fs1.htm**

USEPA Infiltration Trench Fact Sheet (September 1999) –
http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post.cfm

Riparian Buffer References

Alliance for the Chesapeake Bay, Pennsylvania Department of Environmental Protection, September 2000. *Forest Buffer Toolkit*, Stream ReLeaf Program.

Penn State College of Agricultural Sciences, 1996. *Establishing Vegetative Buffer Strips Along Streams to Improve Water Quality.* Publication # AGRS-67.

Fike, Jean, June 1999. *Terrestrial & Palustrine Plant Communities of Pennsylvania*, Pennsylvania Natural Diversity Inventory, The Nature Conservancy, Western Pennsylvania Conservancy, and Pennsylvania Department of Conservation and Natural Resources.

Pennsylvania Association of Conservation Districts, Inc., Keystone Chapter, Soil and Water Conservation Society, Pennsylvania Department of Environmental Protection, Natural Resources Conservation Service, 1998. P*ennsylvania Handbook of Best Management Practices for Developing Areas.* Prepared by CH2MHill.

Palone, R. S. and A. H. Todd (eds), 1997. *Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers.* Chesapeake Bay Program and Northeastern Area State and Private Forestry. Natural Resources Conservation Service Cooperative State Research Education and Extension Services.

The Federal Interagency Stream Restoration Working Group (FISRWG, 10/1998). *Stream Corridor Restoration Principles, Processes, and Practices*. GPO Item No. 0120-A; SuDocs No. A57.6/2:EN3/PT.653. ISBN-0-934213-59-3. Published October 1998. Revised August 2000.

ORDINANCE APPENDIX G

WEST NILE VIRUS GUIDANCE

WEST NILE VIRUS GUIDANCE

(This source is from the Monroe County, PA Conservation District that researched the potential of West Nile Virus problems from BMPs due to a number of calls they were receiving)

Monroe County Conservation District Guidance:
Stormwater Management and West Nile Virus

Source: Brodhead McMichaels Creeks Watershed Act 167 Stormwater Management Ordinance Final Draft 2/23/04

The Monroe County Conservation District recognizes the need to address the problem of nonpoint source pollution impacts caused by runoff from impervious surfaces. The new stormwater policy being integrated into Act 167 stormwater management regulations by the PA Department of Environmental Protection (DEP) will make nonpoint pollution controls an important component of all future plans and updates to existing plans. In addition, to meet post-construction anti-degradation standards under the state National Pollutant Discharge Elimination System (NPDES) permitting program, applicants will be required to employ Best Management Practices (BMPs) to address nonpoint pollution concerns.

Studies conducted throughout the United States have shown that wet basins and in particular constructed wetlands are effective in traditional stormwater management areas such as channel stability and flood control and are one of the most effective ways to remove stormwater pollutants (United States Environmental Protection Agency 1991, Center for Watershed Protection 2000). From Maryland to Oregon, studies have shown that as urbanization and impervious surfaces increase in a watershed, the streams in those watersheds become degraded (CWP 2000). Although there is debate over the threshold of impervious cover when degradation becomes apparent (some studies show as little as 6% while others show closer to 20%), there is agreement that impervious surfaces cause non-point pollution in urban and urbanizing watersheds and that degradation is ensured if stormwater BMPs are not implemented.

Although constructed wetlands and ponds are desirable from a water quality perspective, there may be concerns about the possibility of these stormwater management structures becoming breeding grounds for mosquitoes. The Conservation District feels that although it may be a valid concern, **municipalities should not adopt ordinance provisions prohibiting wet basins for stormwater management.**

Mosquitoes

The questions surrounding mosquito production in wetlands and ponds have intensified in recent years by the outbreak of the mosquito-borne West Nile Virus. As is the case with all vector-borne maladies, the life cycle of West Nile Virus is complicated, traveling from mosquito to bird, back to mosquito, and then to other animals including humans. *Culex pipiens* was identified as the vector species in the first documented cases from New York in 1999. This species is still considered the primary transmitter of the disease across its range. Today there are some 60 species of mosquitoes that inhabit Pennsylvania. Along with *C. pipiens*, three other species have been identified as vectors of West Nile Virus while four more have been identified as potential vectors.

The four known vectors in NE Pennsylvania are *Culex pipiens*, *C. restuans*, *C. salinarius*, and *Ochlerotatus japonicus*. All four of these species prefer, and almost exclusively use, artificial containers (old tires, rain gutters, birdbaths, etc.) as larval habitats. In the case of *C. pipiens*, the most notorious of the vector mosquitoes, the dirtier the water, the better they like it. The important factor is that these species do not thrive in functioning wetlands where competition for resources and predation by larger aquatic and terrestrial organisms is high.

The remaining four species, *Aedes vexans*, *Ochlerotatus Canadensis*, *O. triseriatus*, and *O. trivittatus*, are currently considered potential vectors due to laboratory tests (except the *O. trivittatus*, which did have one confirmed vector pool for West Nile Virus in PA during 2002). All four of these species prefer vernal habitats and ponded woodland areas following heavy summer rains. These species may be the greatest threat of disease transmission around stormwater basins that pond water for more than four days. This can be mitigated, however, by establishing ecologically functioning wetlands.

Stormwater Facilities

If a stormwater wetland or pond is constructed properly and a diverse ecological community develops, mosquitoes should not become a problem. Wet basins and wetlands constructed as stormwater management facilities should be designed to attract a diverse wildlife community. If a wetland is planned, proper hydrologic soil conditions and the establishment of hydrophytic vegetation will promote the population of the wetland by amphibians and other mosquito predators. In natural wetlands, predatory insects and amphibians are effective at keeping mosquito populations in check during the larval stage of development while birds and bats prey on adult mosquitoes.

The design of a stormwater wetland must include the selection of hydrophytic plant species for their pollutant uptake capabilities and for not contributing to the potential for vector mosquito breeding. In particular, species of emergent vegetation with little submerged growth are preferable. By limiting the vegetation growing below the water surface, larvae lose protective cover, and there is less chance of anaerobic conditions occurring in the water.

Stormwater ponds can be designed for multiple purposes. When incorporated into an open space design, a pond can serve as a stormwater management facility and a community amenity. Aeration fountains and stocked fish should be added to keep larval mosquito populations in check.

Publications from the PA Department of Health and the Penn State Cooperative Extension concerning West Nile Virus identify aggressive public education about the risks posed by standing water in artificial containers (tires, trash cans, rain gutters, bird baths) as the most effective method to control vector mosquitoes.

Conclusion

The Conservation District understands the pressure faced by municipalities when dealing with multifaceted issues such as stormwater management and encourages the incorporation of water quality management techniques into stormwater designs. As Monroe County continues to grow, conservation design, groundwater recharge, and constructed wetlands and ponds should be among the preferred design options to reduce the impacts of increases in impervious surfaces. When designed and constructed appropriately, the runoff mitigation benefits to the community from these design options will far outweigh their potential to become breeding grounds for mosquitoes.

ORDINANCE APPENDIX H

STORMWATER CONTROLS AND BEST MANAGEMENT PRACTICES
OPERATIONS AND MAINTENANCE AGREEMENT

STORMWATER CONTROLS AND BEST MANAGEMENT PRACTICES OPERATIONS AND MAINTENANCE AGREEMENT

THIS AGREEMENT, made and entered into this ____________ day of _________, 200__, by and between ______________________________________, (hereinafter the "Landowner"), and _________________________________, ___________________________ County, Pennsylvania, (hereinafter "Municipality");

WITNESSETH

WHEREAS, the Landowner is the owner of certain real property as recorded by deed in the land records of ________________ County, Pennsylvania, Deed Book ___________ at Page ______, (hereinafter "Property").

WHEREAS, the Landowner is proceeding to build and develop the Property; and

WHEREAS, the Stormwater Controls and BMP Operations and Maintenance Plan approved by the Municipality (hereinafter referred to as the "Plan") for the property identified herein, which is attached hereto as Appendix A and made part hereof, provides for management of stormwater within the confines of the Property through the use of Best Management Practices (BMPs); and

WHEREAS, the Municipality and the Landowner, his successors, and assigns agree that the health, safety, and welfare of the residents of the Municipality and the protection and maintenance of water quality require that on-site stormwater BMPs be constructed and maintained on the Property; and

WHEREAS, for the purposes of this agreement, the following definitions shall apply:

BMP – "Best Management Practice"-activities, facilities, designs, measures, or procedures used to manage stormwater impacts from land development, to protect and maintain water quality and groundwater recharge, and to otherwise meet the purposes of the municipal Stormwater Management Ordinance, including but not limited to infiltration trenches, seepage pits, filter strips, bioretention, wet ponds, permeable paving, rain gardens, grassed swales, forested buffers, sand filters, and detention basins.

- Infiltration Trench – A BMP surface structure designed, constructed, and maintained for the purpose of providing infiltration or recharge of stormwater into the soil and/or groundwater aquifer,

- Seepage Pit – An underground BMP structure designed, constructed, and maintained for the purpose of providing infiltration or recharge of stormwater into the soil and/or groundwater aquifer,

- Rain Garden – A BMP overlain with appropriate mulch and suitable vegetation designed, constructed, and maintained for the purpose of providing infiltration or recharge of stormwater into the soil and/or underground aquifer, and

WHEREAS, the Municipality requires, through the implementation of the Plan, that stormwater management BMPs as required by said Plan and the municipal Stormwater Management Ordinance be constructed and adequately operated and maintained by the Landowner, his successors, and assigns.

NOW, THEREFORE, in consideration of the foregoing promises, the mutual covenants contained herein, and the following terms and conditions, the parties hereto agree as follows:

1. The BMPs shall be constructed by the Landowner in accordance with the plans and specifications identified in the Plan.

2. The Landowner shall operate and maintain the BMP(s) as shown on the Plan in good working order acceptable to the Municipality and in accordance with the specific maintenance requirements noted on the Plan.

3. The Landowner hereby grants permission to the Municipality, its authorized agents, and employees to enter upon the property, at reasonable times and upon presentation of proper identification, to inspect the BMP(s) whenever it deems necessary. Whenever possible, the Municipality shall notify the Landowner prior to entering the property.

4. In the event that the Landowner fails to operate and maintain the BMP(s) as shown on the Plan in good working order acceptable to the Municipality, the Municipality or its representatives may enter upon the Property and take whatever action is deemed necessary to maintain said BMP(s). This provision shall not be construed to allow the Municipality to erect any permanent structure on the land of the Landowner. It is expressly understood and agreed that the Municipality is under no obligation to maintain or repair said facilities, and in no event shall this Agreement be construed to impose any such obligation on the Municipality.

5. In the event that the Municipality, pursuant to this Agreement, performs work of any nature or expends any funds in performance of said work for labor, use of equipment, supplies, materials, and the like, the Landowner shall reimburse the Municipality for all expenses (direct and indirect) incurred within ten (10) days of receipt of an invoice from the Municipality.

6. The intent and purpose of this Agreement is to ensure the proper maintenance of the on-site BMP(s) by the Landowner; provided, however, that this Agreement shall not be deemed to create or effect any additional liability on any party for damage alleged to result from or be caused by stormwater runoff.

7. The Landowner, its executors, administrators, assigns, and other successors in interest shall release the Municipality's employees and designated representatives from all damages, accidents, casualties, occurrences, or claims which might arise or be asserted against said employees and representatives from the construction, presence, existence, or maintenance of the BMP(s) by the Landowner or Municipality. In the event that a claim is asserted against the Municipality, its designated representatives, or employees, the Municipality shall promptly notify the Landowner, and the Landowner shall defend, at his own expense, any suit based on the claim. If any judgment or claims against the Municipality's employees or designated representatives shall be allowed, the Landowner shall pay all costs and expenses regarding said judgment or claim.

8. The Municipality shall inspect the BMP(s) at a minimum of once every three (3) years to ensure their continued functioning.

This Agreement shall be recorded at the Office of the Recorder of Deeds of ______________ County, Pennsylvania, and shall constitute a covenant running with the Property and/or equitable servitude and shall be binding on the Landowner, his administrators, executors, assigns, heirs, and any other successors in interest, in perpetuity.

ATTEST:

WITNESS the following signatures and seals:

(SEAL) For the Municipality:

____

(SEAL) For the Landowner:

____

ATTEST:

_____________________________ (City, Borough, Township)

County of ___________________________, Pennsylvania

I, _______________________________________, a Notary Public in and for the County and State aforesaid, whose commission expires on the __________ day of __________________, 20__, do hereby certify that ____ whose name(s) is/are signed to the foregoing Agreement bearing date of the ___________ day of ___________________, 20__, has acknowledged the same before me in my said County and State.

GIVEN UNDER MY HAND THIS _____________ day of ___________, 200_.

________________________________ ____________________________________

NOTARY PUBLIC **(SEAL)**

PLAN APPENDIX 3

Nonpoint Discharge Elimination System (NPDES) Phase II Requirements

What is NPDES Phase II?

Polluted stormwater runoff has been determined to be the leading cause of impairment threatening our nation's surface waters. Mandated by Congress under the Clean Water ACT, the National Pollutant Discharge Elimination System (NPDES) Stormwater Program is a comprehensive two-phased approach to addressing sources of stormwater pollution which affect the quality of the nation's waters.

In Pennsylvania, the state Department of Environmental Protection (PaDEP) has implemented Phase I of this program which affects certain industrial sites, construction sites over 5 acres and municipalities with populations over 100,000, which includes Philadelphia, Pittsburgh, Allentown and Erie. NPDES permits which were issued under this program were the state's first step in addressing the affects of Nonpoint Source Pollution on our lakes and streams.

Building upon the success of this program, Phase II of Pennsylvania's NPDES program will require permitting of over 700 Municipal Separate Storm Sewer System (MS4) in Pennsylvania. Operators of these regulated MS4s are required to apply for NPDES permit coverage by March 10, 2003. Phase II also requires permitting of all constructions sites, regardless of location, with over 1 acre of disturbance.

Am I an MS4 Municipality?

The over 700 MS4s are located in 20 designated Urban Areas (UAs) and 17 Potential UAs in Pennsylvania. An Urban Area is defined by the US Census Bureau as "a place and the adjacent densely settled surrounding territory that together have a minimum population of 50,000 people and a density of 1000 persons/square mile". The list of MS4 municipalities can be obtained from DEP's website, DEP ID 385-2000-012.

Even if your Municipality is not a designated MS4, it may be beneficial to adopt some or all of the requirements under Phase II of the NPDES program to address existing stormwater pollution problems within your Municipality. Although not mandated by federal or state law, non- MS4 municipalities should consider the goals of the program and the overall return it may provide in improving overall water quality in the community.

What are the Minimum Stormwater Management Requirements Under Phase II?

The Phase II Stormwater regulations specify six program elements that must be addressed by designated Municipal Separate Storm Sewer System (MS4) municipalities. The regulations also imply that additional things will need to be done but the lack of specific requirements gives permit holders a great deal of flexibility if not a lot of guidance about what to do about some aspects of stormwater management, chiefly monitoring.

The six required stormwater program elements include:

1. Public Education and Outreach
2. Public Involvement and Participation
3. Illicit Discharge Detection and Elimination
4. Construction Site Runoff Control
5. Post-Construction Runoff Management
6. Pollution Prevention/Good Housekeeping Practices for All Municipal Operations

1. <u>Public Education and Outreach</u>

Awareness of stormwater related environmental issues and problems is generally low. A variety of surveys suggest that public awareness of the fact that storm drains are usually not connected to the sewers or that individual actions around our homes causes significant environmental impact to urban streams is not high! Many citizens do not know that our urban streams and watersheds are being damaged by the effects of urbanization and by the pollutants found in urban environments. Support for stormwater or urban watershed management will not be strong, particularly if new resources are needed, unless citizens are aware of the condition of urban watersheds and stream segments.

In some Phase II communities the presence of 303d list streams (streams listed by U.S. EPA as impaired streams) and the TMDL (Total Maximum Daily Load) process for reducing pollution and restoring water quality in these streams may help to increase awareness. Nonetheless, a strong, well-designed and ongoing or at least periodic education program will be needed both to build support for the stormwater program and make citizens aware of changes they can and need to make to reduce unnecessary stormwater impacts. A strong, effective community education program will include general public awareness education as well as more technical education that targets specific groups such as developers, construction contractors, landscapers, lawn care services, and a variety of small businesses. It is important to address specific sectors of the community due to special concerns about pollution or other impacts associated with that activity as well as general things that homeowners and property owners can do to address needless or avoidable pollution.

In many communities there may already be an educator or educators involved in environmental education in the classroom who would be happy to assist the community by developing a stormwater education unit for delivery at appropriate grade levels. Likewise, local scouting organizations or student conservation organization would probably be willing to conduct educational activities in the neighborhood using activities like the stream walk or storm drain activity. Hands-on activity and involvement is critical to learning at all ages. Stormwater programs should utilize these existing resources whenever possible.

2. <u>Public Involvement and Participation</u>

It is absolutely vital to involve the public as early as possible in the design and implementation of the stormwater or urban watershed management program. A diverse cross section of the community representing all the different stakeholder groups should be represented. This should include the regulated community (developers, builders, business owners or managers etc.), the taxpayers who will be paying the tab, the property owners who have been impacted by flooding in the past, environmental groups and environmental activists, landowners, educators, volunteer citizen monitors and others. These are the people who will pay the bills, work with you to reduce pollution from their activities *(or oppose you at every turn if they are not informed and do not buy into the progra*m), work with you to implement school and community education programs, work on cleanups and assist with monitoring through citizen monitoring programs.

The Phase II U.S. EPA requirements include public involvement and there is probably no better way to do this than to form a citizen advisory committee. This should not be a committee appointed from political insiders. It should be composed of stakeholders who come to the table and are interested enough to stay with the process and who are in basic agreement that the community or stormwater management area organization is responsible for and must develop a stormwater management program. Truly open public involvement can avoid expensive and time-consuming controversies that often lead to legal actions. They can also reduce the potential of citizen lawsuits from groups or individuals critical of the progress toward addressing stormwater management. As parties involved from the beginning in designing, implementing and evaluating the program, it is likely that the concerns of all groups will be addressed sufficiently to avoid serious controversy that can be resolved only through legal remedies. Citizen groups and persons fully involved in a meaningful way in the process will not choose expensive legal action to resolve disputes. Furthermore, most Phase II communities are not going to find it easy to fund stormwater management efforts.

Volunteer involvement will probably be a critical component of many successful programs. Volunteers can contribute a lot, whether it is scout troops interested in helping with neighborhood education through activities like storm drain stenciling, educators willing to help design education materials, citizens interested in working to help via involvement in volunteer water monitoring or businesses willing to contribute to the support of these citizen efforts or other forms of volunteerism.

3. Illicit Discharge Detection and Elimination

In some areas pollutants from illicit or illegal discharges may be a significant contribution to pollutant loadings. These may be intentional or unintentional. In older areas they may be discharges that were never rerouted to the sewer system as regulations for discharges were put in place. They may also be things like floor drains that were never properly connected to the sewer system. The task facing permit holders is to develop strategies and methods for detecting these illicit/illegal discharges so that they can be eliminated. A strategy for addressing this problem should first employ education of business owners and operators and homeowners and involve the public in detecting and correcting these problems voluntarily. Addressing the problem will also require a monitoring strategy. Monitoring for illicit/illegal discharges should be kept as simple as possible given resource realities and should progress from simpler, cheaper methods to more complex and more expensive methods as needed. Some techniques for detecting these discharges include:

- visual inspection along watercourses for pipes and unusual discharges (at the same time a check can be made for leaking or broken sewer pipes)
- visual inspections of business and industrial sites
- smoke or dye testing to detect or confirm suspected illicit/illegal connections
- dry weather sampling of suspicious discharges for substances indicative of domestic or industrial wastewater (detergent, optical brighteners, caffeine or high conductivity)
- inspection, visual or remote camera, inside stormwater conveyances
- reconnaissance sampling upstream of where contamination hot spots are found

4. Construction Site Runoff Control

Perhaps one of the most damaging and preventable forms of pollution in rapidly growing urban areas is the excessive sediment loads that can be contributed to streams due to erosion and transport of sediments from construction sites. Communities must have in place measures to control polluted runoff from construction sites. The Phase II rule requires permitting of construction sites down to 1 acre. Also a robust and effective program for erosion and sediment control from construction sites will require education and enforcement. Since it is the permit holder that will be the most likely target of any clean water suits filed by local citizens or by environmental groups representing citizens who feel that enforcement is in-adequate, permit holders should have their own program for enforcement. This means that the community or (in cases of a watershed authority with multiple jurisdictions), the authority, will need to have an erosion and sediment control program. Some suggestions for doing this include:

- ✓ adopt and implement a strong erosion and sediment control ordinance
- ✓ provide education and training for municipal personnel who are involved in municipal construction projects from supervisors to equipment operators
- ✓ encourage erosion and sediment control training for construction contractors and
- ✓ homebuilders or if possible work with others to provide training locally
- ✓ require that at least one appropriate individual (an engineer, landscaper, engineering technician etc.) become certified as a Certified Professional in Erosion and Sediment Control Specialist and assist that person with the costs associated with certification
- ✓ create a process for review and approval of construction site erosion and sediment
- ✓ control plans and provide for review of significant projects by the CPESC
- ✓ cross-train building inspectors to do initial inspections of construction sites
- ✓ as necessary have the CPESC conduct more detailed inspections
- ✓ determine whether you wish to develop a local enforcement program

Having an effective erosion and sediment control ordinance and program is a critical part of an effective stormwater management program. An effective erosion and sediment control program coupled with effective public involvement in the stormwater program provides insurance against costly legal actions.

5. Post-Construction Runoff Management

The phase II minimum requirements also include management of runoff after the active construction period. These requirements assure that a responsible party will take care of maintaining best management practices (BMPs) until the site is stabilized for erosion control practices and that maintenance of detention, retention basins and other structural BMPs will be funded and taken care of in the future. If the permit holder can through incentives (fee structures etc.) induce developers to utilize non-structural BMPs, the potential and actual future obligations of the permit holder or community will be lessened. Even then, it is desirable to have some sort of bonding mechanism in place or some sort of recurring fee so that funds for maintenance will be available when needed. The permit holder or community should research the positive and negative aspects of different mechanisms for post-construction maintenance before choosing an approach that it believes best suits the needs of the community or area.

6. Pollution Prevention and Good Housekeeping for Municipal Operations

The final requirement for stormwater Phase II permit holders is for the Municipality or municipalities regulated under the permit to develop and implement pollution reduction and good housekeeping procedures for prevention of pollution from stormwater runoff. This means that a program for prevention of stormwater impacts from city facilities and city operations will have to be developed or perhaps strengthened if such a program already exists. Elements of such a program might include structural components or such things as fuel and materials storage and handling safeguard improvements, erosion and sediment control on municipal projects, protection or restoration of riparian corridors on municipal property, use of design elements to prevent stormwater runoff and pollution on new projects or redevelopment projects, flow and pollution control BMPs for municipal parking areas and other actions for prevention or reduction of polluted stormwater runoff. Since careless or thoughtless actions of individuals often contribute to stormwater pollution, a pollution prevention and housekeeping improvement program should include an education component for appropriate city employees and contractors. This public sector pollution prevention and housekeeping component of the stormwater management program can be important particularly so when a community or permit holder is going to implement voluntary or even regulatory programs for reducing stormwater pollution. The public pollution prevention and housekeeping improvements can be used to demonstrate improvements and thus serve as education activities for private sector businesses and industries in the community.

When Should a Community do More than the Minimum?

Clearly these six activities represent the minimum requirements for Phase II communities or permit holders. Every community is different and every community may have issues, concerns or problems a little different from those in other communities. For example, some communities may have concerns about streams or water bodies that are special, very high quality resources that the community places special value on or which have important economic value. A community may have a TMDL stream for which special additional actions are needed or required to restore water quality in order to avoid growth restrictions or other possible sanctions. A community might have a specific problem like bacteriological contamination from waterfowl that threatens a public beach, flooding problems or something else that is a special concern in the community that causes it to desire to do more. Communities should pursue everything that makes sense to do for which there is a public consensus and adequate funding to complete. However, permit holders *should not* list anything in their plan or permit (if they are applying for an individual permit) that they do not definitely plan and know that they can and will complete. EPA will hold permit holders to those things that they say they will do as part of the permit. *It is safer for permit holders to do more than they indicated they would do than to list something tenuous and not be able to accomplish it.*

PLAN APPENDIX 4

TOOKANY/TACONY-FRANKFORD INTEGRATED WATERSHED MANAGEMENT PLAN

Tookany/Tacony-Frankford Integrated Watershed Management Plan

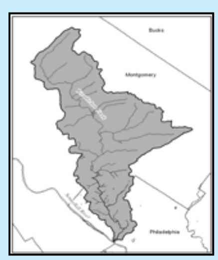
December 2005

Prepared by:

Philadelphia Water Department
Tookany/Tacony-Frankford Watershed Partnership

Cobbs Watershed

Tookany/Tacony-Frankford Watershed



Wissahickon Watershed

Pennypack Watershed

Poquessing Watershed

Watershed Management Plan 2 of 5

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Section 9: Cost and Institutional Analysis

TTFIWMP User Guide

Below is a brief orientation to the type of content found in each section of this report. These "snapshots" are repeated on the first page of each section as well.

Section 1: Background

Details the reasons for developing the Tookany/Tacony-Frankford Integrated Watershed Management Plan, or TTFIWMP, and the purposes the plan is intended to serve. Provides an orientation to various facets of the TTF Watershed itself (geographical, ecological, historical, cultural, etc.), and describes the TTF Partnership, which was involved throughout the plan's development and will be instrumental to its implementation. Finally, the overall watershed planning and regulatory framework is outlined in Sections 1.4 – 1.7.

Section 2: Integrated Watershed Management for the TTF Watershed

Describes the watershed planning approach behind the TTFIWMP. Outlines the types of existing and new data that were assembled and analyzed, as well as the process for modeling stormwater flow under various scenarios. Introduces several key concepts of the TTFIWMP: the overall goals and objectives (detailed in Section 3), the 21 watershed "indicators" (Section 4); and the screening of numerous methods, or "management options," for meeting the goals (Section 7). In addition, introduces the approach of setting multiple strategies – Targets A, B, and C – for promoting successful implementation of the TTFIWMP.

Section 3: Goals and Objectives

Describes the process for setting overall watershed goals for the TTFIWMP, as well as numerous objectives for helping to reach those goals. The seven prioritized goals, referenced throughout this document, are useful for evaluating the wide range of possible management options for implementing the plan.

Section 4: Watershed Indicators: TTF Study Results

Details the 21 measurable "watershed indicators" that were created in order to assess historic and current conditions, and to track progress as the TTFIWMP is implemented over time. The information presented can serve as a basis for understanding the state of the TTF Watershed, its relative environmental quality, and trends in the management of factors that influence its quality.

Section 5: Problem Definition and Analysis

The watershed indicators described in Section 4 are used both to characterize the current state of the TTF Watershed, and to set a baseline for future comparison. Section 5 identifies the wide range of potential problems that have been identified in the watershed, and describes the analysis tools used to define them.

Section 6: Causes of Impairment

Discusses the causes of the various watershed problems identified through field study, stakeholders input, modeling, and data analysis. This section forms the link between the problem analysis presented in Section 5, and the identification of alternative solutions, or management options, presented in Section 7.

Section 7: Development and Screening of Management Options
Summarizes a comprehensive list of stormwater and watershed corrective measures, or "management options," that the TTF Watershed Partnership judged to be potentially applicable to their watershed. This list serves as the starting point for the screening and evaluation steps (Section 7.2) that lead to the array of recommendations contained in the Implementation Guidelines (Section 8).

Section 8: Implementation Guidelines
Presents guidelines for watershed-wide implementation of the management options identified by the Tookany/Tacony-Frankford Watershed Partnership as best meeting the goals and objectives of the TTF Integrated Watershed Management Plan. Following extensive screening and evaluation (described in Section 7), only those options that are likely to be cost-effective and feasible under the specific conditions found in the TTF Watershed are carried over and included in these guidelines. The section begins with tips on how to navigate the information presented.

Section 9: Cost and Institutional Analysis
Presents cost estimates for the various recommended management options, and for the full set of Implementation Guidelines (from Section 8). Those cost estimates are then broken down by county and by municipality within the TTF Watershed. Finally, the section outlines the primary roles and responsibilities for the various levels of stakeholders in the implementation of the TTFIWMP.

Executive Summary

Tookany/Tacony-Frankford Integrated Watershed Management Plan (TTFIWMP)

Foreword

This plan presents a logical and affordable roadmap for the restoration and protection of the beneficial and designated uses of the Tookany/Tacony-Frankford Creek basin. The Tookany/Tacony-Frankford Integrated Watershed Management Plan (TTFIWMP) is based on extensive physical, chemical, and biological assessments. It explores the nature, causes, severity, and opportunities for control of water quality impairments in the TTF Watershed. The primary intent of this planning process is to improve the environmental health and safe enjoyment of the Tookany/Tacony-Frankford Creek by sharing resources and through cooperation among residents and other stakeholders in the watershed.

The goals of the initiative are to protect, enhance, and restore the beneficial uses of the Tookany/Tacony-Frankford waterway and its riparian areas. This plan recommends appropriate remedial measures for the Tookany/Tacony-Frankford Creek basin and a financial commitment to initiate implementation of recommendations right away. This planning process has sought to provide the impetus for stakeholders of the Tookany/Tacony-Frankford basin to follow suit.

The Philadelphia Water Department conducted a comprehensive, multi-year assessment of the Tookany/Tacony-Frankford Watershed (see Figure E.1). Results of the watershed-wide assessment suggests that at some times during dry weather periods, bacteria contamination of the Tookany/Tacony-Frankford's waters prevents the achievement of water quality standards that would support swimming or other forms of primary contact recreation in the creek. (For a detailed account of the assessment methodology and data results, see the 2004 Tookany/Tacony-Frankford Comprehensive Characterization Report.) Stream aesthetics, accessibility, and safety are compromised due a number of factors, including litter and illegal dumping, trash from stormwater discharges, channelization of portions of the stream, and bank deterioration along stream corridors. The existing aquatic and riparian habitats have been degraded by urban runoff, limiting the diversity of fish and other aquatic life and preventing the development of healthy living resource conditions necessary to support recreational activities such as fishing. Wet weather water quality is limited by bacteria discharged from combined and separate storm sewers. High rates of urban runoff cause flooding during larger storms, and flood flows that erode the stream banks and bottoms and have subsequently exposed and compromised utility infrastructure.

The good news is that measurable progress can be made towards restoring the legislated designated uses of the stream. To this end, this plan provides a commitment from the Philadelphia Water Department to an investment strategy for achieving definable levels of environmental return in the Tookany/Tacony-Frankford Creek basin. It is estimated that significant progress towards improving the various areas of environmental concern can be made for an investment of less than $290 per household per year over a 20-year horizon.

The plan proposes that the upstream municipalities of Montgomery County in the Tookany/Tacony-Frankford basin make similar financial commitments to implementation in order to ensure the restoration and preservation of the waters that flow through and from their communities, helping to shape their quality of life along the way. A significant portion of this funding is directed towards work that reflects the widely recognized national need to renew our water resources infrastructure. It is proposed that a combination of Federal, state and local government, along with private funding, be brought to bear in order to implement this plan watershed-wide. The Philadelphia Water Department has expended over $1 million for the development of the plan, and will commit an additional $2-3 million per year or more towards implementing its recommendations over the next 20 years.

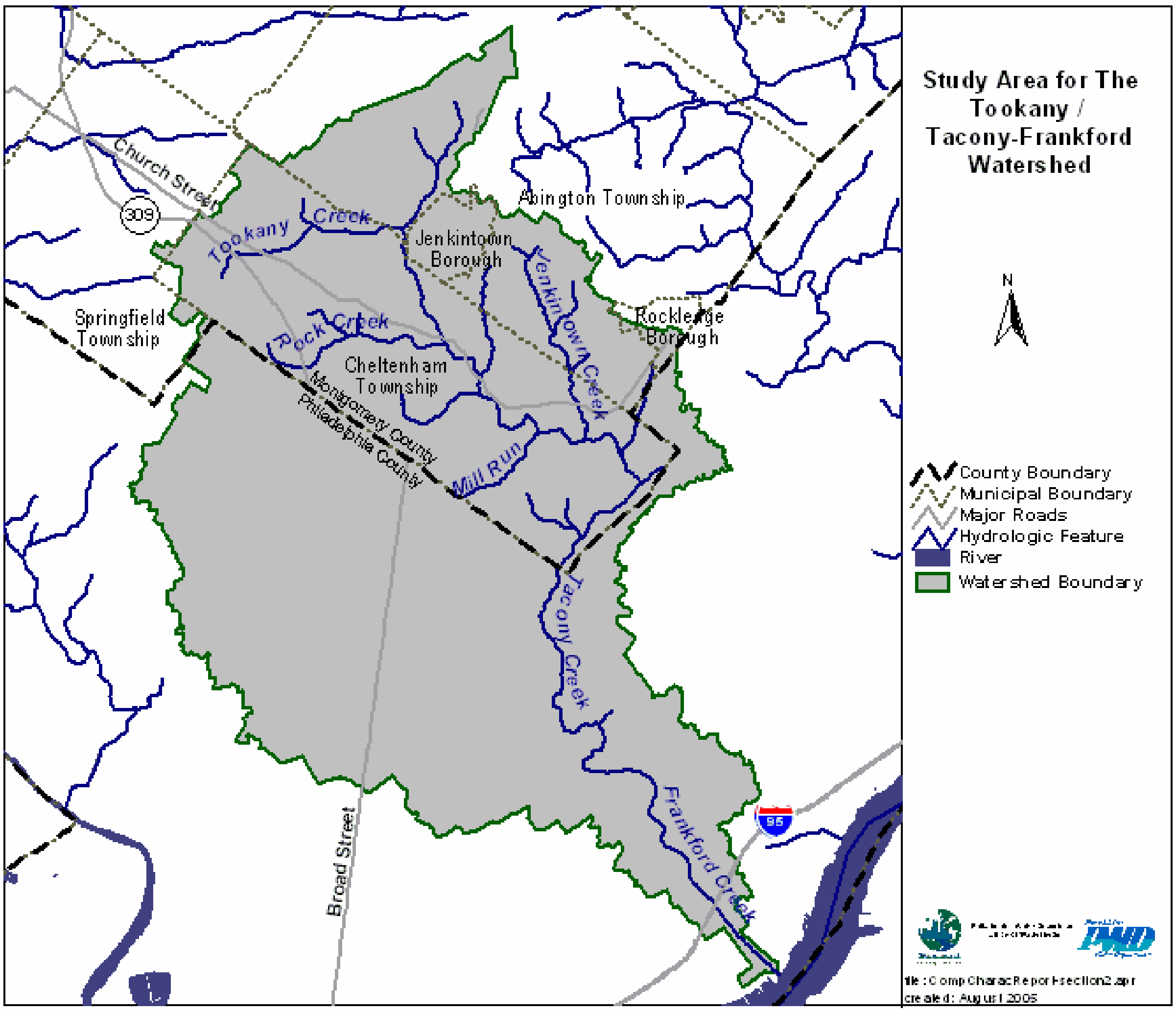


Figure E.1 Tookany/Tacony-Frankford Watershed

Background

Stewardship of a river must be built around the needs of the community. It will grow by making visible the critical way the health of the watershed is integral to basic quality of life issues. Once the seeds of stewardship have been planted, members of the community can be recruited to take action in protecting their watershed.

In 2000, PWD acted as the municipal sponsor of the Tookany/Tacony-Frankford Watershed Partnership, an exciting and groundbreaking effort to connect residents, businesses, and government as neighbors and stewards of the watershed. PWD hired the Pennsylvania Environmental Council (PEC), a well-respected, non-profit institution with a reputation for supporting watershed-based, holistic planning in the form of smart growth planning, as the facilitator and outreach coordinator of this partnership. PEC pulled together a diverse representation of the watershed including municipalities, "friends" groups, educators, agencies, residents, and other nonprofit organizations for participation in this planning process. Since then, the Partnership has been active in developing a vision for the watershed and guiding and supporting subsequent planning activities within the Tookany/Tacony-Frankford watershed.

The mission of the TTF Partnership was summarized as follows:

- 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.
- To improve and enhance our parks, streams, and surrounding communities in the Tookany/Tacony-Frankford Watershed.

With this Tookany/Tacony-Frankford Integrated Watershed Management Plan, PWD, supported by the TTF Partnership, has now completed the multi-year watershed planning effort intended to lead to the restoration of the Watershed as one that can boast fishable, swimmable, and enjoyable streams.

The main purposes of the plan, as articulated by the stakeholders, are: to mitigate wet weather impacts caused by urban stormwater runoff and combined sewer overflow (CSO); to identify ways to improve water quality, aesthetics, and recreational opportunities in dry weather; and to restore living resources in the stream and along the stream corridor. PWD placed a high priority on the development of the TTFIWMP because it represents one of the three major components of the City of Philadelphia's CSO Long Term Control Plan strategy. This component entails a substantial commitment from the City to watershed planning to identify long term improvements throughout its watersheds, including any additional CSO controls that will result in an improvement of water quality and, ultimately, the attainment of water quality standards.

PWD was not alone in this planning effort. Significant support from other agencies has helped to fund various components of the plan and helped to better integrate this effort with other regulatory programs. The U.S. EPA provided funding under its Wetland Program Grant to help assess existing wetlands within the Tookany/Tacony-Frankford Watershed and provide basic data for developing wetland restoration projects. Through the Act 167 Stormwater Management Program, PA DEP provided funding to PWD for modeling and analysis to support stormwater planning, as well as to initiate the creation of an Act 167 Plan for this watershed. Finally, initial planning efforts and the development of planning goals were embodied in two Rivers Conservation Plans (one for the Montgomery County portion and one for Philadelphia portion of the watershed) funded by PA DCNR.

Plan Goals

Considerable stakeholder input towards developing watershed goals was sought from the beginning of this planning effort. Stakeholder input was primarily organized through the Partnership; through a weighting and evaluation process, consensus on a set of planning goals and objectives was achieved. In addition, the plan sought to integrate goals derived from other relevant regulatory programs and both Rivers Conservation Plans to more fully achieve the ideal of integrated water resource planning. The resulting integrated planning goals, and their relation to the major regulatory programs, are summarized in Table E.1.

Table E.1 Regulatory Support for Stakeholder Goals for the Tookany/Tacony-Frankford Watershed

Goal Description	Act 167 Stormwater	Act 537 Sewage Facilities	TMDL Program	NPDES Stormwater	CSO Program	RCPs
1. Streamflow and Living Resources. Improve stream habitat and integrity of aquatic life.	X		X	X	X	X
2. Instream Flow Conditions. Reduce the impact of urbanized flow on living resources.	X				X	X
3. Water Quality and Pollutant Loads. Improve dry and wet weather stream quality to reduce the effects on public health and aquatic life.		X	X	X	X	X
4. Stream Corridors. Protect and restore stream corridors, buffers, floodplains, and natural habitats including wetlands.						X
5. Flooding. Identify flood prone areas and decrease flooding by similar measures intended to support Goals 1, 2, and 4.	X					X
6. Quality of Life. Enhance community environmental quality of life (protect open space, access and recreation, security, aesthetics, historical/cultural resources).	X	X	X	X	X	X
7. Stewardship, Communication, and Coordination. Foster community stewardship and improve inter-municipal, inter-county, state-local, and stakeholder cooperation and coordination on a watershed basis.	X	X	X	X	X	X

Planning Approach

Once the Partnership had established the goals and objectives for the TTFIWMP, a planning approach was designed to achieve the desired results through a cooperative effort between the City of Philadelphia and upstream municipalities. The approach has four main elements:

- Data collection, organization, and analysis
- Systems description
- Problem identification and development of plan objectives
- Strategies, policies, and approaches

Watershed Status and Problem Identification

An integral part of this plan is the assessment and description of existing conditions within the watershed and stream. This assessment has identified specific problem areas, while establishing a "watershed baseline" from which we can measure our future progress as recommendations are implemented. Based upon these existing conditions, a series of "watershed indicators" were developed so that as implementation occurs in the coming years, progress can be quantified. "Indicators" are specifically designed to be measurable. For the TTF Watershed, 21 indicators (discussed in Section 4) were used for assessing current conditions and will be revisited annually to measure progress.

Through the extensive field studies, modeling, and data analysis, the highest priority problems in the Tookany/Tacony-Frankford Creek were identified, and the means for addressing the problems were developed. Given that the Tookany/Tacony-Frankford Watershed is highly urbanized with both CSOs and significant stormwater flows, some of the highest priority problems included:

Dry Weather Water Quality and Aesthetics

- Water quality concerns including high fecal coliform during dry weather
- Potential dry weather sewage flows in separate sewered areas
- Trash-filled, unsightly streams that discourage residential use
- Safety concerns along streams and stream corridors

Healthy Living Resources

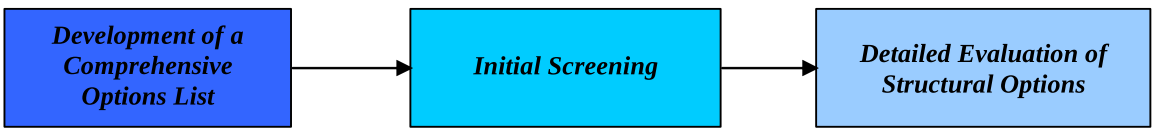
- Degraded aquatic and riparian habitats
- Loss of wetlands
- Channelized stream sections
- Limited diversity of fish and other aquatic life
- Periodic, localized occurrences of low dissolved oxygen in downstream areas
- Wide diurnal swings in dissolved oxygen
- Utility infrastructure threatened by bank and streambed erosion
- Limited public awareness and sense of stewardship for the creek

Wet Weather Water Quality and Quantity

- Water quality concerns including high fecal coliform, and nutrients and metals during wet weather flows
- CSO impacts on water quality and stream channels
- Little volume control and treatment of stormwater flows in separate sewered areas

Development and Screening of Management Options

Lists of options were developed as potential "solutions" to address the identified problems and to meet each of the goals and objectives established for the Tookany/Tacony-Frankford Watershed. Only those options deemed feasible and practical for the TTF Watershed were considered in the final list of management options. Options were developed and evaluated in three steps:



Since the plan cannot prescribe actions to be undertaken by all the participants in the planning process, recommendations and guidelines for implementation were developed. Modeling and other analyses were used to help recommend an approach for municipalities. Ultimately, it will be up to the TTF Partnership and the Montgomery County municipalities to turn these recommendations into a watershed-wide implementation plan.

Implementation Approach

In developing a recommended watershed management alternative and discussing goals and objectives with stakeholders, it became clear that implementation could best be achieved by defining three distinct targets to meet the overall plan objectives. Targets A and B were defined so that they could be fully met with full implementation of a limited set of options. For Target C, it was agreed to set interim objectives, recommend measures to achieve the interim objectives, implement those controls, and monitor and reassess the effectiveness of the plan in meeting the objectives.

Target A: Dry Weather Water Quality and Aesthetics

The first target is to meet water quality standards in the stream during dry weather flows. Target A was defined for Tookany/Tacony-Frankford Creek with a focus on trash removal and litter prevention, and the elimination of sources of sewage discharge during dry weather.

Sewers must be assessed to identify segments in need of rehabilitation, particularly where leakage is directly flowing into the stream. In separate sewered areas, a detection program for potential cross-connections is needed in order to eliminate dry weather flows.

Target A is also associated with improving the esthetic quality of the stream so that it can be viewed and treasured as a resource. Stream clean-ups are a way to achieve this while also involving residents and volunteers in the process.

Target B: Healthy Living Resources

Improvements to the number, health, and diversity of benthic macroinvertebrate and fish species in the Tookany/Tacony-Frankford Creek will require investment in habitat improvement and measures to provide the opportunity for organisms to avoid high velocities during storms. Improving the ability of an urban stream to support viable habitat and fish populations must focus primarily on the elimination or remediation of the more obvious impacts of urbanization. These include loss of riparian habitat, eroding and undercut banks, scoured streambed or excessive silt deposits, channelized and armored sections, trash buildup, and invasive species.

Target B is focused on improving the instream conditions of the Tookany/Tacony-Frankford Creek. Implementation projects are aimed at habitat improvements as well as measures to provide the opportunity for organisms to avoid high velocities during storms. Improvements to the number, health, and diversity of the benthic macroinvertebrate and fish species are anticipated as a result of these measures.

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 and address flooding issues. Improving water quality and flow conditions during and immediately following storms is the most difficult target to meet in the urban environment. The only rational approach to achieve this target must include stepped implementation with interim targets for reducing wet weather pollutant loads and stormwater flows, along with monitoring for the efficacy of control measures.

Initial load reduction goals for parameters such as stormwater flow, metals, total suspended solids, and bacteria were set in conjunction with the stakeholders. Based on preliminary work by PWD, a 20% reduction has emerged as a challenging but achievable interim goal.

Implementation Guidelines

All management options were thoroughly screened and evaluated using a variety of approaches, including computer simulation modeling and cost-effectiveness. This resulted in the selection of only those options appropriate and deemed effective for the particular conditions found in the Tookany/Tacony-Frankford Watershed. The Implementation Guidelines (Section 8) seek to present the options in such a way that each major stakeholder or responsible party understands what is expected. The guidelines are designed such that, if implementation follows the recommendations, all plan objectives associated with Targets A and B will be fully met, and the interim objectives for Target C will be met or even exceeded.

In Section 8, each recommended option is fully described, and a recommended level of implementation is provided. Where possible, locations for on-the-ground implementation are indicated.

Implementation Plans

The Implementation Guidelines presented in this document are intended to present a long-range vision for implementation over the upcoming 20-year horizon, and to be used as a reference by parties creating actual Implementation Plans in the future. Such plans will be designed to provide a detailed blueprint for specific tasks during a shorter planning period. Detailed planning for implementation of the TTFIWMP will be broken into four sequential 5-year periods to cover our 20-year implementation horizon.

The Philadelphia Water Department has created and committed to a detailed 5-year Implementation Plan for the portion of the Tookany/Tacony-Frankford Watershed within the City of Philadelphia (see summary in Appendix E). This plan has been designed to begin in 2006 and run through 2011; however, many recommended projects had already been initiated prior to 2006.

Planning Level Costs

Planning-level cost estimates have been developed for the majority of the options recommended. Because actual costs are highly dependent on site specific conditions and the extent to which implementation occurs, cost estimates are only approximate. These estimates are useful, however, in providing order of magnitude funding needs, and also as a comparison to potential costs associated with more traditional approaches to CSO control (e.g., large scale storage tanks designed to reach the 85% capture goal).

Estimated costs to PWD are separated from those to outside agencies (primarily municipalities) by apportioning costs based on ownership of facilities or simply by the relative areas of the watershed within and outside of Philadelphia City limits. “Cost per acre” values (Table E.2) are provided as a simple measure of the way costs are apportioned in the tables. Actual costs will depend on the exact mix of options ultimately implemented.

Table E.2 Total Watershed Plan Cost

Total		Philadelphia		Montgomery County	
Annual Cost	One-Time	Annual Cost	One-Time	Annual Cost	One-Time
$6,172,000	$148,459,000	$3,532,000	$68,839,000	$2,637,000	$79,625,000
$290/ac	$7,060/ac	$290/ac	$5,650/ac	$300/ac	$9,000/ac

The affordability of the costs associated with this plan was also analyzed. The results of this analysis are presented in Table E.3 for Philadelphia and for the combined suburban communities comprising the remainder of the watershed. For Philadelphia, the affordability calculation indicates that the incremental cost of the Tookany/Tacony-Frankford improvements would be approximately $10 per household per year, representing 0.03% of median household income. For the combined suburban communities, the cost would be $157 per household per year, representing 0.26% of the weighted median household income for those areas. Both of these values are well within U.S. EPA affordability guidelines, and represent relatively limited increases in the current rates being paid for water, sewer, and stormwater in Philadelphia.

The overall impact on affordability would need to be evaluated in the context of all the programs comprising water quality improvement within a given community. For example, residents of Philadelphia will ultimately help pay for management programs in five or more watersheds, while residents of Cheltenham, for example, will pay only for this one program. Because residents of Philadelphia will ultimately pay for improvements in a number of watersheds, the total cost per household in Philadelphia likely will be similar to the cost for households in the suburban communities.

Table E.3 Incremental Affordability Measure

		Philadelphia	Suburban Communities *(Combined)*
1	**One-time cost (annualized)**	$3,338,000	$3,875,000
2	**Annual cost**	$2,598,733	$2,268,386
3	**Total annual cost associated with TTFIWMP**	$5,936,733	$6,143,386
4	**Cost per acre in watershed**	$487	$694
5	**2000 MHI (median household income)**	$30,746	$59,621
6	**Estimated annual sewer user charge***	$343	$250
7	**WMP cost per household in watershed (in entire municipalities)**	$52.53 ($10.06)	$258.93 ($157.00)
8	**WMP cost as % of MHI in watershed (in entire municipalities)**	0.17% (0.03%)	0.43% (0.26%)
9	**Existing sewer cost + TTFIWMP cost in watershed (in entire municipalities)**	1.59% (1.15%)	0.62% (0.46%)

** The sewer user charge in Philadelphia includes a stormwater collection and treatment fee. Stormwater-related charges outside Philadelphia were not investigated.*

Tables E.4 and E.5 provide data to help communities outside Philadelphia place projected TTFIWMP costs in a local context. Table E.4 expresses estimated costs for communities per acre and per household inside the watershed boundaries; Table E.5 presents costs within the boundaries of all municipalities that intersect the watershed. These cost tables are but one illustration of a possible cost distribution, and are provided to help municipalities decide what funding and institutional mechanisms may be most appropriate given local conditions.

Table E.4 Distribution of Costs among Rate Payers in Tookany/Tacony-Frankford Watershed in Communities Outside Philadelphia

	Abington	Cheltenham	Jenkintown	Philadelphia	Rockledge
Municipality area in watershed (ac)	2,712	5,691	367	12,178	81
Area of municipality in watershed (% of municipality total)	27%	98%	99%	13%	37%
Households in municipality and watershed	7,147	14,218	2,013	113,022	348
Annual cost associated with TTFIWMP	$807,899	$1,695,749	$109,277	$3,532,000	$24,075
Cost per acre (within watershed)	$297.95	$297.95	$297.95	$290.03	$297.95
Cost per household (within watershed)	$113.04	$119.27	$54.29	$31.25	$69.18
Median household income ($/year)	$59,921	$61,713	$47,743	$30,746	$47,958
Cost per household (% of MHI)	0.19%	0.19%	0.11%	0.10%	0.14%

Table E.5 Distribution among All Rate Payers in Communities Outside Philadelphia

	Abington	Cheltenham	Jenkintown	Philadelphia	Rockledge
Municipality area (ac)	9,893	5,779	369	91,287	219
Watershed area in municipality (ac)	2,712	5,691	367	12,178	81
Watershed area in municipality (% of watershed total)	12.9%	27.1%	1.7%	57.9%	0.4%
Households in municipality	21,690	14,346	2,035	590,071	1,060
Annual cost associated with TTFIWMP	$807,899	$1,695,749	$109,277	$3,532,000	$24,075
Cost per acre (whole municipality)	$81.66	$293.42	$296.36	$38.69	$109.91
Cost per household (whole municipality)	$37.25	$118.20	$53.70	$5.99	$22.71
Median household income ($/year)	$59,921	$61,713	$47,743	$30,746	$47,958
Cost per household (% of MHI)	0.06%	0.19%	0.11%	0.02%	0.05%

Section 1
Background

This section details the reasons for developing the Tookany/Tacony-Frankford Integrated Watershed Management Plan, or TTFIWMP, and the purposes the plan is intended to serve. It provides an orientation to various facets of the TTF Watershed itself (geographical, ecological, historical, cultural, etc.), and it describes the TTF Partnership, which was involved throughout the plan's development and will be instrumental to its implementation. Finally, the overall watershed planning and regulatory framework is outlined in Sections 1.4 – 1.7.

The Tookany/Tacony-Frankford Integrated Watershed Management Plan (TTFIWMP) 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.

1.1 What Is a Watershed and Why a Plan?

Consider this vision, as presented by the Tacony-Frankford River Conservation Plan:

> *"Welcome to our world – a world that includes a Tacony Creek that is beautiful and full of life. A world that boasts a Tacony Creek Park and a host of community green spaces that make the heart leap at the beauty of nature. A world that offers the residents of the watershed opportunities to bike, run and play at its recreation centers and parks. A world that recognizes that a community that values and protects its natural spaces is a community that will economically and culturally thrive."*

A watershed is a natural formation including land and communities connected by the drainage area of a water body (Figure 1.1). Simply said, the health of a stream depends on the quality of the land surrounding it, which in turn relies on the people charged with the care for that land. How do we care for an urban watershed? By addressing practices of the past, including paving the land and piping the stormwater, which took place as the area was urbanized. These practices were deemed an important step in development at the time, but they have had a devastating impact on the natural environment. As scientific knowledge and values have changed over time, we have realized that we can have both a vibrant community and healthy natural resources, and that the two can reinforce one another.

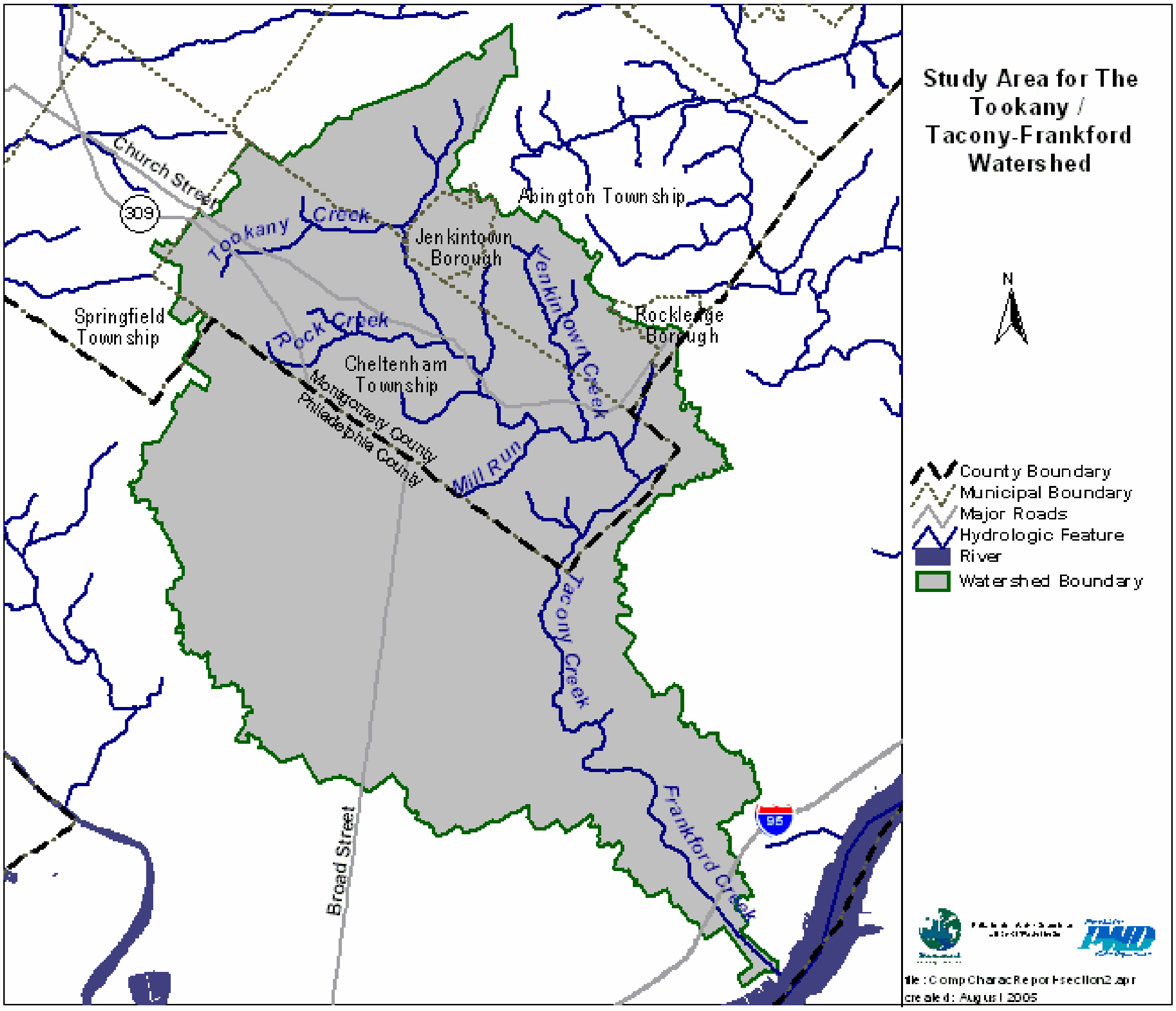


Figure 1.1 Tookany/Tacony-Frankford Watershed Study Area

An integrated watershed management plan is a long-term road map designed to achieve these twin goals of a healthy community and healthy natural resources. An integrated plan embraces the laws designed to save our streams, preserves the streams' ecology, and enhances the parkland and riparian buffers that shelter these streams. The plan also reaches out to include the best of municipal and conservation planning that strives to ensure that growth within the watershed occurs with particular care to the environment. Most importantly, the plan incorporates a diversity of people who live, work, and dream in all areas of the watershed. People provide the catalyst for change, the energy to create the plan, and the vigilance to sustain the plan. These people, the stakeholders, become the watershed's guardians – the keepers of the integrated plan.

The Tookany/Tacony-Frankford Partnership has provided a forum for stakeholders to work together to develop strategies that embrace our dual focus of improving stream water quality as well as the quality of life in our communities. Stakeholders care with their minds, hearts, and hands. TTF stakeholders include various government agencies – regulatory agencies, whose jobs empower them to guard the quality of our rivers and streams, as well as counties and municipalities, separate political entities bound together by nature. Stakeholders also include all those groups – nonprofit groups, neighborhood groups, religious groups, and schools – who define themselves as environmental advocates. Finally, stakeholders include concerned citizens who care about the state of their natural environment and their own quality of life.

Stakeholders have come together to discuss visions for the watershed. They shared thoughts of what they would like to see in our streams, parks, and neighborhoods. They are passionate about the possibilities – of revived aquatic and plant life, of streams that flow naturally, of parks that appear lush and inviting, of wetlands, and of meadows and woods that abound with wildlife. Together, we decide that our visions must become a reality.

The TTF Partnership discussed priorities and the actions necessary to make our initiative a successful one. These actions have become our strategy, and they address our desire to improve our water and land environment through a number of avenues. The TTFIWMP is built upon the foundation of environmental regulations, already in place and providing the impetus for stakeholders to work together to meet watershed goals. The plan's framework includes a number of elements – innovative land use controls and best management practices, improvements to piping and other conveyance systems, restoration of damaged stream corridors, and education and public awareness. These components, like good building materials, can result in a solid, sustainable structure, a plan that will result in a healthier and greener environment.

Stakeholders are committed to implementing the plan while canvassing for funds to nurture and sustain it, and they look to our governments and to stakeholders to contribute the dollars, expertise, and people to make their vision a reality. We will review our plan on a regular basis to ensure that it remains vital and to measure incremental successes that place us on the path of achieving our long-term goals. We share our plan with the residents of the watershed, showing how it works, and how each of them plays a part in its success. We empower them to share in our vision of a vital, dynamic watershed.

We look for solutions on the land where rainfall drains to our waterways, in the underground infrastructure that carries rainwater and wastewater away, and in and along our streams where natural ecosystems should thrive. As champions of our water resources, we believe this approach benefits not only our water environment, but also the region's physical, social, and economic environment.

1.2 Brief History of the Tookany/Tacony-Frankford Watershed

As part of both River Conservation Planning (RCP) initiatives, the Tookany/Tacony-Frankford Watershed Partnership has compiled a brief history of the watershed, including Tookany Creek. Portions of this history are reproduced here exactly as they appear in the RCPs.

Prior to the European settlement in the early 1600s, the area that is now Philadelphia was inhabited by the Lenape Indian tribe. The Lenape people, referred to as Delaware Indians by European Settlers, considered themselves the "original people." Lee Sultzman, in his *History of Delaware,* indicates that there was a widespread belief among native peoples that the Lenape were the original tribe of Algonquin speaking peoples to inhabit the area.

The Unami bank of Lenapes occupied the territory of Pennsylvania and New Jersey from Staten Island to just south of Philadelphia. The Unamis were not a politically cohesive group, but shared common language and cultural characteristics.

The Lenape people lived in villages and depended on agricultural crops such as squash and corn as their primary source of sustenance. Men of the tribe supplemented the tribe's diet through hunting and fishing. Tribal government consisted of three sachems or captains that represented the three matrilineal clans that comprised Lenape society. The head chief was always from the Turtle clan, although the position was elected and not strictly hereditary. The other two clans were the Wolf and Turkey clans.

First contact between the Lenape and Europeans (primarily Dutch explorers) occurred in the early 1600s. The Tacony-Frankford Watershed was colonized in the mid seventeenth century by different groups of immigrants. Swedes and Finns traveling up the Delaware River were the first European inhabitants of the Tacony Creek Valley, while Germans fleeing religious persecution settled in the western portion of the watershed in what is now Germantown. In 1664, the land that is southeastern Pennsylvania was surrendered to the English by the Dutch. In 1681, King Charles II of England granted William Penn 40,000 acres of land in the Delaware Valley as repayment for a debt owed to Penn's father. The entire Tookany/Tacony-Frankford Watershed lies within the area of this land grant. With the establishment of Penn's colony, English settlers flocked to the region, establishing homesteads, plantations, and towns.

The Tacony Creek and surrounding valley was primarily developed as an area of agriculture and milling operations. The Tacony Creek was dammed several times for mills and become a center for industrial operations during the late eighteenth and early nineteenth centuries. Expansion of the city in the late 1800s converted farmland into residential neighborhoods. Active agriculture persisted in the upper watershed until the early 1900s. Land for the Tacony Creek Park was purchased by the city in 1915, while land was being consumed for the need for new housing. The park was added to in 1939, and now occupies 302 acres. High-density housing characterizes the development of the area after the 1940s.

1.3 Watershed Description and Demographics

The Tookany/Tacony-Frankford Watershed is defined as the land area that drains to the Delaware River via that variously named creek. The Tookany/Tacony-Frankford study area includes parts of Montgomery County and a portion of Philadelphia County and covers a total of approximately 29 square miles, or about 20,000 acres. Figure 1.1 includes the watershed boundaries, hydrologic features, and political boundaries. The creek is referred to as the Tookany Creek until it enters Philadelphia at Cheltenham Avenue. It is then called the Tacony Creek from that Montgomery County border until the confluence with the historical Wingohocking Creek in Juniata Park. The section of stream from Juniata Park to the Delaware River is referred to as the Frankford Creek, and is underlain by a concrete channel.

The streams in the western portion of the watershed are contained in pipes and combined sewer infrastructure. Historic streams, including the Wingohocking Creek, Rock Run, and Little Tacony Creek, were encapsulated in combined sewers to facilitate the development of this watershed in the early twentieth century. Combined sewers convey sanitary waste, as well as stormwater to the city’s wastewater treatment facilities. The total number of stream miles in this study is 14.4 miles in the mainstem creek and approximately 31.9 miles of encapsulated tributaries.

The drainage area is highly urbanized both in the lower reaches, which are primarily located in Philadelphia County, and in the upper reaches; however, that upper portion, included mainly in Montgomery County, is characterized by a more varying mixture of land uses. The population of the entire drainage area, based on 2000 census data, is approximately 331,400 people. This yields an average population density of approximately 16 -17 persons/acre.

In addition to CSO discharges to Frankford Creek from the City of Philadelphia, the drainage area receives a significant amount of point and non-point source discharges that impact water quality. According to the USGS data for the study area, the breakdown by sewer type is as follows: combined sewer areas make up 9,800 acres, or 47% of the drainage area; separate sewers, including areas outside of the City of Philadelphia, account for 9,200 acres or 44% of the drainage area; and non-contributing sewers make up 1,900 acres or 9% of the drainage area.

The waters in the drainage area receive point source discharges including CSOs 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, overland runoff from urban and suburban areas, and potentially some remaining individual on-lot domestic sewage systems discharging through shallow groundwater.

In a relatively undisturbed watershed, the watershed boundaries follow topographic high points or contours. The U.S. Geological Survey (USGS) has further subdivided the Tookany/Tacony-Frankford Watershed based on topography, as shown in Figure 1.2. These USGS subwatersheds are determined from the land area draining to a particular point of interest, such as a stream confluence or gauging site. These boundaries allow initial determinations of drainage areas and modeling elements. However, it is important in the urban environment to include the effects of man-made changes to natural drainage patterns. In the Philadelphia portion of the watershed, drainage areas were adjusted to account for the combined sewer system drainage boundaries.

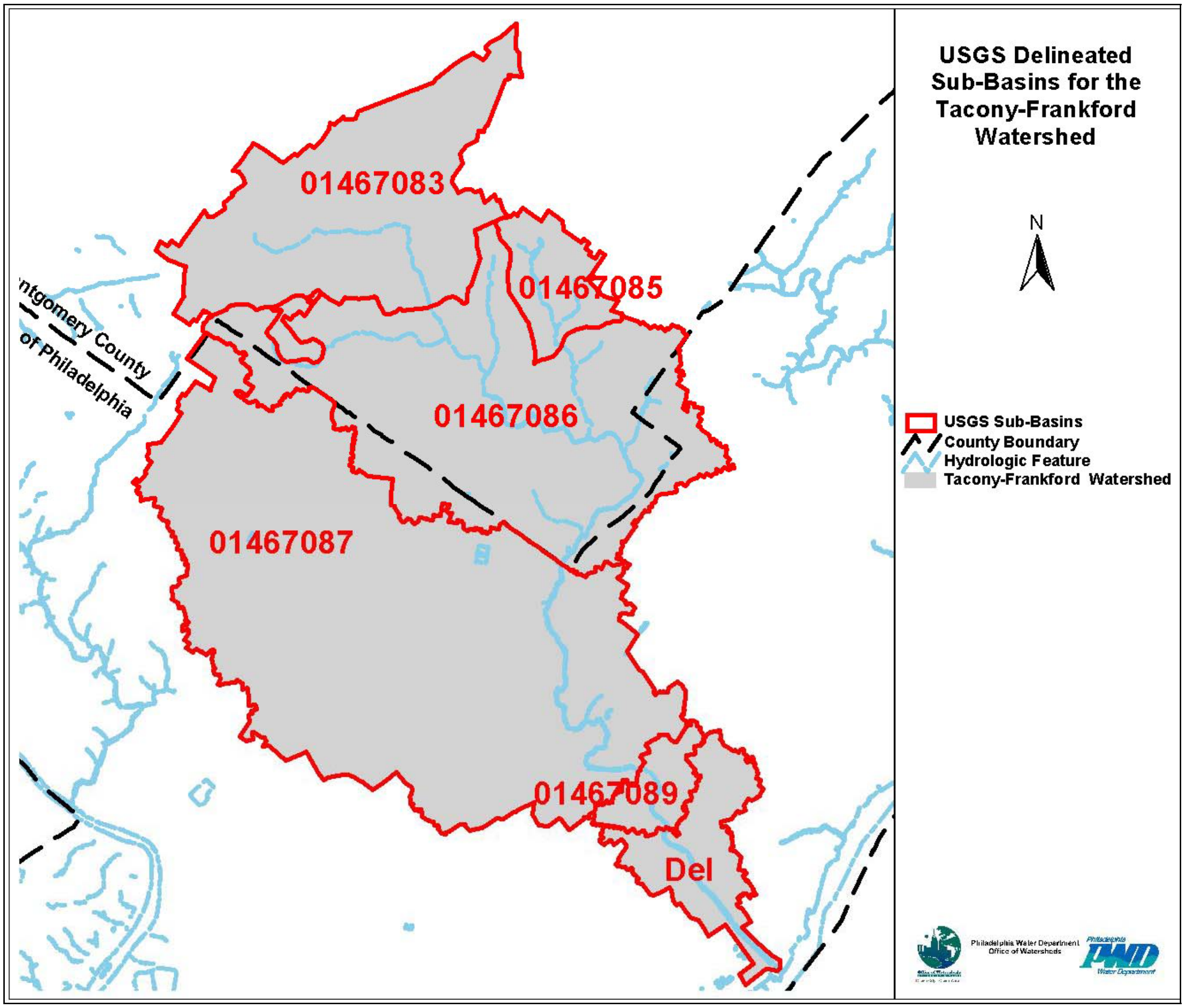


Figure 1.2 USGS Topographic Subwatersheds of the Tookany/Tacony-Frankford Watershed

Geology and Soils

Geology and soils play a role in the hydrology, water quality, and ecology of a watershed. The middle and upper reaches of the study area are in the Northern Piedmont Ecoregion (EPA Enviromapper). The Piedmont is characterized by ridges, hills, and deep narrow valleys. Elevation can vary from 40 feet at the fall line to 400 feet at the ridge tops. The topography of the study area is level except for steep slopes along the banks of the Tacony Creek. This section of the watershed is generally underlain by metamorphic and igneous geologic formations, predominately the Wissahickon Formation with small areas of gneiss and hornblende. These formations are exposed where the Tacony Creek has eroded overlying sediments to the bedrock (PA DEP 2001).

The lower portion of the watershed lies within the Middle Atlantic Coastal Plain Ecoregion. This is an area of low relief. Historically, the coastal plain in the city of Philadelphia was tidal marsh. These marshes were filled and paved over for urban development (PA DEP 2001). The topography of the coastal plain is gently sloping with elevations from 0 to 40 feet above sea level. The coastal plain is mainly comprised of unconsolidated sand and clay. These sands and clays are represented by the Pennsauken Formation, which was deposited in the Cretaceous period, and unconsolidated sand and clay (Trenton Gravel) deposited during the current quaternary geologic period.

Figure 1.3 displays a map of the geologic formations within the study area. The following are generalized descriptions of the geologic formations:

- **Wissahickon formation:** Typically a phyllite comprised of quartz, feldspar, muscovite, and chlorite. Moderately resistant to weathering. Fractures in platy patterns.
- **Mafic Gneiss, horneblend bearing:** Medium to fine grained, dark colored calcic plagioclase, hyperthene, augite, and quartz. Highly resistant to weathering.
- **Pennsauken formation:** Sand and gravel yellow to dark reddish brown, mostly comprised of quartz, quartzite, and chert. Deeply weathered floodplain formation.
- **Bryn Mawr formation:** White, yellow, and brown gravel and sand. Deeply weathered formation.
- **Quaternary deposits (Trenton gravel):** Unconsolidated sand and clays deposited by the Delaware River during the current geologic period.

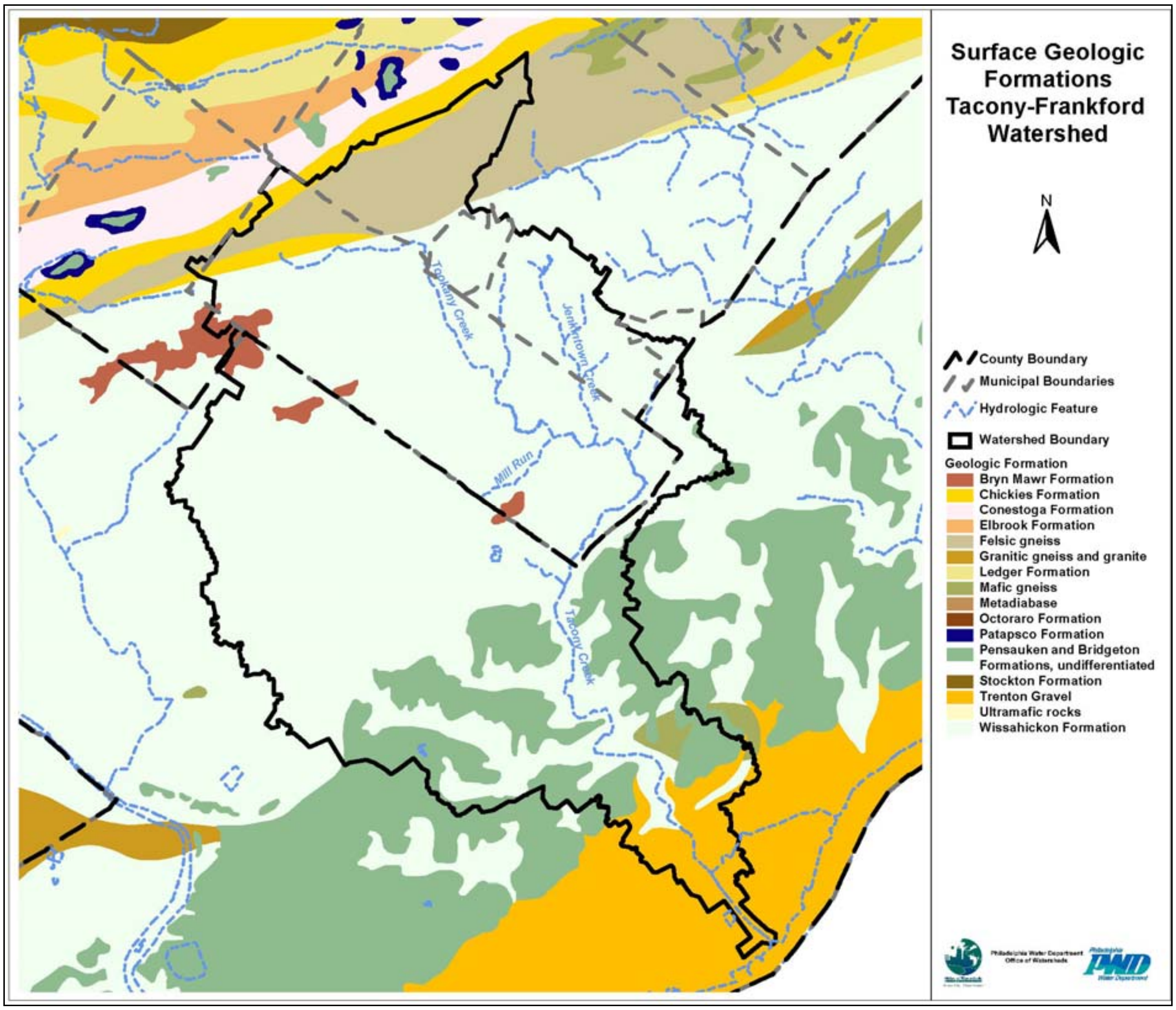


Figure 1.3 Surface Geologic Formations of the Tookany/Tacony-Frankford Watershed

Soils in the United States have been assigned to Hydrologic Soil Groups (HSG). The assigned groups are listed in Natural Resources Conservation Service 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.

Soils in hydrologic group A have low runoff potential. These soils have a high rate of infiltration when thoroughly wet. 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 when thoroughly wet 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 when thoroughly wet. 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 when thoroughly wet. 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 a 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 undrained 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.

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 1.4 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 downstream end shown as category C. This means that most of the study area has soils that have a moderate to high rates of infiltration when thoroughly wet, and water movement through these soils is generally rapid. This has implications for the design of stormwater infiltration systems, and also affects the amount of water that needs to be infiltrated in newly developing areas to maintain predevelopment or natural infiltration rates. The HSG classification is also used when doing stormwater runoff calculations for site development design, and was used in this study in developing the SWMM model runoff calculations.

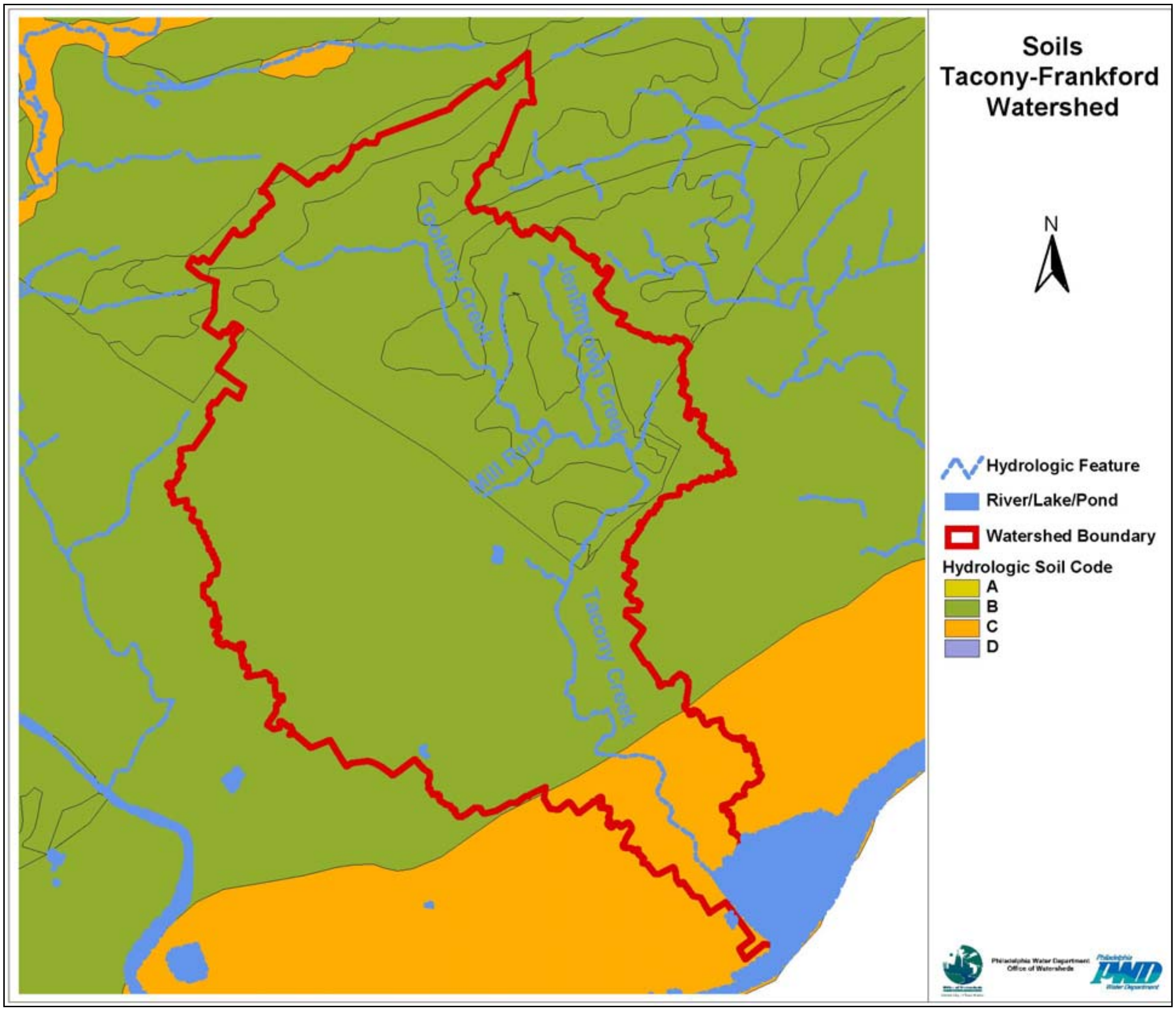


Figure 1.4 Hydrologic Soil Groups in the Tookany/Tacony-Frankford Watershed

<u>Demographic Information</u>

Population density and other demographic information in the watershed are available from the results of the 2000 Census. Approximately 357,104 people live within the drainage area of the Tookany/Tacony-Frankford Creek. Figure 1.5 shows the population density in the watershed at the census block level. Spatial trends in population correspond closely to land use, with multiple-family row homes displaying the greatest population density of 20 people per acre or more, single-family homes displaying a lower density, and other land use types displaying the lowest density. In addition to population data, the U.S. Census Bureau provides a range of socioeconomic data that are often useful in watershed planning and general planning studies. Median household income and mean home value (Figures 1.6 and 1.7) are two of the many sample datasets provided.

The population density of a residential area is related closely to its imperviousness and thus to the quantity and quality of runoff produced. Figure 1.5 depicts the population density in people per acre for the watershed area.

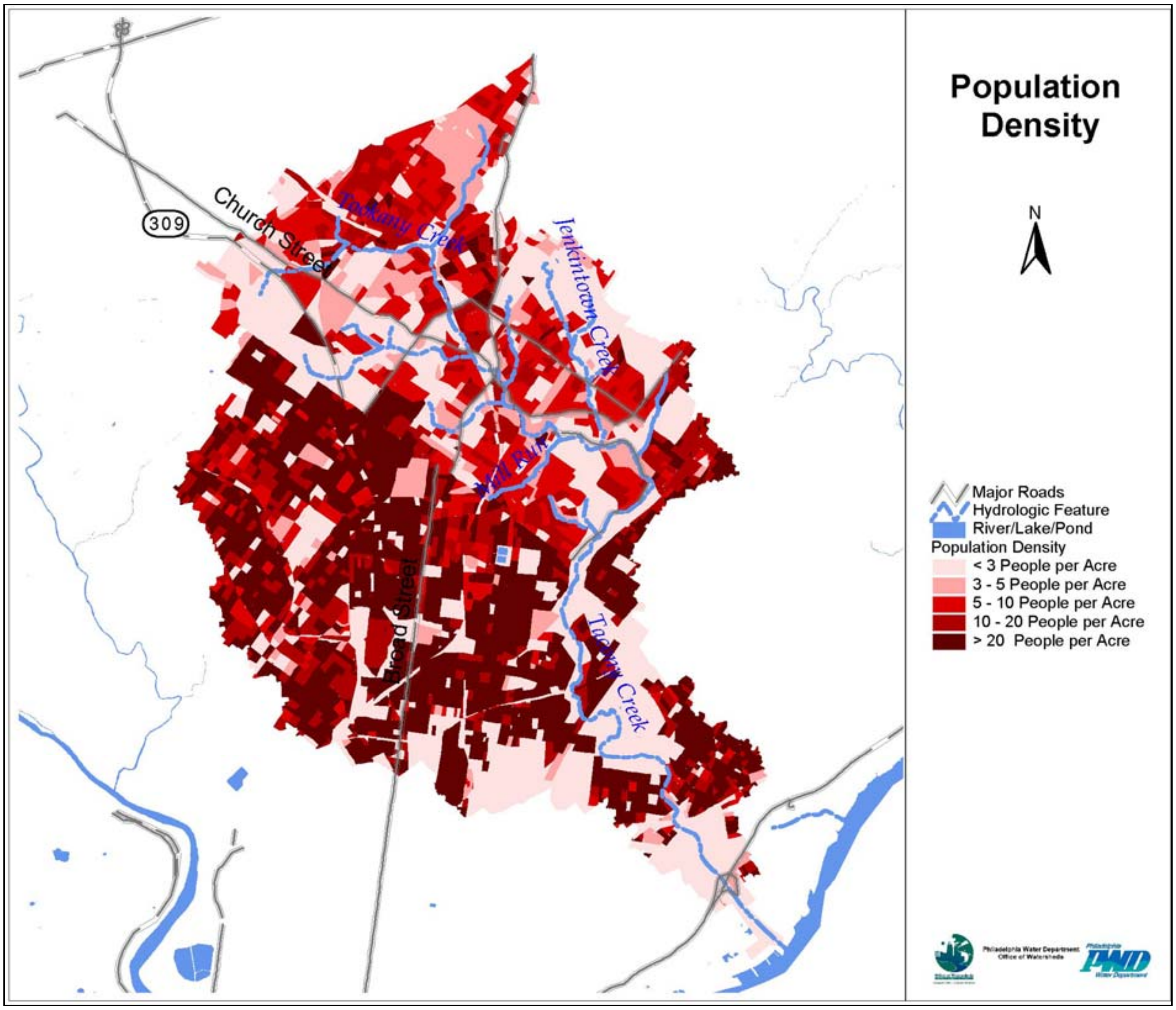


Figure 1.5 Population Density of the Tookany/Tacony-Frankford Watershed (Source: 2000 US Census)

Within the Tookany/Tacony-Frankford drainage area, based on 2000 census data, are 357,104 people. Represented by county, this corresponds to 59,456 people in the Montgomery County portion and 297,648 people in the Philadelphia County portion. The average population/acre in each county is determined to be 7 people/acre for Montgomery County and 24 people/acre for Philadelphia County. Based on this quantitative data and the visual data from the figure above, it is evident that Philadelphia County is more heavily populated than Montgomery County. Therefore, the combination of contributions from both counties yields an overall average (area-weighted) population density of approximately 17 persons/acre.

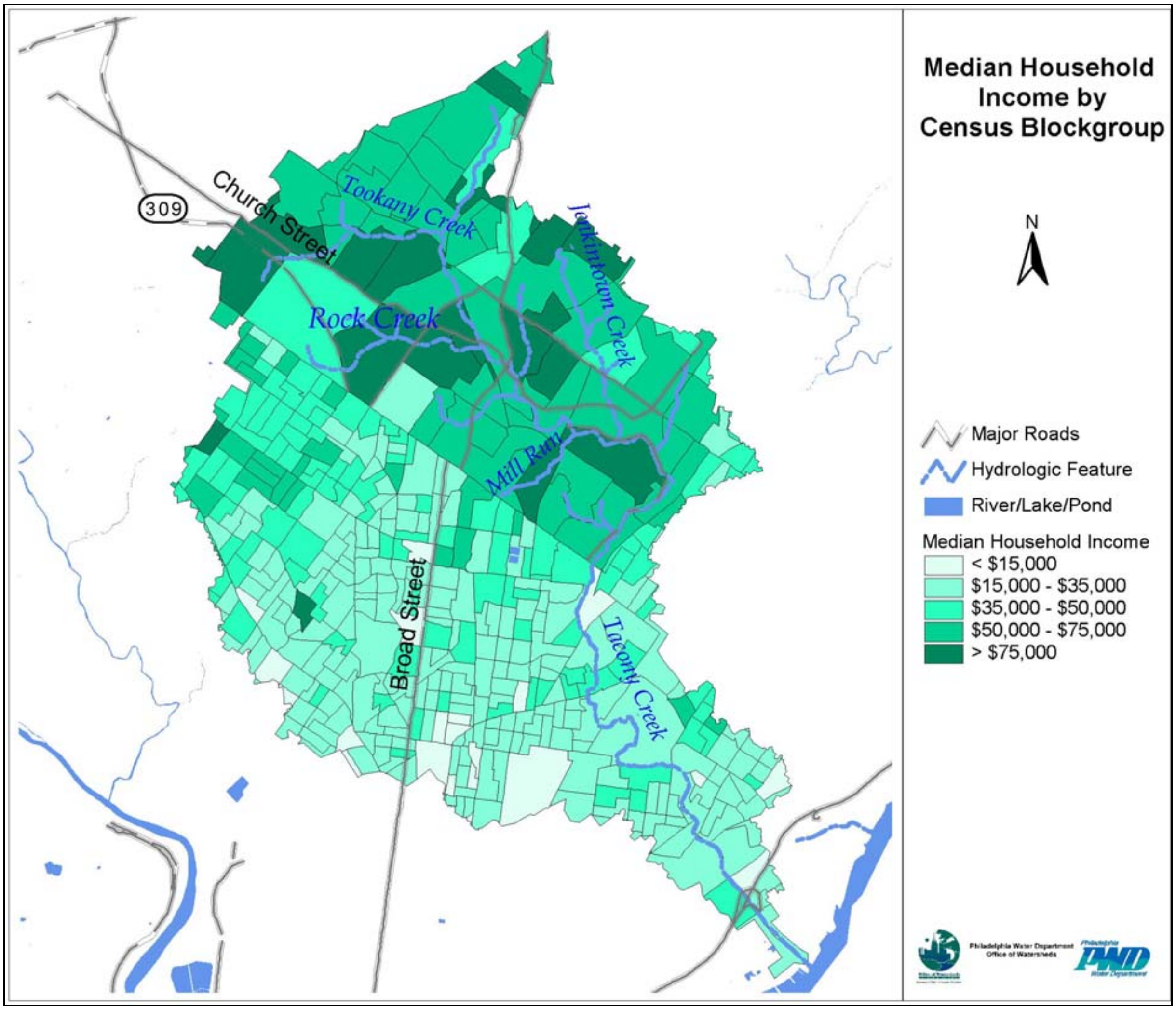


Figure 1.6 Median Household Income in the Tookany/Tacony-Frankford Watershed (Source: 2000 US Census)

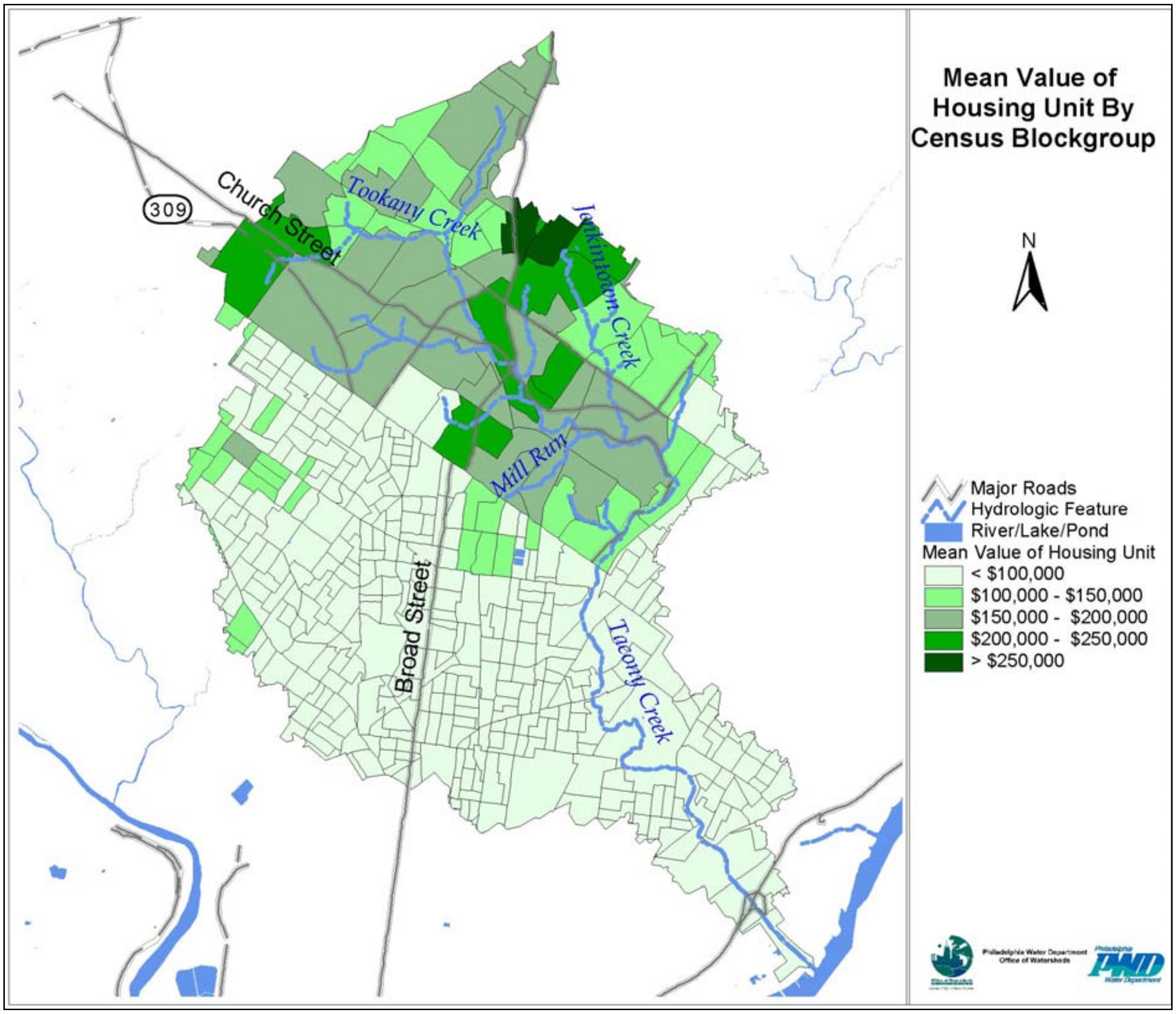


Figure 1.7 Mean Home Value in the Tookany/Tacony-Frankford Watershed (Source: 2000 US Census)

Figure 1.8, below, shows numerical population change, based on municipality areas within the watershed, from the 1990 to year 2000 census. This graph shows that all municipalities except Cheltenham have experienced slight losses in population and also a loss in population watershed-wide.

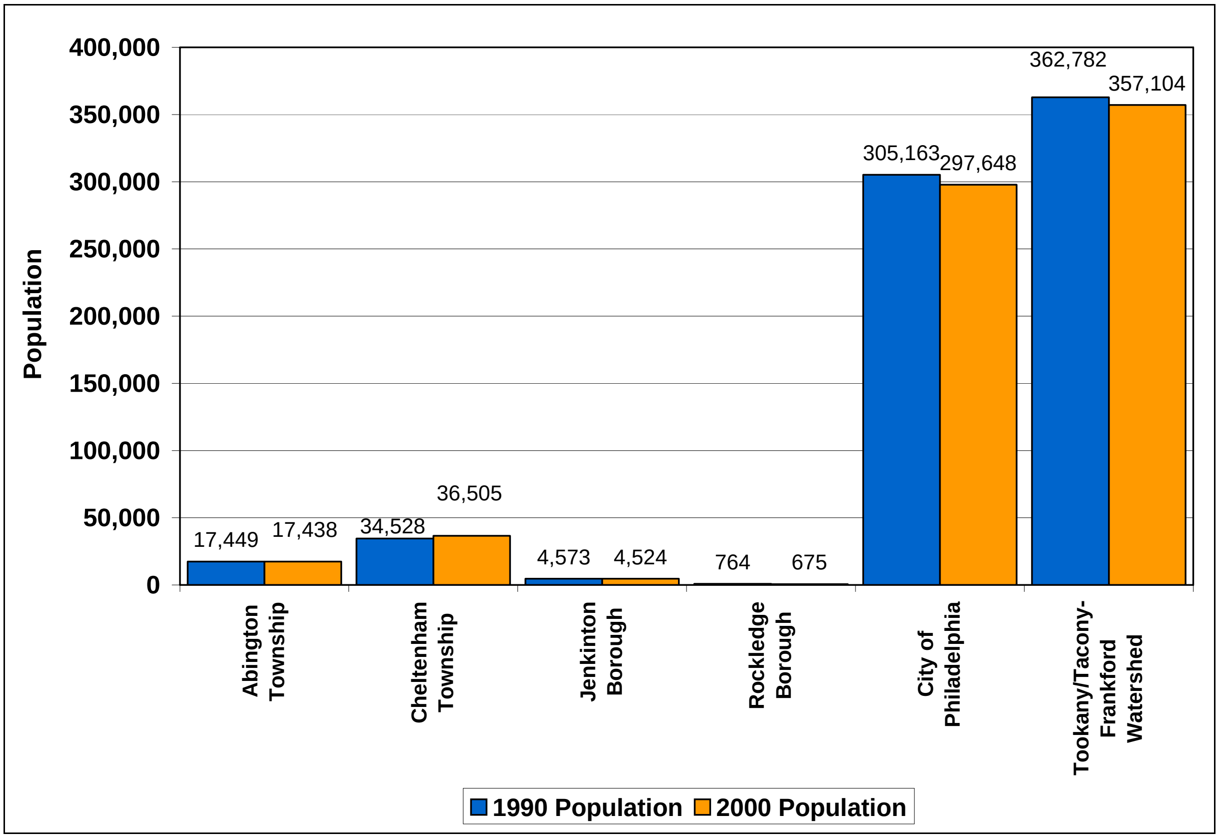


Figure 1.8 Population Change 1990-2000 in Tookany/Tacony-Frankford Watershed (Source: 2000 US Census)

1.4 Comprehensive Planning and the Regulatory Framework

In many states, numerous federal and state regulations and programs are aimed at improving the water quality and flow patterns in urban streams, while at the same time reducing flooding. Pennsylvania is no exception; the U.S. EPA and the Pennsylvania Department of Environmental Protection (PA DEP) have a complex regulatory framework for managing water resources with frequently overlapping demands and requirements. There are five major regulatory programs that contain significant elements related to watershed management in the Tookany/Tacony-Frankford Watershed. These are:

- the NPDES Phase I and Phase II stormwater regulations to control pollution due to stormwater discharges from municipal stormwater systems;
- the stormwater management PA Act 167 to address management of stormwater runoff quantity particularly in developing areas;
- PA Act 537 sewage facilities planning to protect and prevent contamination of groundwater and surface water by developing proper sewage disposal plans;
- the TMDL process to improve water quality on impaired streams and water bodies; and
- EPA's Combined Sewer Overflow (CSO) Control Policy to minimize mixed sewage and stormwater overflowing directly into streams.

Each of these programs, described on the pages that follow, provides guidelines that are transformed into a series of planning objectives within the watershed management planning process, leading directly to the selection of watershed management options to address those objectives.

1.4.1 NPDES Stormwater Rules

In response to the 1987 Amendments to the Clean Water Act (CWA), the Environmental Protection Agency (EPA) developed Phase I of the NPDES Stormwater Program in 1990. Phase I required NPDES (National Pollutant Discharge Elimination System) permits for all stormwater discharging from storm sewers (MS4s) of medium and large urban areas with populations of 100,000 or more. It also required permits from eleven categories of industrial activity, including construction activities that disturb five or more acres of land. Permit coverage can be either under an individually tailored NPDES permit (used by MS4s and some industrial facilities) or a general NPDES permit (used by most industrial facilities and construction sites).

Phase II of the NPDES Stormwater Program was published in November 1999. The Phase II regulation requires NPDES permit coverage, mostly general permits, for stormwater discharges from most small-urbanized areas (small MS4s) and construction activities that disturb from 1 to 5 acres of land. A list of affected communities has been published in the Federal Register.

There are six “minimum control measures” (MCMs) that communities must implement as part of a municipal stormwater management program whose goal is Phase II compliance. These are:

1. Public Education and Outreach: Distributing educational materials and performing outreach to inform citizens about the impacts polluted stormwater runoff discharges can have on water quality.

2. Public Participation and Involvement: Providing opportunities for citizens to participate in program development and implementation, including effectively publicizing public hearings and/or encouraging citizen representatives to be part of a stormwater management panel.

3. Illicit Discharge Detection and Elimination: Developing and implementing a plan to detect and eliminate illicit discharges to the storm sewer system. Includes the developing of a system map as well as informing the community about hazards associated with illegal discharges and improper waste disposal.

4. Construction Site Runoff Control: Developing, implementing, and enforcing an erosion and sediment control program for construction activities that disturb one or more acres of land (controls could include for example, silt fences, and temporary stormwater detention ponds).

5. Post Construction Runoff Control: Developing, implementing, and enforcing a program to address discharges of post-construction stormwater runoff from new development and redevelopment areas. Applicable controls could include preventative actions such as protecting sensitive areas (e.g., wetlands) or the use of structural BMPs such as grassed swales or porous pavement.

6. Pollution Prevention/Good Housekeeping: Developing and implementing a program with the goal of preventing or reducing pollutant runoff from municipal operations. The program must include municipal staff training on pollution prevention measures and techniques (e.g., regular street sweeping, reduction in the use of pesticides or street salt, and frequent catch-basin cleaning).

The EPA has listed the following municipalities within the Tookany/Tacony-Frankford watershed for inclusion in the Phase II program: Cheltenham Township, Jenkintown Borough, and Rockledge Borough. The permit cycle for these permits started in 2003.

1.4.2 Act 167 Stormwater Management

The Stormwater Management Act 167 of 1978 is administered by PADEP and is designed to address the inadequate management of accelerated stormwater runoff resulting from development. An Act 167 plan must address a wide range of hydrologic impacts due to development on a watershed basis, and include such considerations as tributary timing, flow volume reduction, base flow augmentation, water quality control, and ecological protection. Watershed runoff modeling is usually a critical component of the study, with modeled hydrologic responses to 2, 5, 10, 25, 50, and 100-year storms.

The primary purposes of Act 167 are to:

- Encourage planning and management of stormwater runoff;
- Authorize a comprehensive program of stormwater management designed to preserve and restore the flood carrying capacity of Commonwealth streams;
- Preserve natural stormwater runoff regimes;
- Protect and conserve groundwater.

Act 167 requires that each county – in consultation with affected municipalities – prepare and adopt a stormwater management plan for each watershed that falls wholly or partially within the county. The Act focuses on reduction of stormwater runoff quantities, rather than on water quality. Each stormwater plan will include, but is not limited to:

- A survey of existing runoff characteristics in small as well as large storms, including the impact of soils, slopes, vegetation, and existing development;
- A survey of existing significant obstructions and their capacities;
- An assessment of projected and alternative land development patterns in the watershed, and the potential impact of runoff quantity, velocity, and quality;
- An analysis of present and projected development in flood hazard areas, and its sensitivity to damages from future flooding or increased runoff;
- A survey of existing drainage problems and proposed solutions;
- A review of existing and proposed stormwater collection systems and their impacts;
- An assessment of alternative runoff control techniques and their efficiency in the particular watershed;
- An identification of existing and proposed state, federal, and local flood control projects located in the watershed and their design capacities;
- A designation of those areas to be served by stormwater collection and control facilities within a 10-year period;
- An estimate of the design capacity and costs of such facilities;
- A schedule and proposed methods for financing the development, construction, and operation of the facilities;

- An identification of the existing or proposed institutional arrangements to implement and operate the facilities;
- An identification of floodplains within the watershed;
- Standards for the control of stormwater runoff from existing and new development which are necessary to minimize dangers to property and life;
- Priorities for implementation of action within each plan;
- Provisions for periodically reviewing, revising, and updating the plan.

After adoption and approval of a stormwater plan, the location, design, and construction within the watershed of stormwater management systems, flood control projects, subdivisions and major land developments, highways, and transportation facilities must all be conducted in a manner consistent with the approved plan.

An Act 167 Plan is under preparation for the Tookany/Tacony-Frankford Creek watershed by Cheltenham Township with assistance from Philadelphia and Montgomery Counties.

1.4.3 Act 537 Sewage Facilities Planning

Act 537, enacted by the Pennsylvania Legislature in 1966, requires every municipality in the state to develop and maintain an up-to-date sewage facilities plan. The Act requires proper planning of all types of sewage facilities, permitting of individual and community on-lot disposal systems, and uniform standards of design.

The main purpose of a municipality's sewage facilities plan is to correct existing sewage disposal problems including malfunctioning on-lot septic systems, overloaded treatment plants or sewer lines, and improper sewer connections. The program is also designed to prevent future sewer problems and to protect the groundwater and surface water of the locality. To meet these objectives, PADEP uses the Official Sewage Planning requirements of Act 537 that prevent and eliminate pollution of the waters of the Commonwealth by coordinating planning for the sanitary disposal of sewage with a comprehensive program of water quality management.

Official plans contain comprehensive information, including:

- Planning objectives and needs;
- Physical description of planning area;
- Evaluation of existing wastewater treatment and conveyance systems;
- Evaluation of wastewater treatment needs.

Currently, all of the municipalities in the watershed have an Act 537 Plan, which provides for the resolution of existing sewage disposal problems, future sewage disposal needs of new land development, and future sewage disposal needs of the municipality. As of December 2005, Abington Township's Act 537 Plan is more than 5 years old and Philadelphia's is more than 10 years old. However, some plans are older than 30 years: Cheltenham, Rockledge, and Jenkintown boroughs. Also, the plans vary in their level of detail.

1.4.4 Impairment Designations and the TMDL Process

Section 303(d) of the Clean Water Act and the U.S. EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) provide a framework for watershed planning based on Total Maximum Daily Loads. TMDLs are the sum of individual waste load allocations (point sources) and load allocations (non-point sources) plus a margin of safety. They establish a link between water quality standards and water quality based controls. The objective of TMDLs is to allocate allowable loads among different pollutant sources so that the appropriate control actions can be taken and water quality standards achieved.

The basic steps in the water quality based approach to TMDLs include:

- Identification of the water quality-limited waters and the quality parameters of concern;
- Prioritizing the locations by ranking and targeting;
- Establishing the TMDL;
- Implementing the control actions;
- Assessment of the control actions.

Pennsylvania has listed water quality-limited waters according to point and non-point sources for toxic, conventional (BOD, TSS, fecal coliform, oil, and grease), and non-conventional (ammonia, chlorine, and iron) pollutants. Streams that are listed under Section 303(d) of the CWA are particularly targeted for improvement. The Tacony Creek Watershed is within Subbasin 03J, which also includes Jenkintown Creek, Mill Run, and Chester Creek watersheds. Within the Tookany-Tacony/Frankford Watershed, the following stream segments are listed as impaired (Figure 1.9):

- 13.4 miles of Tookany Creek and 13.0 miles of tributaries outside of Philadelphia are impaired due to habitat modification, siltation, and water/flow variability from urban runoff and storm sewers.
- 3.1 miles of Tacony-Frankford Creek inside the City are impaired due to habitat modification, siltation, and water/flow variability from urban runoff and storm sewers.
- The tidal portion of the creek (illustrated in blue) flowing toward the confluence with the Delaware River has not been assessed.

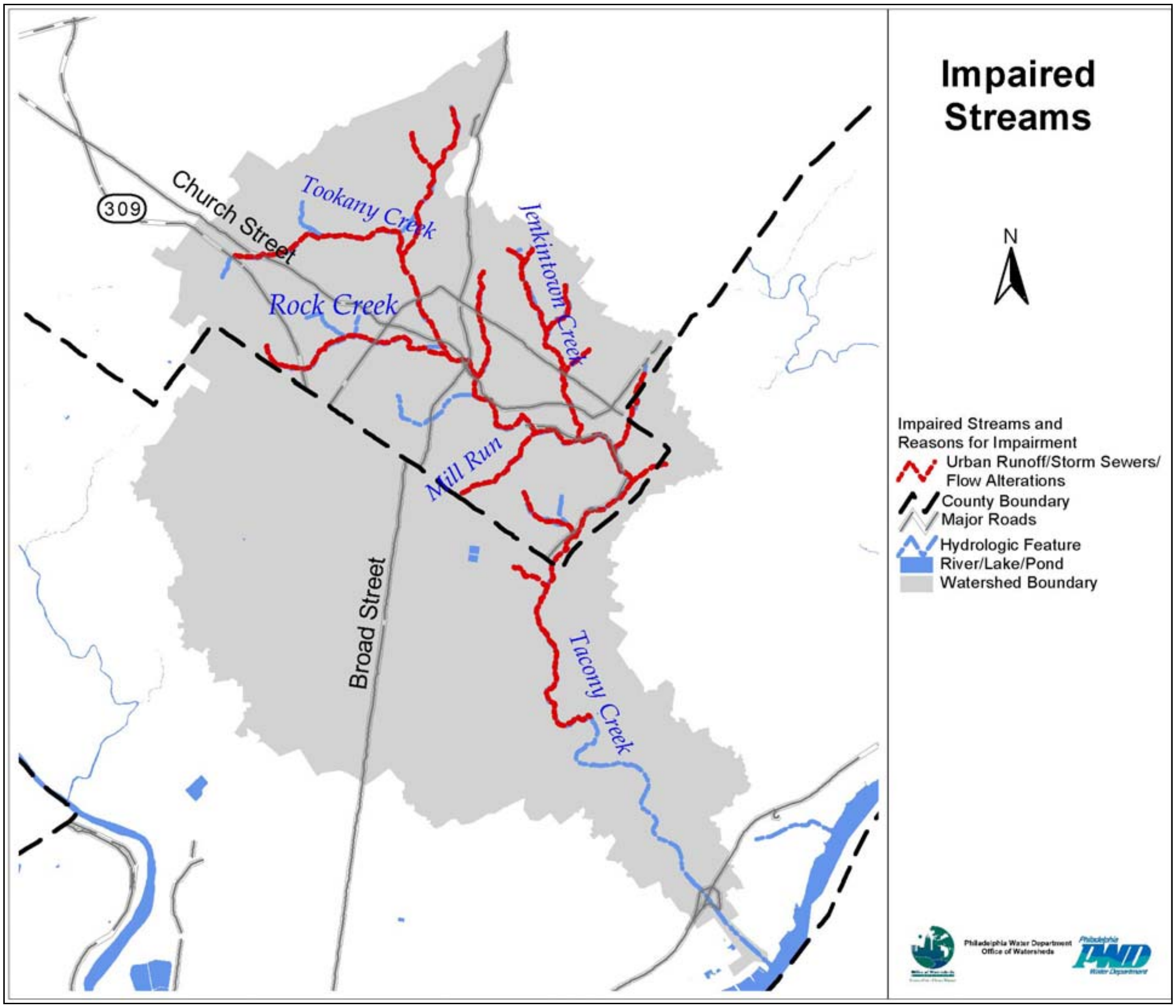


Figure 1.9 Impaired Streams in the Tookany/Tacony-Frankford Watershed

The next step in the statewide TMDL process includes prioritization of the list and the development of TMDLs for high-priority water bodies. It is this phase of the TMDL process that is of interest to the integrated watershed planning process.

Prioritization must take into account the severity of the pollution and the designated uses of the water body. It should consider the following:

- Risks pertaining to human health and aquatic life;
- Degree of public interest and support;
- Recreational, economic, and aesthetic importance;
- Vulnerability or fragility of the aquatic habitat.
- New permit applications for discharges or revisions to existing permits;
- Court orders and decisions;
- National policies and priorities.

TMDL development requires the quantification of pollutant sources and the allocation of maximum discharge loads to contributing point and non-point sources in order to attain water quality standards. TMDLs are best developed on a watershed basis in order to efficiently and effectively manage the quality of the water. The TMDL process may be developed using a phased approach that includes monitoring requirements and it generally includes the following five activities:

- Selection of the pollutants;
- Evaluation of the water body's assimilative capacity;
- Assessment of the pollutants discharged from all sources;
- Predictive analysis of the water body's response to pollution and determination of the total allowable pollutant load;
- Allocation (with a margin of safety) of the allowable pollutant load among the different sources.

The National Pollutant Discharge Elimination System's (NPDES) permitting process is used to implement control measures to limit effluent from point sources. In the case of non-point sources, state and local laws can be used to implement best management practices (BMPs), as well as Section 319 state management programs. These programs must be coordinated in order to effectively achieve the required non-point source reductions.

1.4.5 Combined Sewer Overflow (CSO) Control Policy

EPA's CSO Control Policy, published in 1994, provides the national framework for regulation of CSOs under NPDES. The policy guides municipalities and 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 CSO Long-Term Control Plans (LTCPs) that will result in full compliance with the CWA, including attainment of water quality standards.

As the first step under the CSO policy, nine technology-based minimum controls are required; these are measures that can reduce the prevalence and impacts of CSOs and that are not expected to require significant engineering studies or major construction.

- Proper operation and regular maintenance programs for the sewer system and the CSOs;
- Maximum use of the collection system for storage;
- Review and modification of pretreatment requirements to assure CSO impacts are minimized;
- Maximization of flow to the publicly owned treatment works for treatment;
- Prohibition of CSOs during dry weather;
- Control of solid and floatable materials in CSOs;
- Pollution prevention;
- Public notification to ensure that the public receives adequate notification of CSO occurrences and CSO impacts;
- Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls.

In the longer term, the CSO policy includes four requirements to ensure that the CSO systems meet the pollution control goals and local environmental objectives in a cost-effective manner:

- Clear levels of control to meet health and environmental objectives;
- Flexibility to consider the site-specific nature of CSOs and find the most cost-effective way to control them;
- Phased implementation of CSO controls to accommodate a community's financial capability;
- Review and revision of water quality standards during the development of CSO control plans to reflect the site-specific wet weather impacts of CSOs.

One of the three major components of the City of Philadelphia's CSO LTCP strategy involves a substantial commitment by the City to watershed planning to identify long term improvements throughout its watersheds, including any necessary additional CSO controls, which will result in further improvements in water quality and, ultimately, the attainment of water quality standards. The need for this watershed initiative is rooted in the fact that insufficient physical, chemical, and biological information currently exists on the nature and causes of water quality impairments, sources of pollution, and appropriate remedial measures. Because of this deficiency, at the time the CSO LTCP was developed, it was impossible to determine what needed to be done for additional CSO control or control of other wet weather sources throughout the watershed. This deficiency, especially with respect to the effects of wet weather discharges and receiving water dynamics, was increasingly recognized nationwide and led to a broader recognition of the need for watershed-based planning and management to properly define water quality standards and goals. In its LTCP, PWD suggested that the National CSO Policy, state and federal permitting and water quality management authorities, cities, environmental groups, and industry all recognized that effective long-term water quality management could be accomplished only through watershed-based planning.

The CSO Control Policy acknowledges the importance of watershed planning in the long term control of CSOs by encouraging the permit writer "... to evaluate water pollution control needs on a watershed management basis and coordinate CSO control efforts with other point and non-point source control activities" (1.B). The watershed approach is also discussed in the section of the CSO Control Policy addressing the demonstration approach to CSO control (II.B.4.b, and Chapter 3 of the U.S. EPA Guidance for Long Term Control Planning), which, in recommending that NPDES permitting authorities allow a demonstration of attainment of water quality standards (WQS), provides for consideration of natural background conditions and pollution sources other than CSOs.

The EPA Long Term Control Planning Guidance suggests that EPA is committed to supporting the implementation of a comprehensive watershed management approach. EPA has convened a Watershed Management Policy Committee consisting of senior managers to oversee the reorientation of all EPA water programs to support watershed approaches.

Of particular importance to CSO control planning and management is the NPDES Watershed Strategy. This strategy outlines national objectives and implementation activities to integrate the NPDES program into the broader watershed protection approach. The strategy also supports the development of basin management as part of an overall watershed management approach.

The Long Term Control Planning Guidance suggests that the sources of watershed pollution and impairment, in addition to CSOs, are varied and include other point source discharges; discharges from storm drains; overland runoff; habitat destruction; land use activities, such as agriculture and construction; erosion; septic systems; and landfills. The benefits to implementing a watershed approach are significant and include:

- Consideration of all important sources of pollution or impairment;
- Closer ties to receiving waters;
- Greater flexibility;
- Greater cost effectiveness (through coordination of monitoring programs, for example);
- Fostering of prevention as well as control;
- Fairer allocation of resources and responsibilities.

The Guidance notes that the major advantage of using a watershed-based approach to develop an LTCP is that it allows the site-specific determination of the relative impacts of CSOs and non-CSO sources of pollution on water quality. For some receiving water reaches within a watershed, CSOs could be less significant contributors to nonattainment than stormwater or upstream sources. In such cases, a large expenditure on CSO control could result in negligible improvement in water quality.

The EPA LTCP Guidance outlines a conceptual framework for conducting CSO planning in a watershed context (Figure 1.10). The approach is intended to identify CSO controls for each receiving water segment based on the concepts of watershed management and use attainability. The Tookany/Tacony-Frankford Watershed planning approach outlined in this document is conceptually identical. It moved from data collection through analysis and modeling to arrive at a set of recommended measures or options designed to meet the goals and objectives agreed upon through the stakeholder process. Figure 1.10 also identifies which section of this TTF Integrated Watershed Management Plan documents each step in the process.

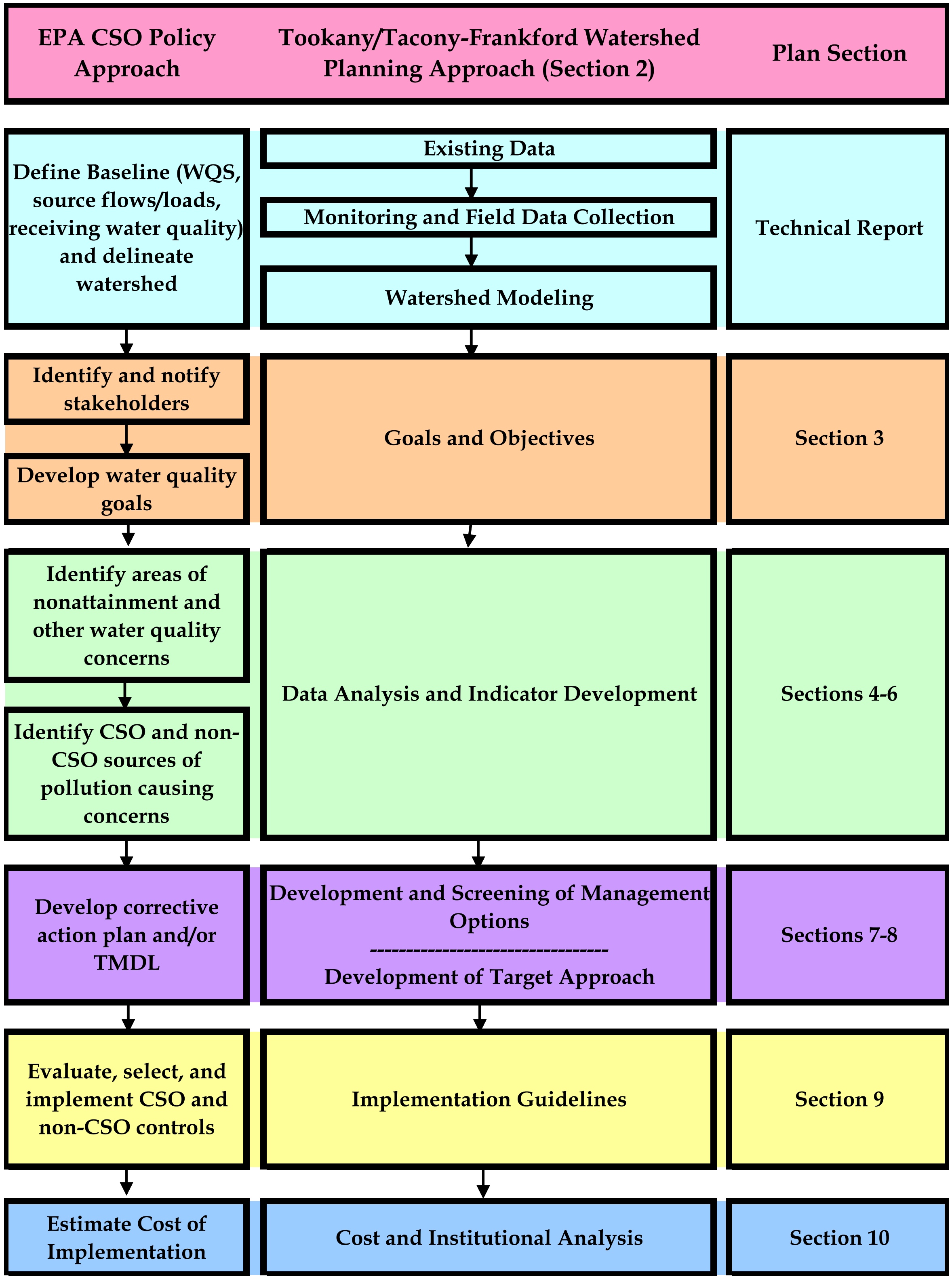


Figure 1.10 Tookany/Tacony-Frankford Planning Approach
Watershed-Based CSO Control Planning Approach for a Receiving Water Segment – from U.S. EPA Guidance for Long Term Control Plan (1995)

1.5 Overlapping Aspects of Regulatory Programs

Integrated watershed planning includes various tasks, ranging from monitoring and resource assessment to technology evaluation and public participation. The scope and importance of each task varies for each watershed, depending on site-specific factors such as environmental features of the watershed, regulatory factors such as the need to revise permits or complete TMDLs, available funding, extent of previous work, land use, and the size and degree of urbanization of watershed.

There are numerous activities required by each of the five programs mentioned above, and those activities demand a wide range of data collection. Table 1.1 gives an overview of the types of data required under each program, and Table 1.2 shows the corresponding types of activities required. Both tables highlight the fact that the task performed or the data collected under one program is often identical or very similar to the work done under other programs. It is clear that significant savings can be achieved through coordination of the programs and the development of one comprehensive plan for a watershed that meets all five program needs.

Table 1.1 Overview of Data Collection Required by Watershed Programs

Data Collection	Act 167 Stormwater	Act 537 Sewage Facilities	TMDL Program	NPDES Stormwater	CSO Program	RCPs
Geographic data (political, transportation, topographic, hydrographic, land use, etc.)	X	X	X	X	X	X
Economic and demographic		X		X	X	X
Meteorological	X	X	X	X	X	
Hydrologic characteristics	X	X	X	X	X	X
Designated uses and impaired water bodies			X	X	X	X
Water quality		X	X	X	X	X
Biological and habitat assessment			X	X	X	X
Floodplains and flooding issues	X					X
Point sources / Potential sources		X	X	X	X	X
Non-point sources of pollution			X	X		X
Sewer system performance and CSO	X	X	X	X	X	
Storm drainage system	X			X	X	
Historical and cultural resources	X					X

Table 1.2 Overview of Planning Tasks Required by Watershed Programs

Planning Tasks	Act 167 Stormwater	Act 537 Sewage Facilities	TMDL Program	NPDES Stormwater	CSO Program	RCPs
Preliminary reconnaissance survey						
Existing data collection and assessment	X	X	X	X	X	X
Preliminary water quality assessment		X	X		X	X
Present / Future land use and resource mapping	X	X	X		X	X
Inventory of point and non-point sources		X	X	X		X
Definition of regulatory issues and requirements			X		X	
Preliminary biological habitat assessment			X	X		X
Preliminary problem assessment	X	X	X		X	X
Public Involvement	X	X	X	X	X	X
Individual Watershed Plan						
Survey of runoff characteristics for storm events	X		X		X	
Survey of drainage problems, flood plains, drainage structures	X			X		X
Mapping of point sources, sewer system	X		X	X	X	
Monitoring, sampling, and bioassessment			X		X	
QA/QC and data evaluation	X	X	X	X	X	X
Sewer system modeling		X			X	
Watershed modeling	X		X		X	
Water body modeling	X		X			
Problem definition and goal setting	X	X	X	X	X	X
Identification and evaluation of runoff, flood control measures	X			X		
Identification of Combined Sewer Overflow				X	X	
Identification and evaluation of pollution control measures		X	X	X	X	
Economic assessment and funding requirements	X	X	X	X	X	X
Public involvement	X	X	X	X	X	X
Development of a Watershed Management Plan	X	X	X	X	X	X*

**Note: An RCP includes some but not all elements of an integrated watershed management plan.*

Watershed-based planning is now the preferred approach on both the federal and state level. General water quality and water quantity goals have been established at a state level, and the next step is to develop specific goals for each watershed. Table 1.3 shows the watershed planning goals for Tookany/Tacony-Frankford Creek and how they correspond to many of the overlapping goals of the five major regulatory programs.

Table 1.3 Overview of the Statement of Goals of the Watershed Programs

Goal Description	Act 167 Stormwater	Act 537 Sewage Facilities	TMDL Program	NPDES Stormwater	CSO Program	RCPs
1. Streamflow and Living Resources. Improve stream habitat and integrity of aquatic life.	X		X	X	X	X
2. Instream Flow Conditions. Reduce the impact of urbanized flow on living resources.	X				X	X
3. Water Quality and Pollutant Loads. Improve dry and wet weather stream quality to reduce the effects on public health and aquatic life.		X	X	X	X	X
4. Stream Corridors. Protect and restore stream corridors, buffers, floodplains, and natural habitats including wetlands.						X
5. Flooding. Identify flood prone areas and decrease flooding by similar measures intended to support Goals 1, 2, and 4.	X					X
6. Quality of Life. Enhance community environmental quality of life (protect open space, access and recreation, security, aesthetics, historical/cultural resources).	X	X	X	X	X	X
7. Stewardship, Communication, and Coordination. Foster community stewardship and improve inter-municipal, inter-county, state-local, and stakeholder cooperation and coordination on a watershed basis.	X	X	X	X	X	X

1.6 Other Relevant Programs

Other programs, both regulatory and non-regulatory, influence the watershed management planning approach and are briefly described under this section.

1.6.1 Rivers Conservation Program (RCP)

One significant non-regulatory program is the PA Department of Conservation and Natural Resources' (DCNR) Rivers Conservation Program (RCP), which was developed to conserve and enhance stream resources by implementing locally initiated plans.

The program provides technical and financial assistance to municipalities and stream support groups for the conservation of local streams. Generally, the RCP plans intend to assess the river's resources, identify potential threats, and recommend restoration/maintenance options. That involves the statement of goals to be accomplished and the listing of recommendations for the development and implementation of the plan.

The goals and recommendations from an RCP can be an important building block for an integrated watershed management plan (IWMP). The programs are similar in structure and approach; they have the same geographic scope, require overlapping data collection; and they involve the statement of goals and listing of recommendations. However, an RCP is narrower in scope than an IWMP and focuses more on quality of life along the stream corridor rather than on regulatory compliance. The RCP for the Tookany Watershed was completed in October 2003 by Abington Township, Cheltenham Township, Jenkintown Borough, and Rockledge Borough. The Tookany/Tacony-Frankford Watershed Partnership completed the Tacony-Frankford RCP in February 2004. The goals and objectives from both RCPs are incorporated into this TTF Integrated Watershed Management Plan.

1.6.2 Summary of Other Programs

Other relevant programs that have been incorporated or that may affect the watershed management program are listed on Table 1.4.

Table 1.4 Other Programs that May Influence the Watershed Management Plan

Sanitary Sewer Overflow (SSO) Policy Requires revisions to the NPDES permit regulations to improve the operation of municipal sanitary sewer collection systems, eliminate the occurrence of sewer overflows, and provide more effective public notification when overflows do occur.
PA DEP On-Lot Sewage Disposal Regulations Require local agencies to administer a permitting program for the installation of on-lot sewage disposal systems.
PENNVEST State Revolving Fund Program Provides funding for sewer, stormwater, and water projects throughout the Commonwealth.
Delaware River Basin Commission (DRBC) Programs Regulate both groundwater and surface water use for withdrawals greater than 100,000 gpd based on average 30-day use in a large portion of the study area, which drains to the Delaware River.
Delaware Valley Regional Planning Commission (DVRPC) Programs Address transportation, land use, and environmental protection issues in addition to economic development. Also provide services in planning analysis, data collection, and mapping.
PA DCNR Greenways Program An Action Plan for Creating Connections is designed to provide a coordinated and strategic approach to creating connections through the establishment of greenways in the state.
CWA Section 104(b)(3) Program Promotes the coordination and acceleration of research, investigations, experiments, training, demonstrations, surveys, and studies relating to the causes, effects, extent, prevention, reduction, and elimination of pollution.
CWA Section 208 Wastewater Planning Intended to encourage and facilitate the development and implementation of area-wide waste treatment management plans.
CWA Section 319(b) Non-point Source Management Program Designed to address mine drainage, agricultural runoff, construction/urban runoff, hydrologic and habitat modifications, on-lot wastewater systems, and silviculture.

1.7 Regulatory Agency and Stakeholder Partnerships

Beginning in 2000, PWD acted as the municipal sponsor of the Tookany/Tacony-Frankford Watershed Partnership, an exciting and groundbreaking effort to connect residents, businesses, and government as neighbors and stewards of the watershed. PWD hired the Pennsylvania Environmental Council (PEC), a well-respected, non-profit institution with a reputation for supporting watershed-based, holistic planning, as facilitator and outreach coordinator of this partnership. PEC pulled together diverse representatives from the watershed: municipalities, "friends" groups, educators, citizens, agencies, and watershed organizations.

Within the partnership there were originally two standing committees: the Public Participation and Outreach Committee and the Technical Advisory Committee. The partnership as a whole was called together for general planning status updates and what were called "focus group" meetings, which were initiated to elicit input on the management planning process. Additionally, in 2004 a third committee called the Structure Committee was initiated. Generally, partnership meetings were devoted to education about watershed concepts and to understanding the visions and concerns of participants as they related to their communities' environmental health. The TTF Partnership participated in the selection and prioritization of goals and objectives for this watershed management plan.

The Public Participation Committee was open to all partnership members. It consisted largely of watershed organizations, educators, residents, and educational non-profits. The committee established a number of projects to raise general awareness about watershed issues and to recruit further partnership membership. Projects included two watershed surveys (as a part of the two River Conservation Planning initiatives), a large-scale public event celebrating "the return of the Great Blue Heron" to the watershed area, a stream signage program, a rain barrel implementation program, clean-ups, participation in Philadelphia Cares Day, and many more.

The Technical Committee was also open to all members of the partnership, though the participants consisted mainly of representatives from local, state, and federal government agencies. This committee reviewed the technical documents produced by PWD, including a watershed reconnaissance of past and existing water quality studies, a current water quality sampling and modeling report, a sediment pollutant loading report, and a bioassessment summary. This technical data is essential for justifying and prioritizing the goals and objectives of the watershed management plan.

The Structure Committee was born out of a recommendation of the Public Participation Committee. It had become apparent to the partnership that in order to fully realize their watershed vision and to move forward with implementation of the recommendations put forth by the TTFIWMP, they would need to evaluate their own organizational structure for its feasibility in making this possible. The result of a series of Structure Committee meetings was that the Tookany/Tacony-Frankford Watershed Partnership evolved into an independent nonprofit watershed organization, with a mission of implementing the recommendations of the TTFIWMP. To view a copy of the new Tookany/Tacony-Frankford Watershed Partnership 501(c)3 bylaws, see Appendix C.

The role of the TTF Partnership will continue to evolve and become more critical to implementation of the plan.

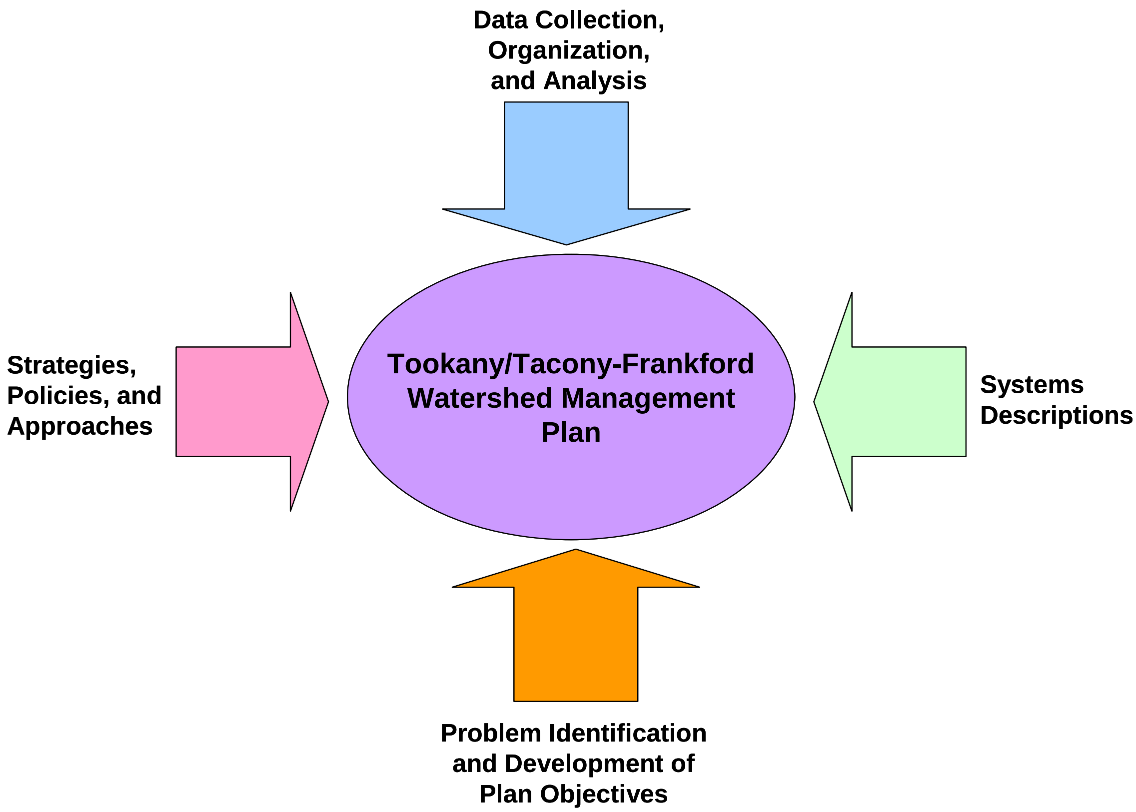
Section 2
Integrated Watershed Management for the Tookany/Tacony-Frankford Watershed

This section describes the watershed planning approach behind the TTFIWMP. It outlines the types of existing and new data that were assembled and analyzed, as well as the process for modeling stormwater flow under various scenarios. Several key concepts of the TTFIWMP are introduced: the overall goals and objectives (detailed in Section 3), the 21 watershed "indicators" (Section 4); and the screening of numerous methods, or "management options," for meeting the goals (Section 7). In addition, this section introduces the approach of setting multiple strategies – Targets A, B, and C – for promoting successful implementation of the TTFIWMP.

The watershed planning approach that serves as the framework for the Tookany/Tacony-Frankford Integrated Watershed Management Plan (TTFIWMP) contains many of the activities included in Philadelphia's CSO Long Term Control Plan and coordinates each of the five regulatory programs discussed in Section 1.4.

2.1 General Planning Approach

The general approach followed for the TTFIWMP has four major elements, as illustrated below, each with multiple tasks specific to the planning efforts within the TTF Watershed.



Data Collection, Organization, and Analysis

The initial step in the planning process is the collection and organization of existing data on surface water hydrology and quality, wastewater collection and treatment, combined sewer overflows, stormwater control, land use, stream habitat and biological conditions, and historic and cultural resources. In addition, existing rules, regulations, and guidelines pertaining to watershed management at federal, state, basin commission, county, and municipal levels also 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 prior to the study, and expanded once 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 and to explore the adequacy of the existing regulatory structure at the federal, state, county, and municipal level to properly manage these natural and built systems. In urban watersheds, the natural systems are, by definition, influenced by the altered environment, and existing conditions reflect these influences. It is not, however, always obvious which constructed systems are having the most influence, and what that influence is. Analyzing and understanding the water resources and water supply/wastewater/stormwater facilities and their interrelationship provides a sound basis for subsequent planning, leading to the development of a realistic set of planning objectives.

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 problems and issues 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 truly reflects the conditions of the watershed. These goals and objectives are prioritized by the stakeholders based on the results of the data analysis.

The priority of objectives becomes the basis for developing a recommended alternative. Potential constraints on implementation require that the objectives be broken down into phased targets, in which an alternative is developed to meet interim objectives. In this way, the effectiveness of implementation can be monitored, and targets adjusted, as more is learned about the watershed, its physical characteristics, and evolving water quality regulations.

Strategies, Policies, and Approaches

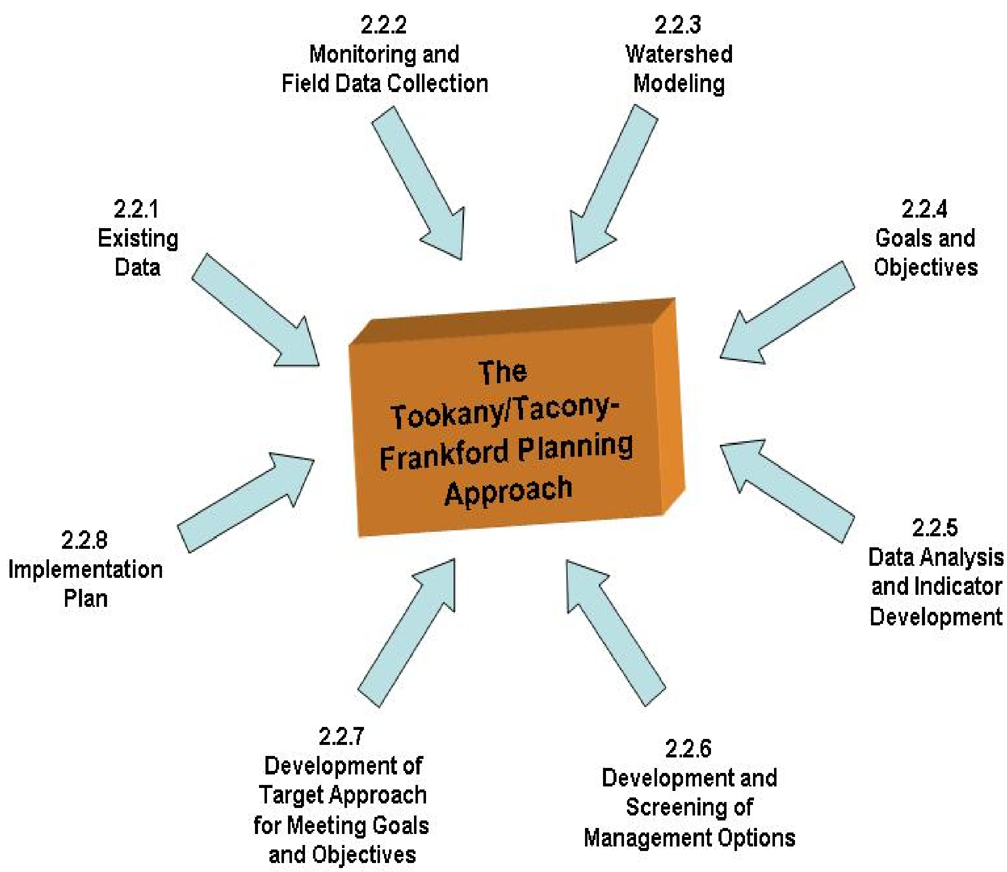
Once end targets and interim targets are established, with a clear list of associated planning objectives based on sound scientific analysis and consensus among stakeholders, a recommended alternative can be developed to meet the agreed upon targets and objectives. This alternative combines selected options from among the many 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 and combined sewer overflows, changes to land use and zoning, stream channel and streambank restoration measures, etc.

Section 8 of this plan provides Implementation Guidelines on how best to combine the many options in a coherent fashion within the context of the watershed-wide management objectives. The plan is designed to provide an implementation process and guidelines to achieve the stated objectives over a specified period of time.

2.2 The Tookany/Tacony-Frankford Planning Approach

As mentioned above, the approach and specific tasks for the TTFIWMP are intended to meet the criteria of the five major regulatory programs discussed in Section 1.4.

In order to establish environmental goals and identify the indicators that measure progress toward these goals, the Tookany/Tacony-Frankford planning strategy utilizes the "plan-do-check-review" methodology often called the "adaptive management approach." To satisfy the five elements included in this procedure, the Tookany/Tacony-Frankford planning process moved from data collection and analysis to plan development in an organized manner, with constant interaction with the established stakeholder groups. The primary data collection, analysis, and technical planning activities of the TTFIWMP are outlined below, and the stakeholder process is discussed in Section 3.



2.2.1 Existing Data

PWD assembled relevant existing data and information collected in the past by other agencies and by prior studies. Several types of geographic and physical data were collected.

Geographic and Demographic Data

The base map for the project study area was prepared from U.S. Census Bureaus TIGER (Topologically Integrated Geographic Encoding and Referencing) database. These files contain local and state political boundaries, rivers and waterways, roads and railroads, and census block and block group boundaries for demographic analysis.

Meteorological Data

In addition to U.S. Census data, meteorological data was gathered to analyze streamflow responses to seasonal changes, climate variation, and storms, and to model stormwater flows. Long-term rainfall data was obtained from the National Oceanic and Atmospheric Administration's rainfall gauge at the Philadelphia International Airport. This gauge has over 100 years of hourly precipitation data, from 1902 through the present. In addition to this long-term rainfall gauge, the PWD CSO Program has over 10 years of 15-minute rainfall data from 24 rain gauges. Ten of these gauges are in the vicinity of the TTF Watershed. The available rainfall data for each gauge is summarized in Table 2.1, and Figure 2.1 shows their locations (next page). Data from each gauge was analyzed for accuracy and completeness and then subjected to statistical analyses to check for changes in the gauge location or physical layout, as well as to explore correlations among gauges to identify potential over- or under-catch trends.

Rain Gauge Data: PWD maintains a database of 15-minute accumulated precipitation depths collected from its county-wide 24 tipping bucket rain gauge network for the period 1990 to the present. The uncorrected, 2.5-minute accumulated, 0.01 inch tip count, rain gauge data is subjected to preliminary quality assurance and quality control procedures. Identification and flagging of bad or missing data is performed for each rainfall event on a monthly basis by visual inspection comparing 15-minute accumulated measurements at nearby gauges and looking for patterns of obvious gauge failures, including plugged gauges and erratic tipping. Next, a bias adjustment procedure is performed to normalize systematic rain gauge biases across the network. Finally, all data flagged as bad or missing is filled with data from up to five nearby gauges using inverse-distance-squared weighting. A continuous rainfall record at each gauge location is thereby produced for use in continuous hydrologic model simulations.

Radar Rainfall Data: Gauge calibrated radar rainfall estimates have been obtained from Vieux and Associates for seven wet weather events sampled during 2003. The spatial resolution of this data is approximately 1km x 1km grid covering the extended watershed area. The 15-minute accumulated rainfall depths are derived from the National Weather Service's Mount Holly, NJ, level 2 radar reflectivity data that has been calibrated to PWD's rain gauge data using mean field bias adjustment. Mean field bias adjustment preserves the average rainfall depth measured at the rain gauges along with the spatial distribution represented by the radar reflectivity data.

Representative Wet Weather Year: A representative year of rainfall data was constructed to more easily evaluate the effectiveness of stormwater management options. This was done by comparing the 100-year hourly rainfall record from the NOAA Philadelphia International

Airport rain gauge station to individual quarterly records for the years 1991 through 2002. Each quarter year was evaluated against the long term record by comparing total quarterly rainfall along with the cumulative distributions of rainfall intensities and storm total depths. The resulting representative year was constructed using data from quarter 1 of 1997, quarter 2 of 1998, quarter 3 of 1996, and quarter 4 of 1997.

Table 2.1 Rainfall Data Available for the Tookany/Tacony-Frankford Watershed Gauges

Gauge Name	Available Data
RG-07	1991-2003
RG-08	1991-2001, 2003
RG-10	1991-2001
RG-11	1991-2000, 2002-2003
RG-13	1991-1998, 2001-2003
RG-14	1991-1998, 2001
RG-17	1991, 1993-2003
RG-18	1992-2003
RG-19	1991-2003

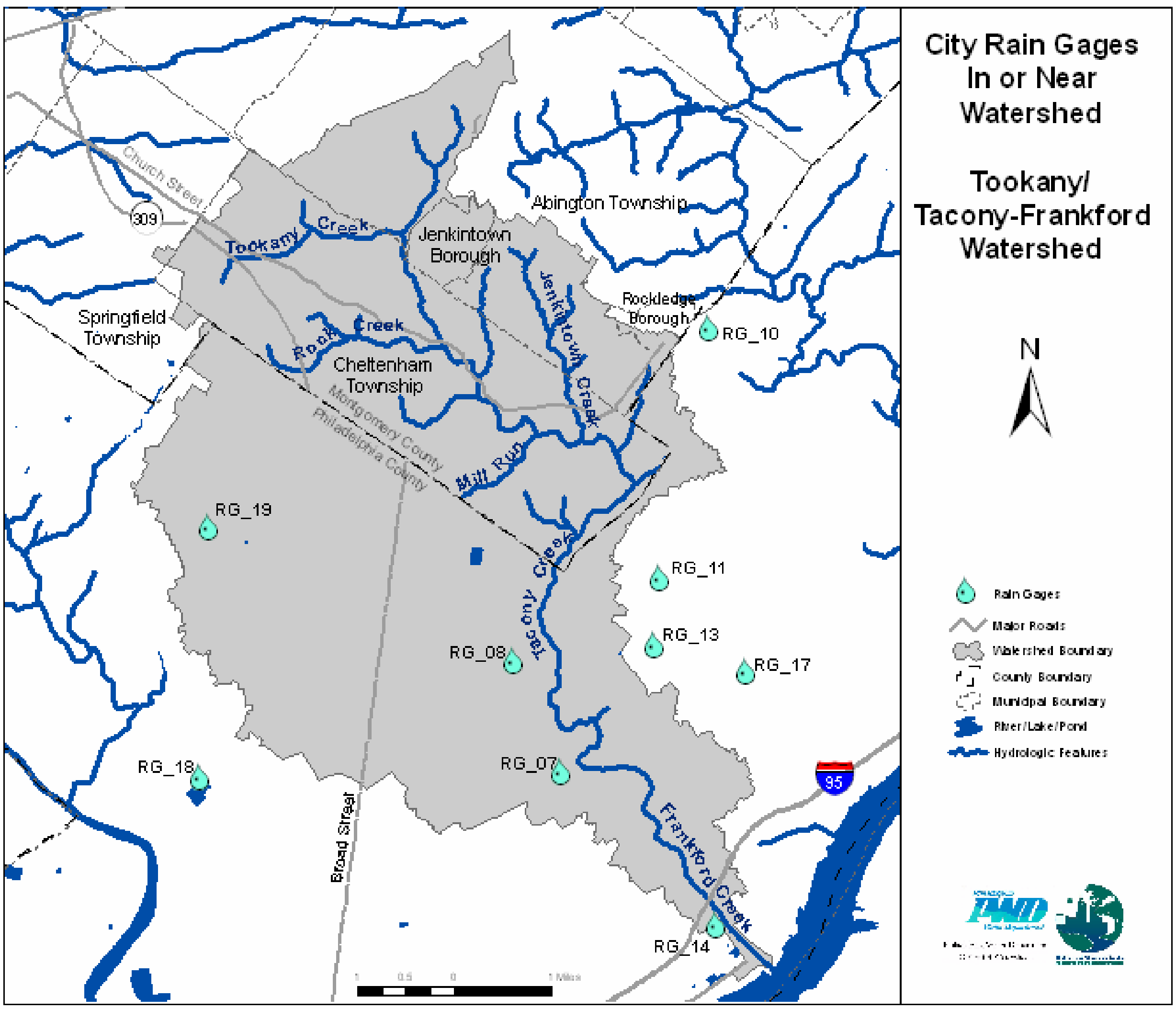


Figure 2.1 City Rain Gauges in or near the Tookany/Tacony-Frankford Watershed

Land Use

Land use information for the Tookany/Tacony-Frankford Watershed was obtained from the Delaware Valley Regional Planning Commission (DVRPC) for Montgomery and Philadelphia counties. The DVRPC land use maps are based on aerial photography from March through May of 1995. The residential areas were updated based on the 2000 Census populations. A useful representation of the existing land use information for hydrologic analyses was developed as shown in Figure 2.2.

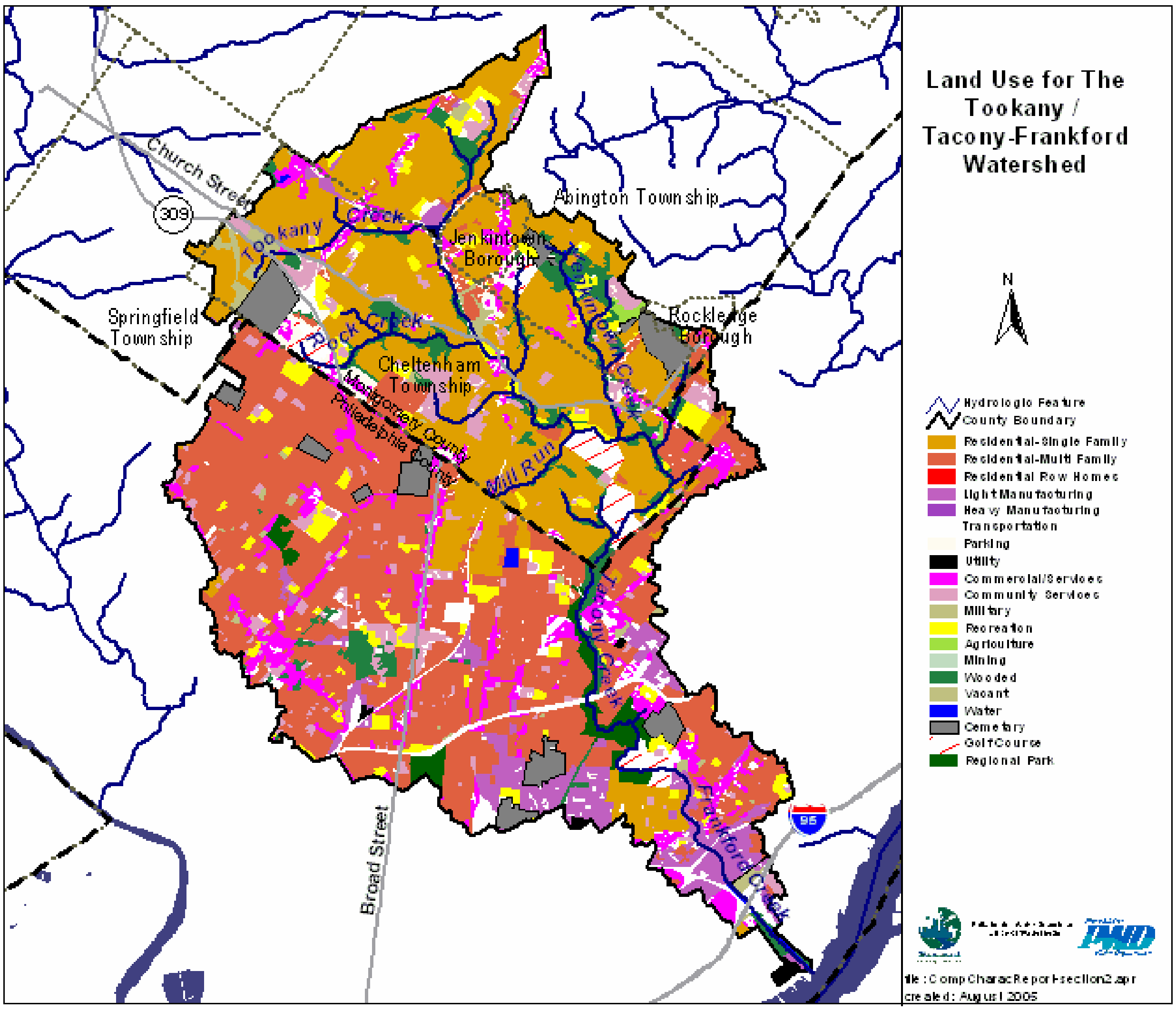


Figure 2.2 Land Use Map for the Tookany/Tacony-Frankford Watershed (Source: DVRPC)

Streamflow

During the 1960s, the United States Geological Survey (USGS), in cooperation with PWD, established streamflow-gauging stations at five locations in the Tookany/Tacony-Frankford Watershed. While only one of these gauges still is active today, the two to three decades of historic record they provided is invaluable in characterizing the hydrologic response of the watershed. The locations of the gauges are listed in Table 2.2 and shown in Figure 2.3, below. Daily streamflow records from the gauges were analyzed, and baseflow separation performed to identify patterns along the stream of baseflow and stormwater runoff. (The results of these analyses are presented in Section 4.2.1 and Section 5.2.)

Water Quality

In the early 1970s, the Philadelphia Water Department began a study in cooperation with the U.S. Geological Survey (USGS) titled, "Urbanization of the Philadelphia Area Streams." The purpose of this study was to quantify the pollutant loads in some of Philadelphia's streams and document any degradation in water quality due to urbanization. The study included three sampling sites in the headwaters and two on the main stem of Tacony-Frankford Creek (see Figure 2.3, next page). Monthly discrete water quality samples were collected at each site and analyzed for a variety of water quality parameters between 1970 and 1980. The USGS established streamflow gauging stations at five locations in the Tacony-Frankford Watershed, partially as a result of its participation in the Cooperative Program. The majority of the data currently available from STORET, U.S. EPA's water quality database, was collected as part of this study.

Table 2.2 USGS Gauges and Periods of Record

Gauge No.	Name	Drainage Area (sq. mi.)	Period of Record
01467089	Frankford Creek at Torresdale Ave.	33.8	10/1/65 - 9/30/81, 5/14/82 - 6/29/82
01467087	Frankford Creek at Castor Ave.*	30.4	7/1/82 - 9/30/98
01467086	Tacony Creek at County Line	16.6	10/1/65 - 11/17/88
01467085	Jenkintown Creek At Elkins Park	1.17	10/01/73 - 9/30/78
01467083	Tacony Creek near Jenkintown	5.25	10/1/73 - 9/30/78

** currently operating gauge*

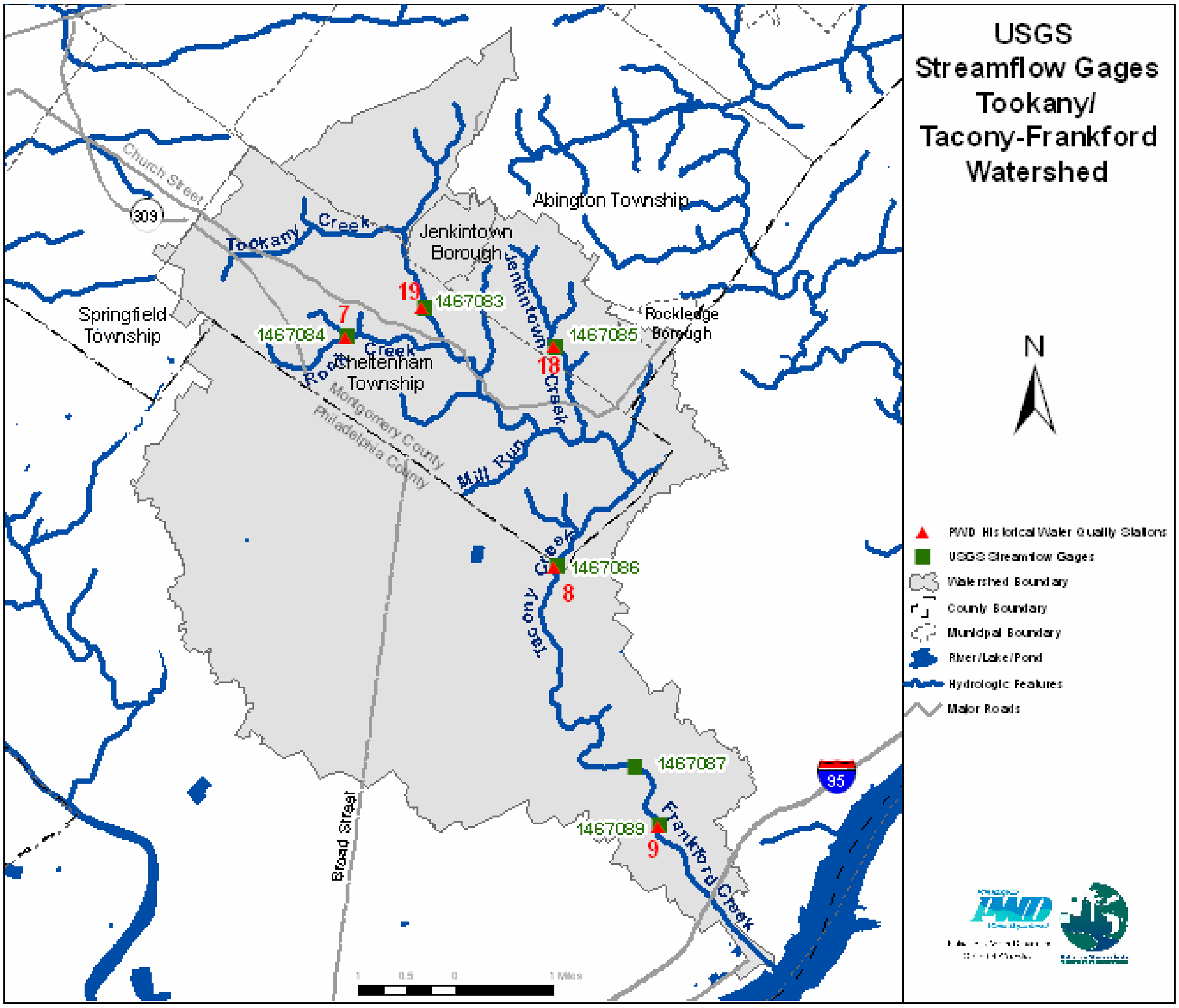


Figure 2.3 PWD/USGS Cooperative Program Water Quality and Streamflow Stations in the Tookany/Tacony-Frankford Watershed

2.2.2 Monitoring and Field Data Collection

To supplement existing data, PWD conducted an extensive sampling and monitoring program to characterize conditions in the TTF Watershed. The program was designed to document the condition of aquatic resources, to provide information for the planning process needed to meet EPA and PA DEP regulatory requirements, and to monitor trends as implementation proceeds.

Water Quality Sampling

PWD performed three types of sampling at eight sites (Figure 2.4). Discrete sampling was done from June 2000 through July 2003. Wet weather sampling involved collecting discrete samples before and during 12 wet weather events from March 2001 through October 2003, allowing the characterization of water quality responses to stormwater runoff and sanitary and combined sewer overflows. The third type of sampling was continuous monitoring, carried out by YSI 6600 and 600 XLM Sondes, shallow depth continuous water quality monitors, and probes that record dissolved oxygen, pH, and turbidity. The equipment was deployed to three locations periodically for a number of days to collect continuous data samples and observe water quality fluctuations. The Sonde data for the Tookany/Tacony-Frankford Watershed includes over 80 deployments.

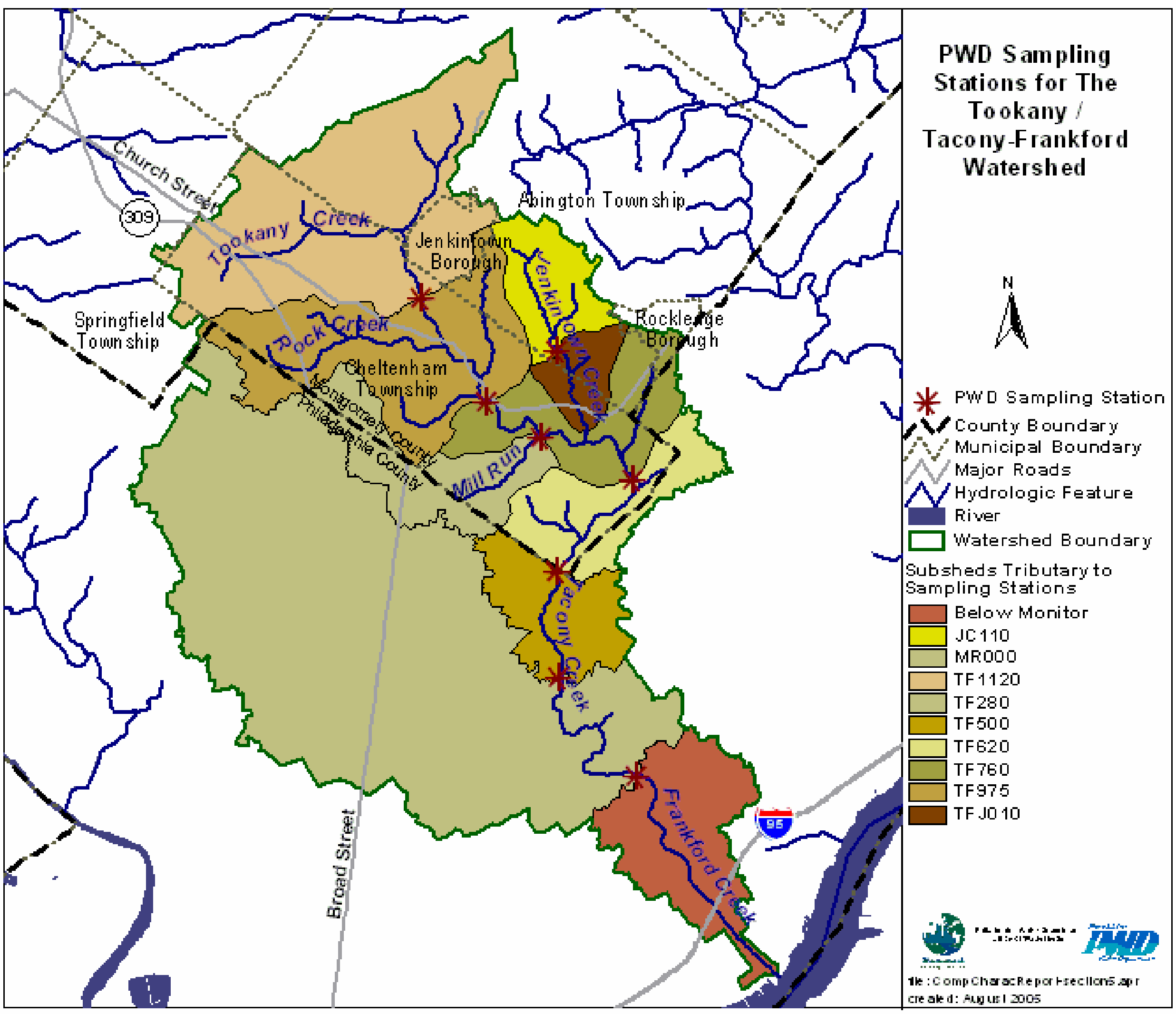


Figure 2.4 Water Quality Monitoring Locations in the Tookany/Tacony-Frankford Watershed

Biological Monitoring

Biological monitoring is a useful means of detecting anthropogenic impacts to the aquatic community. Resident biota (e.g., benthic macroinvertebrates, fish, and periphyton) in a water body are natural monitors of environmental quality and can reveal the effects of episodic and cumulative pollution and habitat alteration (Plafkin et. al. 1989, Barbour et al. 1995). The Philadelphia Water Department's Office of Watersheds and Bureau of Laboratory Services, along with the Philadelphia Academy of Natural Sciences and the Pennsylvania Department of Environmental Protection have been developing a preliminary biological database to assess the aquatic integrity of the Tookany/Tacony-Frankford Watershed. During the winter of 2000-2001, the Philadelphia Water Department conducted biological assessments (Rapid Bioassessment Protocols III and V) at seven non-tidal locations along the Tacony-Frankford Watershed to investigate the various point and non-point source stressors. Macroinvertebrate and ichthyfauna monitoring was conducted at specific locations within the watershed. Geographical Information Systems (GIS) databases and watershed maps were constructed to provide accurate locations of the sampling sites.

An ichthyfauna (fish) assessment occurred at four sampling stations on the mainstem of the Tookany/Tacony-Frankford Creek. Six metrics were used to assess the quality of the fish assemblages in the study stream.

1. Species richness
2. Species diversity
3. Trophic composition relationships
4. Pollution tolerance levels
5. Disease and parasite abundance/severity
6. Introduced (exotic) species

In addition to the fish assessment, the results of a PA DEP Rapid Bioassessment Protocol (RBP) assessment of seven sites in the Tookany/Tacony-Frankford Watershed were also compiled. PA DEP biologists used a combination of habitat and biological assessments to evaluate the Tookany/Tacony-Frankford under the Unassessed Waters Program. Biological surveys included kick screen sampling of benthic macroinvertebrates, which were identified by family and by their tolerance to pollution. Benthic macroinvertebrates mainly are aquatic insect larvae that live on the stream bottom. Since they are short-lived and relatively immobile, they reflect the chemical and physical characteristics of a stream and chronic sources of pollution. The biological integrity and benthic community composition was determined using U.S. EPA guidelines for RBP III.

Upon completion of the total biological scoring criteria, each site was compared to a reference site according to its drainage area and geomorphological attributes. The reference site chosen was French Creek, located at Coventry Road Bridge, South Coventry Township, Chester County. The comparison of the biological assessment of each site with the reference site was designed to create a baseline for monitoring trends in benthic community structure that might be attributable to improvement or worsening of conditions over time. Several Biological Condition Categories were developed:

- Non-impaired
- Slightly impaired
- Moderately impaired
- Severely impaired

Habitat Assessment

Habitat assessments evaluate how deeply the stream substrate is embedded, the degree of streambank erosion, the condition of riparian vegetation, and the amount of sedimentation. Data from the PA DEP surveys were available for the Tookany/Tacony-Frankford Creek. Habitat assessments at seven non-tidal sites were completed based on the Stream Classification Guidelines for Wisconsin (Ball, 1982) and Methods of Evaluating Stream, Riparian, and Biotic Conditions (Platts et al., 1983). Reference conditions were used to normalize the assessment to the Tookany/Tacony-Frankford (mainstream) "best attainable" situation. Habitat parameters were separated into three principal categories to characterize the site:

- Primary or microscale habitat
- Secondary or macroscale habitat (stream channel)
- Tertiary or riparian and bank structure

Resource based Habitat Suitability Indices (HSI) were developed to add aquatic life-based habitat and flow requirement criteria to the watershed assessment. HSIs integrate the expected effects of a variety of physicochemical and hydrological variables on a target species of environmental or economic concern. Data is used to construct sets of suitability index curves, each of which relates a habitat parameter to its suitability for the species of interest. Curves rate habitat variables on a scale of 0 to 1.0, and were developed to measure food and cover, water quality, and reproduction (e.g., substrate type, percent pools, percent cover, depth of pools, pH, DO, turbidity, temperature).

Fluvial Geomorphological Assessment

For the Tacony Creek Watershed, members of the Philadelphia Water Department performed a fluvial geomorphological (FGM) assessment which included baseline determination of stream stability and habitat parameters. The measurement of geomorphic parameters and physical and hydraulic relationships were performed at both Level I and Level II using the Rosgen classification methodology (D.L. Rosgen Applied River Morphology 1996).

Level I: Desktop survey included desktop delineation of the stream using generalized major stream types based on available topographic information, geological maps, soils maps, and aerial photographs. The purpose of the inventory was to provide an initial framework for organizing and targeting subsequent field assessments of important reaches where problems are known to occur or are anticipated to occur. Available topographic information, geological maps, soils maps, and aerial photographs were reviewed.

Level II: Reach stream survey was performed for approximately 30 miles of stream including the Main Stem Tookany/Tacony-Frankford Creek and 14 tributaries within the Watershed. A field team consisting of engineers and biologists walked the designated lengths of each stream and tributary and estimated several parameters related to channel morphology:

- Bankfull elevations/widths
- Floodprone elevations/widths
- Bankfull/Floodprone discharges
- Entrenchment ratios
- Width/Depth ratios
- Sinuosity
- Channel/Water surface slopes
- Channel materials (pebble count) – D50's
- Meander pattern
- Rosgen stream types
- Velocities
- Shear stresses

Wetland Study Method

Wetlands play a significant role in ecosystem health and water quality in a watershed. For this reason, two wetland field investigations were conducted to characterize the presence and condition of wetlands in the Tookany/Tacony-Frankford Watershed. Potential wetlands within Philadelphia were evaluated in July of 2001, and potential wetlands in Montgomery County were evaluated in August 2003. The wetland field investigation was designed to survey existing wetlands, evaluate potential wetland enhancement actions, and identify potential wetland creation sites.

The field investigation plan was developed based on orthophoto basemaps, and indicator information such as National Wetlands Inventory (NWI) mapping, hydric soil information, Fairmount Park Commission (FPC) mapping, and Delaware Valley Regional Planning Commission (DVRPC) existing open space mapping.

The wetland field investigation evaluated the hydrology, vegetation, soils, general location, estimated acreage, and landscape position of the wetlands in the riparian corridors. Although wetlands were not delineated, all identified wetlands within the watershed met the criteria for jurisdictional wetlands as described in the 1987 *U.S. Army Corps of Engineers* (USACE) *Wetlands Delineation Manual* (Environmental Laboratory 1987). Where possible, significant and representative points were mapped using global positioning systems (GPS).

Existing wetlands located during the field survey were also evaluated for existing wetland functions using the Oregon Assessment Method. The *Oregon Freshwater Wetland Assessment Methodology* (Roth, et al. 1996) and the Human Disturbance Gradient (Gernes and Helgen, 2002) were applied to each wetland location. The Oregon Assessment Method values were calculated for Wildlife Habitat, Fish Habitat, Water Quality, Hydrologic Control, and Sensitivity to Future

Impact. An additional function, termed Wetland Improvement, was evaluated using relevant questions from other areas of the Oregon Assessment Method. The Wetland Improvement Function was intended to reflect field observations that the potential for wetland enhancement may exist without a significant buffer, so long as there was sufficient access to create the enhancement.

Water quality is a factor of both the Oregon Assessment Method and the Human Disturbance Gradient (HDG). A combination of field observations, including the location of the wetland and waterway within the watershed or sub-watershed, as well as the PA DEP's *2002 Section 303(d) List of Impaired Waterbodies* (PA DEP 2002) was used as a measure of water quality. Four PWD monitoring stations within the Tookany/Tacony-Frankford Watershed that assess chemical, macroinvertebrate, and fish habitat data also contributed data to the Oregon and HDG analyses.

Where applicable, the redirection of outlets was considered in determining sites for streambank restoration and/or wetland restoration. Existing undeveloped areas were considered as potential wetland creation sites; factors included proximity to a waterway, the presence of stormwater outlets, the presence of existing wetlands nearby, whether these wetlands would be negatively impacted by the creation of additional wetland, and construction access and physical limitations of the site.

2.2.3 Watershed Modeling

An important tool for developing the watershed plan is a hydrologic and hydraulic model of the stream and stormwater system. In most streams in the eastern U.S., stormwater flows can range from less than 30% of total annual streamflow in less-developed watersheds to over 70% in highly urbanized settings. Modeling of stormwater flows is, therefore, a critical component of a watershed management plan. The model should, at a minimum, be built to provide storm-by-storm flows to the streams as well as estimates of pollutant loads carried by the stormwater reaching the streams.

A Stormwater Management Model (SWMM) was built for the entire Tookany/Tacony-Frankford Watershed. SWMM is a comprehensive set of mathematical models originally developed for the simulation of urban runoff quantity and quality in storm, sanitary, and combined sewer systems. The model subdivides the watershed into approximately 300 subwatersheds and estimates flow and pollutant loading from each land use type within each of the subwatersheds. It simulates the hydraulics of combined sewers, the open channel of the creek itself, and the floodplain. Thus, the model is useful for simulation of stormwater runoff quantity and quality, combined sewer overflow, and streamflow. The model was calibrated by comparing stormwater runoff to estimated runoff, calculated through hydrograph separation at the USGS gauges in the watershed. Model simulations included:

- Existing conditions using a long-term rainfall record from Philadelphia Airport;
- Annual average pollutant loads for key pollutants found in stormwater. The list of pollutants includes parameters such as nitrate, phosphorus, total suspended solids, heavy metals, biochemical oxygen demand, and dissolved oxygen;
- Numerous simulations to test the effectiveness of various BMPs within the Tookany/Tacony-Frankford Watershed. Effectiveness was judged based on reductions in stormwater discharges, CSOs, and reduced pollutant loading during wet weather.

The model results helped identify areas where stormwater runoff or pollutant loads are particularly high and in need of control. Model flow results, in combination with the results of the fluvial geomorphic assessment, provided excellent tools for identifying areas of the watershed that are undergoing stormwater-related stress and an efficient way of developing alternative integrated watershed management approaches, particularly with regard to the Wet Weather “Target C” objective (described in Section 2.2.7).

2.2.4 Goals and Objectives

Early in the planning process, project goals and objectives were developed in conjunction with the stakeholders. In general, goals represent consensus on a series of "wishes" for the watershed. Seven project goals were established that encompass the full spectrum of goals from all the relevant regulatory programs as well as the River Conservation Plans (as summarized in Table 1.3). A significant effort was made to consolidate the various goals into a single, coherent set that avoids overlap and is organized into clear categories:

1. Streamflow and Living Resources
2. Instream Flow Conditions
3. Water Quality and Pollutant Loads
4. Stream Corridors
5. Flooding
6. Quality of Life
7. Stewardship, Communication, and Coordination

Once the preliminary set of goals was established, a series of associated objectives was developed. Objectives translate the goals into measurable quantities; "indicators" (described below) are the means of measuring progress toward those objectives. This relationship is the link between the more general project goals and the indicators developed to assess the watershed and to track future improvement.

The preliminary planning goals and objectives were presented to stakeholders for initial review. However, the final, prioritized goals and objectives were subjected to final review and approval when the data analysis and modeling work were completed. (See Section 3 for more detail.)

2.2.5 Data Analysis and Indicator Development

An integral part of this plan is the assessment and description of existing conditions within the watershed and stream. This assessment has identified specific problem areas, while establishing a "watershed baseline" from which we can measure our future progress as recommendations are implemented. Based upon these existing conditions, a series of "watershed indicators" were developed so that as implementation occurs in the coming years, progress can be quantified. These indicators were developed to represent the results of the data collection efforts and the data analysis and modeling. An indicator is a measurable quantity that characterizes the current state of at least one aspect of watershed health. Every indicator is directly linked to one or more project objectives. Thus, they serve to describe the current conditions, and provide a clear method of monitoring progress and achievement of objectives as watershed management strategies are implemented over time.

The 21 indicators selected for their potential use in assessing both current conditions and future progress in improving conditions are listed in Table 2.3 (next page) and discussed in detail in Section 4.

Table 2.3 Tookany/Tacony-Frankford Watershed Indicators

The Land Use and Stream Health Relationship

Indicators	
1	**Land Use and Impervious Cover**

Flow Conditions and Living Resources

Indicators	
2	**Streamflow**
3	**Stream Channels and Aquatic Habitat**
4	**Restoration and Demonstration Projects**
5	**Fish**
6	**Benthic Macroinvertebrates**

Water Quality

Indicators	
7	**Effects on Public Health (Bacteria)**
8	**Effects on Public Health (Metals and Fish Consumption)**
9	**Effects on Aquatic Life (Dissolved Oxygen)**

Pollutants and Their Sources

Indicators	
10	**Point Sources**
11	**Non-point Sources**

The Stream Corridor

Indicators	
12	**Riparian Corridor**
13	**Wetlands and Riparian Woodlands**
14	**Wildlife**

Quality of Life

Indicators	
15	**Flooding**
16	**Public Understanding and Community Stewardship**
17	**School-Based Education**
18	**Recreational Use and Aesthetics**
19	**Local Government Stewardship**
20	**Business and Institutional Stewardship**
21	**Cultural and Historic Resources**

2.2.6 Development and Screening of Management Options

Clear, measurable objectives provided the guidance for developing options designed to meet the project goals. A "management option" is a technique, measure, or structural control that addresses one or more objectives (e.g., a detention basin that gets built, an ordinance that gets passed, an educational program that gets implemented).

The following example clarifies the difference among a goal, an objective, and a management option.

> **Goal**: Improve water quality.
>
> **Objective:** Maintain dissolved oxygen levels above 5 mg/L.
>
> **Management Option:** Eliminate deep, poorly mixed plunge pools where low DO is detected.

Lists of management options were developed to meet each of the goals and objectives established for the Tookany/Tacony-Frankford Watershed. Only those options deemed feasible and practical were 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 were collected. These options were identified from a variety of sources, including other watershed plans, demonstration programs, regulatory programs, literature, and professional experience.
2. **Initial Screening.** Some options could be eliminated as impractical for reasons of cost, space required, or other considerations. Options that already were implemented, were mandated by one of the programs, or were agreed to be vital, were identified for definite implementation. The remaining options were screened for applicability to the TTF Watershed and for their relative cost and the degree to which they met the project objectives. Only the most cost-effective options were considered further.
3. **Detailed Evaluation of Structural Options.** Structural best management practices (BMPs) for stormwater and combined sewage were subjected to a modeling analysis. Effects on runoff volume, overflow volume, peak stream velocity, and pollutant loads were evaluated at various levels of coverage.

Detailed evaluation of structural options (step 3) used the SWMM model to assess the effectiveness of each option and used planning-level cost estimates of each option. All options that had an effect on CSOs or stormwater-related pollutant loads were modeled at several degrees of implementation. Graphs of effectiveness versus degree of implementation were developed, and the results were then combined with more accurate cost estimates to provide guidance on selecting effective options or combinations of options.

2.2.7 Development of Target Approach for Meeting Goals and Objectives

In developing a recommended watershed management alternative and discussing goals and objectives with stakeholders, it became clear that implementation could best be achieved by defining three distinct targets to meet the overall plan objectives. Targets A and B were defined so that they could be fully met with a limited set of options that are fully implemented. Target C fit better with an adaptive management approach. In other words, it was agreed to set interim objectives, recommend measures to achieve the interim objectives, implement those controls, and reassess the capability to meet the objectives or agree to raise the bar to more complete achievement of the final objectives.

These three targets represent 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. The targets are specifically designed to help focus plan implementation.

By defining these targets, and designing the recommended alternative 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.

The targets for the Tookany/Tacony-Frankford Integrated Watershed Management Plan are defined as follows:

Target A: Dry Weather Water Quality and Aesthetics

Target A was defined for Tookany/Tacony-Frankford Creek with a focus on trash removal and litter prevention, and the elimination of sources of sewage discharge during dry weather. Streams should be aesthetically appealing (look and smell good), be accessible to the public, and be an amenity to the community. 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 on the Tookany/Tacony-Frankford Creek. These are also the times when the public is most likely to be near or in contact with the stream. The water quality of the stream in dry weather, particularly with respect to bacteria, should be similar to background concentrations in groundwater.

In many urban streams, monitoring indicates that the water quality rarely meets the standard for bacteria, and occasionally exhibits dissolved oxygen (DO) problems, even during baseflow or dry weather conditions. Thus, the first target focuses on dry weather water quality, coupled with the visual aesthetics of the stream, primarily the removal of trash and the elimination of illegal dumping so often associated with degraded, urban waterways. Target A also includes a range of regulatory and nonstructural options that address both water quality and quantity concerns. Because the options under consideration are aimed at the total elimination of dry weather sources of trash and sewage, virtually all options related to this target were included in the implementation plan.

Target B: Healthy Living Resources

Based on the results of the water quality monitoring, habitat assessment, and biological monitoring, water quality was not identified as the primary cause of the low diversity and impaired nature of the fish population in the stream. Improvements to the number, health, and diversity of the benthic macroinvertebrate and fish species in the Tookany/Tacony-Frankford Creek need to focus on habitat improvement and the opportunity 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.

Restoration will focus on improving channel stability, improving instream and riparian habitat, providing refuges for fish from high velocity conditions during storms, and managing land within the stream corridor. Restoration strategies include:

- Bank stabilization, including boulder structures, bioengineering, root wads, plantings, and log and woody structures;
- Bed stabilization, including rock/log vanes with grade control, rock/log cross vanes, and using naturally occurring boulders and bedrock;
- Realignment and relocation, used only on severely degraded stream sections;
- Dam and debris removal;
- Reforestation, with priority to floodplains, steep slopes, and wetlands;
- Invasive species management to increase biodiversity;
- Wetland creation, often used in conjunction with stream realignment to improve floodplain areas subject to annual flooding;
- Forest preservation;
- Fish holding areas, with low- to no-current zones created to provide fish with places to hold position during high flows.

Stream restoration measures to meet Target B were identified, and all options required to meet the target are planned for implementation.

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. Because wet weather conditions on Tookany/Tacony-Frankford Creek occur to some degree about 35-40% of the time during the year, measures to improve wet weather quality have a somewhat lower priority than measures designed to address dry weather water quality. During wet weather, extreme increases in streamflow are common, accompanied by short-term changes in water quality. Stormwater generally does not cause immediate DO problems.

A comprehensive watershed management approach must also address flooding issues. 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 eliminating all flooding. Meeting these goals will be difficult. It will be expensive and will require a long-term effort. The only rational approach to achieve this target must include stepped implementation with interim goals for reducing wet weather pollutant loads and stormwater flows, along with monitoring for the efficacy of control measures.

Initial load reduction targets for parameters such as metals, total suspended solids (TSS), and bacteria were set in conjunction with the stakeholders. Based on preliminary work by PWD, a 20% reduction is a challenging but achievable initial interim target.

It is expected that changes to the approach, and even to the desired results, will occur as measures are implemented and results are monitored. This process of continually monitoring progress and adjusting the approach is known as “adaptive management.” The NPDES permit programs for stormwater and CSO outfalls can lead to a cycle of monitoring, planning, and implementation that helps define a time frame to this process.

2.2.8 Implementation Plan

Implementation plan guidelines were developed to provide Philadelphia and the upstream municipalities with a blueprint for improving water quality and habitat conditions. The guidelines (detailed in Section 8) include:

- Specific recommendations and a schedule for meeting Target A objectives;
- Specific recommendations and a schedule for meeting Target B objectives;
- Guidance on which BMPs or mixes of BMPs are most effective in Tookany/Tacony-Frankford Creek for meeting Target C objectives;
- Guidance on the needed degree of implementation to achieve Target C objectives;
- Guidance on areas of the watershed where BMPs would be most effective;
- Recommendations on Target C options for the CSO areas and separate storm sewer areas;
- Planning level cost estimates for implementation.

Section 3
Goals and Objectives

This section describes the process for setting overall watershed goals for the TTFIWMP, as well as numerous objectives for helping to reach those goals. The seven prioritized goals, referenced throughout this document, are useful for evaluating the wide range of possible "management options" for implementing the plan.

Developing a focused and prioritized list of goals (general) and objectives (specific, measurable) is critical to a successful planning process. Goals and objectives need to be:

- initially developed by stakeholders and regulatory agencies;
- analyzed and informed by the watershed data collection, analysis, and modeling carried out by the project team;
- finalized by the project team and stakeholders;
- prioritized by the stakeholders.

3.1 Stakeholder Goal Setting Process

Considerable stakeholder input toward developing watershed goals was sought from the beginning of this planning effort. Responses were summarized, and additional stakeholder input organized through further contacts with the stakeholders.

Tookany/Tacony-Frankford Partnership Mission Statement

The mission for the Tookany/Tacony-Frankford planning effort, developed by the stakeholders, is to improve the environmental health and safe enjoyment of the Tookany/Tacony-Frankford 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 Tookany/Tacony-Frankford waterways and riparian areas. Watershed management seeks to mitigate the adverse physical, biological, and chemical impacts of land uses as surface and groundwater are transported throughout the watershed to the waterways. The TTF Partnership seeks to achieve higher levels of environmental improvement by sharing information and resources.

Goals of Related Studies and Programs

Other studies have already provided a list of goals. Generally, the goals in this section are those identified through the Rivers Conservation Planning process, supplemented by those goals that are required as a result of various environmental regulatory requirements. Additional goals identified in the Tookany/Tacony-Frankford stakeholder meetings were also included once consensus was established.

Existing goals included:

- Aquatic life designated use attainment goal (warm water fishery)
- Public health: Contact recreation (bacteria, noxious plants)
- Aesthetics: Visual and olfactory conditions (noxious plants, bank erosion, litter, odor, etc.)
- Riparian corridors
- Wetlands, woodlands, and meadows
- Wildlife
- Act 167 plan goals
- Act 537 goals
- TMDL-related goals
- NPDES program goals (including stormwater management and CSO control)
- Environmental Futures Program goals
- River Conservation Plan goals

3.2 Consolidated Watershed Planning Goals and Objectives

The large list of goals from the existing stakeholder process needed to be organized. This was accomplished by consolidating goals from various sources into a coherent set for the integrated plan. Other considerations included stakeholders' desire to restore the living resources, and the preference for achieving goals through innovative, land-based, low-impact, and cost-effective management options. Consensus was reached around the following seven goals. Under each goal, more specific objectives are listed.

Goal 1 – Streamflow and Living Resources. Improve stream habitat and integrity of aquatic life.

- Improve quantitative measures of fishery health.
- Improve quantitative measures of benthic macroinvertebrate quality.
- Adapt or develop quantitative measures of attached algae to assess current stream conditions.
- Improve migratory fish passage.
- Increase miles of stable stream banks and stream channels by reducing deposition and scour.

Goal 2 – Instream Flow Conditions. Reduce the impact of urbanized flow on living resources.

- Increase baseflow as a percentage of total flow.
- Increase groundwater recharge.
- Prevent increases in the stormwater flow peaks in future development/redevelopment areas.
- Reduce directly connected impervious cover in developed and new development areas.
- Revise municipal codes to encourage new development and redevelopment using responsible stormwater management techniques.
- Reduce the frequency of occurrence of bankfull flow.

Goal 3 – Water Quality and Pollutant Loads. Improve dry and wet weather stream quality to reduce the effects on public health and aquatic life.

- Develop a phased approach to meeting appropriate water quality criteria in dry weather and wet weather.
- Work with regulatory agencies to re-evaluate designated uses.
- Prevent fish consumption advisories.
- Decrease loads of targeted water quality parameters from stormwater.
- Identify and eliminate SSOs and storm sewer cross-connections.
- Minimize CSO volume and frequency.
- Decrease inputs of floatables, debris, and litter from all sources.
- Increase "Inflow & Infiltration" studies, sewer cleanings, and inspections.
- Eliminate septic tank failures.

Goal 4 – Stream Corridors. Protect and restore stream corridors, buffers, floodplains, and natural habitats including wetlands.

- Maximize open space and habitat by responsibly managing new development and redevelopment of existing, vacant, and abandoned lands.
- Inventory and protect existing wetlands.

- Identify and pursue opportunities for wetland enhancement and wetland creation for stormwater treatment.
- Improve floodplain conditions through restoration or improvement of the connections between streams and their floodplains.
- Protect and restore riparian and upland habitats along stream corridors with native species.

Goal 5 – Flooding. Identify flood prone areas and decrease flooding by similar measures intended to support Goals 1, 2, and 4.

- Reduce the effects and frequency of out-of-bank flooding through management of stormwater.
- Remediate stream-related flooding in known problem areas without increasing the problem in other areas.
- Increase regular storm drain maintenance and cleaning programs throughout the watershed.
- Incorporate sound floodplain management principles in flood planning.
- Minimize the effects of structural floodway and stream encroachments with regard to sediment load and natural streamflow.

Goal 6 – Quality of Life. Enhance community environmental quality of life.

- Increase community green and open space.
- Increase community access and recreational activities in city parks and streams (e.g., by increasing miles of greenways and trails along stream corridors).
- Increase the public sense of security along stream corridors (e.g., by lighting, signage, park maintenance, increased police presence).
- Improve and protect aesthetics along stream corridors (e.g., by litter/graffiti removal, enforcement against illegal practices such as dumping, controls on ATV use).
- Identify and protect historical and cultural resources along stream corridors.

Goal 7 – 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 public awareness of the value of streams to the community.
- Improve public, business, and institutional awareness of and accountability for activities that affect water quality.
- Encourage and support establishment of watershed organizations, EACs, and the like, to bear the watershed banner.
- Engage local officials and planners.
- Increase volunteer participation in implementing management options.
- Increase school-based education.

3.3 Goals Prioritization

The goals and objectives represent the collective ideas of the stakeholders on what the watershed management plan should achieve. Not all goals, however, are of equal importance. It is helpful to elicit from the stakeholders a collective opinion on the relative importance of each goal for the Tookany/Tacony-Frankford Watershed. Because the achievement of goals is a key aspect of measuring the effectiveness of the management plan, some numerical representation of the importance of each goal is useful.

To develop a set of numerical weights that represent the importance of each goal relative to the other goals, a workshop was held in May 2003, with participation from members of the partnership. The goal of the workshop was to drive towards a consensus on a numerical set of weights that best represent the collective opinion on the importance of each goal. Each participant filled in a worksheet weighting each of the seven goals with the percentage that described the individual contribution of each goal to the overall goal of watershed management. These sheets provided a variety of opinions on how the goals should be weighted, and served as a guide to a discussion on the relative importance of each goal. Through the group discussion, a consensus set of goal weights was developed that best represents the importance of each goal as defined by the stakeholders. Table 3.1 shows the weights assigned to each goal. The weights represent a percentage of the overall importance of each goal relative to all goals.

Table 3.1 Stakeholder Priorities as Weights for Goals

1. Streamflow and Living Resources. Improve stream habitat and integrity of aquatic life.	**15**
2. Instream Flow Conditions. Reduce the impact of urbanized flow on living resources.	**15**
3. Water Quality and Pollutant Loads. Improve dry and wet weather stream quality to reduce the effects on public health and aquatic life.	**20**
4. Stream Corridors. Protect and restore stream corridors, buffers, floodplains, and natural habitats including wetlands.	**15**
5. Flooding. Identify flood prone areas and decrease flooding by similar measures intended to support Goals 1, 2, and 4.	**5**
6. Quality of Life. Enhance community environmental quality of life (protect open space, access and recreation, security, aesthetics, historical/cultural resources).	**10**
7. Stewardship, Communication, and Coordination. Foster community stewardship and improve inter-municipal, inter-county, state-local, and stakeholder cooperation and coordination on a watershed basis.	**20**

The weights assigned to each goal were important in screening and evaluating the many possible alternative water management approaches to arrive at the recommended options.

The workshop participants also offered their opinions on the relative priority – high, medium, or low – of each of the objectives within the goals. A consensus building process was not attempted for all of the objectives, however, since these play a lesser role in the overall evaluation.

Section 4
Watershed Indicators: TTF Study Results

This section details the 21 measurable "watershed indicators" that were created in order to assess historic and current conditions, and to track progress as the TTFIWMP is implemented over time. The information presented can serve as a basis for understanding the state of the TTF Watershed, its relative environmental quality, and trends in the management of factors that influence its quality.

This section summarizes the results of the numerous recent studies of the Tookany/Tacony-Frankford Watershed. When available, results are included for the combined Montgomery County (Tookany) and Philadelphia County (Tacony-Frankford) portions of the watershed; however, several studies have provided more detailed information within Philadelphia. These assessments have identified problem areas for future focus, while establishing a "watershed baseline" from which we can measure our progress as recommendations are implemented. The 21 indicators fall into six broad categories, covered in the following sections:

4.1 The Land Use and Stream Health Relationship

Urbanization of natural lands affects watershed hydrology, water quality, stream stability, and ecology.

4.1.1 Indicator 1: Land Use and Impervious Cover

One of the primary indicators of watershed health is the percent of impervious cover in the watershed. Based on numerous research efforts, studies, and observations, a general categorization of watersheds has been widely applied to watershed management based on percent impervious cover (Schueler 1995). Table 4.1 summarizes several of the impacts of traditional development on streams and watersheds, most of which are created by the addition of impervious cover across portions of the land surface.

Table 4.1 Impervious Cover as an Indicator of Stream Health (Schueler 1995)

Characteristic	Sensitive	Degrading	Non-Supporting
Percent Impervious Cover	0% to 10%	11% to 25%	26% to 100%
Channel Stability	Stable	Unstable	Highly Unstable
Water Quality	Good to Excellent	Fair to Good	Fair to Poor
Stream Biodiversity	Good to Excellent	Fair to Good	Poor
Pollutants of Concern	Sediment and temperature only	Also nutrients and metals	Also bacteria

This indicator measures:

- **GIS-estimated impervious cover of each municipality (% of total area)**
- **Model-estimated Directly Connected Impervious Area (DCIA) of each subwatershed (% of total area)**
- **Open space in each municipality (% of total area)**
- **Publicly-owned land in each municipality (% of total area)**
- **Vacant land**

<u>Where We Were</u>:

By 1820, the majority of the woodland in the watershed had been cut down for use as fuel and for construction. After this time, the land use of the watershed began to change drastically. During the 1890s, there were transportation improvements which brought to the watershed new industries that were seeking to take advantage of the growing riverfront industrial community. Streets were laid, and roads, houses, churches, and stores were built. During the 19th and early 20th centuries, the Tookany/Tacony-Frankford Watershed became an industrial center for textile production. Many mills and factories were built in the flood plains of the stream and the tributaries. In the early 20th century, in order to protect the creek from further pollution, the City of Philadelphia set aside hundreds of acres of parkland along the creek, called the Fairmount Park System, which included Juniata Park and Tacony Creek Park in the Tacony-Frankford Watershed.

Since World War II, half a million people have left Philadelphia, which has increased the amount of vacant land within the city. The incentives for construction of single homes in the suburbs created a flight of people out of the city, leaving many building and lots vacant and untended. These abandoned properties decrease the value of homes within the neighborhood and are a drain on city resources.

<u>Where We Are</u>:
The geographic breakdown of land use within the Tookany/Tacony-Frankford watershed was displayed in Figure 2-2; the spatial distribution of land use is shown here in Figure 4.1. Land use within the watershed is predominantly residential (around 59% of total land use). Headwater regions located in Montgomery County are dominated by single-family residences (26.5% of the total watershed), while mid-portions of the watershed located in the City of Philadelphia are predominantly multi-family residential, such as row or cluster housing (32.9% of the total watershed). The lower portions of the watershed are characterized mainly by industrial facilities (4.9% of the total watershed) and multi-family residential. The section of Tookany/Tacony-Frankford Watershed within the City of Philadelphia is dominated by urban land uses. Furthermore, the lack of a well-defined riparian corridor and forested regions within the watershed is evident, with only 5.8% of land attributed to parklands and natural surfaces and 5.1% classified as wooded regions.

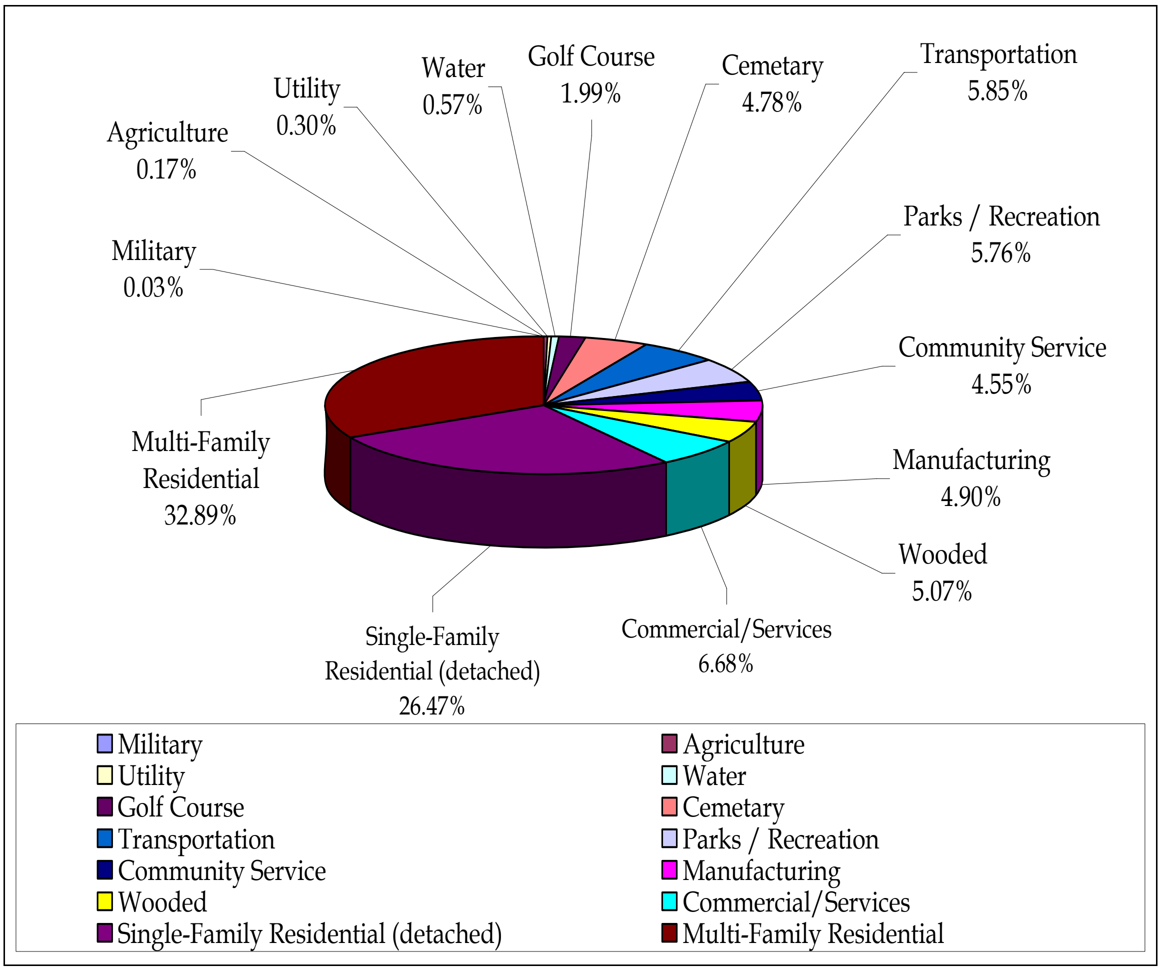


Figure 4.1 Land Use Breakdown in Tacony-Frankford Watershed

As seen in Table 4.2, Abington Township has the lowest percentage of impervious cover in the watershed, with just under 32% of their land within the watershed listed as impervious. Philadelphia has the highest percent impervious, with more than 47% of the land within the watershed listed as impervious. The entire watershed is at a level where stream channels are highly unstable, water quality is either fair or poor, and there is poor stream biodiversity (Table

4.1). Many of the pollutants associated with watersheds at this level of percent impervious cover include sediment, temperature, nutrients, metals, and bacteria.

Table 4.2 Breakdown of % Imperviousness by Municipality (within watershed boundaries)

Municipality	County	Total Area Within Watershed (acres)	% Impervious
Abington	Montgomery	2,661	31.9%
Cheltenham	Montgomery	5,609	32.6%
Rockledge	Montgomery	97	35.3%
Springfield	Montgomery	66	38.0%
Jenkintown	Montgomery	332	43.5%
Philadelphia	Philadelphia	12,161	47.3%

From the land use data, the part of each municipality that lies within the watershed was analyzed to determine the percentage of open space and publicly owned land. The watershed on a whole averages about 17% open space and 19% publicly owned land. As seen in Table 4.3, the amount of open space varies by municipality within the watersheds, with Jenkintown with as little as 3.5% open space and Rockledge with as much as 30% of their land within the watershed as open space. Included in our open space calculation were categories such as agriculture, cemeteries, golf courses, regional parks, urban recreation areas, water, wetlands, and wooded areas. The percentage of publicly owned land varied greatly depending on municipality, with the small portion of Springfield that lies within the watershed having 8% of this area publicly owned, while Rockledge had the most publicly owned land at almost 28% of the total acreage within the watershed. Publicly owned land included cemeteries, commercial, transportation, regional parks, urban recreation areas, water, and wetlands.

Table 4.3 Estimated Open Space and Publicly Owned Land

Municipality	County	Total Area Within Watershed (acres)	Publicly Owned (% of total)	Open Space (% of total)
Abington	Montgomery	2,661	17.2%	27.0%
Cheltenham	Montgomery	5,609	15.0%	23.6%
Rockledge	Montgomery	97	27.9%	30.6%
Springfield	Montgomery	66	8.1%	5.9%
Jenkintown	Montgomery	332	20.5%	3.5%
Philadelphia	Philadelphia	12,161	25.9%	14.4%

The City of Philadelphia began the Neighborhood Transformation Initiative (NTI) in 2001; the goal of the program is revitalizing Philadelphia neighborhoods. The NTI includes a vacant lot program that cleans and maintains vacant lots throughout the City. The program includes the removal of debris from vacant lots, and when possible, the transformation of some of them into green space. Through the NTI program, 31,000 of the City's vacant lots were cleaned at least once and 33,950 tons of debris was removed. Additionally, as of June 2003, the City had "greened" 470 vacant parcels of land (over 13 acres). Figure 4.2 displays the vacant lands within the Tookany/Tacony-Frankford Watershed. Another aspect of NTI is the demolition of dangerous vacant buildings. From 2000-2003, more that 4100 vacant buildings were demolished in Philadelphia.

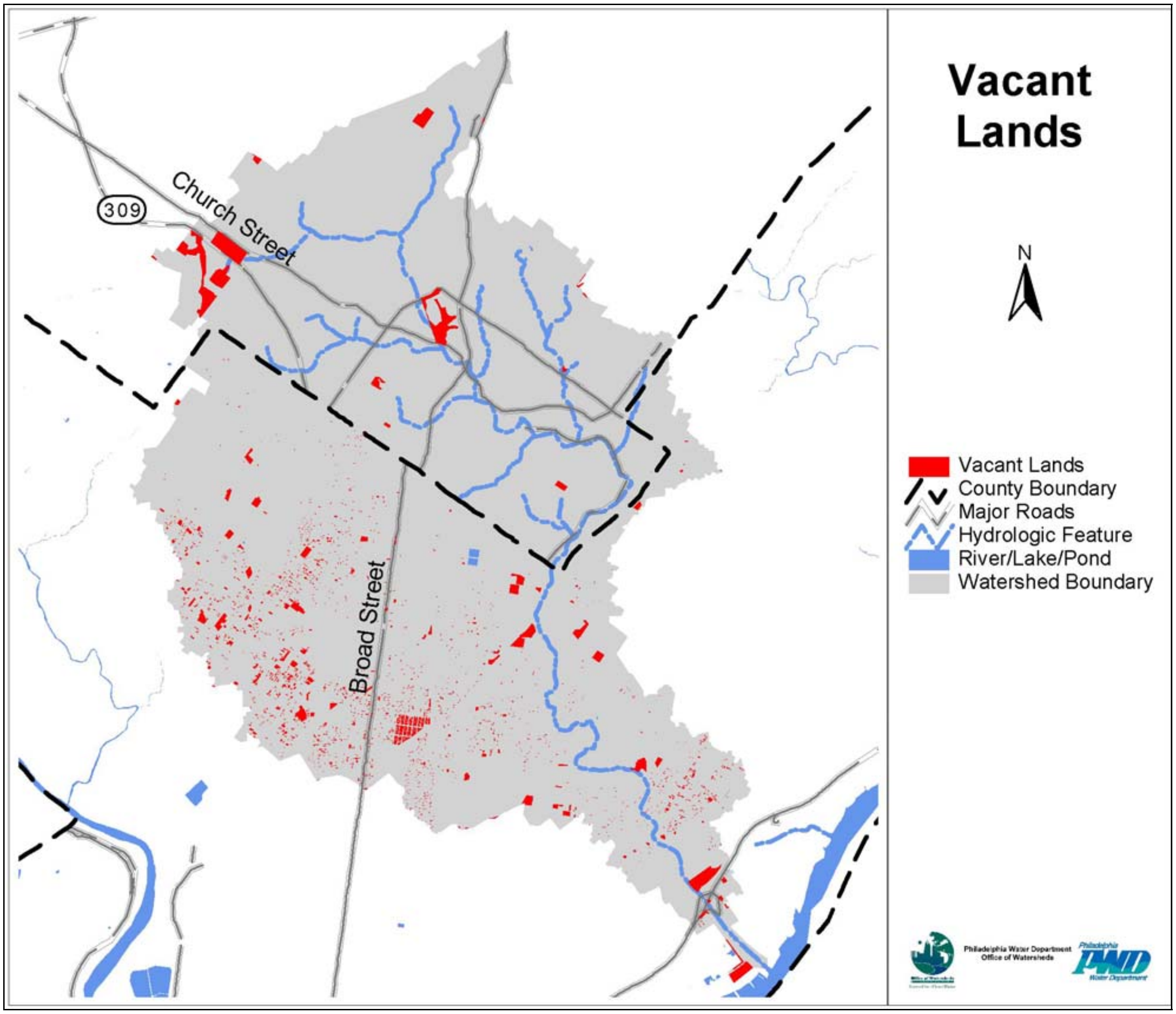


Figure 4.2 Vacant Lands in the Tookany/Tacony-Frankford Watershed

4.2 Flow Conditions and Living Resources

Urbanized land uses affect stormwater runoff, streamflow, the shape of stream banks and channels, water quality, and aquatic habitat and ecosystems.

4.2.1 Indicator 2: Streamflow

Increases in impervious cover affect stream hydrology in a variety of ways:

- Increased magnitude and frequency of severe floods;
- Increased frequency of erosive bankfull and sub-bankfull floods;
- Reduced groundwater recharge leading to reduced baseflow;
- Higher flow velocities during storm events.

This indicator measures:

- **Average annual baseflow (% of total flow)**
- **Average annual baseflow (% of annual precipitation)**
- **Average annual stormwater runoff (% of annual precipitation)**

As discussed in Indicator 1, the entire watershed is highly urbanized and contains a large proportion of impervious cover. The hydrologic impact of urbanization can be observed through analysis of streamflow data taken from USGS gauges on the Tacony-Frankford Creek. In addition, data from French Creek in Chester County provides a picture of a nearby, less-developed watershed to utilize for comparison as a "reference stream."

Where We Were:

The analysis below represents a long-term period of record for each stream gauge. It is difficult to establish a trend over time, but an attempt will be made when the watershed is reassessed.

Where We Are:

Streamflow data were separated into two main components: baseflow and stormwater runoff. In perennial streams, baseflow is the portion of streamflow caused by groundwater inflow and streamflow will be present in both dry and wet weather conditions. The stormwater runoff component is the portion of streamflow that is contributed during wet weather as a result of excess stormwater runoff flowing over the land surface and through the storm drainage system to the creek.

The results of a hydrograph decomposition analysis support the relationship between land use and hydrology discussed above. In Table 4.4, the results for the Tacony-Frankford Creek analysis are compared with that of French Creek, our unimpaired reference stream, and the Darby Creek, a stream in a mixed urban and suburban watershed similar to the Tookany/Tacony-Frankford. The table demonstrates how the three chosen statistics help describe the hydrologic condition of the streams, ranging from rural to highly urbanized. Results for French Creek are somewhat typical of an undeveloped watershed, with baseflow comprising 64% of mean annual streamflow and stormwater only 17% of annual precipitation.

Table 4.4 Summary of Hydrograph Separation Results over the Period of Record

	Baseflow (% of total flow)	Baseflow (% of precip.)	Stormwater Runoff (% of precip.)
French Creek 01475127	64	31	17
Darby Creek 01475510	62	34	21
Tacony Creek 01467086	58	29	21
Frankford Creek 01467087	38	17	27

The Frankford Creek gauge represents most of the urbanized area in the Tookany/Tacony-Frankford watershed. At this gauge, the stormwater component of streamflow is a much greater percentage of total annual streamflow (62%), and baseflow represents a much smaller percentage of total annual streamflow (only 38%). These results confirm that Tacony-Frankford is a highly urbanized stream. Figure 4.3 displays the hydrograph decomposition for the Frankford Creek USGS gauge for a six month period in 2000. The daily baseflow is estimated and plotted on top of the total flow. The area above the baseflow curve indicates the daily runoff. Storm events can be seen clearly by the peaks in runoff.

The Tacony Creek USGS gauge, representing the headwaters of the Tacony-Frankford watershed, exhibits behavior intermediate between the two extremes. However, the statistics suggest that it is more urbanized than the Darby Creek watershed, another urbanized watershed in Philadelphia.

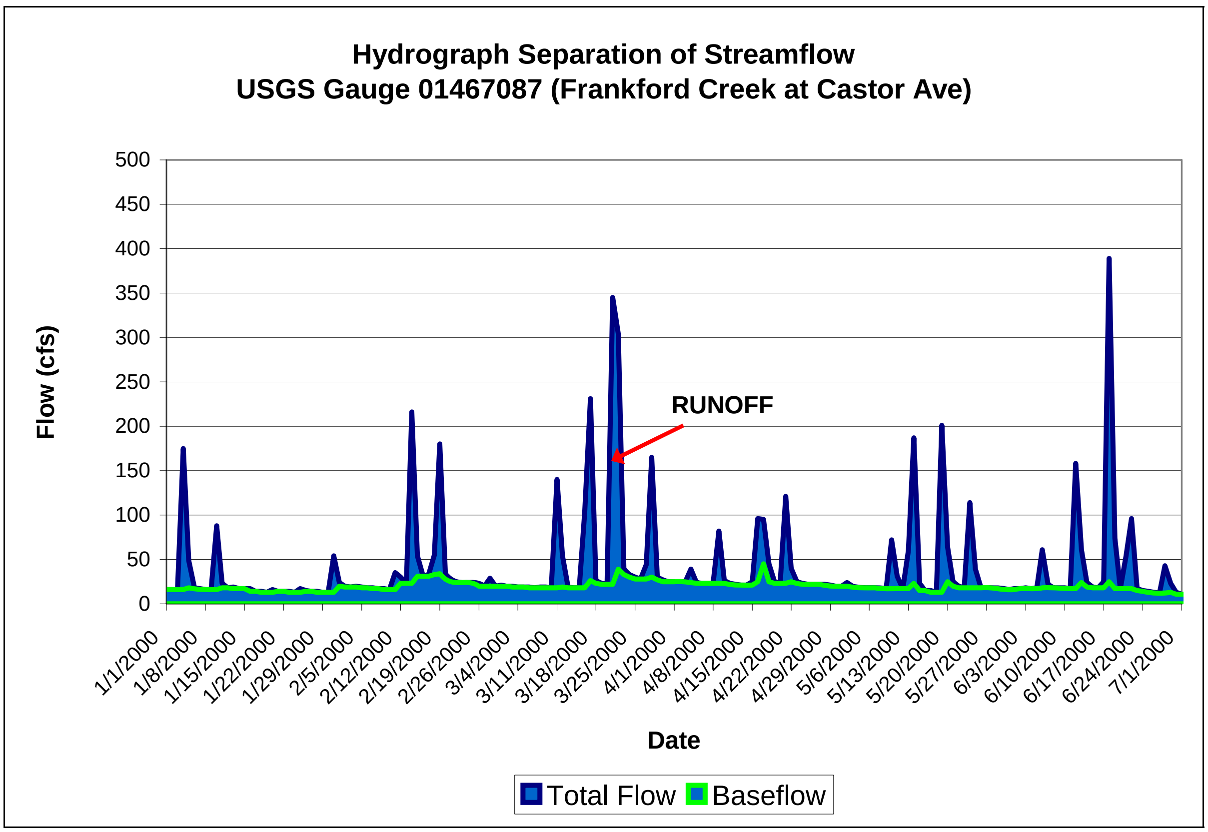


Figure 4.3 Hydrograph Separation at Frankford Creek gauge (USGS gauge 01467087)

4.2.2 Indicator 3: Stream Channels and Aquatic Habitat

Stream life (fish, invertebrates, and plants) require physical habitat features that allow them to feed, reproduce, and seek shelter during periods of high flow. In the urban environment where significant erosion and deposition occur, these areas often are not available (Figure 4.4).

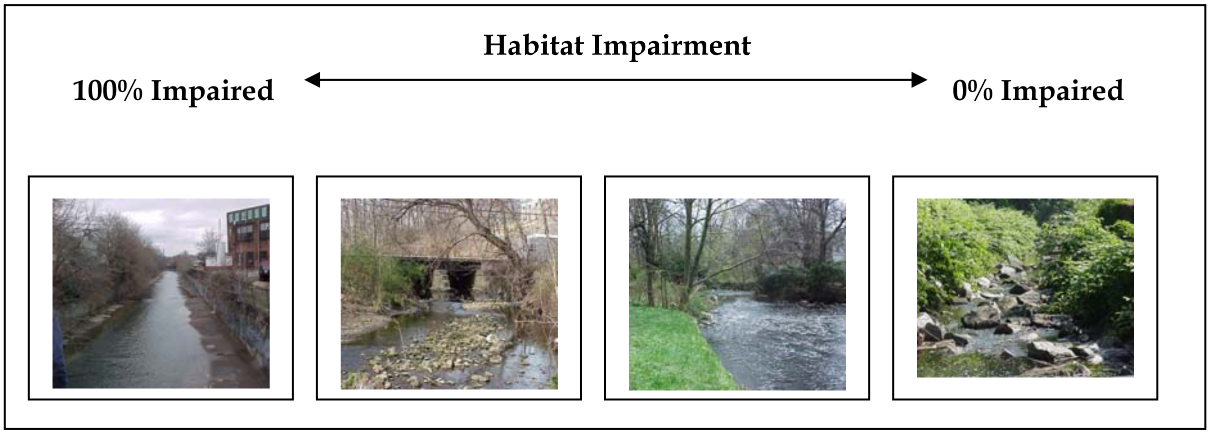


Figure 4.4 Photo Comparison of Impaired and Unimpaired Habitats

Fluvial geomorphology (FGM) is the study of landforms associated with river channels and the processes that form them. The Rosgen classification system was used to assess the physical channel conditions. The Rosgen classification system was developed by Dave Rosgen and assigns a channel type based on channel slope, width-to-depth ratio, bed material, entrenchment ratio, and sinuosity. This classification system is based primarily on the appearance of a stream in combination with a number of delineative criteria associated with the stream's morphology.

This indicator measures:

- **Habitat score relative to reference condition at various sites**
- **Channel type and expected trend**

<u>Where We Were</u>:
There is no historical data available for this indicator. Habitat and stream channels most likely degraded over a long period of time as development took place within the watershed. A trend will be established the next time this area is reassessed.

<u>Where We Are</u>:
Habitat assessments were performed at the seven sites where benthic macroinvertebrate community assessments were completed. Each site was assessed on habitat conditions for Epifaunal Substrate/Available Cover, Pool Substrate Characterization, Pool Variability, Sediment Deposition, Embeddedness, Velocity/Depth Regime, Frequency of Riffles (or bends), Channel Flow Status, Channel Alteration, Channel Sinuosity, Bank Stability, Vegetative Protection, and Riparian Vegetative Zone Width. Habitat assessments are scored in comparison with a healthy stream, as a percentage of the expected diversity found in an unimpaired reach. The results show two sites found to be "Partially Supporting," and the other five sites found to be "Non-Supporting"(Table 4.5 and Figure 4.5). This is a clear indication of the impacts of urbanization on the stream habitat.

Table 4.5 Habitat Assessment Scores

Site	Score	Percent Comparison	Assessment Category
TF 280	108.5	52%	Non-Supporting
TF 500	97	47%	Non-Supporting
TF 620	147.5	71%	Partially Supporting
TFM 000	91	44%	Non-Supporting
TF 975	122	59%	Non-Supporting
TF 1120	120.5	58%	Non-Supporting
TFJ110	128	70%	Partially Supporting

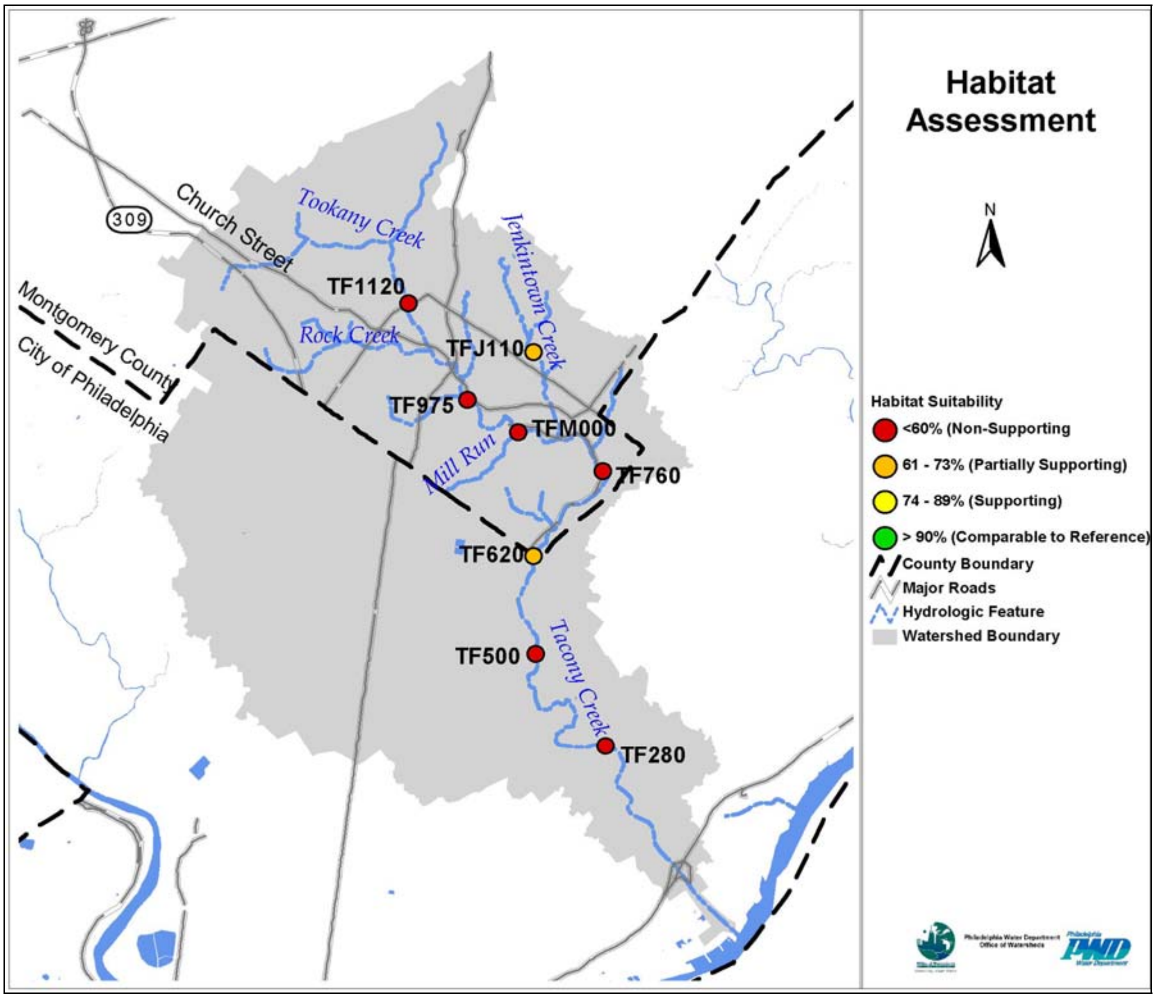


Figure 4.5 Tookany/Tacony-Frankford Watershed Habitat Assessment

4.2.3 Indicator 4: Restoration and Demonstration Projects

Funding for watersheds and water–related projects has been increasing throughout the country in recent years. Grants are being issued to complete various types of projects throughout the state of Pennsylvania. The Growing Greener program has been an enormous source of environmental funding over the last few years and has become the largest single investment of state funds in Pennsylvania's history. There are also many other organizations and governmental agencies offering grant money and technical assistance for communities and other associations to accomplish their environmental projects for improving our watersheds. Figure 4.6 is one example of a stream reach that is planned for eventual restoration.

This indicator measures:

- **Lists of completed, in progress, and planned projects**

Figure 4.6 Streambank Restoration in the Tookany/Tacony Frankford Creek

Where We Were:

There is no historical data available for this indicator. The number of restoration and other environmental projects in this watershed has increased with the introduction of the Growing Greener program and other funding programs.

Where We Are:

There has been a flurry of environmental projects in the Tookany/Tacony-Frankford Watershed over the past few years. There has been an influx of grant monies from programs such as the Growing Greener Program and the League of Women's Voters. The types of projects that are underway or have been completed include wetlands assessment, technical assistance, demonstration projects, education, watershed planning, property acquisition, and restoration projects. A list of many of the grants for environmental projects in the Tacony-Frankford Watershed issued from 1999 to 2004 has been assembled. Table 4.6 represents a profile of the grants received and the projects being performed. The list includes 20 projects either completely or partially in the watershed with a total amount of over $1.7 million in grants received.

One example project conducted by the TTF Partnership was the Rain Barrel Implementation Project. This project demonstrated the use of rain barrels as a method to reduce stormwater runoff. The rain barrel project enlisted members of the communities in and around Philadelphia, as well as several environmental organizations to install rain barrels on their personal property or on the property of their organization. This project included an educational component that consisted of instruction on the assembly and maintenance of the rain barrel, as well as the uses and benefits. The primary goal was to implement an individual "property-level" Best Management Practice (BMP) to help reduce the volume of stormwater reaching the receiving stream and to increase the length of time it takes the stormwater to reach the receiving stream.

Table 4.6 Grants Awarded in the Tookany/Tacony-Frankford Watershed

Funding Agency	Funding Program	Year	Lead Agency	Project Title	Amount Awarded	Project Description
PA League of Women Voters	Watershed Education for Pollution Prevention Projects	1999	Awbury Arboretum	Tacony- Frankford Watershed Lesson	$3,000	To develop a watershed education program, including brochures and lessons plans, about the Tacony-Frankford Watershed. The program will include the theme of Backyard Conservation and will be targeted at school age children who visit Awbury Arboretum.
DCNR	Rivers Conservation Program	1999	Cheltenham Township	Tookany Creek River Conservation Plan	$25,000	To prepare a River Conservation Plan for the Tookany Creek watershed from its headwaters to the Montgomery/Philadelphia county line.
DEP	Growing Greener	1999	Awbury Arboretum	Tacony-Frankford watershed education initiative	$13,000	To implement a new watershed-protection education initiative which aims to greatly increase the public's awareness of the Tacony-Frankford Watershed.
DCNR	Rivers Conservation Program	2001	Philadelphia Water Department	Tacony-Frankford Watershed River Conservation Plan	$100,000	To develop a River Conservation Plan for the Philadelphia County portion of the Tacony-Frankford watershed.
EPA	Five Star Restoration Challenge Grant Program	2001	Township of Cheltenham	Tookany Park Streambank Restoration	$15,000	The project will revitalize and restore one section of flood-ravaged Tookany Creek. Along with this comprehensive creekside restoration, the project will develop watershed information and a training manual for middle school students about issues related to the Tookany Creek Watershed. Partial funding for this grant is provided by Lockheed Martin Corporation.
DCNR	Growing Greener	2001	Fairmount Park Commission	Acquisition of the Delaware River/ Kensington Tacony Trail	$350,000	To acquire 16 acres of rail line property to develop the Delaware River/Kensington Tacony Trail.
DEP	Growing Greener	2002	Awbury Arboretum	Awbury Arboretum watershed restoration project	$42,000	This project will redirect stormwater runoff from adjacent properties; remove obstructions to the flow from two natural springs; daylight a stretch of stream; enhance existing meadow; and restore degraded areas with native plantings.

Funding Agency	Funding Program	Year	Lead Agency	Project Title	Amount Awarded	Project Description
DEP	Growing Greener	2002	Philadelphia Water Department	Rain barrel Implementation project	$28,000	To install rain barrels on properties of the communities comprising the Tacony-Frankford Watershed as a method of reduction of stormwater runoff. This project includes an educational component that consists of instruction on the assembly and maintenance of the rain barrel, as well as the uses and benefits.
EPA	Five Star Restoration Challenge Grant Program	2002	Township of Cheltenham	Tookany Park Streambank Restoration II	$10,000	The project will continue efforts to revitalize and restore one section of flood-ravaged Tookany Creek. Along with this comprehensive creekside restoration, the project will develop watershed information and a training manual for middle school students about issues related to the Tookany Creek Watershed. Partial funding for this grant is provided by EPA Region III and Lockheed Martin Corporation.
NFWF	Foundation Grants	2002	Township of Cheltenham	Tookany Park Streambank Restoration	$10,000	Continue efforts to revitalize and restore one section of flood-ravaged Tookany Creek in Pennsylvania. Project will also develop a watershed information and a training manual for middle school students about issues related to the Tookany Creek watershed.
DEP - CZM	CNPP	2002	Pennsylvania Environmental Council	Kensington & Tacony Trail Pre-Acquisition & Development	$50,000	Complete all pre-acquisition activities as well as develop appropriate communications and stakeholder educational materials describing the importance of the trail for recreational activity and coastal zone access.
DEP	Growing Greener	2003	Township of Cheltenham	Streambank restoration on Tookany Creek	$100,000	Streambank restoration on Tookany Creek.
DEP	Growing Greener	2003	Philadelphia Water Department	Restore Tacony Creek using natural channel design	$25,000	The primary goal of this project is to identify and document existing stream conditions of the Tacony Creek stream corridor near Whitaker Avenue in Northern Philadelphia.
DEP - CZM	CNPP	2004	Township of Cheltenham	Tookany Creek stabilization and restoration	$50,000	For stabilization and restoration of 3,900 feet of streambank along the Tookany Creek in a Cheltenham Township riparian park. The project will use bioengineering techniques and non-structural best management practices.
DEP	Act 167	2002	Philadelphia Water Department	Tacony-Frankford Act 167 SW Plan Phase I	$15,000	Preparation and submission of a Scope of Study to DEP for a watershed stormwater plan.
EPA	Wetland Program Development Grants	2002	Philadelphia Water Department	Southeast Regional Wetland Inventory and Water Quality Improvement Initiative	$250,000	This project is to expand Philadelphia Water Department's existing wetland inventory and assessment program to define opportunities for wetland protection and enhancement for four watersheds in the Southeast region of the commonwealth of Pennsylvania. *(includes other watersheds)*

Funding Agency	Funding Program	Year	Lead Agency	Project Title	Amount Awarded	Project Description
DEP	Act 167	2004	Philadelphia Water Department	Tacony-Frankford Act 167 SW Plan Phase II	$363,000	Preparation and adoption of the detailed watershed stormwater plan; includes modified Level 2 FGM assessment.
DEP	Growing Greener	2003		Norris Square Civic Association Mercado	$140,000	Build a green roof and rain garden at the Mercado.
USACE	Southeastern Pennsylvania Environmental Assistance Program	2000	City of Philadelphia	Logan Sinking Homes Study	$150,000	Sinking homes in the Logan neighborhood – The focus of the project was to gather and develop data to perform a preliminary analysis of the potential magnitude, extent, and scope of the problem and its possible causes.
DEP	Growing Greener	2003	City of Philadelphia	Technical Assistance Grant	$232,000	This project provides a wide range of assistance to community-based conservation efforts in urban settings of Southeastern Pennsylvania. *(includes other watersheds)*
					$1,739,000	

4.2.4 Indicator 5: Fish

Fish are good indicators of stream health because their presence requires favorable environmental conditions within a certain range of streamflow, water temperature, water quality, and channel habitat. Abundance and diversity of fish are indicators of good water quality. The number of pollution tolerant fish and the presence of fish with abnormalities will indicate degraded or poor water quality. Having a large percentage of the fish population made up of pollution tolerant species is undesirable because it is an indication of habitat deterioration and water quality degradation.

This indicator measures:

- **Abundance and pollution tolerance of species found at various sites**
- **Fish community integrity relative to reference condition at various sites**
- **Whether stream meets criteria for trout-stocking**

<u>Where We Were</u>:
There is no historical data available for this indicator. A trend will be established the next time this area is reassessed.

<u>Where We Are</u>:
A biological assessment of the Tookany/Tacony-Frankford Watershed was completed in 2001 by the Philadelphia Water Department, with fish assessments at four locations on the main stem of the creek. The biological assessment locations are named according to river mile (where TF 0 is where the Tookany/Tacony-Frankford meets the Delaware River, and TF 280 is 2.8 miles upstream from that point), and the four locations with fish assessments completed are TF 280, TF 620, TF 975, and TF 1120. The fish assessments looked at a variety of quantitative and qualitative analyses including species richness, species diversity, trophic composition relationships, pollution tolerance levels, Modified Index of Well-Being (MIWB), biomass per unit area, and species descriptions.

The pollution tolerance metric identifies the abundance of tolerant, moderately tolerant and pollution intolerant individuals at the study site. Figure 4.7 shows the percentage of the total number of fish at each site, by their tolerance level. Both pollution tolerant and moderately tolerant species were found at each site, with pollution tolerant species being the predominant at every site. No pollution intolerant species were found during the fish assessment.

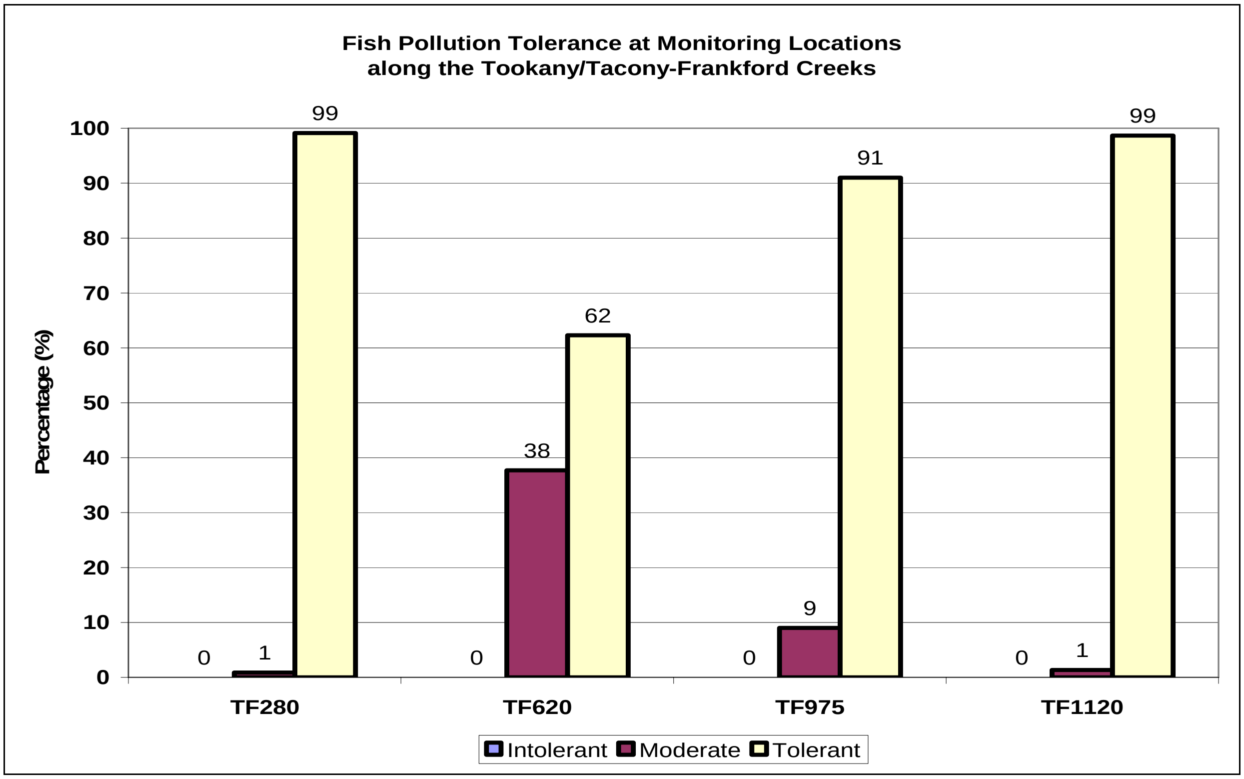


Figure 4.7 Fish Tolerance at Specific Monitoring Sites

Also, sites were classified based on their fish community integrity and compared to a reference condition. On a rating scale of poor, marginal, fair, and optimal, sites TF 280 and TF1120 received ratings of poor and sites TF 620 and TF 975 received ratings of marginal (Figure 4.8). Follow-up baseline assessments are planned every five years for this watershed, with the latest assessment completed in 2005, to be revisited next in 2010.

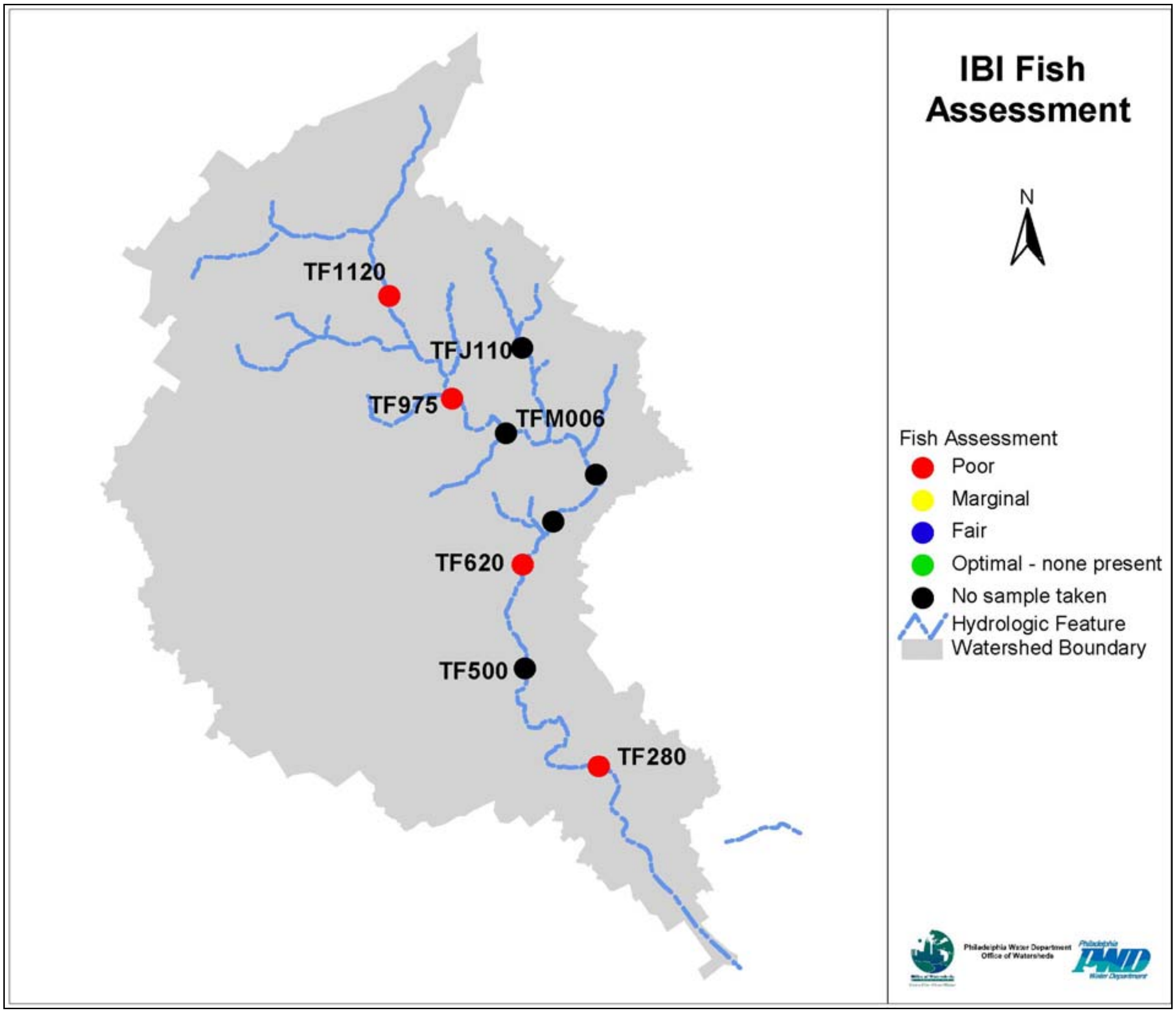


Figure 4.8 Tookany/Tacony-Frankford Fish Assessment (Philadelphia Water Department, 2001)

There were a total of 14 different species found in the watershed, some in more abundance then others. A breakdown of the relative abundance of each species at each assessment site can be seen in Figure 4.9, along with the pollution tolerance category of each fish species.

Pennsylvania Fish and Boat Commission biologists are continuously monitoring the Commonwealth's waters and adding and removing lengths of streams to be trout-stocked. Factors to determine whether a stream is stocked are water quality, public access, use, and a variety of other factors. There are no stream lengths in the Tookany-Tacony-Frankford Watershed that meet the criteria qualifying them to be stocked with trout by the Fish & Boat Commission.

	Site #					
Species	**TF 280**	**TF 620**	**TF 975**	**TF 1120**	**Pollution Tolerance**	**Picture**
American Eel	R	R	R	R	M	
Common Shiner	N	R	R	N	M	
Redbreast Sunfish	N	R	N	N	M	
Spottail Shiner	N	R	R	N	M	
Swallowtail Shiner	N	R	N	N	M	
Bluegill	N	R	N	N	M	
Satinfin Shiner	N	R	C	A	M	
Banded Killifish	R	R	N	N	T	
Blacknose Dace	N	R	C	A	T	
Brown Bullhead Catfish	R	R	N	N	T	
Creek Chub	N	N	R	R	T	
Fathead Minnow	N	R	N	N	T	
Mummichog	A	N	N	N	T	
White Sucker	N	C	C	N	T	

Species Abundance	**Symbol**	%
Abundant	A	60% -100%
Common	C	30% - 60%
Rare	R	0% - 30%
None	N	0
Pollution Tolerance	**Symbol**	
Moderate	M	
Tolerant	T	

Figure 4.9 Fish Types and Abundance

4.2.5 Indicator 6: Benthic Macroinvertebrates

The community of organisms on the bottom of water bodies is a good indicator of long-term water quality and the overall health of an aquatic system. Organisms inhabiting the stream bottom play roles in the aquatic ecosystem similar to the ones terrestrial small plant and animal species play in land-based communities. Benthic macroinvertebrate communities respond to changes in the aquatic environment and often provide an indication of concerns or evidence of successful restoration projects. Figure 4.10 is an example of a benthic macroinvertebrate.

This indicator measures:

- **State designation of attained and unattained reaches**
- **Benthic macroinvertebrate community integrity relative to reference condition at various sites**

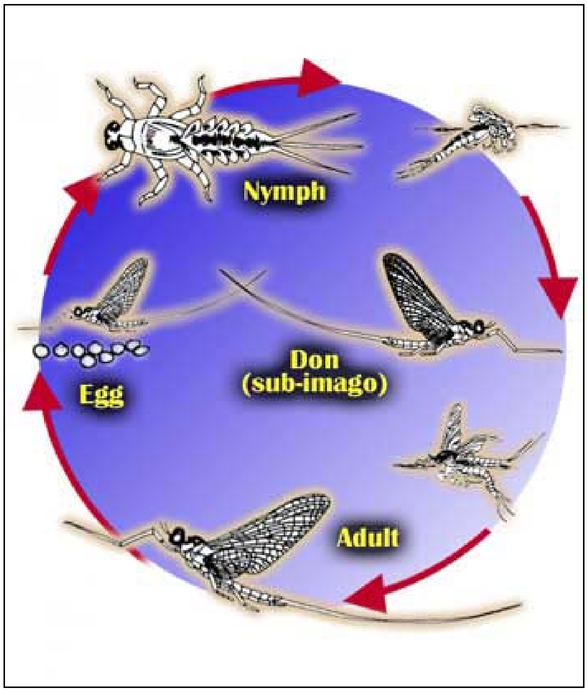


Figure 4.10 Life Cycle of a Mayfly

<u>Where We Were</u>:

There is no historical data available for this indicator. A trend will be established when this area is reassessed.

<u>Where We Are</u>:

The Pennsylvania DEP assesses the water quality of water bodies throughout the state and categorizes them according to their water quality status attainment. The assessments are found in the Pennsylvania Integrated Water Quality Monitoring and Assessment Report. Water bodies that do not meet water quality standards are designated as "impaired" and those that meet the designated water quality standards are designated as "attained."

Table 4.7 summarizes the impairments for the Tookany/Tacony-Frankford Creek. The tidal portion of the watershed, Frankford Creek (4.11 miles), has not been assessed since it is not wadeable, and therefore has no established procedure for assessment. The remaining streams in the watershed, including the main branch Tacony, Jenkintown, and East Branch Jenkintown Creek, all were placed in the category of "Streams Impaired by Pollution Not Requiring a TMDL." Figure 4.11 shows the delineation of the sections identified as attained, not attained (impaired), and unassessed. The streams were assessed for aquatic life, and the main source for impairment was identified as Urban Runoff/Storm Sewers. The main causes for impairment were identified as Flow Alterations, Other Habitat Alterations, and Water/Flow Variability.

Table 4.7 Descriptions of Impairment Causes and Sources (from the Commonwealth Of Pennsylvania Assessment and Listing Methodology for the 2004 Integrated Water Quality Monitoring and Assessment Report)

Impairment Cause / Source	Description
Urban Runoff / Storm Sewers	Runoff from impervious or urban areas to surface waters from precipitation, snowmelt, and subsurface drainage, and may be conveyed by storm sewers. The most obvious probable causes of impairment associated with this source are habitat removal caused by bank erosion, or streambed scouring, or smothering of habitat by siltation. Other probable causes are oils and grease, metals, pathogens, and nutrients.
Flow Alterations	Changes in hydrologic regime as a result of water regulation (including dams without or with insufficient minimum releases), or dewatering as a result of bedrock fracturing from mining activities, or lack of base flow due to reduced rain water infiltration in urban areas, or reduction in base flow caused by ground water withdrawals.
Other Habitat Alterations	Habitat changes due to severe bank erosion, removal or lack of riparian vegetation, and concrete channels and streambeds.
Water / Flow Variability	Changes in hydrologic regime caused by water releases, increased surface runoff from impervious surfaces during storm events, scouring, and drought. Results in unstable environment for macroinvertebrates and fishes. Habitat alterations include stream widening, substrate paving, shallower pools, etc.

The biological assessment of the Tookany/Tacony-Frankford Watershed completed in 2000-2001 by the Philadelphia Water Department looked at macroinvertebrates in the streams and collected data which led to a biological condition score. The macroinvertebrate assessments took place at all seven monitoring sites in the watershed, identified as TF 280, TF 500, TFM0000, TF 620, TF 975, TFJ 110, and TF 1120. Each site is given a biological score based on conditions in the stream – such as Taxa Richness, Taxa Comparison, Hilsenhoff Biotic Index (modified), Modified EPT Taxa, Percent Modified Mayflies, Dominant Family, Ratio of Scrapers/ Filter Collectors, Ratio of Shredders/Total, Community Loss Index, Biological Quality, Biological Assessment, Habitat Quality, and Habitat Assessment – and then compared to a reference stream. Every site in this watershed received a rating of either moderately impaired or severely impaired (Figure 4.11 and Table 4.8). The impaired benthic macroinvertebrate community is a result of habitat deterioration and episodic water quality degradation throughout the entire watershed. Increases in flow, sediment deposition, and scouring in the Tacony-Frankford Creek have impeded reproductive and feeding strategies of many species of macroinvertebrates.

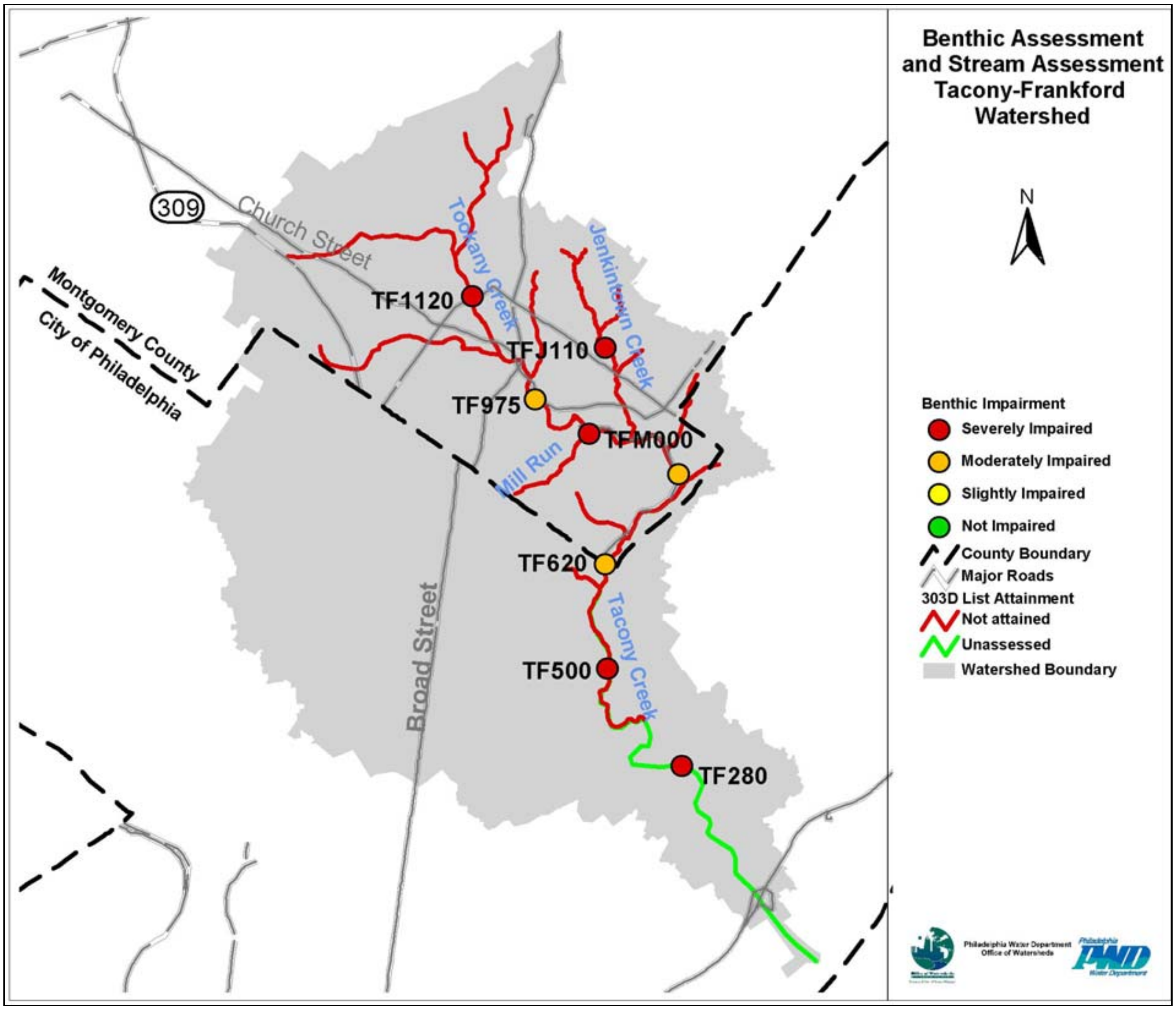


Figure 4.11 Benthic Macroinvertebrate Community Assessment Sites and Impaired Reaches

Table 4.8 Biological Condition Category as Percent Comparison to a Reference Score

% Comparison to Reference Score *	Biological Condition Category	Attributes
>83%	Nonimpaired	Comparable to the best situation within an ecoregion. Balanced trophic structure. Optimum community structure for stream size and habitat quality.
54-79%	Slightly impaired	Community structure less than expected. Species composition and dominance lower than expected due to loss of some intolerant forms. Percent contribution of tolerant forms increases.
21-50%	Moderately impaired	Fewer species due to loss of most intolerant forms. Reduction in EPT index.
<17%	Severely impaired	Few species present. If high densities of organisms, then dominated by one or two taxa.

** Scores that fall between score ranges are assigned based on best professional judgment*

4.3 Water Quality

The following three indicators for assessing watershed health and tracking changes concern factors that influence water quality conditions.

4.3.1 Indicator 7: Effects on Public Health (Bacteria)

Fecal contamination may originate from both human and animal sources and poses a threat to human health. Stormwater runoff transports waste from pets, livestock, and other animals to surface waters. Wet weather sewer overflows (SSOs and CSOs) introduce domestic wastewater constituents to surface water. Illegal or accidental cross-connection of sanitary sewers to storm sewers may also result in discharges of raw wastewater to the creek. Additionally, septic systems release some bacteria to surface waters, but these inputs are generally small.

Fecal coliform bacteria are abundant in the intestines of warm blooded animals, including humans. Fecal coliform is a fairly accurate indicator of harmful bacteria in natural water, drinking water, and wastewater. Measures taken to reduce the input of fecal coliform to natural waters are likely to reduce other microorganisms found in sewage and surface runoff as well.

The water quality standard for fecal coliform is as follows: during the swimming season (May through September), the maximum level shall be a geometric mean of 200 per 100 mL based on five consecutive samples, each collected on a different day; for the remainder of the year, the maximum level shall be a geometric mean of 2000 per 100 mL based on five such samples.

This indicator measures:

- **Percent of fecal coliform samples meeting state standards at various sites**

Where We Were:
Approximately 100 samples of fecal coliform were taken between 1970 and 1980 at five different sites. For samples taken in the headwaters in Tacony and Jenkintown Creeks, approximately one-half to two-thirds met the current standard. For samples taken in Rock Creek and on the main stem at the Philadelphia-Montgomery county line, only one-quarter of the samples met the standard. At the most downstream site at Castor Avenue, less than 15% of samples taken met the standard. Conditions under wet weather are not significantly worse than dry weather, suggesting that dry weather inputs were the main source of bacteria in the stream.

Where We Are:
Samples were collected between June 2000 and October 2003 at seven sites in the watershed. Table 4.9 compares the data collected to water quality standards. At each of three of the seven sites, roughly half of dry weather samples met the standard. At the remaining four sites, no more than one-quarter of dry weather samples met the standard. And in wet weather, fewer than one-tenth of all samples taken at each of the seven sites met the water quality standard.

The two sites on the lower main stem were sampled in both the historical and 2000–2003 periods and can be directly compared. Over time, the percent of samples meeting the standard in dry weather improved slightly at both the main stem county-line site and the Castor Avenue site. There was a decrease in the percentage of samples meeting the standard from the historical data to current data at the two main stem sites, suggesting that wet weather conditions may have declined over time.

Table 4.9 Percent of Samples Meeting Bacteria Standards

Site	Percent of Samples that Meet the Standard					
	Historical			Current		
	All Data	Dry Weather	Wet Weather	All Data	Dry Weather	Wet Weather
19	60%	67%	50%			
18	55%	67%	38%			
7	27%	29%	24%			
8 / TF620	35%	39%	29%	24%	44%	9%
9 / TF280	13%	14%	12%	12%	23%	6%
TF1120				8%	18%	3%
TF500				26%	45%	8%
TF760				29%	50%	8%
TF975				10%	25%	3%
TF680				2%	8%	0%

Criteria			
Lower Limit		Upper Limit	
67%	<= % meeting <=	100%	GREEN
33%	<= % meeting <=	67%	YELLOW
0%	<= % meeting <=	33%	RED

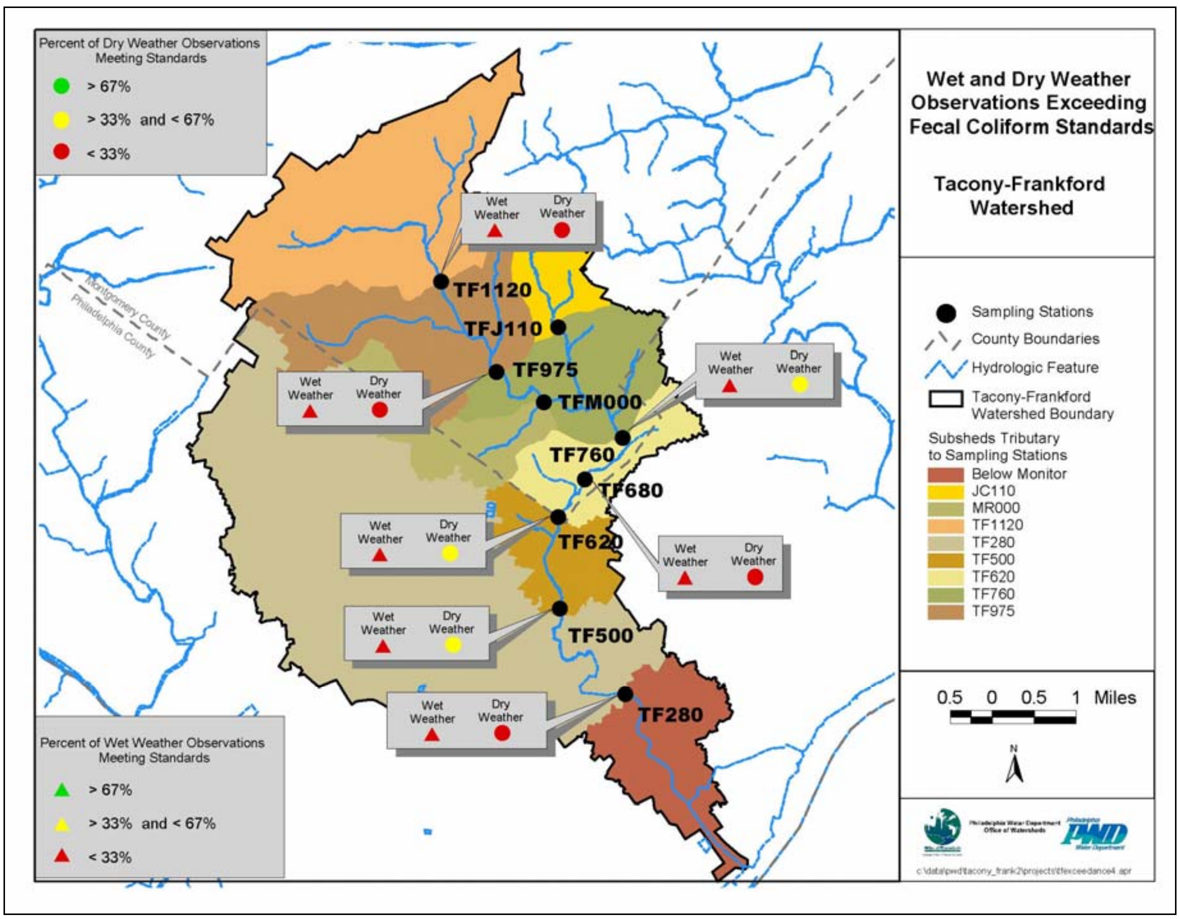


Figure 4.12 Current Water Quality Data for Fecal Coliform

4.3.2 Indicator 8: Effects on Public Health (Metals and Fish Consumption)

Toxic substances, including metals (such as mercury) and organic substances (such as PCBs), are sometimes introduced into the aquatic environment due to human activity. These substances exist in some sediments as a result of historical discharges, are introduced to the atmosphere through burning of fossil fuels, and are deposited on the land surface through industrial and transportation activities. Precipitation and surface runoff introduce small concentrations of these substances to surface waters. Over time, fish ingest the toxic chemicals from the water they live in and the food they eat, in some cases developing harmful concentrations in their tissues. Because toxic substances in the environment can affect aquatic life and humans who eat fish, the PA DEP has set maximum allowable concentrations for the water column. The standards based on aquatic life protection are generally strict. In addition, the DEP samples fish tissue and issues advisories designed to warn the public about species that may contain toxic chemicals. These contaminants can build up in the human body over time, possibly leading to health effects.

This indicator measures:

- **Areas with fish consumption advisories (graphical)**
- **Percent of aluminum (Al), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), and zinc (Zn) samples meeting state standards at various sites**

Where We Were:

Pennsylvania updates its fish consumption advisories at least yearly. Table 4.10 shows the Fish Consumption Advisory for 2003. This advisory applies only to tributaries of the Delaware River such as the Tacony-Frankford, only to the head of tide, which can be seen on Figure 4.13.

Table 4.10 Commonwealth of Pennsylvania Public Health Advisory – 2003 Fish Consumption

Water Body	Area Under Advisory	Species	Meal Frequency	Contaminant
Delaware River and Estuary, including all tributaries to head of tide and the Schuylkill River to the Fairmount Dam (Bucks, Philadelphia, and Delaware counties)	Yardley to PA/Delaware state line	White perch, Flathead catfish, Striped bass, Carp	1 meal/month	PCB
		Channel catfish	6 meals/year	PCB
		American eel	Do Not Eat	PCB
		Smallmouth bass	2 meals/month	Mercury

Historical information on concentrations of toxins in fish tissue is not readily available. Data on some metals was collected in the 1970s, and can be compared to current water quality standards. Approximately 60 samples were collected at each of three sites between 1970 and 1980 for lead, cadmium, chromium, copper, and zinc together. Metals concentrations frequently exceeded standards at the observation sites, in both dry and wet weather. With the exception of Site 7 during wet weather, which met the standard 82% of the time, samples from all three sites during both dry and wet weather only met that standard roughly 50-60% of the time (Table 4.12).

Where We Are:

The 2004 Fish Consumption Advisory (Table 4.11) recommended limiting consumption of white perch, flathead catfish, striped bass, carp, channel catfish, and American eel due to PCB contamination in an area that includes the Tacony-Frankford Creek, up to the head of tide (area below TF 280, Figure 4.13). The only change seen from the previous year's advisory was that an advisory for mercury in smallmouth bass was lifted.

Table 4.11 Commonwealth of Pennsylvania Public Health Advisory – 2004 Fish Consumption

Waterway	Area Under Advisory	Species	Meal Frequency	Contaminant
Delaware River and Estuary, including the tidal portion of all PA tributaries and the Schuylkill River to the Fairmount Dam (Bucks, Philadelphia, & Delaware Co.)	Yardley to PA/Delaware state line	White perch, flathead catfish, striped bass, carp	1 meal/month	PCB
		Channel catfish	6 meals/year	
		American eel	Do Not Eat	

Samples collected between June 2000 and October 2003 at seven sites were tested for aluminum, cadmium, chromium, copper, lead, and zinc (Figure 4.13 and Table 4.12). At each site, at least 90% of dry weather samples met the standard for each metal, with the exception of copper at two sites; 100% of samples met the dry weather standard for lead and cadmium; and at two upstream sites, every sample met all dry weather metal standards. Wet weather data varied from site to site and for the individual metals, but the samples usually met the standard less than 90% of the time.

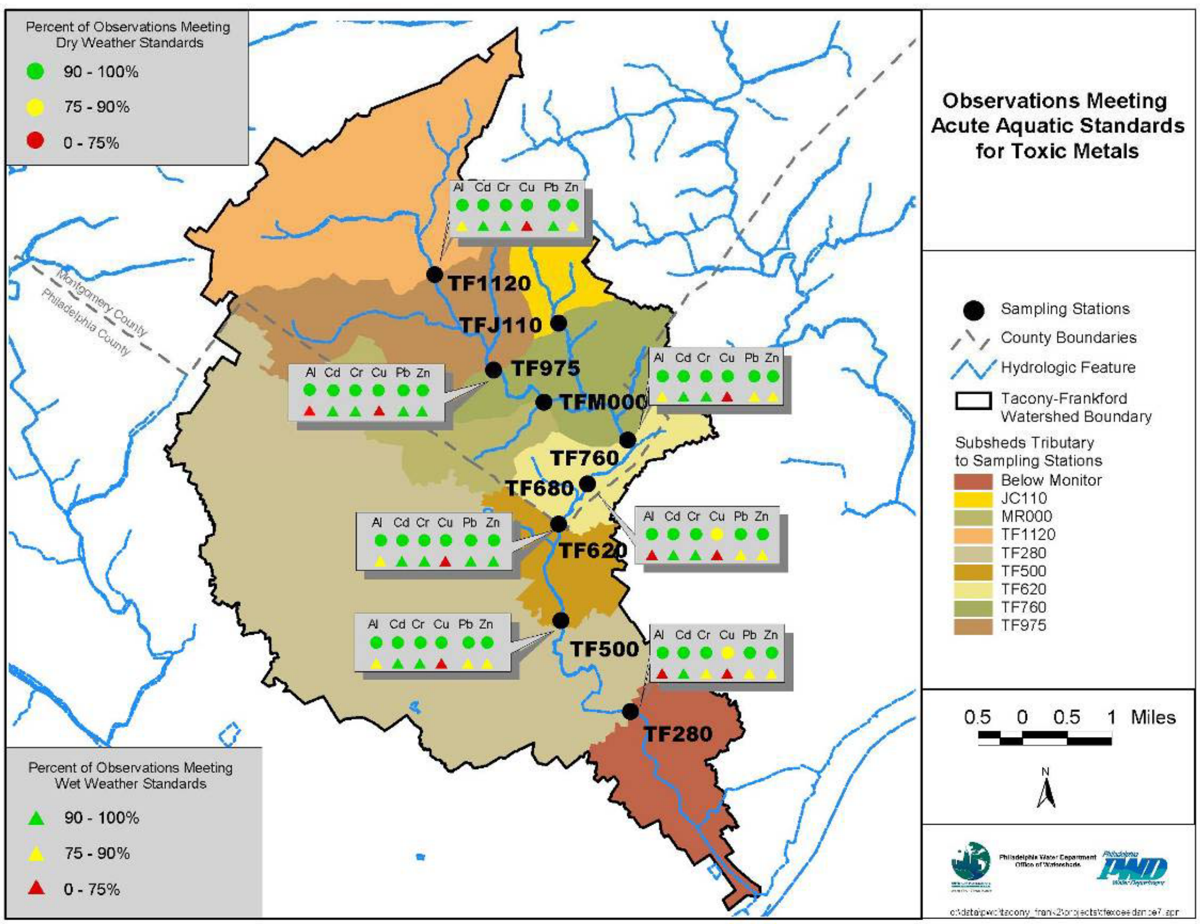


Figure 4.13 Current Metals Water Quality Data with Fish Consumption Advisory Areas

Of the three sites for which historical data exist, two of those sites also have corresponding current data. At both of the sites, the percent of samples meeting the water quality standard has increased dramatically over the last 20 to 30 years, in both wet and dry weather. Historical data showed dry weather samples met the standard an average of 50% of the time; current data shows an average at those two sites of meeting the standard 98% of the time. With wet weather sampling, the average increased from around 60% to 82% of the samples meeting the standard.

Table 4.12 Percent of Samples Meeting Toxic Metals Standards

	Percent of Samples that Meet the Standard					
	Historical			Current		
Site	All Data	Dry Weather	Wet Weather	All Data	Dry Weather	Wet Weather
19						
18						
7	58%	48%	82%			
8 / TF620	55%	52%	61%	93%	99%	88%
9 / TF280	50%	47%	59%	84%	97%	76%
TF1120				90%	100%	84%
TF500				87%	99%	75%
TF760				91%	100%	82%
TF975				89%	98%	83%
TF680				86%	97%	80%

Criteria			
Lower Limit		Upper Limit	
90%	<= % meeting <=	100%	GREEN
75%	<= % meeting <=	90%	YELLOW
0%	<= % meeting <=	75%	RED

4.3.3 Indicator 9: Effects on Aquatic Life (Dissolved Oxygen)

Just as humans require oxygen gas for respiration, most aquatic organisms require dissolved oxygen (DO). Oxygen dissolves in water through air-water interaction at the surface of the flow and through photosynthesis of plants and algae. At the same time, DO is depleted through the respiration of microorganisms, animals, plants, and algae. In a healthy system, the balance between oxygen-depleting and oxygen-providing processes maintains DO at a level that allows aquatic organisms to survive and flourish. In a less healthy system, dissolved oxygen may be depleted below levels needed by aquatic organisms. The minimum dissolved oxygen concentration required by many common fish species found in rivers and streams is approximately 5 mg/L. The PA DEP has set a water quality standard, or minimum allowable concentration, of 5 mg/L as a daily average and 4 mg/L as an instantaneous value for the Tookany/Tacony-Frankford Creek.

This indicator measures:

- **Percent of DO samples meeting state standards at various sites**

Where We Were:

Discrete samples of DO were taken at five sites in the watershed in the 1970s and 1980s. At all five sites, 100% of the wet weather samples met the average minimum standard. Dry weather samples met the standard 100% of the time at three of the sites, and met the standard 95% and 98% of the time at the remaining two sites.

Where We Are:

Both discrete and continuous samples were collected between 2000 and 2003 (see Figures 4.14 and 4.15). Discrete samples produce a single DO value at the time the sample is taken; continuous monitoring measures DO over the entire photic period, including the night when DO is lowest due to algal respiration. Both the discrete and continuous samples suggest that dissolved oxygen is rarely below the standard under dry or wet conditions. At each of the seven sites where discrete samples were taken, 100% of the discrete samples taken in both wet weather and dry weather met both the average minimum standard and the instantaneous minimum standard, with the exception of one site downstream, TF280. At this site, 4 out of 19 samples were below the average minimum standard in dry weather and 2 out of 19 samples were below the instantaneous minimum standard in dry weather. No discrete samples at any of the sites were below the standard in wet weather.

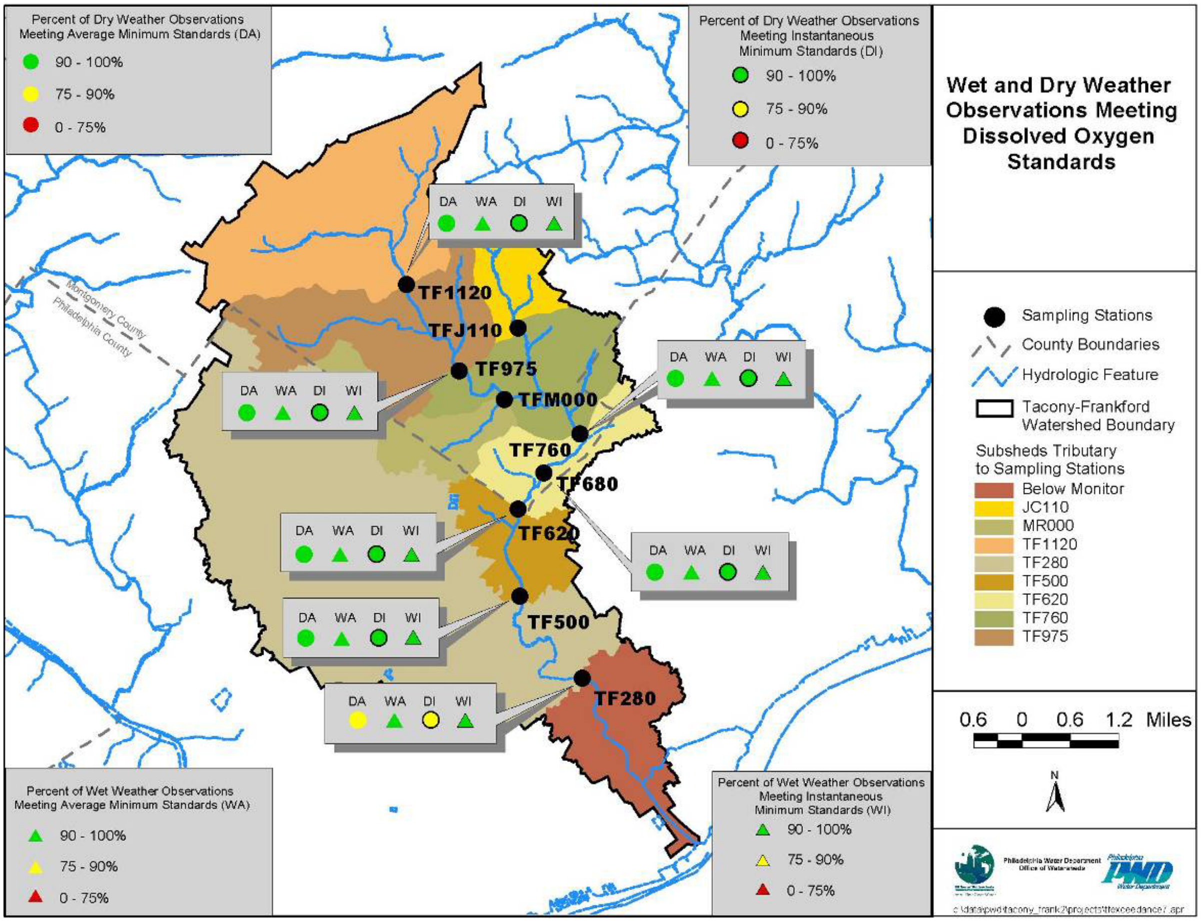


Figure 4.14 Current Water Quality Discrete Data for Dissolved Oxygen

With the continuous samples, 100% of the samples taken at each of six sites at which discrete sampling occurred met the DO daily mean standard, except for at site TF280. At least 90% of the samples at each site met the DO daily minimum standard. Again, for the DO daily minimum standard, site TF280 shows the highest number of samples that do not meet the standard. Overall, 100% of the discrete samples met the standard for DO daily mean and 94% of the samples met the standard for DO daily minimum.

The continuous Sonde data collected shows more than 2% of the readings below the DO daily minimum near the downstream end of the watershed and just upstream of the City boundary. Figure 4.15 displays the Sonde DO data compared to the daily minimum standard.

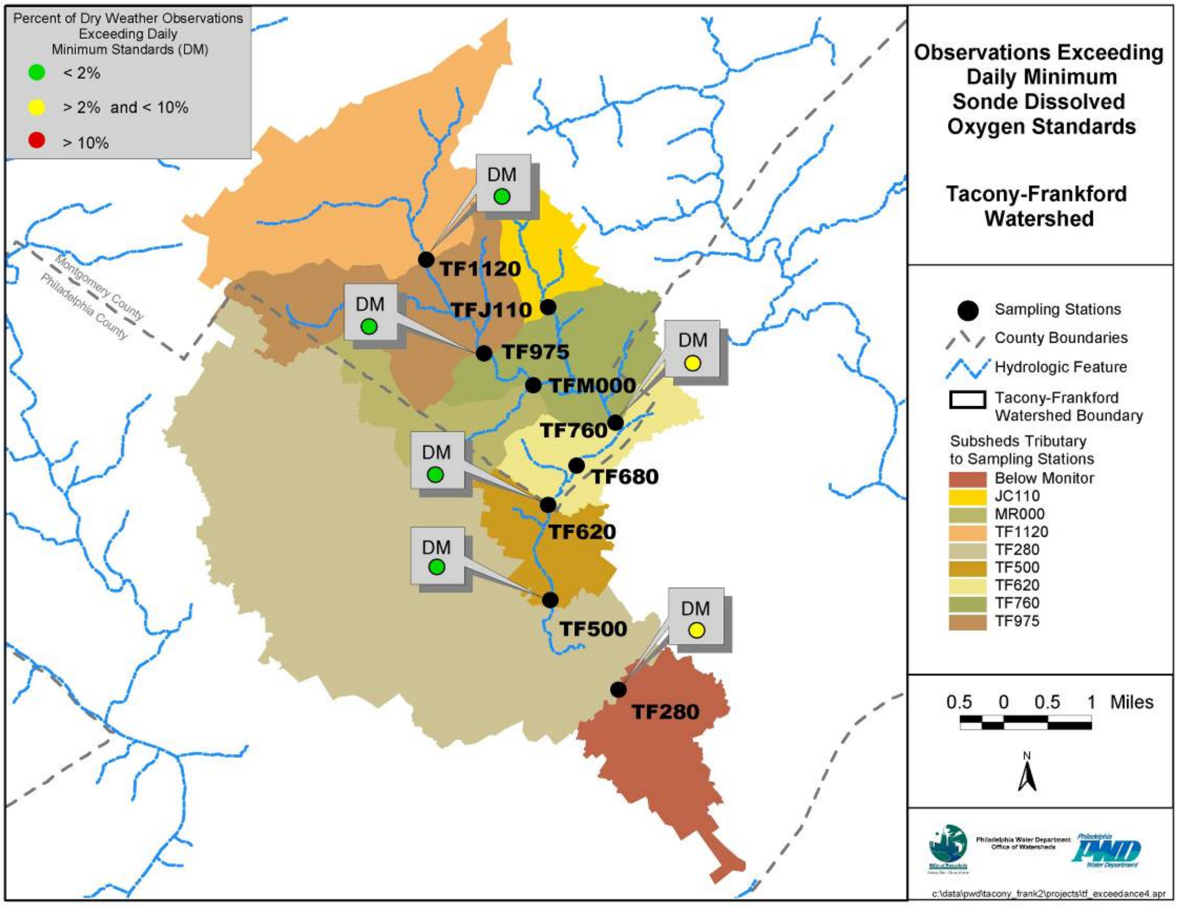


Figure 4.15 Current Water Quality Continuous Data for Dissolved Oxygen

Comparing the current data with historical data for two sites in the watershed, TF280 and TF 620, the number of samples not meeting the average minimum standard has increased. Historically, 100% of wet weather samples met the standard at both sites, which is consistent with current sampling results. With dry weather samples, the results have remained fairly consistent at site TF620 with 98% of samples meeting the standard historically and 100% of the samples meeting the standard currently. At site TF280, dry weather sampling results show a decrease in the number of samples meeting the standard. Historically, 95% of dry weather samples met the standard at this site while currently only 79% of the samples are meeting the standard.

4.4 Pollutants

The following two watershed indicators categorize pollutants broadly by their sources: "point" and "non-point."

4.4.1 Indicator 10: Point Sources

A point source is any point where pollutants enter the water, such as a pipe, channel, or ditch (Figures 4.16 to 4.18). Point source discharges can include treated municipal wastewater, combined sewer overflows (CSOs), separate sanitary overflows (SSOs), industrial process water, municipal separate storm sewer system (MS4) discharges, and/or cooling waters. Point sources are regulated under the Clean Water Act by the National Pollutant Discharge Elimination System (NPDES).

Figure 4.16 Stormwater Outfall

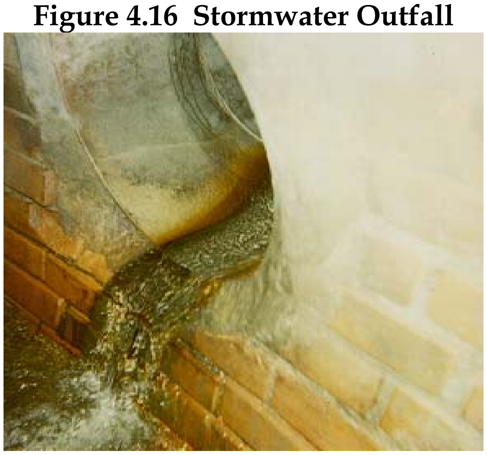


Figure 4.17 CSO Outfall

Figure 4.18 Municipal Wastewater Treatment Plant

A municipal separate storm sewer system (MS4) collects stormwater runoff from the land surface and discharges it directly to a receiving stream.

Combined sewer systems use one pipe to convey sanitary sewage and stormwater runoff to a combined sewage regulator chamber. The regulator captures all of the sanitary sewage in dry weather, and some of the combined sewage in wet weather, and sends it to a wastewater treatment plant. The balance of the wet weather flow is discharged to an area water body through a CSO outfall.

Sanitary Sewer Overflows (SSOs) occur when a municipal separate sanitary sewer system becomes overcharged in wet weather and overflows unintentionally to an area water body.

Municipal Wastewater Treatment Plants are facilities that process municipal sanitary waste and industrial and commercial discharges to the sewer system. These facilities treat the waste stream and discharge it to a local stream.

Industrial processes use water in manufacturing, power generation, or other activities to produce a product. The by-products from the process can be discharged to area waterways with varying levels of treatment.

This indicator measures:

- **Number of industrial and municipal point sources permitted to discharge to water bodies (if available, number meeting permit requirements)**
- **Estimated annual percent capture of combined sewage**
- **Model-estimated pollutant contributions of industrial/municipal, CSO, and stormwater outfalls**

Where We Were:

Point source discharges from treatment plants and industrial facilities were a priority for increased control during the 1970s and 1980s as secondary wastewater treatment requirements and industrial pre-treatment regulations were imposed. Historical data indicated that there were three facilities in the watershed with National Pollutant Discharge Elimination System (NPDES) Permits.

Historical SSO and CSO discharges are not well documented, and there is only limited current data on SSOs. However, it can be inferred from water quality data that dry weather sewage discharges were much more common in the past (see Indicator 8). It is reasonable to conclude that the frequency and volume of CSO discharges in the Philadelphia portion of the Tacony-Frankford Watershed have decreased over the past 20 years due to improved sewer maintenance and CSO control measures (discussed in detail later in this section).

Where We Are:

Active Industrial and Municipal Point Source Dischargers

Current facilities with NPDES permits to discharge to the Tookany, Tacony, Frankford, and Baeder creeks are believed to be SPS Technologies, Allegheny Iron Radiation, Bayway Refining Company, Roadway Express, BFI Waste Services Of Pa, S D Richman Sons Incorporated, and Sunoco Incorporated Frankford Plant. The Philadelphia Water Department is also permitted for its CSO outfalls. The permit for one facility, Biello Auto Parts Inc, that was once listed as active has expired. All municipalities in the watershed – Abington, Jenkintown, Rockledge, Cheltenham, Springfield, and Philadelphia – have MS4 permits, which all large, medium, and regulated small municipal separate storm sewer systems need in order to discharge pollutants.

Estimated Annual Percent Capture of Combined Sewage

Portions of Philadelphia County, including 47% of the Tookany/Tacony-Frankford Creek Watershed, are serviced by combined sewer. The City of Philadelphia has 31 regulator structures within the watershed, as shown in Figure 4.19. Since the 1980s, PWD has made significant progress in reducing CSO discharges to the Tacony-Frankford Creek. As required under EPA's CSO Control Policy, PWD has developed and implemented a CSO Long Term Control Plan (LTCP) to improve and preserve the water environment in the Philadelphia area. Table 4.13 lists estimated capture percentages for regulator structures in the Tacony-Frankford Watershed, based on the modeling results listed in PWD's CSO Annual Reports.

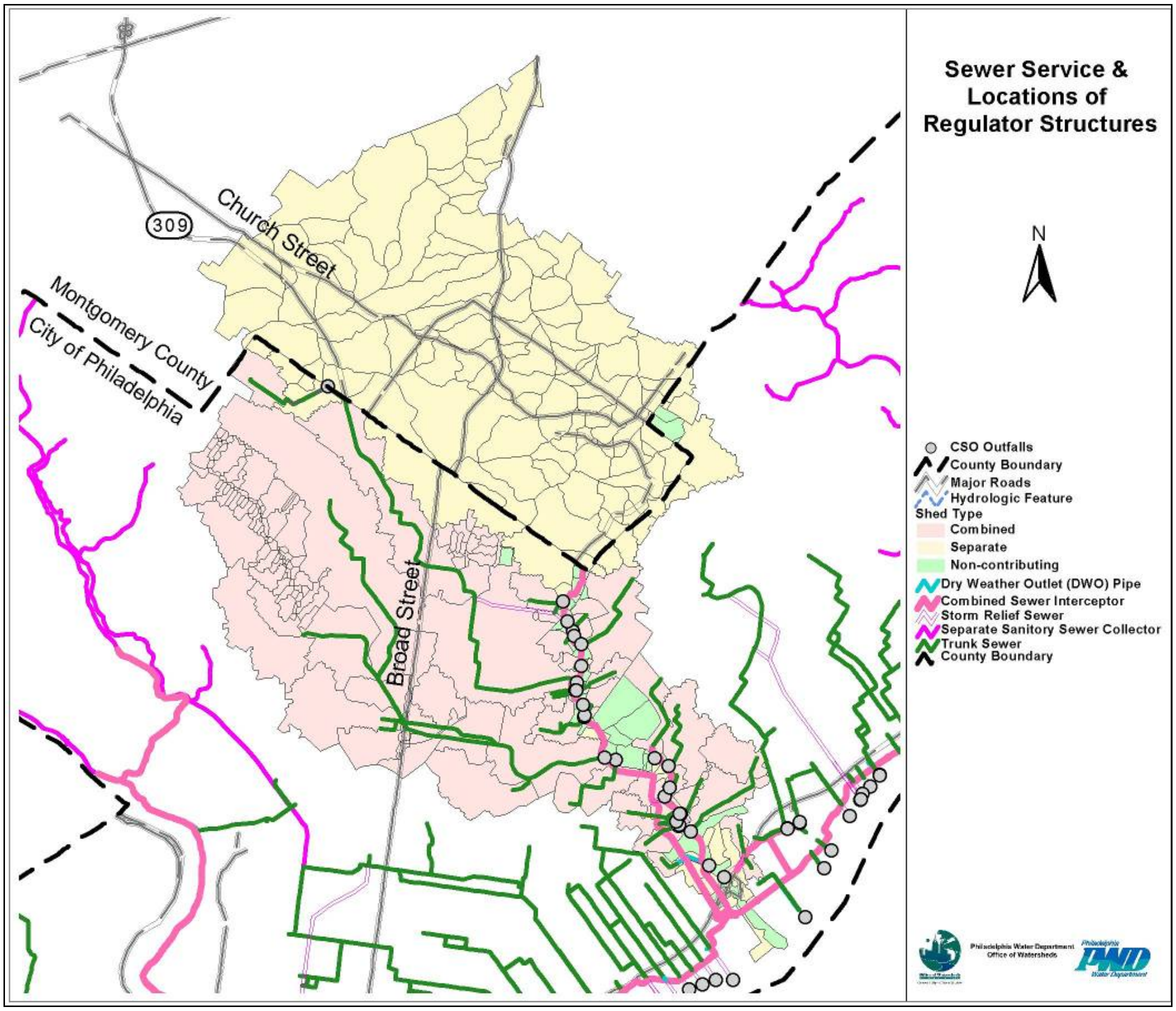


Figure 4.19 Types of Sewer Service and Locations of Regulator Structures

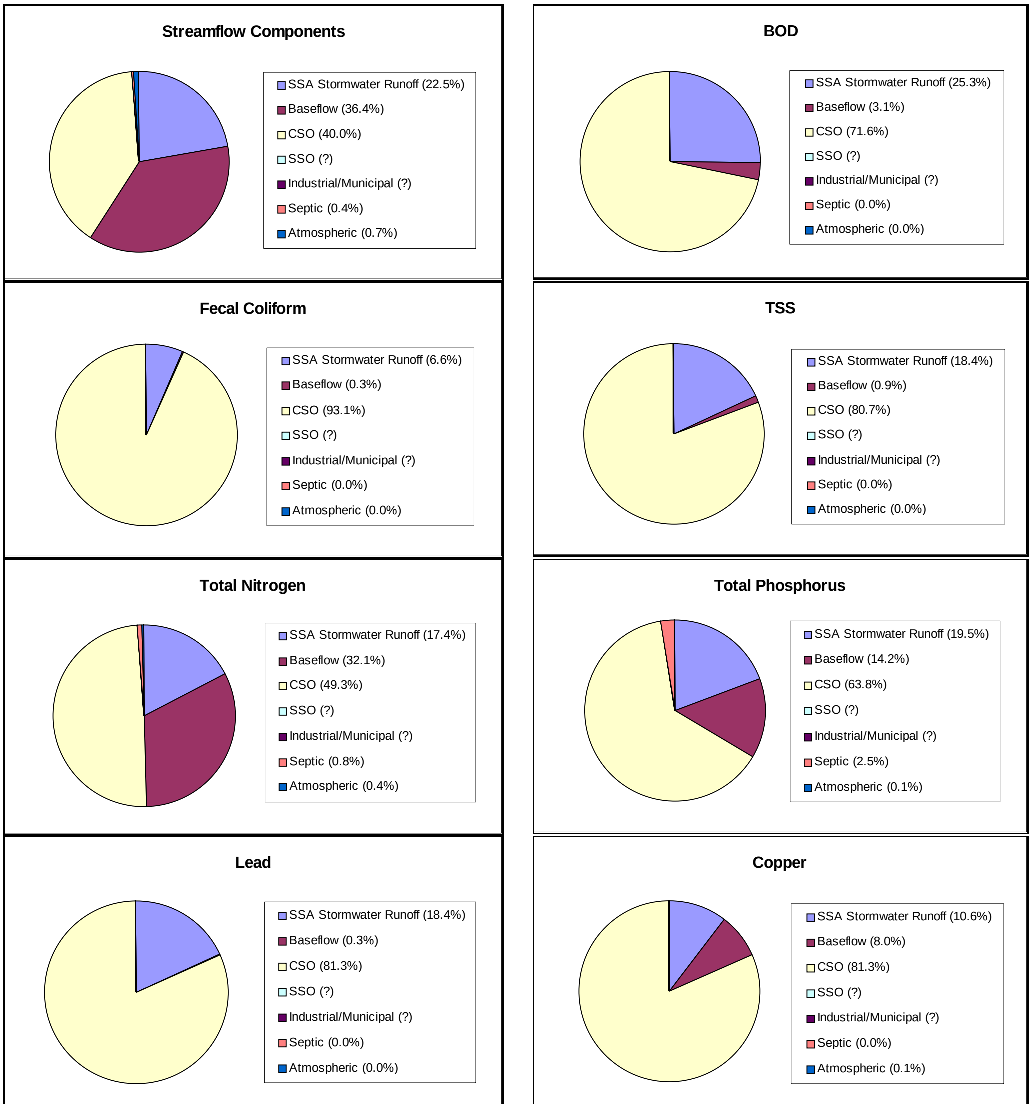
A capture percentage is defined as the percentage of combined sewage (mixed sanitary sewage and stormwater) that is sent to a treatment plant during rainfall events over the course of a year. 85% capture is considered to be an ultimate goal for many communities, as they implement CSO Long Term Control Plans (since it is not possible to capture and treat large storms). It is important to note that percent capture for a given year is strongly dependent on the frequency and magnitude of rainfall events during that year. The five years of data listed in Table 4.13 are not sufficient to determine whether an increasing or decreasing trend has taken place. However, as the amount of data increases throughout implementation of the Long Term Control Plan, it will ultimately be possible to evaluate the effectiveness of the control measures

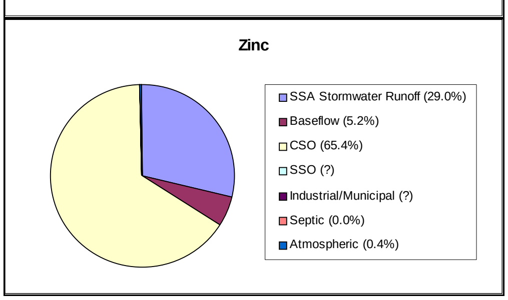
Table 4.13 Estimated Annual Combined Sewage Capture Percentages

Year	Precipitation (in)	Capture (%) – Lowest and Highest Structure	
		Tacony	Upper Frankford Low Level
2003	46.72	43 - 45	64 - 65
2002	34.11	59 - 64	76 - 79
2001	30.62	51 - 53	70 - 72
2000	43.26	40 - 42	58 - 60
1999	48.6	39 – 40	57 - 59

Model-Estimated Pollutant Contributions of Different Sources

Estimated annual pollutant contributions to the Tookany/Tacony-Frankford Creek are shown below. CSO is the largest source associated with urban and suburban runoff, including nutrients such as phosphorus and metals such as lead. Stormwater outfalls are a smaller but significant source of these constituents. CSO discharges are the main source of fecal coliform. Permitted industrial and municipal point source discharges make up less than 1% of annual streamflow in both systems. SSOs are thought to occur in both watersheds but have not been well documented.





Notes:

- SSA = Separate Sanitary Area runoff
- CSO = Combined Sewer Overflow
- Sanitary Sewer Overflows (SSOs) were not explicitly included in this analysis.

Figure 4.20 Annual Pollutant Contribution

Spatial distributions of model-based constituent loads are shown in Figures 4.21 through 4.28. The darker areas represent areas of higher loads per acre per year. For BOD, a significant amount is within the City from combined-sewered areas. Highest fecal coliform estimates are found in the City portion of the watershed. Metals (lead and zinc) are generally higher in the more urbanized areas of the watershed. Total suspended solids (TSS) loads follow a similar trend to metals. Nutrients (phosphorus and nitrogen) have significant contributions throughout the watershed, with the highest near the Philadelphia County line. (For more information about modeling used to estimate this annual loading to the Tookany/Tacony-Frankford Creek, see Section 9 of the Tookany/Tacony-Frankford Watershed Comprehensive Characterization Report, 2005.)

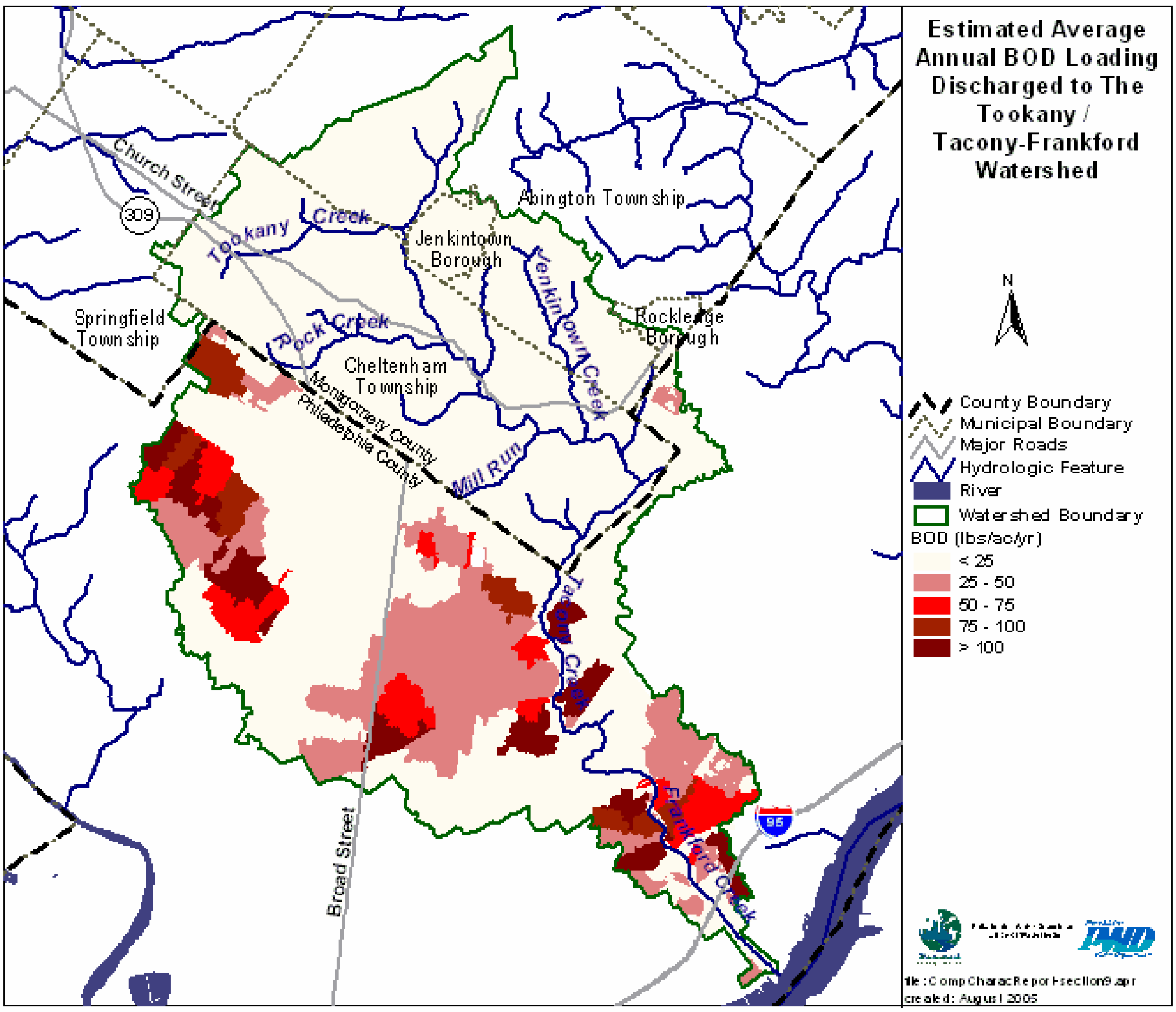


Figure 4.21 Estimated Annual BOD Loading to the Tookany/Tacony-Frankford Creek

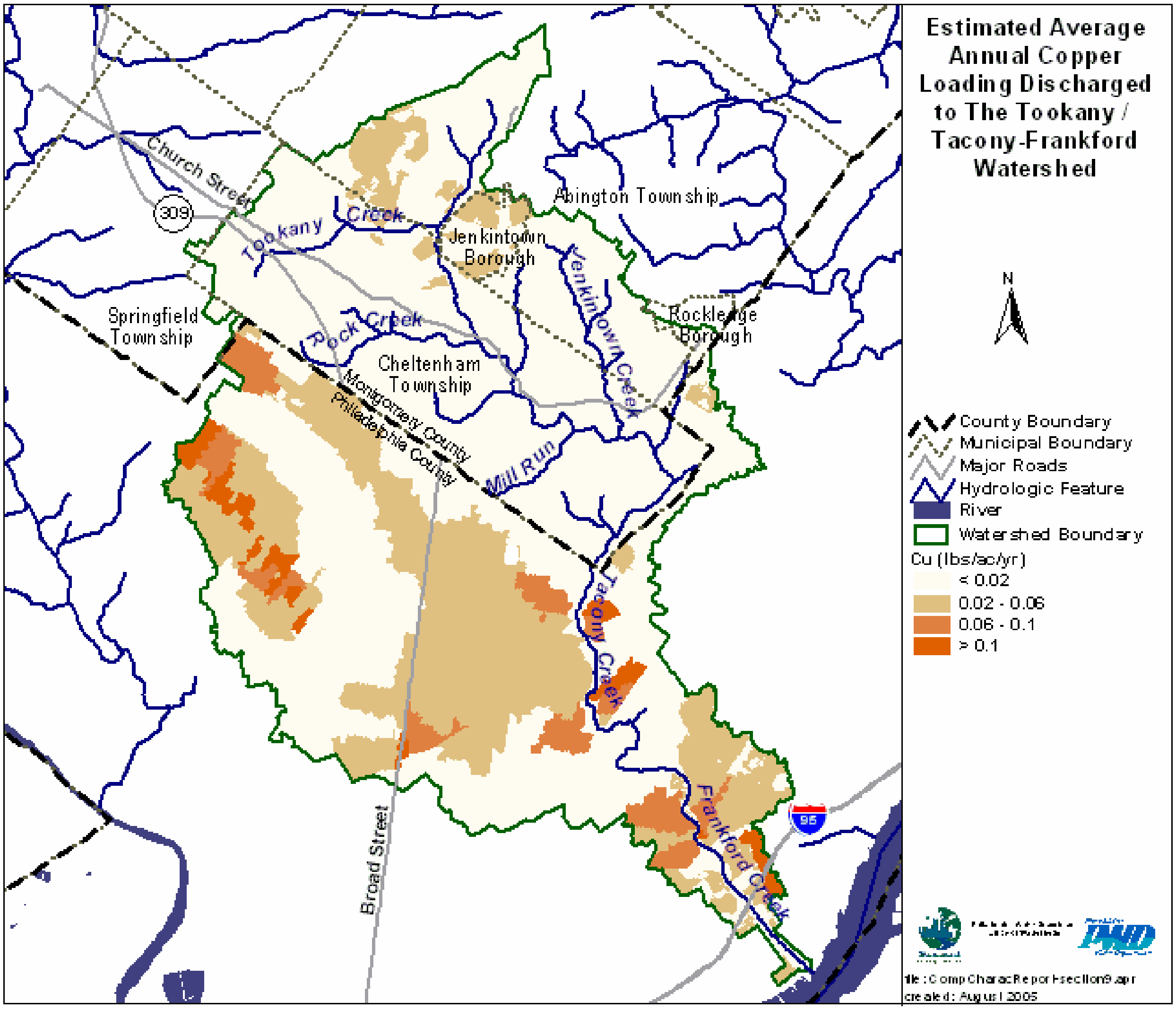


Figure 4.22 Estimated Annual Copper Loading to the Tookany-Tacony-Frankford Watershed

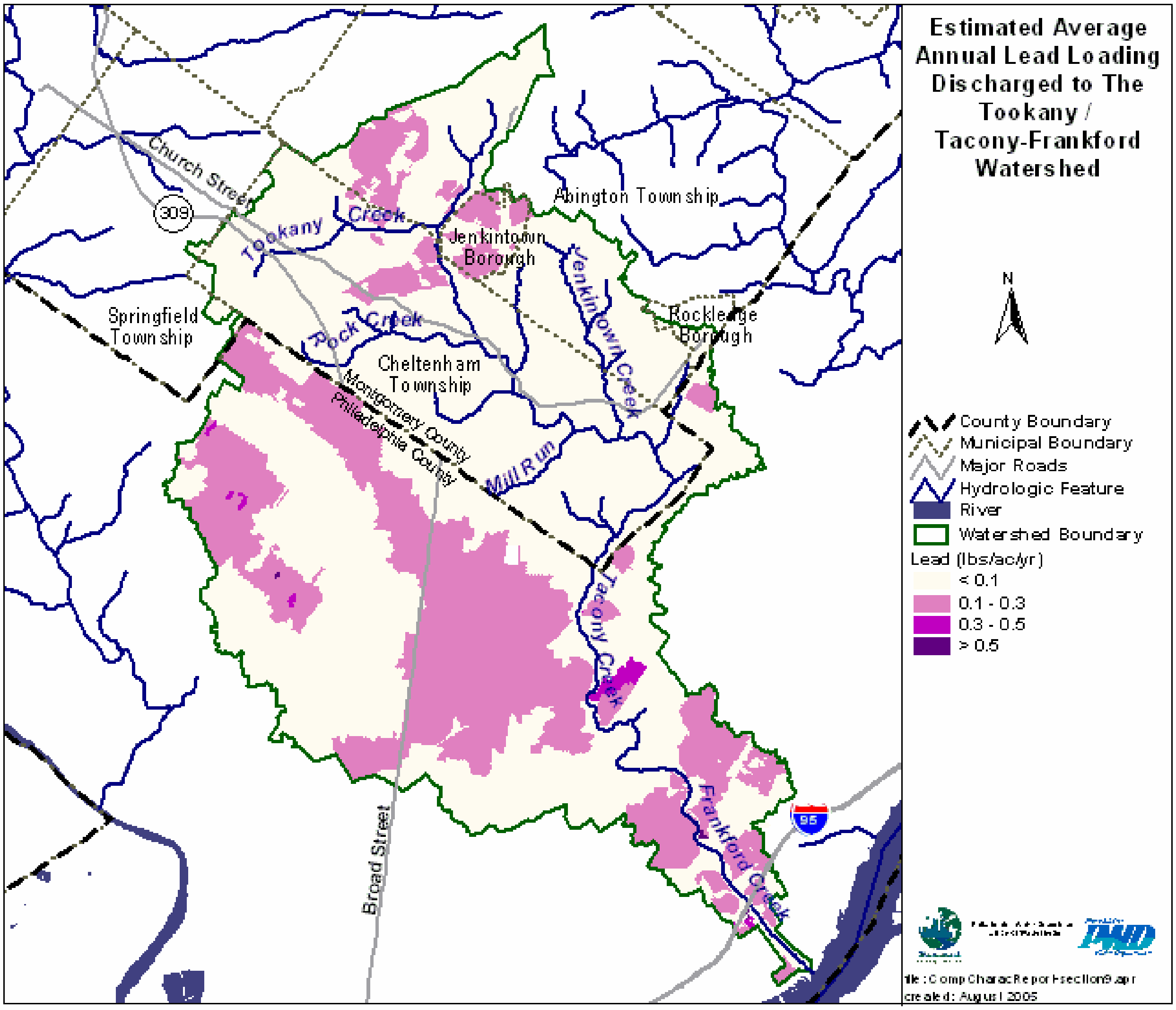


Figure 4.23 Estimated Annual Lead Loading to the Tookany/Tacony-Frankford Creek

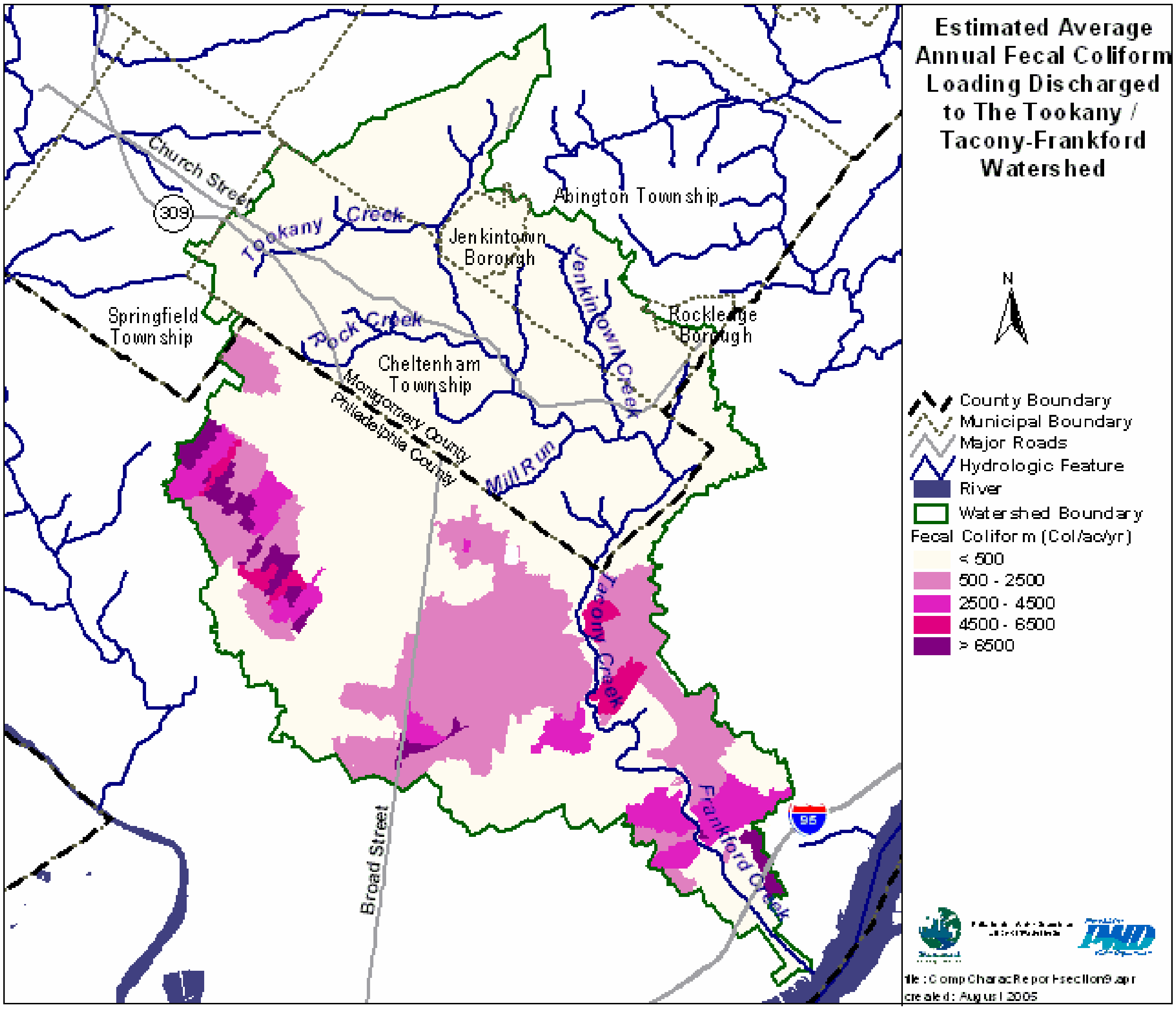


Figure 4.24 Estimated Annual Fecal Loading to the Tookany/Tacony-Frankford Creek

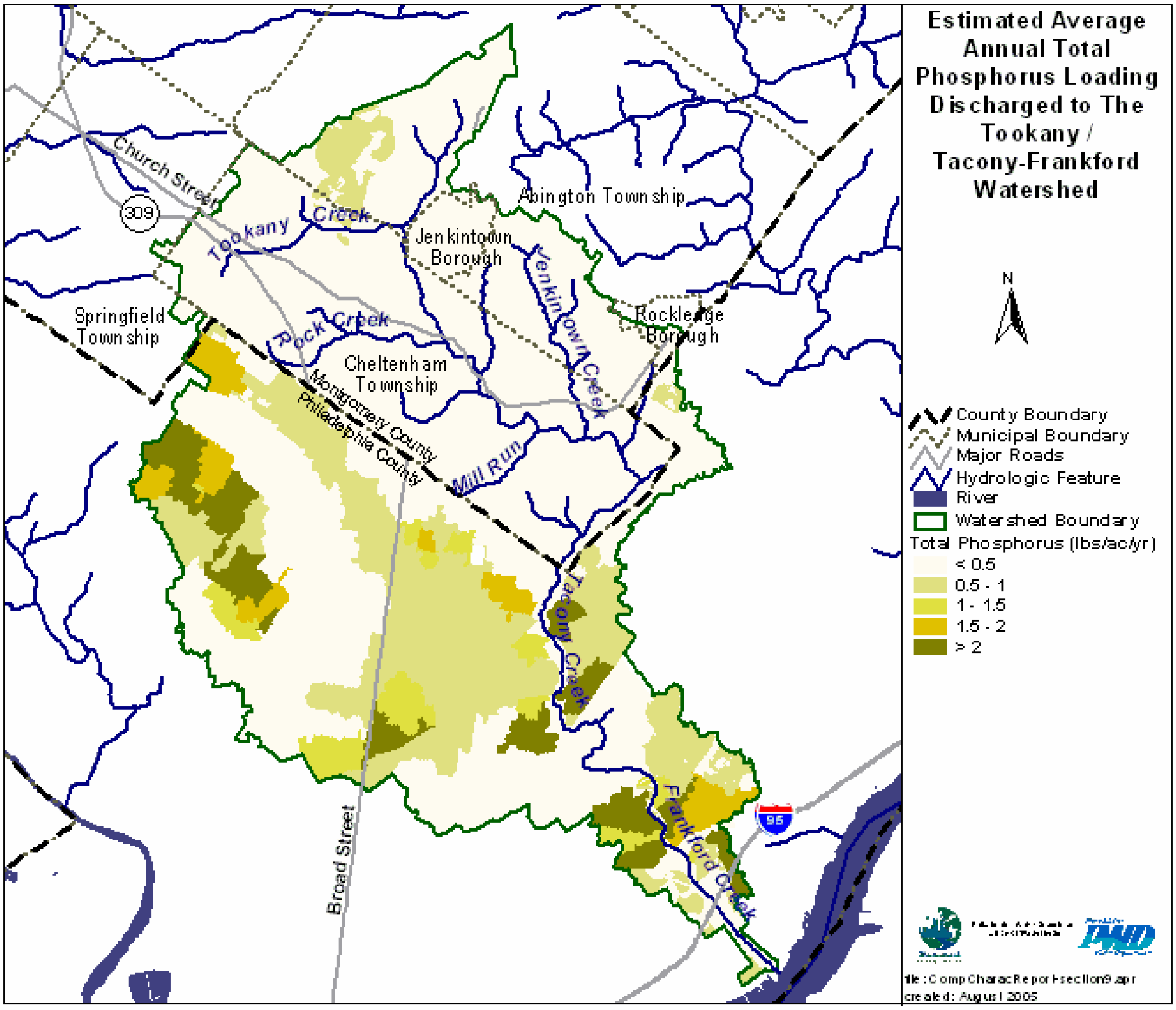


Figure 4.25 Estimated Annual Phosphorus Loading to the Tookany/Tacony-Frankford Creek

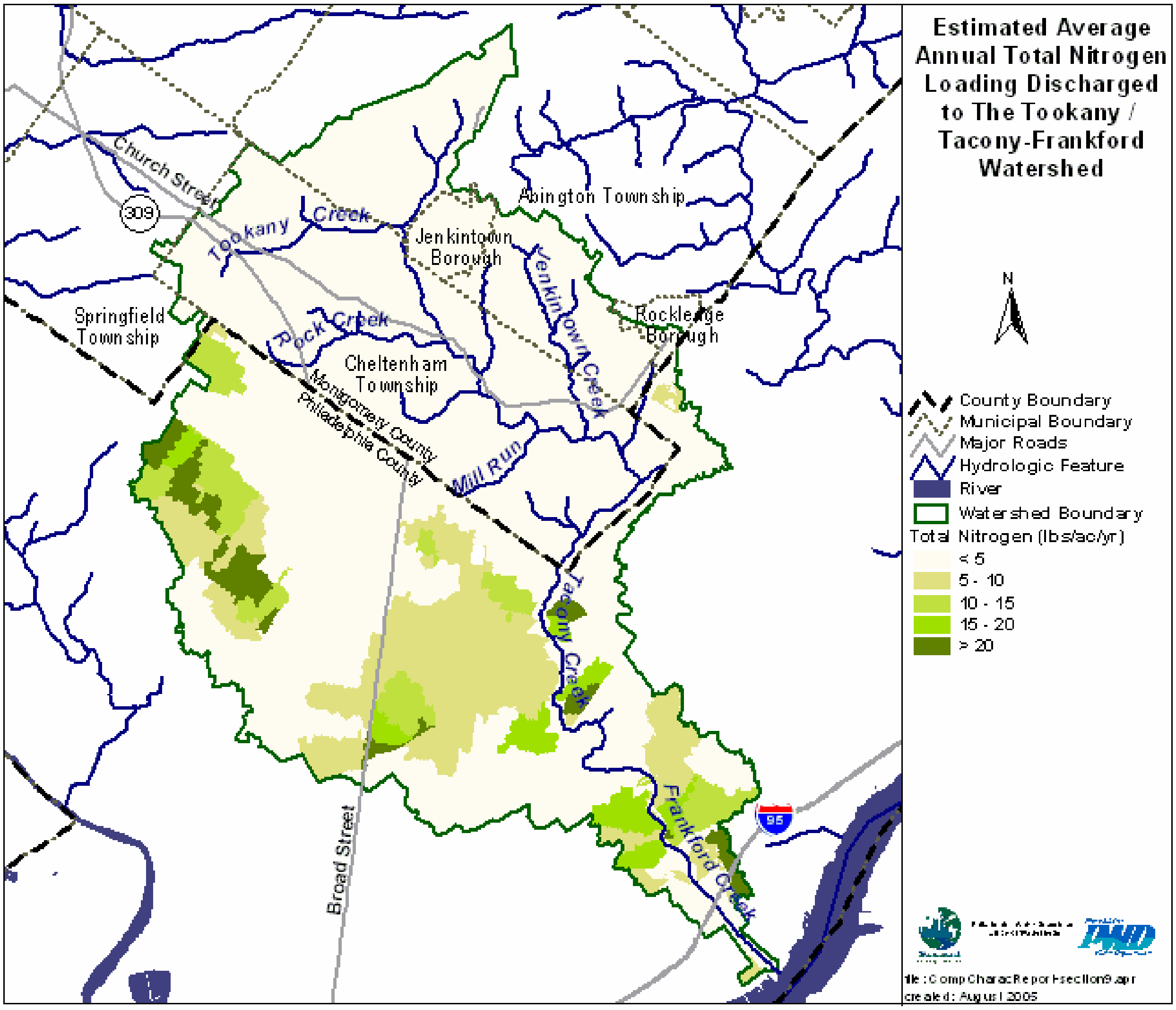


Figure 4.26 Estimated Annual Nitrogen Loading to the Tookany/Tacony-Frankford Creek

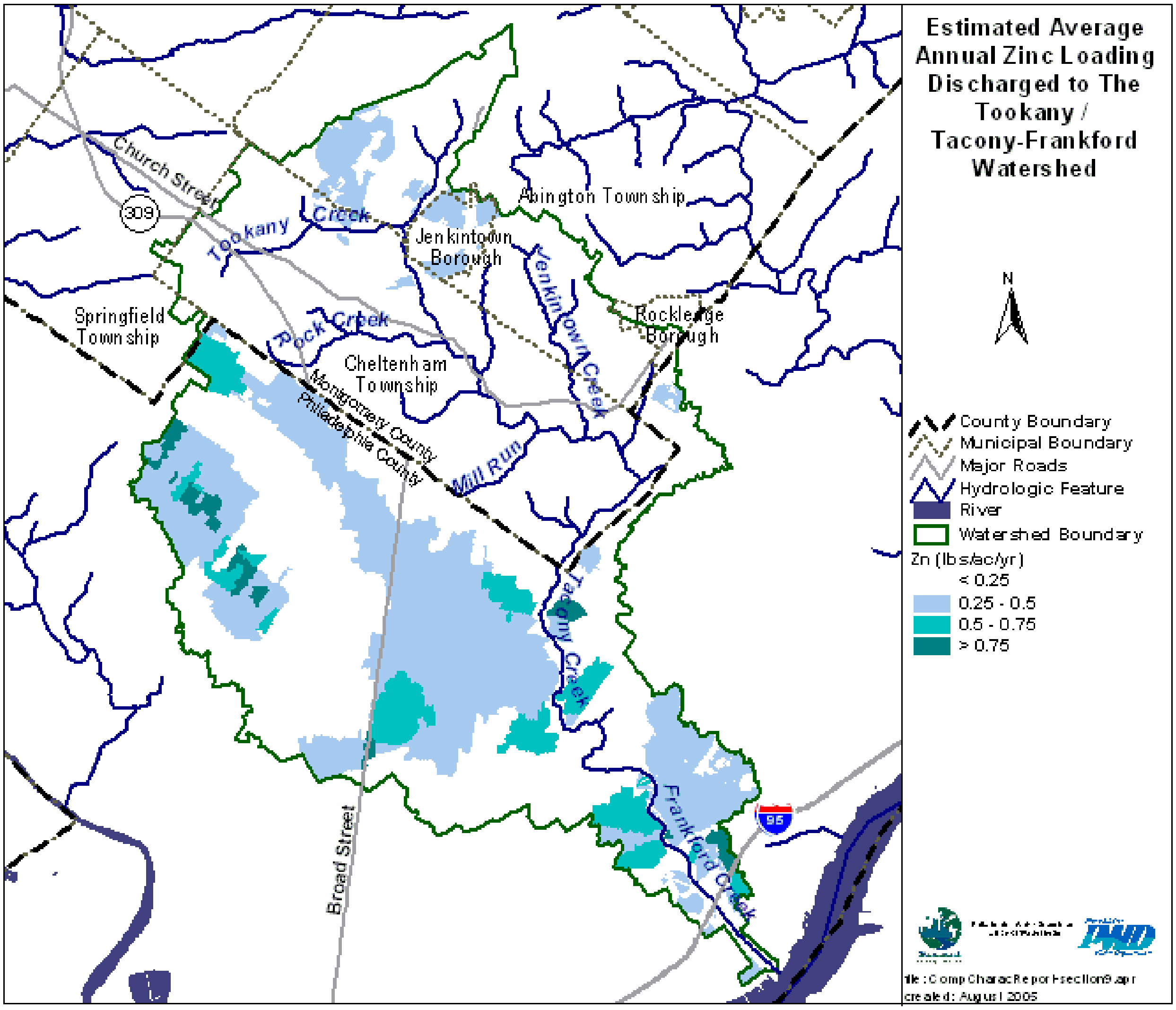


Figure 4.27 Estimated Annual Zinc Loading to the Tookany/Tacony-Frankford Creek

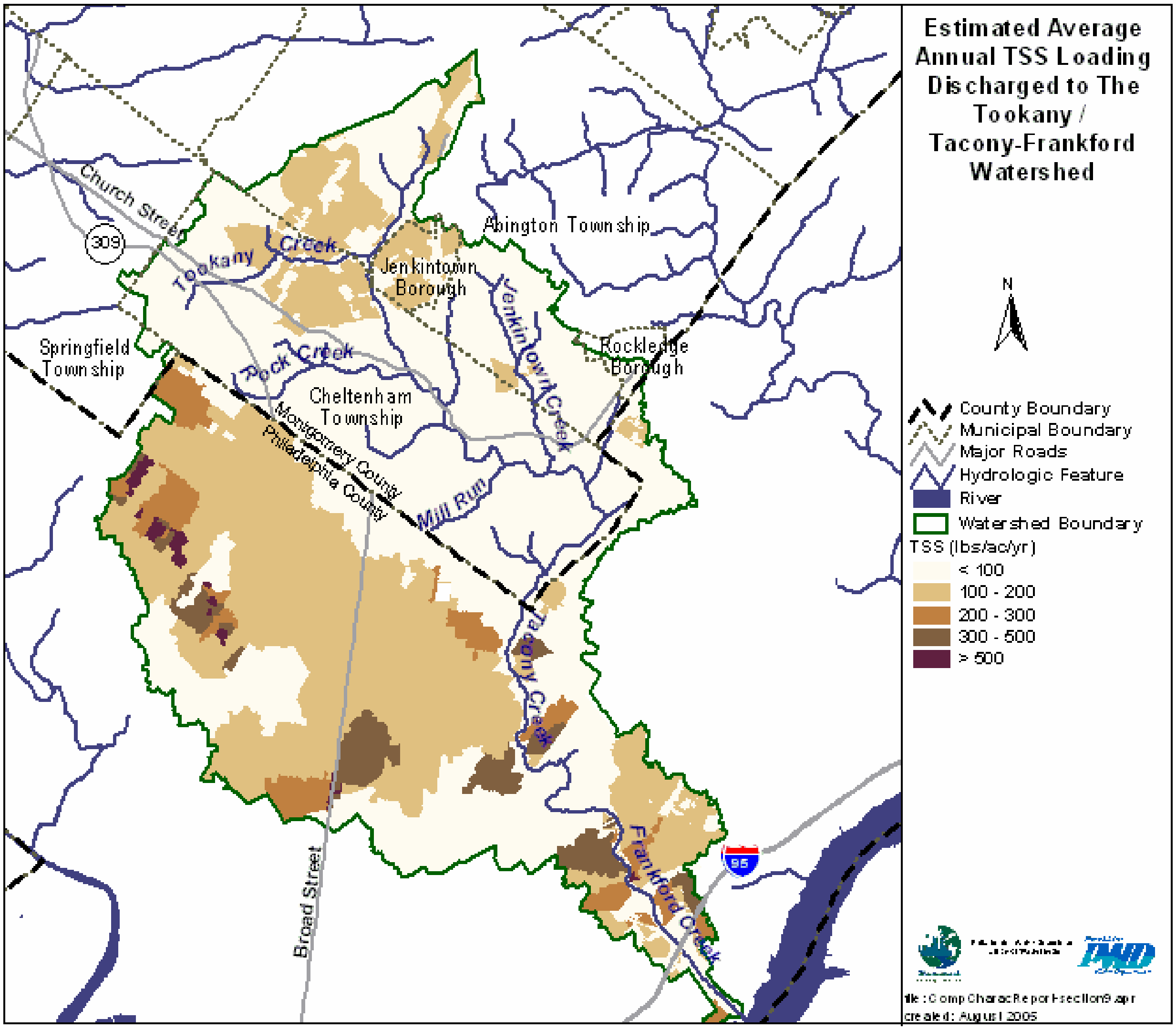


Figure 4.28 Estimated Annual TSS Loading to the Tookany/Tacony-Frankford Creek

4.4.2 Indicator 11: Non-point Sources

Non-point source pollution is any source of water contamination not associated with a distinct discharge point. This type of pollution is a leading cause of water quality degradation in the United States. Non-point sources include atmospheric deposition, stormwater runoff from pasture and crop land, and individual on-lot domestic sewage systems discharging through shallow groundwater. Stormwater from urban and suburban areas is considered a point source for regulatory purposes because it is collected in a pipe system and discharged at a single point.

Figure 4.29 Pasture Land

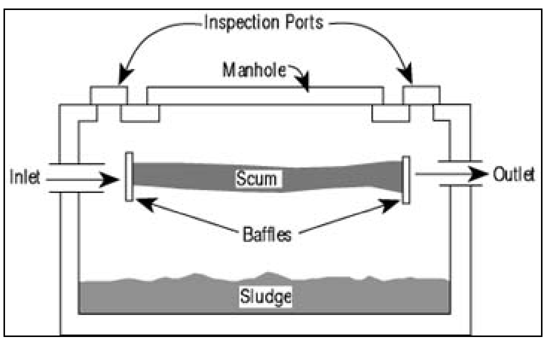


Figure 4.30 Septic System
Source: Ohio State University Extension

Agricultural activity is a major source of non-point source pollution in many areas. Animal manure and fertilizers applied to crops may lead to pollutant inputs to surface water and groundwater.

A properly sited and maintained **septic system** should not result in inputs of nutrients to groundwater. However, failing septic systems are common and can result in nutrient inputs to shallow groundwater and ultimately to stream baseflow.

Background concentrations of some water quality constituents are present in groundwater and may be transferred to stream baseflow. Some constituents may be introduced through agricultural activity or failing septic systems, while others may be present as a result of local geology.

This indicator measures:

- **Model-estimated percent of total pollutant loads contributed by septic tanks**
- **Evidence that sanitary sewers are leaking during dry weather, or are in direct contact with the stream**

<u>Where We Were</u>:
Since most point sources were addressed in the 1970s and 1980s, regulatory agencies have been turning attention towards controlling non-point sources of pollution. Many of these sources began to be addressed during the 1990s.

<u>Where We Are</u>:
Non-point sources in the Tookany/Tacony-Frankford Watershed include atmospheric deposition, stormwater runoff from a very small amount of agricultural land, background concentrations in groundwater, and individual on-lot disposal systems (OLDS) discharging through shallow groundwater. The number of septic tanks within the watershed is hard to accurately quantify. According to 1990 census data, about 1075 septic tanks were present in the

watershed; however, this is believed to be a high estimate of the actual number. Figure 4.31 shows the septic areas within the watershed. Based on modeling estimates (Figures 4.32 and 4.33), septic tanks contribute less than 1% of total nitrogen and 2.5% of phosphorus loads. Atmospheric loads to wetlands and open water were estimated to be less than 1%. Background groundwater concentrations of total nitrogen were a large source of loading through stream baseflow at over 30%. Dry weather contributions from leaking sanitary sewers could not be estimated based on current data; however, evidence that leaking is occurring is presented below.

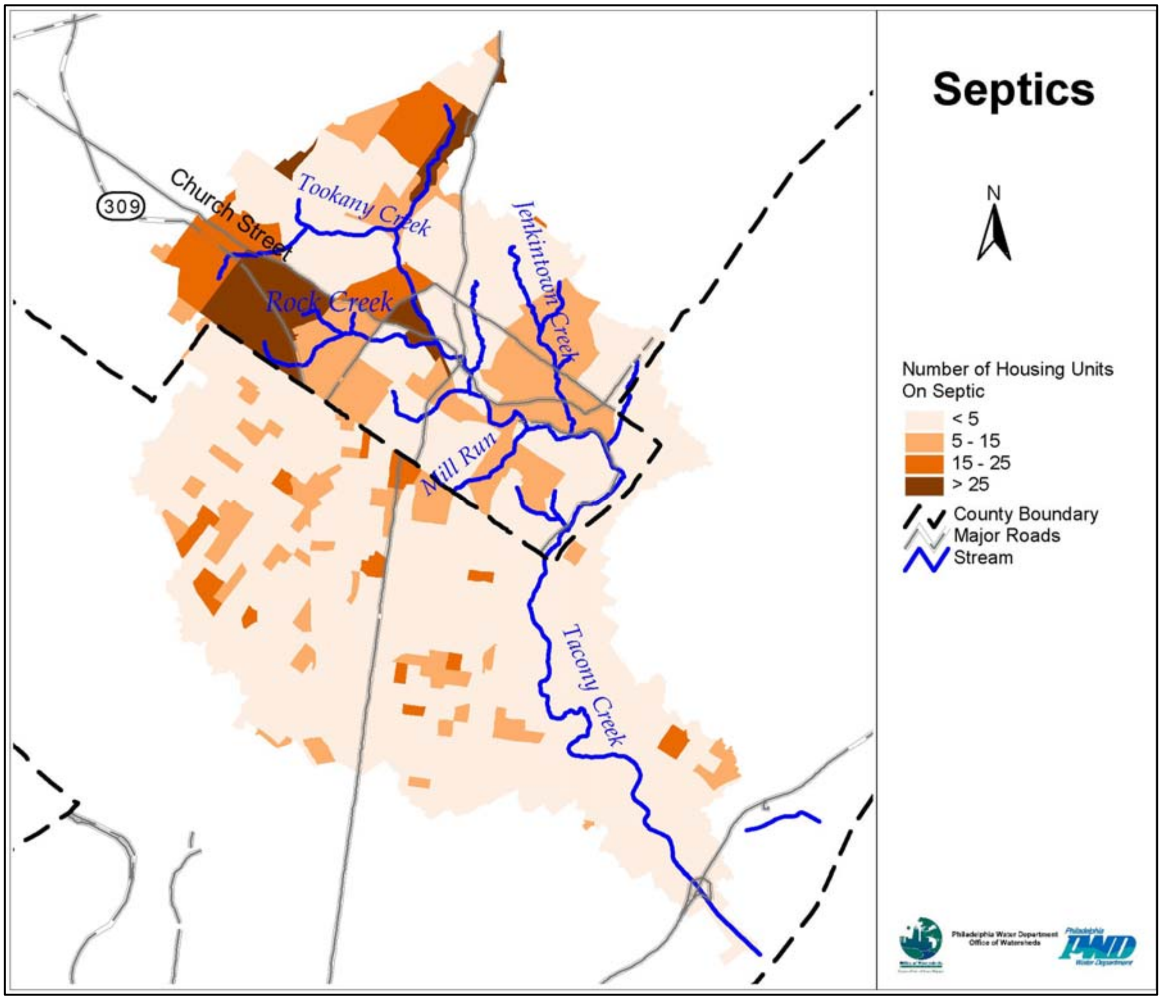


Figure 4.31 Septic Housing Units in the Tookany/Tacony-Frankford Watershed

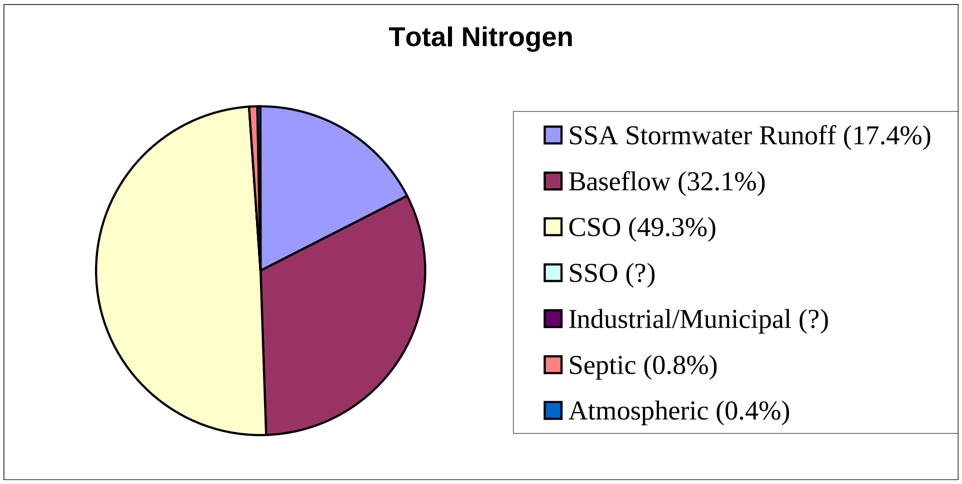


Figure 4.32 Estimated Nitrogen Inputs

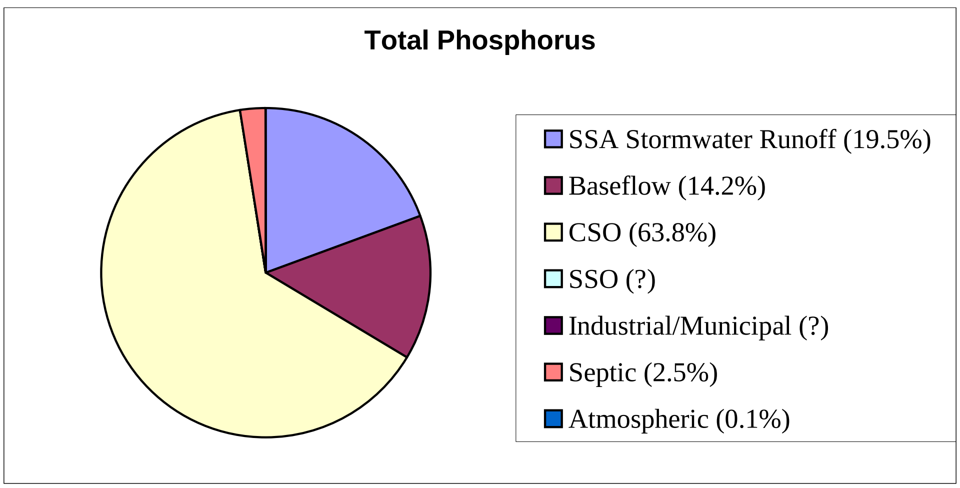


Figure 4.33 Estimated Phosphorus Inputs

4.5 Stream Corridor

The next three indicators of watershed health address environmental features of the lands immediately surrounding the waterway.

4.5.1 Indicator 12: Riparian Corridor

The riparian areas buffering streams, rivers, lakes, and other water bodies are especially sensitive watershed zones. In their naturally vegetated and undisturbed state, floodplains and riparian areas provide stormwater management and flood control functions, providing both water quantity and water quality benefits.

This indicator measures:

- **Miles of stream with a minimum buffer of 50 feet and 50 percent canopy cover**

Figure 4.34 Riparian Corridor in Jenkintown

Where We Were:

There is no historical data available for this indicator. A trend will be established the next time this area is reassessed.

Where We Are:

In the Tacony Creek Park, riparian zones no longer function as they should due to a loss of native community assemblages, which has had a deleterious effect on the riparian zone's ability to efficiently sequester pollutants and stormwater runoff. Japanese knotweed, an exotic plant species, has invaded the banks of the creek and contributes to the vulnerability of the banks to erosion during storms. There are currently volunteer efforts underway to eradicate this species from riparian zones, but it still persists. The riparian areas along the creeks in the Fairmount Park System are superior in quality compared to most of the areas in the watershed, which have almost completely lost their riparian buffers.

Buffers along stream corridors can be an important factor in enhancing stream habitat and preventing erosion. In 2002, the Heritage Conservancy was funded to develop a rapid assessment method to identify and map sections of stream lacking riparian forest buffers. The conservancy assessed watersheds in southeastern Pennsylvania and mapped waterways lacking riparian forest buffers. Interpretation of 1" = 200' black-and-white high altitude aerial photographs and videotape from helicopter flyovers were used to determine the presence or absence of a forested buffer for 975 miles of stream. For this analysis, a stream bank was classified as having a forested buffer if it was determined to have a 50 foot wide buffer of trees and 50 percent canopy cover. Each stream bank was analyzed independently. Table 4.14 shows that there are about 8½ miles of stream within the watershed that are lacking forested riparian buffers on one or both banks, which amounts to about one-third of the stream miles assessed.

Table 4.14 Lack of Riparian Forested Buffer

Riparian Buffer	Length (Stream Miles)
Buffer Lacking on One Bank	5.4
Buffer Lacking on Both Banks	3.1
Total Miles Lacking Buffer	8.5
Total Miles Assessed	27.3
% of stream lacking buffer	31.1%

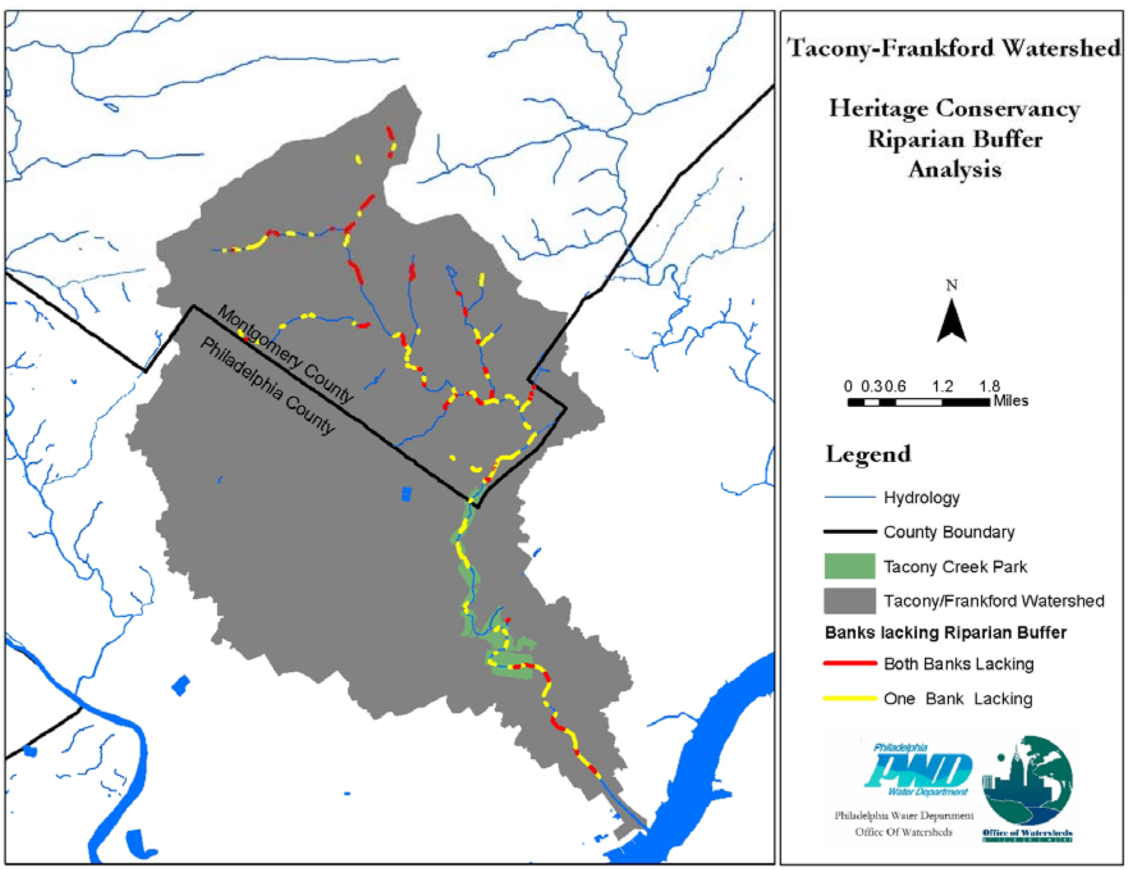


Figure 4.35 Heritage Conservancy's Forested Riparian Buffer Analysis (2002)

4.5.2 Indicator 13: Wetlands and Riparian Woodlands

Wetlands and riparian woodlands are important natural filters for pollutants in stormwater. They increase diversity of vegetation while providing feeding and nesting habitat for birds and animals. They are important in preventing slope erosion and mitigating flood peaks by slowing runoff, and they promote natural infiltration of rainfall and groundwater recharge.

The most significant functions that wetlands perform are:

- Wildlife habitat
- Fish habitat
- Water quality improvement (nutrient and toxicant reduction)
- Hydrologic (flood flow) modification
- Groundwater recharge

The location and size of a wetland influence the functions it can perform. For example, the geographic location may determine its habitat functions, and the location of a wetland within a watershed can influence its hydrologic and water-quality functions. Many factors determine how well a wetland will perform these functions – such as the size and type of wetland, the quantity and quality of water entering the wetland, and the disturbances or alteration within the wetland or in the surrounding ecosystem.

Wetlands of the Tookany/Tacony-Frankford Watershed were evaluated for the first four of the functions listed above, and were further studied to understand the degree to which they have experienced disturbance and their potential for enhancement and improvement, where they have experienced disturbance. Figure 4.36 shows a typical wetland in the watershed.

This indicator measures:

- **Approximate area of wetland in the watershed**
- **Area of riparian buffer along waterways**
- **The quality of (and disturbance to) the wetlands**
- **The ability of the wetland and woodlands to improve water quality**

Figure 4.36 Example of a Wetland Area

Where We Were:
There is little data available about the historical presence of wetlands and riparian woodlands in the watershed. The Fairmount Park Commission (FPC) compiled some information regarding historic wetlands in their 1999 Natural Lands Restoration Master Plan. FPC reported that Philadelphia had an abundance of wetlands along the Delaware and Schuylkill Rivers in pre-Colonial times. These included a variety of inter-tidal channels, marshes and mudflats, and gravel bars. Much of the south and southwestern parts of the city, including what is now FDR Park, were a mix of tidal channels and marshes. Non-tidal wetlands were present inland from the tidal marshes and along streams (FPC, 1999).

Urban and suburban development has resulted in the piping of historic streams, destruction of wetlands, and deforestation and modification of historic floodplains. Stormwater is piped directly to waterways, and no longer flows overland through vegetation, wetlands, and woodlands. Also, because stormwater runoff frequently flows over impervious surfaces and is then piped to the streams, the flow and volume of runoff is intensified. Stream channels of the watershed exhibit many effects of urbanization: degradation of the stream channel (including overwidening), bank erosion, loss of sinuosity, loss of the floodplain-stream connection, and loss/degradation of aquatic habitat. Because most stormwater is piped directly to the channel of the waterways of the Tookany/Tacony-Frankford Watershed and does not flow over land, there is no longer a source of water input to maintain many of the wetlands that once existed.

Extensive development in the Tookany/Tacony-Frankford Watershed has resulted in conversion of natural riparian lands to residential, institutional, and active recreational land use. Primary land uses in the watershed, for the most part, preclude the existence of natural vegetated areas due to the high density of development. For example, 33% of the residential land uses are row or multi-family homes, which typically have relatively little vegetated open area that might control, improve, and recharge stormwater runoff.

In summary, the number and area of wetlands and riparian woodlands in the Tookany/Tacony-Frankford Watershed have declined significantly over time as a result of development close to the stream edges, changes to the floodplain from concentrated stormwater flows, and routing of nearly all stormwater flow into pipes.

Where We Are:
The Tookany/Tacony-Frankford Watershed is 21,000 acres in size, or about 31 square miles. The watershed is nearly totally developed: 87% (18,200 acres) of the watershed now hosts residences, businesses, industries, and utilities.

Land use data indicates that only 13% of the Tookany/Tacony-Frankford Watershed land area is non-urbanized (e.g., agriculture, cemetery, recreation, woodland), and only 5% of the watershed land area remains as woodland (1,060 acres). The undeveloped riparian corridor, which comprises the undeveloped land directly adjacent to the Tookany/Tacony-Frankford waterways, totals about 3.3% (685 acres) of the watershed land area. The undeveloped riparian corridor is illustrated in Figure 4.37. About one-third of the total woodland is located within the Tookany/Tacony-Frankford undeveloped riparian corridor. (Also see Indicator 1: Land Use and Impervious Cover.)

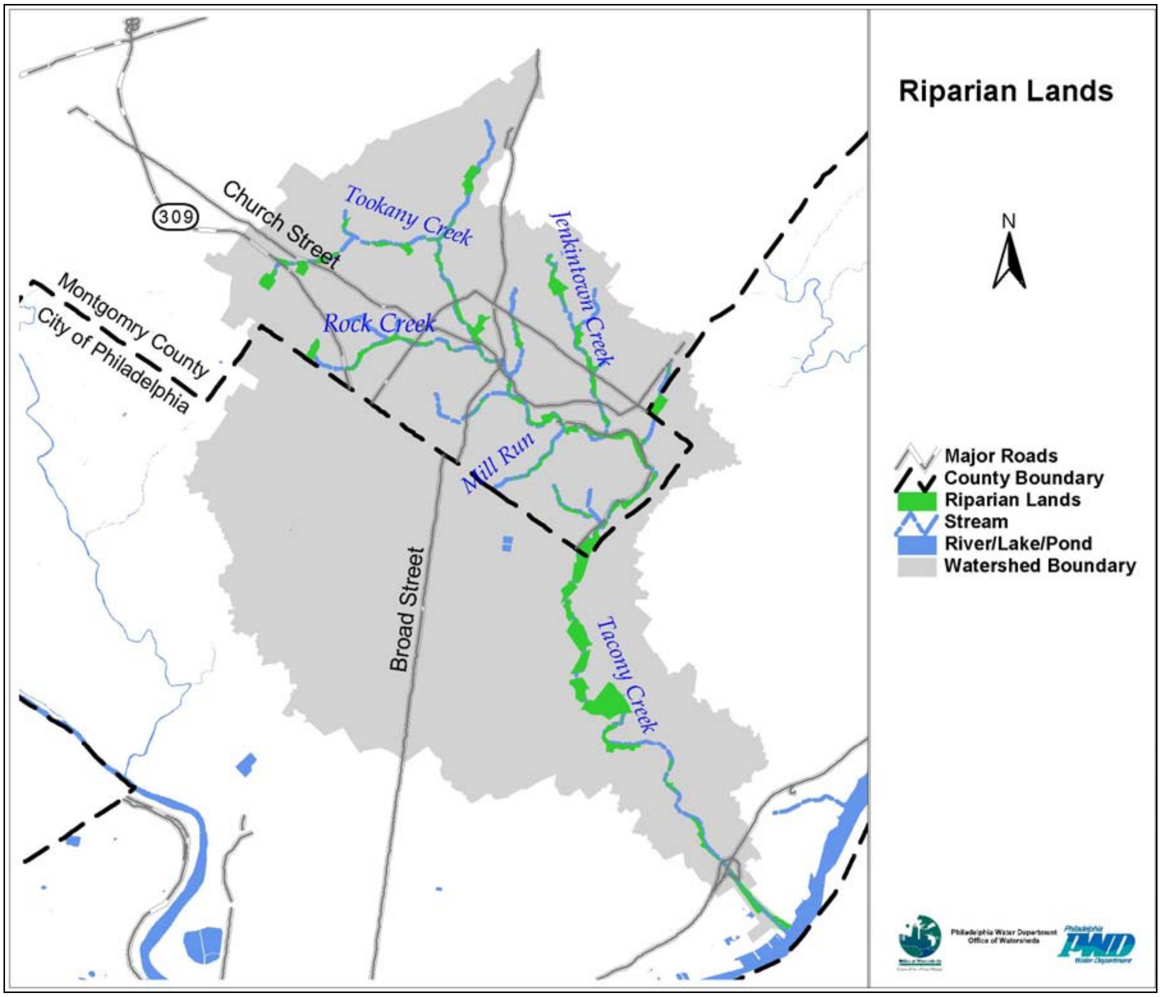


Figure 4.37 Undeveloped Riparian Lands in the Tookany/Tacony-Frankford Watershed

Forested areas in the Tookany/Tacony-Frankford Watershed are generally more contiguous within the Fairmount Park lands, where several large areas of woodland are found. In upstream areas, where there is greater urban encroachment in the riparian corridor, wooded areas are more fragmented, creating habitat for exotic, aggressive tree species. Regrowth of understory and herbaceous layers is usually limited once these non-indigenous species become established. Exotic control, replanting, and trash removal are components of riparian woodlands restoration.

A field study conducted by the Philadelphia Water Department found only small, scattered wetlands remaining along the riparian corridor (see Figure 4.38 and Tables 4.15 and 4.16). The estimated area of these remnants is roughly 15 acres (based on field survey, not jurisdictional mapping), which means wetlands are present in only 2.2% of the undeveloped riparian lands. Wetland communities of native vegetation are also scarce along the riparian corridor.

If runoff from the developed parts of the watershed could be settled and filtered by flowing through a restored riparian corridor, a substantial portion of the total solids in the stormwater could be removed before it reached the creek. However, most stormwater in the watershed is piped directly to the stream channel, bypassing the wetlands and riparian woodlands that could improve water quality through detention, trapping sediment, and recharge. Much of the woodland along the creek and its tributaries is now largely public open space (or in some cases, privately owned residential yards). Return of these lands to their original stormwater functions requires a public discussion and decision-making process for resolving competing uses for riparian lands (which currently include active and passive recreation).

As noted above, the total area of wetland in the watershed is small considering the 29 miles of waterways. Field investigation found only about 24 wetlands, totaling approximately 15 acres, along the creek and its tributaries. The wetlands range in size from 0.01 acre to approximately 2.5 acres. Most are very small: 13 of the 24 wetlands surveyed were less than one-quarter acre in size, and all but two of those were in the upstream Montgomery County reaches.

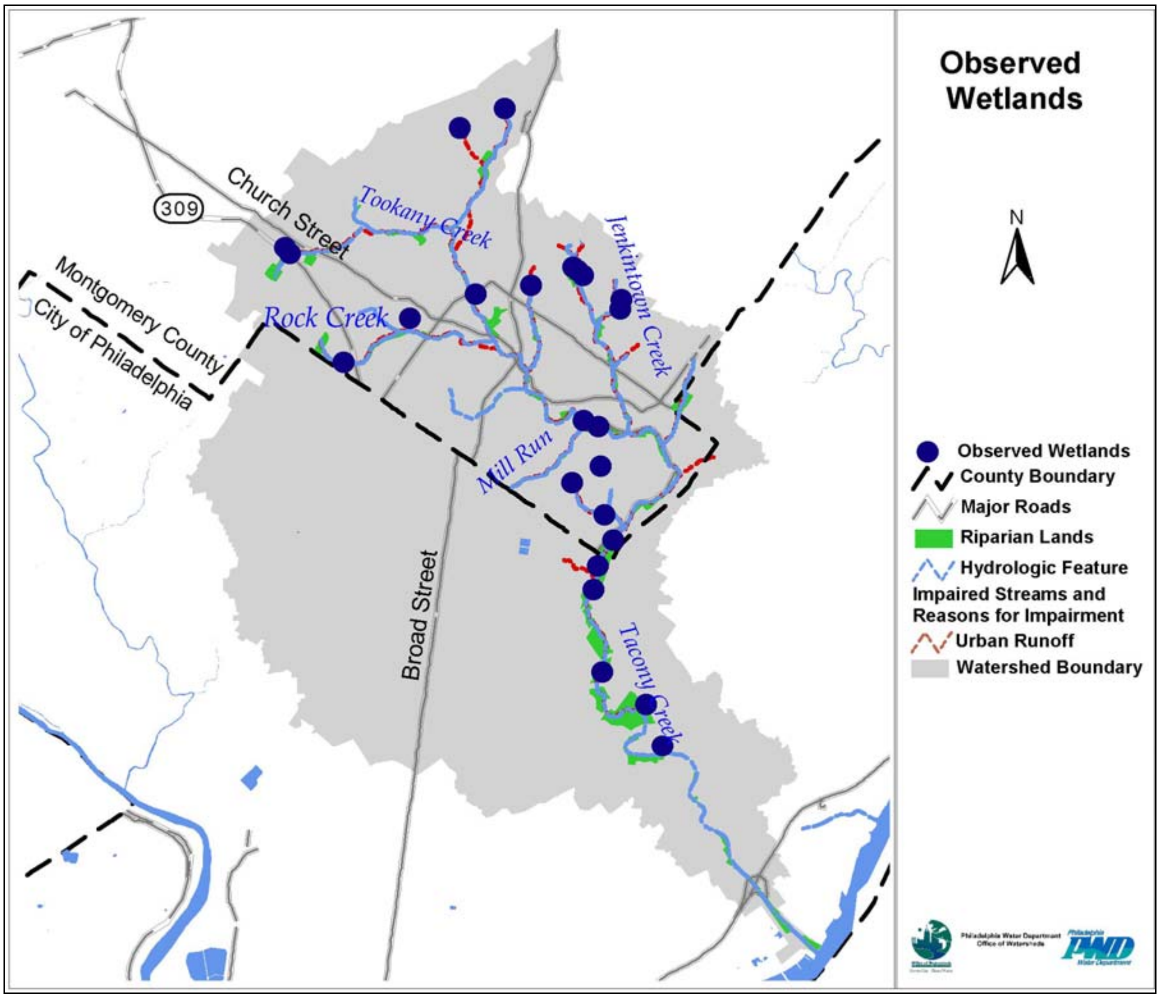


Figure 4.38 PWD Field Surveyed Wetlands (2002 – 2003)

Table 4.15 Estimated Wetland Area by County

County	Total Area (ac)	Woodlands (% of total)	Wetlands (% of total)
Montgomery	8,915	9%	0.20%
Philadelphia	12,178	2%	0.05%

Table 4.16 Estimated Wetland Area in the Tookany/Tacony-Frankford Watershed Area

Wetland	Location	County	Approximate Area (ac)
TF01-00612-W	Oak Lane and Brookfield Road	Philadelphia	0.25
TF-06190-W(E)	Crescentville Road and Godfrey Ave.	Philadelphia	1.4
TF-05911-W(E)	Adams Ave. at Tacony Creek	Philadelphia	0.01
TF-04933 -W(E)	Tabor Ave. at Tacony Creek	Philadelphia	2.5
TF-03968-W(E)	Friends Hospital and Oaklin Cemetery	Philadelphia	2.5
TF-02947-W(E)	Juniata Golf Course, Cayuga Street	Philadelphia	0.5
TF-06509-W	Tookany Creek Parkway, church parking lot	Montgomery	0.01
TF01-00295-W(E)	Hilldale Rd. & Boncouer Rd.	Montgomery	0.02
TF01-0805-W(E)	Parkview Rd. & Front St.	Montgomery	0.03
TF-14056-W(E)	Waverly Rd. at Holy Sepulchre Cemetery	Montgomery	1.7
TF-08853-W	Ashbourne Country Club	Montgomery	0.03
TF-09016-W(E)	Tacony Creek Parkway	Montgomery	0.4
TF-11331-W(E)	Bryer Estates, Washington Ln. and Township Line Rd.	Montgomery	0.8
TF03-001050-W(E)	Abington Country Club, Meetinghouse Rd.	Montgomery	0.4
TFR-00140-W(E)	Curtis Arboretum, Church Rd	Montgomery	0.02
TFJ-01855-W(E)	Alverthorpe Park	Montgomery	0.15
TFJ-01776-W(E)	Alverthorpe Park	Montgomery	0.06
TFJ-01737-W(E)	Alverthorpe Park	Montgomery	0.07
TF04-01071-W(E)	Abington High School	Montgomery	1
TF04-01561-W(E)	Abington Junior High School	Montgomery	0.2
TFEJ-00429-W(E)	Manor Junior College	Montgomery	2.4
TFEJ-00363-W	McKinley Elementary School	Montgomery	0.5
TF-14014-W(E)	Holy Sepulchre Cemetery	Montgomery	0.1
TFR-01887-W(E)	Cedarbrook Country Club	Montgomery	0.2
TOTAL # Wetlands	**24**		
TOTAL WETLAND ACREAGE	**15.25**		

Functional Assessment of Wetlands

The Tookany/Tacony-Frankford Watershed wetlands were evaluated for their value as wildlife and fish habitat, potential for water quality improvement (nutrient and toxicant reduction), and potential for hydrologic (flood flow) modification. Nearly all wetlands in the watershed exhibit impaired functions that indicate extensive disturbance and deterioration.

Results of the wetland functional field assessments (Table 4.17) indicate that the remaining wetlands in the TTF Watershed are degraded, and do not serve as high quality habitats or perform many of their water quality improvement or ecological functions. If stormwater was redirected to the small areas of remaining wetlands, rather than being rerouted directly to the Tookany/Tacony-Frankford Creek, water quality improvement would be minimal given the current compromised conditions of most of the wetlands. The water quality improvement potential for surveyed wetlands is mapped in Figure 4.39, and illustrates the extensively compromised ability of wetlands to perform their natural water quality improvement functions.

Table 4.17 Wetland Functional Assessment Results (based on 24 wetland locations)

Function	Number of Wetlands with Stated Condition
Wildlife Habitat	
Diverse Habitat	10
Moderate	14
Fish Habitat	
Intact Habitat	6
Degraded	12
Lost / Not Present	6
Water Quality Improvement	
Intact Function	3
Degraded	21
Hydrologic Connection to Stream	
Intact Connection	16
Degraded	7
Lost / Not Present	1

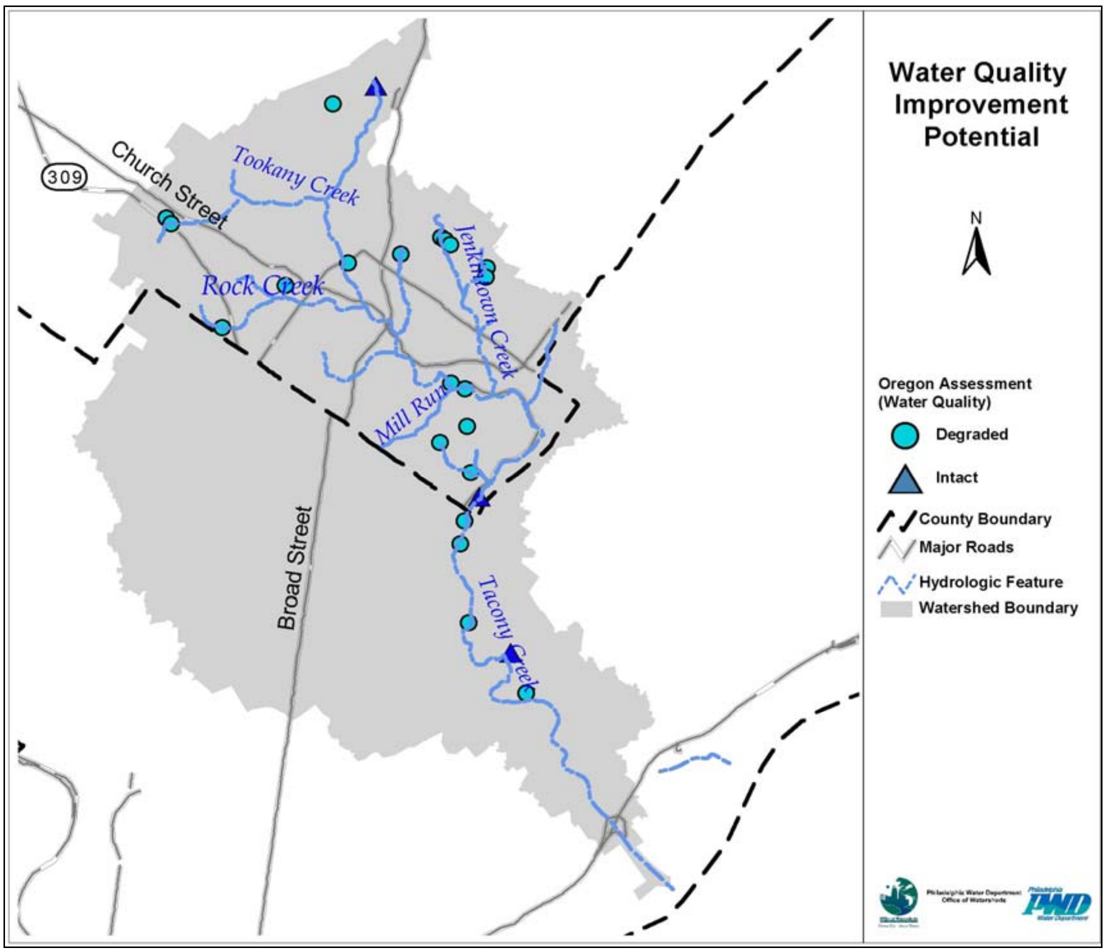


Figure 4.39 Results of Tookany/Tacony-Frankford Creek Functional Assessments for the Water Quality Improvement Function (2002 – 2003)

Human Disturbance of Wetlands

The wetlands that exist along the riparian corridor have been extensively disturbed by urbanization and the related hydrologic alterations to natural overland stormwater flows. A human disturbance score was calculated for each wetland based on several factors: disturbance to the immediate and intermediate wetland buffer zone; habitat alteration (specifically to soils and vegetation); hydrologic alteration (draining and disconnection from the surface drainage network); and chemical pollution from runoff, dumping, and spills.

Table 4.18 Wetland Human Disturbance Gradient Results

Human Disturbance Gradient Rank	Number of Wetlands
Moderately Low Disturbance	10
Moderately High Disturbance	12
Highly Disturbed	2

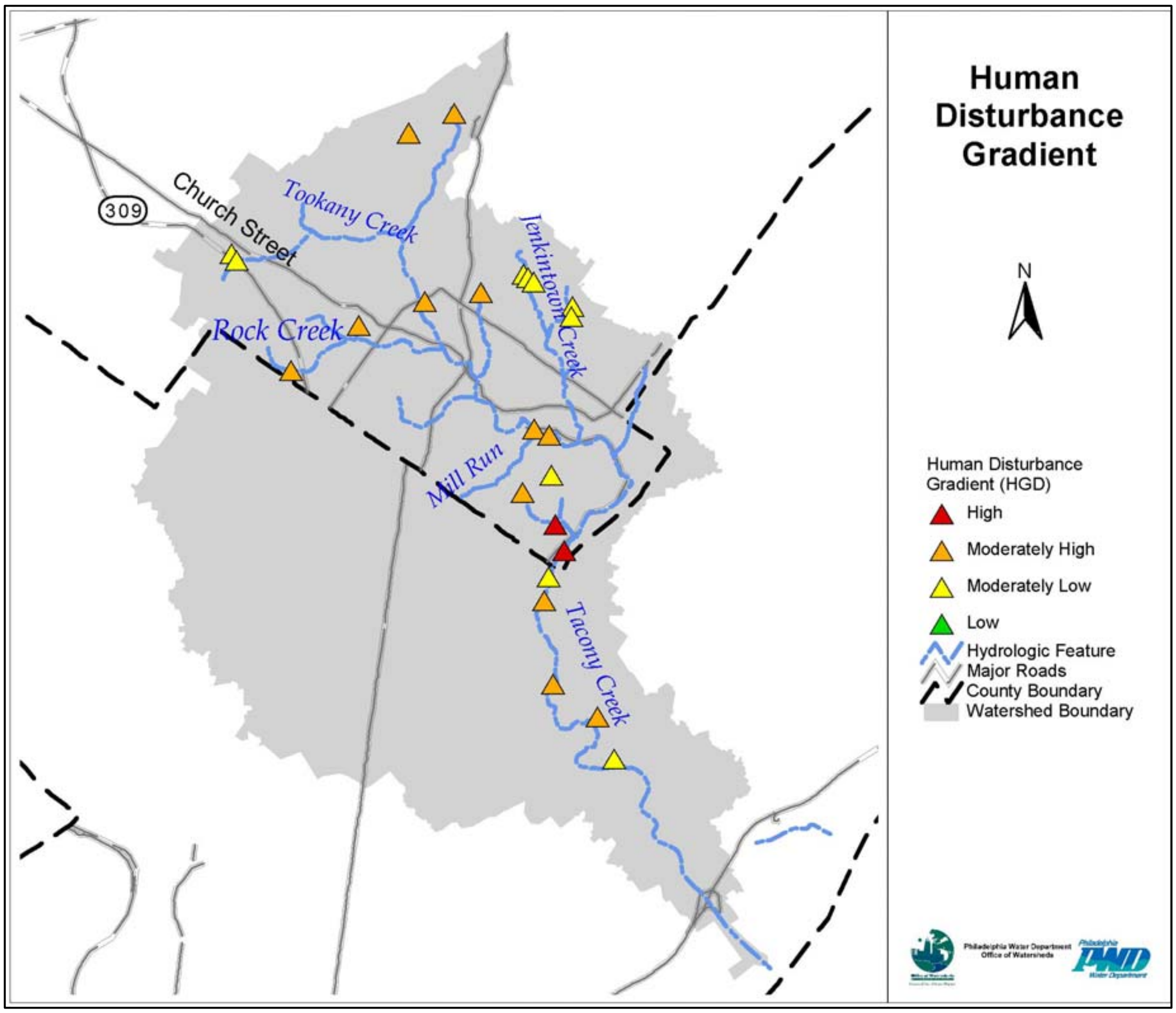


Figure 4.40 Human Disturbance Gradient Scores for Wetland Assessments (2002 – 2003)

4.5.3 Indicator 14: Wildlife

Wildlife includes birds, amphibians, and other animals that make their home in the watershed. Quality and diversity of wildlife habitats are also indicators of watershed health. Many species have specific habitat requirements. Their presence or absence indicates the health of the habitats. For example, healthy, naturally reproducing amphibian communities indicate the presence of appropriate habitats.

This indicator measures:

- **Species inventory**
- **Identification of any threatened and endangered species**

Figure 4.41 Photo of a Baltimore Oriole in Tacony Creek Park

<u>Where We Were</u>:
There is not much information on birds, reptiles, amphibians or mollusk species in Tacony Creek Park before the census was completed in 1998.

<u>Where We Are</u>:
In the Montgomery County section of the watershed, although no formal survey has been completed, there have been reported sightings of northern water snakes, garter snakes, box turtles, and several species of salamanders and frogs.

The Tookany section of the watershed has abundant geese and deer populations. These two animals can act as pests when their populations go unchecked.

In the Philadelphia portion of the watershed, a census was completed in 1998 in Tacony Creek Park (Figure 4.42). It was determined that the Park lacked healthy bird habitat. There were only 39 species of birds, 36 of which are probable breeders in Tacony Creek Park. 20 of these 39 species are indicator species, and only several individuals of each indicator species were found (Table 4.19).

The 1998 inventory found mollusks at six sites, two native Holarctic species, one native North American species and two introduced species. When looking at reptiles and amphibians, bullfrogs and green frogs are common along the creek. Isolated occurrences of two-lined salamanders, a northern red salamander, and northern brown snakes were found. No turtles were documented, though remains of a wood turtle were found. It is believed that a longer study would reveal more reptiles and amphibian species in this Park.

There are no known Pennsylvania Natural Heritage Program (PNHP) – formerly Pennsylvania Natural Diversity Inventory (PNDI) - species within the watershed.

Table 4.19 Park-Specific List of Individual Bird Indicator Species Observed in 1998 in Tacony Creek Park

Species ID	#	Species ID	#
Acadian Flycatcher	1	Eastern Towhee	2
Baltimore Oriole	12	Eastern Woodpewee	2
Barn Swallow	3	Great Crested Flycatcher	2
Belted Kingfisher	2	Great Egret	1
Black-crowned Night-heron	1	House Wren	3
Blue-gray Gnatcatcher	1	Orchard Oriole	1
Carolina Wren	3	Red-eyed Vireo	7
Common Yellowthroat	1	Redwinged Blackbird	1
Eastern Kingbird	4	Warbling Vireo	4
Eastern Phoebe	1	Wood Thrush	6
Total # of Species			**20**
Total # of Birds			**78**

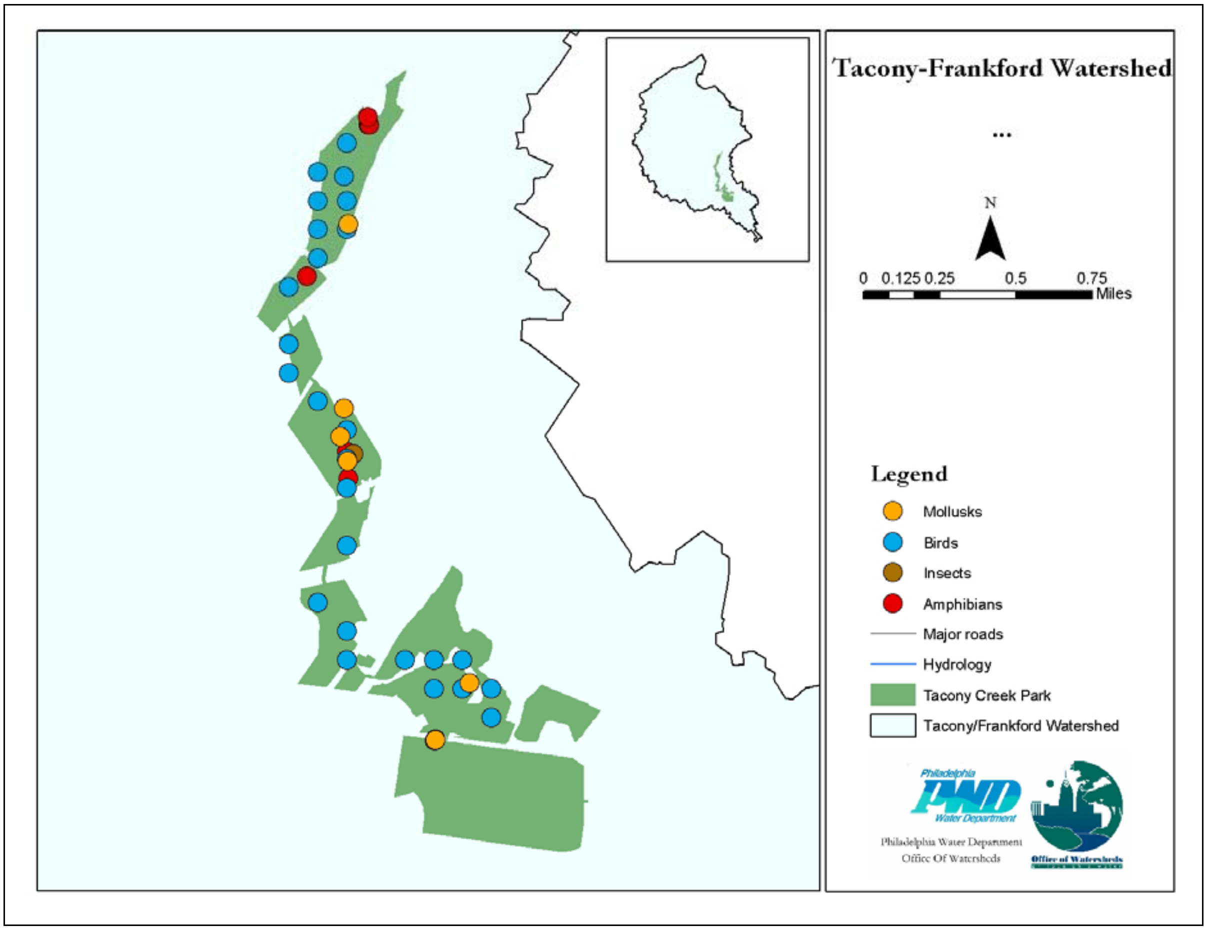


Figure 4.42 Species Locations Found During Tacony Creek Park Survey

4.6 Quality of Life

This group of watershed indicators relate to factors that affect the daily lives of people who live, work, or dream within the Tookany/Tacony-Frankford community.

4.6.1 Indicator 15: Flooding

Impervious cover and improperly sized or maintained drainage systems in urban watersheds occasionally lead to flooding. Act 167, the Stormwater Management Act of 1978, requires each county in Pennsylvania to prepare and adopt a stormwater management plan for each designated watershed in the county. An official plan provides a mechanism for municipalities to plan for and manage increased runoff associated with possible future development and land use change.

This indicator measures:

- **Areas susceptible to flooding along Tookany/Tacony-Frankford Creek**

Where We Were:

Frequent, serious flooding has not been a major concern in the Tookany/Tacony-Frankford watershed for many years since the stream was channelized. Floodplain mapping studies were conducted by FEMA to establish flood insurance rates for Montgomery County and for Philadelphia County in 1996. These studies include anecdotal evidence of major flooding during tropical storms.

Where We Are:

FEMA studies include stream cross-sections at major road crossings. Figure 4.43 identifies several road crossings where bridge decks are in the 100-year floodplain. As an example, several pictures were taken from the storm on August 1, 2004. The locations of the photos are along the Tacony Creek near Adams Avenue. Figures 4.44 through 4.46 indicate that extensive flooding occurred near the bridge, almost overtopping the bridge. Considerable debris was trapped at the culverts, shown in the photos after the stormflows had subsided.

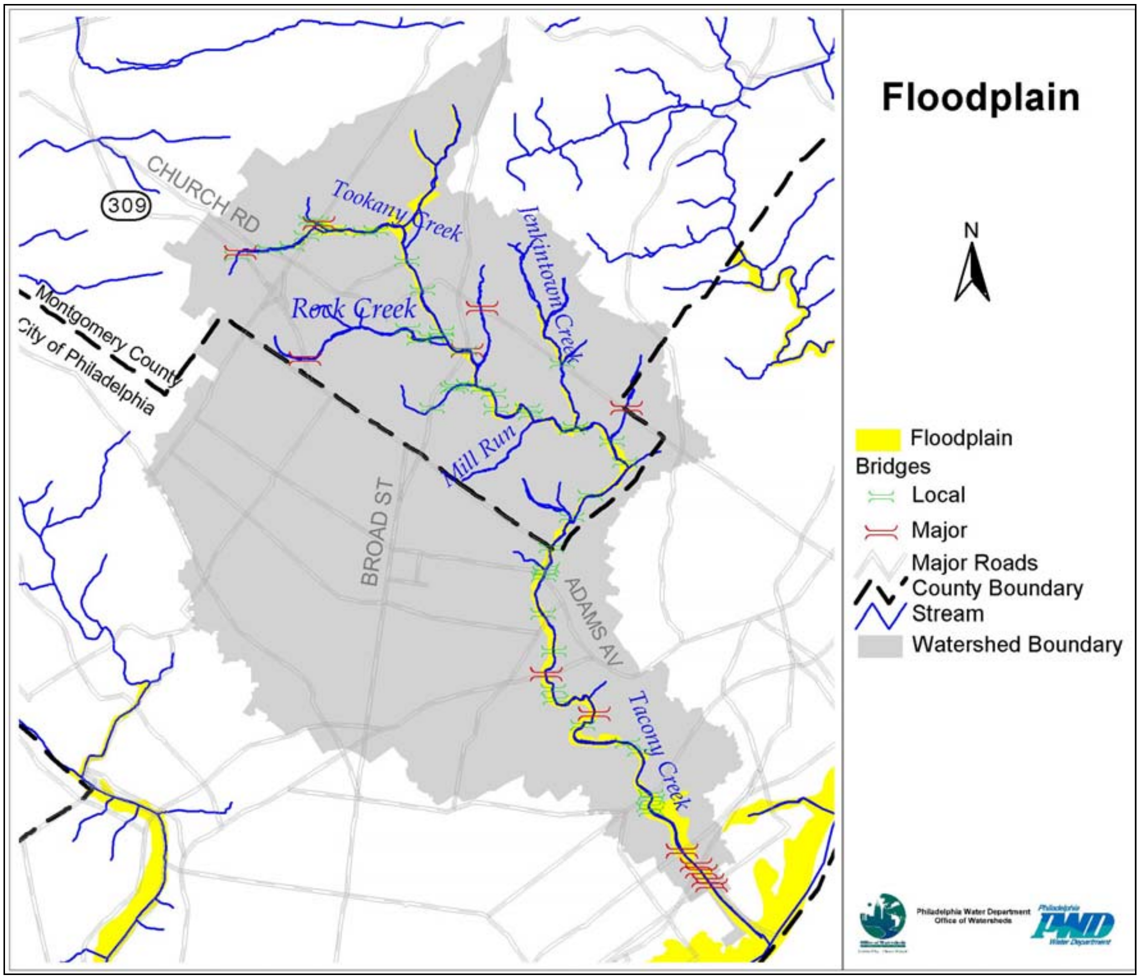


Figure 4.43 Estimated Flood-Prone Areas in the Tookany/Tacony-Frankford Watershed

Figure 4.44 Adams Avenue during August 1, 2004 Storm

Figure 4.45 Tacony Creek near the County Border during August 1, 2004 Storm

Figure 4.46 Adams Avenue after August 1, 2004 Storm

4.6.2 Indicator 16: Public Understanding and Community Stewardship

Because a connection to the natural world and its waterways is less apparent in some communities of the Tookany/Tacony-Frankford Watershed, the notion of environmental stewardship does not always top the list of daily priorities for many residents. Stewardship, therefore, must be built around the needs of the community as users of the watershed, as well as by making visible the critical ways in which the health of the watershed is integral to basic quality of life issues. Once this connection has been established, members of the community can be recruited to take action in protecting their watershed. Within this context, citizens need to 1) become aware of the meaning of the term "watershed" and understand the watershed in which they live, 2) become informed about the actions they can take to improve watershed health and 3) move from understanding into action and stewardship. Citizens must also remain informed of the progress made as implementation occurs.

Stakeholders are those who care with their minds and hearts because they already understand their vital connection to the environmental health of their community. The watershed stakeholders include state and federal regulators, those whose jobs empower them to guard the quality of our rivers and streams. The stakeholders include all of the municipalities, separate entities on paper yet bound together by nature including: neighborhood groups, religious groups, schools, and all groups who define themselves as environmental advocates.

This indicator measures:

- **Number of responses to surveys**
- **Number of newspaper stories and letters to the editor about watershed-related issues**
- **Changes in membership in the Tookany/Tacony-Frankford Watershed Partnership**
- **Participation in local environmental stewardship projects**

Where We Were:

A historical baseline has not been established for this indicator. Progress will be assessed next time this plan is updated.

Where We Are:

Surveys

As a part of the Rivers Conservation Planning Program, surveys of residents' understanding of their watershed were conducted by PWD and the Pennsylvania Environmental Council (PEC) for the Philadelphia portion of the watershed and by Heritage Conservancy for the Montgomery County portion of the watershed. The Philadelphia County survey was disseminated in 2002 and can be viewed in Appendix B (Survey 1). The Montgomery County survey was distributed in 2001 and can be viewed in Appendix B (Survey 2). It is evident from the results of both sets of surveys that there is an interest and desire on behalf of the residents to better manage the Tookany/Tacony-Frankford Watershed and to revitalize its creeks. It is also apparent that watershed education and outreach for the residents in both counties are necessary as reflected by a number of the answers in the surveys, in addition to the low response rate on both the Philadelphia County and Montgomery County surveys. A summary of the results of the Tookany survey (Montgomery) is listed at the end of this section. The results of the Tacony-Frankford (Philadelphia) survey and an analysis of the survey results follow (Figure 4.48).

The Tacony-Frankford survey was created with several goals in mind: 1) to provide baseline information on resident knowledge of watershed issues, 2) to understand the residents' hopes and concerns for the Tacony-Frankford Creek, and 3) to educate these residents about the impacts of their actions on the creek. The timeframe for the Tacony-Frankford survey to be completed and returned was approximately seven months. The distribution of the survey was broad, with roughly 800 surveys placed within 16 libraries, 600 surveys distributed through community contacts, 150 distributed at community presentations, and an additional 275 sent to high school teachers at 11 Philadelphia high schools, for a rough total of 1,875 surveys disseminated throughout the watershed. Although there was a low response rate with only 71 completed surveys returned, the surveys did cover a broad area of the watershed. Of the returned surveys, 18 zip codes spanning 31 neighborhoods were represented (Figure 4.47).

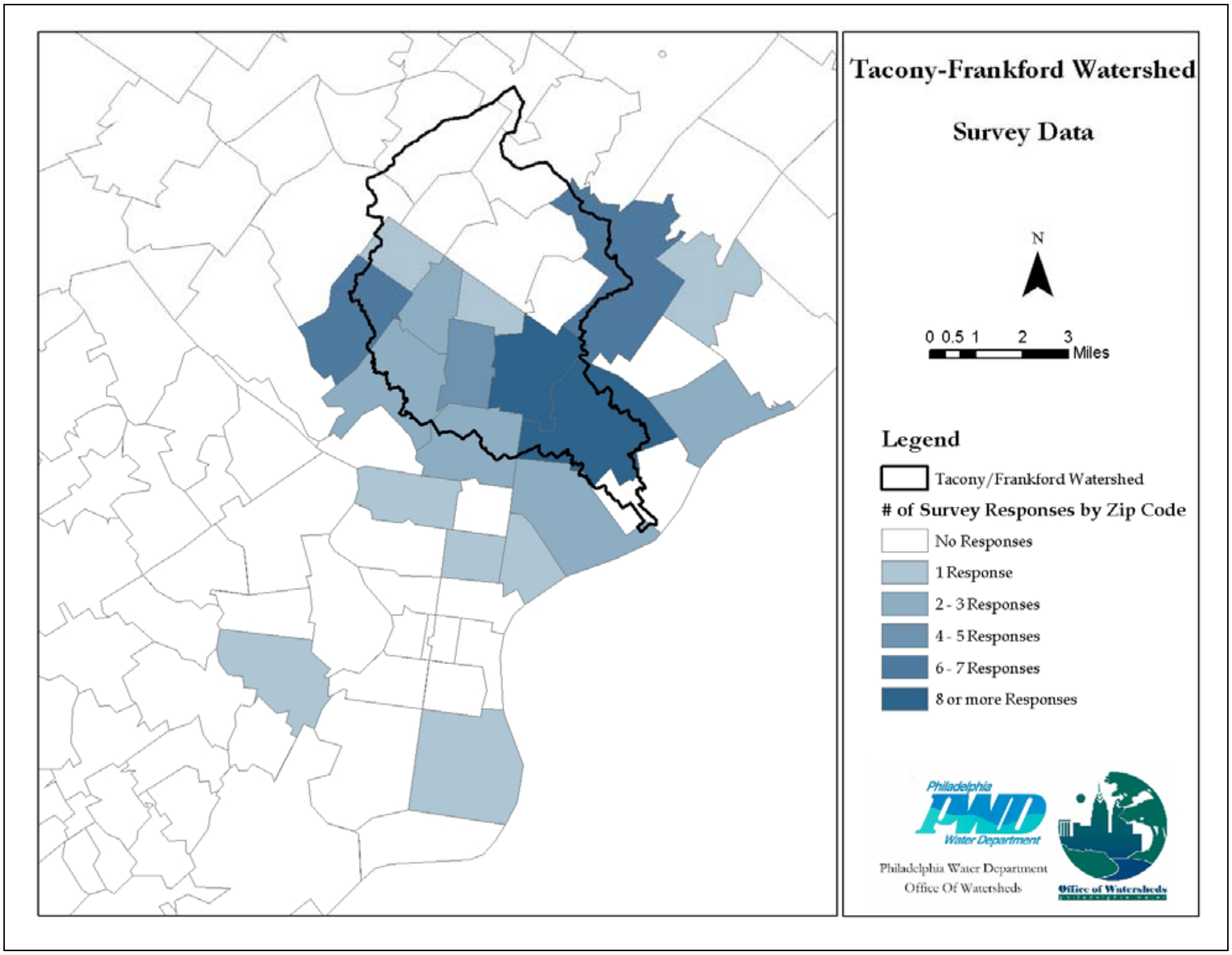


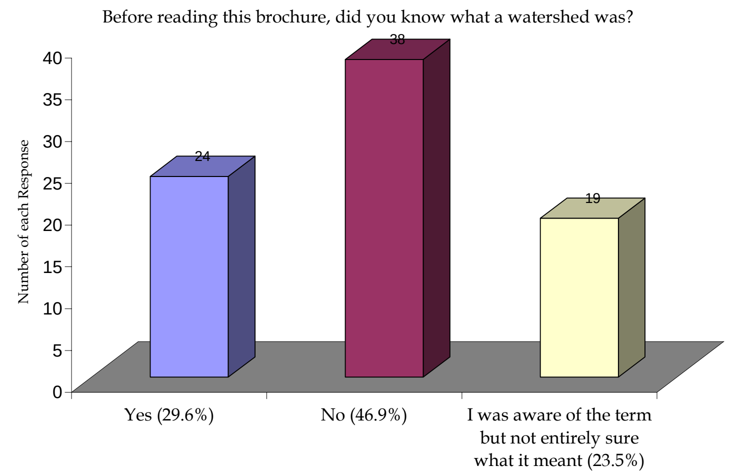
Figure 4.47 Neighborhoods of Respondents to Tacony-Frankford River Conservation Plan Watershed Survey

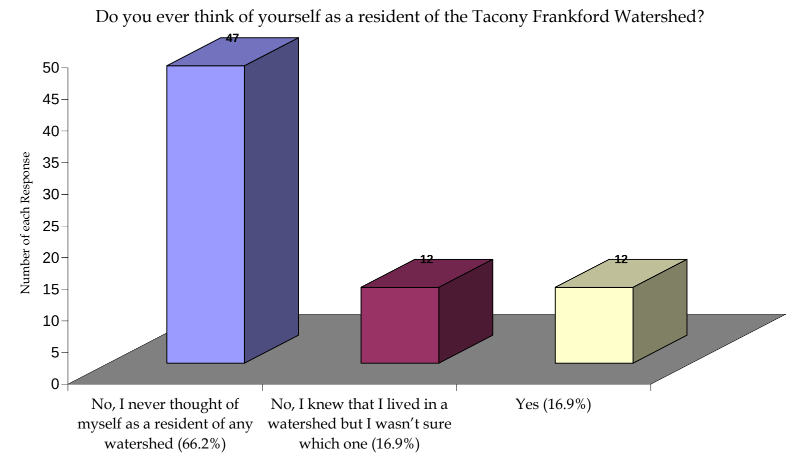
Results indicate that the majority of residents responding to the Tacony-Frankford survey did not have prior knowledge of the definition of the term "watershed" before reading the brochure. Additionally, only 30% of respondents (21 total responses) thought of themselves as residents of the Tacony-Frankford Watershed.

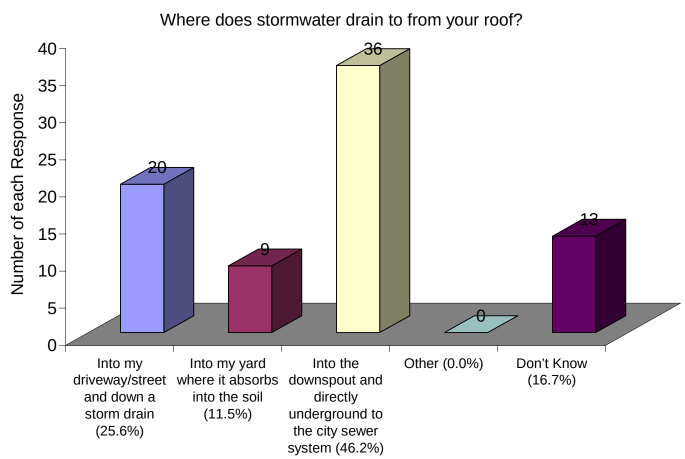
Sixty four percent (64%) of the Tacony-Frankford survey responses (43 respondents) indicate that residents rarely, if ever, spend recreational time along the creek. Also, more than half of the respondents perceive the water quality of the Tacony-Frankford Creek as poor. The surveyed residents have identified trash and litter in the streams as the most significant source of pollution to the watershed. Sedimentation was ranked as the second most significant source of pollution and illegal dumping ranked third. When asked where money should be directed for the purpose of enhancing the greater community, the answer most frequently rated as most important was the “cleaning of the water in the creek.” The removal of trash from the creek area ranked second, and increased safety and security in parks ranked third.

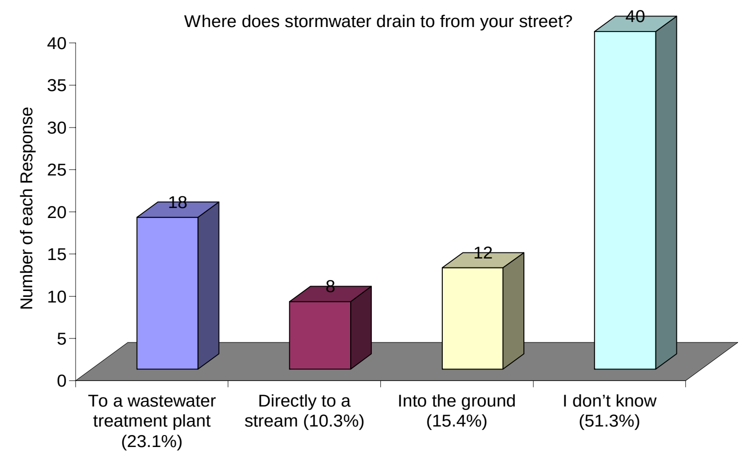
Once the Tacony-Frankford survey results were broken down into two age groups, respondents 18 years and over, and respondents under the age of 18, additional interesting results emerged. Of the 48 individuals surveyed that were 18 years and over, 35 % responded that they knew what a watershed was, and 23% had at least heard of the term before. In contrast, only 6% of the 17 respondents in the category of “under the age of 18 years” knew what a watershed was, although 35% of them claimed to have at least heard the term before.

When asked about the amount of recreational time spent along the Tacony-Frankford Creek, of those under the age of 18, only 12% (2 of the respondents) claimed to spend any time at all along the creek, and then only a few times a year. It seems that residents in the “18 years and over” category have been more likely to make use of the areas along the creek, with 39% (19) of them having visited the area at least a few times a year. Of the 45 respondents who do spend time in the parks, 53% go there to walk, the most frequent recreational activity in the area.


Before reading this brochure, did you know what a watershed was?
Number of each Response
0
5
10
15
20
25
30
35
40
24
38
19
Yes (29.6%)
No (46.9%)
I was aware of the term but not entirely sure what it meant (23.5%)


Do you ever think of yourself as a resident of the Tacony Frankford Watershed?
Number of each Response
0
5
10
15
20
25
30
35
40
45
50
47
12
12
No, I never thought of myself as a resident of any watershed (66.2%)
No, I knew that I lived in a watershed but I wasn't sure which one (16.9%)
Yes (16.9%)


Where does stormwater drain to from your roof?
Number of each Response
0
5
10
15
20
25
30
35
40
20
9
36
0
13
Into my driveway/street and down a storm drain (25.6%)
Into my yard where it absorbs into the soil (11.5%)
Into the downspout and directly underground to the city sewer system (46.2%)
Other (0.0%)
Don't Know (16.7%)


Where does stormwater drain to from your street?
Number of each Response
0
5
10
15
20
25
30
35
40
18
8
12
40
To a wastewater treatment plant (23.1%)
Directly to a stream (10.3%)
Into the ground (15.4%)
I don't know (51.3%)

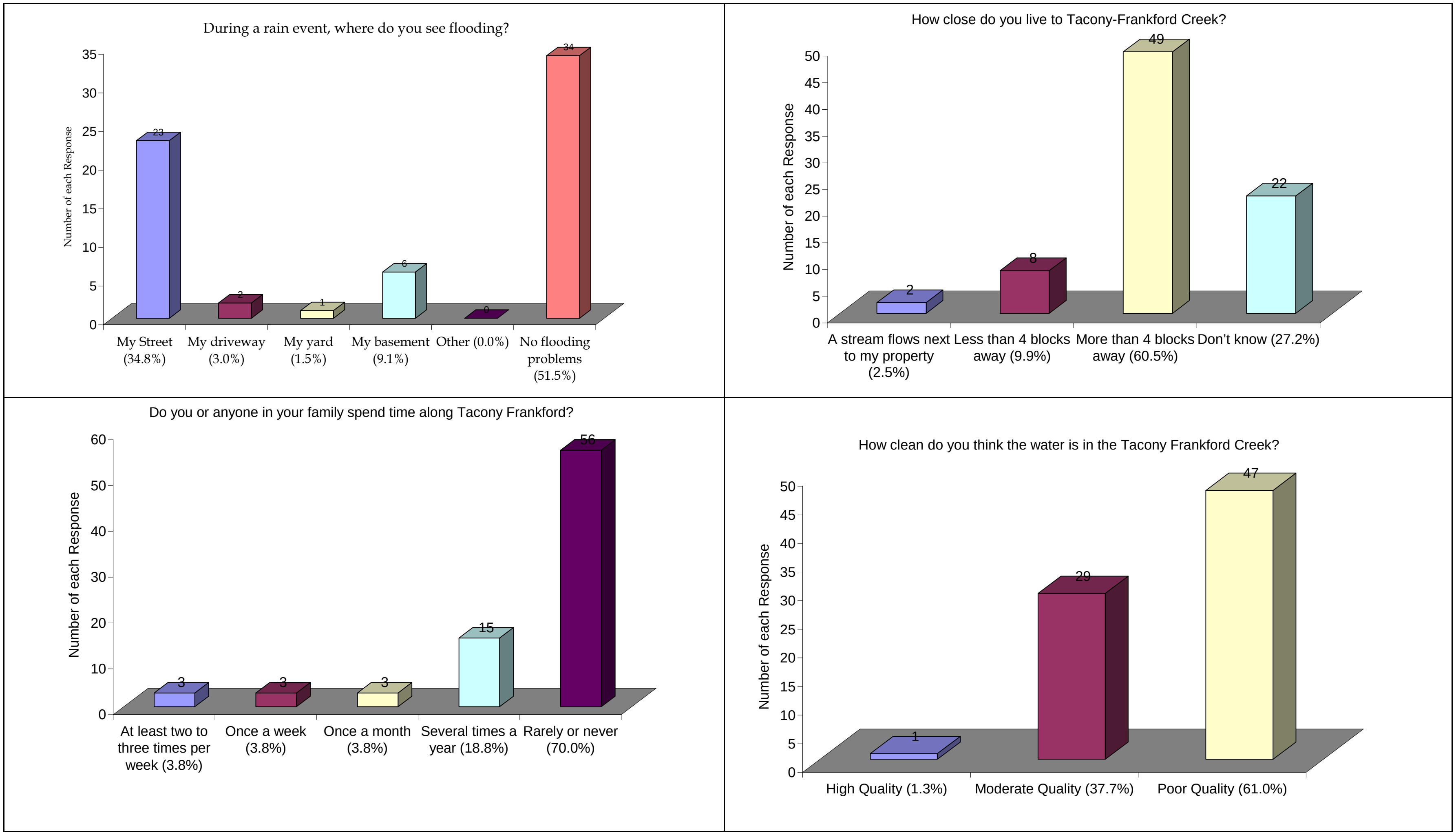


Figure 4.48 Tacony-Frankford Resident Survey Results

For the Tookany survey, 147 (15%) questionnaires were returned out of the 1,000 that were randomly disseminated to the four Montgomery County municipalities. Out of the 147 completed surveys, 101 were returned from Cheltenham County residents. Below is a summary of the Tookany survey results as listed in the "Tookany Creek Watershed Management Plan."

Tookany Creek Survey Results

- The majority (90%) think that the Tookany Creek is an important natural and scenic resource.
- A majority recommended preservation of undeveloped land, preservation of historic resources, preservation of scenic character, protection of wildlife habitat, municipal ordinances that preserve forested land, improvement of water quality, and education.
- A majority also recommended discouraging residential development, shopping centers, retail development, and other commercial and industrial development.
- The main issues that respondents feel need to be addressed are trash, water pollution, and flooding.
- One-half (51%) of respondents said they use the Tookany Creek or its tributaries for nature walks. 29% use it for biking and hiking, 22% use it for jogging, and a small percentage use it for fishing (8%). Respondents participate in the above activities about five times per month.
- When asked what improvements they would like to see, comments included more parking, trails for biking, walking, signage, safety, and better maintenance in general.
- If there were better access to the creeks, more than half would use the creek and its tributaries more.
- 77% feel that municipalities should be responsible for increased conservation and management; 65% feel it should be a county park system responsibility.
- 44% said the money for these projects should come from municipal bonds, and 77% said it should come from federal, state, or private grants.
- When asked to rank eight priority projects, most projects were in the low to average ranking. About one-third (32%) said they want stronger land use ordinances to regulate how land is used along stream corridors, one-third (31%) want streambank restoration to filter pollutants, and 17% indicated that they would want a tree replacement program and physical improvements to reduce flooding.
- Most respondents want education and land use regulations to conserve and protect creek corridors.
- Prior to this survey, 65% of people had not heard about any conservation efforts along the Tookany Creek, and those who did (20%) had read it in the newspaper.
- More than one-half of the respondents (55%) would like to receive written updates on the progress of the TTFIWMP.
- Only 3% of respondents own creek front property.

- Half of the respondents said they do not want to serve on a volunteer coalition or volunteer to participate in a streambank restoration.

Articles

The media greatly influence community perception and may indicate, via public reaction, which events and issues are important to the community. Through an examination of newspaper clipping articles and "letters to the editor" in local weekly and daily papers that serve the Tookany/Tacony-Frankford Watershed, 15 articles specific to the watershed or the TTF Partnership have been identified since 2000.

In the fall of 2002, the Tookany/Tacony-Frankford Watershed Partnership initiated what they called the Tookany/Tacony-Frankford Newspaper Series. They wrote a series of six articles about their watershed history and current issues that were printed on a bi-weekly basis in local newspapers. These six articles (listed below) can be found on the TTF Partnership website at www.phillywater.org/tacony-frankford/Education/education.htm:

1) *Restoring Our Watershed Means Healthier, Safer Communities*
2) *Demographics/ History/ Development of the Tacony-Frankford*
3) *Recent Watershed History*
4) *Natural Amenities*
5) *Challenges*
6) *"What's going on in your Watershed?"*

Membership

Attendance at meetings held by watershed-related groups is another way to gauge interest among citizens. Some 37 stakeholders (Table 4.20) have attended or participated in meetings sponsored by the Tookany/Tacony-Frankford Partnership and other watershed-related forums.

Table 4.20 Organizations/Agencies Represented at TTF Partnership Meetings

Abington Township Environmental Advisory Council (EAC)
Awbury Arboretum
Cardone Industries
CDM
Central East Middle School
Centro Nueva Creacion
Cheltenham Township
City Year Philadelphia
Delaware Riverkeeper Network
Delaware Valley Earth Force
Earthright
Edison / Fareira High School
Fairmount Park Commission
Frankford Group Ministry
FrankfordStyle Community Arts Organization
Friends of High School Park
Friends of Tacony Creek Park
Friends of Pennypack Park
Glenside Green
Heritage Conservancy
LaSalle University
Melrose Park Neighbors Association
Montgomery County Planning Commission
National Park Service Rivers & Trails
PA Department of Conservation and Natural Resources
PA Department of Environmental Protection
Pennsylvania Environmental Council
Pennsylvania Horticultural Society, Philadelphia Green Program
Philadelphia City Planning Commission
Philadelphia Police Department
Philadelphia Water Department, Office of Watersheds
Rohm & Haas Co.
Senior Environmental Corps
Tookany Creek Watershed Management Plan Steering Committee
U.S. Army Corp of Engineers
U.S. Environmental Protection Agency
U.S. Environmental Protection Agency (*VISTA)

Stewardship

Members of the Tookany/Tacony-Frankford Watershed Partnership have been active in participating in and leading local stewardship projects throughout the watershed. Volunteer groups host stream clean-ups and coordinate restoration projects, such as the planting of native vegetation along the creek's riparian corridors. Partnership members have led rain barrel workshops at their homes and in their communities as a means to educate local residents about the impacts of stormwater runoff and the use of rain barrels as stormwater controls. PWD (on behalf of the TTF Partnership) and the Montgomery County Conservation District have each sponsored rain barrel projects in overlapping areas of this watershed, resulting in the installation of 215 rain barrels in the Tookany/Tacony-Frankford Watershed from the PWD program and 35 rain barrels in the Tookany section of the watershed from the Montgomery County program.

In order to broaden community support and involvement throughout the watershed, Partnership members also coordinated various public events. Self-guided watershed tours and Visual Stream Assessments were sponsored as a way to familiarize residents with the watershed area. The Wingohocking Mystery Tour, which follows the route of the now sewered Wingohocking stream, the largest tributary to the Tacony-Frankford Creek, has now been held annually since 2002. The Return of the Great Blue Heron Day was organized in spring of 2003 to celebrate and bring attention to the good work being done in the watershed that has made it possible to see wildlife return to portions of this region. An overwhelmingly well attended invasive plants workshop was hosted in 2004 in the Tacony Creek Park. This workshop educated stakeholders about types of invasive species and options for removing these plants without damaging the surrounding plant life. An urban streams restoration workshop was held in January 2004 at The Franklin Institute, featuring an urban streams restoration expert who discussed the types of restoration solutions that could be applied in an urban stream such as the Tookany/Tacony-Frankford. The workshop was such a success that it inspired a more detailed follow-up program: the Urban Watersheds Revitalization Conference, a two-day event held in January 2005 at the Franklin Institute.

4.6.3 Indicator 17: School-Based Education

School-aged children of today are the watershed stewards of the future. For that reason, school-based education is an integral component of the long-term health of the watershed. School-based education takes many forms, from lesson plans within the classroom to hands-on activities outside of the classroom such as field trips to the Tookany/Tacony- Frankford Creek and direct involvement in actual restoration projects.

Figure 4.49 Students Collecting Insects in the TTF watershed

Being engaged in actual restoration projects, either through service learning, after-school clubs, or as part of lesson plans translates lessons into action. There are several ways to measure the success of school-based education programs, and each depends on the other.

This indicator measures:

- **Survey of schools on whether they have environmental or watershed management curriculum**
- **Number of schools participating in local environmental stewardship projects**

<u>Where We Were</u>:
A historical baseline has not been established for this indicator. Progress will be assessed next time this plan is updated.

<u>Where We Are</u>:
To date, there are various schools in the watershed that have incorporated environmental or watershed management into the curricula. Furthermore, there are schools that have led local stewardship projects that involve, for example, the creation of a wetland on-campus, participation in a streambank restoration project, and the installation of rain barrels on-campus. Students throughout the watershed also submitted 24 logo entries into the Tookany/Tacony-Frankford Partnership Logo Contest. The winning school's logo became the TTF Partnership's emblem.

In Montgomery County, there are at least seven schools that incorporate environmental and watershed lesson plans into their curricula. These schools include Cheltenham Elementary, Myers Elementary, Wyncote Elementary, Glenside Elementary, Elkins Park Middle School, Cedarbrook Middle School, and Cheltenham High School. In Philadelphia, there are at least 10 schools integrating watershed and environmental education into their curricula. Five of the schools listed below participate in watershed and environmental education programs offered at nearby Awbury Arboretum, while other schools develop their own stewardship projects in their local neighborhoods. Schools in Philadelphia that have incorporated watershed and environmental education into their curricula include Edison Fareira High School, Frankford High School, Grover Washington Junior High School, Hill-Freedman Middle School, Ada Lewis Middle School, Henry R. Edmunds Middle School, Germantown Settlement Charter School, Fulton Elementary School, Hopkinson Elementary, and Holy Innocents Parish Elementary.

The Academic Standards for Science and Technology and Environment and Ecology became a core requirement of the public school curriculum in January 2002 and testing on these topics commenced for the first time in spring 2003 as part of the Pennsylvania System of School Assessment (PSSA). The standards establish the basic elements of what students should know and be able to accomplish at the end of grades 4, 7, 10, and 12. Section 4.1 of these standards is dedicated to watersheds and wetlands. The goals for this topic area are for students to gain knowledge about water cycles, the role of watersheds, physical factors, characteristics and functions of wetlands, and the impacts of watersheds and wetlands. A scope and sequence has been predetermined for each of the aforementioned grades.

4.6.4 Indicator 18: Recreational Use and Aesthetics

People seem to be innately drawn to water and areas of natural beauty. Not surprisingly, park and recreational areas are often centered on scenic water features, such as lakes or rivers. Indeed, many acres of parkland are already established along the Tookany/Tacony-Frankford Creek (see Figure 4.51). However, many miles of the creek are not accessible to the public. If the public has no way to get to the stream, it is less likely to be enjoyed. Parks, and the waterways that flow through them, serve many functions; some obvious and others unseen. For instance, parks and waterways are areas of active and passive recreation. Active recreation includes football, baseball, and canoeing, while passive recreation implies that areas are intended for quiet contemplation or conversation, an essential respite from the concrete and asphalt of the urban world. Natural amenities, when protected and preserved, elevate the quality of life for residents by providing a myriad of recreational, educational, and other activities, in addition to enhancing the market value of homes and institutions.

This indicator measures:

- **Stream accessibility for the Tookany/Tacony-Frankford Creek and its tributaries**
- **Tons of trash removed from the creek and buffer areas**
- **Miles of trails**

Where We Were:

A historical baseline has not been established for this indicator. Progress will be assessed next time this plan is updated.

Where We Are:

Stream Accessibility

An accessibility indicator was developed to determine the degree to which a community is able to reach their waterways (Table 4.21 and Figure 4.50). Accessibility was determined on a scale from 0 through 5, with zero representing a particular segment of a stream that is inaccessible and 5 representing a completely accessible stream segment. The greater the availability of parking, trails, and public recreational land adjacent to the stream, the higher the accessibility rating given to that reach of stream. A segment of a stream running through a private, industrial, or commercial site was given a rating of 0. A segment of a stream running through a public park that has parking and trails leading to the stream was given an accessibility rating of 5. The number of stream miles and the percentage of the total stream miles with each particular accessibility rating were calculated. Fifteen percent of the waterways within the Tacony-Frankford Watershed were given a "Completely Accessible" rating. An additional 20% of the stream miles were rated as "Highly" or "Somewhat Accessible."

Table 4.21 Accessibility by Stream Miles

Accessibility Rating	Length (miles)	Description	% of Stream Miles
0	3.70	Not Accessible	8%
1	10.50	Minimally Accessible	24%
2	15.28	Moderately Accessible	34%
3	6.11	Somewhat Accessible	14%
4	2.26	Highly Accessible	5%
5	6.48	Completely Accessible	15%

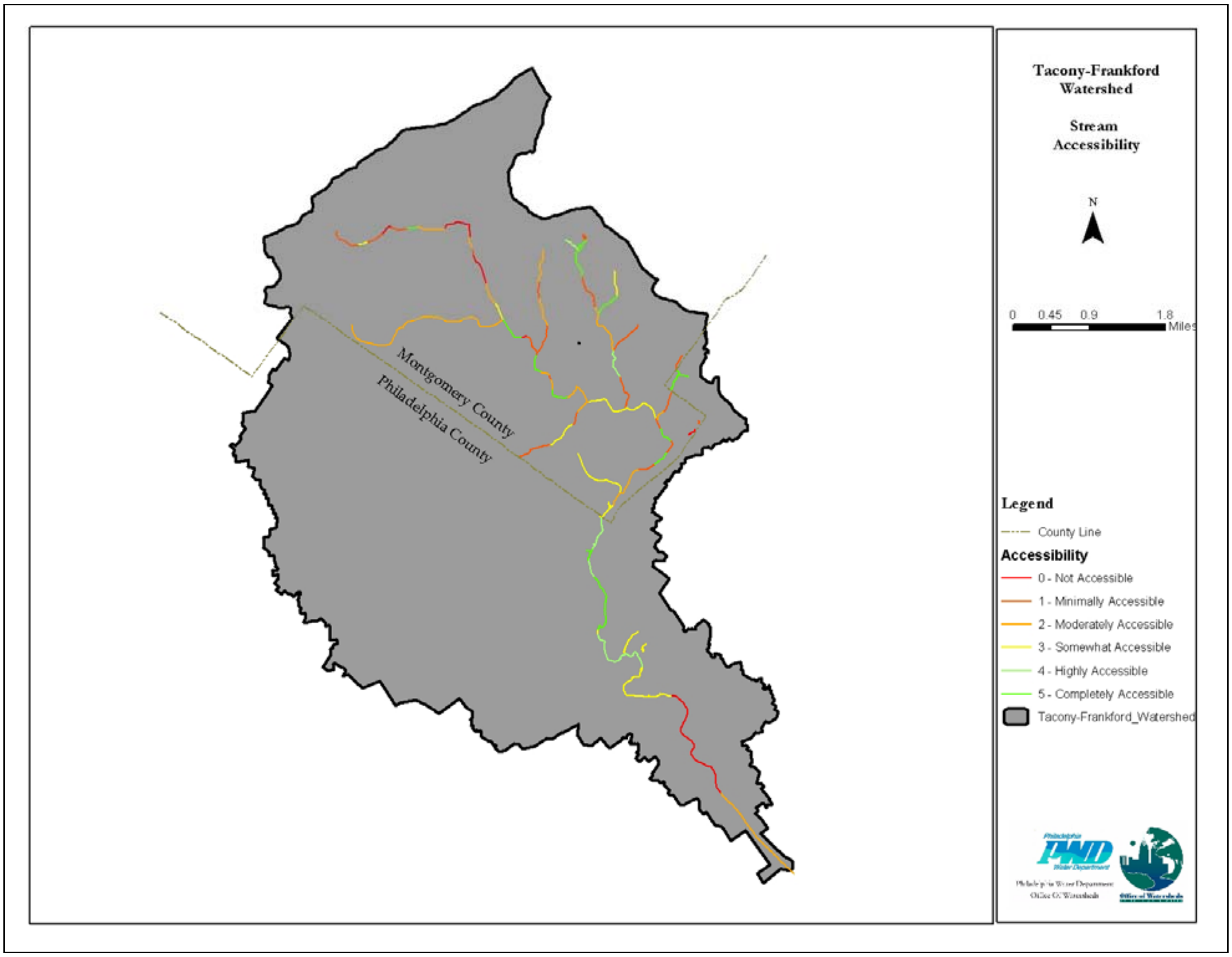


Figure 4.50 Stream Accessibility and Parks in Tacony-Frankford Watershed (2004)

Trash Removal

Maintenance records indicate that 78.45 tons of trash and debris were removed from creeks and riparian buffers in Philadelphia between July 2003 and July 2004 by the Philadelphia Water Department's Waterways Restoration Unit (WRU). The WRU is dedicated to removing large trash and debris – cars, appliances, shopping carts – from our streams in addition to restoring streambanks and streambeds that have been eroded as a result of pipe outfalls. The WRU partners with the Fairmount Park Commission and dedicated volunteers throughout Philadelphia on clean-up and restoration efforts.

Miles of Trails

Burlholme Park and Tacony Creek Park offers residents the opportunity to walk trails along the creek in the watershed. Burlholme's trails parallel an unnamed tributary to the Tookany Creek as it flows into Cheltenham Township. Tacony Creek Park has an extensive trail network along the Tacony Creek, including a trail that extends the length of the park. These trails are the most tangible connection that city residents have to this watershed. Other parks that have walking trails include Awbury Arboretum, Fern Hill, Wister Woods, Kemble, and Fisher Park.

There are 43.8 miles of bike paths within the Tacony Frankford watershed. Most of the bike paths follow major thoroughfares.

The Parkland map (Figure 4.51) details bike routes and walking trails that contribute to the amount of open space within the watershed.

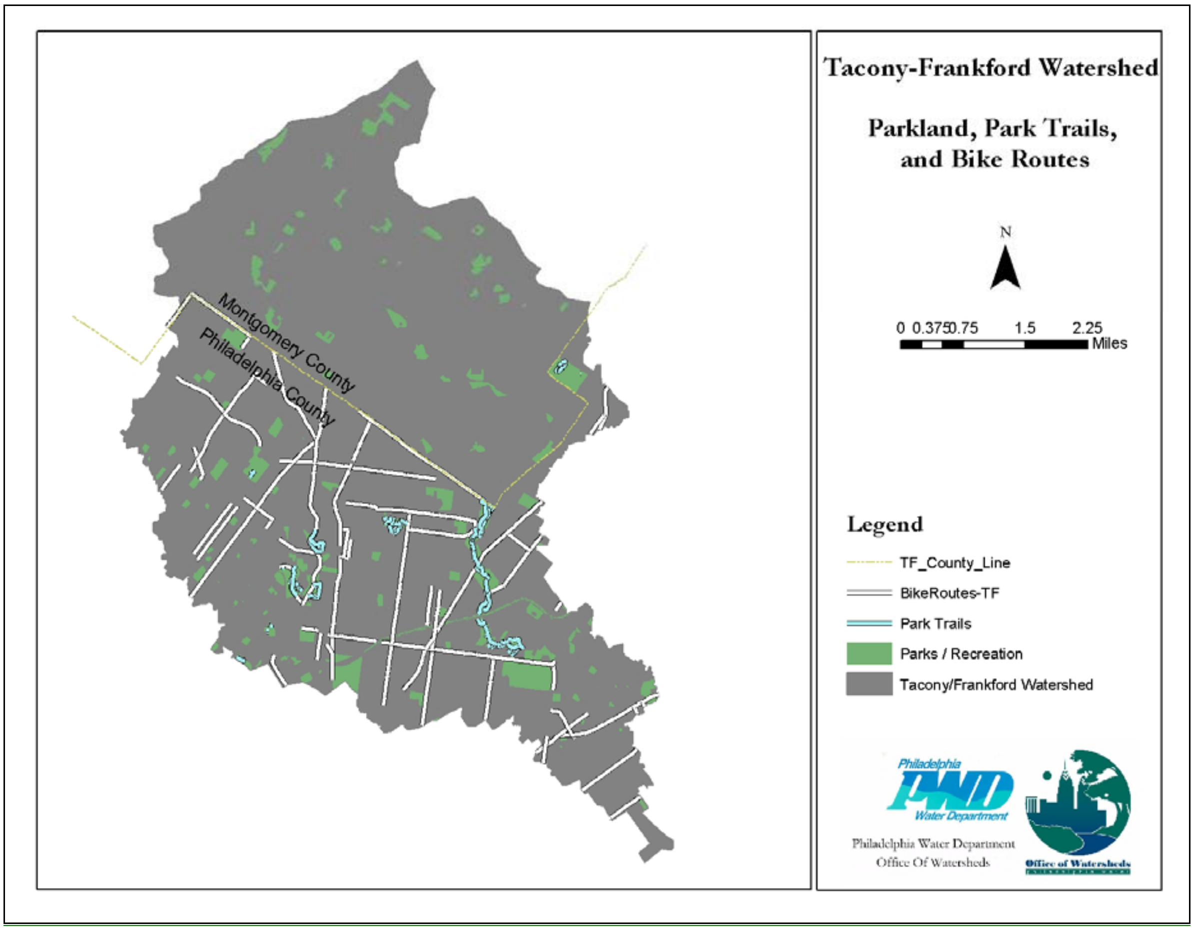


Figure 4.51 Parkland, Park Trails, and Bike Routes in the Tookany/Tacony-Frankford Watershed

4.6.5 Indicator 19: Local Government Stewardship

Local government leadership is essential to ensuring that improvements made under watershed restoration planning are sustainable. Local governments must also support, encourage, and complement the stewardship efforts of individuals, environmental groups, and businesses. A major goal is for local governments to work within their regulatory and statutory obligations while actively supporting the stewardship efforts within the watershed. It is also important that local governments implement voluntary actions to restore the watershed. Most importantly, to ensure the success of the watershed management plan, each local government within the watershed must embrace the goals and implementation strategies of the plan. A formal adoption of this plan would enhance its chance for success tremendously.

This indicator measures:

- **Municipalities participation in initiatives such as Act 167 planning, the TTF Partnership, River Conservation Plans (RCPs), and representation on the Board of the new 501(c)3 organization**
- **Age of sewage facilities (Act 537) plans**

<u>Where We Were</u>:

A historical baseline has not been established for this indicator. Progress will be assessed next time this plan is updated.

<u>Where We Are</u>:

To date, the Philadelphia Water Department and Cheltenham Township have received state grants to develop Act 167 Plans in the Tookany/Tacony-Frankford Watershed. Act 167 Plans require counties to prepare and adopt stormwater management plans for each designated watershed in a county. Consequently, PWD and four municipalities in the Montgomery County portion of the watershed have committed to participating in these plans. Those Montgomery County municipalities include Abington and Cheltenham townships, and the boroughs of Jenkintown and Rockledge (Figure 4.52).

Cheltenham Township is also leading an effort to explore the possibility of creating a watershed-wide Environmental Advisory Council (EAC) in collaboration with the other municipalities in Montgomery County. An EAC is a group of three to seven community residents, appointed by local elected officials, that advises the local planning commission, park and recreation board, and elected officials on the protection, conservation, management, promotion, and use of natural resources within its jurisdictional limits. Municipalities are authorized to establish EACs through Act 177 of 1996 (originally Act 148 of 1973).

As mentioned previously, PWD initiated the Tookany/Tacony-Frankford Watershed Partnership in 2000. The TTF Partnership represents a consortium of proactive environmental groups, municipal officials, community groups, government agencies, businesses, residents, and other stakeholders who have a vested interest in improving the Tookany/Tacony-Frankford Watershed. The Partnership formed various committees and has met periodically ever since.

Soon after the TTF Partnership was formed, a River Conservation Plan (RCP) for the Tacony-Frankford Watershed was developed by PWD and the Partnership members. The RCP Team was comprised of representatives from PWD, Frankford Group Ministry, Fairmount Park

Commission, Heritage Conservancy, and the Pennsylvania Environmental Council. In addition, the Plan was guided by an RCP Steering Committee, which included representatives from LaSalle University, the Philadelphia City Planning Commission, Frankford Community Development Corporation, Cheltenham Township, PA Department of Conservation and Natural Resources, Awbury Arboretum, National Park Service and Trails, Delaware Riverkeeper Network, Friends of Tacony Creek Park, 35th Police District, and the U.S. Army Corps of Engineers.

The Tookany RCP (referred to as the Tookany Creek Watershed Management Plan), led by Heritage Conservancy, was also developed by a diverse team of representatives. The RCP Steering Committee members were made up of officials from each municipality, in addition to representatives from Montgomery County Conservation District and Planning Commission, PECO Energy Company, PWD, and the Old York Road Historical Society.

Today, the Tacony-Frankford River Conservation Plan is complete and currently undergoing an approval process in order to be placed on the PA DCNR's Rivers Registry. The Tookany RCP is also complete and has been approved by the Montgomery County municipalities and listed on the Rivers Registry.

In 2003, a diverse group of Tookany/Tacony-Frankford Partnership members developed a committee to evaluate the group's organizational structure for effectiveness in plan implementation, in order to determine how to effectively guide the TTF Partnership's future progress. The Structure Committee expanded the goals of the Partnership and established the recommendation for transformation of the existing Partnership into an independent nonprofit watershed organization. It was decided that this would enable the Partnership to focus on coordinating the on-the-ground implementation of the recommendations in the TTFIWMP and to broaden community and political support for the revitalization of the watershed. The TTF Partnership was incorporated as an independent 501(c)3 organization in 2005. (See bylaws in Appendix C.)

Garnering political support from all municipal officials is an especially important priority for the TTF Partnership. Members of the Structure Committee included representatives from the Fairmount Park Commission, Awbury Arboretum, Cheltenham Township, Abington Environmental Advisory Council, Frankford Group Ministry, Friends of High School Park, Friends of Tacony Creek Park, Heritage Conservancy, Melrose Park Neighbors Association, Delaware Riverkeeper Network, Montgomery County Planning Commission, PA DEP, PA DCNR, and the U.S. Army Corps of Engineers. Many of those same entities, as well as various others, are represented on the board of directors of the newly incorporated nonprofit organization.

Currently, all of the municipalities in the watershed have an Act 537 Plan, which provides for the resolution of existing sewage disposal problems, future sewage disposal needs of new land development, and future sewage disposal needs of the municipality. However, some plans are newer and more detailed than others (Table 4.22).

Table 4.22 Act 537 Municipal Sewage Facilities Plans

Municipality	County	Plan Approval Date	Status (as of 12/2005)
Abington Township	Montgomery	12/16/99	Plan older than 5 years
Cheltenham Township	Montgomery	1/1/73	Plan older than 30 years
Jenkintown Borough	Montgomery	1/1/73	Plan older than 30 years
Philadelphia	Philadelphia	11/10/93	Plan older than 10 years
Rockledge Borough	Montgomery	1/1/73	Plan older than 30 years

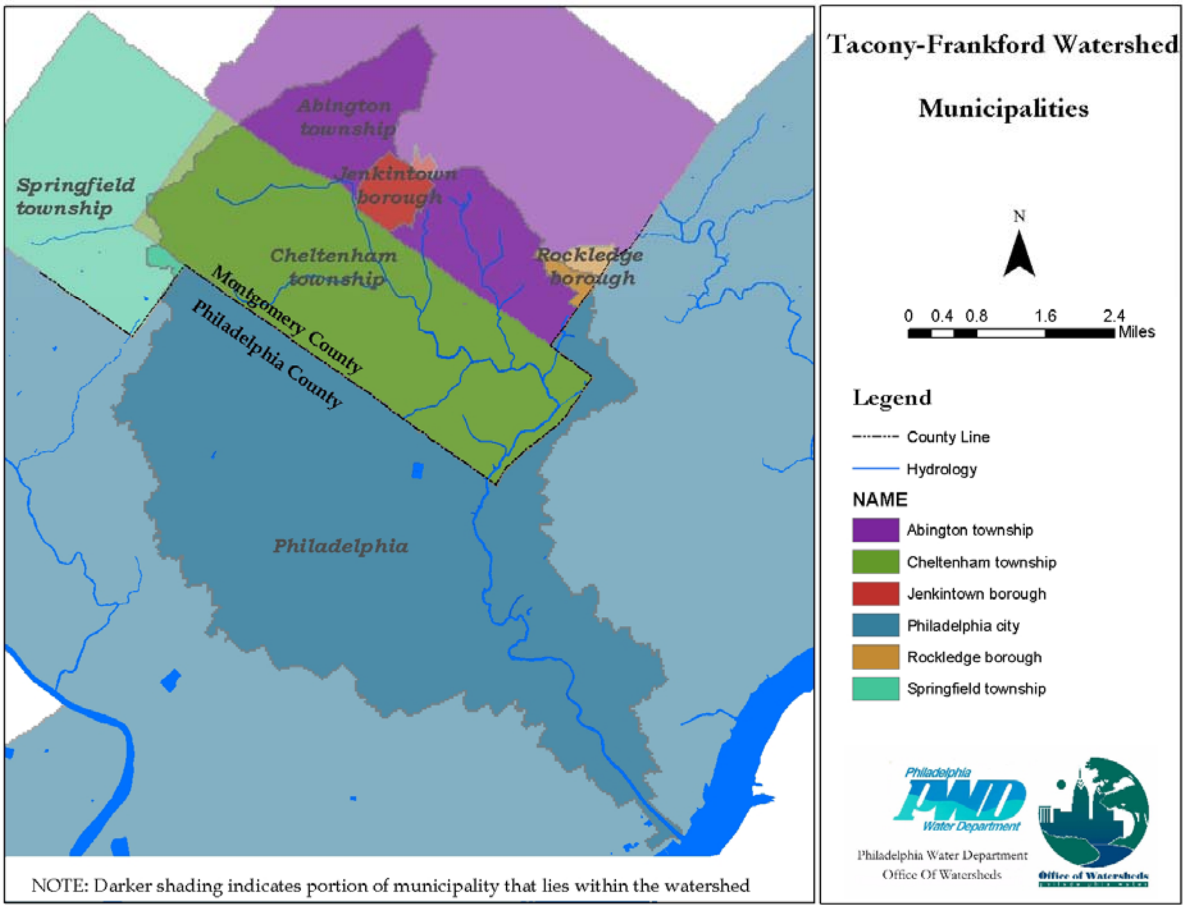


Figure 4.52 Tookany/Tacony-Frankford Watershed Municipalities and Counties

4.6.6 Indicator 20: Business and Institutional Stewardship

Awareness of the role of businesses and institutions in watershed degradation and restoration is growing. Success of the watershed management plan will require stewardship on the part of stakeholders who represent the diversity of land uses in the watershed, including conservation groups, commercial, industrial, institutional, and residential users. The goal of the TTF Partnership is to have a proportional representation of these groups.

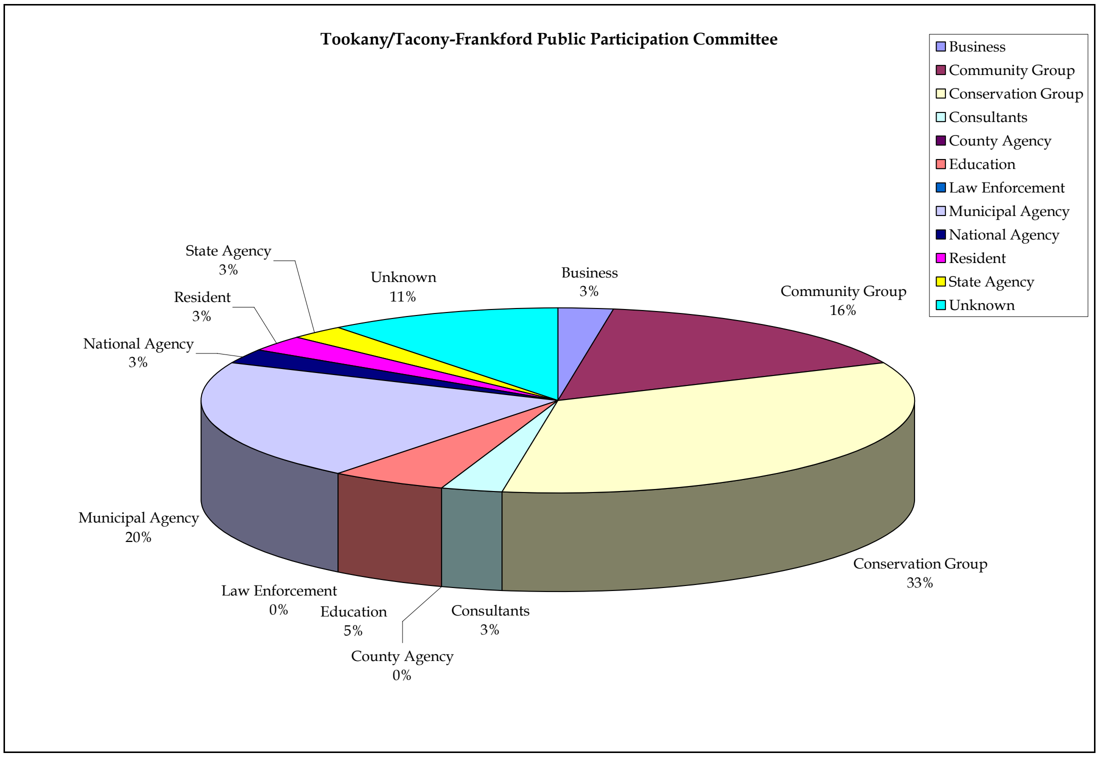
This indicator measures:

- **Breakdown of TTF Partnership committee participation by organization type**

Where We Were:
A historical baseline has not been established for this indicator. Progress will be assessed next time this plan is updated.

Where We Are:
Figure 4.53 illustrates the percentage of representatives of each type of group on the TTF Partnership's Technical and Public Participation Committees. To date, three business representatives have participated in Partnership meetings and events, as illustrated in the below charts. These business representatives included Rohm & Haas Co., Hankin Management, and Cardone Industries. These industries are all located near the creek.

Recently, PWD has developed a partnership with Shop Rite Supermarkets and the Pennsylvania Food Merchants Association (PFMA) to address the removal of shopping carts from local streams. Shop Rite has committed to sponsoring stream side clean-up events with students throughout the watershed.



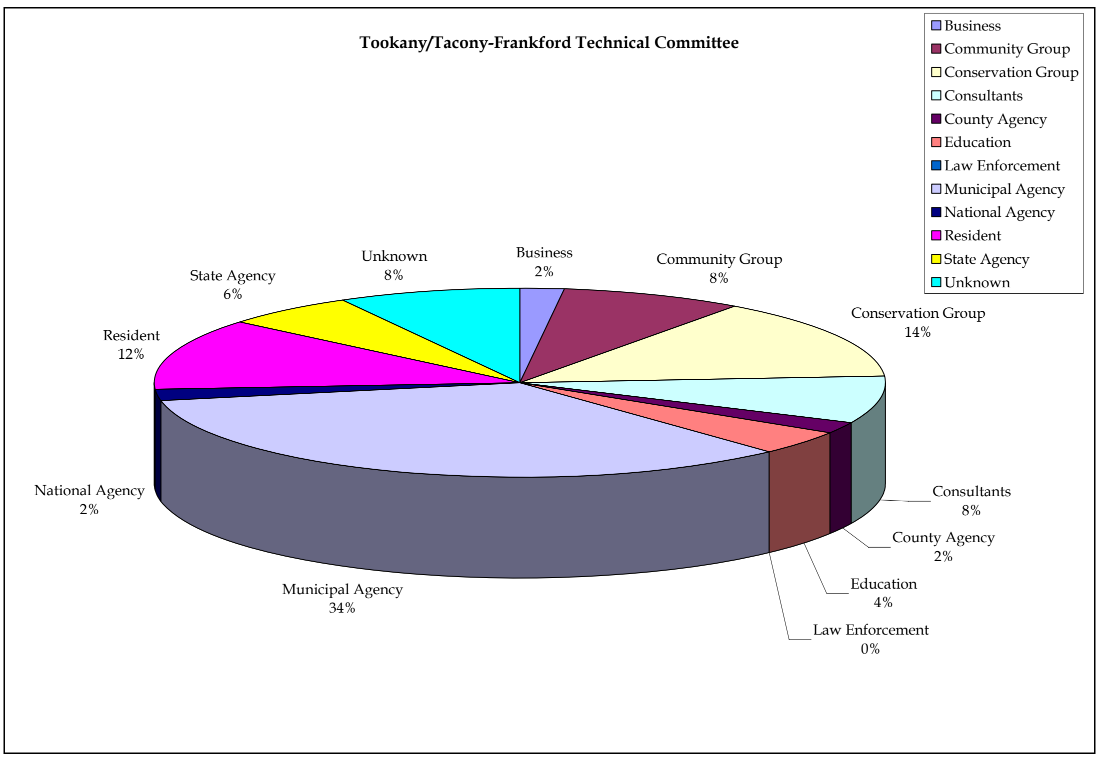


Figure 4.53 Distribution of Partnership Members' Affiliations (2003)

4.6.7 Indicator 21: Cultural and Historic Resources

Waterways have always been cradles of civilization, providing, among many other things, a means of travel and rich floodplain soils in which to cultivate crops. Waterways provided power for mills and fueled the beginnings of the industrial revolution. Consequently, historical and cultural resources are often concentrated in and along waterways. These resources enable us to better understand and appreciate different cultures and traditions, to recognize the struggles endured by our ancestors, and to comprehend the technologies of past generations; and they can be an invaluable tool to inform our understanding of present conditions.

This indicator measures:

- **National Register of Historic Places inventory**
- **National Register of Historic Districts inventory**
- **Number of nonprofit historical/cultural organizations**

Where We Were:
A historical baseline has not been established for this indicator. Progress will be assessed next time this plan is updated.

Where We Are:
Although it is hard to pinpoint the actual number of historic properties located in the watershed, it is approximated that 11 historic properties exist in the municipalities in the Tookany section of the watershed and approximately 46 historic properties exist in the Philadelphia section of the watershed. The Fairmount Park Commission has identified eight historic resources located in Tacony Creek Park. Additionally, six districts are identified as National Register Districts. The four National Register Historic Districts in Philadelphia include Awbury, Germantown, Friends Hospital, and Tulpehocken. The two Districts that exist in Montgomery County include La Mott Historic District with 40 resources, and Wyncote Historic District with 232 resources. The watershed is rich with numerous other historical, cultural, and social amenities throughout both counties, many of which are deemed eligible for listing on the National Registry by the Pennsylvania Historical and Museum Commission. The National Register was authorized by an Act of Congress in 1966 and serves as the nation's official list of cultural resources worthy of protection. The National Register is administered by the National Park Service of the U.S. Department of the Interior.

Furthermore, five nonprofit historical societies or cultural organizations exist to preserve the history and culture of the rich communities of the watershed: Germantown Historical Society, Historical Society of Frankford, Old York Road Historical Society, Ryerss Victorian Mansion, and the Settlement Music School. The City of Philadelphia also has the distinction of being an important destination for fugitive slaves seeking freedom in the North. There are numerous important Underground Railroad sites within the watershed. Two sites that are listed in Charles Blockson's *Hippocrene Guide to the Underground Railroad* are the John Johnson House in Germantown and the Campbell AME Church in Frankford.

Section 5
Problem Definition and Analysis

The watershed "indicators" described in Section 4 are used both to characterize the current state of the TTF Watershed, and to set a baseline for future comparison. Here, Section 5 identifies the wide range of potential problems that have been identified in the watershed, and describes the analysis tools used to define them.

Many of the problems in the TTF Watershed have been identified through the assessments carried out by the project team and others. Other problems were identified through stakeholder participation. Water quality problems were identified by taking samples and comparing results to water quality criteria. Several criteria were relevant to the analysis, many of which provided specific numeric standards with which to comply. Others were less specific, but nonetheless relevant. These are often referred to as narrative standards.

National water quality criteria include aesthetic qualities that protect the quality of streams. The criteria state:

"All waters free from substances attributable to wastewater or other discharges that:

(1) settle to form objectionable deposits;

(2) float as debris, scum, oil, or other matter to form a nuisance;

(3) produce objectionable color, odor, taste, or turbidity;

(4) injure or are toxic or produce adverse physiological responses in humans, animals or plants; and

(5) produce undesirable or nuisance aquatic life." (EPA, Goldbook, 1986)

Also, PA DEP's general water quality criteria state:

(a) Water may not contain substances attributable to point or non-point source discharges in concentration or amounts sufficient to be inimical or harmful to the water uses to be protected or to human, animal, plant, or aquatic life.

(b) In addition to other substances listed within or addressed by this chapter, specific substances to be controlled include, but are not limited to, floating materials, oil, grease, scum and substances which produce color, tastes, odors, turbidity or settle to form deposits. (PA DEP, Chapter 93 § 93.6.)

Some standards were related to the uses of the creek. The Tookany/Tacony-Frankford Creek's protected uses as designated by PA DEP are:

- Aquatic Life – Warm Water Fishes
- Water Supply – Potable Water Supply
- Recreation and Fish Consumption - Boating, Fishing, Water Contact Sports, and Esthetics

5.1 Visual Stream Assessment (Aesthetics and Narrative Criteria)

The Tacony-Frankford RCP Team and Tookany Creek Watershed Management Plan Steering Committee conducted visual assessments along the major tributaries and mainstem streams. These assessments provided a baseline inventory of the existing conditions along the stream corridor. The method utilized a modified version of the USDA's Visual Streambank Assessment Protocol. Members of these committees and volunteers conducted the visual stream assessments.

The visual assessments assisted in identification of problems and problem locations in the Tookany/Tacony-Frankford Watershed. Generally, the issues found in the watershed included:

- Erosion of creek banks (undercutting, exposed roots).
- Appearance of invasive species – Disturbed areas throughout the watershed are susceptible to invasion by non-native exotic vegetation. Japanese knotweed, kudzu, purple loosestrife, and multiflora rose were identified as issues within the watershed.
- Trash and debris – Along the creeks, there was an abundance of trash and debris.
- Illegal dumping – Dumping of trash, cars, and appliances are an issue for Tacony Creek Park and vacant land. Secluded open areas are especially susceptible to dumping. Sites of abandoned cars often become targets for fire. Illegal dumping ranges from trucks dumping construction materials and appliances to residents throwing trash directly into the creek.
- Illegal recreational activities (e.g., ATVs, swimming) – ATV use is illegal in Tacony Creek Park and has had a detrimental effect on the health of the park. Illegal trails disturb native vegetation and open habitat for invasives while contributing to erosion on slopes of the creek banks.
- Sewage and odors.
- Lack of riparian buffer – The lack of riparian buffer was observed on both public and private property. Native vegetation usually found in the riparian buffer often has been removed or mowed. Sections of the creeks where flooding has been problematic tend not to have riparian buffer areas, coupled with a high percentage of impervious surface.
- Exposed and eroded sewer and stormwater pipes.
- Instream flow obstructions.
- Chemical runoff which may include but is not limited to fertilizers, pesticides, herbicides, oil and grease, antifreeze, and industrial spills.
- Illicit and disconnected sewers.
- Lack of best management practices (BMPs).

Figure 5.1 displays the results of the visual stream assessments, with the locations of problems identified by stream reach.

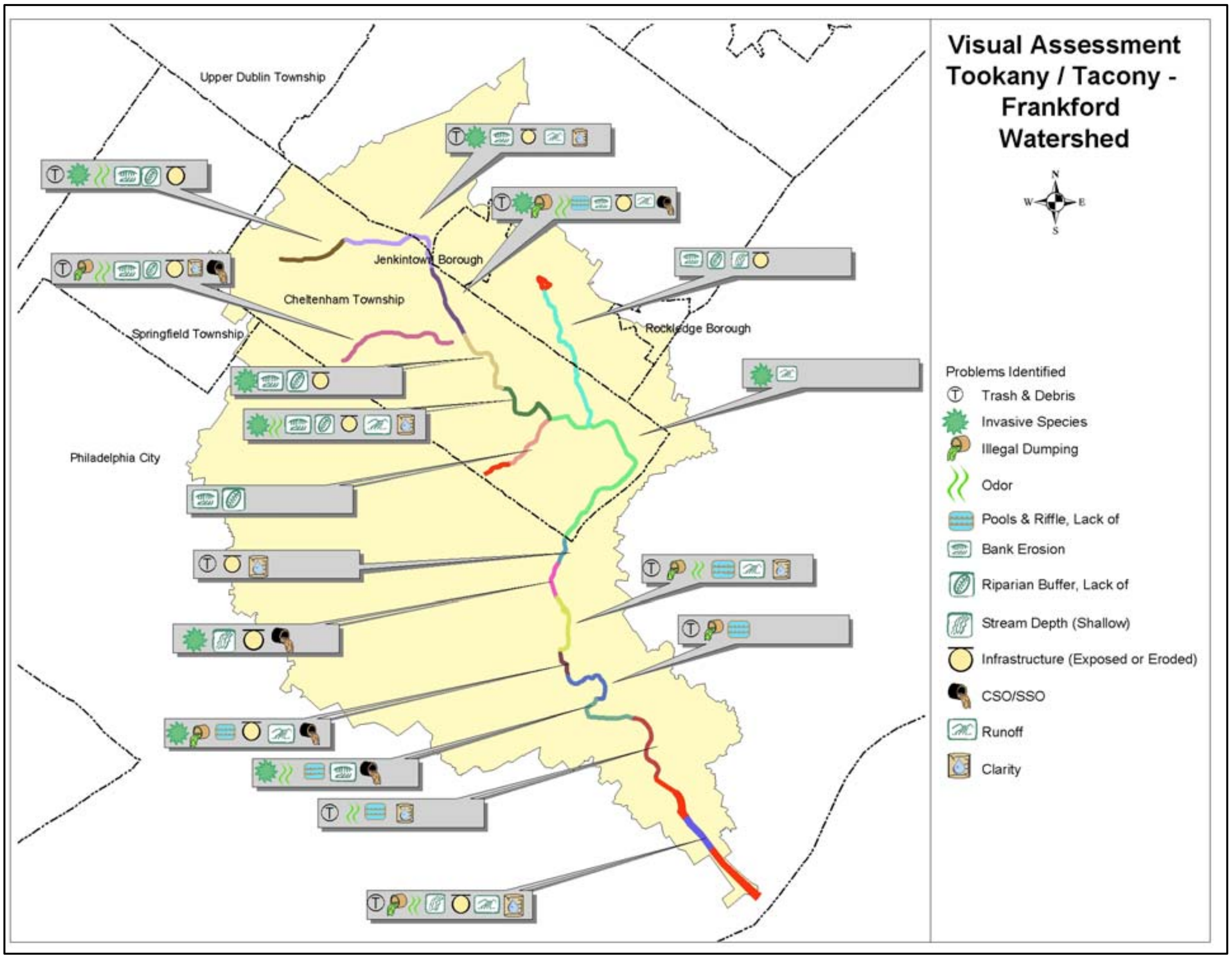


Figure 5.1 Summary of Visual Assessments

Various problems have been identified throughout the watershed. Evidence of streambank erosion was observed at all but one reach of the visually assessed streams. Trash and debris and invasive species were recorded at most reaches. There is no pattern with regards to the location of the reaches, with problems identified both in the city and outside the city.

5.2 Streamflow Analysis

Indicator 2, Streamflow, measures baseflow and runoff to analyze the impact of urbanization on watershed hydrology. As noted previously in Sections 2.2.1 and 4.2.1, the flow records at each of the USGS gauges in the Tookany/Tacony-Frankford Watershed were separated into runoff and baseflow components.

In Table 5.1, the results for Tacony-Frankford Creek are compared with French Creek, a rural stream, and Darby Creek, a stream in a mixed urban and suburban watershed. Results for French Creek are somewhat typical of an undeveloped watershed, with baseflow comprising 64% of mean annual streamflow and stormwater only 17% of annual precipitation.

At the Frankford Creek gauge, representing most of the urbanized Tacony-Frankford watershed, the stormwater component of streamflow is a much greater percentage of total annual streamflow (62%), and baseflow represents a much smaller percentage of total annual streamflow (only 38%). These results are indicative of a highly urbanized stream. The Tacony Creek USGS gauge, representing the headwaters of the Tacony-Frankford Watershed, exhibits a relationship between stormflow and baseflow that is between the two extremes.

Table 5.1 Summary of Hydrograph Separation Results over the Period of Record

USGS Gauge	Period of Record	Baseflow (% of Total Flow)	Baseflow (% of Precip)	Stormwater Runoff (% of Precip)
Tacony Creek near Jenkintown 01467083	10/1/73 - 9/30/78	56%	27%	21%
Rock Creek 01467084	5/1/71 – 9/30/78	46%	28%	33%
Jenkintown Creek 01467085	5/1/71 – 9/30/78	60%	27%	18%
Tacony Creek at County Line 01467086	10/1/65 - 11/17/88	58%	29%	21%
Frankford Creek at Castor Ave 01467087	7/1/82 - 9/30/03	38%	17%	27%
Frankford Creek at Torresdale Ave 01467089	10/1/65 - 9/30/81, 5/14/82 – 6/29/82	35%	17%	31%
French Creek 01475127	10/1/68 – 9/30/03	64%	31%	17%
Darby Creek 01475510	2/1/64 – 10/3/90	62%	34%	21%
Cobbs Creek 01475550	2/1/64 – 10/3/90	43%	19%	26%

5.3 Water Quality Analysis

As noted above, water uses relevant to the TTF Watershed include the following:

- Aquatic Life – Warm Water Fishes
- Water Supply – Potable Water Supply
- Recreation and Fish Consumption - Boating, Fishing, Water Contact Sports, and Esthetics

As described in Section 2.2.2, an analysis was conducted on the water quality data collected in the Tookany/Tacony-Frankford Watershed. A number of constituents, which are listed in Table 5.2, were used as indicators of watershed health in Section 4.3. Using the data collected from discrete wet and dry weather sampling, comparisons were made to water quality standards. National water quality standards and reference values were used if state water quality standards were not available. The water quality standards or reference values and their sources are also listed in Table 5.2.

The aquatic life criteria for metals were "established to control the toxic portion of a substance in the water column. Depending upon available data, aquatic life criteria for metals are expressed as either dissolved or total recoverable." (PA DEP, Chapter 16)

A color coding is used to indicate problems (red) and potential problems (yellow). Problems are identified if more than 10% of samples exceed the applied water quality standard or criteria. Potential problems are identified if between 2% and 10% of samples exceed the standard or criteria.

Table 5.2 Water Quality Standards and Reference Values

Parameter	Criteria	Water Quality Criteria or Reference Value	Source
Alkalinity	Minimum	20 mg/L	PA DEP
Aluminum	Aquatic Life Chronic Exposure Standard	87 mg/L (pH 6.5-9.0)	53FR33178
Aluminum	Aquatic Life Acute Exposure Standard	750 mg/L	PA DEP
Chlorophyll A	Reference reach frequency distribution approach for Ecoregion IX, subregion 64, 75th percentile	seasonal median: 3 ug/L, (Spectrophotometric)	EPA 822-B-00-019
Dissolved Cadmium	Aquatic Life Acute Exposure Standard	Hardness Dependent	PA DEP
	Aquatic Life Chronic Exposure Standard	Hardness Dependent	PA DEP
	Human Health Standard	10 mg/L	EPA Goldbook
Dissolved Chromium	Aquatic Life Acute Exposure Standard	16 mg/L	PA DEP
	Aquatic Life Chronic Exposure Standard	10 mg/L	PA DEP
Dissolved Copper	Aquatic Life Acute Exposure Standard	Hardness Dependent	PA DEP
	Aquatic Life Chronic Exposure Standard	Hardness Dependent	PA DEP
	Human Health Standard	1000 mg/L	EPA Goldbook
Dissolved Iron	Maximum	0.3 mg/L	PA DEP

Parameter	**Criteria**	**Water Quality Criteria or Reference Value**	**Source**
Dissolved Lead	Aquatic Life Acute Exposure Standard	Hardness Dependent	PA DEP
	Aquatic Life Chronic Exposure Standard	Hardness Dependent	PA DEP
	Human Health Standard	50 mg/L	EPA Goldbook
Dissolved Zinc	Aquatic Life Acute Exposure Standard	Hardness Dependent	PA DEP
	Aquatic Life Chronic Exposure Standard	Hardness Dependent	PA DEP
	Human Health Standard	5000 mg/L	EPA Goldbook
DO	Instantaneous Minimum	4 mg/L	PA DEP
	Average Minimum	5 mg/L	PA DEP
Fecal coliform	Maximum	Geometric Mean of 5 consecutive samples on different days within a 30 day period may not exceed 200/100mL (Summer) or 2000/100mL (Winter)	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 dependent	PA DEP
NO2+NO3	Nitrates – Human Health Consumption for water + organisms	10 mg/L	PA DEP
NO23-N	Maximum	10 mg/L	PA DEP
Periphyton Chlorophyll A		Ecoregion IX – 20.35 mg/m2	Goldbook
pH	Range	6.0 mg/L - 9.0 mg/L	PA DEP
Phenolics	Maximum	0.005 mg/L	PA DEP
TDS	Maximum	750 mg/L	PA DEP
Temperature		Varies w/ season. Additionally, waters may not result in a change by more than 2°F during a 1-hour period.	PA DEP
TKN	Maximum	Ecoregion IX, subregion 64 seasonal median: 0.675 mg/L	EPA 822-B-00-019
TN	Maximum	Ecoregion IX, subregion 64 seasonal median: 4.91 mg/L	EPA 822-B-00-019
TP	Maximum	Ecoregion IX, subregion 64 seasonal median: 140 ug/L	EPA 822-B-00-019
TSS	Maximum	25 mg/L	Other US states
Turbidity	Maximum	Ecoregion IX, subregion 64 seasonal median: 8.05 NTU	EPA 822-B-00-019

Based on a comparison of water quality sampling data with standards, criteria, or reference values, the problem and potential problem parameters have been identified and are discussed in this section. The issues have also been identified during wet and dry weather, if applicable.

5.3.1 Water Supply

The state's potable water supply criteria were applied to the Tookany/Tacony-Frankford Watershed. The criteria are listed above in Table 5.2. Comparisons between the water quality data and the criteria for water supply are listed in Table 5.3, which displays observed water quality exceedances of these criteria during dry and wet weather.

Table 5.3 Summary of Water Supply Criteria Exceedances

Parameter	Criteria	Dry			Wet		
		No. Obs.	No. Exceed	% Exceed	No. Obs	No. Exceed	% Exceed
Dissolved Iron (Fe)	Maximum	64	3	4.69	123	5	4.07
Fluorine (F)	Maximum	61	1	1.64	438	0	0.00
Manganese (Mn)	Maximum	90	0	0.00	461	9	1.95
Ammonia (NH_3)	Maximum	41	0	0.00	144	0	0.00
Nitrate-Nitrite (NO_2+NO_3)	Maximum	62	0	0.00	464	0	0.00
Total Dissolved Solids (TDS)	Maximum	36	0	0.00	144	2	1.39

Green – Parameter is not a problem *Yellow – Potential problem parameter* *Red – Problem parameter*

The results indicate dissolved iron, manganese, and total dissolved solids (TDS) as potential problem parameters. On the pages that follow, Figures 5.2 – 5.4 show the criteria comparison by monitoring location in the Tookany/Tacony-Frankford Watershed. Dissolved iron, prevalent in clay soils, has been identified to exceed the criteria more than 2% of the time in both dry and wet weather. Manganese appears to be a potential wet weather problem, and TDS a potential dry weather problem.

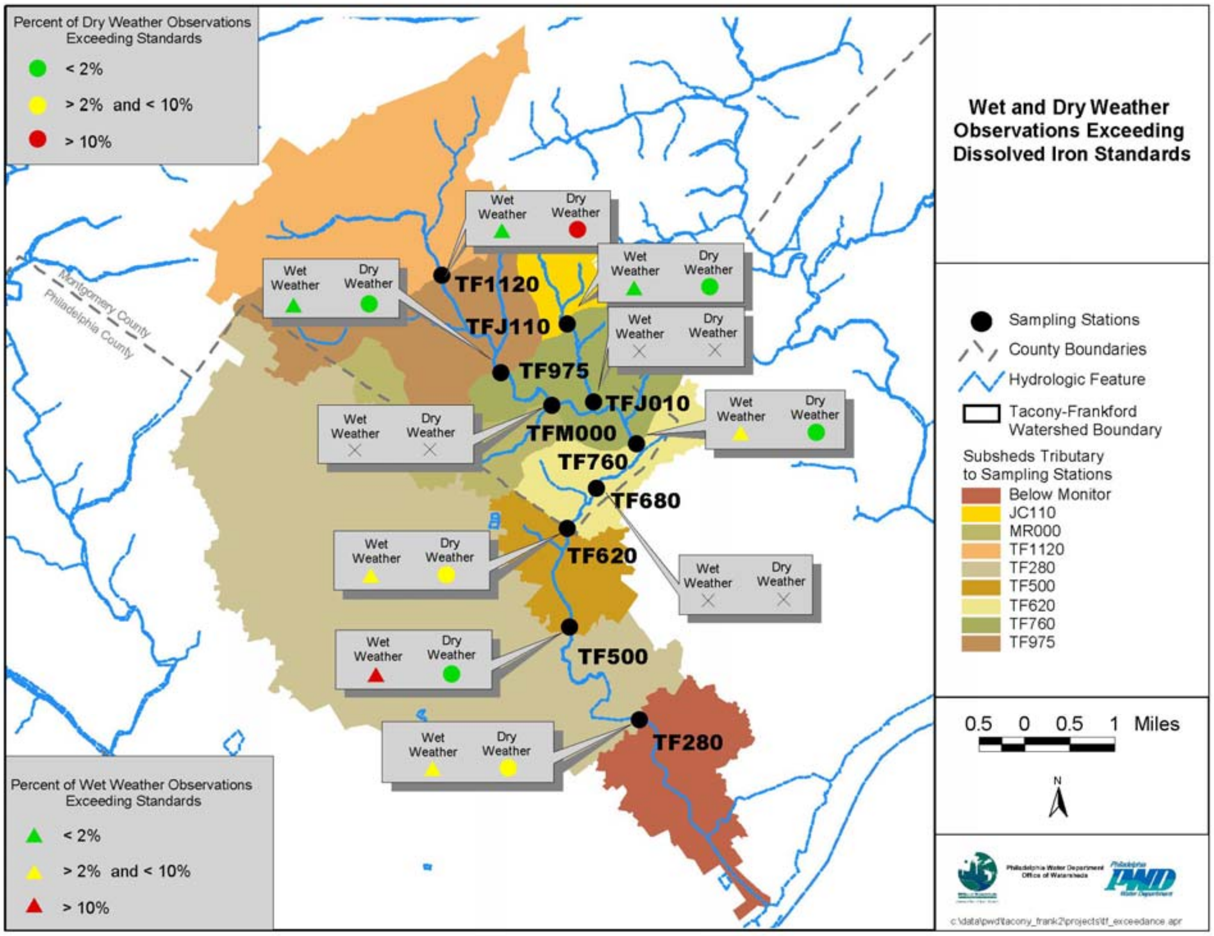


Figure 5.2 Water Supply Criteria for Dissolved Iron

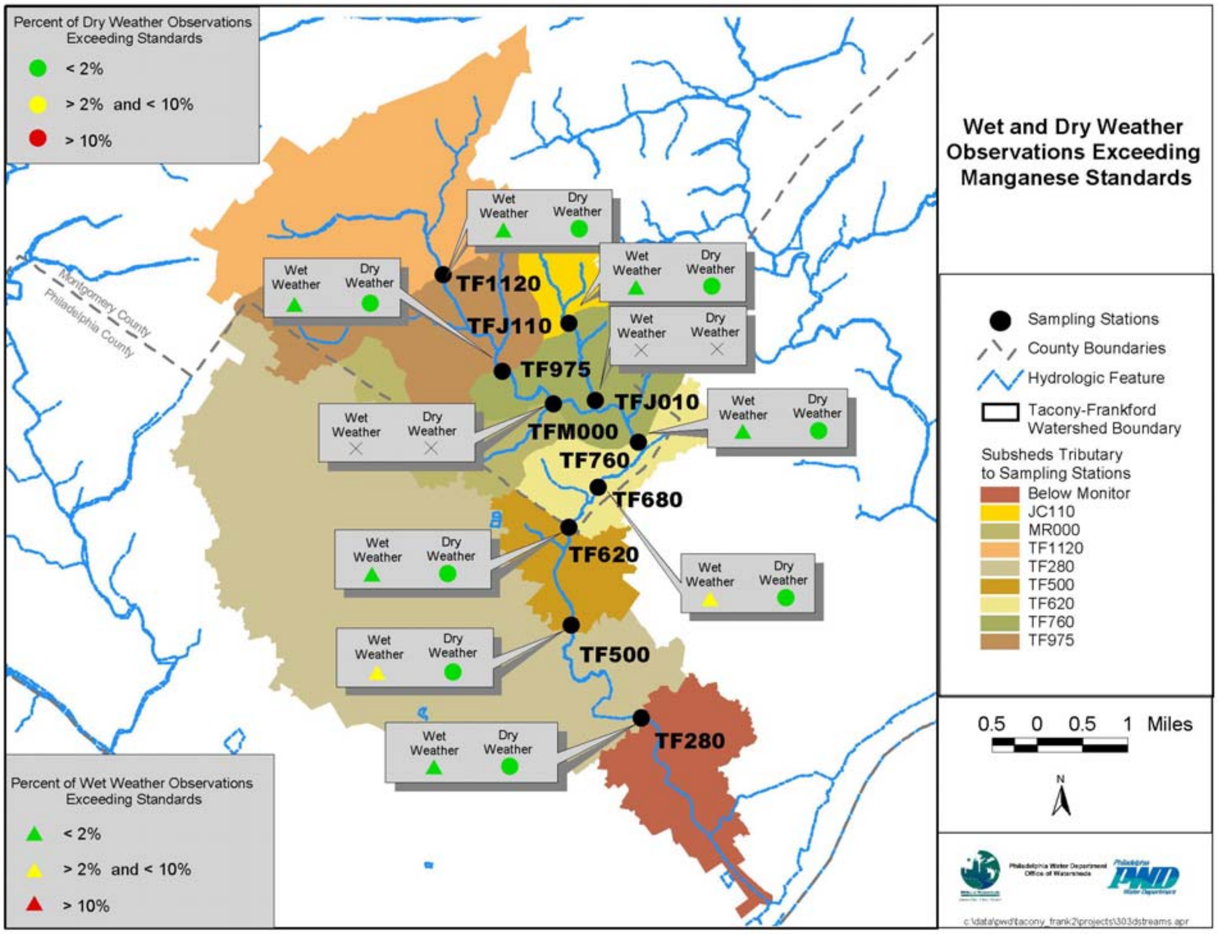


Figure 5.3 Water Supply Criteria for Manganese

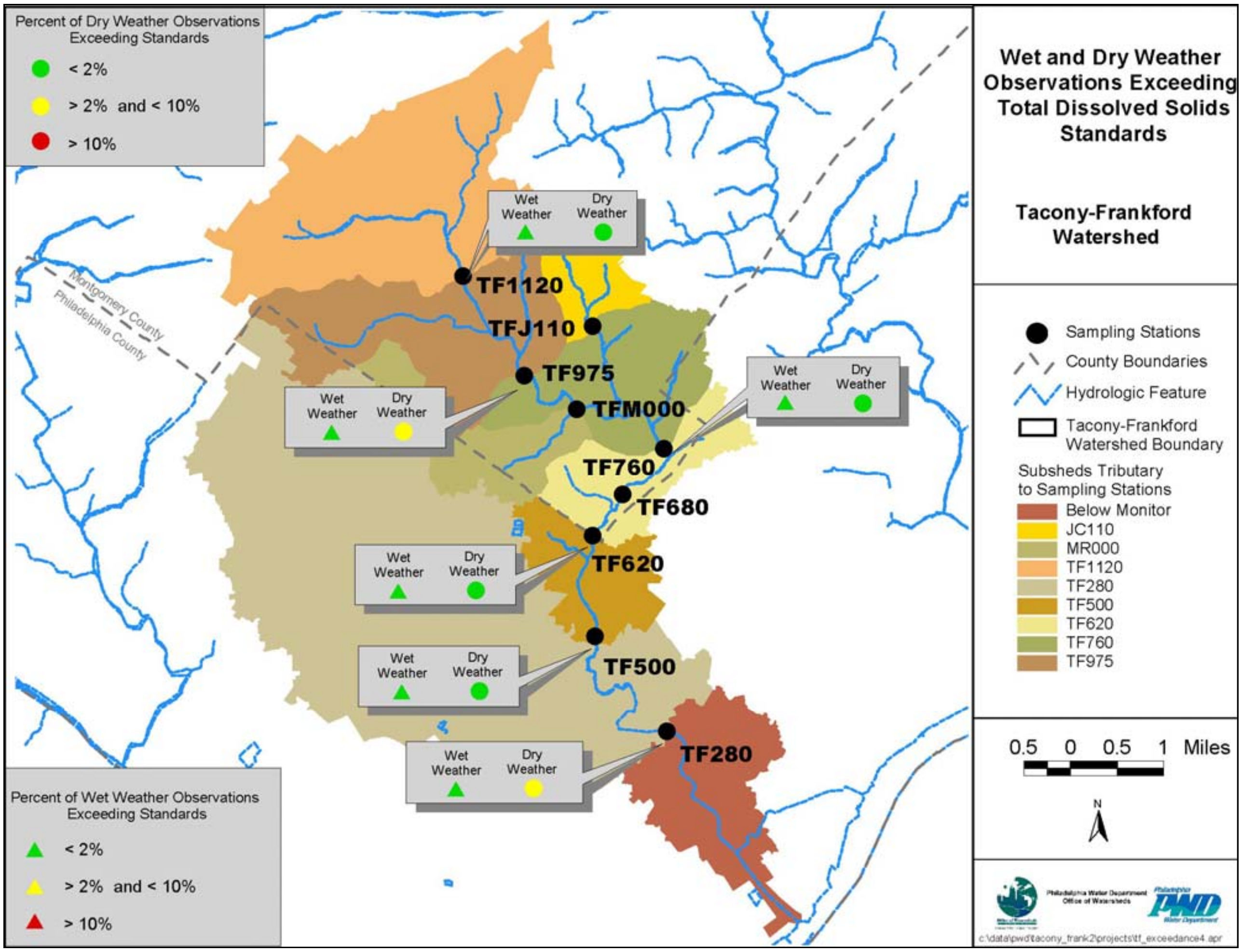


Figure 5.4 Water Supply Criteria for Total Dissolved Solids

5.3.2 Recreation and Fish Consumption

The protected and statewide water use for recreation and fish consumption applicable to the TTF Watershed is water contact sports. The specific water quality criterion for water contact is fecal coliform. Figure 5.5 displays comparisons at the monitoring locations with the criteria throughout the watershed. The data has been compared to the criteria during both swimming and non-swimming seasons. During the swimming season, fecal coliforms are identified as a problem. During the non-swimming season, they are characterized as a potential problem.

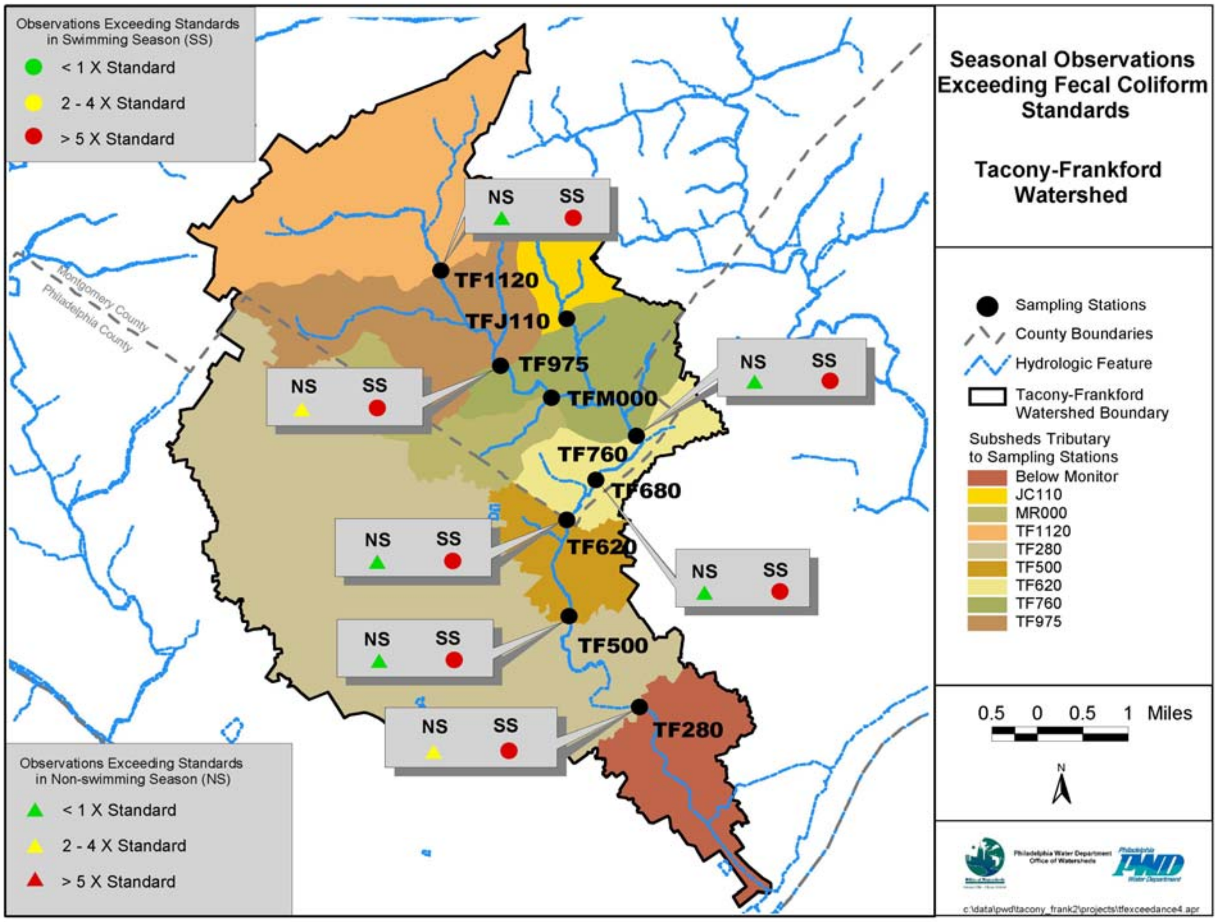


Figure 5.5 Water Contact Criteria for Fecal Coliform

Table 5.4 Summary of Recreation Criteria Exceedances

Season	Site	No. Obs.	No. Exceed	Percent Exc.
Nonswimming	TF500	1	1	100.00
	TF620	7	6	85.71
	TF760	1	0	0.00
	TF975	3	3	100.00
Swimming	TF1120	8	8	100.00
	TF280	7	7	100.00
	TF975	8	8	100.00

5.3.3 Human Health

The relevant human health criteria developed by EPA and PA DEP include exposure to toxic metals from drinking water and fish consumption. No problem parameters were identified among dissolved metals.

Table 5.5 Summary of Human Health Criteria Exceedances

Parameter	Criteria	Dry			Wet		
		No. Obs.	No. Exceed	% Exceed	No. Obs	No. Exceed	% Exceed
Dissolved Cadmium (Cd)	Human Health Maximum	37	0	0.00	118	0	0.00
Dissolved Copper (Cu)	Human Health Maximum	28	0	0.00	5	0	0.00
Dissolved Lead (Pb)	Human Health Maximum	19	0	0.00	N.A.	N.A.	N.A.
Dissolved Zinc (Zn)	Human Health Maximum	27	0	0.00	4	0	0.00
Nitrite (NO_3)	Human Health Maximum	62	0	0.00	464	0	0.00

Green – Parameter is not a problem *Yellow – Potential problem parameter* *Red – Problem parameter*

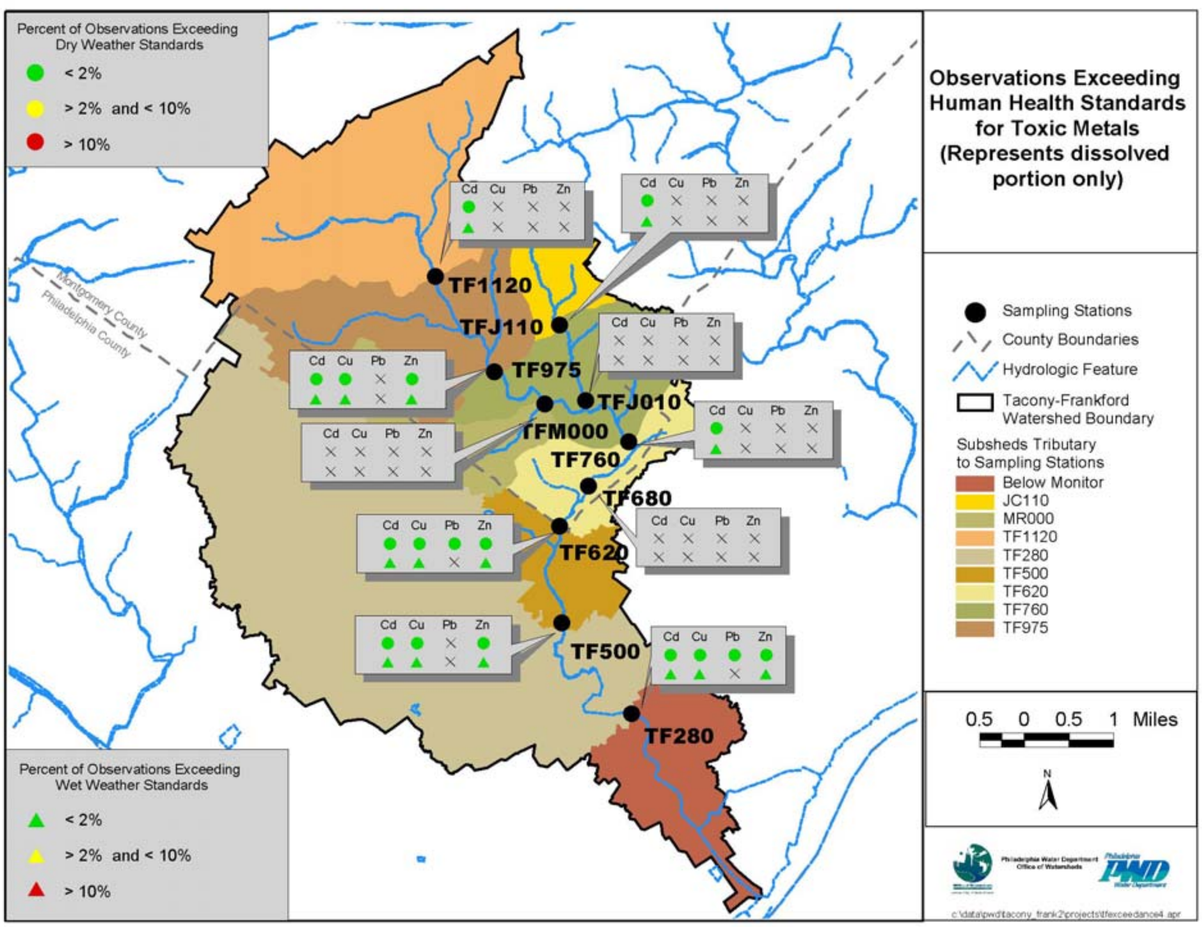


Figure 5.6 Spatial View of Human Health Criteria Exceedances

5.3.4 Aquatic Life

The criteria shown in Table 5.6 are designed to protect reproduction, growth, and survival of aquatic life from acute effects.

Table 5.6 Summary of Aquatic Life Acute Criteria Exceedances

Parameter	Criteria	Dry			Wet		
		No. Obs.	No. Exceed	% Exceed	No. Obs	No. Exceed	% Exceed
Al	Acute Maximum	78	0	0.00	402	77	19.15
Dissolved Cu	Acute Maximum	28	0	0.00	5	3	60.00
DO	Average Minimum (WWF)	59	2	3.39	143	2	1.40
DO	Instantaneous Minimum (WWF)	59	2	3.39	143	0	0.00
Dissolved Iron	Maximum (WWF)	64	3	4.69	123	5	4.07

Green – Parameter is not a problem *Yellow – Potential problem parameter* *Red – Problem parameter*

The above table suggests that there are a number of problem and potential problem parameters based on water quality criteria related to acute effects on aquatic life.

- During dry weather, only dissolved iron and dissolved oxygen (DO) are flagged as potential problems.
- During wet weather, aluminum and dissolved copper are flagged as problem parameters.
- During wet weather, dissolved iron is flagged as a potential problem.

Table 5.7 lists parameters that have been identified as problems because they exceed aquatic life chronic criteria. Since these are chronic, thus long term, exposure limits, they are not split into dry weather and wet weather results.

Table 5.7 Summary of Aquatic Life Chronic Criteria Exceedances

Parameter	Standard	No. Observations	No. Exceed	% Exceed
Al	Chronic Maximum	480	271	56.46
Dissolved Cd	Chronic Maximum	155	0	0.00
Dissolved Cu	Chronic Maximum	33	5	15.15
Dissolved Pb	Chronic Maximum	19	0	0.00
Dissolved Zn	Chronic Maximum	31	0	0.00

Green – Parameter is not a problem *Yellow – Potential problem parameter* *Red – Problem parameter*

Table 5.6 (at top of previous page) and Figure 5.7 (below) show the results of dissolved oxygen measurements. Both the figure and table suggest that, in general, dissolved oxygen is not a problem upstream of TF280. Within the tidal portion of the watershed below TF280, insufficient data exists to properly characterize the potentiality of a DO problem.

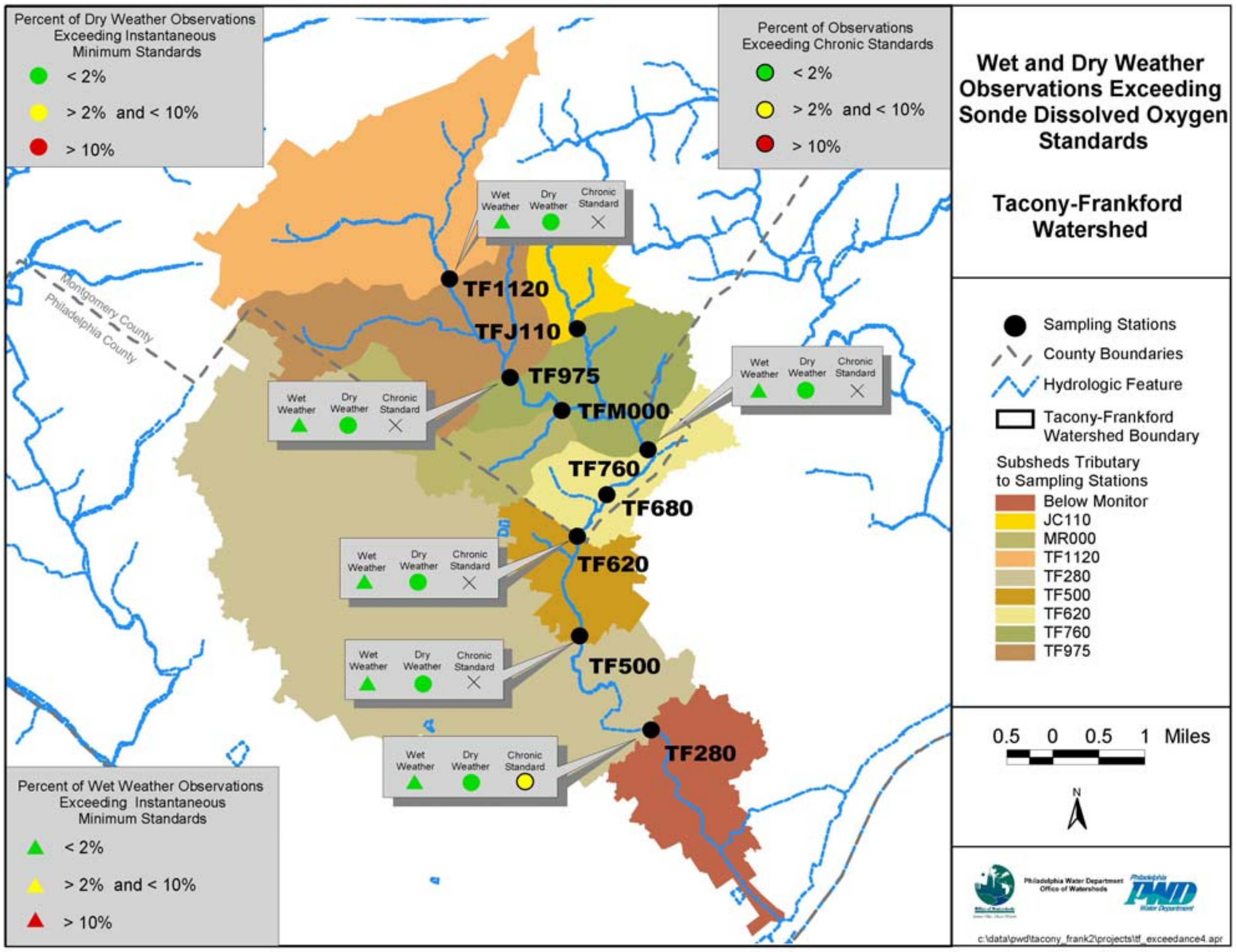


Figure 5.7 Spatial View of Dissolved Oxygen Exceedances in Wet and Dry Weather

Figure 5.8 shows dissolved oxygen measurements taken with one of the Sondes designed to take continuous DO measurements. Although the overall DO levels are adequate in this figure, the figure does point out a rather wide, diurnal fluctuation in DO, in this case over 6 mg/l. This suggests a great deal of biological activity. Although insufficient data exist at this point to indicate the fluctuations in DO are a potential problem, further investigation is important to determine the cause of these unusually wide, short term variations.

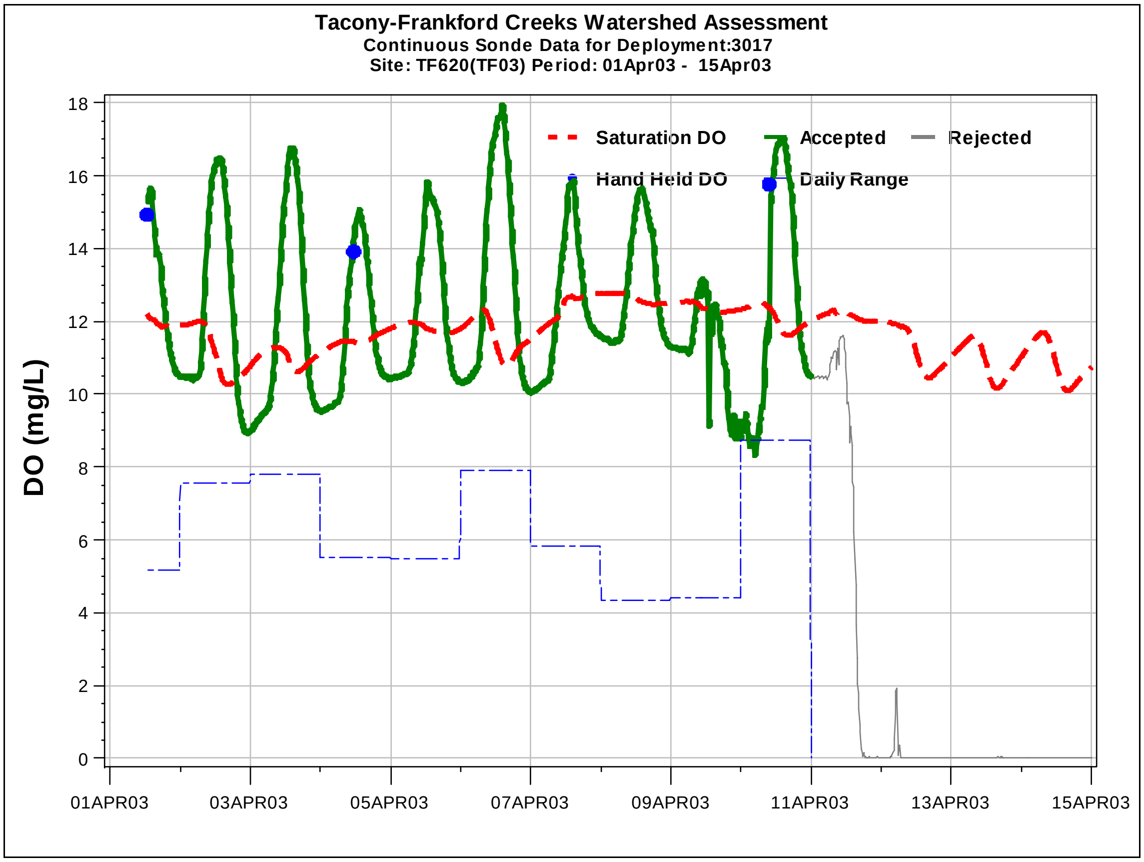


Figure 5.8 Time Series Plot of Dissolved Oxygen Exceedances in Wet and Dry Weather

Finally, Table 5.8 lists several other criteria that are related to aquatic life, but have no set regulatory limits. Criteria were established for this study as "flags of potential problems" using values relating to medians found through the U.S. EPA relevant to Ecoregion IX, subregion 64. As shown in the table, Chlorophyll A is high during both wet and dry weather, and is probably related to the above mentioned problem of large diurnal swings in DO. The nutrients nitrogen and phosphorus are also fairly high, possibly contributing to excessive algal growth. Turbidity and Total Suspended Solids are also quite high during wet weather, suggesting that bank and channel erosion may be occurring, as well as high wash loads of sediments in stormwater during rain events.

Table 5.8 Summary of Aquatic Life Criteria Exceedances

Parameter	Criteria	Dry			Wet		
		No. Obs.	No. Exceeds	% Exceed	No. Obs	No. Exceed	% Exceed
Chlorophyll A	Maximum	25	10	40.00	62	27	43.55
TKN	Maximum	55	5	9.09	404	225	55.69
TP	Maximum	67	8	11.94	451	165	36.59
TSS	Maximum	48	0	0.00	148	30	20.27
Turbidity	Maximum	61	1	1.64	441	148	33.56

Green – Parameter is not a problem *Yellow – Potential problem parameter* *Red – Problem parameter*

5.4 Potential Problem Parameter Summary

Based on the analysis, the problem and potential problem parameters are summarized below. The problem parameters are those constituents for which more than 10% of the samples exceed the standard. Parameters where the standards (or reference values) were exceeded over 2% of the time for all samples throughout the Tookany/Tacony-Frankford Watershed are listed as potential problems. Also, at the least, over 10% of parameter samples at one sampling location must exceed the standard to be considered a problem parameter.

In Table 5.9, the problem and potential problem parameters are listed by category. They are also broken down as either wet or dry weather problems, if applicable. For the metals, the listing is further broken down for chronic versus acute criteria.

Table 5.9 Summary of Problem and Potential Problem Parameters

Parameter	Standard	Dry	Wet	Chronic
Acute				
Al	Acute Maximum		✓	
Dissolved Cu	Acute Maximum		✓	
Chronic				
Al	Chronic Maximum			✓
Dissolved Cu	Chronic Maximum			✓
Water Supply				
Dissolved Fe	Maximum	✓	✓	
Other Parameters based on reference values				
Chla	Maximum	✓	✓	
Fe	Maximum		✓	
Phenolics	Maximum		✓	
TKN	Maximum	✓	✓	
TP	Maximum	✓	✓	
TSS	Maximum		✓	
Temp C	Maximum		✓	
Total Nitrogen	Maximum		✓	
Turbidity	Maximum		✓	
DO	Minimum	✓		
DO	Minimum Average	✓		

Green – Parameter is not a problem *Yellow – Potential problem parameter* *Red – Problem parameter*

5.5 Stream Ecology

The biological community of the TTF Watershed is heavily impacted by its urban surroundings. The impaired state of the creek is a result of habitat deterioration and water quality degradation. High levels of urbanization and development, and poor stream bank stability and flood control deeply influence the creek itself and the entire watershed. These factors have resulted in creek channelization, further inducing erosion and sedimentation problems. Natural water flows have been redirected to storm sewers and natural land surfaces replaced by block after block of impervious surfaces. Due to the changes in the hydrologic profile of the stream and watershed, storm events result in more concentrated runoff and cause more damage than they once did. Instead of percolating into the ground, stormwater is collected and rushed into an already unstable creek where it scours banks, fills pools, and covers riffles. The rushing water strips soil from the banks and deposits some of it over the embedded cobbles and takes the rest to the Delaware River, all the while holding on to the chemicals and pathogens collected on the city streets and in sewers. Figure 5.9 displays the results of the biological and habitat assessments.

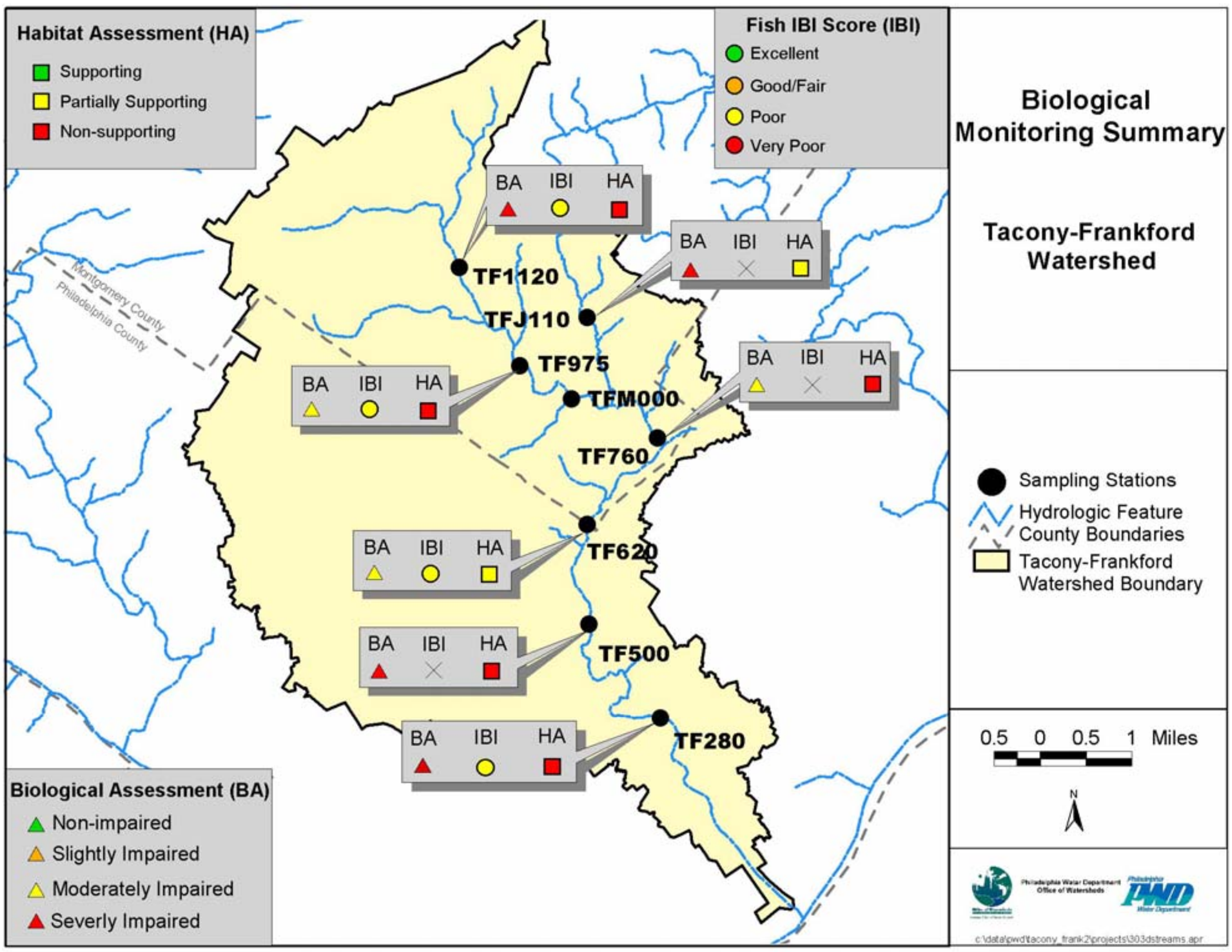


Figure 5.9 Tookany/Tacony-Frankford Biological Monitoring Summary

Biological monitoring indicates that the entire watershed suffers from impaired aquatic habitat and does not meet its designated use as a warm water fishery. As a result, the whole length of the Tacony-Frankford Creek and its tributaries were listed in PA DEP's 303d list of impaired waters in 1999. This impairment is due to severe water flow fluctuations, habitat alteration, point and non-point source (NPS) pollution from urban development, hydro-modification, and combined sewer overflows (CSOs) (PA DEP 2001). The tidal portion of the Frankford Creek remains unassessed because the biological assessment protocol is not applicable to tidal stream segments.

Habitat assessments of the Tacony-Frankford Watershed have determined much of the area to be non-supporting of a biological community. Eight sites within the watershed were assessed based on environmental features such as available vegetation and vegetative cover, riparian zones, stream bank stability, stream flow, riffles, pools, and other factors. Of these eight sites, six were determined to be lacking the attributes needed to support aquatic communities of organisms, while the other two were determined only capable of partially supporting aquatic communities.

Benthic macroinvertebrates rely heavily on stream riffles for at least part of their life cycle. Clinging to life in a riffle requires various adaptations, and most macroinvertebrates are not further prepared for the extreme hydrologic fluctuations that can occur in a channelized creek such as the Tookany/Tacony-Frankford. Increased stream velocities and sediment loads from eroding stream banks disrupt the benthic environment by alternately scouring the stream bottom of appropriately sized cobble substrate and burying those cobbles in sediment. Storm events lead to decreased species richness and evenness, which in turn changes the dynamics of feeding groups within the communities. Specialized feeders are greatly diminished, and generalists such as gatherer/collectors dominate the feeding community. Organisms well adapted to hydrologic extremes and to pollution also begin to dominate the communities. Of the eight sites evaluated for macroinvertebrate life, five were found to be severely impaired, and three were classified as moderately impaired. Only two of the sites were categorized as partially supporting of macroinvertebrate habitats, while the other six are non-supporting.

Like the benthic macroinvertebrate community, fish communities rely heavily on various habitats within a stream reach. An altered hydrologic profile in the stream leads to fewer offspring and decreased diversity in the fish community. The extreme flow conditions disrupt nesting habitats and routines for many species. Fish are also unable to rely on the presence of the calm pools and runs they often inhabit. A fish assessment of the Tookany/Tacony-Frankford Creek collected a total of 14 taxa, all of which being at least moderately tolerant of pollution. One of the sites evaluated had only three species of fish present. The low diversity and species richness is indicative of poor habitat and stream health.

5.6 Wetlands Assessment

As discussed in Section 4.5.2 (Indicator 13), the Philadelphia Water Department conducted an extensive wetlands assessment along the riparian corridor of the Tookany/Tacony-Frankford Watershed. Wetland indicators were used to identify possible wetland locations (e.g., soils, hydrology). Over 100 potential wetland locations were field evaluated, and 24 existing wetlands were identified. These wetlands were characterized using the Oregon Freshwater Wetland Assessment method, which evaluates how effectively a wetland performs the following functions: Wildlife Habitat, Fish Habitat, Water Quality, and Hydrologic Control.

The existing wetlands ranged in size from 0.01 to 2.5 acres. In total, only 15 acres of wetland (excluding open water) remain within the 685 acres that constitute the undeveloped riparian corridor of the Tookany/Tacony-Frankford Watershed, and most of those wetlands exhibit degraded wetland functions as a result of hydrologic disconnection from the waterways, encroachment, and invasive vegetation.

The most significant issues affecting wetlands are:

- Many wetlands have been lost to development;
- Remaining wetlands are not sufficiently inundated because stormwater is piped directly to streams;
- Wetlands are no longer hydrologically connected to the primary waterway;
- Wetlands have suffered encroachment and disturbance from urbanization;
- Wetland vegetative and wildlife diversity has been compromised by disturbance;
- Remaining wetlands are extensively compromised in terms of their water quality improvement function.

The extent of disturbance to the remaining wetlands is indicated by the degree to which the wetland functions have been degraded and the degree of human disturbance. The wetland field investigation produced ratings of the degree to which wetland functions have been compromised and the extent of human disturbance to the wetlands sites. This information is summarized in the tables and figures below.

Table 5.10 Wetland Functional Assessment Results for Tookany/Tacony-Frankford Creek Watershed (based on 24 wetland locations)

Function	*Number of Wetlands with Stated Condition*
Wildlife Habitat	
Diverse Habitat	10
Moderate Habitat	14
Fish Habitat	
Intact Habitat	6
Degraded	12
Lost / Not Present	6
Water Quality Improvement	
Intact Function	3
Degraded Function	21
Hydrologic Connection to Stream	
Intact Connection	16
Degraded Connection	7
Connection Lost / Not Present	1

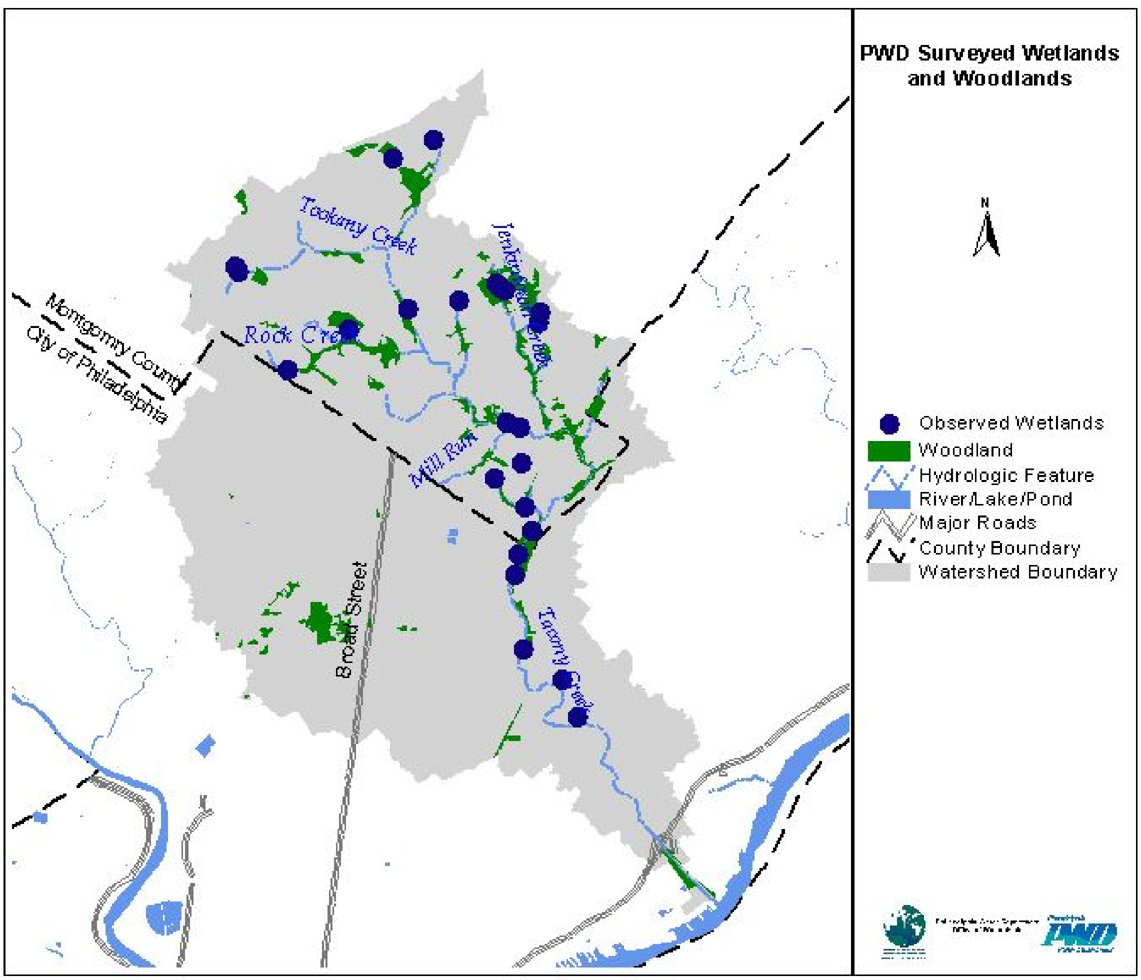


Figure 5.10 Location of Wetlands

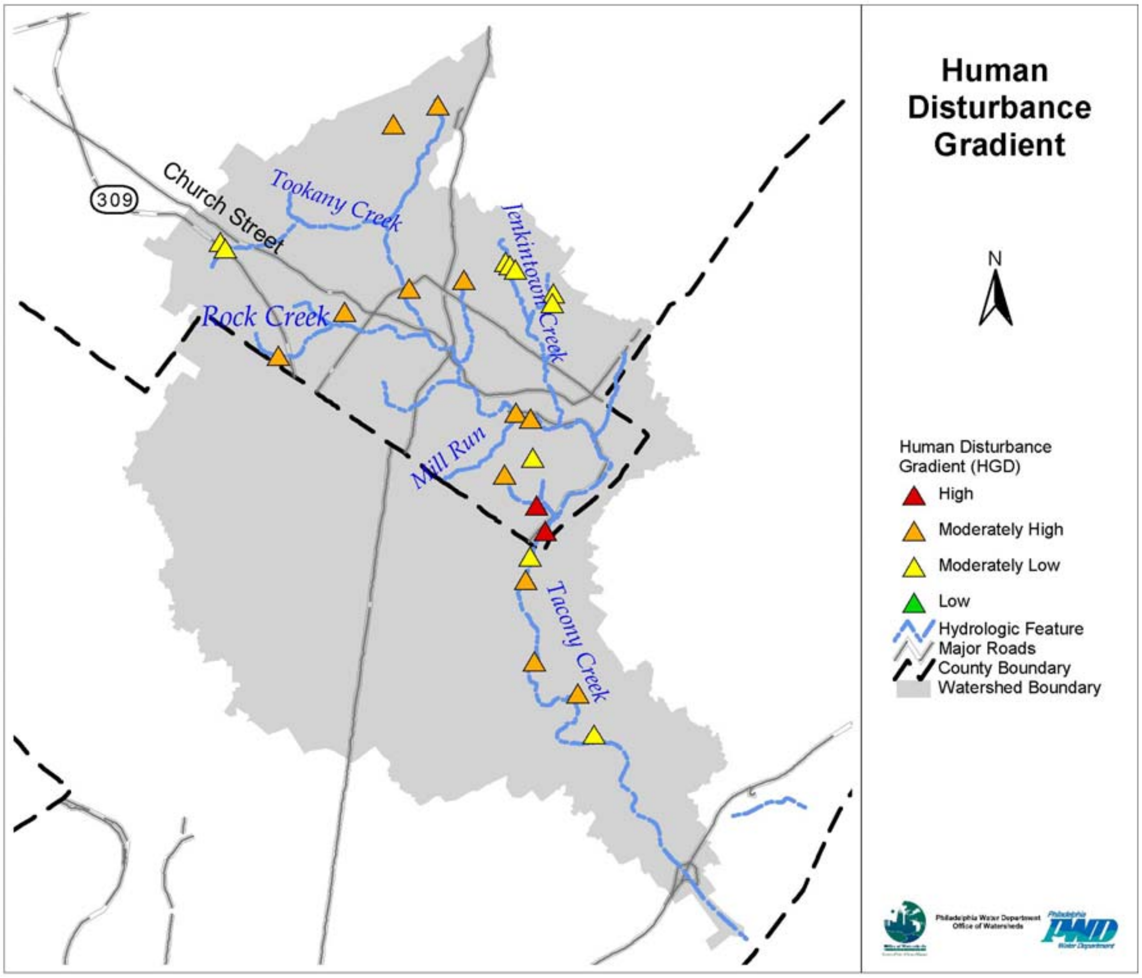


Figure 5.11 Rank of Human Disturbance Gradient

Table 5.11 Rank of Human Disturbance Gradient

Human Disturbance Gradient Rank	Number of Wetlands
Moderately Low Disturbance	10
Moderately High Disturbance	12
Highly Disturbed	2

5.7 Potential Problem Parameters and Planning Implications

Based on the comparisons to water quality criteria, the problem and potential problem parameters have been identified for the Tookany/Tacony-Frankford Watershed. Table 5.12 summarizes these parameters.

Table 5.12 Summary of Problem and Potential Problem Parameters

Parameter	Dry Weather	Wet Weather	Chronic
Fecal Coliform	Red ✓	Red ✓	
Chlorophyll A	Red ✓	Red ✓	
TKN	Red ✓	Red ✓	
TP	Red ✓	Red ✓	
Turbidity	Red ✓	Red ✓	
Cu	Yellow ✓	Red ✓	Red ✓
TSS	Yellow ✓	Red ✓	
Iron	Green	Red ✓	
Zn	Green	Red ✓	Yellow ✓
Al	Green	Red ✓	Red ✓
Pb	Green	Red ✓	Red ✓
Dissolved Fe	Yellow ✓	Yellow ✓	
Temperature	Yellow ✓	Yellow ✓	
DO	Yellow ✓	Green	
TN	Green	Yellow ✓	
Chromium			Yellow ✓

Green – Parameter is not a problem *Yellow – Potential problem parameter* *Red – Problem parameter*

The Tookany/Tacony-Frankford Watershed is faced with many challenges. Stormwater outfalls (SWOs) and combined sewer overflows (CSOs) have exacerbated problems within the watershed. Poor water quality and diurnal variations in levels of dissolved oxygen are added stresses on local fauna. Insufficient habitat combined with the highly variable stream flow makes it difficult to establish a diverse and healthy biotic community. An urban watershed must overcome many obstacles to establish meaningful habitat within and alongside a stream.

Table 5.13 (below) lists the indicators that directly link to water quality and aquatic habitat. The water quality sampling locations have been graded according to sampling results and watershed assessments. For most of the Tookany/Tacony-Frankford Watershed, the indicators have been marked as poor or very poor. Dissolved oxygen, important to maintaining aquatic life, has been identified as a potential problem in the downstream portion of the watershed area.

Table 5.13 Related Watershed Indicator Ratings by Sampling Location

	Indicator 1: Land Use and Impervious Cover	Indicator 2: Streamflow	Indicator 3: Stream Channels and Aquatic Habitat	Indicator 5: Fish	Indicator 6: Benthos	Indicator 7: Effects on Public Health (Bacteria)	Indicator 8: Effects on Public Health (Metals and Fish Consumption)	Indicator 9 : Effects on Aquatic Life (Dissolved Oxygen)	Indicator 10: Point Sources	Indicator 11: Non-point Sources	Indicator 12: Riparian Corridor	Indicator 13: Wetlands and Woodlands
TF280	Very Poor	Poor	Very Poor	Poor	Very Poor	Very Poor	Very Poor	Good/Fair	Good/Fair	Very Poor	Very Poor	Very Poor
TF500	Very Poor	Poor	Very Poor	X	Very Poor	Poor	Poor	Excellent	Excellent	Very Poor	Good/Fair	Poor
TF620	Poor	Good/Fair	Very Poor	Poor	Poor	Good/Fair	Good/Fair	Excellent	Excellent	Good/Fair	Very Poor	Poor
TF680	X	X	X	X	X	Very Poor	Poor	Excellent	Excellent	Poor	X	Very Poor
TF760	Poor	Good/Fair	Very Poor	X	Poor	Good/Fair	Good/Fair	Excellent	Good/Fair	Good/Fair	Poor	Excellent
TF975	Poor	Good/Fair	Very Poor	Poor	Poor	Poor	Good/Fair	Excellent	Excellent	Good/Fair	Good/Fair	Excellent
TF1120	Poor	Good/Fair	Very Poor	Poor	Very Poor	Good/Fair	Good/Fair	Excellent	Good/Fair	Poor	Very Poor	Excellent
TFM000	Poor	X	Very Poor	X	X	X	X	Excellent	Excellent	Good/Fair	Poor	Poor
TFJ110	Poor	X	Very Poor	X	Very Poor	X	X	X	Excellent	Good/Fair	Poor	Excellent

Very Poor	●
Poor	◒
Good/Fair	◓
Excellent	○

Results of the water quality sampling indicate that the water quality of the Tookany/Tacony-Frankford is impaired, with the problems associated primarily with wet weather conditions. Some problems have been identified during dry weather. Sources of bacterial contamination during dry weather may include inappropriate or illicit discharges from storm or sanitary sewerage systems. Detection of these sources is valuable to the management goals of the Tookany/Tacony-Frankford Watershed. Dry weather concentrations of nutrients may be attributed to treated wastewater effluent, over-watering of lawns and gardens, pet waste, and failing septic tanks.

In wet weather, the model-estimated pollutant loadings have identified contributions from different sources. Estimated annual pollutant contributions for the Tookany/Tacony-Frankford Watershed are discussed in Section 4.4. Permitted industrial and municipal point source discharges make up less than 1% of annual streamflow in both systems. SSOs are thought to occur in both watersheds but have not been well documented to date.

Section 6
Causes of Impairment

This section discusses the causes of the various watershed problems identified through field study, stakeholders input, modeling, and data analysis. It forms the link between the problem analysis presented in Section 5, and the identification of alternative solutions or "management options" presented in Section 7.

There are seven types of primary problems to be addressed. These include:

- Trash and dumping
- Erosion, sediment accumulation, and flow variability
- Instream sewer odors
- Lack of healthy riparian habitat
- Poor instream habitat and biological impairment
- Impaired wetlands
- Water quality concerns (metals, TSS, fecal coliform, DO)

In most cases, field studies and data analysis have identified one or more causes for the problem or impairment. In some cases, particularly regarding dissolved oxygen, further studies will be required before a full understanding of the problem is achieved. The high priority problems and their probable causes are discussed below, with recommendations for additional study where appropriate.

6.1 Trash and Dumping

Cause

The source of litter and dumped material is not hard to establish. Litter reaches the stream through careless behavior resulting from trash and litter accumulation in the streets. If not controlled, this accumulation will wash into the storm sewers or combined sewers and eventually be discharged into the streams. Once in the stream, it can get trapped along banks, or build up near flow obstructions such as bridge supports. In general, littering is not an intentional activity, but results from carelessness or lack of concern for its effect on the environment. Dumping, however, is a more deliberate act, and occurs when people gain access to the stream and dump waste material from the home or business directly into the stream. Dumping is generally done to avoid the costs associated with proper disposal. In either case, the cause of the buildup of litter and trash in the stream is clear, and can only be addressed through education and enforcement to eventually modify the behavior of people living and working in the watershed.

Further Studies

Some further study will be required to identify points along the stream that are most easily accessible by vehicle, and where illegal dumping has been a common practice in the past.

6.2 Erosion, Sediment Accumulation, and Flow Variability

Cause

Erosion of the channel bed and along the streambanks has been identified as a problem in many areas of the watershed. High levels of urbanization and development and poor stream bank stability deeply influence the Tookany/Tacony-Frankford Creek. Natural water flows from some portions of the creek have been redirected to storm sewers and replaced by block after block of impervious surfaces. Due to the changes in the hydrologic profile of the stream and watershed, storm events result in greater amounts of runoff and cause more damage than they once did. Instead of percolating into the ground, stormwater is collected and rushed into an already unstable creek where it scours banks, fills pools, and covers riffles. The rushing water strips soil from the banks and deposits some of it over the embedded cobbles and takes the rest to the Delaware River, all the while holding on to the chemicals and pathogens it collected on the city streets and in the sewers.

The cause of erosion can be traced primarily to the above mentioned flow variability, particularly to bankfull flow conditions that occur more frequently than in more natural watersheds due to the urbanized nature of the Tookany/Tacony-Frankford watershed. Sediment buildup can be caused either by streambed and streambank erosion, or by sediment washing into the creek from stormwater discharges. Note that flow variability has been identified as both a problem in itself, and as the cause of erosion and poor instream habitat (discussed below).

Further Studies

The flow variability is well established and understood, and does not require additional studies. The erosion problem has been generally identified through stream assessments. Further studies will be required, however, to prioritize areas undergoing erosion, and to more exactly identify the cause of erosion or sediment buildup for each reach of the river where erosion or deposition is occurring. These studies will be carried out during conceptual design of stream restoration measures.

6.3 Instream Sewer Odors

Cause

Sewer odors occur during dry weather when sewer lines leak into the stream, or when waste lines from homes or businesses are cross-connected to storm sewers in areas where the sanitary and storm sewer systems are separate. Odors also occur during wet weather, with the cause identified as combined sewer overflows (CSOs), or in areas of separate storm and sanitary sewers, through sanitary sewer overflows (SSOs).

Further Studies

Although the causes are well known, further studies will be required to pinpoint the location and cause of all dry weather sewer discharges in separate sewered areas, and to identify SSOs and opportunities for reduced CSOs during wet weather.

6.4 Lack of Healthy Riparian Habitat

Cause

The entire length of the Tookany/Tacony-Frankford Creek has been assessed, and the existence or absence of riparian buffers noted. The cause is usually obvious: Either development has encroached on the riparian buffer, leaving little or no room for a vegetated buffer, or the riparian area is open but poorly managed.

Further Studies

Additional studies will be required in developing a riparian buffer improvement program. These studies will primarily involve the identification of land ownership of riparian areas.

6.5 Poor Instream Habitat and Biological Impairment

Cause

Poor instream habitat has been identified as both a problem itself, as well as the cause of biological impairment found throughout the watershed. Stream channels in the Tookany/Tacony-Frankford Watershed exhibit many effects of urbanization, including over-widening, erosion, loss of sinuosity, loss of the floodplain, loss of stream connection, channel modification, and loss/degradation of aquatic habitat. Biological monitoring indicates that the whole Tookany/Tacony-Frankford Watershed suffers from impaired aquatic habitat and does not meet its designated use as a warm water fishery. As a result, the whole length of the non-tidal Tookany/Tacony-Frankford Creek and its tributaries were listed in PA DEP's 303d list of impaired waters in 1999. This impairment is due to severe water flow fluctuations, habitat alteration, point and non-point source pollution from urban development, hydromodification, and combined sewer overflows (PA DEP 2001). The tidal portion of the Frankford Creek remains unassessed because the biological assessment protocol is not applicable to tidal stream segments.

The biological community of the Tookany/Tacony-Frankford Watershed is heavily impacted by its urban surroundings. The impaired state of the creek is a result of habitat deterioration due to urbanized stormwater flow patterns and/or water quality degradation.

Benthic macroinvertebrates rely heavily on stream riffles for at least part of their life cycle. Clinging to life in a riffle requires various adaptations, and most macroinvertebrates are not prepared for the extreme hydrologic fluctuations that can occur in a channelized creek such as the Tookany/Tacony-Frankford. Increased stream velocities and sediment loads from eroding stream banks are disrupting the benthic environment by scouring the stream bottom of appropriately sized substrates. The cobble substrate has limited interstitial space, often filled by finer materials, for benthic macroinvertebrates to thrive. Storm events lead to decreased species richness and evenness, which in turn changes the dynamics of feeding groups within the communities. Specialized feeders are greatly diminished, and generalists such as gatherer/collectors dominate the feeding community.

Like the benthic macroinvertebrate community, fish communities rely heavily on various habitats within a stream reach. An altered hydrologic profile in the stream leads to fewer offspring and decreased diversity in the fish community. The extreme flow conditions disrupt nesting habitats and routines for many species. Fish are also unable to rely on the presence of the calm pools and runs they often inhabit.

Further Studies

Additional detailed studies will be required to better understand the degree of impairment and to pinpoint the causes of impairment for each stretch of the stream system. It is also critical to better understand the relative importance of the habitat impairment and the low dissolved oxygen conditions found in the downstream areas of the watershed as it relates to impaired benthic macroinvertebrate and fish communities. These studies must be completed prior to making detailed recommendations on habitat improvement.

6.6 Impaired Wetlands

Cause

Wetland assessments have identified the loss of wetlands and the impairment of remaining wetlands as a problem. The remaining wetlands were evaluated for their value as wildlife and fish habitat, and for their potential to improve water quality (nutrient and toxicant reduction) and temper the hydrologic regime (flood flow). Nearly all wetlands in the watershed exhibit impaired functions that indicate extensive disturbance and deterioration. Urban and suburban development has resulted in the piping of historic streams, destruction of wetlands, and deforestation and modification of historic floodplains. Stormwater is piped directly to waterways rather than flowing overland through vegetation, wetlands, and woodlands. Also, because stormwater runoff frequently flows over impervious surfaces, and is then piped to the streams, the flow and volume of runoff is intensified. Because most stormwater is piped directly to the waterways of the watershed, there is no longer a source of water to maintain many of the wetlands that once existed.

Further Studies

No further studies are anticipated, beyond those associated with the conceptual design of wetland enhancement or wetland creation at specific sites within the watershed.

6.7 Water Quality Concerns (Metals, TSS, Fecal Coliform, DO)

Cause

The primary water quality concerns were identified as elevated concentrations of some metals and Total Suspended Solids (TSS), particularly during wet weather events, high fecal coliform counts, particularly in wet weather, and low dissolved oxygen (DO) in downstream areas of the creek. The primary sources of contaminants are wet weather flows from separate and combined sewers, and some sewage flows during dry weather due to the connection of waste lines to a separate storm sewer, or to leaking combined sewer lines.

Stormwater running off of impervious areas can carry pollutants to the stream through the storm sewers and, during overflow events, through the combined sewer. Stormwater-borne pollutants can include litter, nutrients, metals, fecal coliform from pet wastes, pesticides used on lawns, and sediment. Non-point source pollution poses a threat to the water quality in the Tookany/Tacony–Frankford creek because of the volume of stormwater runoff and the concentrations of pollutants found in the stormwater.

A model was used to estimate runoff quantity and quality in storm, sanitary, and combined sewer systems and from each land use type within the subwatersheds. The list of pollutants simulated using the model included parameters such as nitrate and phosphorus, total suspended solids, heavy metals, and BOD (biological or biochemical oxygen demand). Although the source of pollutants is well established, the model results helped identify areas where stormwater runoff or pollutant loads are particularly high and in need of control.

Using lead and copper to represent metals in the Tookany/Tacony-Frankford watershed, the model-generated stormwater runoff loads are compared with the wet weather exceedance of the standards in Figures 6.1 and 6.2. The results show areas where higher loads are contributing to degraded stream water quality during wet weather, however, the lack of wet weather sampling data does not allow for comparison with runoff loads.

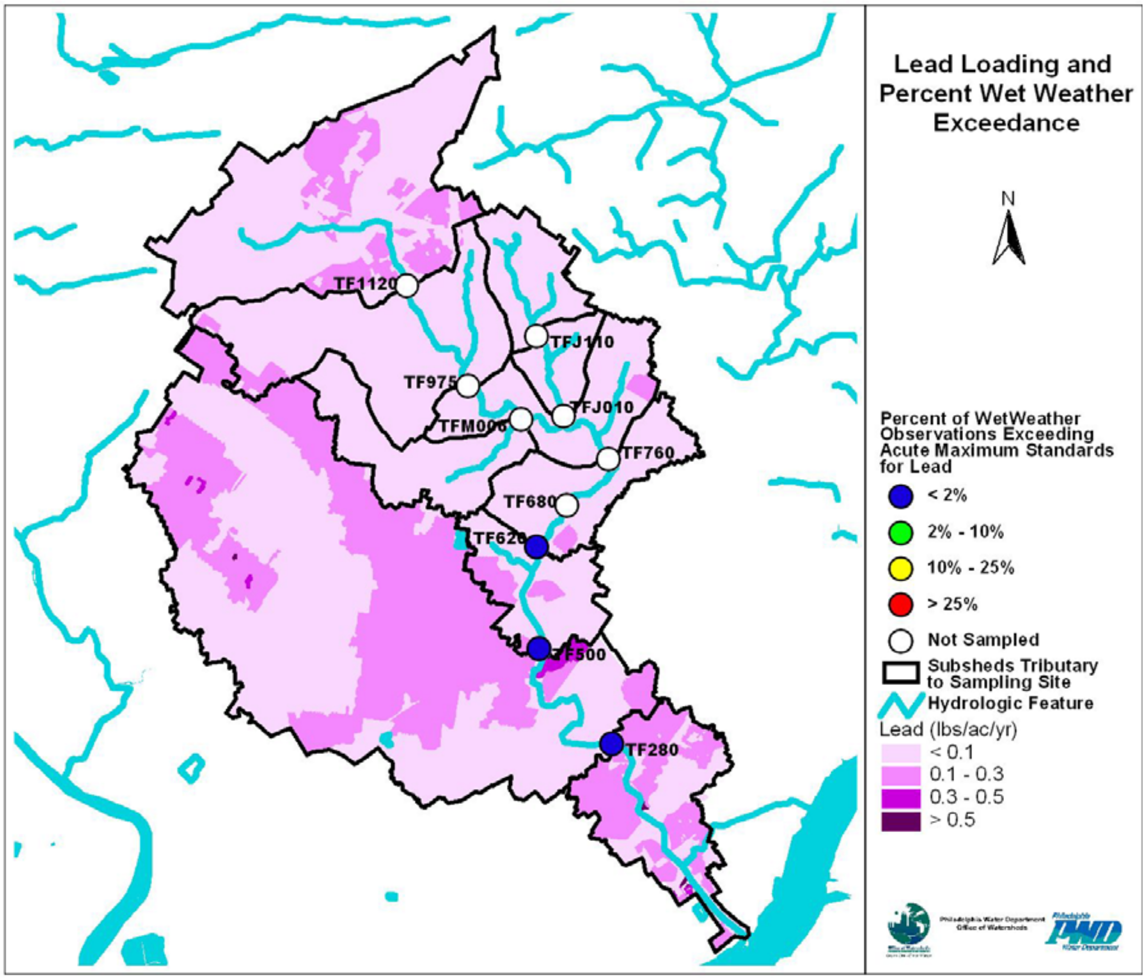


Figure 6.1 Lead Loading

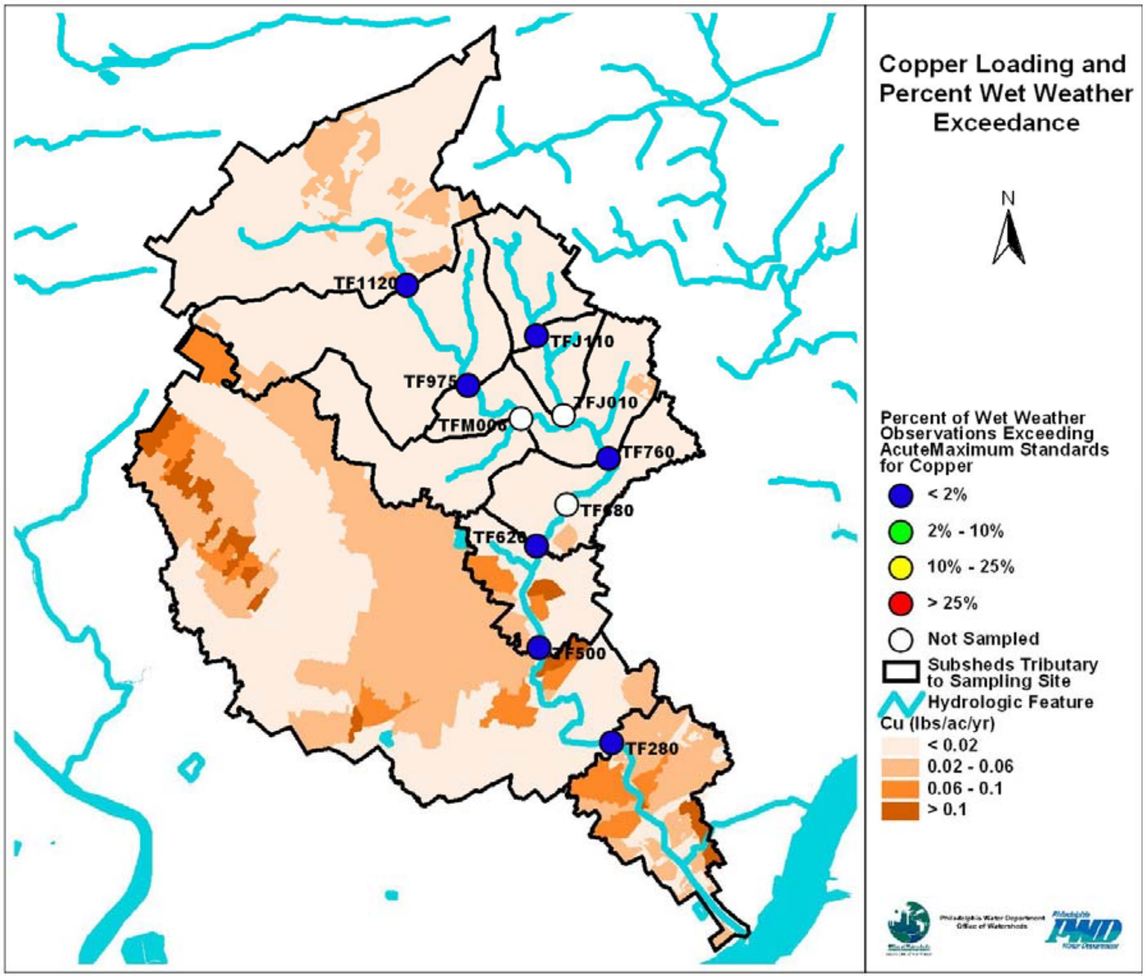


Figure 6.2 Copper Loading

CSO and stormwater discharges are the dominant sources of fecal coliform in the Tookany/Tacony-Frankford Watershed during wet weather. Figure 6.3 displays the spatial distribution of runoff loads for fecal coliform compared with the wet weather water quality. As indicated from the water quality data, fecal coliforms are a problem throughout the watershed.

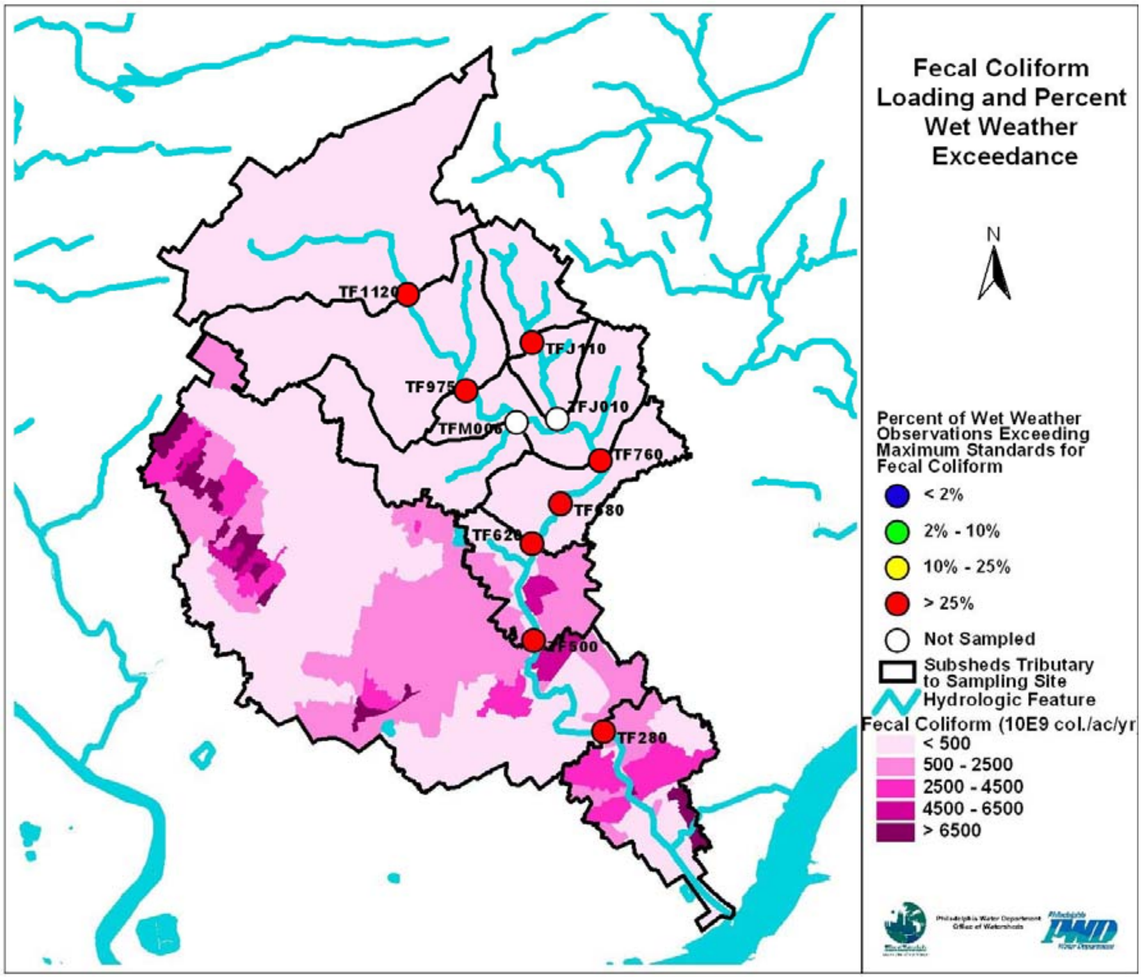


Figure 6.3 Fecal Coliform Loading

Figure 6.4 shows the model-estimated TSS loading and the wet weather sampling results. The pattern of sample results and model-estimated loads is a little less clear for TSS than for some of the other pollutants, with exceedances occurring both upstream and downstream, and loading more heavily weighted toward the urbanized, downstream portion of the watershed. This may indicate that stormwater runoff is not the only source of sediment, and that instream channel and bank erosion may also be a significant source. Additional studies would be necessary to further pinpoint the sources.

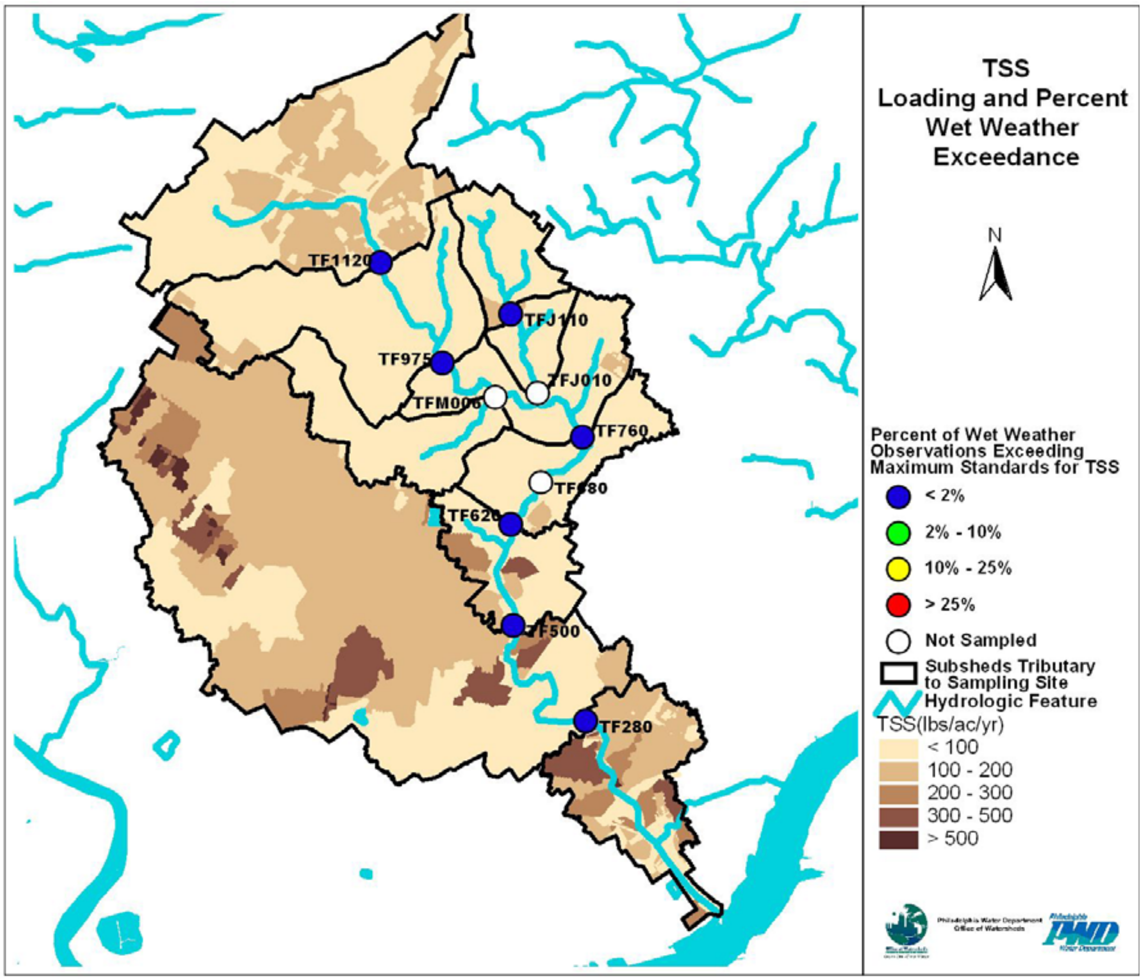


Figure 6.4 Total Suspended Solids Loading

CSOs are the largest source of pollutants associated with urban and suburban runoff, including nutrients such as phosphorus and metals such as lead, copper, and zinc. For the Tookany/ Tacony-Frankford Watershed, stormwater outfalls are a smaller but significant source of these constituents. (Figure 4.20 illustrated the model-estimated contributions for metals and fecal coliforms as percentages of the total estimated load.)

Low dissolved oxygen has been identified as a potential problem in the downstream section of the creek. In addition, unusually high diurnal fluctuations in DO have also been observed in the downstream sections. There are several potential causes of low DO. These include:

- High BOD loading during dry and wet weather;

- The existence of scour pools or pools upstream of dams that do not flush frequently enough, allowing anoxic conditions to occur;
- Excessive growth of attached algae that alternately produce and consume oxygen resulting in large diurnal fluctuations in DO;
- The buildup of organic material in the sediment that exerts high oxygen demand.

BOD (biological or biochemical demand) loading is a concern in the watershed. The BOD load estimates are shown in Figure 6.5. Sediments may store BOD, which may become re-suspended during storms, moving the area of DO deficit further downstream. Generally, the loads carried to the stream by stormwater are highest further downstream in the watershed.

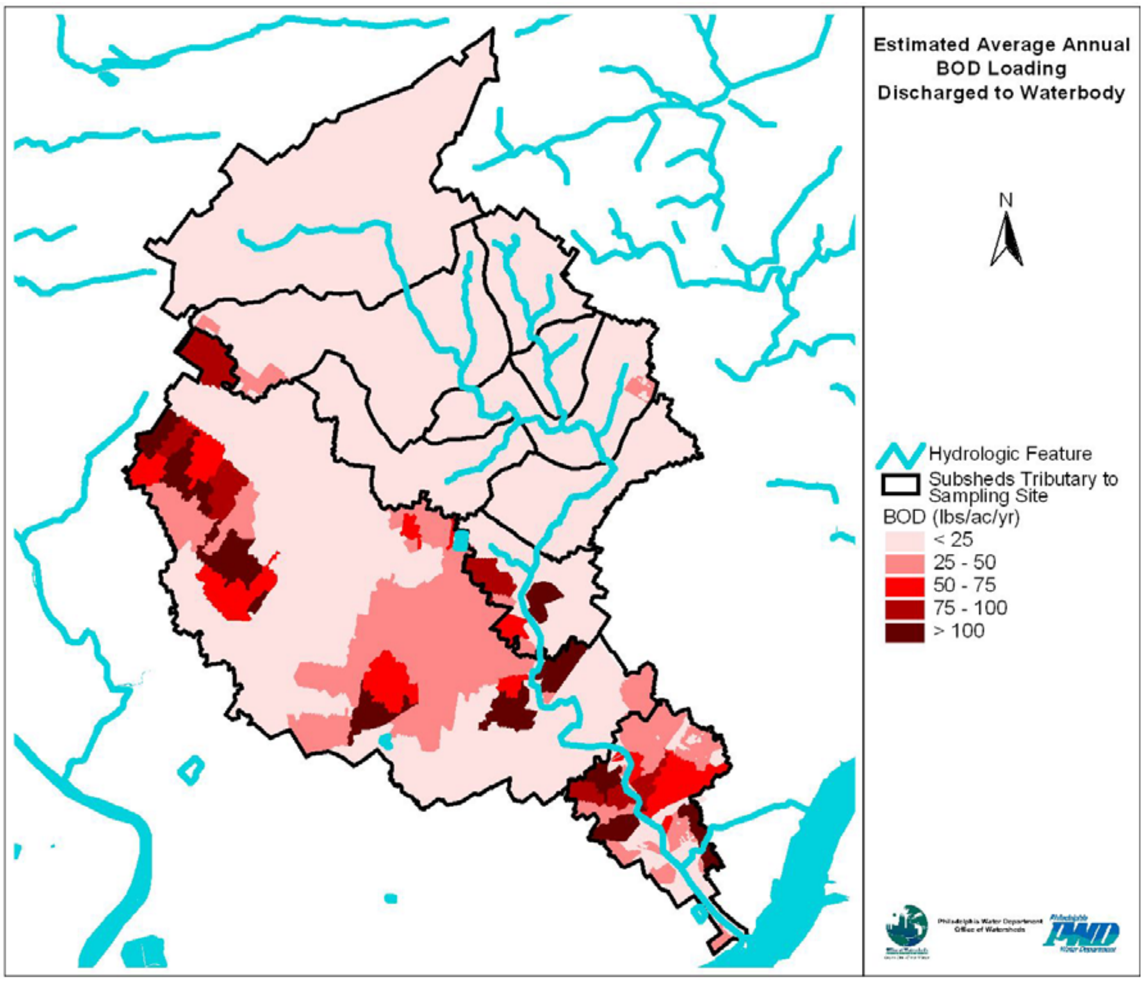


Figure 6.5 Total BOD Loading

Low DO is suspected in the area upstream of the dam at Adams Avenue. This may be caused by a combination of a deep pool that does not flush frequently, and high sediment oxygen demand.

Further Studies

The causes of TSS exceedances have been identified as stormwater discharges, CSOs, and instream erosion. The relative contributions of each, however, have not been adequately characterized. This will require additional analysis once the stream assessment data are available, combined with some additional modeling.

The causes of suspected DO problems in the Tookany/Tacony Frankford Watershed are not yet sufficiently understood, and will require further studies.

Studies should be carried out to:

- better understand the impact of attached algae on DO fluctuations (water quality modeling and field studies);
- identify areas where plunge pools and dams may be the cause of localized occurrences of low DO;
- assess the sediment oxygen demand and the BOD in the water column to better understand the relative contributions of each to low DO; and
- better assess sources of BOD during both dry and wet weather.

Section 7
Development and Screening of Management Options

This section summarizes a comprehensive list of stormwater and watershed corrective measures, or "management options," that the TTF Watershed Partnership judged to be potentially applicable to their watershed. This list serves as the starting point for the screening and evaluation steps (Section 7.2) that lead to the array of recommendations contained in the Implementation Guidelines (Section 8).

7.1 Menu of Options

A large amount of detailed information on these watershed management options is already available from existing sources. Rather than reproducing this information, this section provides references and links to these sources.

The options are grouped under the three targets introduced in Section 2 (with codes listed parenthetically for reference below and in the sections that follow):

Target A: Dry Weather Water Quality and Aesthetics

- Regulatory Approaches (AR1,2)
- Public Education and Volunteer Programs (AP1-3)
- Municipal Measures (AM1-7)
- Enhancing Stream Corridor Recreational and Cultural Resources (AO1)
- Monitoring, Reporting, and Further Study (AMR)

Target B: Healthy Living Resources

- Channel Stability and Aquatic Habitat Restoration (BM1-5)
- Lowland and Upland Restoration and Enhancement (BM6-9)
- Monitoring, Reporting, and Further Study (BMR)

Target C: Wet Weather Water Quality and Quantity

- Regulatory Approaches (CR1-9)
- Public Education and Volunteer Programs (CP1)
- Municipal Measures (CM1-9)
- Stormwater Management:
  - Source Control Measures (CS1-5)
  - Onsite and Regional Stormwater Control Facilities (CS6-16)
- Monitoring, Reporting, and Further Study (CMR)

7.1.1 Target A: Dry Weather Water Quality and Aesthetics

Target A is defined for Tookany/Tacony-Frankford Creek as focusing on trash removal and litter prevention, and the elimination of sources of sewage during dry weather. Streams should be aesthetically appealing (look and smell good), accessible to the public, and be an amenity to the community. Sewer odors occurring from dry weather sewer discharges in both combined and separate sewered areas should be remedied.

Regulatory Approaches

AR1 On-Lot Disposal (Septic System) Management
AR2 Pet Waste, Litter, and Dumping Ordinances

These typical pollution reduction and aesthetic ordinances are already in effect in many locations, and can be effective at controlling diffuse sources of pollutants. They are particularly important in urban watersheds; however, they must be consistently enforced to be effective.

Public Education and Volunteer Programs

AP1 Public Education
AP2 School-Based Education
AP3 Public Participation and Volunteer Programs

Municipal Measures

AM1 Capacity Management Operation and Maintenance (CMOM)
AM2 Inspection and Cleaning of Combined Sewers
AM3 Sanitary Sewer Rehabilitation
AM4 Combined Sewer Rehabilitation
AM5 Illicit Discharge, Detection, and Elimination (IDD&E)
AM6 Stream Cleanup and Maintenance
AM7 Household Hazardous Waste Collection

Enhancing Stream Corridor Recreational and Cultural Resources ***(AO1)***

Preservation and enhancement of recreational and cultural resources may be integrated into comprehensive watershed management. These resources are part of the link between the human population and natural resources in a watershed. Strategies to provide access to water resources for recreational purposes encourage appreciation for and stewardship of these areas. Strategies to protect water-based historic structures should be implemented to insure that flooding and other impacts are avoided.

Monitoring, Reporting, and Further Study ***(AMR)***

Monitoring and reporting under Target A include monitoring of progress toward achievement of objectives (as measured by indicators introduced in Section 4) and monitoring of implementation of recommended management measures. For example, Indicator 18 measures "tons of trash removed from streams and riparian areas" (a measure of option implementation) and derives a stream accessibility score for individual reaches of the creek (a measure of progress toward an objective).

7.1.2 Target B: Healthy Living Resources

Improving the ability of an urban stream to support viable habitat and fish populations focuses primarily on remediation of the more obvious impacts of urbanization on the stream. These impacts include loss of healthy riparian habitat, eroding and undercut banks, scoured streambed or excessive sediment deposits, channelized and armored stream sections, and invasive species. Encroaching development on the riparian buffer can leave little or no room for a vegetated buffer, while other open riparian areas are often left poorly managed. Biological monitoring indicates that the whole Tookany/Tacony-Frankford Watershed suffers from impaired aquatic habitat and does not meet its designated use as a warm water fishery. This impairment is due to severe water flow fluctuations, habitat alteration, point and non-point source pollution from urban development, hydromodification, and combined sewer overflows (PA DEP 2001).

The primary tool to address these problems is stream restoration. Restoration addresses poor instream habitat and biological impairment, focusing on improving channel stability, improving instream and riparian habitat, providing refuge that allows fish to avoid high velocity conditions during storms, and managing land within the stream corridor. Lowland restoration and enhancement addresses the problem of wetland loss and impairment. Nearly all wetlands in the watershed exhibit impaired functions that indicate extensive disturbance and deterioration.

The wet weather strategy includes both restoration of physical stream habitat and reduction of discharges from stormwater and combined sewage. These measures are complementary; stream restoration provides areas of lower flow where aquatic life can avoid higher flows, and discharge reduction helps limit velocities and protects the long-term investment in the restored stream. Targets B and C are intended to accomplish the restoration of physical stream habitat through control measures involving erosion, sediment accumulation, and flow variability.

Many of the stresses faced by aquatic life in urban streams are the result of alternating extremes of high and low flow, and the resulting sediment scour and deposition. While stormwater BMPs that promote infiltration do help to reduce these extremes, a recent modeling analysis conducted by PWD indicates that impervious cover would have to be reduced by half or more to have a significant effect. This result indicates that stream restoration measures may be a more feasible means of improving the aquatic habitat in the short term. Modern design techniques may create areas of reduced velocity where aquatic life is protected during high flow. Techniques appropriate to our area are summarized in “Guidelines for Natural Stream Channel Design for Pennsylvania Waterways,” by the Alliance for the Chesapeake Bay, March 2003. This publication is available online at http://www.acb-online.org/toolkits.cfm.

Channel Stability and Aquatic Habitat Restoration

BM1 Bed Stabilization and Habitat Restoration
BM2 Bank Stabilization and Habitat Restoration
BM3 Channel Realignment and Relocation
BM4 Plunge Pool Removal
BM5 Improvement of Fish Passage

Lowland and Upland Restoration and Enhancement

BM6 Wetland Improvement
BM7 Invasive Species Management
BM8 Biofiltration
BM9 Reforestation

Monitoring, Reporting, and Further Study ***(BMR)***

Monitoring and reporting under Target B includes monitoring of progress toward achievement of objectives (as measured by indicators introduced in Section 4) and monitoring of implementation of recommended management measures. For example, Indicator 3 measures the channel condition and trend for each reach of the stream. This indicator is both a measure of implementation and a measure of progress toward the goal of reducing streambank and stream channel deposition and scour to protect and restore the natural functions of aquatic habitat and ecosystems, streambanks, and stream channels.

7.1.3 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. A comprehensive watershed management approach also must address flooding issues. The wet weather strategy includes both restoration of physical stream habitat and reduction of discharges from stormwater and combined sewage. These measures are complementary; stream restoration provides areas of lower flow where aquatic life can avoid higher flows, and discharge reduction helps limit velocities and protects the long-term investment in the restored stream. Targets B and C are intended to attend to restoration of physical stream habitat through control measures involving erosion, sediment accumulation, and flow variability.

Regulatory Approaches

CR1 Requiring Better Site Design in New Development
- Open Space Preservation Plan
- Stream Buffer/Corridor Protection Ordinance
- Wetlands Protection Ordinance
- Steep Slope Ordinance
- Cluster Development Ordinance
- Transfer of Development Rights Ordinance

CR2 Requiring Better Site Design in Redevelopment (may include options in CR1)
CR3 Stormwater and Floodplain Management
CR4 Industrial Stormwater Pollution Prevention
CR5 Construction Stormwater Pollution Prevention
CR6 Post-construction Stormwater Runoff Management
CR7 Pollution Trading
CR8 Use Review and Attainability Analysis
CR9 Watershed-Based Permitting

Following is a brief discussion of each of those nine regulatory approaches toward reaching Target C, as outlined above.

CR1&2 – Requiring Better Site Design in New Development and Redevelopment

The regulatory authority for controlling land use is vested in the municipalities through their ability to develop ordinances that regulate zoning and development practices. In areas that are undergoing development pressures, these ordinances are some of the most effective tools for watershed protection. In fully developed, urban watersheds such as the Tookany/Tacony-Frankford Creek Watershed, they are less effective, and are needed primarily to help improve conditions in areas that are re-developing.

A variety of approaches to environmentally responsible land use controls have been developed in recent years, and some are being implemented in the areas adjacent to Philadelphia that are undergoing rapid development. The Delaware Valley Regional Planning Commission (DVRPC) has collected information on these practices and local applications on their web site at http://www.dvrpc.org/planning/community/protectiontools.htm.

CR3 – Stormwater and Floodplain Management

Ordinances that deal directly with the way that stormwater is handled and floodplains are developed or re-developed are important in both developing and developed areas. Municipal ordinances for stormwater and floodplain management should be consistent with the "Comprehensive Stormwater Management Policy" (Document 392-0300-002) released by PA DEP in September 2002. This policy is intended "to more fully integrate post-construction stormwater planning requirements, emphasizing the use of ground water infiltration and volume and rate control best management practices (BMPs), into the existing NPDES permitting programs and the Stormwater Management Act ('Act 167') Planning Program." The comprehensive policy is available on PA DEP's web site at http://www.dep.state.pa.us/dep/deputate/watermgt/wc/Subjects/StormwaterManagement/GeneralInformation/default.htm.

In late 2004, the municipalities of the Tookany/Tacony Frankford Watershed embarked on the process of developing an Act 167 plan. This will include developing and adopting a model ordinance intended to satisfy the requirements of both the Act 167 and NPDES Phase II programs. This model ordinance may be based on a recently completed model ordinance developed for the Darby-Cobbs Watershed, adapted to meet the needs of the TTF Watershed.

CR4 – Industrial Stormwater Pollution Prevention

Industrial stormwater pollution prevention includes attention to the following measures:

- Good Housekeeping
- Preventive Maintenance
- Visual Inspections
- Spill Prevention and Response
- Employee Training
- Record Keeping and Reporting
- Fueling
- Maintaining Vehicles and Equipment
- Painting Vehicles and Equipment
- Washing Vehicles and Equipment
- Loading and Unloading Materials
- Liquid Storage in Above-Ground Tanks
- Industrial Waste Management and Outside Manufacturing
- Outside Storage of Raw Materials, By-Products, or Finished Products
- Salt Storage
- Flow Diversion
- Exposure Minimization Structures (dikes, drains, etc.)
- Erosion Prevention and Sediment Control
- Infiltration Practices

Detailed guidance on these industrial measures is available in EPA publication 832-R-92-006, "Storm Water Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices", released in September 1992. Municipalities may choose to adopt more stringent controls at the local level, or may work with state authorities to enforce the existing requirements. These measures are also appropriate for commercial and government operations involved in similar activities. The publication mentioned above is available online at http://nepis.epa.gov/pubtitleOW.htm.

CR5 – Construction Stormwater Pollution Prevention

Stormwater pollution prevention during construction activities includes attention to the following measures:

- Sediment and Erosion Control Practices
- Good Housekeeping
- Waste Disposal
- Minimizing Offsite Vehicle Tracking of Sediments
- Sanitary/Septic Disposal
- Material Management
- Spill Response
- Control of Allowable Non-Stormwater Discharges
- Maintenance and Inspection
- Stormwater Management

Detailed guidance on these measures is available in PA DEP publication 363-2134-008, "Erosion and Sediment Pollution Control Program Manual," released in April 2000. Municipalities may choose to adopt more stringent controls at the local level, or may work with state authorities to enforce the existing requirements. These measures are also appropriate for commercial and government operations involved in similar activities. The publication is available online at http://www.dep.state.pa.us/dep/deputate/watermgt/wc/Subjects/StormwaterManagement/GeneralInformation/default.htm.

CR6 – Post-construction Stormwater Runoff Management

Post-construction Stormwater Runoff Management is part of the NPDES Phase 2 stormwater management plan. (Options CR3 and CR6 have substantial overlap.)

CR7 – Pollution Trading

U.S. EPA is exploring market-based measures as a way of reaching targeted overall pollutant load reductions in a watershed. EPA's "Final Water Quality Trading Policy," released in January 2003, may be accessed at http://www.epa.gov/owow/watershed/trading/tradingpolicy.html. As this policy is adopted by the states and incorporated in regulations, it may increase incentives for cooperation and coordination between the municipalities and counties that share a watershed.

CR8 – Use Review and Attainability Analysis

U.S. EPA provides procedures for reviewing the applicability and attainability of designated uses. This process may be appropriate for urban watersheds like the Tookany/Tacony-Frankford. EPA document 833-R-01-002, "Coordinating CSO Long-Term Planning with Water Quality Standards Reviews," provides a framework for the process in areas served by combined sewers. The document is available at http://cfpub.epa.gov/npdes/cso/guidedocs.cfm.

CR9 – Watershed-Based Permitting

A holistic watershed management approach provides a framework for addressing all stressors within a hydrologically defined drainage basin instead of viewing individual sources in isolation. Within a broader watershed management system, the watershed-based permitting approach is a tool that can assist with implementation activities. The utility of this tool relies heavily on a detailed, integrated, and inclusive watershed planning process. Watershed planning includes monitoring and assessment activities that generate the data necessary for clear watershed goals to be established and permits to be designed to specifically address the goals. The policy statement and implementation guidance, "Watershed-Based National Pollutant Discharge Elimination System (NPDES) Permitting Implementation Guidance," finalized in 2004, are available at http://cfpub.epa.gov/npdes/wqbasedpermitting/wspermitting.cfm.

Public Education and Volunteer Programs

CP1 Public Education and Volunteer Programs

Municipal Measures

CM1 Sanitary Sewer Overflow Detection
CM2 Sanitary Sewer Overflow Elimination: Structural Measures
CM3 Reduction of Stormwater Inflow and Infiltration to Sanitary Sewers
CM4 Combined Sewer Overflow (CSO) Control Program
- Nine Minimum Controls
- Long Term CSO Control Plan
- Watershed-Based Planning

CM5 Catch Basin and Storm Inlet Maintenance
CM6 Street Sweeping
CM7 Responsible Landscaping Practices on Public Lands
CM8 Household Hazardous Waste Collection
CM9 Responsible Bridge and Roadway Maintenance

The first three measures above apply primarily to municipalities with separate sanitary sewer systems. The second measure, eliminating sanitary sewer overflow, is believed to be of critical importance in the Tookany/Tacony-Frankford Watershed. Inspection, cleaning, and when necessary, rehabilitation of aging sanitary sewers may be the single most important pollution reduction measure, and should be implemented immediately in this watershed. Reduction of pollutant loads due to stormwater may be of secondary importance if significant loads are being introduced by sanitary sewage.

Structural Stormwater Management Facilities

Detailed information on structural BMPs for stormwater management is available in various existing BMP manuals:

- PA DEP's Comprehensive Stormwater Management Policy (see links in Appendix A): http://www.dep.state.pa.us/dep/deputate/watermgt/wc/Subjects/StormwaterManagement/GeneralInformation/default.htm
- City of Philadelphia Stormwater BMP Manual: http://www.phillyriverinfo.org
- Center for Watershed Protection Stormwater Manager's Resource Center: http://www.stormwatercenter.net/
- Maryland Stormwater Design Manual: http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/stormwater_design/index.asp
- New Jersey: Best Management Practices for Control of Nonpoint Source Pollution: http://www.state.nj.us/dep/watershedmgt/bmpmanual.htm

Stormwater Management

Source Control Measures

CS1 Reducing Effective Impervious Cover Through Better Site Design
CS2 Porous Pavement and Subsurface Storage
CS3 Green Rooftops
CS4 Capturing Roof Runoff in Rain Barrels or Cisterns
CS5 Increasing Urban Tree Canopy

The first option above, reducing effective impervious cover, refers to a variety of measures, including encouraging homeowners to reduce the size of paved areas on their properties. Use of porous pavement is an alternative to reduction of paved areas. Rooftops represent a large proportion of the impervious area in highly urbanized watersheds such as the Tookany/Tacony-Frankford; constructing rooftop gardens over public and private buildings can be an effective structural measure to reduce urban runoff. Though this technology is catching on slowly in the United States, there are some examples in Southeastern Pennsylvania to look to as models.

The Tookany/Tacony-Frankford Partnership implemented a rain barrel pilot program. Rain barrels are inexpensive but need to be implemented throughout a watershed and drained between storms to be effective as a runoff reduction measure. It is also important that their owners are properly trained and committed to operate and maintain them. Cisterns are similar to rain barrels in function; they also must be drained on a regular basis to provide effective stormwater control.

Tree planting and urban reforestation programs provide hydrologic benefits in addition to quality of life improvements. Leaf surfaces intercept some rainfall that might otherwise fall on impervious surfaces. The rainfall then either evaporates or is conveyed more slowly to the ground along plant stems and trunks. Trees located over or near impervious cover provide the greatest stormwater control benefits.

Municipalities have the opportunity to provide incentives for private landowners to implement these innovative measures through ordinances, tax incentives, or a stormwater fee linked to impervious cover.

Stormwater Management

Onsite and Regional Stormwater Control Facilities

CS6 Maintaining/Retrofitting Existing Stormwater Structures
CS7 Modifying Catch Basins to Delay Stormwater Inflow
CS8 Retrofitting Existing Sewer Inlets with Dry Wells
CS9 Residential Dry Wells, Seepage Trenches, and Rain Gardens
CS10 Infiltration Basins
CS11 Vegetated Swales and Open Channels
CS12 Bioretention Basins and Porous Media Filtration
CS13 Treatment Wetlands: Onsite and Regional
CS14 Dry Detention Basins
CS15 Wet Retention Basins
CS16 BMPs for Highway Runoff (may include various structural options in this list)

The options listed above (CS6-16) are documented in the state manuals. Most of them may be implemented on the small scale of an individual property. Residential dry wells are an inexpensive way to infiltrate residential roof runoff and provide a benefit distributed over the watershed. Infiltration basins are similar but typically used on a larger scale requiring more land. Porous media filters and bioretention basins are most often used to detain, treat, and infiltrate parking lot runoff. Rain gardens are similar to bioretention and can be implemented in backyards or public land such as school grounds. Proper design and maintenance, along with an effective public relations campaign, can alleviate typical concerns about mosquito control and basement flooding.

Retrofit of existing sewer inlets with dry wells is an innovative option that, while expensive, may be attractive in a completely urbanized area with very little land available for traditional BMPs. Using this technology, existing catch basins are retrofitted to provide some measure of storage and infiltration. With full implementation and favorable soil conditions, the resulting outflows may resemble the pre-development condition. The City of Portland, Oregon, has implemented this approach and has provided some documentation in its Stormwater Management Manual (http://www.portlandonline.com/bes/index.cfm?c=35117).

Dry detention and wet retention basins are traditional BMPs that typically provide detention and treatment functions but only limited infiltration. Their design is extensively documented in the state manuals. Constructed wetlands, either onsite or regional, provide even greater detention and treatment functions; in addition, they may provide a cooling function and removal of some stormwater through evapotranspiration.

Monitoring, Reporting, and Further Study ***(CMR)***

Monitoring and reporting under Target C includes monitoring of progress toward achievement of objectives (as measured by indicators introduced in Section 4) and monitoring of implementation of recommended management measures. For example, Indicator 7 measures the percent of water quality samples where the state fecal coliform standard is met. This indicator is a measure of progress toward the goal of improved water quality in wet weather. Water Quality Concerns such as metals, TSS (total suspended solids), fecal coliform, and DO (dissolved oxygen) require further study to pinpoint sources. However, the problem can still be addressed (as most of the Target C options intend to do).

7.2 Screening of Options

The extensive lists of management options described above were developed to meet each of the goals and objectives established for the Tookany/Tacony-Frankford Watershed. Only those options deemed feasible and practical, however, were considered in the final list of management options. Options were evaluated in three steps:

1) Identification of Clearly Applicable Options (Section 7.2.1). Some options were already being implemented or were mandated by a regulatory program. For some options, the planning team reached an early consensus that they were needed. These options did not require further evaluation.

2) Screening Based on Watershed Characterization (Section 7.2.2). The extensive data analyses undertaken to characterize the watershed are summarized in Section 4 (Watershed Indicators: TTF Study Results), Section 5 (Problem Definition and Analysis), and Section 6 (Causes of Impairment). The results were used to evaluate the remaining options.

3) Detailed Evaluation of Structural Options (Section 7.2.3). Structural best management practices (BMPs) for stormwater and combined sewage were subjected to a more rigorous modeling analysis. Effects on runoff volume, overflow volume, and pollutant loads were evaluated at various levels of coverage. That analysis is described in Section 7.3.

The table below lists the options chosen for each of those three evaluation steps.

Table 7.1 Options Chosen for Initial Screening and Detailed Evaluation

Option	Clearly Applicable	Screening	Detailed Model Evaluation
Target A	X*		
Target B	X		
Target C – Regulatory Approaches			
CR1 Requiring Better Site Design in New Development		X	
CR2 Requiring Better Site Design in Redevelopment	X		
CR3 Stormwater and Floodplain Management	X		
CR4 Industrial Stormwater Pollution Prevention	X		
CR5 Construction Stormwater Pollution Prevention	X		
CR6 Post-Construction Stormwater Runoff Management	X		
CR7 Pollution Trading		X	
CR8 Use Review and Attainability Analysis		X	
CR9 Watershed Based Permitting		X	
Target C – Public Education and Volunteer Programs			
CP1 Public Education and Volunteer Programs	X		
Target C – Municipal Measures			
CM1 Sanitary Sewer Overflow Detection	X		
CM2 Sanitary Sewer Overflow Elimination: Structural Measures	X		

* All Target A options except Option AM7, Household Hazardous Waste Collection, which was eliminated due to results of cost-benefit analysis.

(Continued on next page)

Table 7.1 Options Chosen for Initial Screening and Detailed Evaluation (continued)

Option	Clearly Applicable	Screening	Detailed Model Evaluation
CM3 Reduction of Stormwater Inflow and Infiltration to Sanitary Sewers	X		
CM4 Combined Sewer Overflow (CSO) Control Program	X*		X**
CM5 Catch Basin and Storm Inlet Maintenance	X		
CM6 Street Sweeping	X		
CM7 Responsible Landscaping Practices on Public Lands	X		
CM8 Household Hazardous Waste Collection	X		
CM9 Responsible Bridge and Roadway Maintenance	X		
Target C – Stormwater Management			
Source Control Measures			
CS1 Reducing Effective Impervious Cover Through Better Site Design			X
CS2 Porous Pavement and Subsurface Storage			X
CS3 Green Rooftops			X
CS4 Capturing Roof Runoff in Rain Barrels or Cisterns			X
CS5 Increasing Urban Tree Canopy	X		
Onsite and Regional Stormwater Control Facilities			
CS6 Maintaining/Retrofitting Existing Stormwater Structures		X	
CS7 Modifying Catch Basins to Delay Stormwater Inflow		X	
CS8 Retrofitting Existing Sewer Inlets With Dry Wells			X
CS9 Residential Dry Wells, Seepage Trenches, and Rain Gardens			X
CS10 Infiltration Basins			X
CS11 Vegetated Swales and Open Channels		X	
CS12 Bioretention Basins and Porous Media Filtration			X
CS13 Treatment Wetlands: Onsite and Regional			X
CS14 Dry Detention Basins		X	
CS15 Wet Retention Basins			X
CS16 BMPs for Highway Runoff		X	
Target C – Monitoring			
CMR Monitoring, Reporting, and Further Study	X		

** CSO program in place; model evaluation conducted to quantify benefits.

7.2.1 Clearly Applicable Options: Targets A, B, and C

Some options were already being implemented or were mandated by a regulatory program before preparation of the integrated plan began. For other options, the planning team reached an early consensus that they were needed. These options did not require further evaluation:

- **Virtually all Target A options.** Measures to reduce litter and improve recreational activities along the stream corridor are a clear priority of stakeholders. Due to deteriorating infrastructure and localized areas of low dissolved oxygen that have been identified in the creek, measures to eliminate dry weather sewage discharges are necessary. (Option AM7, Household Hazardous Waste Collection, was eliminated due to results of cost-benefit analysis.)

- **All Target B options.** The results of watershed characterization and experiences in other urban watersheds indicate that some restructuring of the streams and stream corridors will be required to restore designated uses.

- **Selected Target C options.** Regulatory approaches CR2 through CR6 are being addressed by the Pa. Act 167 planning program already underway in the TTF Watershed. Many of these measures are also required under the NPDES program. Public education and volunteer programs (Option CP1) are a critical component of any approach to integrated watershed management. In addition, most of the municipal measures listed under Target C, including the City of Philadelphia's Long Term CSO Control Program, are already being implemented in the watershed. Recommendations for these programs will be to continue or improve upon existing efforts.

7.2.2 Results of Target C Screening Based on Watershed Characterization

CR1 Requiring Better Site Design in New Development

Result: Not Recommended

Discussion:
Based on the analysis of land use and ownership presented in Section 4 (Indicator 1), the potential for new development in the TTF Watershed is limited. Concepts of low impact development may be applied on larger redevelopment sites (Option CR2), but extensive planning for new development is not necessary.

CR7 Pollution Trading

Result: Not Recommended

Discussion:
The Tookany/Tacony-Frankford Creek is currently listed by the PA DEP as impaired for one or more designated uses, not requiring a TMDL. Without a TMDL in place, the "driver" for initiating pollution trading does not exist. If a TMDL were to be enacted, the EPA's "Water Quality Trading Assessment Handbook" (EPA 841-B-04-001) could be used to provide an analytical framework to assess the conditions and water quality problems and determine whether water quality trading (WQT) could be effectively used.

CR8 Use Review and Attainability Analysis

CR9 Watershed Based Permitting

Result: Recommended for Further Study

Discussion:
The U.S. Environmental Protection Agency has endorsed these innovative options for improving the water resources environment in practical, sustainable, and cost-effective ways. Taken together, these three options represent a powerful opportunity for regulatory change in the watershed.

CS6 Maintaining/Retrofitting Existing Stormwater Structures

Result: Recommended

Discussion:
PWD performed an inventory of existing privately owned stormwater control basins in 2000. The results found seven confirmed structures within the Philadelphia portion of the watershed. Retrofit of existing basins, including maintenance and modification of outlet structures, can often increase the benefits from an older structure at minimal cost. This option is recommended and will be discussed in detail in the implementation section.

CS7 Modifying Catch Basins to Delay Stormwater Inflow

Result: Not Recommended

Discussion:
This option delays entry of stormwater runoff into street inlets and catch basins,

providing some level of detention while temporarily storing water on roadways. Based on discussions with stakeholders and local officials, this option is unpopular due to public perception. Other forms of detention are preferred.

CS11 Vegetated Swales and Open Channels

Result: Not Recommended

Discussion:
Vegetated swales and open channels are an attractive option as an alternative to traditional infrastructure in areas with new development. They are generally not applicable on smaller sites or on redevelopment sites. This option is not recommended except in very limited cases to be determined on a site-by-site basis.

CS14 Dry Detention Basins

Result: Not Recommended

Discussion:
Wet retention and infiltration basins are generally recommended over dry detention basins. Wet retention provides more effective water quality treatment in most cases. Dry extended detention ponds have only moderate pollutant removal when compared to other structural stormwater practices, and are ineffective at removing soluble pollutants. If a standing pool is not desired, designing for infiltration is recommended. This option is not recommended except in limited cases to be determined on a site-by-site basis.

CS16 BMPs for Highway Runoff

Result: Not Recommended

Discussion:
Transportation infrastructure in the watershed is dominated by city streets rather than highways. In most cases, there is not sufficient space available on roadway shoulders for significant storage to be created. In some cases, medians and islands in intersections may be appropriate for infiltration. These cases will be discussed under option CS12, Bioretention Basins and Porous Media Filtration.

7.2.3 Detailed Evaluation of Target C Structural Options

Structural options such as best management practices (BMPs) for stormwater and combined sewage were subjected to a rigorous modeling analysis. Effects on runoff volume, overflow volume, and pollutant loads were evaluated at various levels of coverage. In this way, the BMPs could be assessed for their cost-effectiveness when implemented in the TTF Watershed. BMPs that appear to cost-effectively decrease stormwater flows or combined sewer overflows, or significantly reduce pollutant loading during wet weather, were subjected to a series of model runs. BMPs were simulated at various levels of implementation within the watershed, and the results are represented graphically. For the assumed level of implementation, the results in terms of pollutant reduction and amount of stormwater treated were then combined with planning level cost estimates, and the options were subsequently ranked according to their cost effectiveness.

Figure 7.1 compares the effectiveness of the BMPs at volume removal (through infiltration and/or evapotranspiration) at their maximum feasible implementation levels. Two measures are capable of reducing total discharge to the receiving water (the sum of stormwater runoff and CSO) by more than 12%. Porous pavement with subsurface storage removes the volume primarily through infiltration, while real time control (RTC) reduces combined sewer overflow.

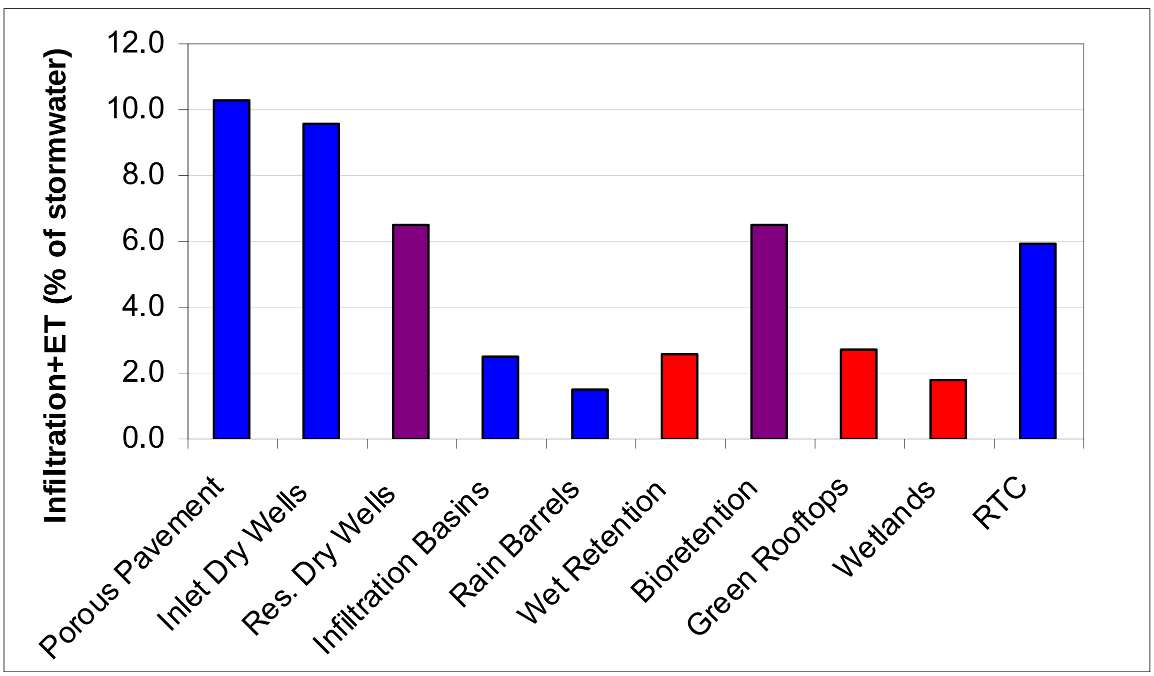


Figure 7.1 Potential Stormwater Volume Removal at Maximum Feasible Coverage

Figure 7.1 represents a range of impervious area draining to BMPs, from existing conditions (46% DCIA, or Directly Connected Impervious Area) to the maximum feasible coverage (varies by BMP). Levels of feasible coverage are chosen to be ambitious but realistic. For example, dry wells may not be technically feasible for all residences due to available space and other site constraints; for planning purposes, the maximum feasible level of coverage for the long term was assumed to be 25% for the TTF Watershed. Table 7.2 ranks the relative ability of each of the

BMPs to store stormwater, treat stormwater, or remove TSS, based on simulations of the maximum feasible level implementation of each of the BMPs. The rankings represent total volume and mass on a watershed basis over the one-year continuous simulation; they are a function of both technical effectiveness and feasible level of coverage. This ranking is independent of cost considerations.

Table 7.2 BMP Performance at Maximum Feasible Coverage

BMP Ranking	Potential Storage	Volume Removed	Load Reduction
Highest	Porous Pavement	Porous Pavement	Porous Pavement
	Wet Retention	Inlet Dry Wells	Res. Dry Wells
	Infiltration Basins	Bioretention	Bioretention
	Bioretention	Res. Dry Wells	Inlet Dry Wells
	Inlet Dry Wells	Real Time Control	Real Time Control
	Res. Dry Wells	Green Rooftops	Wet Retention
	Green Rooftops	Wet Retention	Infiltration Basins
	Wetlands	Infiltration Basins	Green Rooftops
	Rain Barrels	Wetlands	Wetlands
Lowest		Rain Barrels	Rain Barrels

Figure 7.2 shows the amount of storage that could be built in the TTF Watershed given the maximum feasible coverage for each BMP. At the simulated depth of 1 foot, subsurface storage under parking facilities represents approximately 45% of the storage that could feasibly be built. However, rain falling on the parking lot above the storage will not be sufficient to fill the storage. The full storage amount will be active only if additional runoff is directed into it. Infiltration and wet retention basins represent the second largest potential storage volume at approximately 15% of the total. Dry wells intercepting runoff from residential rooftops add 4%.

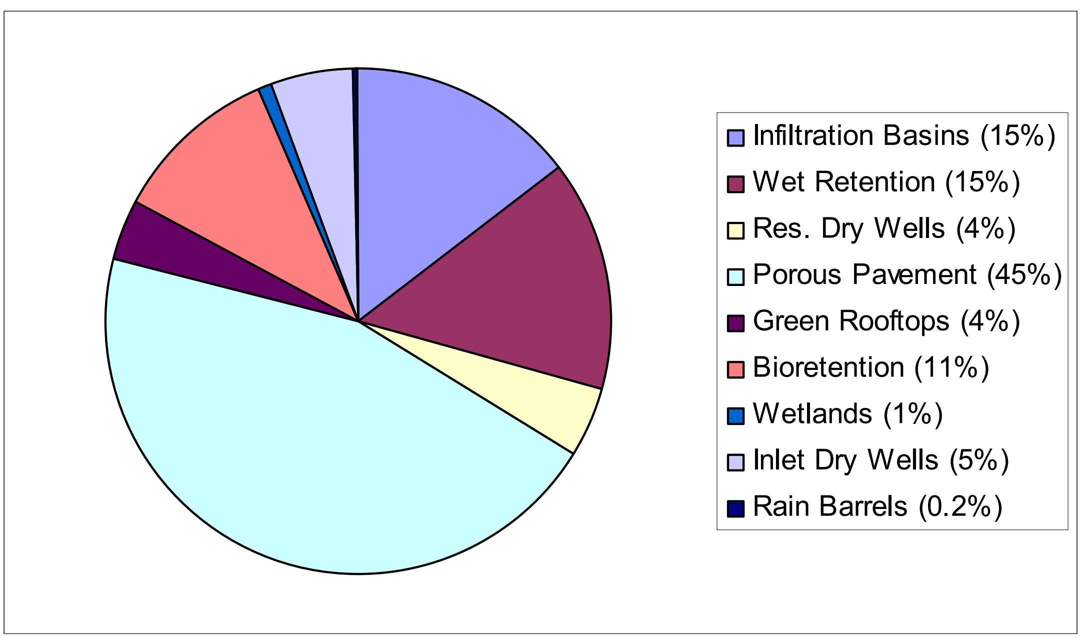


Figure 7.2 Maximum Storage Volume Feasible for Tookany/Tacony-Frankford Watershed

To gain some insight into the cost-effectiveness of various BMPs in the watershed under study, the precise hydraulic modeling results were combined with construction cost estimates. Literature values for costs of some BMPs are available in terms of storage volume. For others, literature values for cost in terms of area or operational unit were combined with model assumptions to obtain approximate costs. Operation and maintenance costs were not included in the current study.

While the hydrologic and hydraulic simulations were performed at a high level of precision, the costs used in this analysis were approximately order-of-magnitude in precision. The purpose of the cost-effectiveness analysis was to identify groups of BMPs that are highly effective, moderately effective, and of limited effectiveness in combined and separate-sewered areas. The values are specific to the climate, development pattern, soil conditions, and sewage systems in the Tookany/Tacony-Frankford Watershed. They are appropriate for long-term planning locally but are not recommended for detailed facilities cost estimating.

Model results were processed to produce relationships between storage volume, discharge reduction, load reduction, and cost. Some BMPs appear to be more efficient at pollutant removal, while others are more efficient at reducing the volume of stormwater reaching the stream; both are objectives of the TTFIWMP. Because the cost-load relationship is approximately linear, it is possible to present the results in the simplified form of approximate cost per gallon of discharge or pound of pollutant eliminated.

Subsurface storage facilities for combined sewage were examined as part of this study, but the cost-discharge and cost-load relationships were found to be nonlinear and could not be presented in the same form as the other results.

The results of the cost-effectiveness analysis are shown in Tables 7.3 and 7.4 (next page). Table 7.3 shows the estimated cost per gallon of stormwater treated and the cost per pound of TSS removed for simulations of feasible levels of implementation for each type of BMP under consideration. The results show that there is a wide range of costs, and that costs differ depending on whether a BMP is implemented in a CSO area or in an area served by separate storm sewers. Table 7.4 shows the list of options, ranked from most cost-effective to least cost-effective, grouped into highly effective, moderately effective, and least effective options.

Table 7.3 Planning-Level Cost-Effectiveness

	WATER QUALITY			WATER QUANTITY		
	TSS Removed			Volume Infiltrated/Evap/Captured		
BMP	Separate ($/lb)	Combined ($/lb)	Watershed ($/lb)	Separate ($/10^3 gal)	Combined ($/10^3 gal)	Watershed ($/10^3 gal)
Wetlands	3.07	1.43	1.80	3.02	1.38	1.75
Wet Retention	19.95	14.39	16.14	27.07	17.78	20.52
Rain Barrels	17.65	3.75	5.41	35.80	2.87	4.47
Inf. Basin	26.21	16.86	19.57	40.29	19.95	24.83
Real Time Control	N/A	5.98	N/A	N/A	4.20	N/A
Residential Dry Wells	19.40	11.47	13.64	44.91	10.38	14.81
Bioretention	42.46	22.09	27.16	60.95	20.86	28.03
Inlet Dry Wells	563.23	37.98	59.60	464.23	26.71	42.17
Green Rooftops	495.50	363.01	405.15	326.32	255.23	278.86
Porous Pavement	146.59	89.75	105.69	97.55	63.60	73.56

The most cost-effective discharge and pollutant reduction strategy is obtained by building the most inexpensive BMP to its maximum feasible level, followed by the next most inexpensive, until wet weather goals are met. Ultimately, other factors (e.g., public vs. private ownership, institutional arrangements for maintenance, degree and length of construction disturbance, feasibility of implementation, socio-political perceptions) must also be considered.

Table 7.4 Cost-Effectiveness of Options (High, Medium, Low)

WATER QUALITY		WATER QUANTITY	
TSS Removed		Volume Infiltrated/Evaporated/Captured	
Separate	Combined	Separate	Combined
Wetlands	Wetlands	Wetlands	Wetlands
Rain Barrels	Rain Barrels	Wet Retention	Rain Barrels
Residential Dry Wells	Real Time Control	Rain Barrels	Real Time Control
Wet Retention	Residential Dry Wells	Inf. Basin	Residential Dry Wells
Inf. Basin	Wet Retention	Residential Dry Wells	Wet Retention
Bioretention	Inf. Basin	Bioretention	Inf. Basin
Porous Pavement	Bioretention	Porous Pavement	Bioretention
Green Rooftops	Inlet Dry Wells	Green Rooftops	Inlet Dry Wells
Inlet Dry Wells	Porous Pavement	Inlet Dry Wells	Porous Pavement
	Green Rooftops		Green Rooftops

<u>**The results of the simulations support a number of general conclusions**</u> about the implementation of BMPs in the TTF Watershed. (**Note:** These numbered comments are referenced in summary Table 7.7, at end of Section 7.)

1. The cost of runoff volume reduction is higher in separate-sewered than in combined-sewered areas because temporary storage and release results in additional capture at CSO regulator structures. Larger cost differences between CSO and separate storm sewer

areas occur where evapotranspiration and/or infiltration are minor functions of the BMP (e.g., retrofitting sewer inlets with dry wells).

2. Generally speaking, if pollutant removal is significant for a given BMP, the cost difference between separate and CSO areas is smaller. One example is wetlands, due to water column pollutant attenuation.

3. Traditional BMPs like infiltration basins and wet retention basins can be effective where land is available. These facilities typically have much larger capacities, are regional in nature, and exhibit economies of scale. They are not thought to be practical alternatives for the TTF Watershed, but were included in our modeling simulations for completeness.

4. For the combined-sewered areas, real time control (RTC) is among the most competitive options in terms of both volume and load reduction. The RTC configuration being considered is highly specific to the TTF Watershed, and these results may not hold generally for other watersheds.

5. In highly urbanized areas, storage under parking facilities may be the only practical option to achieve large storage volumes. Porous pavement is one way to direct runoff from the parking lots themselves into the storage facility, while runoff from nearby rooftops can be piped into the facility.

The cost analysis of options in areas of separate storm sewers shows:

6. Wetlands and rain barrels are the most cost effective options for TSS removal on a cost per pound basis. Wetlands and wet retention are the most cost effective on a cost per gallon stormwater removed basis.

7. Dry wells in sewer inlets and green rooftops are particularly expensive for both TSS and discharge reduction. Porous pavement is expensive for TSS removal, but is more cost effective as a volume control measure.

The cost analysis of options in areas of combined sewers shows:

8. Wetlands, rain barrels, residential dry wells, and real time control are all relatively cost-effective options on the basis of cost-per-pound of TSS removed and cost-per-gallon of stormwater removed.

9. Green rooftops are the more expensive choice either on the basis of TSS removal or on the basis of dollars per gallon stormwater treated. Dry wells in sewer inlets are only moderately expensive in combined sewer areas (in contrast with separate sewer areas).

10. It is clear that the most expensive options in combined-sewered areas cost less than the most expensive options in separate-sewered areas. Because hydraulic detention is the most important mechanism in combined-sewered areas, there is less difference in cost-effectiveness between the different types of BMPs.

11. In combined areas, the regulator structures represent an investment already made in pollution reduction. Thus, money spent on stormwater BMPs results in greater load and volume reductions per additional dollar spent than in separate areas without stormwater controls. To meet an overall load reduction target in watersheds with both combined and separate areas, it may be more efficient to focus on the combined areas.

Table 7.5 lists ten measures, a feasible implementation level for each, and discharge and pollutant load reductions that are possible with each. These results may be used as a guide for individual municipalities or a watershed organization to select suitable BMPs.

Table 7.5 Maximum Feasible Discharge and Pollutant Reduction

Target C	Maximum Feasible Implementation	Volume Reduction CSO	Volume Reduction Stormwater	Pollutant Reduction
Municipal Measures				
CM4 Combined Sewer Overflow (CSO) Control Program				
• Real Time Control	2 sites	5.9%	N/A	6.1%
Structural Stormwater Management Facilities				
Source Control Measures				
CS1 Reducing Impervious Cover Through Better Site Design	1% reduction in DCIA	0.5%	0.5%	1.0%
CS2 Porous Pavement and Subsurface Storage	50% of parking lots	8.0%	3.3%	11.6%
CS3 Green Rooftops	5% of rooftops	1.8%	0.9%	2.7%
CS4 Capturing Roof Runoff in Rain Barrels or Cisterns	10% of homes	1.4%	0.1%	1.8%
CS5 Increasing Urban Tree Canopy	5% of watershed area	0.3%	0.3%	0.5%
Onsite and Regional Stormwater Control Facilities				
CS8 Retrofitting Existing Sewer Inlets with Dry Wells	100% of inlets	6.9%	0.3%	7.5%
CS9 Residential Dry Wells, Seepage Trenches, Rain Gardens	school grounds; 25% of homes	5.7%	0.8%	10.4%
CS12 Bioretention Basins and Porous Media Filtration	50% of parking lots	6.3%	2.1%	11.6%
CS13 Treatment Wetlands: Onsite and Regional	100% of identified potential	1.4%	0.4%	2.5%

Notes:
1) Volume reductions are % of total discharge (sum of CSO and stormwater).
2) “Maximum Feasible” considers technical feasibility and social acceptance, but not cost.

In spite of its cost, subsurface storage under parking lots is recommended because it is one of the few practical options in the most urban areas. Green rooftops are not recommended as a short-term management strategy due to the high cost and practical constraints they currently impose on private land owners. However, they may become more cost-effective in the future due to economies of scale and increased local availability of materials and expertise. For these reasons, the watershed planning team has recommended that local government implement demonstration projects on public buildings and consider incentives for private land owners. In the near term, the benefit of these projects will be primarily educational rather than technical.

While effectiveness and cost may be the two most important criteria used to assess and choose BMPs, feasibility and sociopolitical factors ultimately play a role. These factors were evaluated using a simpler method. Table 7.6 assigns a rating to assess the effect of each factor on the BMPs studied; the significance of the possible ratings is explained below.

Table 7.6 Evaluation Criteria Applied to Individual BMPs

	Technical Feasibility	Time to Implement	Legal Feasibility	Social/Political Support	Construction Disturbance	Maintenance
Real Time Control	●	●	●	●	●	●
Structural CSO Storage	●	◒	●	◒	○	○
Constructed Wetlands	●	●	○	◒	◒	◒
Rain Barrels	◒	◒	○	●	●	○
Residential Dry Wells	◒	◒	○	○	●	●
Bioretention/Porous Media Filter Systems	●	○	○	●	◒	◒
Green Rooftops	○	○	○	◒	○	○
Porous Pavement	◒	○	○	●	○	◒
Dry Wells in Sewer Inlets	◒	○	○	●	○	●

Legend

Excellent	●
Good/Fair	◒
Poor	○

Technical Feasibility

Excellent ● — The technology has been widely and successfully applied. Several local contractors will have experience with the technology.

Good/Fair ◒ — The technology has been successfully applied in other cities or has been successfully demonstrated locally. At least one local contractor will have experience with the technology.

Poor ○ — The technology has been applied in only a few pilot or demonstration programs. It may be impossible to find an experienced local contractor.

Length of Time to Implement

Excellent ● — The technology can be implemented in 2 years or less.

Good/Fair ◒ — The technology can be implemented in 2 to 5 years.

Poor ○ — The technology takes more than 5 years to implement.

Feasibility within the Legal Structure

Excellent ●	Existing laws require or provide an incentive for implementation. For example, measures proposed may overlap with the "six minimum controls" required by NPDES Phase II regulations.
Poor ○	Existing laws do not affect or do provide disincentives for different aspects of the plan. For example, a local ordinance may discourage infiltration.

Social/Political Support

Excellent ●	Overall, the measure proposed will be seen as positive by a majority of stakeholders (citizens, local governments, and non-profits).
Good/Fair ◒	The measure has both positive and negative aspects.
Poor ○	Overall, the measure proposed will be seen as negative by a majority of stakeholders (citizens, local governments, and non-profits).

Construction Disturbance

Excellent ●	Pavement removal is not required or is minimal. Effects on parking, traffic patterns, and noise are minimal. Rain barrels are one example.
Good/Fair ◒	Some pavement removal is required. Effects on parking, traffic patterns, and noise are moderate.
Poor ○	Construction will require removal of large amounts of pavement (streets, parking lots) and/or significantly affect parking, movement of people and vehicles, and the noise level. Examples include porous pavement and installation of dry wells in sewer inlets.

Maintenance – Cost and Institutional Considerations

Excellent ●	Maintenance can be performed through existing programs and existing funding. For example, maintenance of retrofit sewer inlets can be integrated into current sewer maintenance.
Good/Fair ◒	Private land owners will be responsible for minor maintenance chores (e.g., minor landscape maintenance for a bioretention basin that would have been a parking island anyway). Public agencies can handle maintenance with existing staff and budget, and/or will dedicate staff time to outreach, workshops, etc.
Poor ○	Existing public programs, staff, and funding will not cover maintenance, or maintenance will be a large burden on private land owners. Or, frequent maintenance is absolutely critical to BMP effectiveness, as with rain barrels.

7.3 Recommended Options

At the end of this section, Table 7.7 summarizes options recommended for full implementation, options recommended for conditional implementation, and options that are not recommended. Those recommended for conditional implementation include most of the structural stormwater and combined sewage management measures. (Note: Each "Conditional" recommendation in Table 7.7 is accompanied by a numbered reference to one or more of the various conclusions presented in Section 7.2.3, below Table 7.4.)

Target A: Options for Dry Weather Water Quality and Aesthetics

For the Tookany/Tacony-Frankford Creek, the focus of Target A is trash removal, litter prevention, and elimination of sources of sewage during dry weather. Because the options under consideration are aimed at the total elimination of trash and dry weather sources of sewage, no complex analysis was required to help define the program or assess its potential benefits. Virtually all options related to this target are recommended for implementation.

Streams should be aesthetically appealing (i.e., look and smell good), accessible to the public, and an amenity to the community. Access to and interaction with the stream during dry weather have the highest priority, because dry weather flows occur about 60-65% of the time during the course of a year, and is also the time when the public is most likely to be near or in contact with the stream. The water quality of the stream in dry weather, particularly with respect to bacteria, should be similar to background concentrations in groundwater. Many urban streams rarely meet water quality standards for bacteria, and urban streams often have significant BOD (biological or biochemical oxygen demand) problems, even during baseflow or dry weather conditions.

Target B: Options for Healthy Living Resources

Improving the ability of an urban stream to support viable habitat and fish populations focuses primarily on the elimination 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. The primary tool to accomplish this is stream and stream corridor restoration. Restoration focuses on improving channel stability, improving instream and riparian habitat, providing refuges for fish from high velocity conditions during storms, and managing land within the stream corridor. Because designated uses in the stream cannot be restored without these options, all options grouped under Target B are recommended for implementation.

Target C: Options for Wet Weather Water Quality and Quantity

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. Stormwater generally does not have DO (dissolved oxygen) problems, but sampling data indicate that concentrations of metals (such as copper, lead, and zinc) and bacteria do not meet water quality standards during wet weather. These pollutants are introduced by both stormwater and wet weather sewer overflows (CSOs and SSOs).

Target C options also must address flooding issues. Where water quality and quantity problems both exist, options must 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 will also help protect the investment in stream restoration made as part of the implementation of Target B options.

Options recommended for Target C are divided into two groups, as shown in Table 7.7 below. The first group includes options recommended for ***full*** implementation. These options include a range of ordinances and regulatory measures and public education measures related to existing municipal infrastructure, selected source controls, and possibilities for pollution trading and use review. The municipal measures focus on the elimination of sanitary sewer overflows and the causes of overflows such as blockages and excessive infiltration.

The second group of Target C options includes structural measures designed to achieve specific, measurable discharge and pollutant load reductions. These options are recommended on a ***conditional*** basis, based on conclusions of screening and modeling studies. (As noted above, each of the “Conditional” recommendations is linked to one or more of the numbered conclusions listed in Section 7.2.3.)

Table 7.7 Summary of Recommended Options

Option	Recommended	Not Recommended	Conditional
Target A	X*		
Target B	X		
Target C – Regulatory Approaches			
CR1 Requiring Better Site Design in New Development		X	
CR2 Requiring Better Site Design in Redevelopment	X		
CR3 Stormwater and Floodplain Management	X		
CR4 Industrial Stormwater Pollution Prevention	X		
CR5 Construction Stormwater Pollution Prevention	X		
CR6 Post-Construction Stormwater Runoff Management	X		
CR7 Pollution Trading		X	
CR8 Use Review and Attainability Analysis	X		
CR9 Watershed Based Permitting	X		
Target C – Public Education and Volunteer Programs			
CP1 Public Education and Volunteer Programs	X		
Target C – Municipal Measures			
CM1 Sanitary Sewer Overflow Detection	X		
CM2 Sanitary Sewer Overflow Elimination: Structural Measures	X		
CM3 Reduction of Stormwater Inflow / Infiltration to Sanitary Sewers	X		
CM4 Combined Sewer Overflow (CSO) Control Program	X		
CM5 Catch Basin and Storm Inlet Maintenance	X		
CM6 Street Sweeping	X		
CM7 Responsible Landscaping Practices on Public Lands	X		
CM8 Household Hazardous Waste Collection	X		
CM9 Responsible Bridge and Roadway Maintenance	X		
Target C – Monitoring			
CMR Monitoring, Reporting, and Further Study	X		

* All Target A options except Option AM7, Household Hazardous Waste Collection, which was eliminated due to results of cost-benefit analysis.

(Continued on next page)

Table 7.7 Summary of Recommended Options (continued)

Option	Recommended	Not Recommended	Conditional*
Target C – Stormwater Management			
Source Control Measures			
CS1 Reducing Effective Impervious Cover Through Better Site Design	X		
CS2 Porous Pavement and Subsurface Storage			urban areas (5,7)
CS3 Green Rooftops			demonstration projects (7,9)
CS4 Capturing Roof Runoff in Rain Barrels or Cisterns			public relations campaign required (6,8)
CS5 Increasing Urban Tree Canopy	X		
Onsite and Regional Stormwater Control Facilities			
CS6 Maintaining/Retrofitting Existing Stormwater Structures	X		
CS7 Modifying Catch Basins to Delay Stormwater Inflow		X	
CS8 Retrofitting Existing Sewer Inlets With Dry Wells			CSO areas (1,7,9)
CS9 Residential Dry Wells, Seepage Trenches, and Rain Gardens			inexpensive in combined areas (8)
CS10 Infiltration Basins		X**	
CS11 Vegetated Swales and Open Channels		X	
CS12 Bioretention Basins and Porous Media Filtration			inexpensive in combined areas (7)
CS13 Treatment Wetlands: Onsite and Regional			site permitting (2,6,8)
CS14 Dry Detention Basins		X	
CS15 Wet Retention Basins		X**	
CS16 BMPs for Highway Runoff		X	

* **Note:** The parenthetical numbers under the "Conditional" column refer to the numbered conclusions of the BMP simulations, as listed in Section 7.2.3.

** Under the current conditions of the TTF Watershed, these measures are not recommended; however, in the event of large-scale redevelopment within the watershed, these BMPs could be considered.

Section 8
Implementation Guidelines

This section presents guidelines for watershed-wide implementation of the "management options" identified by the Tookany/Tacony-Frankford Watershed Partnership as best meeting the goals and objectives of the TTF Integrated Watershed Management Plan. Following extensive screening and evaluation (described in Section 7), only those options that are likely to be cost-effective and feasible under the specific conditions found in the TTF Watershed are carried over and included in these guidelines. The section begins with tips on how to navigate the information presented.

Navigating Section 8: Summary Tables and Boxes

Following the introductory information below and on the next page, three **summary tables** are presented. These tables categorize the recommended management options according to the agency or level of government responsible for carrying out each recommendation under current regulations: PA DEP, the City of Philadelphia, and the Montgomery County municipalities.

Sections 8.1, 8.2, and 8.3 are then devoted to presenting detailed information about each of those recommended options, grouped under Targets A, B, and C (introduced in Section 2.2.7 and discussed throughout this plan). Most of those options begin with a **summary box** that names (1) "What" the option involves, (2) "Who" is responsible, (3) "Where" the option is to be carried out, and (4) "When." In addition, each summary box lists the numbers of "Related Goals" and "Related Indicators," discussed in Sections 3 and 4, respectively. The summary box is followed by text, figures, and tables that further describe the option and the implementation approach being recommended.

Implementation Guidelines and Five-Year Plans

These guidelines present a long-range vision for implementation over a 20-year horizon, with the intent of meeting both Target A (Dry Weather Water Quality and Aesthetics) and Target B (Healthy Living Resources) within a 15-year planning horizon, while simultaneously proposing step-by-step implementation to meet Target C (Wet Weather Water Quality and Quantity), allowing for adaptive management over time. The guidelines provide information on location and degree to which implementation needs to be accomplished in order to meet the targets. Based upon these recommendations, PWD and the Tookany/Tacony-Frankford Watershed Partnership will prepare detailed, 5-year plans to carry out the recommended projects.

The Implementation Guidelines presented here are intended to offer a long-range vision for implementation over the upcoming 20-year horizon, and to be used as a reference by parties creating actual implementation plans in the future. The implementation plan is to be designed to provide a detailed blueprint for specific implementation tasks during the initial five-year period. Detailed planning for implementation of the TTFIWMP will be broken into four sequential five-year periods to cover the 20-year implementation horizon. The Philadelphia Water Department has created and committed to a detailed five-year Implementation Plan for the portion of the

Tookany/Tacony-Frankford Watershed within the City of Philadelphia (see summary in Appendix E). This plan has been designed to begin in 2006 and run through 2011; though the start date for the implementation period is in 2006, many projects have already been initiated.

The cost estimated for full implementation of the TTFIWMP in the Philadelphia portion of the watershed is roughly $18,000,000, to which PWD has committed staff and resources in the first five years. Detailed comparable costs for the first five years within the Montgomery County portion of the watershed have not yet been derived. A total estimated cost for watershed-wide implementation of this plan for the initial five-year period will be calculated by the Board of the Tookany/Tacony-Frankford Watershed Partnership once budgetary information for municipal implementation is available.

Role of the TTF Watershed Partnership in TTFIWMP Implementation

In the summer of 2005, the Tookany/Tacony-Frankford Watershed Partnership filed official incorporation papers in order to become a 501(c)3 nonprofit watershed organization. As noted in Article 2, Section 2.2 of the TTF Partnership By-Laws:

> *"The primary purposes of the Corporation are to carry out all activities allowable under Section 501(c)(3) of the Internal Revenue Code (or the corresponding section of any future Internal Revenue Law of the United States), including but not limited to: implement the Integrated Watershed Management Plan for the Tookany/Tacony-Frankford Watershed ("TTF Watershed"); improve stream habitat and integrity of aquatic life; reduce the impact of urbanized flow on living resources; improve dry and wet weather stream quality to reduce the effects on public health and aquatic life; protect and restore stream corridors, buffers, floodplains, and natural habitats including wetlands; identify flood prone areas and decrease flooding; enhance community environmental quality of life; foster community stewardship; and improve inter-municipal, inter-county, state-local and stakeholder cooperation and coordination on a watershed wide basis through dedicated public education and outreach."* (See Appendix C for complete By-Laws.)

This organization will strive to help the municipalities and other stakeholders throughout the watershed to realize the vision of a restored and vital Tookany/Tacony-Frankford Watershed.

Table 8.1 PA DEP Actions

Code	Option	Where	When
CR4	Industrial Stormwater Pollution Prevention	Industrial sites	Short-term
CR5	Construction Stormwater Pollution Prevention	Construction sites	Short-term
N.A.	Stewardship/Advocacy of Watershed Management Plan	Watershed-wide	Short-term
A/B/CMR	Monitoring, Reporting, and Further Study	Watershed-wide	Ongoing

Table 8.2 City of Philadelphia Actions

Code	Option	Where	When
AR2	Pet Waste, Litter, and Dumping Ordinances	Watershed-wide	Short-term
N.A.	Revised Stormwater Ordinance and BMP Manual	Watershed-wide	Short-term
AP1	Public Education	Watershed-wide	Short-term
AP2	School-Based Education	All schools	Short-term
AP3	Public Participation and Volunteer Programs	Watershed-wide	Short-term
AM2	Inspection and Cleaning of Combined Sewers	Watershed-wide	Short-term
AM4	Combined Sewer Rehabilitation	Combined-Sewered Areas	Medium-term
AM6	Stream Cleanup and Maintenance	Tookany/Tacony-Frankford Creek within or along City boundary	Short-term
AO1	Enhancing Stream Corridor Recreational and Cultural Resources	Along the stream corridor	Medium-term
BM1	Bed Stabilization and Habitat Restoration	Tookany/Tacony-Frankford Creek	Short-term
BM2	Bank Stabilization and Habitat Restoration	Middle section of Tookany/Tacony-Frankford Creek	Short-term
BM3	Channel Realignment and Relocation	Tookany/Tacony-Frankford Creek,	Short-term
BM4	Plunge Pool Removal	CSO and stormwater outfalls	Short-term
BM5	Improvement of Fish Passage	Tacony Creek Dams	Short-term
BM6	Wetland Creation	Riparian corridor	Short-term
BM7	Invasive Species Management	Riparian corridor	Short-term
BM9	Reforestation	Riparian corridor	Short-term
CR3	Stormwater and Floodplain Management	Watershed-wide	Short-term
CR6	Post-Construction Stormwater Runoff Management	Watershed-wide	Short-term
CM1	Sanitary Sewer Overflow Detection	Separate-Sewered Areas	Short-term
CM2	Sanitary Sewer Overflow Elimination: Structural Measures	Separate-Sewered Areas	Medium-term
CM4	CSO Control Program	Philadelphia combined sewer system	Short-term
CM5	Catch Basin and Storm Inlet Maintenance	All inlets	Short-term
CM6	Street Sweeping (Philadelphia Streets Department)	Streets and Parking Lots	Short-term
CM7	Responsible Landscaping on Public Lands	Green space	Short-term
CM9	Responsible Bridge and Roadway Maintenance	Roadways and bridges	Short-term
CM3	Green Rooftops	Appropriate public buildings chosen by PWD	Medium-term
CM4	Capturing Roof Runoff in Rain Barrels or Cisterns	Homes where dry wells are not feasible	Medium-term
CM5	Increasing Urban Tree Canopy	Watershed-wide	Medium-term
CS6	Maintaining/Retrofitting Existing Stormwater Structures	Watershed-wide	Short-term
CS8	Retrofitting Existing Sewer Inlets with Dry Wells	Inlets in combined-sewered areas	Long-term
CS9	Residential Dry Wells, Seepage Trenches, and Water Gardens	Homes and schools watershed-wide	Long-term
CS12	Bioretention Basins and Porous Media Filtration	Watershed-wide	Long-term
CS13	Treatment Wetlands: Onsite and Regional	Riparian corridor	Medium-term
A/B/CMR	Monitoring, Reporting, and Further Study	Watershed-wide	Ongoing

Table 8.3 Montgomery County Municipality Actions

Code	Option	Where	When
AR1	On-Lot Disposal (Septic System) Management	All areas with septic systems	Short-term
AR2	Pet Waste, Litter, and Dumping Ordinances	Watershed-wide	Short-term
AP1	Public Education	All Tookany/Tacony-Frankford Creek municipalities	Short-term
AP2	School-Based Education	All schools	Short-term
AP3	Public Participation and Volunteer Programs	All Tookany/Tacony-Frankford Creek municipalities	Short-term
AM1	Capacity Management Operation and Maintenance of Sanitary Sewers	Separate-Sewered Areas	Short-term
AM3	Sanitary Sewer Rehabilitation	Separate-Sewered Areas	Medium-term
AM5	Illicit Discharge, Detection, and Elimination (IDD&E)	All Tookany/Tacony-Frankford Creek municipalities	Short-term
AM6	Stream Cleanup and Maintenance	Tookany/Tacony-Frankford Creek within or along City boundary	Short-term
A01	Enhancing Stream Corridor Recreational and Cultural Resources	Along the stream corridor	Medium-term
BM1	Bed Stabilization and Habitat Restoration	Tookany/Tacony-Frankford Creek	Short-term
BM2	Bank Stabilization and Habitat Restoration	Middle section of Tookany/Tacony-Frankford Creek	Short-term
BM3	Channel Realignment and Relocation	Tookany/Tacony-Frankford Creek	Short-term
BM4	Plunge Pool Removal	Stormwater outfalls	Short-term
BM5	Improvement of Fish Passage	Dam locations	Short-term
BM6	Wetland Creation	Riparian corridor	Short-term
BM7	Invasive Species Management	Riparian corridor	Short-term
BM8	Biofiltration	Locations to be determined	
BM9	Reforestation	Riparian corridor	Short-term
CR2	Requiring Better Site Design in Redevelopment	Watershed-wide	Short-term
CR3	Stormwater and Floodplain Management	Watershed-wide	Short-term
CR6	Post-Construction Stormwater Runoff Management	Municipalities required to do Phase II permit	Short-term
CM1	Sanitary Sewer Overflow Detection	Separate-Sewered Areas	Ongoing program
CM3	Reduction of Stormwater Inflow and Infiltration to Sanitary Sewers	Separate-Sewered Areas	Medium-term
CM5	Catch Basin and Storm Inlet Maintenance	All inlets	Ongoing program
CM6	Street Sweeping	Streets and Parking Lots	Short-term
CM7	Responsible Landscaping on Public lands	Green space	Short-term
CM9	Responsible Bridge and Roadway Maintenance	Roadways and bridges	Short-term
CS2	Porous Pavement and Subsurface Storage	Parking lots watershed-wide	Long-term
CS4	Capturing Roof Runoff in Rain Barrels or Cisterns	Homes where dry wells are not feasible	Medium-term
CS5	Increasing Urban Tree Canopy	Watershed-wide	Medium-term
CS6	Maintaining/Retrofitting Existing Stormwater Structures	Watershed-wide	Short-term
CS9	Residential Dry Wells, Seepage Trenches, and Water Gardens	Homes and schools watershed-wide	Long-term
CS12	Bioretention Basins and Porous Media Filtration	Watershed-wide	Long-term
CS13	Treatment Wetlands: Onsite and Regional	Riparian corridor	Medium-term
A/B/CMR	Monitoring, Reporting, and Further Study	Watershed-wide	Ongoing

8.1 Target A: Dry Weather Water Quality and Aesthetics

Below are the recommended options for Target A. As explained in Section 7, virtually all Target A (and all Target B) options were recommended for implementation. These options are described in detail in the pages that follow.

Section 8.1.1 **Regulatory Approaches**

AR1 On-Lot Disposal (Septic System) Management
AR2 Pet Waste, Litter, and Dumping Ordinances

Section 8.1.2 **Public Education and Volunteer Programs**

AP1 Public Education
AP2 School-Based Education
AP3 Public Participation and Volunteer Programs

Section 8.1.3 **Municipal Measures**

AM1 Capacity Management Operation and Maintenance (CMOM)
AM2 Inspection and Cleaning of Combined Sewers
AM3 Sanitary Sewer Rehabilitation
AM4 Combined Sewer Rehabilitation
AM5 Illicit Discharge, Detection, and Elimination (IDD&E)
AM6 Stream Cleanup and Maintenance

Section 8.1.4 **Recreational and Cultural Resources**

AO1 Enhancing Stream Corridor Recreational and Cultural Resources

Section 8.1.5 **Monitoring and Reporting**

AMR Monitoring, Reporting, and Further Study

8.1.1 Target A Options: Regulatory Approaches

On-Lot Disposal (Septic System) Management (AR1) Related Goals: 3 Related Indicators: 7, 11, 19, 20			
What	Who	Where	When
Septic tank management program required as part of the municipality's Official Act 537 Sewage Facilities Plan.	Municipalities through state certified Sewage Enforcement Officers (SEO). • All Act 537 plans should be updated as necessary.	All areas with septic systems (see Table 8.4).	Within next 5 years.

Septic tank management programs are currently required of all Pennsylvania municipalities as part of their Official Act 537 Sewage Facilities Plans. Keeping these plans up to date, including provisions related to operation and maintenance of on-lot sewage disposal systems (OLDS), is an important means of controlling the release of pathogens and nutrients within the watershed.

The Pennsylvania Sewage Facilities Act (Act 537) requires that all Commonwealth municipalities develop and implement comprehensive official plans that provide for resolution of existing sewage disposal problems, provide for future sewage disposal needs of new land development, and provide for future municipal sewage disposal needs. When a municipality adopts a plan, the plan is submitted for review and approval by the Pennsylvania Department of Environmental Protection. By regulation, the planning process is not final until an Act 537 Plan has been approved by PA DEP. Municipalities are required to revise (unless they are exempt from revising) the "Official Plan" if a new land development project is proposed or if unanticipated conditions or circumstances arise, making the base plan inadequate. There are two basic types of plan changes: "Plan revisions" resulting from new land development are completed using "planning modules" that are specific to individual projects; an "update revision" is used by municipalities to make broad changes to their Official Plan.

Act 537 planning has been a municipal requirement since July 1, 1967. Legally, all municipalities have an Act 537 Plan; however, some plans are newer and more detailed than others. A list of municipalities within the Tookany/Tacony-Frankford Creek Watershed indicating the status of their Act 537 Plans is presented in Table 8.4. Note that most of the plans are quite outdated. The municipalities are shown in Figure 8.1.

Table 8.4 Act 537 Municipal Sewage Facilities Plans

Municipality	County	Plan Approval Date	Status (as of 12/2005)
Abington Township	Montgomery	12/16/99	Plan older than 5 years
Cheltenham Township	Montgomery	1/1/73	Plan older than 30 years
Jenkintown Borough	Montgomery	1/1/73	Plan older than 30 years
Philadelphia	Philadelphia	11/10/93	Plan older than 10 years
Rockledge Borough	Montgomery	1/1/73	Plan older than 30 years

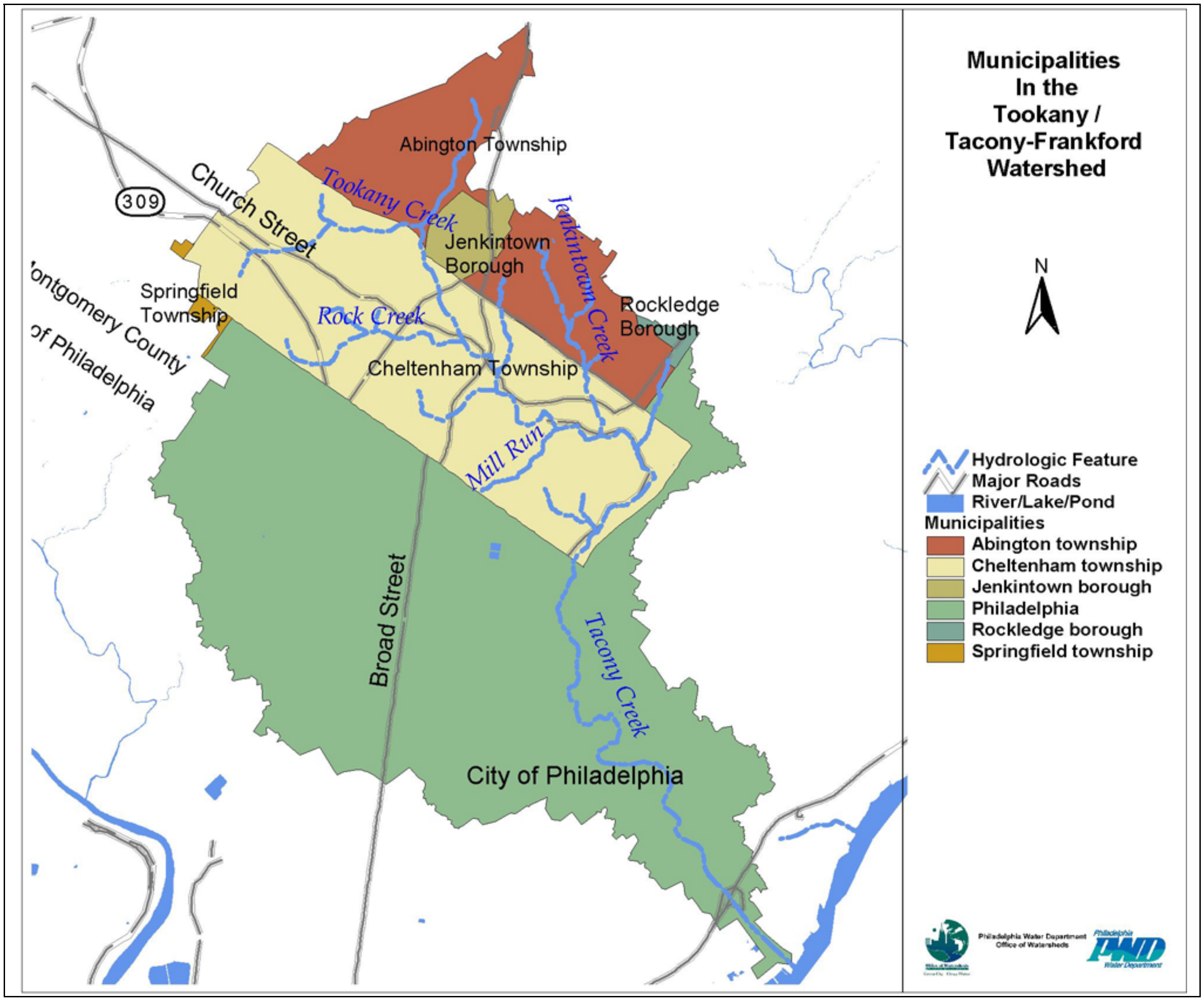


Figure 8.1 Tookany/Tacony-Frankford Watershed Municipalities

Relevant Provisions of Act 537

- All municipalities must develop and implement an official sewage plan that addresses their present and future sewage disposal needs. Local agencies are required to employ both primary and alternate Sewage Enforcement Officers (SEO) responsible for overseeing the daily operation of that agency's OLDS permitting program.
- Local agencies, through their SEO, approve or deny permits for construction of on-lot sewage disposal systems prior to system installation. The SEO is responsible for conducting soil profile testing, percolation testing, OLDS design review, and approving or denying OLDS permit applications.
- Local agencies, through their SEO, must manage the permitting program for individual on-lot disposal systems and community on-lot systems with design flows of 10,000 gallons-per-day or less.

- Municipalities are required to assure the proper operation and maintenance of sewage facilities within their borders.

Municipalities should maintain information on the location, type, and operational status of existing sewage facilities, as well as results of sanitary surveys. This information, however, is often incomplete. Septic tank data were included in the U.S. census through 1990, but were believed to be inaccurate and were not included in the 2000 census. County health departments may have information, and assessments have been attempted through voluntary questionnaires submitted by municipalities. These tasks have proven to be difficult but can be completed through perseverance.

Implementation of a Comprehensive Septic Tank Management Program

Each municipality shown in Table 8.4 should update its Act 537 Plan in the coming five-year period, as necessary.

Table 8.5 presents 1990 census sanitary survey results along with the area within the watershed. Better counts and, if appropriate, implementation of septic system management programs should be actively pursued in municipalities that have a large estimated number of septic systems and a high percentage of their total area within the watershed: Philadelphia, and Abington and Cheltenham townships.

The implementation of comprehensive septic tank management programs in those three municipalities ideally will be consistently designed to provide degrees of protection based on an assessment of the environmental sensitivity of the area.

Table 8.5 Septic System Data from 1990 Census*

Municipality	Area (Acres)	Area in Watershed (Acres)	Percent of Area in Watershed (Acres)	Housing Units with Public Sewer	Housing Units with Septic Systems	Total Housing Units Occupied
Abington Township	9,893	2,712	12.9%	10,717	101	10,818
Cheltenham Township	5,779	5,691	27.0%	14,174	262	14,436
Jenkintown Borough	369	12,178	57.7%	2,072	0	2,072
Philadelphia City	91,287	367	1.7%	134,408	706	135,114
Rockledge Borough	219	81	0.4%	751	0	751
Springfield Township	4,352	65	0.3%	1,186	3	1,189

* Septic data is unavailable for 2000 Census.

The EPA has recently issued Voluntary National Guidelines for Management of Onsite and Clustered Wastewater Treatment Systems (EPA 832-B-03-001), covering all aspects of a comprehensive program, from design, inspection, and enforcement to public education and long-term planning. This document presents several different management models (see below) to choose from; division of responsibility and ownership between private land owners and public agencies varies between the different models. Municipalities should select that approach which best suits their conditions.

The Five Management Models

- Management Model 1 - "Homeowner Awareness" specifies appropriate program elements and activities where treatment systems are owned and operated by individual property owners in areas of low environmental sensitivity. This program is adequate where treatment technologies are limited to conventional systems that require little owner attention. To help ensure that timely maintenance is performed, the regulatory authority mails maintenance reminders to owners at appropriate intervals.
- Management Model 2 - "Maintenance Contracts" specifies program elements and activities where more complex designs are employed to enhance the capacity of conventional systems to accept and treat wastewater. Because of treatment complexity, contracts with qualified technicians are needed to ensure proper and timely maintenance.
- Management Model 3 - "Operating Permits" specifies program elements and activities where sustained performance of treatment systems is critical to protect public health and water quality. Limited-term operating permits are issued to the owner and are renewable for another term if the owner demonstrates that the system is in compliance with the terms and conditions of the permit. Performance-based designs may be incorporated into programs with management controls at this level.
- Management Model 4 - "Responsible Management Entity (RME) Operation and Maintenance" specifies program elements and activities where frequent and highly reliable operation and maintenance of decentralized systems is required to ensure water resource protection in sensitive environments. Under this model, the operating permit is issued to an RME instead of the property owner to provide the needed assurance that the appropriate maintenance is performed.
- Management Model 5 - "RME Ownership" specifies that program elements and activities for treatment systems are owned, operated, and maintained by the RME, which removes the property owner from responsibility for the system. This program is analogous to central sewerage and provides the greatest assurance of system performance in the most sensitive of environments.

Pet Waste, Litter, and Dumping Ordinances (AR2) Related Goals: 3, 6, 7 Related Indicators: 7, 8, 9, 10, 11, 16, 17, 18, 19, 20			
What	Who	Where	When
Adopt and enforce ordinance to require the removal of pet waste by the animal's owner within the municipality. Adopt and enforce ordinance to prohibit littering and dumping within the municipality.	See Table 8.6 (may not identify all municipalities with ordinance).	Entire watershed.	Within 5 years; update as needed.

A study was conducted to identify municipalities in the watershed that have adopted an ordinance to address removal of pet waste by the animal's owner and an ordinance that prohibits littering and dumping. The study verified existing ordinances related to pet waste, litter, and illegal dumping only in the City of Philadelphia; the study is believed to be comprehensive, but it is possible that additional ordinances exist that were not identified by the study. Table 8.6 shows the municipalities in the watershed that are known to have adopted pet waste and littering ordinances.

Table 8.6 Pet Waste and Littering Ordinances in the Tookany/Tacony-Frankford Watershed

Municipality	Pet Waste Ordinance	Littering and Dumping Ordinance
Abington Township		
Cheltenham Township		
Jenkintown Borough		
Philadelphia County	X	X
Rockledge Borough		

Source: www.ordinance.com, *Delaware Valley Regional Planning Commission*

Municipalities currently without ordinances are strongly encouraged to adopt them within the next two years. As an example of possible ordinance language, excerpts from Philadelphia County appear on the following page.

Pet Waste Ordinance	Littering and Dumping Ordinance
CHAPTER 10-100. Animals §10-105. Animals Committing Nuisances No person, having possession, custody or control of any animal, shall knowingly or negligently permit any dog or other animal to commit any nuisance upon any gutter, street, driveway, alley, curb or sidewalk in the City, or upon the floors or stairways of any building or place frequented by the public or used in common by the tenants, or upon the outside walls, walkways, driveways, alleys, curbs or stairways of any building abutting on a public street or park, or upon the grounds of any public park or public area, or upon any private property, including the property of the owner of such animal.	CHAPTER 10-700. REFUSE AND LITTERING §10-702. Litter in Public Places No person shall place or deposit litter in or upon any street, sidewalk or other public place within the City except in public receptacles or in authorized private receptacles.

Source: http://www.phila.gov/philacode/html/maintoc.htm , *The Philadelphia Code and Charter*

While pet waste and littering ordinances are enacted primarily for aesthetic purposes, reduction of pathogens and debris in stormwater, and thus in the Tookany/Tacony-Frankford Creek, can be reduced through their enforcement. Municipalities can assist residents in abiding by ordinances by placing trash cans in areas with higher pedestrian traffic. Plastic bags should be provided with trash cans in areas heavily used by dog owners, perhaps following the model established by the Partnership for the Delaware Estuary's "Dogi Pots" pet waste control program. Homeowners' associations should also be asked to notify residents of these ordinances and to provide trash cans and plastic bags in those neighborhoods as well.

8.1.2 Target A Options: Public Education and Volunteer Programs

Public Education (AP1) Related Goals: 4, 6, 7 Related Indicators: 16, 17, 18, 19, 20, 21			
What	Who	Where	When
Public Education Plan. Educational Program Implementation.	Municipalities on the Phase II List (see Table 8.7).	All municipalities in the TTF Watershed.	Short-term: first 5 years coinciding with the stormwater permit (see Table 8.8).

Public education about watershed management is an integral part of plan implementation. It will be designed to educate citizens on the importance of the watershed to the community, and on ways that individual behavior can impact water quality and the riparian and aquatic environment associated with Tookany/Tacony-Frankford Creek. In accordance with the TTFIWMP's stated purpose of integrating various existing programs, and to avoid duplication of effort, the recommended implementation plan follows the Stormwater Management Program Protocol to meet the six Minimum Control Measures required of municipal permittees under Phase II NPDES Stormwater Regulations (listed in Section 1.4.1 of this report, and found at 40 CFR § 122.26 – 123.35). In this way, implementation of these public education measures by municipalities will satisfy federal NPDES permit requirements for municipal separate storm sewer systems (MS4s), described in detail at 40 CFR §122.34.

Table 8.7 below lists the municipalities participating in the Phase II program that could work together with the City of Philadelphia on Public Education about watershed management issues. Assuming that a single, watershed-wide public education campaign focusing on all three Targets (A, B, and C) can be implemented, municipalities would meet their regulatory requirements while helping to implement the TTFIWMP, and avoiding the duplication of work with limited resources that would occur if each municipality were to initiate their own outreach campaign.

Table 8.7 Tookany/Tacony-Frankford Creek Municipalities on Phase I or II Stormwater List

Municipality	County	% of Muni. Area Drained by Watershed	% of Watershed within Muni.
Abington Township	Montgomery	27.41%	12.85%
Cheltenham Township	Montgomery	98.48%	26.98%
Jenkintown Borough	Montgomery	99.47%	1.74%
Rockledge Borough	Montgomery	36.89%	0.38%
Springfield Township	Montgomery	1.49%	0.31%

Public Education Plan

PWD and watershed municipalities should jointly develop a public education plan. The public education plan must target three audiences – homeowners, business owners, and developers – focusing on connections between their actions, stormwater runoff, and water quality. By the end of Year 1 of the permit cycle, cooperating municipalities should have a comprehensive plan in place that will help tap into the target audiences' existing communication channels to inform them about improving stormwater quality. During the following permit years, municipalities should monitor the effectiveness of the plan, and update it to ensure information about the target audiences is accurate.

PA DEP has guidelines for a public education plan. The plan should include an approach to collecting information on the three target audience categories. Municipalities should create a comprehensive inventory of the newsletters, newspapers, web sites, meetings, magazines, organizations, associations, etc. used by the target audiences. Cooperation of the municipalities with the assistance of the Tookany/Tacony-Frankford Watershed Partnership in gathering this information should help eliminate redundancy of effort. During the remaining years of the stormwater permit, municipalities are responsible for ensuring that information in the public education plan is accurate and current.

The River Conservation Plans (RCPs) recommend developing a comprehensive educational program for private land owners and businesses. A "do's and don'ts" format is suggested. The RCPs contain additional details and mapping for the following recommendations:

- Holy Sepulchre Cemetery to Ralph Morgan Park: Emphasize effect of land management practices on the creek.
- Washington Lane Underpass to Church Road: Focus on effects of land management on the creek. Target homeowners.
- High School Park to Ashbourne Road along the Tookany Creek Parkway: Emphasize infiltration BMPs.
- Unnamed Tributary in Glenside: Target homeowners, businesses, and SEPTA. Focus on rain barrels and riparian buffer zones.
- Baeder Creek Watershed: Focus on riparian buffer management and native species. Target land owners and apartment complexes.
- Rock Creek Watershed: Emphasize effect of land management practices on the creek.
- Mill Creek Watershed: Emphasize effect of land management practices on the creek.
- Leeches Run Watershed: Emphasize effect of land management practices on the creek. Target religious organizations and land owners.
- Township Line Road near Foxcroft Road to Main Stem: Focus on "no mow" zones, management of lawn waste, bank restoration, and invasive species.
- Township Line Road to Tookany Creek Parkway: Emphasize effect of land management practices on the creek.
- Rising Sun Avenue to Roosevelt Boulevard: Focus on illegal dumping.

- Castor Avenue to Erie Avenue: Emphasize effect of land management practices on the creek. Target local business owners, high school teachers, and students.
- Aramingo Avenue between Wheatsheaf Lane and Church Street: Emphasize effect of land management practices on the creek. Target local business owners, high school teachers, and students.
- Holy Sepulchre Cemetery to Ralph Morgan Park: Work with Bishop McDevitt to implement BMPs to focus on decreasing stormwater runoff from property.
- Wyncote Post Office to Washington Lane Underpass: PECO energy environmental department should be contacted for information regarding the results of studies being done in this area.
- Washington Lane Underpass to Church Road: The township should develop a dialogue and educate SEPTA regarding the needs of the bird sanctuary, the health of the creek, and railroad track safety.
- Eastern Branch of the Baeder Creek: Work with Abington Township School District to develop a land management plan. Focus on increasing on site infiltration.

In addition, other information relevant to watershed management should be included on topics such as:

- Improper Disposal to Storm Drains
- Automobile Maintenance
- Car Washing
- Animal Waste Collection
- Restorative Redevelopment: Public Education Aspects

Public Education Implementation

Once the public education plan is developed, it must be implemented. This means distributing educational materials provided by PA DEP or others that contain messages related to watershed (and stormwater) management. Municipalities can find educational materials needed to implement the educational program on the PA DEP website at http://www.dep.state.pa.us/dep/deputate/watermgt/wc/NPDSMS4/MS4CD/.

To fulfill NPDES stormwater permit requirements, municipalities should implement two phases of educational outreach. During the first stage, the focus is on raising the awareness of target audiences. In the second stage, municipalities should aim to educate the target audiences about the problems and potential solutions. PA DEP presents requirements in the stormwater permit for the “what” and “when” of this minimum measure component, but it does not specify the “how.” Municipalities should use their Public Education Plan to determine the most effective means of getting educational materials into the hands of target audiences. Any additional educational activities should show compliance with this Minimum Control Measure. This includes educational activities by watershed groups, and certainly should make use of the existing Tookany/Tacony-Frankford Watershed Partnership activities.

In Year 1, municipalities are required to start raising target audience awareness. Raising awareness can be accomplished by use of PA DEP materials. PA DEP has made available copies of the pamphlet entitled "When It Rains, It Drains" (available on the PA DEP website, http://www.dep.state.pa.us/dep/deputate/watermgt/wc/NPDSMS4/MS4CD/).

This document addresses the issue of pollution related to stormwater runoff and activities that citizens can use to improve stormwater quality. It also provides an overview of a typical stormwater management program. Using the information on distribution channels in the Public Education Plan, municipalities should disseminate these pamphlets to all the target audience categories in the community.

In Year 2, municipalities should begin to educate all the target audiences. This includes distributing fact sheets to developers about their responsibilities under the state and federal stormwater regulations. To meet this requirement, municipalities should distribute the Fact Sheets prepared by PA DEP, and run a "stormwater ad" in local newspapers.

In addition to targeting developers, municipalities may distribute posters to schools, community organizations and institutions, and businesses. Topics such as responsible vehicle maintenance, household hazardous waste disposal, and pet waste are important to stormwater management. PA DEP has developed a series of posters that convey messages about these topics.

Another useful measure is storm drain stenciling. While not required by the Stormwater Management Program Protocol, any stenciling done by outside organizations may contribute to meeting permit requirements for this Minimum Control Measure.

Public education directors should check any links to PA DEP's stormwater website and update the links if necessary.

In Years 3-5, the implementation continues. This consists mainly of continuing with distribution of posters and fact sheets, and running additional ads in local newspapers.

The schedule for developing and implementing the plan to meet Phase II stormwater requirements is shown in Table 8.8.

Table 8.8 Schedule for Implementation of the Public Education Program

PERMIT YEAR	**Education Plan**	**Educational Program**
Year 1	Determine Target Audience. Develop Public Education Plan. Raise Target Audience Awareness.	• Disseminate materials to all target audiences using appropriate distribution channels. • Newspaper advertisement. • Other components of Plan.
Years 2-5	Implement the plan. Revise Plan as needed.	• Disseminate materials to all target audiences using appropriate distribution channels. • Newspaper advertisement. • Other components of Plan.

Source: PA DEP MS4 Stormwater Management Program Protocol, 2003

School-Based Education (AP2) Related Goals: 6, 7 Related Indicators: 17, 18, 21			
What	Who	Where	When
Implement PA Environmental Education Curriculum.	School districts, supported by municipal governments and non-profits.	All schools.	Short-term (within 5 years).

Besides requirements found in the MS4 Stormwater Management Program Protocol, another important aspect of public education is to reach children through school curricula.

School-based watershed education takes many forms, from lesson plans within the classroom, to hands-on activities outside of the classroom such as field trips to Tookany/Tacony-Frankford Creek and nearby nature centers, as well conducting actual restoration projects. Teacher training programs, developed to assist teachers in bringing watershed concepts to their students, are critical. Being engaged in actual restoration projects, whether through service learning, after school clubs, or integrated as a part of lesson plans helps to translate these lessons into actions.

Sources for lesson plans include the following:

- Incorporate the Pennsylvania Environmental Education Curriculum developed by PA DEP into middle school curricula. This curriculum introduces concepts in watersheds, wetlands, stormwater, drinking water, and water and air pollution.
- Use local examples of watershed protection and restoration to enhance the program, work with schools to provide watershed-based educational opportunities, including the Environmental Scholars Program, Tree Survey Project, Urban Watershed Program, Environmental Clubs, Learning Grove/Trail Development Project, Park Management Program, and Teacher Training Program.

The River Conservation Plans (RCPs) suggest that a statewide environmental education curriculum could spark the interest of younger members of the watershed therefore making them aware of the problems at an earlier age. This could include incorporating riparian buffer restoration with some of the mandatory ecology curriculum.

Public Participation and Volunteer Programs (AP3) Related Goals: 3, 4, 5, 6, 7 Related Indicators: 10, 11, 12, 13, 14, 15, 16, 17, 18, 21			
What	Who	Where	When
Public Participation. Volunteer Monitoring and Storm Drain Stenciling.	Municipalities.	All municipalities in the TTF Watershed.	First 5 years coinciding with the stormwater permit.

Public participation is another facet of implementation that must follow the PA DEP Stormwater Management Program Protocol to meet the six Minimum Control Measures required of municipal permittees under the Phase II NPDES Stormwater Regulations (listed in Section 1.4.1 of this report, and found at 40 CFR §§ 122.26 – 123.35). The public must participate in issues related to municipal actions to address stormwater impacts on water quality. This includes new planning initiatives, changes to ordinances and other local regulations. This requirement overlaps the public participation aspects of the watershed management plan, and suggests that a unified and coordinated approach between municipalities would be most efficient. All municipalities in the watershed (listed in Table 8.7) are required to have a public participation program. Again, the Tookany/Tacony-Frankford Watershed Partnership would be able to assist in fostering this coordination and performing public outreach.

Prior to adoption of any ordinance required under the PA DEP Stormwater Protocol, municipalities must provide adequate public notice and opportunities for public review and input, and hold hearings to obtain public feedback. This can be done in conjunction with normal public sessions of the municipal governing body. The notice must be published in a local newspaper of general circulation. Involving citizen groups, watershed organizations, and businesses as much as possible will obtain broad support for stormwater management efforts. The TTF Partnership itself is an obvious example of such inclusion, and can help municipalities to meet this requirement.

Although the actual public participation requirements can be met by following guidelines for Act 167 planning, it is recommended that municipalities go beyond the minimum. Some options for additional public participation are listed below.

- Develop a Public Involvement and Participation Plan: By the end of Year 1, a municipality may want to have a comprehensive plan in place that will guide your efforts to recruit volunteers and obtain participation at public meetings. This could be part of the Public Education Plan discussed above (see Option AP1).

- Produce strategies for recruiting participation from six categories of stakeholders: municipal employees, homeowners, businesses, schools, watershed associations and other volunteer groups, and developers.

- Develop a comprehensive stakeholder mailing list.

- Conduct Public Meetings: PA DEP suggests using a general stormwater public meeting to kick-off public education and participation efforts. This has already been done for the Tookany/Tacony-Frankford Partnership and Steering Committee, and municipalities are encouraged to make use of this. Invite representatives from all six stakeholder categories. It is important that all stakeholder interests have the opportunity to participate. Meeting agendas should include, but not be limited to, the overview presentation on the watershed management and stormwater program and time for questions from the audience.

An important aspect of public participation is the establishment of volunteer programs. There are many types of volunteer programs that can help manage stormwater and improve a community's water quality. The goal of the volunteer program is to obtain and sustain volunteer support that will aid watershed management efforts. To reach this goal, it is important to develop a program that reflects stakeholders' concerns and interests. Examples of volunteer programs are:

- **Volunteer Monitoring Program:** Municipalities should determine which type of assessment the program will undertake and develop a study design using the manual entitled "Designing Your Monitoring Program: A Technical Handbook for Community-Based Monitoring in Pennsylvania" as the basis for planning and implementing your monitoring program (PA DEP, 2001).

- **Storm Drain Stenciling Program:** Municipalities should establish procedures for storm drain stenciling and organize volunteers to carry out the program. PA DEP has provided resource materials in a References and Resources CD-ROM on developing and implementing a storm drain stenciling program.

- **Stream Cleanup and Restoration Activities:** Citizen participation in stream cleanups is a good way to get the community involved in keeping the streams free of trash and debris. In Philadelphia, stream cleanups can be coordinated with PWD's Waterways Restoration Unit. Other participatory activities can include support of riparian plantings during stream restoration activities.

The River Conservation Plans (RCPs) suggest that increased volunteer work will increase the general awareness regarding what citizen can do to keep the watershed free of problems. For example, at the Washington Lane Underpass to Church Road, a group could be organized to adopt the bird sanctuary area.

8.1.3 Target A Options: Municipal Measures

Capacity Management Operation and Maintenance (CMOM) (AM1) Related Goals: 1, 2, 3 Related Indicators: 7, 9, 11			
What	Who	Where	When
Program to manage and maintain sewer systems; plans in place to track SSOs and overflow response plan.	Separate Sewered Municipalities.	Separate Sanitary Sewer Areas.	Medium term: 5+ years.

Capacity, management, operation, and maintenance (CMOM) programs are recommended for all areas with separate sanitary sewer systems and are an important component of Target A because they help prevent dry weather discharges. Recommendations in this section cover both the dry and wet weather aspects of the program; recommendations that are specific to SSO abatement are included here for completeness and are referred to under Target C. The recommendations in this section are adapted from the "Consensus Recommendation of the SSO Federal Advisory Subcommittee," published in October 1999.

1) General Standards

- Properly manage, operate, and maintain, at all times, all parts of collection system. Perform maintenance and inspections using techniques similar to those recommended for combined sewers in Option AM2.
- Provide adequate capacity to convey base flows and peak flows for all parts of the collection system.
- Take all feasible steps to stop, and mitigate the impact of, sanitary sewer overflows in portions of the collection system.
- Provide notification to parties with a reasonable potential for exposure to pollutants associated with the overflow event.
- Develop a written summary of the CMOM program and make it, and the audit under section (5), available to any member of the public upon request.

2) Management Program

Develop a CMOM program to comply with the above general standards. If any element of this section is not appropriate or applicable for the CMOM program in question, it does not need to address the element, but a written summary must explain why that element is not applicable. The management program should consist of the following six components:

1. Goals
The program must identify in detail the major goals of the CMOM program consistent with the general standards identified above.

2. Organization
(A) Identify administrative and maintenance positions responsible for implementing measures in the CMOM program, including lines of authority by organization chart or similar document, and (B) establish the chain of communication for reporting SSOs from receipt of a complaint or other information to the person responsible for reporting to the NPDES authority.

3. Legal Authority
Include legal authority, through sewer use ordinances, service agreements or other legally binding documents, to:

(A) Control infiltration and connections from inflow sources;

(B) Require that sewers and connections be properly designed and constructed;

(C) Ensure proper installation, testing, and inspection of new and rehabilitated sewers (such as new or rehabilitated collector sewers and new or rehabilitated service laterals);

(D) Address flows from satellite municipal collection systems; and

(E) Implement the general and specific prohibitions of the national pretreatment program that you are subject to under 40 CFR 403.5.

4. Measures and Activities
The CMOM program must address the elements listed below that are appropriate and applicable to the sewer system and identify the person or position in the organization responsible for each element.

(A) Maintenance of facilities.

(B) Maintenance of a map of the collection system.

(C) Management of information and use of timely, relevant information to establish and prioritize appropriate CMOM activities, and to identify and illustrate trends in overflows.

(D) Routine preventive operation and maintenance activities.

(E) Assessment of the current capacity of the collection system and treatment facilities.

(F) Identification and prioritization of structural deficiencies and identification and implementation of short-term and long-term rehabilitation actions to address each deficiency.

(G) Appropriate training on a regular basis.

(H) Equipment and replacement parts inventories including identification of critical replacement parts.

5. Design and Performance Provisions
(A) Requirements and standards for the installation of new sewers, pumps, and other appurtenances, and for rehabilitation and repair projects.

(B) Procedures and specifications for inspecting and testing the installation of new sewers, pumps, and other appurtenances, and for rehabilitation and repair projects.

6. Monitoring, Measurement, and Program Modifications

Monitor the implementation and, where appropriate, measure the effectiveness of each element of the CMOM program. Program elements must be updated as appropriate based on monitoring or performance evaluations. The summary of the CMOM program should be modified as appropriate to keep it updated and accurate.

3) Overflow Response Plan

An overflow response plan should be developed and implemented that identifies measures to protect public health and the environment including, but not limited to, mechanisms to:

(i) Ensure that all overflows are made aware of (to the greatest extent possible);

(ii) Ensure that overflows are appropriately responded to, including ensuring that reports of overflows are immediately dispatched to appropriate personnel for investigation and appropriate response;

(iii) Ensure appropriate reporting pursuant to 40 CFR 122.42(e);

(iv) Ensure appropriate notification to the public, health agencies, and other impacted entities (e.g. water suppliers) pursuant to 40 CFR 122.42(h). The CMOM plan should identify the public health and other officials who will receive immediate notification;

(v) Ensure that appropriate personnel are aware of and follow the plan and are appropriately trained; and

(vi) Provide emergency operations.

4) System Evaluation and Capacity Assurance Plan

A plan should be prepared and implemented for system evaluation and capacity assurance if peak flow conditions are contributing to an SSO discharge unless either (1) already taken steps to correct the hydraulic deficiency or (2) the discharge meets the criteria of 122.42(g)(2). At a minimum the plan must include:

(i) *Evaluation:* Steps to evaluate those portions of the collection system which are experiencing or contributing to an SSO discharge caused by hydraulic deficiency or to noncompliance at a treatment plant. The evaluation should provide estimates of peak flows (including flows from SSOs that escape from the system) associated with conditions similar to those causing overflow events, provide estimates of the capacity of key system components, identify hydraulic deficiencies, including components of the system with limiting capacity and identify the major sources that contribute to the peak flows associated with overflow events.

(ii) *Capacity Enhancement Measures:* Establish short- and long-term actions to address each hydraulic deficiency including prioritization, alternative analysis, and a schedule.

(iii) *Plan Updates:* The plan should be updated to describe any significant change in proposed actions and/or implementation schedule. The plan should also be updated to reflect available information on the performance of measures that have been implemented.

5) <u>CMOM Program Audits</u>

As part of the NPDES permit application, an audit should be conducted, appropriate to the size of the system and the number of overflows, and a report submitted of such audit, evaluating the CMOM program and its compliance with this subsection, including its deficiencies and steps to respond to them.

6) <u>Communications</u>

The permittee should communicate on a regular basis with various interested parties on the implementation and performance of its CMOM program. The communication system should allow interested parties to provide input to the permittee as the CMOM program is developed and implemented.

Inspection and Cleaning of Combined Sewers (AM2) Related Goals: 3, 4, 7 Related Indicators: 11, 19			
What	Who	Where	When
Inspection activities, routine maintenance, monitoring activities.	PWD	Combined Sewered Areas (see Figure 8.3).	First 5 years coinciding with the stormwater permit.

Maintenance of sewers includes activities required to keep the system functioning as it was originally designed and constructed. Any reinvestment in the system, including routine maintenance, capital improvements for repair or rehabilitation, inspection activities, and monitoring activities are generally classified as maintenance.

An inspection program is vital to proper maintenance of a wastewater collection system. Without inspections, a maintenance program is difficult to design, since problems cannot be solved if they are not identified. Sewer inspections identify problems such as blocked, broken, or cracked pipes; tree roots growing into the sewer; sections of pipe that settle or shift so that pipe joints no longer match; and sediment and other material building up and causing pipes to break or collapse. The elements of an inspection program include flow monitoring, manhole inspections, smoke/dye testing, closed circuit television inspection, and private sector inspections. Private sector building inspection activities include inspection of area drains, downspouts, cleanouts, sump discharges, and other private sector inflow sources into the system.

In addition to inspection, routine maintenance must also include sewer cleaning, root removal/treatment, cleaning of mainline stoppages, cleaning of house service stoppages, and inspections and servicing of pump stations.

PWD is responsible for implementation of this option in the combined sewer areas of the Tookany/Tacony-Frankford Watershed, but municipalities with separate sewers should have similar permanent and active sewer maintenance programs in place under CMOM (see Option AM1). In Section 4.4.1, Figure 4.19 illustrated the areas where sanitary sewers and combined sewers exist. All municipalities in the watershed are responsible for sewer maintenance.

PWD has combined sewer maintenance responsibilities in the Tookany/Tacony-Frankford Watershed. CSO regulations (including the Nine Minimum Controls discussed in Section 1.4.5) have required that PWD carry out improved sewer maintenance. Some of the activities PWD is carrying out include the review and improvement of ongoing operation and maintenance programs, and comprehensive inspection and monitoring programs to characterize and report overflows and other conditions in the combined sewer system.

Sanitary Sewer Rehabilitation (AM3) Related Goals: 3 Related Indicators: 7, 11			
What	Who	Where	When
Perform major repairs or replacement on sections of sewer determined to be in poor condition.	All municipalities with separate sanitary sewer systems.	All municipalities with separate sanitary sewer systems.	Medium-term.

The CMOM and sewer inspection programs discussed in the two preceding sections may identify segments of sewer that are in poor condition and in need of major repair or replacement. The information in this section is adapted from fact sheets on the EPA web site: http://www.epa.gov/owm/mtb/rehabl.pdf.

Under the traditional method of sewer relief, a replacement or additional parallel sewer line is constructed by digging along the entire length of the existing pipeline. While these traditional methods of sewer rehabilitation require unearthing and replacing the deficient pipe (the dig-and-replace method), trenchless methods of rehabilitation use the existing pipe as a host for a new pipe or liner. Trenchless sewer rehabilitation techniques offer a method of correcting pipe deficiencies that requires less restoration and causes less disturbance and environmental degradation than the traditional dig and-replace method.

Trenchless Sewer Rehabilitation Methods:

- Pipe Bursting, or In-Line Expansion
- Sliplining
- Cured-In-Place Pipe
- Modified Cross Section Liner

These alternative techniques must be fully understood before they are applied. These four sewer rehabilitation methods are described further below:

Pipe Bursting or In-Line Expansion: Pipe bursting, or in-line expansion, is a method by which the existing pipe is forced outward and opened by a bursting tool. The Pipebursting™ method, patented by the British Gas Company in 1980, was successfully applied by the gas pipelines industry before its applicability was identified by other underground utility agencies. Over the last two decades, other methods of in-line expansion have been patented as well. During in-line expansion, the existing pipe is used as a guide for inserting the expansion head (part of the bursting tool). The expansion head, typically pulled by a cable rod and winch, increases the area available for the new pipe by pushing the existing pipe radially outward until it cracks. The bursting device pulls the new pipeline behind itself.

Sliplining: Sliplining is a well-established method of trenchless rehabilitation. During the sliplining process, a new liner of smaller diameter is placed inside the existing pipe. The annular space, or area between the existing pipe and the new pipe, is typically grouted to prevent leaks and to provide structural integrity.

Cured-In-Place Pipe: During the cured-in-place pipe (CIPP) renewal process, a flexible fabric liner, coated with a thermosetting resin, is inserted into the existing pipeline and cured to form a new liner. The liner is typically inserted into the existing pipe through an existing manhole. The fabric tube holds the resin in place until the tube is inserted in the pipe and ready to be cured. Commonly manufactured resins include unsaturated polyester, vinyl ester.

Modified Cross Section Lining: The modified cross section lining methods include deformed and reformed methods, sewagelining™, and rolldown. These methods either modify the pipe's cross sectional profile or reduce its cross sectional area so that the liner can be extruded through the existing pipe. The liner is subsequently expanded to conform to the existing pipe's size. Another method of obtaining a close fit between the new lining and existing pipe is to temporarily compress the new liner before it is drawn through the existing pipeline. The sewagelining™ and rolldown processes use chemical and mechanical means, respectively, to reduce the cross-sectional area of the new liner.

External Sewer Rehabilitation Methods (adapted from EPA/600/R-01/034)

External rehabilitation methods are performed from the above ground surface by excavating adjacent to the pipe, or the external region of the pipe is treated from inside the pipe through the wall. Some of the methods used include:

- External Point Repairs
- Chemical Grouting (Acrylamide Base Gel, Acrylic Base Gel)
- Cement Grouting (Cement, Microfine Cement, Compaction)

Internal Sewer Rehabilitation Methods

The basic internal sewer rehabilitation methods include:

Chemical Grouting: Internal grouting is the most commonly used method for sealing leaking joints in structurally sound sewer pipes. Chemical grouts do not stop leaks by filling cracks; they are forced through cracks and joints, and gel with surrounding soil, forming a waterproof collar around leaking pipes. This method is accomplished by sealing off an area with a "packer," air testing the segment, and pressure injecting a chemical grout for all segments which fail the air test. The three major types of chemical grout are: Acrylic, Acrylate, and Urethane.

Continuous Pipe: Insertion of a continuous pipe through the existing pipe (Polyethylene and Polypropylene).

Segmental: Short segments of new pipe are assembled to form a continuous line, and forced into the host pipe. Generally, this method is used on larger sized pipe and forced into the host pipe. (Polyethylene, Polyvinyl Chloride, Reinforced Plastic Mortar, Fiberglass Reinforced Plastic, Ductile Iron, Steel).

Fold and Form Pipe: This is similar to sliplining, except that the liner pipe is deformed in some manner to aid insertion into the existing pipe. Depending on the specific manufacturer, the liner pipe may be made of PVC or HDPE. One method of deforming the liner is to fold it into a "U" shape before insertion into the existing pipe. The pipe is then returned to its original circular shape using heated air or water, or using a rounded shaping device or mandrel. Ideally, there will be no void between the existing pipe and the liner pipe after expansion of the liner pipe with the shaping device. For the "U" shape liner, the resulting pipe liner is seamless and jointless.

Spiral Wound Pipe: This involves winding strips of PVC in a helical pattern to form a continuous liner on the inside of the existing pipe. The liner is then strengthened and supported with grout that is injected into the annular void between the existing pipe and the liner. A modified spiral method is also available that winds the liner pipe into a smaller diameter than the existing pipe, and then by slippage of the seams, the liner expands outward.

Combined Sewer Rehabilitation (AM4) Related Goals: 3, 7 Related Indicators: 7, 8, 9, 10, 11, 19, 20			
What	Who	Where	When
Perform major repairs or replacement on sections of sewer determined to be in poor condition.	PWD	Combined-Sewered Areas.	Medium-term.

Rehabilitation of combined sewers is conceptually similar to rehabilitation of separate sanitary sewers. Refer to Option AM3 above for information on specific techniques.

Illicit Discharge, Detection, and Elimination (IDD&E) (AM5) Related Goals: 3, 6, 7 Related Indicators: 7, 8, 9, 10, 11, 16, 19, 20			
What	Who	Where	When
IDD&E Program in conformance with Phase II Stormwater Permits and the LTCP for PWD.	All Municipalities required to do Phase II permit (see Table 8.7); PWD in CSO Areas.	All areas with a storm sewer or combined sewer (see Figure 8.3).	5-year program associated with stormwater permit (see Table 8.10).

In accordance with the Tookany/Tacony-Frankford Watershed Plan's stated purpose of integrating various existing programs, and to avoid duplication of effort, the recommended implementation plan follows the PA DEP Stormwater Management Program Protocol to meet the six minimum control measures required of municipal permittees under the Phase II NPDES Stormwater Regulations (listed in Section 1.4.1 of this report, and found at 40 CFR §§ 122.26 – 123.35). One of the six minimum controls is an IDD&E program. The IDD&E program can be summarized as consisting of the following steps:

- Develop map of municipal separate storm sewer system outfalls and receiving water bodies.
- Prohibit illicit discharges via PA DEP-approved ordinance.
- Implement an IDD&E Program that includes 1) field screening program and procedures and 2) elimination of illicit discharges.
- Conduct public awareness and reporting program (see Option AP1, "Public Education," in Section 8.1.2).

A similar approach to controlling dry weather flows is being followed by PWD under the Long Term Control Plan (LTCP) for CSOs.

Each step is explained in more detail below:

Develop an Outfall Map

The federal regulations define an outfall as "a point source as defined by 40 CFR 122.2 at the point where a municipal separate storm sewer discharges to waters of the United States." A "point source" is defined as "any discernable, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, vessel, or other floating craft from which pollutants are or may be discharged."

Many of the outfalls along Tookany/Tacony-Frankford Creek have already been located under the studies performed for the Tookany/Tacony-Frankford Creek RCP. Municipalities should work with PWD to develop a consistent set of outfall maps that meet the specific requirements of the Phase II program.

Illicit Discharge Ordinance

A model ordinance is available from PA DEP and should be used as is. PA DEP discourages changes to the model ordinance, because it has been prepared to meet the MS4 permit requirements. However, some municipalities already have good stormwater ordinances. Municipalities who do not wish to enact the model ordinance in its entirety must get approval from PA DEP to ensure that the MS4 permit requirements are met.

The model ordinance must be enacted in the first year of the permit term, except where a municipality commits to a multi-municipal, watershed-based program following the Stormwater Management Program Protocol, in which case the schedule is delayed one year. Subsequent to completion of the Act 167 Plan (or Plan Update), the ordinance must be modified to reflect Plan requirements. Regardless of the timing of the Act 167 Plan (or Plan Update) an ordinance must be enacted within the first two years of the permit term for all municipalities in the Tookany/Tacony-Frankford Watershed.

IDD&E Program

Following the PA DEP Protocol, the IDD&E Program must consist of the following three elements, which must be implemented according to the schedule shown below:

- Conduct Field Screening.
- Identify Source of Illicit Discharges.
- Develop and Implement a Strategy to Remove or Correct Illicit Discharges.

Field Screening: Field screening is necessary to identify source(s) of actual illicit discharges. Field screening must start in Year 2 of the permit. PA DEP provides a checklist that must be used when conducting field screening. Every outfall in priority areas must be screened two times a year. This activity can be accomplished concurrently with other existing field activities, such as regularly scheduled fire hydrant inspections, road repairs, landscaping activities, other field work conducted during county preparation of the Act 167 stormwater plan, etc.

Using a PA DEP supplied Checklist, the staff designated to conduct field screening collect visual data. The screening should be conducted at least 72 hours since the last precipitation event, and at least 48 hours should pass between the first screening at a particular outfall and the second screening at that outfall. If someone conducting the field screening discovers a dry-weather flow, they (or another designated individual with the proper training) must collect a sample of that flow for analysis. Such a discovery triggers the requirements under the other two program elements, below.

Identify Source of Illicit Discharges: The following IDD&E Program elements apply only if a dry-weather flow is identified during field screening activities in Years 2, 3, 4, and/or 5.

If field inspectors identify a dry-weather flow at an outfall during field screening, they should take two grab samples of the flow and analyze the samples for the characteristics and pollutants listed in the Table 8.9 below.

Table 8.9 Dry-Weather Flow Sampling Analysis Requirements

Characteristic/Pollutant	Method
Color	Visual observation
Odor	Visual observation
Turbidity	Visual observation
Sheen/scum	Visual observation
PH	In-field analysis
Total chlorine	In-field analysis
Total copper	In-field analysis
Total phenol	In-field analysis
Detergents/surfactants	In-field analysis
Flow	In-field measurement
Bacteria	Laboratory analysis

The data obtained from visual, in-field, and laboratory analyses will provide the information necessary to determine the source of the dry-weather flow or floatables. Based on the pollutants contained in the sample, it should be possible to determine if the source is from illegal dumping in a storm drain, a cross-connection, or a leak in a pipe. Potential sources of the dry-weather flow can be located by tracing the flow upstream using storm drain maps and by inspecting upgradient manholes and storm drains. If need be, a more focused test to pinpoint the source can be tried, such as dye testing, smoke testing, and television camera inspection.

Remove or Correct the Illicit Discharge: Once the source has been identified, municipalities need to determine if it is a case of improper dumping or if a property owner has an improper physical connection to the storm sewer system. This will help to select the most appropriate method for correcting or removing the discharge. If it is a case of improper dumping, the only recourse may be to conduct intensified education of residents living in and traveling through that area. If it is a case of an improper physical connection, the appropriate action can be taken to correct the discharge. A plan of action to eliminate illicit connections might include plugging discharge points or disconnecting and reconnecting lines.

If a violation is found, the property owner should be notified of the violation and given a timeframe for removal of the source. After that time has passed, the outfall can be screened to identify the dry weather discharge. The property should be visited a final time to confirm that the property owner removed or corrected the source. The results of all discussions, tests, and screenings should be documented for follow-up purposes. Progress evaluation of the municipal IDD&E program will depend on the ability to tabulate the number of illicit connections corrected and the status of those in the process of being corrected.

All municipalities within the Tookany/Tacony-Frankford Watershed that have a sanitary sewer system are required to carry out this program. Table 8.7 lists the municipalities, and Figure 8.3 shows the location of the sewered areas.

The PA DEP Protocol has laid out a very specific time table for completion of this program by the municipalities. The timing is shown in Table 8.10 below.

Table 8.10 Implementation Schedule for IDD&E Program

PERMIT YEAR	***IMPLEMENTATION SCHEDULE PERMIT REQUIREMENTS AND MEASURABLE GOALS***			
	Mapping	**Ordinance**	**Program**	**Education**
Year 1	Complete map of all outfalls.	Adopt and enact.	Screen Priority Areas. Take corrective actions to remove illicit discharges (as needed).	Presentation on IDD&E. Program and Ordinance during a public meeting. Distribute educational material (see Public Education and Outreach Minimum Measure).
Years 2 - 5	Establish priority areas for 25% of system.	Implement and enforce.	Screen Priority Areas. Take corrective actions to remove illicit discharges (as needed).	Distribute educational material (see Public Education and Outreach Minimum Measure).

The River Conservation Plans (RCPs) noted the following:

- Rising Sun Avenue to Roosevelt Blvd: Investigate exposed pipe at Tabor Road.

Stream Cleanup and Maintenance (AM6) Related Goals: 1, 3, 4, 6, 7 Related Indicators: 3, 4, 5, 6, 10, 11, 15, 16, 17, 19, 20			
What	Who	Where	When
Remove litter and heavy debris. Maintain habitat improvements (fish ladders, FGM, elimination of plunge pools).	PWD Waterways Restoration Unit; Fairmount Park volunteers and other volunteer groups.	Entire creek system.	Begin within 5 years; monthly maintenance schedule to be determined.

Keeping streams free of trash is a continuous activity. Fairmount Park volunteers alone have removed over 2,000 bags of trash from the stream corridor since 1998. Public education should help in reducing trash and debris reaching the streams; however, PWD and municipalities need to put into place a permanent maintenance schedule. PWD has implemented a permanent Waterways Restoration Unit. This team periodically removes trash and large debris from Tookany/Tacony-Frankford Creek on a rotating schedule. For reaches of stream within the City or along the City boundary, the team will focus on removal of litter and heavy debris, and maintenance of instream aquatic habitat improvement projects including fish ladders, fluvial geomorphologic restoration projects, and elimination of outfall plunge pools. For reaches of stream outside the City, municipalities should organize periodic stream cleanups using volunteer groups.

In addition to noting the specific trouble spots listed below, the River Conservation Plans (RCPs) recommend a general cleanup routine be established to conserve both the biological and aesthetical quality of the rivers. Any plans that reduce the amount of trash or illegal dumping would be considered essential. Local township volunteers can be of great assistance in this particular BMP.

- Wyncote Post Office to Washington Lane Underpass: Investigate dumping of construction material.
- Rock Creek Watershed: Monitor commercial areas for illegal dumping.
- Rising Sun Avenue to Roosevelt Boulevard: Erect a barricade to deter illegal dumping.
- Roosevelt Boulevard to Whitaker Avenue: Install a barrier to stop dumping at Whitaker Ave. Bridge.
- Whitaker Avenue to Wyoming Avenue: Erect a barricade to deter illegal dumping.
- Aramingo Avenue between Wheatsheaf Lane and Church Street: Install fence barrier at Aramingo Ave. overpass to stop illegal dumping.
- Holy Sepulchre Cemetery to Ralph Morgan Park: Conduct regular trash removal.
- Ralph Morgan Park to Greenwood Avenue: Clear debris blocking stormwater outlets and ask staff not to dump leaves in the creek.

- Greenwood Avenue to Wyncote Post Office: Routinely clear creek of trash and debris after storms.
- Wyncote Post Office to Washington Lane Underpass: Major cleanup required. SEPTA should be contacted to clean railroad debris.
- Washington Lane Underpass to Church Road: Remove trash, storm debris, and graffiti.
- High School Park to Ashbourne Road along the Tookany Creek Parkway: Conduct regular trash removal.
- Unnamed Tributary in Glenside: Clean up trash and storm debris along Tyson Ave. SEPTA should monitor culverts for blockage.
- Rock Creek Watershed: Continue to improve infrastructure that has a negative impact on water quality. Conduct regular trash removal.
- Abington Country Club to Township Line Road: Clean and maintain channelized portion of the creek on a regular basis.
- Township Line Road near Foxcroft Road to Main Stem (unnamed tributary): Clear entire reach of storm debris.
- Abington Friends School to Township Line Road: Regularly remove trash in the creek area.
- Township Line Road to Tookany Creek Parkway: Conduct regular trash/debris removal.
- Cheltenham Avenue to Adams Avenue: Clear creek of debris. Concentrate on woody debris at bridge. Evaluate trash pick-up schedule with Fairmount Park.
- Crescentville and Adams Avenues to Rising Sun Avenue: Conduct regular trash removal.
- Rising Sun Avenue to Roosevelt Boulevard: Conduct a massive trash removal, concentrating at the F Street site. Clear overgrown vegetation.
- Roosevelt Boulevard to Whitaker Avenue: Conduct massive trash removal of the whole segment.
- Wyoming Avenue to Castor Avenue: Conduct a trash cleanup. Contact Ferko Playground regarding trashcans and regular trash removal.
- Castor Avenue to Erie Avenue: Remove graffiti from walls and secure access areas.
- Aramingo Avenue between Wheatsheaf Lane and Church Street: Clear creek of all debris.
- Rohm & Haas, 5000 Richmond Street: Conduct trash removal at mouth of embankment.
- Intersection of Adams and Newtown Avenue: Investigate illegal dumpsite and install fencing.
- Driveway connecting Adams Ave to Godfrey Ave: Investigate illegal dumpsite and install fencing.
- Castor Avenue near Wyoming Avenue: Investigate illegal dumpsite and install fencing.
- I and Ramona: Investigate illegal dumpsite and install fencing.
- Awbury Arboretum: Investigate illegal dumpsite and install fencing.

8.1.4 Target A Options: Recreational and Cultural Resources

Enhancing Stream Corridor Recreational and Cultural Resources (AO1) Related Goals: 4, 6, 7 Related Indicators: 16, 17, 18, 19, 20, 21			
What	Who	Where	When
Establish and improve trails and greenways using measures recommended in the RCPs and the Fairmount Park Trails Master Plan. Protect historic sites listed in the RCPs.	Outside Philadelphia: partnership of Department of Conservation and Natural Resources (DCNR), county planning departments, and municipalities. Inside Philadelphia: Fairmount Park Commission.	See Figures 8.2.	Medium-term: 5-15 years.

Part of Target A addresses the accessibility of Tookany/Tacony-Frankford Creek. Once dry weather water quality and aesthetics have been improved, the recreational value of the Creek will be enhanced, and better accessibility becomes important. A stream accessibility analysis (Section 4.6.4, Indicator 18) illustrated that much of the headwaters and the downstream portion of the Tookany/Tacony-Frankford are inaccessible. The recommended actions focus primarily on improving access to public lands where recreational potential is greatest.

The River Conservation Plans (RCPs) recommend improving existing stream corridor recreation resources in order for the watershed to gain value as a civic asset. This goal can be achieved through building/repairing trails or by blocking disruptive activities (such as ATV use). Protecting historically significant items is also a recommendation. The RCPs noted in particular:

- Church Road at Chelten Hills Drive to Church Road near Ogontz Field: Remove millstones for historic display at Wall House.
- Rock Creek Watershed: Consider a trail or greenway along township-owned segments.
- Cheltenham Avenue to Adams Avenue: Repair trail erosion at benches. Recommend repair or removal of exercise stations.
- Crescentville and Adams Avenues to Rising Sun Avenue: Research and implement swimming deterrents.
- Whitaker Avenue to Wyoming Avenue: Create barriers to stop ATV use.
- Holy Sepulchre Cemetery to Ralph Morgan Park**:** Create a parks master plan for this area.

Fairmount Park's Natural Lands Restoration and Trails Master Plan contains specific recommendations for creating and enhancing trails in their park system. These are shown in Table 8.11 and Figure 8.2 on the pages that follow.

Table 8.11 Fairmount Park Trails Master Plan Recommendations
■ Provide maximum support and development of positive volunteer educational and restoration efforts already in place. ■ Eliminate redundant and problematic trails that are contributing to the ecological decline of the natural areas. ■ Increase perceived safety by providing better trail sight lines and perimeter lighting. ■ Create well-defined trail heads that have good transit and regional connections. ■ Provide access points/gateways to adjacent neighborhoods. ■ Provide interpretive and educational opportunities for the diverse ecological and cultural settings of the park. ■ Provide for adequate parking and controlled access to the trails to eliminate/reduce likelihood of trails as entrance points for motorized vehicles (particularly ATV's and abandoned autos). ■ Provide maintenance strategies and restoration solutions for eroded and degraded trails that will continue to be used.

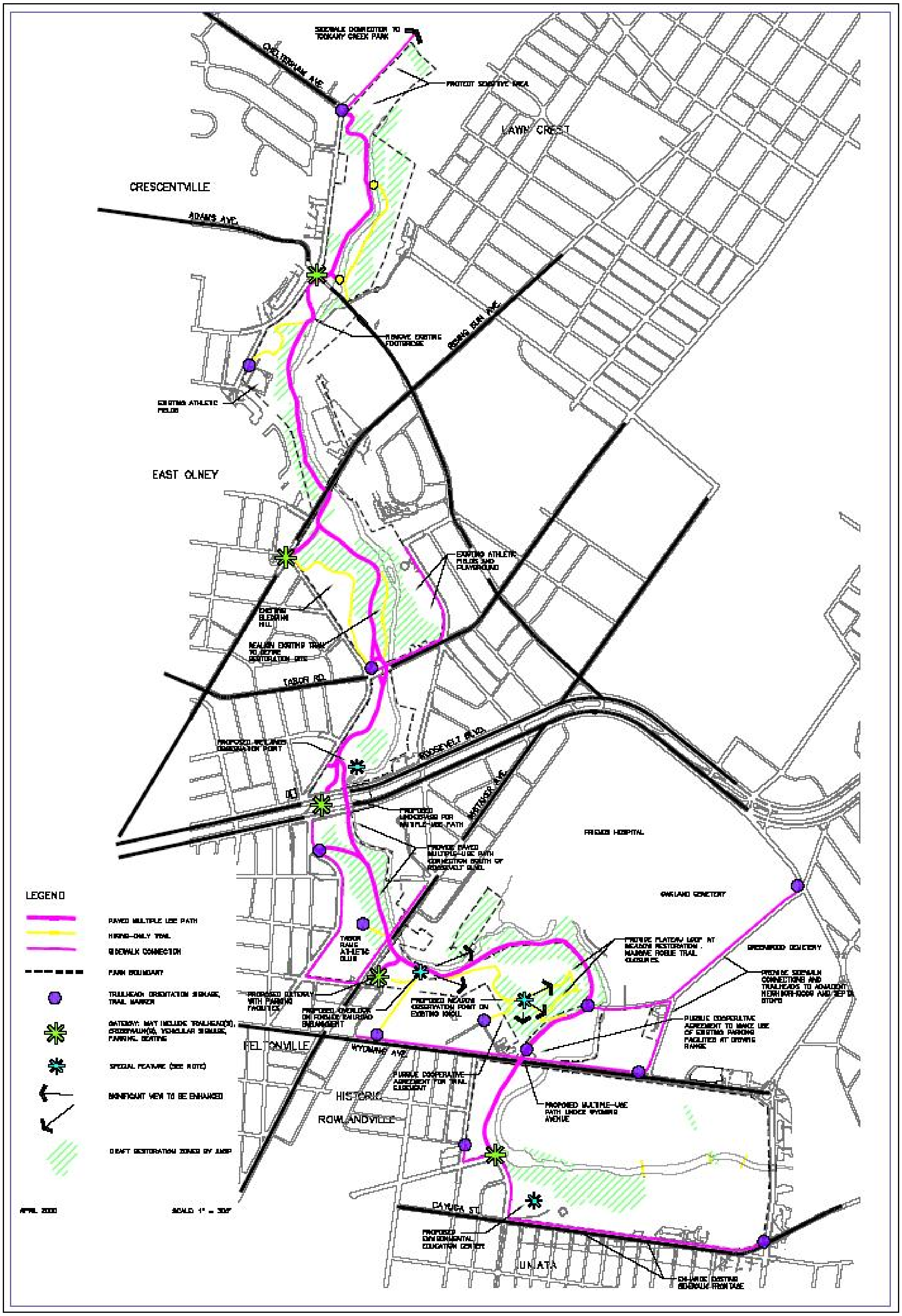


Figure 8.2 Fairmount Park's Proposed Trails Plan for Tookany/Tacony-Frankford Creek

8.1.5 Target A Options: Monitoring and Reporting

Monitoring, Reporting, and Further Study (AMR) Related Goals: Related Indicators: 16, 17, 18, 19, 20, 21			
What	Who	Where	When
Monitor and collect data in areas where more information is needed to clarify the situation or establish a proper BMP.	PWD in CSO areas; municipal townships in separate sewered areas.	See Figure 8.3.	Short-term: 1-5 years.

The River Conservation Plans (RCPs) recommend monitoring sites where there is an unexpected substance, odor, or bacteria. A comprehensive water quality analysis is also recommended.

- Ralph Morgan Park to Greenwood Avenue: Identify the orange milky substance. Focus on water quality.
- Wyncote Post Office to Washington Lane Underpass: Investigate orange gel-like substance. Township to lead investigation.
- Rock Creek Watershed: Continue to monitor the areas with excessive coliform levels.
- Rising Sun Avenue to Roosevelt Boulevard: Target the cause of sewer odor and rectify.
- Roosevelt Boulevard to Whitaker Avenue: Target outfalls. Investigate possible disconnected sewer line.
- Wyoming Avenue to Castor Avenue: Target outfalls. Investigate sewage smells.
- Aramingo Avenue between Wheatsheaf Lane and Church Street: Investigate discharge from outfall pipe.

In the first five-year implementation plan, additional studies will be recommended to focus on dissolved oxygen, sources of fecal coliform, and the potential causes of large dissolved oxygen swings in the lower portion of the watershed.

8.2 Target B: Healthy Living Resources

Given the historic degradation of the water quality and ecology of Tookany/Tacony-Frankford Creek and its tributaries from urbanization, an interdependent set of corridor improvement actions are recommended. Because of that interdependent nature, this section begins with an overview that addresses various points common to many or all of the recommended Target B options. Following that overview, the individual options – all of which were recommended for implementation (as explained in Section 7) – are described in detail.

Section 8.2.1 **Overview: Stream and Riparian Corridor Improvement**

Section 8.2.2 **Channel Stability and Aquatic Habitat Restoration**

BM1 Bed Stabilization and Habitat Restoration
BM2 Bank Stabilization and Habitat Restoration
BM3 Channel Realignment and Relocation
BM4 Plunge Pool Removal
BM5 Improvement of Fish Passage

Section 8.2.3 **Lowland and Upland Restoration and Enhancement**

BM6 Wetland Creation and Enhancement
BM7 Invasive Species Management
BM8 Biofiltration
BM9 Reforestation

Section 8.2.4 **Monitoring and Reporting**

BMR Monitoring, Reporting, and Further Study

8.2.1 Overview: Stream and Riparian Corridor Improvement

This Tookany/Tacony-Frankford Integrated Watershed Management Plan proposes a comprehensive stream and riparian corridor restoration strategy. The recommended actions presented throughout Section 8.2 – ranging from conservation of existing open spaces, to stream stabilization actions, to creation of new wetlands and biofiltration areas – together constitute a fully integrated riparian corridor improvement strategy that provides new habitat and water quality improvement. In the Philadelphia portion of the riparian corridor, this approach is intended to complement and expand the Fairmount Park Commission's Environmental Stewardship and Education Program.

These riparian corridor improvement actions, when implemented simultaneously, will result in improvements that span the waterway and riparian corridor. Thus, riparian corridor actions improve the ecology of the Tookany/Tacony-Frankford Creek landscape and optimize the ways in which the limited remaining open space can help improve water quality. The long-term benefits of an integrated riparian strategy significantly outweigh the short-term construction disturbances that are needed to implement the Tookany/Tacony-Frankford Creek riparian corridor improvements.

The riparian corridor is defined here as the land area that borders a stream and which directly affects and is affected by the water quality, including floodplains, shorelines, wetlands, and riparian forest. For the purposes of the Tookany/Tacony-Frankford Creek riparian corridor improvement strategy, the riparian area also includes the stream channel. Thus, the full undeveloped land and waterway area between the existing land development that surrounds the corridor will be considered for ecological improvement and for biofiltration functions that will improve water quality. Listed below are the options recommended for implementation across the corridor, from the lowest point in the landscape (the stream channel) to the highest (upland forest).

The most effective approach to riparian corridor improvement is to perform all the proposed streambed, streambank, wetland, and riparian upland improvements simultaneously along a reach, or stream section, to realize the synergy of the full set of landscape improvements. When one stream segment is completed, work would shift to the next priority location, section by section, for the length of the Tookany/Tacony-Frankford Creek corridor.

Implementing one set of corridor actions, for example, bed stabilization, without complementary actions, such as bank stabilization, will result in only limited success, because the aquatic and streamside land environments must function interactively to provide optimal stability. For this reason, the riparian corridor improvement strategy is both a short-term and long-term plan. Restoration activities in sections of the watershed that are in greatest need of improvement should be implemented early (targeting stream sections that are causing or contributing to water quality or ecological impairment first). For the Tookany/Tacony-Frankford Creek corridor, it is anticipated that significant improvements in water quality and ecology can be realized by addressing high priority locations that are principally upstream during the first 5 years, with sections downstream of Castor Ave. that require further evaluation of water quality issues receiving riparian corridor improvement during a second 10 year period (see Figure 8.4 and Table 8.12). It is important to note that the next step in implementing the riparian corridor improvement strategy is to develop a corridor improvement facilities plan, under which integrated designs are prepared for the full range of corridor improvements (e.g., bed and bank stabilization, and wetland creation and enhancement).

PWD recently performed stream assessments along the entire Tookany/Tacony-Frankford Creek corridor. The results of this study will provide more specific guidance on priority stream sections and recommended improvements.

The River Conservation Plans (RCPs) include the following recommendations for restoring buffer zones and undercut creek banks in an effort to control both stream contamination and flooding:

- Holy Sepulchre Cemetery to Ralph Morgan Park: Initiate plan to study geomorphology and sinuosity. Restore and enforce riparian buffer regulations. Conduct streambank stabilization.
- Ralph Morgan Park to Greenwood Avenue: Restore banks where there is severe undercutting. Plant creek banks to prevent washed out areas. Create "no-mow" zones. Remove a retaining wall, regrade, and plant the bank to facilitate a natural retaining basin. Relocate and replace the macadam walking path with natural material.
- Church Road at Chelten Hills Drive to Church Road near Ogontz Field: Possible relocation of playground equipment away from stream bank to promote healthier buffer zone. Check stability of rip-rap and stacked cement retaining wall. Restore and/or stabilize some of the undercut bank and root exposed trees.
- High School Park to Ashbourne Road along the Tookany Creek Parkway: Initiate plan to study local geomorphology and sinuosity. Conduct streambank stabilization.
- Unnamed Tributary in Glenside: Redesign, regrade, and plant banks along Grove Park. Create "no-mow" zone. Create riparian buffer zone, restore streambank along Waverly Rd. Formally name all unnamed tributaries.
- Baeder Creek Watershed: Consider removal of vertical gabion baskets and concrete wall in place of natural bank slopes. Conduct a hydrological assessment to correct serious flooding and bank instability; much of the creek's geometry has been altered. Conduct biotechnical streambank stabilization in most severe areas.
- Rock Creek Watershed: Restore the riparian buffer.
- Mill Run Watershed: Restore the riparian buffer. Enforce regulations.
- Abington Country Club to Township Line Road: Re-establish riparian buffer, possibly a 20-ft "no-mow" zone.
- Township Line Road near Foxcroft Road to Main Stem (unnamed tributary): Restore and stabilize some of the undercut and eroded banks.
- Abington Friends School to Township Line Road: Consider restoration of natural riparian buffer and channel along residential areas. Repair eroded areas using naturalized approaches such as native plantings.

- Township Line Road to Tookany Creek Parkway: Replant riparian areas and restore riparian buffer. Enforce regulations. Conduct biotechnical streambank stabilization.
- Cheltenham Avenue to Adams Avenue: Restore creek banks where there is severe undercutting.
- Crescentville and Adams Avenues to Rising Sun Avenue: Restore creek banks where there are exposed roots.
- Rising Sun Avenue to Roosevelt Boulevard: Repair undercut streambanks.
- Roosevelt Boulevard to Whitaker Avenue: Restore creek banks where there is severe erosion.
- Whitaker Avenue to Wyoming Avenue: Restore creek banks and repair restoration site.
- Wyoming Avenue to Castor Avenue: Repair undercut and exposed streambank. Repair manmade restoration project.
- Aramingo Avenue between Wheatsheaf Lane and Church Street: Restore creek banks.
- Holy Sepulchre Cemetery to Ralph Morgan Park: Remove fencing crossing stream; it appears to impede normal flow.

8.2.2 Target B Options: Channel Stability and Aquatic Habitat Restoration

Bed Stabilization and Habitat Restoration (BM1) Related Goals: TK Related Indicators: TK			
What	Who	Where	When
Text to be inserted	Placeholder box	Text to be inserted	Placeholder box

Bank Stabilization and Habitat Restoration (BM2) Related Goals: TK Related Indicators: TK			
What	Who	Where	When
Text to be inserted	Placeholder box	Text to be inserted	Placeholder box

Channel Realignment and Relocation (BM3) Related Goals: TK Related Indicators: TK			
What	Who	Where	When
Text to be inserted	Placeholder box	Text to be inserted	Placeholder box

Plunge Pool Removal (BM4) Related Goals: 5, 7 Related Indicators: 3, 15, 19, 20			
What	Who	Where	When
Remove plunge pools below stormwater and CSO outfalls.	PWD, and municipalities bordering streams recommended for restoration.	Outfalls shown in Figure 8.3.	Begin within 5 years; monthly maintenance schedule to be determined.

When stormwater and combined sewer outfalls discharge directly to the stream channel, they may create deep, poorly mixed pools. Both types of outfalls discharge along the length of the Tookany/Tacony-Frankford and its tributaries (Figure 8.3). Because these pools are typically near the bank and not in the main flow, they can become poorly mixed during low flow. These pools often have increased odors and reduce the aesthetic quality of the stream. Biological activity in the sediment and water column can reduce dissolved oxygen to low levels, and this low-DO water can be flushed out and affect downstream areas during wet weather. The depression of DO is a function of both pollutant loads from the outfalls and in stream baseflow, and the physical condition of the channel. When DO is in an acceptable range in the well-mixed portion of the channel but not in nearby plunge pools, elimination of the plunge pools can eliminate a water quality condition that might affect the aquatic ecosystem.

When possible, outfalls can discharge further up the bank into a wetland or biofiltration area; these areas provide detention, evaporation, cooling, and treatment of pollutant loads in addition to protecting the integrity of the stream channel. Opportunities for creation of these areas (Options BM6 and BM8, respectively) will be discussed later in this section. Where the only place for an outfall to discharge is directly into the stream channel, the area may be protected using appropriate bed and bank stabilization features (Options BM1 and BM2), as discussed above.

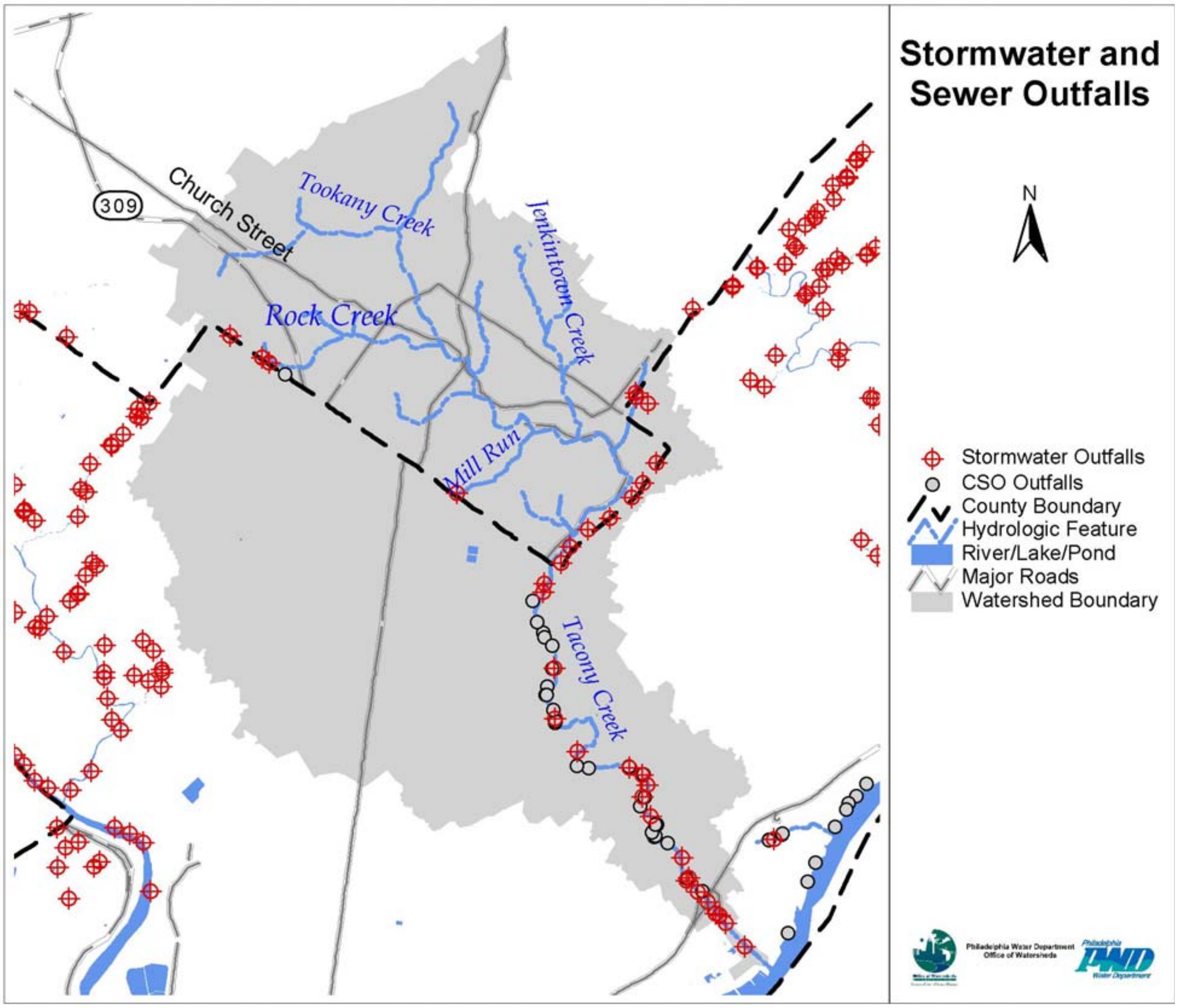


Figure 8.3 Stormwater and CSO Outfalls in the Philadelphia Portion of the Tookany/Tacony-Frankford Watershed

Improvement of Fish Passage (BM5) Related Goals: 1, 6, 7 Related Indicators: 3, 5, 6, 16, 19, 20, 21			
What	Who	Where	When
Assess potential to improve fish migration through dam modification or installation of fish ladders.	PWD; Fairmount Park Commission.	To be determined by future study.	Long-term; after pollutant sources in lower Tacony are addressed.

For the Tookany/Tacony-Frankford Creek, the State-designated aquatic life uses for the non-tidal portion of the creek are Warm Water Fishes (WWF) and Migratory Fishes (MF). The designated recreational water uses also include boating, when surface water flow or impoundment conditions allow; fishing, for recreation and/or consumption; water contact sports; and aesthetics.

Investigation and restoration of fish migration is recommended as a long-term goal. However, areas of low dissolved oxygen (DO) have been identified south of Castor Avenue. Further investigation and remediation of this problem is recommended as a short-term goal; efforts to remove barriers to fish migration will not succeed in restoring populations until water quality conditions are sufficient to support fish.

The River Conservation Plans (RCPs) noted the following:

- Township Line Road to Tookany Creek Parkway: Work with landowner to remove wooden plank to allow fish to pass through.

8.2.3 Target B Options: Lowland and Upland Restoration and Enhancement

Wetland Creation and Enhancement (BM6) Related Goals: 1, 2, 3, 4, 5, 7 Related Indicators: 1, 2, 3, 4, 7, 8, 9, 15, 19			
What	Who	Where	When
Wetland creation and enhancement for flood flow alteration, groundwater recharge, increased habitat, increased plant and animal diversity, and improved water quality.	PWD; Fairmount Park Commission. Municipalities bordering streams recommended for restoration.	Recommended locations for floodplain wetland creation; areas for pocket wetland creation need to be field determined, based on where they are adjacent to lands proposed for stream realignment and bank restoration (see Figure 8.5).	Prototype design and evaluation phase, followed by upstream creation/enhancement in years 1-5; downstream implementation over two 10-year phases.

One high-priority riparian corridor improvement action, from both an ecological and water quality improvement perspective, is creation and enhancement of wetlands along the Tookany/Tacony-Frankford Creek. The Fairmount Park Commission has proposed four vegetation restoration sites along the creek, two of which are wetland sites. The Tookany/Tacony-Frankford Creek subwatersheds were field surveyed in 2002/2003 to assess wetland improvement opportunities for existing wetlands, and wetland creation opportunities for new locations. Existing wetlands were evaluated for their ability to perform important wetland functions (e.g., flood flow alteration, water quality improvement, and habitat), where degraded actions were evaluated to improve compromised functions. Existing wetlands were then assessed to determine if they might be effectively expanded. Finally, locations where new wetlands could be created were identified. New wetland creation opportunities were classified into two groups:

- Wetlands immediately adjacent to the waterway and which would receive flood flows frequently during the year (< one year storm); and
- Pocket wetlands that can be created using checkdams that are higher in the landscape and that would receive stormwater flows from adjacent subwatershed areas, but would receive flood flows only from major storm events.

Wetlands Enhancement

The wetland field investigations for the TTF Watershed rated the opportunity to improve and expand existing wetlands, by evaluating opportunities to reconnect the wetland to the waterway, to receive additional overland flows, to remove sources of encroachment, and to expand the size of the wetlands. Nearly all the 24 existing wetlands exhibited potential for functional improvement through hydrologic improvements, re-vegetation, or reducing historic disturbance. The field analysis indicates significant opportunity for wetland improvement, as shown in Table 8.12 and Figure 8.4.

Table 8.12 Wetland Improvement Potential

Wetland Improvement Potential	
Improvement Rating	*Wetland Areas*
High	15
Moderate	8
Low	1

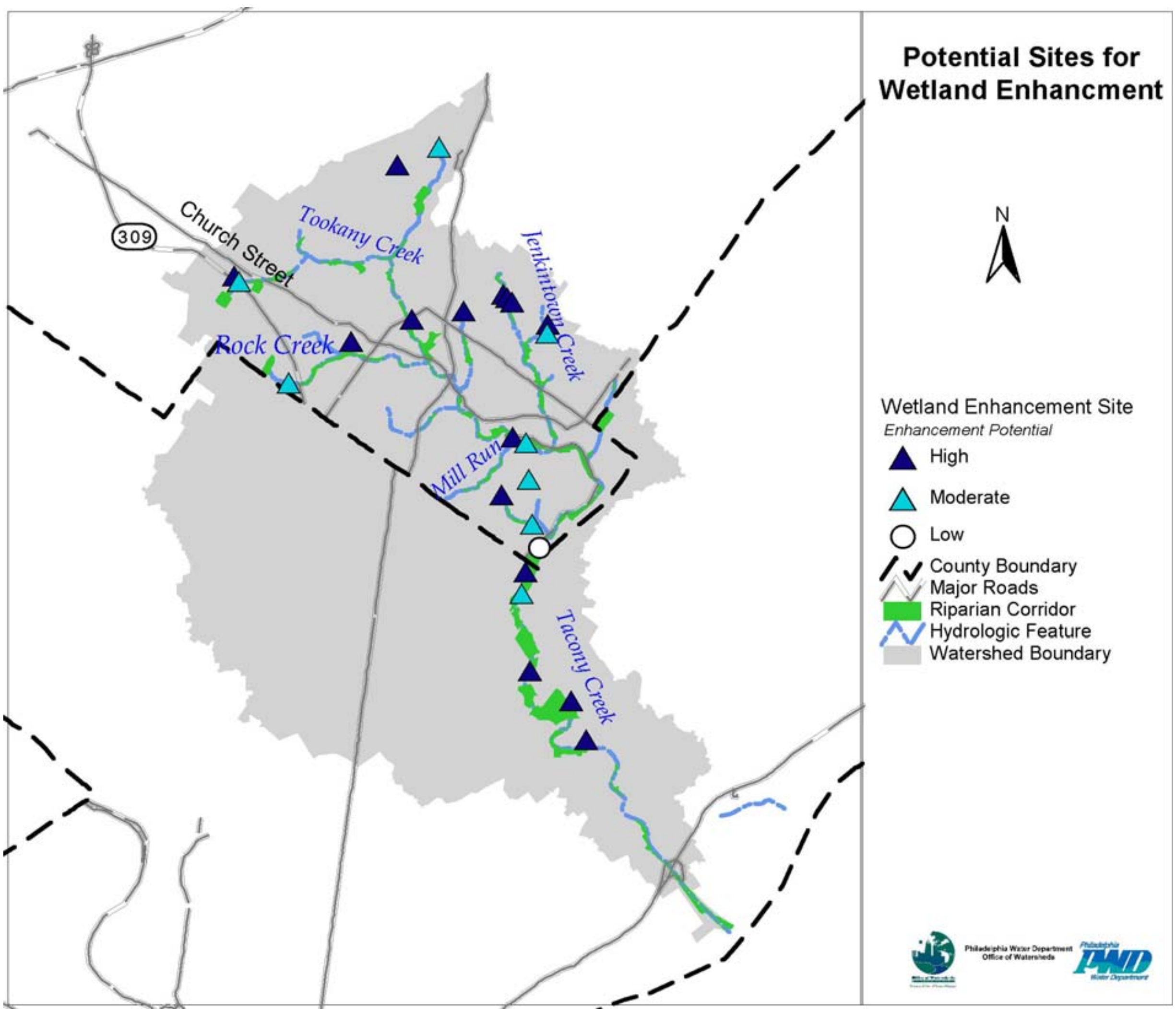


Figure 8.4 Potential Sites for Wetland Improvement

While there are many opportunities for wetland improvement, there is only limited opportunity for wetland expansion. The total potential estimated increase in wetland area for the moderate and high potential wetland sites was limited to less than 3 acres, increasing the existing inventory from about 15 acres to 18 acres. Greater opportunity for increasing wetland acreage is available from wetland creation/re-creation activities.

Wetlands Creation

The wetland field analysis also included an evaluation of potential opportunities for wetland creation along the riparian corridor. The evaluation of wetland creation potential was focused on the physical potential (undeveloped land area present, proximity to waterway, position in landscape) and did not address institutional or ownership factors.

Because stream relocation and realignment typically involve extensive grading and replanting, new runoff patterns and hydrology can be created that are more similar to original riparian conditions, whereby riparian corridor wetlands could receive storm runoff sheet flow from the adjacent landscape. In addition, wetland habitats can be created that allow more diverse habitat. Wetlands are rich habitats that rely on saturated soils and vegetation adapted to these conditions. They could be recreated concurrently with channel realignment, bank restoration, and planting of more diverse native vegetation, including hydrophytic species adapted to saturated soil conditions.

Wetlands must have an adequate input of water, either by flooding or runoff, to maintain the soil and vegetation characteristics that are unique to wetlands. Field investigation of wetlands revealed, however, that several factors constrain the creation of extensive areas of new wetland. These include:

- Extensive urban and suburban encroachment into the riparian corridor;
- Competing active recreational uses along the waterway; and
- Steep slopes adjacent to the waterway limiting potential for floodplain hydrology.

Field estimates indicate that over 24 acres of wetland might be created in 26 separate creation locations. This would result in a more than 150% increase in wetland acreage along the riparian corridor. If wetland expansion potential were also included, the wetland acreage along the riparian corridor could be increased by 175% to about 42 acres. These estimates represent a highly optimistic wetland expansion scenario, but indicate the significant potential to at least double the area of wetland along the riparian corridor. These wetland creation locations are identified in Figure 8.5 below.

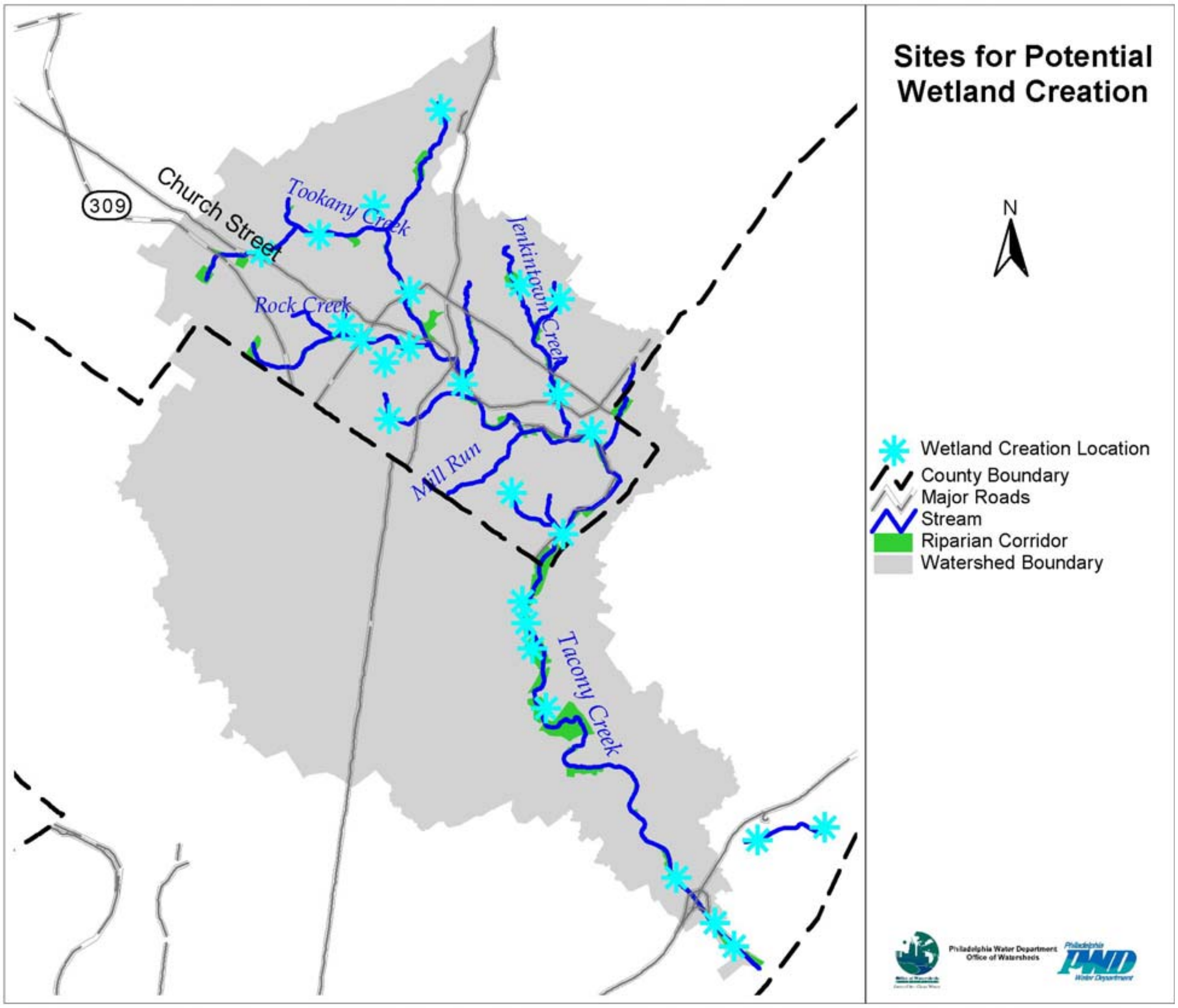


Figure 8.5 Potential Sites for Wetland Creation

In general, priority will be given to wetland creation and improvement over reforestation of uplands because of the greater water quality benefits provided by wetlands.

As noted above, two types of wetland creation are recommended: floodplain wetlands and pocket wetlands. There are numerous opportunities for creation of pocket wetlands throughout the watershed; as stormwater runoff from the adjacent subwatershed is redirected over the riparian landscape, checkdams and piping may be used to spread the runoff over the vegetated riparian land surface. More specific locations for creating pocket wetlands will need to be evaluated in the future as the riparian corridor restoration design is developed during the facilities planning stage. This is because opportunities for creation of pocket wetlands arise from bank restoration, revegetation, and biofiltration actions that will be implemented as part of the integrated riparian corridor improvement strategy for the TTF Watershed.

Both floodplain wetlands and pocket wetlands offer significant opportunity for water quality and ecological improvement along the Tookany/Tacony-Frankford Creek riparian corridor, and both will play a central role as the design of the riparian corridor improvements is developed.

Assuring long term success for wetland creation projects will involve future monitoring to measure integration of the wetland into the riparian landscape and to correct defective conditions, where possible. However, proper design of the wetland to assure adequate input of water (via flooding or runoff), protection from erosion, and maintenance of the diverse planted vegetation is essential to long-term success. Wetland creation projects typically involve monitoring and maintaining the created wetland's hydrology, vegetation (including invasive species, discussed below), and erosion characteristics for a period of three years following creation.

Further investigation of all potential wetland enhancement and creation opportunities should include the following: identification of landowners, rainfall data collection and evaluation, runoff calculations, soils investigation, water budget, native species investigation, and groundwater/soil saturation monitoring.

Invasive Species Management (BM7) Related Goals: 4 Related Indicators: 12, 13, 14, 19			
What	Who	Where	When
Implement an Invasive Species Management Plan (already in effect in Fairmount Park).	PWD; Fairmount Park Commission.	Lowland and upland habitat restoration sites.	Within 5 years.

A plan to control invasive plant species is necessary when restoring or enhancing wetlands and riparian forests. Invasive species provide little value to native animals that depend on native species for habitat and food. Japanese knotweed (*Polygonum cuspidatum*) is one prevalent invasive species that was observed during the field reconnaissance. In many areas, knotweed, due to its aggressive nature, has already out-competed native vegetation. Maintaining a healthy riparian plant community along Tookany/Tacony-Frankford Creek will retain biodiversity and support a healthy stream ecosystem.

The Fairmount Park Commission has implemented an invasive species control program in the Fairmount Park portion of the stream corridor. It is recommended that invasive species control be expanded to the remaining natural areas of the corridor. Implementation of an invasive species management plan would assist natural succession within the riparian buffer and decrease further impacts of invasive species.

Planting plans for all restoration efforts should complement the invasive species management plan by recommending appropriate native planting to supplement areas where invasives have been eliminated. Although invasive species management priority areas are considered those that contain 80% or greater invasive species, the most practical approach is to recommend invasive species management be implemented for all riparian restoration sites. An invasive species management plan will require, at a minimum, a three-year commitment to ensure success.

The River Conservation Plans (RCPs) highly recommend removing invasives and replant native vegetation. The most common invasive was Japanese knotweed. Specific sites noted include:

- Holy Sepulchre Cemetery to Ralph Morgan Park**:** Control invasive plants and replant with natives.
- Ralph Morgan Park to Greenwood Avenue: Remove Japanese Knotweed and replant with natives. Remove invasive vines from trees.
- Greenwood Avenue to Wyncote Post Office: Remove invasive plants from banks and replant with natives.
- Washington Lane Underpass to Church Road: Remove invasive vines from trees and knotweed. Replant native shrubs and groundcover.

- Church Road at Chelten Hills Drive to Church Road near Ogontz Field: Remove knotweed and other invasives. Replant a native buffer zone.
- High School Park to Ashbourne Road along the Tookany Creek Parkway: Eradicate invasive plants and replant with natives.
- Unnamed Tributary in Glenside: Clear knotweed.
- Baeder Creek Watershed: Eradicate invasives and replant natives.
- Rock Creek Watershed: Plant creek banks with natives to prevent invasives from dominating.
- Mill Creek Watershed: Eradicate invasives plants and replant with natives.
- Cheltenham Avenue to Adams Avenue: Remove invasives and replant with natives.
- Crescentville and Adams Avenues to Rising Sun Avenue: Remove invasives and replant with native plants.
- Rising Sun Avenue to Roosevelt Boulevard: Remove invasives and replant with native plants.
- Roosevelt Boulevard to Whitaker Avenue: Remove invasives and replant with native plants.
- Whitaker Avenue to Wyoming Avenue: Remove invasives and replant with native plants.
- Wyoming Avenue to Castor Avenue: Remove invasives and replant with native plants.
- Castor Avenue to Erie Avenue: Remove Japanese knotweed.
- Aramingo Avenue between Wheatsheaf Lane and Church Street: Remove Japanese knotweed.
- Rohm & Haas, 5000 Richmond Street: Remove invasives.

Biofiltration (BM8) Related Goals: 1, 2, 3, 5, 7 Related Indicators: 1, 2, 3, 4, 15, 19, 20			
What	Who	Where	When
Biofiltration involves creating sheet flow over the vegetated landscape to slow the rate of runoff, facilitate groundwater recharge, and remove sediment, nutrients, and toxicants from the runoff.	PWD; Fairmount Park Commission.	Throughout Tookany/Tacony-Frankford riparian corridors; focus on vegetated landscape.	Two 10-year implementation phases (high and medium priority).

The goal of the Tookany/Tacony-Frankford Creek riparian corridor improvement strategy is to identify all opportunities along the riparian corridor for natural landscape designs that achieve water quality improvement. For higher landscape positions at the outer edges of the riparian corridor there are extensive opportunities to implement biofiltration to improve runoff. Biofiltration involves creating sheet flow over the vegetated landscape to slow the rate of runoff, facilitate groundwater recharge, and remove sediment, nutrients, and toxicants from the runoff. Typical biofiltration approaches include installation of stormwater swales and checkdams along natural drainage-ways that spread runoff, creation of bioretention plantings and hydrology, and creation of hydrologic features that allow sheet flow to spread over grassed and shrub/scrub fields to achieve water quality improvement. The advantage of biofiltration is that it is compatible with recreational use of the riparian corridor, because flows are very shallow and are usually present only during rainfall events.

Analysis of the existing stormwater management in the Tookany/Tacony-Frankford Watershed shows that most stormwater outfalls discharge directly to the waterway. However, if the stormwater was redirected over the vegetated landscape higher in the stream valley, it would follow the natural slope and land contour as it traveled down to the stream. There are over 685 acres of undeveloped land along the Tookany/Tacony-Frankford Creek riparian corridor, but almost none of that land carries runoff sheet flow because the stormwater piping system conveys all flows, from storms large and small, directly to the stream. In order to achieve water quality improvement goals, it is important to optimize the ability of this vegetated riparian land to receive overland runoff, rather than piping the runoff directly into the stream.

Biofiltration has an effectiveness range of about 25-60% in removing suspended solids from runoff, and the concept of directing runoff to sheet flow over the vegetated riparian landscape matches fully with the way that such lands function naturally in an undeveloped watershed. Thus, the goal of biofiltration is to restore sheet flow of runoff over the landscape, by using piping and hydraulic controls to spread runoff from smaller storms over the vegetated surface. To avoid erosion, it is essential that the design for biofiltration provide for high velocity flows from major storms to be bypassed.

Reforestation (BM9) Related Goals: 1, 2, 4, 5, 6, 7 Related Indicators: 1, 2, 4, 12, 13, 16, 18, 19			
What	Who	Where	When
Reforestation adjacent to the channel to provide wetland habitat and other associated benefits.	PWD; Fairmount Park Commission. Municipalities bordering streams recommended for restoration.	Priority reforestation sites: lands adjacent to the creek that are not developed and are currently unforested. Potential reforestation sites are existing ball fields, golf courses, hospital grounds, seminaries, and cemeteries located adjacent to the channel. These should also be evaluated.	Begin within 5 years; monthly maintenance schedule to be determined.

The riparian corridor restoration and enhancement plan being proposed in this section covers the width of the stream corridor from developed edge to developed edge, including both lowland and upland forest. Reforestation that occurs adjacent to the channel will provide wetland habitat and other associated benefits. Although priority reforestation areas consist of floodplains, steep slopes, and wetlands, smaller areas such as public rights-of-way, parks, schools, and neighborhoods also provide reforestation opportunities. Benefits of reforestation are numerous: cooler temperatures, rainfall interception, reduced runoff, reduced sediment load, reduced discharge velocities, increased groundwater recharge, increased species diversity and habitat, and improved air quality and aesthetics.

At this time, only the recommendations from the River Conservation Plans (RCPs) are available. These include:

- Washington Lane Underpass to Church Road: Have SEPTA plant low growing shrubs in the areas of the bird sanctuary to develop wildlife habitat.
- Unnamed Tributary in Glenside: Partner with SEPTA to plant native vegetation that is in keeping with their track maintenance requirements in order to reduce NPS pollution and stabilize soil to prevent erosion and downstream sedimentation.

8.2.4 Target B Options: Monitoring and Reporting

Monitoring, Reporting, and Further Study (BMR) Related Goals: 1, 2, 3, 4, 5, 6, 7 Related Indicators: all indicators relevant to Target B			
What	Who	Where	When
Monitoring of implementation and benefits for all Target B options. Creation of a Tookany/Tacony-Frankford Stream Corridor Restoration Master Plan.	PWD; Fairmount Park Commission; municipalities bordering streams.	All implementation sites.	Monitoring and reporting to begin immediately and continue throughout the life of the plan. Master Plan creation within 5 years.

The preceding sections are a first step in identifying proposed projects that can lead to comprehensive stream corridor restoration. However, additional planning is needed to ensure that individual projects do not interfere with one another. For example, realignment of a stream section might eliminate a proposed wetland or reforestation site; or removal of a dam might increase stream velocity and erode restored streambanks or eliminate flow of water to a riparian wetland. Creation of a more detailed Restoration Master Plan for the stream corridor is necessary before individual projects can proceed. This plan will be primarily graphical and will identify boundaries and key elevations for existing features and proposed projects. Detailed designs on individual projects will be required to be consistent with the Master Plan. The plan will show the following on a single map:

- Proposed stream bank stabilization and bed stabilization;
- Proposed stream realignment and relocation;
- Proposed dam modification or fish ladder sites;
- Stream obstructions proposed for further study or removal;
- Existing wetlands; proposed wetland creation and enhancement;
- Existing habitat not to be disturbed, including threatened or endangered species;
- Proposed reforestation and habitat creation areas;
- Existing and proposed upland BMPs (biofiltration); and
- Key recreation and access facilities (trails, parking lots).

Before habitat restoration is recommended, however, water quality problems that might now be the cause of poor fish species diversity must be better investigated, and eventually solved.

8.3 Target C: Wet Weather Water Quality and Quantity

Target C must be approached somewhat differently from the first two targets. Full achievement of this target means meeting all water quality standards during wet weather, as well as eliminating all flooding. Clearly, that will be difficult, particularly with regard to wet weather water quality. It would certainly be extremely expensive, and would require a long-term effort. The only rational approach to full achievement of Target C goals is through stepped implementation with interim targets for reducing wet weather pollutant loads and stormwater flows. During implementation, monitoring must continuously assess the effectiveness of the program. Based on the extensive modeling analysis carried out for Tookany/Tacony-Frankford Creek to date, an initial goal of a 20-25% reduction in stormwater flows and stormwater/CSO related pollutant loads has been identified as a challenging but achievable goal. The stakeholders have identified Mill Creek (also called Mill Run) as a priority area for stormwater control.

It is expected that changes to the approach required to meet Target C, and even to the desired results, will occur as measures are implemented and results are monitored. With most discharge permits of five-year duration, discharge targets and reduction targets must be set and implementation designed in the first five years. Implementation for meeting Target C will begin over the next five years with Targets A and B, while monitoring for effectiveness in order to utilize an adaptive management approach for subsequent years to achieve full implementation of Target C. During the final five-year period, PWD should also work with the regulatory agencies to review water quality standards and determine whether any adjustments to them may be appropriate based on the results of monitoring.

Below are the Target C options that were "recommended" (either fully or conditionally) in Section 7. Most of these options are described in detail in the pages that follow.

Section 8.3.1 **<u>Regulatory Approaches</u>**

- *CR2* Requiring Better Site Design in Redevelopment
- *CR3* Stormwater and Floodplain Management
- *CR4* Industrial Stormwater Pollution Prevention
- *CR5* Construction Stormwater Pollution Prevention
- *CR6* Post-Construction Stormwater Runoff Management
- *CR8* Use Review and Attainability Analysis
- *CR9* Watershed-Based Permitting

Section 8.3.2 **<u>Public Education and Volunteer Programs</u>**

- *CP1* Public Education and Volunteer Programs

Section 8.3.3 **<u>Municipal Measures</u>**

- *CM1* Sanitary Sewer Overflow Detection
- *CM2* Sanitary Sewer Overflow Elimination: Structural Measures
- *CM3* Reduction of Stormwater Inflow and Infiltration to Sanitary Sewers
- *CM4* Combined Sewer Overflow (CSO) Control Program
  - Nine Minimum Controls
  - Long Term CSO Control Plan
  - Watershed-Based Planning
- *CM5* Catch Basin and Storm Inlet Maintenance
- *CM6* Street Sweeping

CM7 Responsible Landscaping Practices on Public Lands
CM9 Responsible Bridge and Roadway Maintenance

Section 8.3.4 Stormwater Management

Source Control Measures

CS1 Reducing Effective Impervious Cover Through Better Site Design
CS2 Porous Pavement and Subsurface Storage
CS3 Green Rooftops
CS4 Capturing Roof Runoff in Rain Barrels or Cisterns
CS5 Increasing Urban Tree Canopy

Onsite and Regional Stormwater Control Facilities

CS6 Maintaining/Retrofitting Existing Stormwater Structures
CS8 Retrofitting Existing Sewer Inlets with Dry Wells
CS9 Residential Dry Wells, Seepage Trenches, and Rain Gardens
CS12 Bioretention Basins and Porous Media Filtration
CS13 Treatment Wetlands: Onsite and Regional

Section 8.3.5 Monitoring and Reporting

CMR Monitoring, Reporting, and Further Study

Table 8.13 Maximum Feasible Reductions for BMPs with Quantifiable Benefits

Target C	Maximum Feasible Implementation	Volume Reduction		Pollutant Reduction
		CSO	Stormwater	
Municipal Measures				
CM4 Combined Sewer Overflow (CSO) Control Program				
Real Time Control	2 sites	5.9%	N/A	6.1%
Stormwater Management				
Source Control Measures				
CS1 Reducing Impervious Cover Through Better Site Design	1% reduction in DCIA	0.5%	0.5%	1.0%
CS2 Porous Pavement and Subsurface Storage	50% of parking lots	8.0%	3.3%	11.6%
CS3 Green Rooftops	5% of rooftops	1.8%	0.9%	2.7%
CS4 Capturing Roof Runoff in Rain Barrels or Cisterns	10% of homes	1.4%	0.1%	1.8%
CS5 Increasing Urban Tree Canopy	5% of watershed area	0.3%	0.3%	0.5%
Onsite and Regional Stormwater Control Facilities				
CS8 Retrofitting Existing Sewer Inlets with Dry Wells	100% of inlets	6.9%	0.3%	7.5%
CS9 Residential Dry Wells, Seepage Trenches, Rain Gardens	school grounds; 25% of homes	5.7%	0.8%	10.4%
CS12 Bioretention Basins and Porous Media Filtration	50% of parking lots	6.3%	2.1%	11.6%
CS13 Treatment Wetlands: Onsite and Regional	100% of identified potential	1.4%	0.4%	2.5%

8.3.1 Target C Options: Regulatory Approaches

Requiring Better Site Design in Redevelopment (CR2) Related Goals: 1, 2, 4, 7 Related Indicators: 1, 12, 13, 16, 19, 20			
What	Who	Where	When
Adopt or improve ordinances to encourage developers to use low impact methods for new ("greenfield") development and redevelopment of urban areas.	See Table 8.14 (may not identify all municipalities with ordinances).	Entire watershed.	Within 5 years; update as needed.

Environmentally friendly site design, also called low impact development (LID) and conservation site design, encompasses a range of site design elements for developers, and design requirements from municipalities. Some examples of LID design concepts include maintaining stream buffers, designing for open space, reduced street and sidewalk footprints where appropriate, and parking lot designs that reduce runoff and encourage infiltration. Stormwater source controls, infiltration BMPs, and treatment BMPs can be integrated with LID designs. Recommendations for incorporating these features in the Tookany/Tacony-Frankford Watershed are found throughout Target C.

LID is intended to reduce the impact of development on natural resources and water resources. Municipal design requirements are intended to preserve or increase open space, protect sensitive natural resources, and limit impervious cover. The environmental goals of land development and stormwater ordinances are closely related, although the ordinances themselves and mechanisms for enforcing them may be separate.

It appears that some of the municipalities in the Tookany/Tacony-Frankford Watershed encourage several standard low impact development practices through their existing land use ordinances. However, these guidelines tend to focus on clustering housing by allowing higher-density multi-family residential developments with common open spaces. Separate language focusing specifically on the protection of natural resources is recommended. While some municipalities in the watershed have already adopted a steep slope ordinance, Abington and Cheltenham Townships are currently the only municipalities within the watershed with cluster development ordinances and non-binding wetlands protection ordinances in place. Table 8.14 demonstrates that all municipalities located in the watershed have adopted some aspects of low impact development.

Table 8.14 Better Site Design in Existing Ordinances

Municipality	Better Site Design Ordinance (at least one component)	Comments
Abington Township	X	Cluster development for residential zoning districts; max. impervious cover by zoning type; wetlands conservation; steep slope conservation overlay district.
Cheltenham Township	X	Planned cluster development; open space requirements; designated wetlands; steep slope conservation district.
Jenkintown Borough	X	Minimum street, sidewalk widths; maximum grades; non-binding guidelines for density and open space.
Philadelphia County	X	Max. impervious cover requirements; minimum street, driveway widths.
Rockledge Borough	X	Max. impervious cover requirements by zoning type.

Source: www.ordinance.com, *Delaware Valley Regional Planning Commission*

The Delaware Valley Regional Planning Commission (DVRPC) has recently completed the task of reviewing the municipal zoning ordinances of the Delaware Valley's 353 municipalities. Based upon this analysis, DVRPC has created a list of "outstanding sample natural resource and open space protection ordinances." These model ordinances as well as additional information on DVRPC's program are available at these sites:

- DVRPC Natural Resource Protection Information:
  http://www.dvrpc.org/planning/community/ProtectionTools.htm

- Model Ordinances:
  http://www.dvrpc.org/planning/community/ProtectionTools/ordinances.htm

Guidelines for LID in an Urban Setting

Table 8.15 (see below) identifies various zoning ordinances that could be adopted by the municipalities in the Tookany/Tacony-Frankford Watershed. While some municipalities already incorporate elements of these zoning measures within their existing code, it is recommended that ordinances specific to low impact development be adopted to better facilitate future growth and redevelopment. Model ordinances for each of these examples are available on the DVRPC website at the address listed above.

Table 8.15 Selected Components of Low Impact Development Ordinances

Municipal Zoning Ordinance	Description
"Net-Out" of Resources / Site Capacity Calculations	Protect wetlands, floodplains, and riparian buffers by removing them from the area considered for new development and redevelopment. In calculating the developable area, environmentally sensitive areas should be excluded. Some local governments allow increased densities in the remaining developable land area to provide an incentive for protecting sensitive environments. Existing trees should be protected if possible; if not, the land owner may contribute to a mitigation fund for each tree cut down.
Wetlands Management Ordinance	Protects environmentally sensitive wetlands areas. This ordinance usually requires wetlands delineation within the municipality and prohibits any type of development in a delineated wetland area.
Cluster Development Ordinance	Allows developers to build at higher densities on one portion of a site in exchange for preserving another portion as open space. Land preservation percentages and densities vary, but the preferred percentage is for at least 50% of the tract to remain as open space. Achieving a landowner's financial objectives may be a function both of partial development and donation of a conservation easement (and its inherent deductibility under the federal tax code).
Planned Residential Development (PRD)	Facilitates residential development in areas designated by the municipality. Provisions are made for higher housing densities, thereby creating larger contiguous common open spaces, and providing for pedestrian access between residential areas.
Steep Slope Ordinance	Regulates development on areas designated as steep slopes. The minimum gradient classified as steep varies by municipality, but, according to DVRPC, 8% is typical.
Transfer of Development Rights (TDR)	Designates areas of a municipality as "sending" and "receiving" areas. Allows community to preserve open space and natural features while still permitting growth. Development is moved from large tracts of rural land (sending area) to areas designated for higher densities (receiving area).

While the measures above were originally intended for new development, they may be adapted for larger redevelopment projects in urban areas. Older areas often have large areas of vacant and abandoned properties that may be demolished all at once, creating significant open space. Cluster development, for example, could be applied on these larger sites.

In addition to the specific ordinances above, municipalities should require, or provide strong incentives for, innovative site design when urbanized areas are redeveloped. Effective conservation design techniques to consider include the following:

- Review municipal codes for any minimum size requirements for impervious surfaces, such as road and sidewalk widths. Review any stipulation of a minimum size lot that development and stormwater ordinances apply to. In the City of Philadelphia, the ordinance requiring all downspouts to be connected directly to the sewer system is not appropriate in all cases; wherever feasible, infiltration (e.g., using dry wells) should be encouraged over disposal of stormwater to combined or separate storm sewers.

- Depending on the zoning classification, specify a maximum effective impervious cover allowed after construction. Many publications recommend that impervious cover connected directly to the drainage system be limited (see Section 8.3.4, Option CS1, "Reducing Effective Impervious Cover through Better Site Design," for specific recommendations). Developers are then free to choose a combination of methods to meet the requirement: an absolute reduction in impervious cover, directing runoff onto depressed landscaped areas, tree credits, and structural BMPs. Consider incentives in the stormwater control calculations to reduce directly connected impervious surfaces.

- For areas experiencing redevelopment, structural stormwater controls may be tied to the impervious area calculations discussed above. Developers have an incentive to reduce impervious area because it may be more cost effective than installing structural stormwater BMPs. Specific recommendations for stormwater ordinances are discussed below, under Option CR3, "Stormwater and Floodplain Management."

- Promote discussions early in the development review process at the sketch plan/conceptual plan level (before developers have spent large sums of money on design and engineering). A number of municipalities around the U.S. have concluded that sketch/conceptual plans are more important in the planning process than preliminary plans because early intervention and change allows greater opportunity to include innovative low impact development designs. Some municipalities have opted to eliminate the final plan and accept the preliminary plan as the final plan as an incentive to developers to participate.

- After the final plan is submitted, require a pre-construction meeting and a site visit to discuss construction issues and pollution prevention.

- Consider incentives in addition to regulations; for small sites, incentives alone may be sufficient. For example, award density or stormwater control bonuses for reducing impervious cover. Streamline project reviews and waive permit fees when conservation design objectives are met. Tie stormwater fees and/or property taxes to impervious cover and stormwater management practices.

The River Conservation Plans (RCPs) noted the following:

- Church Road at Chelten Hills Drive to Church Road near Ogontz Field: For areas that are redeveloped, landscape architects should design a more natural buffer zone.

Stormwater and Floodplain Management (CR3) Related Goals: 1, 2, 3, 4, 5, 7 Related Indicators: 1, 2, 12, 13, 15, 19, 20			
What	Who	Where	When
Participate in finalization of the watershed-wide Act 167 plan and model ordinance being developed in the watershed. Adopt and enforce the model ordinance.	Counties to adopt plan and ordinance first, followed by all municipalities (see Table 8.16).	Entire watershed.	Begin within 5 years; update as needed.

Table 8.16 identifies the municipalities in the Tookany/Tacony-Frankford Watershed that currently have a floodplain protection or stormwater ordinance in place.

Table 8.16 Floodplain and Stormwater Ordinances in the TTF Watershed

Municipality	Floodplain Ordinance	Stormwater Ordinance	Erosion and Sedimentation Control	Comments
Abington Township	X	X	X	Stormwater design requirements; floodplain conservation district; erosion and sedimentation control plan.
Cheltenham Township	X	X	X	Storm drainage requirements; floodplain conservation district; soil erosion and sediment control (DEP Manual compliance).
Jenkintown Borough	X	X	X	Storm drainage design requirements; floodplain conservation district; erosion and sedimentation control measures required (no description).
Philadelphia County	X	X	X	Stormwater management controls; erosion and sedimentation control measures – engineer required.
Rockledge Borough				No stormwater/floodplain ordinances; all development served by public sewer and public water.

Source: www.ordinance.com, *Delaware Valley Regional Planning Commission*

The majority of municipalities in the watershed have adopted ordinances limiting development in the floodplain or designating a floodplain conservation district. The protection offered varies by municipality, but an effective ordinance should place controls on land development within the 100-year floodplain as well as limit development within riparian corridors. EPA posts a model floodplain preservation ordinance at: www.epa.gov/owow/nps/ordinance/osm1.htm

Philadelphia and Montgomery Counties are cooperating to develop an official Act 167 Stormwater Management Plan and model ordinance. The model ordinance will specify measures that must be undertaken to promote infiltration, improve water quality, reduce streambank erosion rates, and protect against flooding. These requirements will apply to both new (also called "greenfield") development and redevelopment (including brownfields or former industrial sites), and to both separate-sewered and combined-sewered areas. The plan and model ordinance shall be completed with county and municipal input by late 2007.

Adoption and implementation of the model ordinance is a critical step that will allow municipalities to begin implementing many of the wet weather management measures mentioned later under Target C. For example, the ordinance may require a specific storage volume to be created on a developed site and may indicate that it must be a BMP capable of water quality treatment. The developer will then consult a state or local stormwater manual designated by the municipality to determine an appropriate BMP and appropriate design criteria.

While many of the state manuals provide excellent guidance for new development, PWD plans to develop a manual with guidance for redevelopment projects given local conditions. Some preliminary ideas for this BMP manual are listed below.

Commercial/Industrial Land Uses

1. Encourage better site design techniques, impervious cover disconnection, and tree credits to decrease impervious cover directly connected to the drainage system.
2. Directly-Connected Parking Lots:
   - Encourage a bioretention system if sufficient space is available to meet parking needs.
   - In highly urban areas where adding landscaping is not possible, encourage porous pavement (or other drainage mechanism) and subsurface storage if feasible.
3. Directly-Connected Rooftops:
   - If parking lot storage is installed, recommend routing rooftop drainage to the storage.
   - If parking lot storage is not feasible, route rooftop drainage to dry wells. If dry wells are not feasible, route rooftop drainage to rain barrels or tanks.
   - Other approaches may be proposed and considered on a case-by-case basis.

Residential Land Uses

1. Encourage better site design techniques, impervious cover disconnection, and tree credits to decrease impervious cover directly connected to the drainage system.
2. Route roof runoff to dry wells if feasible. If dry wells are not feasible, route rooftop drainage to rain barrels or tanks.
3. Other approaches may be proposed and considered on a case-by-case basis.

The River Conservation Plans (RCPs) recommend the following:

- Holy Sepulchre Cemetery to Ralph Morgan Park: Purchase properties in floodplain to convert land to open space.
- Mill Creek Watershed: Relocate or purchase then demolish structures in the floodplain.
- Church Road at Chelten Hills Drive to Church Road near Ogontz Field**:** Assess upstream issues to see why Shoemaker Road area floods more.

Industrial Stormwater Pollution Prevention (CR4) Related Goals: 1, 2, 3, 7 Related Indicators: 1, 2, 3, 4, 7, 8, 9, 10, 19, 20			
What	Who	Where	When
Enforcement of NPDES requirements for Industrial Stormwater Management. Dissemination of information on spill prevention and pollution prevention plans.	PA DEP is the Designated Authority responsible for issuing, administering, and enforcing NPDES permits. Municipalities are responsible for information dissemination.	All sites contributing stormwater discharges associated with industrial activity within the watershed.	Within 5 years.

Industrial stormwater pollution prevention measures can contribute significantly to achieving the watershed plan's wet weather implementation targets. These measures include monitoring and enforcing existing industrial stormwater permit requirements under Phase I of the NPDES program, as well as Official Industrial Pollution Prevention Plans and Spill Response Actions required by the state. Full implementation of these measures should be monitored and enforced throughout the watershed.

NPDES Industrial Stormwater Permits

All sites contributing stormwater discharges associated with industrial activity, defined in federal regulations (40 CFR §§ 122.26(b)(14)(i)-(xi)), are required to be covered under Phase I of the NPDES stormwater program. This includes discharges from any conveyance that is used for collecting and conveying stormwater and that is directly related to manufacturing, processing, or raw materials storage areas at an industrial plant. This includes, but is not limited to, stormwater discharges from industrial plant yards; immediate access roads and rail lines used or traveled by carriers of raw materials, manufactured products, waste material, or by-products used or created by the facility; material handling sites; refuse sites; sites used for the application or disposal of process waste waters; sites used for the storage and maintenance of material handling equipment; sites used for residual treatment, storage, or disposal; shipping and receiving areas; manufacturing buildings; storage areas (including tank farms) for raw materials, and intermediate and final products; and areas where industrial activity has taken place in the past and significant materials remain and are exposed to stormwater. The term "material handling activities" includes storage, loading and unloading, transportation, or conveyance of any raw material, intermediate product, final product, by-product, or waste product.

The PA DEP is the Designated NPDES Authority responsible for issuing, administering, and enforcing NPDES stormwater permits under the EPA's regulatory provisions set forth in 40 CFR.

Stormwater discharges from most industrial facilities are covered under General Permits when they discharge into municipal separate sanitary sewers. General NPDES permits have a fixed term not to exceed five years. An operator of a stormwater discharge associated with industrial activity which discharges through a large or medium municipal separate storm sewer system shall submit, to the operator of the municipal separate storm sewer system receiving the discharge, the following information: the name of the facility; a contact person and phone number; the location of the discharge; a description, including Standard Industrial Classification, which best reflects the principal products or services provided by each facility; and any existing NPDES permit number.

In addition, the operator of a stormwater discharge associated with industrial activity covered under a general, group, or individual permit, shall provide the following minimum information (40 CFR § 122.26 (c)(i)):

- A site map showing topography, drainage features, buildings, and areas where materials or activities may contribute pollutants to stormwater.
- An estimate of the area of impervious surfaces (including paved areas and building roofs) and the total area drained by each outfall (within a mile radius of the facility) and a narrative description of materials handled or stored as well as measures taken to control pollutants in the runoff.
- A certification that all outfalls that should contain stormwater discharges associated with industrial activity have been tested or evaluated for the presence of non-stormwater discharges which are not covered by a NPDES permit. Tests for such non-stormwater discharges may include smoke tests, fluorometric dye tests, analysis of accurate schematics, as well as other appropriate tests. The certification shall include a description of the method used, the date of any testing, and the onsite drainage points that were directly observed during a test.
- Existing information regarding significant leaks or spills of toxic or hazardous pollutants at the facility that have taken place within the three years prior to the submittal of this application.

Quantitative data based on samples collected during storm events from all outfalls containing a stormwater discharge associated with industrial activity for a number of water quality parameters.

Industrial Pretreatment Requirements

Industrial pretreatment requirements are another area where enforcement can result in lower pollutant concentrations in stormwater. Under PA Code Title 25 § 94.15, the operator of the sewerage facilities in cases where pollutants contributed by industrial users result in interference or pass through, and the violation is likely to recur, must develop and implement specific local limits for industrial users and other users, as appropriate, that together with appropriate sewerage facility or operational changes, are necessary to ensure renewed or continued compliance with the plant's NPDES permit or sludge use or disposal practices.

Additional Measures

Information on existing pollution prevention plans and spill response requirements should be provided to relevant industries in the watershed as part of the Phase II public education measures.

Industrial Pollution Prevention Plans are one means to prevent spills and accidental releases. Under PA Code Title 25 § 91.34 (Activities Utilizing Pollutants):

- Persons engaged in an activity which includes the impoundment, production, processing, transportation, storage, use, application, or disposal of pollutants shall take necessary measures to prevent the substances from directly or indirectly reaching waters of this Commonwealth, through accident, carelessness, maliciousness, hazards of weather, or from another cause.

- PA DEP may require a person to submit a report or plan setting forth the nature of the activity and the nature of the preventative measures taken. The Department will encourage consideration of the following pollution prevention measures, in descending order of preference, for environmental management of wastes: reuse, recycling, treatment, and disposal.

Spill response is another area that can improve wet weather water quality in Tookany/Tacony-Frankford Creek. Spill response requirements are promulgated under PA Code Title 25 and issued under section 5 of The Clean Streams Law (35 P. S. § 691.5).

Under PA Code Title 25 § 91.33 (Incidents Causing or Threatening Pollution):

- If, because of an accident or other activity or incident, a toxic substance or another substance which would endanger downstream users is discharged, it is the responsibility of the person at the time in charge of the substance to immediately notify PA DEP by telephone of the location and nature of the danger and, if reasonably possible to do so, to notify known downstream users of the waters.

- In addition to the notices, the person shall immediately take steps necessary to prevent injury to property and downstream users, and within 15 days from the incident, remove from the ground the residual substances to prevent further pollution.

The River Conservation Plans (RCPs) noted the following:

- <u>Rising Sun Avenue to Roosevelt Boulevard</u>: Examine car-recycling shop for runoff and determine if it’s a legal operation.

Construction Stormwater Pollution Prevention (CR5) Related Goals: 1, 2, 3, 7 Related Indicators: 1, 2, 3, 4, 7, 8, 9, 10, 19, 20			
What	Who	Where	When
Construction Site Stormwater Program in conformance with Phase II Stormwater Permits: • Enact an ordinance. • Review and approve Erosion and Sediment Control Plans. • Distribute educational materials.	All municipalities required to do Phase II permit (see Table 8.7).	N/A	5-year program associated with stormwater permit (see Table 8.17).

In accordance with the TTF Integrated Watershed Management Plan's stated purpose of integrating various existing programs, and to avoid duplication of effort, the recommended implementation plan follows the PA DEP Stormwater Management Program Protocol to meet the six minimum control measures required of municipal permittees under the Phase II NPDES Stormwater Regulations (listed in Section 1.4.1 of this report, and found at 40 CFR §§ 122.26 – 123.35). One of the six minimum controls is a Construction Site Stormwater (CSS) Program.

In Pennsylvania, two programs currently exist that address stormwater runoff from construction activities: 1) the Erosion and Sediment Control Program under 25 Pa. Code Chapter 102, and 2) the NPDES Stormwater Construction Permit Program.

The Erosion and Sediment Control Plan submitted by the developer must contain BMPs appropriate to the site and the surrounding area that might be impacted by the construction activities, as well as for post-construction runoff. Construction activity-related BMPs are available to developers and others through the Erosion and Sediment Pollution Control Program Manual (PA DEP ID: 363-2134-008) at www.dep.state.pa.us (directLINK "stormwater"), as well as at the County Conservation District (CCD).

The CSS program can be summarized as consisting of the following steps:

- Enact, implement, and enforce a stormwater control ordinance using PA DEP model language;

- Coordinate the review and approval of Erosion and Sediment Control Plans with the County Conservation District(s) (CCD) or PA DEP for any earth disturbance of one acre or more causing runoff, or for any earth disturbance of five acres or more. Make approval of the Erosion and Sediment Control Plan a prerequisite for the formal approval of land development and redevelopment plans or the issuance of building permits; and

- Distribute educational materials to land developers with the applications for building permits and other land development/redevelopment.

Municipalities must have an agreement with their local CCD that addresses these reviews and permitting requirements. This agreement ensures the close coordination between the municipality and the CCD on these important issues affecting water quality. Note that a NPDES Stormwater Construction Permit is required for earth disturbance activities where the construction disturbs five acres or more, or where there is a discharge from a site to the MS4 where earth disturbance is one acre or more.

In most cases, the County Conservation District implements these two programs, and PA DEP is responsible for implementing and enforcing these programs in cases where the County does not have this responsibility. By requiring review and approval of Erosion and Sediment Control Plans by the CCD or PA DEP (and proof of NPDES Stormwater Construction Permits where required), and by coordinating building permit and other land development permits or approvals with the CCD (or PA DEP in some cases), municipalities will meet MS4 permit requirements for this component of the Construction Stormwater Runoff Management Minimum Control Measure. Utilizing this existing statewide program, the municipality avoids the need to do a duplicative, independent review of every Erosion and Sediment Control Plan.

All municipalities in the watershed are required to fulfill this aspect of the stormwater regulations. Table 8.17 shows the schedule for implementation.

Table 8.17 Implementation Schedule for Construction Stormwater Pollution Prevention

PERMIT YEAR	***IMPLEMENTATION SCHEDULE***	
	Construction Site Stormwater Program	**Developer Education**
Year 1	**Ordinance:** Enact an ordinance requiring: • the review and approval of Erosion and Sediment Control Plans by the local County Conservation District or PA DEP; • for any earth disturbance one acre or more with runoff to the MS4, or five acres or more regardless of the planned runoff; and • as a prerequisite for the formal approval of land development plans or the issuance of building permit. **Process:** Establish an agreement with the local CCD for the review and approval of Erosion and Sediment Control Plans for all earth disturbance activities equal to or greater than one acre with runoff to the MS4 (or five acres or more regardless of the planned runoff). **Standard:** Require that the Erosion and Sediment Control Plans be developed in accordance with the requirements of Chapters 102 (erosion and sedimentation) of the PA DEP regulations.	Meet permit requirements and measurable goals for Year 1 under Public Education and Outreach MCM.
Years 2-5	Implement the ordinance and agreement for review of Erosion and Sediment Control Plans.	Meet permit requirements and measurable goals for Year 2 under Public Education and Outreach MCM.

Post-Construction Stormwater Runoff Management (CR6) Related Goals: 1, 2, 3, 7 Related Indicators: 1, 2, 3, 4, 7, 8, 9, 10, 19, 20			
What	Who	Where	When
Post-Construction Stormwater Runoff Management in conformance with Phase II Stormwater Permits: • Enact ordinance. • Coordinate review and approval of Plans. Ensure BMP maintenance.	All Municipalities required to do Phase II permit (see Table 8.7).	N/A	5-year program associated with stormwater permit (see Table 8.18).

In accordance with the TTFIWMP's stated purpose of integrating various existing programs, and to avoid duplication of effort, the recommended implementation plan follows the PA DEP Stormwater Management Program Protocol to meets the six minimum control measures required of municipal permittees under the Phase II NPDES Stormwater Regulations (listed in Section 1.4.1 of this report, and found at 40 CFR §§ 122.26 – 123.35). One of the six minimum controls is a Post-Construction Stormwater Runoff Management Program. The program can be summarized as consisting of the following steps:

- Enact, implement, and enforce a stormwater control ordinance using PA DEP model language;
- Coordinate the review and approval of post-construction BMPs simultaneously with the review and approval for construction Erosion and Sediment Control Plans as described in the Construction Minimum Control Measure; and
- Ensure long-term operation and maintenance of the BMPs.

PA DEP links management of post-construction runoff with the Construction Minimum Control Measure component discussed above (see Option CR5). Approvals for construction activities will be dependent on how post-construction issues are addressed. For example, if an applicant's plan for a land development or redevelopment project adequately addresses stormwater issues during construction but does not do so for post-construction impacts, then it must not be approved until the post-construction issues are addressed.

Ordinance

Municipalities must enact, implement, and enforce a stormwater control ordinance using PA DEP model language. The ordinance must address the proper standard for BMPs and operations and maintenance requirements for the BMPs. The ordinance will apply a statewide post-construction requirement until the water quality-based Act 167 Plan is adopted by the County and implemented by the municipality, at which time the municipality will need to amend it to include those requirements.

The ordinance should require that all development and redevelopment activities with earth disturbance one acre or more with runoff to the MS4 (or five acres or more regardless of the planned runoff) be conducted in accordance with the ordinance. No formal approval of land development plans or issuance of building permits should occur without municipal approval of post-construction stormwater controls. A model ordinance is available from PA DEP.

Implement Program

The municipalities must commit resources or establish an agreement with the local County Conservation District (CCD) or other service provider (e.g., municipality's consulting engineer) for coordination of post-construction BMP approvals. There must be a process to review the post-construction controls in conjunction with the review process for construction approval.

Municipalities must ensure that the post-construction controls will meet state water quality requirements. Those requirements depend upon the status of the Act 167 Stormwater Management planning in the watershed. Where a water-quality-based Act 167 plan has been completed (or updated), those local watershed requirements apply. Otherwise, statewide requirements must be implemented.

While it is the municipalities' responsibility to ensure that the BMPs meet the water quality requirements, PA DEP will be reviewing post-construction plans for individual permits, and some County Conservation Districts have the expertise to conduct the reviews under an agreement with the municipality similar to that for the Construction Minimum Control Measure.

Operation and Maintenance of Post-Construction BMPs

It is the municipalities' responsibility to ensure that the post-construction BMPs required and approved pursuant to the program are constructed, operated, and maintained. Many BMPs may be "non-structural," and will require no operation or maintenance. Examples are use of open space and vegetated buffers in development design, minimization of soil disturbance and compaction during construction, and minimization of directly connected impervious areas. Other BMPs – "structural BMPs" – will require proper operation and maintenance. Examples include wet ponds, grassed swales, infiltration basins, and bioretention areas.

Municipalities will need to have a monitoring program that ensures that the post-construction BMPs are constructed, operated, and maintained, within the first permit term of five years. The program must have two elements:

- Implementation: Ensure installation of the BMPs as designed. Coordinate the monitoring with the CCD, especially where a permit has been issued.

- Operation and Maintenance: Some of the structural BMPs will require maintenance over time to be effective. Municipalities must have a system to monitor these BMPs. If any BMPs are not operated or maintained and are ineffective, municipalities must develop a plan to address them. The PA DEP Model Ordinance provides legal tools to accomplish this.

All municipalities within the Tookany/Tacony-Frankford Watershed must carry out this program (see Table 8.7). The schedule for full implementation is provided, in accordance with the new Phase II rules, in the table below.

Table 8.18 Post-Construction Stormwater Runoff Management: Implementation Schedule

PERMIT YEAR	*IMPLEMENTATION SCHEDULE*	
	Stormwater Management Program	Long Term Operation and Maintenance
Year 1	**Ordinance:** Enact an ordinance requiring: • No formal approval of land development plans or issuance of building permits without municipal approval of post-construction stormwater controls. • Development and redevelopment activities with earth disturbance of one acre or more with runoff to the MS4, or five acres or more regardless of the planned runoff, must be conducted in accordance with the ordinance. **Process:** Rely on PA DEP review of permits where applicable; where no PA DEP review of post-construction controls is conducted, use municipal resources, or establish an agreement with the local CCD or other service provider (e.g., municipal engineer) for coordination of post-construction BMP approvals. **Standard:** Require post-construction structural and non-structural BMPs be designed, constructed, and maintained to meet (1) the requirements of the approved Act 167 plan and the municipal ordinance, or (2) the PA DEP statewide water quality requirements, until such Act 167 Plan is in place.	Ensure that stormwater BMPs are built, operated, and maintained as designed.
Years 2-5	• Implement the ordinance and post-construction BMP approval process.	Ensure that stormwater BMPs are built, operated, and maintained as designed.

Use Review and Attainability Analysis (CR8) Related Goals: 1, 2, 3, 4 Related Indicators: 7, 8, 9, 10, 11			
What	Who	Where	When
Coordinate water quality standards review and revision with PWD's CSO LTCP	EPA and PADEP in partnership with PWD and other permitted dischargers	The Tookany/Tacony-Frankford creek and tributaries	Within 5 years (1 NPDES CSO permit cycle)

The CSO Policy calls for the development of a long-term control plan (LTCP) which includes measures that provide for compliance with the Clean Water Act, including attainment of water quality standards. The CSO Policy provides that "development of the long term plan should be coordinated with the review and appropriate revision of water quality standards (WQS) and implementation procedures on CSO-impacted receiving waters to ensure that the long-term controls will be sufficient to meet water quality standards" (59 FR 18694).

As part of a renewed focus on this commitment, EPA has issued a guidance document, Coordinating CSO Long-Term Planning with Water Quality Standards Reviews (EPA-833-R-01-002). This document lays a strong foundation for integrating water quality standards reviews, implementation of high-priority CSO controls, and development of well-designed and operated LTCPs that support attainment of water quality standards without causing substantial and widespread economic and social impacts. In addition to CSO impacts, many of the processes, procedures and ideas presented can be used to address wet weather issues such as stormwater and other point and nonpoint sources on a watershed basis. An iterative, phased implementation of CSO controls fits well with the watershed approach.

Depending on the impacts, possible water quality standards revisions could include:

1. Re-evaluating recreational uses and applying criteria for bacteria at the point of contact rather than at the end-of-pipe,

2. Segmenting the water body to preserve recreation in areas where it actually occurs, and

3. Revising the use by creating subclasses to recognize intermittent exceedances of bacteriological criteria.

Watershed-Based Permitting (CR9) Related Goals: 2, 3, 4, 5, 7 Related Indicators: 1, 2, 3, 7, 10, 11, 15, 16, 19			
What	Who	Where	When
Explore approaches to developing NPDES permits for multiple point sources located within the watershed	PADEP	Watershed-wide	Long term

Source: Watershed-Based National Pollutant Discharge Elimination System (NPDES) Permitting Implementation Guidance, December 2003 (EPA 833-B-03-004)

Watershed-Based NPDES Permitting

Watershed-based NPDES permitting is an approach to developing NPDES permits for multiple point sources located within a defined geographic area (watershed boundaries) to meet water quality standards. This approach, aimed at achieving new efficiencies and environmental results, provides a process for considering all stressors within a hydrologically defined drainage basin or other geographic area, rather than addressing individual pollutant sources on a discharge-by-discharge basis. This plan provides the first steps in this process. In the long term, a watershed-based permit in the Tookany/Tacony-Frankford system can provide the regulatory framework for implementation of this integrated watershed management plan.

A truly comprehensive watershed management approach should bring together key programs under the Clean Water Act, such as the NPDES Program, the TMDL Program, the Section 319 Nonpoint Source Program, and Section 404 Wetlands Permitting, as well as the Source Water Assessment Program under the Safe Drinking Water Act. Watershed-based NPDES permitting can be another tool to facilitate comprehensive programmatic integration at a watershed level and ensure that permitting activities tie into existing watershed management efforts.

Developing and Implementing a Watershed-Based NPDES Permitting Approach EPA's suggested process for developing and implementing a watershed-based NPDES permitting approach consists of the following six steps. This integrated watershed management plan fulfills most requirements of the first three steps.

Step One - Select a Watershed and Determine the Boundaries

Step Two - Identify Stakeholders and Facilitate Their Participation

Step Three - Collect and Analyze Data for Permit Development

Step Four - Develop Watershed-Based Permit Conditions and Documentation

Step Five - Issue Watershed-Based NPDES Permit

Step Six - Measure and Report Progress

8.3.2 Target C Options: Public Education and Volunteer Programs

Public Education and Volunteer Programs (CP1) Related Goals: 4, 6, 7 Related Indicators: 16, 17, 18, 19, 20, 21			
What	Who	Where	When
See Public Education and Volunteer Programs under Target A options (Section 8.1.2).	All municipalities.	All municipalities.	Short-term: first 5 years coinciding with the stormwater permit (see Table 8.8).

8.3.3 Target C Options: Municipal Measures

Sanitary Sewer Overflow Detection (CM1) Related Goals: 3, 7 Related Indicators: 10, 11, 19, 20			
What	Who	Where	When
SSO Detection Program.	Municipalities with separate sewer systems in TTF Watershed (see Table 8.7).	See Figure 8.3 (map of separate sewers and responsible authorities).	Permanent ongoing program should be part of each agency's program.

Discharges from sanitary sewers to Tookany/Tacony-Frankford Creek during wet weather are suspected in some areas. Some of the techniques used for inspection of sewer lines can also be used for identifying potential locations of SSOs. Some of the most effective techniques for identifying the location of SSOs are listed below. (Source: Protocols for Identifying Sanitary Sewer Overflows, American Society of Civil Engineers EPA Cooperative Agreement #CX 826097-01-0, June 2000.)

Sewer System Mapping

GIS maps of the sewer system should be developed in all municipalities. These maps serve as the basis for hydraulic modeling, and are key to many of the techniques described below.

Customer and/or Public Complaint

When a basement backup occurs or an SSO occurs in an area exposed to view, it is almost certain that someone will call the sewerage agency and report the incident. The agency should have a plan in place to investigate the reported SSO, find its cause, and take remedial measures to avoid recurrence of the SSO.

Visual Inspections after Overflows

Visual inspections can be used to confirm the occurrence of SSOs at suspected locations. The agency should develop a list of such locations and update it periodically. Immediately following a major storm, an inspection team should be sent to investigate these locations. A visual inspection program can be enhanced by encouraging participation of the public through providing opportunities for the public to become part of the solution.

Scheduled Maintenance Inspection

Municipal sewerage agencies should be performing routine maintenance inspections of their system. While the maintenance crew is performing the inspection, it can also look for signs of SSOs. These are most likely to occur at pumping stations, manholes, stream crossings, and cleanouts.

GIS-Based Analysis of Past SSOs

GIS analysis can answer questions related to location, condition, trends, patterns, and modeling. Listed below are some typical questions that GIS can answer:

- What exists at a given location?
- Where is the location of an object or outcome with a number of specific characteristics?
- What has changed over a given period?
- What is the spatial distribution of areas with a certain attribute?

Sanitary Sewer Management Systems

A Sanitary Sewer Management System (SSMS) can be used to store, organize, and analyze large quantities of data associated with sewer system operation, maintenance, inspection, modeling, and rehabilitation. The SSMS may include the following modules:

- Inventory Module
- Flow Module
- Modeling Module
- Inspection Module
- Maintenance Module
- Rehabilitation (CIP) Module
- Mapping Module

Analysis of the data in the SSMS can reveal many problem areas, trends, and patterns. For example, the database can be searched to develop a list of lines with flat slopes or areas where frequent maintenance is needed. Another application of the SSMS is analysis of historical data.

Flow Monitoring

Flow monitoring at strategic locations may be used to identify potential locations of SSOs. Flow monitors can be installed in open channels and pumping stations to obtain the data necessary for proper system evaluation. In conjunction with flow monitoring, rain gauges should also be installed. Many open channel temporary flowmeters have both velocity and depth measuring sensors. Municipalities should use the existing rain gauge network in the TTF Watershed.

Flow data can be used to determine the average daily flow, the infiltration rate, and the inflow rate. The rain gauge data can be used to determine the recurrence interval or severity of the storm event (for example, 5-year) that caused the inflow. The flow data will also indicate whether a surcharge occurred during the flow monitoring period.

Monitoring of Receiving Stream for Sewage Indicators

This technique may be used for identifying the locations of dry weather SSOs. Samples from a nearby stream are taken at regular intervals along the stream and tested for fecal coliforms. Significant presence of these bacteria could be an indication of sewage leaking from the sewer line into the stream.

Closed Circuit Television (CCTV) Inspection

CCTV inspection has been widely used for inspection of sewer line interiors. The final product of a CCTV inspection is videotape and a field log prepared and narrated by an operator. The videotape provides a visual and audio record of problem areas in the sewer line. Evaluation of the CCTV records help identify structural problems; locate leaking joints and non-structural cracks, blockages, and dropped joints; and identify areas of root intrusion.

Sewer Scanner and Evaluation Technology Surveys (SSET)

The SSET is a new pipeline inspection technology developed in Japan. The equipment consists of a scanner, a CCTV, and a three-axis mechanical gyroscope. The mechanics of placing the SSET in the sewer line are similar to those of CCTV inspection. The images produced by SSET are of higher quality than CCTV images. Interpretation of the results is done in the office by an engineer rather than in the field by a technician. This increases the speed of field operations and reduces the cost.

Surcharge Level Alarms/Remote Monitoring

These devices can be placed at strategic locations in the manholes and pumping stations. Once the flow reaches a certain elevation, the alarm goes off and sends a signal to a control center via a telephone line or SCADA system. The sewerage agency should have a plan in place to respond immediately to such alarms. In addition, the responding agency should also record the event in a database.

Dye Tracing

Dyed water testing consists of dye tracing or flooding, and is done to locate possible sources of inflow such as area drains or catch basins suspected of being connected to the sewer line, or sources of rainfall-induced infiltration/inflow which indirectly contribute to the flow in the sewer line through the soil and pipe cracks. Dye testing is normally used to complement smoke testing of suspect areas. The downstream manhole is monitored to see if the dye water injected into an outside source such as a downspout has found its way into the sewer system. Color CCTV may also be used for locating problem areas after the dye enters the pipeline through the surrounding soil.

Smoke Testing

The purpose of smoke testing is to locate rainfall-dependent I/I (Inflow and Infiltration)sources which could lead to SSOs during a storm events. Public notification is an important and critical element of any smoke testing program. Specific I/I sources detected by smoke testing includes roof, yard, and area drain connections; catch basins; and broken service lines. The testing procedure consists of pumping non-toxic smoke through a manhole into the sewer pipe for distances up to 600 ft. The smoke will surface through open breaks in the pipe connections. All such sources are photographed and documented.

Aerial Monitoring

Aerial monitoring by helicopter may be used to gain a general understanding of conditions along a sewer line which may lead to an SSO. For example, washout may expose a section of pipe, which would then be at risk of damage and subsequent SSO. Examples of features which may be observed during such monitoring include manholes with broken or missing covers and sewer lines exposed by erosion.

Monitoring of Grease Buildup

A significant cause of SSOs during dry weather is sewer stoppages resulting from grease buildup. Such stoppages occur most frequently in downtown areas where restaurants are major sources of flow in the sewer system. A list of locations of grease buildup should be developed and these locations should be regularly inspected. Grease buildup can be prevented by enforcing grease ordinances, by effective pretreatment programs, and by promoting public education. The grease accumulations can be removed using the many available cleaning techniques, such as bucket machines with brushes, power rodders, and high velocity jet cleaners. Bioaugmentation, which involves the addition of bacteria cultures to sewers to speed up the breakdown of grease deposits, can also be effective.

Pump Station Inspection

Pump station failures can lead to significant SSO problems. Such failures can be avoided by regular inspections. The frequency of inspections may vary from once a day to once a month, depending on the size and criticality of the station, and reliance on monitoring by means such as the SCADA system.

Manhole Inspection

Manhole interiors are inspected for physical soundness for evidence surcharging such as high water marks on manhole walls. The observed defects should be compiled into a database that will be used to estimate the I/I attributable to each manhole and to establish manhole maintenance and rehabilitation program.

Line Lamping

Line lamping is done in conjunction with manhole inspection by inspecting the interior of the sewer lines connected to the manhole using an artificial light and a mirror. Lamping helps identify pipe defects and provides a basis for selecting sewers for television inspection.

Building Inspection

Building inspections are conducted to investigate extraneous flow from connections to sump pumps, foundation drains, downspouts, or leaking laterals. Building inspections should include investigation of the causes of basement backups.

Ground Penetrating Radar

Ground penetrating radar uses the transmission and reflection properties of an electromagnetic wave passing through the soil to determine soil properties and the depth and extent of subsurface objects. The speed and amplitude of the electromagnetic wave are dependent on the moisture content of the soil. This principle can be used to detect leaking joints in the line and voids around the pipe, which may be caused by soils being washed out. In such locations, the signal will be delayed because the speed of the wave will be reduced, and the amplitude of the wave will be attenuated.

Soil Moisture and Temperature Monitoring

When the ground is relatively dry, a larger portion of the rainfall will penetrate the soil, which will result in a decrease of groundwater to sanitary sewers. However, as the soil moisture increases, the amount of infiltration to sewers increases. For this reason, the impact of subsequent storm will be more severe: while the system did not overflow during the first storm, it will do so during the second storm, although the second storm of smaller intensity than the first. By monitoring the soil moisture and temperature, it may be possible to develop a measure for assessing the occurrence of SSOs.

Inspections of Stream Crossings and Parallel Lines

Pipes running alongside or crossing streams are often vulnerable to SSOs. If the sewer is buried under the stream bed, the scouring action of the stream bed will eventually expose it, causing the pipe to lose its soil support. The pipe segments may move under the water pressure and joints may open, or the pipe may become exposed as a result of bank erosion. Any such openings admit significant amounts of flow, which may exceed the capacity of the sewer pipe. Stream crossings that include inverted siphons often become clogged with accumulations of silt and debris, which may cause an overflow upstream. The foundations of aerial stream crossing piers are also subject to scouring and may lead to foundation failure of the sewer line.

Sewer pipes that cross or parallel streams should be inspected to ensure that they are not broken or cracked. The manholes on each side of the stream should be checked for excess flow, which would indicate a leaking sewer under the stream. Since these sewers are usually in remote areas, they are vulnerable to vandalism and can overflow undetected for long periods.

All municipalities in the Tookany/Tacony-Frankford Watershed should have a routine and effective SSO detection program. Once SSOs are found and the cause determined, proper measures to eliminate the SSO should be taken.

All municipalities with separate sanitary sewers are responsible for developing an effective SSO detection program.

The River Conservation Plans (RCPs) recommend the following:

- Greenwood Avenue to Wyncote Post Office: Inspect and repair manhole covers as needed.
- Wyncote Post Office to Washington Lane Underpass: Inspect and repair all manhole covers and cement encasements.

Sanitary Sewer Overflow (SSO) Elimination: Structural Measures (CM2) Related Goals: 3, 7 Related Indicators: 10, 11, 19, 20			
What	Who	Where	When
Implement a CMOM program (see Option AM1). Update and implement official Act 537 Sewage Facilities Plans.	Municipalities with separate sewer systems in Tookany/Tacony-Frankford Creek (see Table 8.7).	See Figure 8.3 (map of separate sewers and responsible authorities).	Short-term (within 5 years of SSO detection).

Discharges to U.S. waters from municipal sanitary sewer collection systems are prohibited, unless authorized by an NPDES permit. Permits authorizing discharges from such systems must contain technology-based effluent limitations, based upon secondary treatment and applicable water quality standards. NPDES permits for municipal wastewater treatment plants should require record-keeping and reporting of overflows that result in a discharge. Permits should also contain requirements for operation and maintenance of the sanitary sewer collection system.

The EPA and PA DEP are continuing to address SSO problems with compliance assistance and enforcement in accordance with the Compliance and Enforcement Strategy Addressing Combined Sewer Overflows and Sanitary Sewer Overflows, issued April 27, 2000. In addition to the national policy, Act 537, enacted by the Pennsylvania Legislature in 1966, requires that every municipality in the state develops and maintains an up-to-date sewage facilities plan. The main purpose of a municipality's sewage facilities plan is to ensure that the sewage collection and treatment systems have adequate capacity to convey present and future to sewage flows to a wastewater treatment facility. Official plans contain comprehensive information, including:

- The location of treatment plants, main intercepting lines, pumping stations and force mains, including their size, capacity, point of discharge and drainage basin served (preferably in a GIS format);
- Descriptions of problems with existing sewerage facilities and operation and maintenance requirements; and
- Planning objectives and needs:
    - Physical description of planning area
    - Evaluation of existing wastewater treatment and conveyance systems
    - Evaluation of wastewater conveyance and treatment needs

EPA has developed a comprehensive management framework called Capacity, Management, Operations, and Maintenance (CMOM) to assist municipalities in developing more comprehensive sanitary sewer system management programs. A CMOM program (described in Section 8.1.3, Option AM1) helps to prevent SSOs. Once a recurring SSO is detected using the methods recommended under Option CM1, measures must be taken to eliminate the discharge.

Reduction of Stormwater Inflow and Infiltration (RDII) to Sanitary Sewers (CM3) Related Goals: 3, 7 Related Indicators: 10, 11, 19, 20			
What	Who	Where	When
RDII Reduction Program.	Municipalities with separate sewer systems in TTF Watershed (see Table 8.7).	See Figure 8.3 (map of separate sewers and responsible authorities).	Short-term.

Where significant RDII is detected, measures can be taken to seal the sanitary sewer system to reduce inflow of stormwater and groundwater. These measures are discussed in detail under Option AM3, “Sanitary Sewer Rehabilitation” (in Section 8.1.3).

Combined Sewer Overflow (CSO) Control Program (CM4) Related Goals: 3, 7 Related Indicators: 7, 8, 9, 10, 11, 19, 20			
What	Who	Where	When
Nine Minimum Controls (NMCs). Long Term Control Plan (LTCP) Capital Projects, including real time control (RTC). Watershed Plan development.	PWD	Philadelphia combined sewer system.	NMCs complete and ongoing. RTC short-term (within 5 years).

The fundamental goal of the Philadelphia Water Department's (PWD) combined sewer overflow (CSO) program is to improve and preserve the water environment in the Philadelphia area and to fulfill PWD's obligations under the Clean Water Act and the Pennsylvania Clean Streams Law by implementing technically viable, cost-effective improvements and operational changes.

The PWD's strategy to attain these goals has three primary phases: aggressive implementation of a comprehensive program for Nine Minimum Controls; planning, design, and construction of capital projects that further enhance system performance and reduce CSO volume and frequency; and comprehensive watershed-based planning and analyses that will identify additional, priority actions to further improve water quality in Philadelphia area water bodies.

The implementation of each of these control measures is discussed briefly below.

Nine Minimum Controls

In the first phase of PWD's CSO strategy, and in compliance with its NPDES permits, PWD submitted CSO Documentation: Implementation of Nine Minimum Controls to the PA DEP on September 27, 1995. 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. To provide information needed for the development of the Nine Minimum Controls (NMC) program, PWD instituted a $6.5 million project to upgrade its comprehensive system flow monitoring network. This program provides information necessary to identify and eliminate dry weather overflows, monitor system performance and operation, and configure and calibrate computer hydraulic models needed to develop the NMCs and long-term CSO control plans. This information provided the basis for the System Hydraulic Characterization Report that was submitted to the PA DEP in June 1995 and provided the technical basis for the development of the NMC plan.

Extensive data from the PWD's Geographic Information System (GIS), flow monitoring system, the U.S. Army Corps of Engineer's Storage, Treatment, Overflow, Runoff Model (STORM), and the EXTRAN and RUNOFF blocks of the EPA Stormwater Management Model (SWMM) were used to support each phase of the CSO program. These tools were developed to support concept engineering through implementation and post-construction monitoring. The monitoring system, models, and GIS will serve as the basis for planning improvements and enhancing operation of the sewerage system over the long-term.

Using the above tools, the PWD's NMC program includes comprehensive, aggressive measures to maximize water quality improvements through the following nine measures:

1. Review and improvement of ongoing operation and maintenance programs.

CSO Regulator Inspection & Maintenance Program

PWD has committed to demonstrating an improved follow-up response to sites experiencing a dry weather overflow. PWD has instituted a policy of next day follow-up inspection at sites that experience an overflow. PWD will conduct an evaluation of the effectiveness of twice-weekly inspections.

A database has been developed to document the maintenance performed on each CSO site. This system will ensure that proper regulator settings are maintained and system changes are documented. This database can also store scanned plan view and profile view drawings of CSO regulator and hydraulic control point chambers for inclusion in the filed inspection report forms.

Additional components of the O&M program include:

- Pumping Station Maintenance
- Sewer Cleaning Contracts
- Inflow Prevention Program
- Tide Gate Inspection and Maintenance Program
- Emergency Overflow Weir Modification

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

Use of the collection system for storage has long been recognized as a potentially cost-effective means to mitigate the occurrence and impacts of CSOs. PWD has been implementing in-system storage in Philadelphia's combined sewer system for nearly 20 years, using a variety of technologies:

- Reducing tidal inflows at regulators can reduce CSO overflows to Tookany/Tacony-Frankford Creek by increasing available treatment capacity at the POTW.
- A program to install tide gates or other backflow prevention structures at Tookany/Tacony-Frankford Creek regulators to protect these regulators from potential inundation.
- Another approach that can be implemented to gain additional in-system storage is to raise the overflow elevation by physically modifying the overflow structure (e.g., raising an overflow weir). However, this approach must be implemented cautiously, since raising the overflow elevation also raises the hydraulic grade line in the combined trunk sewer during storm flows, and therefore increases the risk of basement and other structural flooding within the upstream sewer system due to backup or surcharge problems.

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

(Also see Section 8.3.1, Option CR4, "Industrial Stormwater Pollution Prevention.")

- Over the years, PWD has implemented a rigorous industrial pretreatment program. The effectiveness of this program has allowed the City to develop one of the largest and most successful biosolids beneficial reuse programs in the nation. As part of the nine minimum controls effort, PWD is committed to taking actions to encourage industries to better manage their process water discharges to the sewer collection system during wet weather periods.

4. Measures to maximize flow to the wastewater treatment facilities.

As a minimum control, maximizing flow to the publicly owned treatment works (POTW) means making simple modifications to the sewer system and treatment plant to enable as much wet weather flow as possible to reach the treatment plant and receive treatment. The secondary capacity of the treatment plant should be maximized, and all flows exceeding the capacity of secondary treatment should receive a minimum of primary treatment (and disinfection, when necessary). The most effective way to determine the ability of the POTW to operate acceptably at incremental increases in wet weather flow, and to estimate the effect of the POTW's compliance with its permit requirement, is to perform stress testing to determine optimum flows, loads, and operations of the plant's unit processes.

5. Measures to detect and eliminate dry weather overflows.

Relevant measures are discussed in Section 8.1.3, which details various recommended Target A Municipal Measures.

6. Control of the discharge of solid and floatable materials.

Solids are waterborne waste material and debris consisting of sand, gravel, silts, clay, and organic matter. Significant concentrations of solids are not only a visual nuisance, but can affect turbidity and dissolved oxygen, and carry pathogens in the receiving water. In addition, excessive amounts of solids can affect the combined sewer system by decreasing hydraulic capacity, thus increasing the frequency of overflows. Solids can enter the system through domestic and industrial wastewater, and debris washed from streets.

Floatables are waterborne waste material and debris (e.g., plastics, polystyrene, and paper) that float at or below the water surface. Floatables seen in significant quantities are aesthetically undesirable and can cause beach closings, interfere with navigation by fouling propellers and water intake systems, and impact wildlife through entanglement and ingestion.

Floatables and solids control measures consist of non-structural and structural technologies.

Non-structural technologies include combined sewer system maintenance procedures such as sewer flushing, street sweeping, and catch basin cleaning. Public education, land use planning and zoning, and ordinances are also considered non-structural technologies implemented to reduce solids and floatables entering the combined sewer system. (These technologies are discussed elsewhere in Section 8, under various relevant options.)

Structural controls typically consist of abatement devices that would be constructed near the point of discharge. Technologies used for removing solids and floatables from CSOs include: Baffles, Booms, Catch Basin Modifications, Netting Systems, Swirl Concentrators, Screens, and Trash Racks. (Modification of storm and combined sewer inlets for solids control, as well as catch basin and storm inlet maintenance are also discussed elsewhere under Section 8 options.)

Solids and floatables discharged from CSOs may represent a potentially significant impact to Tookany/Tacony-Frankford Creek. PWD currently expends considerable effort to minimize the potential discharge of solids and floatables.

- PWD performs over 50,000 inlet cleanings each year preventing many tons of street surface-related materials from discharging to waterways through CSOs. The significant pipe cleaning and grit removal activities conducted by PWD also remove a great deal of material that otherwise might discharge through CSO outlets during wet weather.

- The continued practice of regularly cleaning and maintaining grit pockets at critical locations in the trunk and interceptor system is an important part of the CSO control strategy. Grit buildup reduces the hydraulic capacity of the interceptor both by constricting its cross sectional area, and by increasing its frictional resistance. For example, quarterly cleaning of the 100-foot deep siphon grit pocket located at the Central Schuylkill wastewater pumping station is a major undertaking requiring specialized equipment and the commitment of significant labor resources. This practice has been shown to reduce the hydraulic grade surface at the siphon, increasing the wet weather flow capacity to the SWWPCP. Prior to the institution of this cleaning practice, the grit pit at this location had not been cleaned regularly in over 40 years.

- Operation condition inspections of regulator chamber and backflow prevention devices are conducted for each structure approximately weekly, resulting in more than 10,000 inspections conducted each year. Additionally, comprehensive structural and preventative maintenance inspections are performed annually.

- A pilot, in-line, floatables netting chamber was constructed as part of a sewer reconstruction project at CSO T-4 Rising Sun Ave. east of Tacony Creek. The construction of the chamber was completed in March 1997 and the netting system continues to operate. The quantity of material collected is weighed with each net change. 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 T-4 has 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.

- 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. Repair, rehabilitation, and/or expansion of debris grills were performed at outfall F05 during calendar year 2002.

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

Most of the city ordinances related to this minimum control are housekeeping practices that help prohibit litter and debris from being deposited on the streets and within the watershed. These measures include litter ordinances and illegal dumping policies and enforcement (see Section 8.1.1, Option AR2). If such pollutants eventually 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.

8. Measures to inform the public about the occurrence, location, and impacts of CSOs.

PWD has developed and will continue to develop a series of informational brochures and other materials about its CSO discharges and the potential affect on the receiving waters, in addition to information regarding dry weather flows from its stormwater outfalls. The brochures provide phone contacts for additional information. Also, the opportunity to recruit citizen volunteers to check or adopt CSO outfalls in their watersheds (e.g.,, notifying 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, the Water Department has enlisted watershed organizations to assist it with this endeavor. PWD continued with this focus in 2002 to raise the level of awareness in its citizens about the function of combined and stormwater outfalls through a variety of educational mediums. The watershed partnerships are important for this kind of public/private effort to protect stream water quality. Lastly, the Department's Waterways Restoration Unit will investigate the feasibility of installing signs that can withstand nature and vandals at PWD outfalls.

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

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. Tables are compiled annually to represent average annual CSO overflow statistics as required in the NPDES Permit.

Long Term Control Plan Capital Projects

The second phase of 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 water quality. The recommended capital improvement program is the result of a detailed analysis of a broad range of technology-based control alternatives.

A Real Time Control (RTC) center is being established at PWD’s Fox Street facility. The ultimate goal for this center is to house a centralized RTC system that will allow telemetered commands to be sent to site-specific, automated controls located throughout the collection and treatment facilities. These signals may be transmitted based upon an optimized response to rainfall patterns and are intended to further enhance capture of CSO volume. Establishing a RTC center will enable PWD to provide 24-hour monitoring and, eventually, control of key collection system facilities including automated CSO regulators, pump stations, and inter-district diversions.

Two RTC projects are currently being designed for regulators that discharge to Tacony Creek. The trunk sewer discharging to regulator structure T-14 near Juniata Park and Tacony Creek Park contains excess storage capacity that can be utilized by increasing the overflow elevation during smaller rain events. A dynamic gate is ideal because the original overflow capacity is still needed to provide adequate drainage during very large storms. The project will reduce discharge volume associated pollutants such as bacteria, organic matter, solids, and litter from both untreated stormwater and wastewater.

The trunk sewer discharging to regulator structure T-08, near Nedro Avenue and Hammond Street in Tacony Creek Park, also has excess storage capacity during smaller storms. A similar dynamic gate is being proposed for this location to take advantage of this capacity and increase capture of combined sewage during wet weather. These projects are cost-effective because they modify existing infrastructure rather than requiring construction of new infrastructure. Both areas are in or near parkland used by the public for recreation.

Watershed-Based Planning and Management

The third component of the City's CSO strategy involves a substantial commitment by the City to watershed planning to identify long term improvements throughout the watershed, including possibly additional CSO controls, which will result in further improvements in water quality and, ultimately, the attainment of water quality standards. The need for this watershed initiative is rooted in the fact that, prior to development of the Integrated Watershed Management Plan, insufficient physical, chemical, and biological information existed on the nature and causes of water quality impairments, sources of pollution, and appropriate remedial measures. Because of this deficiency, it was impossible to determine what needed to be done for additional CSO control or control of other wet weather sources throughout the watershed. This deficiency, especially with respect to the effects of wet weather discharges and receiving water dynamics, is increasingly recognized nationwide and has led to a broader recognition of the need for watershed-based planning and management to properly define water quality standards and goals. PWD believes that the National CSO Policy, state and federal permitting and water quality management authorities, cities, environmental groups, and industry, now recognize that effective long-term water quality management can be accomplished only through watershed-based planning. Completion of the Tookany/Tacony-Frankford Integrated Watershed Management Plan represents the realization of this commitment to watershed-based planning.

Catch Basin and Storm Inlet Maintenance (CM5) Related Goals: 3, 5, 6, 7 Related Indicators: 11, 15, 16, 19, 20			
What	Who	Where	When
Regularly inspect catch basins (in combined areas) and storm inlets (in separate areas). Remove sediment as needed.	Sewer owners (PWD and municipalities).	All inlets throughout watershed.	Continue existing programs.

Catch basins and storm inlets that are part of the stormwater collection and conveyance system should be cleaned on a regular basis. Sediment, leaves, grass clippings, pet wastes, litter, and other materials commonly accumulate in catch basins. These materials can contain significant concentrations of nutrients, organics, bacteria, metals, hydrocarbons, and other pollutants. When a storm occurs, runoff entering the basin may dislodge and suspend some of this material. This debris can be conveyed along the storm sewer system and released to a surface water body. Catch basin clean out should be scheduled for the fall and early spring in order to remove leaves and road salt and sand before the spring rains. In general, this is done with vacuum trucks, with disposal of the debris handled as solid waste.

In separate sewered areas of the Tookany/Tacony-Frankford Watershed, each municipality is responsible for an effective storm sewer cleaning program. In Philadelphia, PWD has this responsibility.

Street Sweeping (CM6) Related Goals: 3, 5, 6, 7 Related Indicators: 11, 15, 16, 19, 20			
What	Who	Where	When
Evaluate existing Street Sweeping programs and implement enhanced practices.	All municipalities.	Streets and parking lots in commercial and dense residential areas.	Within next 5 years.

Street and parking lot cleaning performed on a regular basis in urban and dense residential areas can be an effective measure for minimizing stormwater pollutant, sediment, and floatables loading to receiving waters.

Street sweeping programs had largely fallen out of favor as a pollutant removal practice following the 1983 NURP report. Recent improvements in street sweeper technology, however, have enhanced the ability of the machines to pick up the fine grained sediment particles that carry a substantial portion of the stormwater pollutant load, and have led to a recent reevaluation of their effectiveness. New studies show that conventional mechanical broom and vacuum-assisted wet sweepers reduce non-point pollution by 5 to 30 percent and nutrient content by 0 to 15 percent. However, newer dry vacuum sweepers can reduce non-point pollution by 35 to 80 percent and nutrients by 15 to 40 percent for those areas that can be swept (Runoff Report, 1998). A benefit of high-efficiency street sweeping is that by capturing pollutants before they are made soluble by rainwater, the need for structural stormwater control measures might be reduced. Structural controls often require costly added measures, such as adding filters to remove some of these pollutants and requiring regular maintenance to change filters. Street sweepers that can show a significant level of sediment removal efficiency may prove to be more cost-effective than certain structural controls, especially in more urbanized areas with greater areas of pavement.

Computer modeling of pollutant removal in the Pacific Northwest suggests that the optimum sweeping frequency appears to be once every week or two (CWP, 1999). More frequent sweeping operations yielded only a small increment in additional removal (Bannerman, 1999; Claytor, 1999).

The following measures should be implemented toward achieving non-point source reductions in wet weather pollutant loads:

- Evaluate existing street and parking lot sweeping practices by municipalities with urban and dense residential areas contributing stormwater runoff to the watershed.

- Implement enhanced street and parking lot sweeping programs in urban and dense residential areas, prioritizing those not served by existing stormwater BMPs designed to reduce stormwater pollutant, sediment, or floatables loading to the receiving waters.

Responsible Landscaping Practices on Public Lands (CM7) Related Goals: 1, 2, 3, 4, 6, 7 Related Indicators: 1, 10, 11, 12, 13, 16, 19			
What	Who	Where	When
Incorporate integrated pest management (IPM) to reduce chemical use on public lands. Prevent clippings and cuttings from being transported by stormwater, and dispose of them through composting if possible.	Fairmount Park Commission, municipalities. PennDOT for vegetation along state roads.	Parks, golf courses, school and institutional grounds, roadside vegetation.	Short-term (within 5 years).

Common pesticides such as diazinon and chlorpyrifos can be harmful to aquatic life even at very low levels (CWP, 1999; Schueler, 1995). Proper use of these chemicals can be encouraged through public relations campaigns and demonstrated on public lands. Clippings and cuttings carried into the stormwater system and receiving streams can degrade water quality in a variety ways. A related problem exists with the illegal dumping of clippings and cuttings in or near drainage facilities. Recommended controls include:

- Consider an integrated pest management (IPM) program that encourages the use of alternatives to chemical pesticides. An IPM program incorporates preventative practices in combination with non-chemical and chemical pest controls to minimize the use of pesticides and promote natural control of pest species. In those instances when pesticides are required, programs encourage the use of less toxic products such as insecticidal soaps. The development of higher tolerance levels for certain weed species is a central concept of IPM programs for reducing herbicide use. This approach should be balanced with the invasive species control methods discussed in Section 8.2.3, Option BM7.

- Collect clippings and cuttings on slopes and the bottom of stormwater control facilities and near stormwater inlets. Avoid mowing when significant rain events are predicted. Dispose of material through composting when possible.

The River Conservation Plans (RCPs) recommend the following:

- High School Park to Ashbourne Road along the Tookany Creek Parkway: Educate Cheltenham Township Public Works in ecological maintenance practices. Encourage the two golf courses to evaluate fertilizing, mowing regime. Consider Audubon Golf Certification Program.

- Baeder Creek Watershed: Work with Abington Jr. High School to restore riparian buffer. Establish "no-mow" zone 30 feet from creek and plant native plants.

- <u>Rock Creek Watershed</u>: The mowed township-owned park would benefit from a change to a wooded area for both habitat enhancement and increased infiltration.
- <u>Abington Country Club to Township Line Road</u>: The Club greens should be maintained in a way to protect water quality.
- <u>Abington Friends School to Township Line Road</u>: Alter land management practices in the park to the restored pond shoreline including BMPs for the chip and putt course.
- <u>Wyoming Avenue to Castor Avenue</u>: Meet with Juniata golf course to discuss creating a "no mow" zone.

Responsible Bridge and Roadway Maintenance (CM9) Related Goals: 1, 2, 4, 7 Related Indicators: 1, 19			
What	Who	Where	When
Incorporate BMPs into regular repairs and maintenance: Road and bridge resurfacing practices, Deicing chemicals and practices, and Existing bridge drains.	Bridge and roadway owners (municipalities and PennDOT).	Roadways and bridges (Figure 8.6).	Short-term (within 5 years).

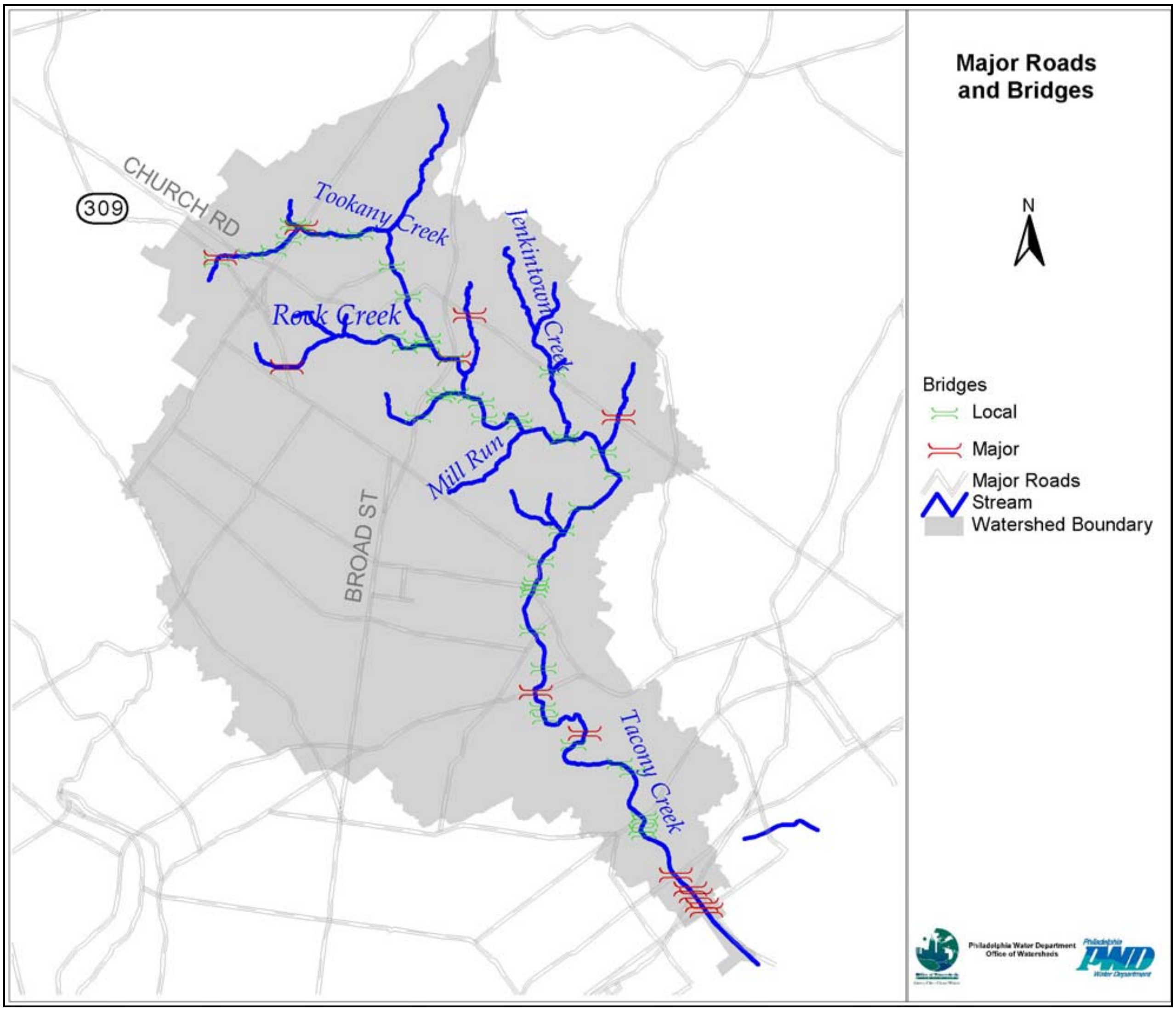


Figure 8.6 Major Roads and Bridges

Sediment and pollutants are generated during daily roadway and bridge use and scheduled repair operations, and these pollutants can impact local water quality by contributing heavy metals, hydrocarbons, sediment, and debris to stormwater runoff. The use of road salt is a public safety and a water quality issue. Aside from contaminating surface and groundwater, high levels of sodium chloride from road salt can kill roadside vegetation, impair aquatic ecosystems, and corrode infrastructure such as bridges, roads, and stormwater management devices.

Recommended techniques are as follows:

- Consider alterations to road and bridge resurfacing practices near the creeks (Figure 8.6). Perform paving operations only under dry conditions. Cover storm drain inlets and manholes during paving operations, use erosion and sediment control measures, and use pollution prevention materials such as drip pans and absorbent material for all paving machines to limit leaks and spills of paving materials and fluids. Finally, consider using porous asphalt for shoulder areas to reduce runoff.

- Consider adjusting the use and application of deicing materials as summarized below.

Table 8.19 Watershed Protection Techniques for Snow and Snowmelt Conditions

Use of De-Icing Compounds:
- Consider alternative de-icing compounds such as $CaCl_2$ and calcium magnesium acetate (CMA).
- Designate salt-free areas on roads adjacent to key streams, wetlands, and resource areas.
- Reduce use of de-icing compounds through better driver training, equipment calibration, and careful application.
- Sweep accumulated salt and grit from roads as soon as practical after surface clears.

Storage of De-Icing Compounds:
- Store compounds on sheltered, impervious pads.
- Locate at least 100 feet away from streams and floodplains.
- Direct internal flow to collection system and route external flow around shelters.

Dump Snow in Pervious Areas Where It Can Infiltrate:
- Stockpile snow in flat areas at least 100 feet from stream or floodplain.
- Plant stockpile areas with salt-tolerant ground cover species.
- Remove sediments and debris from dump areas each spring.
- Choose areas with some soil-filtering capacity.

Blow or Shovel Snow from Curbside to Pervious Areas.
Operate Stormwater Ponds on a Seasonal Mode.
Use Level Spreaders and Berms to Spread Meltwater Over Vegetated Areas.
Intensive Street Cleaning in Early Spring Can Help Remove Particulates on Roads.

- Consider alterations to existing bridge drains. Scupper drains can cause direct discharges to surface waters and have been found to carry relatively high concentrations of pollutants (CDM, 1993). At a minimum, routinely clean existing drains to avoid sediment and debris buildup, and consider retrofitting with catch basins or redirecting runoff to vegetated areas to provide treatment.

Runoff from bridges and roadways can become a serious hazard to water quality when the toxic pollutants from vehicles are taken into consideration.

The River Conservation Plans (RCPs) recommend the following:

- Ralph Morgan Park to Greenwood Avenue: Communicate with SEPTA regarding their maintenance practices of the parking lot.
- Cheltenham Avenue to Adams Avenue: Check railroad area for possible chemical runoff.

8.3.4 Target C Options: Stormwater Management

Source Control Measures

Reducing Effective Impervious Cover through Better Site Design (CS1) Related Goals: 3, 5, 7 Related Indicators: 1, 15, 16, 19			
What	Who	Where	When
Reduce effective impervious cover by approximately 1% through: Downspout disconnection. Pervious landscaping. Sidewalk and driveway width reduction. Vacant lands management.	All municipalities require and/or encourage these measures using regulatory and/or public education options discussed elsewhere in this section.	All areas.	Long term: 15+ years.

Small changes in site design can lead to a gradual reduction in effective impervious cover that becomes significant over time. When applied consistently, the measures above can result in a 5-10% reduction in areas that are redeveloped. Assuming 10% of the watershed might be redeveloped over the planning horizon, a reduction in effective impervious area of 1% is a reasonable goal. Programs to require or encourage these practices are discussed under the regulatory approaches and public education options (Sections 8.3.1 and 8.3.2, respectively).

Downspout disconnection: In highly urbanized areas of the watershed, it is not always possible to direct runoff to pervious areas, and an informal inspection of lower density areas indicates that many properties are already disconnected. However, a further reduction in directly connected roof leaders from just 10% of residences will result in an effective impervious cover reduction of about 5%.

Pervious Landscaping: When repaving parking lots and loading areas, conversion of 10% of the area in half of parking lots to pervious landscaping (a measure required by some municipalities, including Portland, OR) will decrease watershed effective impervious cover by approximately 0.5%.

Sidewalk and Driveway Width Reduction: Reducing sidewalk and driveway widths by one foot will result in a watershed effective impervious cover reduction of approximately 1%.

Vacant Lands Management: Vacant and abandoned lands in Philadelphia are gradually being acquired and demolished by the City. Proper grading of these sites to encourage infiltration, or addition of small, inexpensive BMPs if needed, can eliminate runoff from these sites during all but the largest storms. Similar techniques can be followed for vacant and abandoned lands in the other municipalities.

Porous Pavement and Subsurface Storage (CS2) Related Goals: 1, 2, 3, 4, 6, 7 Related Indicators: 1, 10, 11, 16, 19, 20			
What	Who	Where	When
Install porous pavement and subsurface storage in 10-50% of parking lots; coverage to be chosen by municipality to meet a share of watershed-wide reduction targets. Route runoff from nearby impervious cover to storage when possible.	Public and private parking lot owners.	See Figure 8.7.	Long-term: 15+ years

As discussed in Section 7.2.3, subsurface storage under parking lots is one of the most feasible and effective ways to create storage and promote infiltration in a highly urbanized environment. Porous pavement is an effective way of directing parking lot runoff to storage, but more conventional inlets or grates are also possibilities. The depth of storage is important. Whenever possible, runoff from nearby impervious areas should be routed into the storage under nearby parking lots. When this is not possible, only a few inches of gravel are needed to store a chosen design storm. Storage designs always include an overflow mechanism for very large storms.

The total parking lot area in the TTF Watershed is estimated at 1039 acres in the combined-sewered portion and 623 acres in the separate-sewered portion. Philadelphia has approximately 75% of parking lot area in the watershed. Other municipalities with large parking lot areas are Cheltenham Township (16%), Abington Township (7%), and Jenkintown Borough (2%). Other municipalities have smaller percentages as listed in Figure 8.8.

Because this BMP is believed to be the most important, an ambitious target is proposed. Begin with demonstration projects on public land. Over the long term, convert 10%-50% of parking lots watershed-wide to porous pavement with subsurface gravel storage.

There are a variety of approaches for implementing porous pavement and other structural BMPs. Regulatory and incentive-based approaches were discussed under low-impact redevelopment (see Option CR2, in Section 8.3.1). Distribution of structural BMPs may also be incorporated in a pollution trading program.

- Install demonstration projects in public parking lots.
- Consider requiring all parking lots to be retrofitted with porous pavement (or other drainage mechanisms) and subsurface storage when they are redone. Private land owners cannot be expected to bear the entire cost of this approach; municipalities should consider funding the additional cost of these changes either directly or through tax incentives.

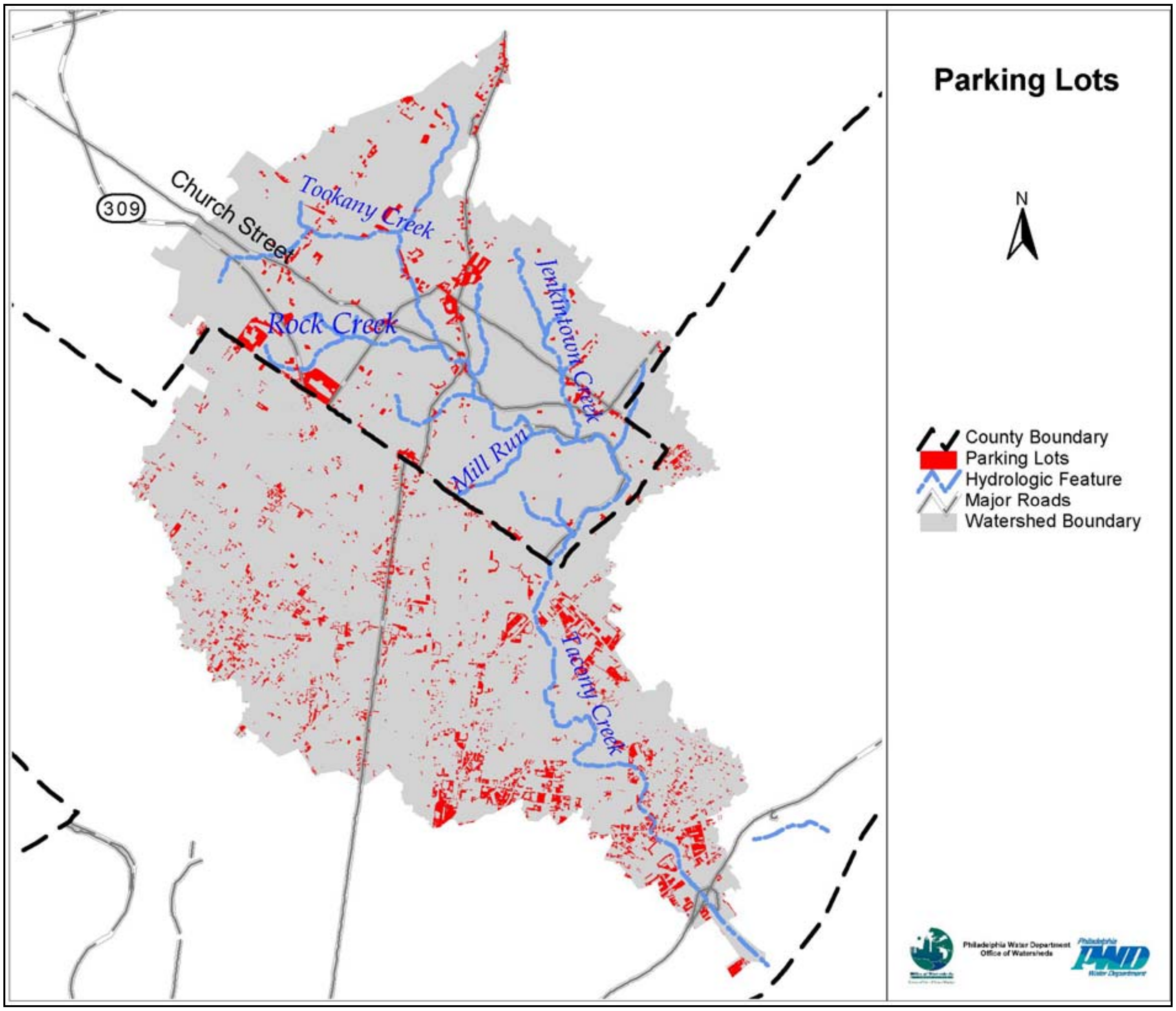


Figure 8.7 Parking Areas in Tookany/Tacony-Frankford Creek Watershed

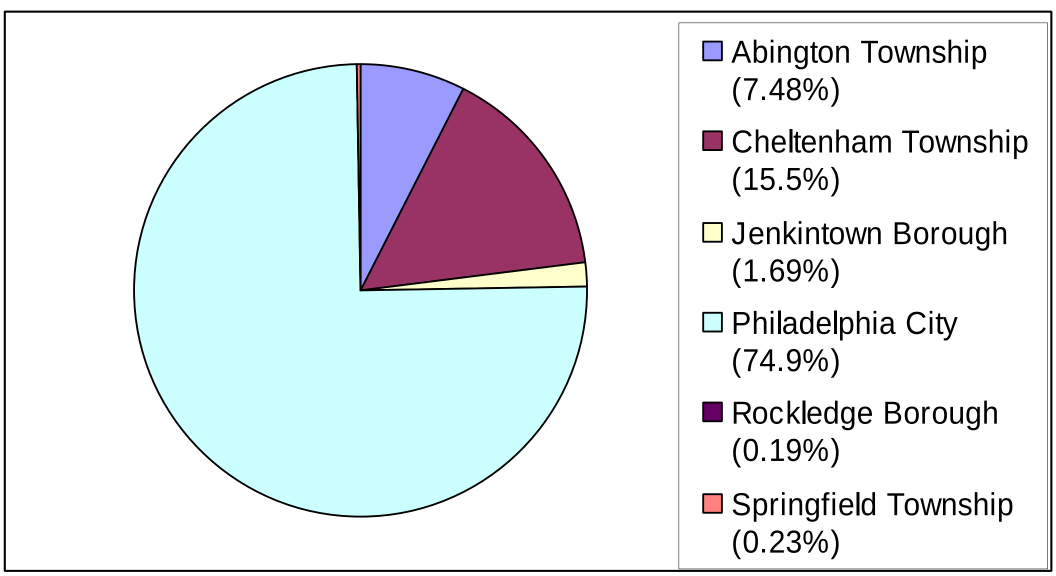


Figure 8.8 Percent of Total Parking Area by Municipality

The River Conservation Plans (RCPs) recommend the following:

- Greenwood Avenue to Wyncote Post Office: If parking lots are renovated, use pervious material to reduce pollutants from washing into creek.

Green Rooftops (CS3) Related Goals: 1, 2, 4, 6, 7 Related Indicators: 1, 16, 18, 19, 20			
What	Who	Where	When
Green rooftop demonstrations. Targeted public information campaign on advantages of green roofs. Feasibility study and green roof implementation plan.	PWD	Appropriate public buildings chosen by PWD.	Medium term: 5-15 years.

The analyses in Section 7.2.3 indicate that green rooftops, while highly effective at detaining and evaporating stormwater, are not currently a cost-effective option for the Tookany/Tacony-Frankford Watershed. However, there is the potential for them to become more cost-effective in the future. As more successful demonstration projects are implemented in the United States, the materials and construction techniques will become more common and the economies of scale will improve. To facilitate this long-term change locally, this plan recommends that Philadelphia take the lead and implement one or more projects on public buildings in the City. Along with this project, we recommend a feasibility study of the potential for a larger-scale green roof program throughout the watershed. The feasibility study will form the basis for future recommendations when this plan is revised. In addition, we recommend a public relations campaign to change the perceptions of citizens, public officials, and contractors.

Capturing Roof Runoff in Rain Barrels or Cisterns (CS4) Related Goals: 1, 2, 4, 6, 7 Related Indicators: 1, 16, 18, 19			
What	Who	Where	When
Install rain barrels on 5 - 25% of homes; coverage to be chosen by municipality to meet a share of watershed-wide reduction targets.	Homeowners through municipal incentive and education programs.	Homes where dry wells are not feasible.	Medium term: 5-15 years.

The Tookany/Tacony-Frankford Watershed Partnership initiated a rain barrel project in 2002, which placed 215 rain barrels at homes throughout the watershed. Rain barrels can be an effective stormwater management tool if they are properly designed and maintained. For detention of residential roof runoff, dry wells are the preferred technique because they have a larger capacity, require no maintenance, and allow more infiltration. Rain barrels are recommended as a secondary technique in areas where dry wells are infeasible. Proper design, including an appropriate slow release, is the responsibility of the municipality or non-profit group leading the rain barrel program. Proper maintenance is accomplished through an intensive public education campaign and series of workshops. An ambitious target is to install rain barrels on 5-25% of homes within a small subshed of "sewershed" area within the watershed in the medium term.

Increasing Urban Tree Canopy (CS5) Related Goals: 1, 2, 4, 6, 7 Related Indicators: 1, 4, 13, 16, 17, 18, 19, 20			
What	Who	Where	When
Increase tree canopy in the watershed from 27% to 32%.	Municipalities (through ordinances, education, and incentive programs affecting land owners).	Private property, parking lots, streets. Parks (riparian corridors under Target B, Section 8.2).	Medium-term (5-15 years).

Tree planting and urban reforestation programs provide hydrologic benefits in addition to quality of life improvements. Leaf surfaces intercept some rainfall that might otherwise fall on impervious surfaces. The rainfall then either evaporates or is conveyed more slowly to the ground along plant stems and trunks. American Forests has assessed tree canopy in the TTF Watershed at 27% (report “Urban Ecosystem Analysis, Delaware Valley Region” available at www.americanforests.org). American Forests recommends the following levels of tree canopy coverage for urban watersheds:

- 40% overall
- 50% in suburban residential zones
- 25% in urban residential zones
- 15% in central business districts

A goal of increasing tree canopy by 5% of the watershed over the medium term was selected as a feasible implementation level. Several regulatory and incentive-based strategies to achieve these goals are listed below. (Also see Option CR2 in Section 8.3.1 on Regulatory Approaches.)

- Requirements to protect existing trees on private property, or creation of “tree banks” to offset loss.
- Tree credits for redevelopers as part of impervious cover requirements or incentives. The City of Portland, Oregon has given developers an impervious cover credit equal to 25% of tree canopy over impervious area.
- Parking lot landscaping or shade requirements.
- Reforestation in parks and along the stream corridor.
- Increases in the number of trees along public streets and on vacant lots. The City of Philadelphia is taking this approach as part of its Green City Strategy.

Tree canopy over an additional 5% of impervious cover will result in an effective impervious cover reduction of approximately 2% over the watershed.

Municipalities with tree related ordinances are shown in Table 8.20.

Table 8.20 Landscape and Tree Related Ordinances

Municipality	Landscaping	Shade Tree/ Street Trees	Wooded Lots*	Tree Advisory Commission	Comments
Abington Township	X	X	X		Buffer areas; tree-planting requirements (streets/parking lots); open space standards/preservation.
Cheltenham Township		X	X	X	Buffer areas; green areas; Tree Commission regulations; Preservation Overlay District.
Jenkintown Borough		X		X	Shade tree-planting desirable along streets; Tree Commission regulations.
Philadelphia County	X	X		X	Fairmount Park Commission regulations; required tree/landscaping ratios in certain residential districts.
Rockledge Borough	X	X			Residential landscaping/buffer area requirements; parking buffer areas for Institutional District; common open space preservation.

Source*:** www.ordinance.com**,** ***Delaware Valley Regional Planning Commission

* Note: “Wooded Lots” refers to any ordinance directly involving the preservation of open space/undisturbed natural areas. Most of the municipality ordinances included the intention of open space preservation under general goals.

Forming a tree commission is one way of implementing an urban forestry program in Pennsylvania. The powers and responsibilities of a tree commission are based on state statute and are assumed by local government. By forming and empowering a tree commission, a community can empower and motivate volunteers to run an effective urban forestry program. Tree commissions are either advisory or administrative and may have various responsibilities, including the following:

- Advise community leaders and staff on administering the community forest.
- Stimulate and organize tree planting and maintenance.
- Develop and implement urban forest inventories, management plans, and ordinances.
- Lessen liability by arranging to remove hazardous trees and repair damage caused by trees.

In Pennsylvania, a tree commission created by municipal ordinance as a decision-making body has exclusive control over a community’s shade trees. No tree can be planted or removed within the public right-of-way except under the auspices of the tree commission. This includes public trees that may be planted or removed in conjunction with subdivisions or approved development plans. Tree commissions can be given additional power within a municipality by a council, including:

- Control over all public trees such as trees within community parks.
- Review and approval of landscaping proposed in development plans.

The formation and empowerment of a tree commission can be a crucial element in developing broad-based support for community trees and ensuring long-term success and continuance of a community forestry program. (For more information, contact the Extension Urban Forestry Program, School of Forest Resources, The Pennsylvania State University, 108 Ferguson, University Park, PA 16802, or call 814-863-7941.)

Onsite and Regional Stormwater Control Facilities

Maintaining/Retrofitting Existing Stormwater Structures (CS6) Related Goals: 1, 2, 3, 4, 5, 7 Related Indicators: 4, 11, 15, 19			
What	Who	Where	When
Inventory structures. Assess potential for increased infiltration.	Municipalities.	Entire watershed.	Short term (within 5 years).

PWD performed an inventory of existing privately owned stormwater control basins in 2000. The results of this study indicate seven confirmed structures within the Philadelphia portion of the watershed. Other municipalities are asked to inventory and inspect existing stormwater control structures. Although this is not an explicit requirement of the Act 167 program, it is a reasonable task to include within the Act 167 framework. Older dry and wet detention basins may have been designed to reduce flood peaks but not to facilitate infiltration; this approach helps prevent property damage but may actually increase stream erosion. In some cases, it may be possible to retrofit these older basins to allow infiltration. Specific guidance on retention times and design recommendations will be included in the Act 167 Plan.

Retrofitting Existing Sewer Inlets with Dry Wells (CS8) Related Goals: 3, 5, 7 Related Indicators: 11, 15, 19			
What	Who	Where	When
Retrofit 5 - 100% of existing stormwater catch basins in the combined sewered area to provide storage and allow infiltration.	PWD	5 - 10% of existing inlets in combined-sewered areas.	Long-term: 15+ years.

As discussed in Section 7 (especially Section 7.2.3), retrofitting existing sewer inlets with dry wells is an expensive but effective measure in combined-sewered areas. Each inlet provides small amounts of storage and detention; distributed over a significant area, these measures reduce the number and duration of overflows.

During the first permit cycle that this plan is in effect, inlets that are being repaired or replaced can be retrofitted at the same time. If, after the first five years, the program is not on track to affect the targeted number of inlets in 15 years, existing inlets in good condition may be retrofitted.

Residential Dry Wells, Seepage Trenches, and Rain Gardens (CS9) Related Goals: 1, 2, 3, 4, 5, 6, 7 Related Indicators: 1, 11, 15, 16, 17, 19			
What	Who	Where	When
Install dry wells in 5-10% of residential yards; coverage to be chosen by municipality to meet a share of watershed-wide reduction targets. Install water gardens on school grounds.	Municipalities. School boards.	Dry wells throughout watershed. Water gardens in school yards with enough space.	Long term: 15+ years.

Routing residential roof runoff to dry wells is recommended as a priority control for the Tookany/Tacony-Frankford Watershed. Dry wells are cost-effective, can potentially affect a large portion of impervious cover, and require virtually no maintenance. They are clearly applicable in the lower density residential areas but can also be installed in some higher density areas; only a small lawn area is necessary. A properly sited and designed dry well will not cause basement flooding. Where soil conditions are insufficient to infiltrate all roof runoff, excess flows can be routed to a combined or sanitary sewer. Because dry wells are a priority control, they are recommended for implementation in the yards of 5%-10% of all homes in the watershed.

Rain gardens are recommended for implementation on school grounds, where they can both promote infiltration and educate students about stormwater management.

The River Conservation Plans (RCPs) recommend the following:

- High School Park to Ashbourne Road along the Tookany Creek Parkway: Incorporate stormwater infiltration devices.
- Rock Creek Watershed: Incorporate stormwater infiltration devices especially in commercial areas.

Bioretention Basins and Porous Media Filtration (CS12) Related Goals: 1, 2, 3, 4, 5, 7 Related Indicators: 1, 7, 8, 9, 15, 19, 20			
What	Who	Where	When
Install bioretention and/or sand filters in 10-50% of parking lots; coverage to be chosen by municipality to meet a share of watershed-wide reduction targets.	Public and private parking lot owners.	Everywhere in watershed.	Long-term: 15+ years. Focus on redevelopment.

The screening and detailed evaluation analyses in Section 7 targeted parking lot runoff for widespread implementation of BMPs. The preferred approach for parking lots is to route runoff to subsurface gravel storage through porous pavement, inlets, or grates. However, there will be cases where that approach is not feasible. The second preferred alternative is to direct parking lot runoff to a bioretention basin and/or a porous media filter. These systems infiltrate smaller storms completely, detain larger storms, and provide effective water quality treatment in separate sewered areas. 10-50% of parking lots are targeted for retrofit with bioretention. Over the long term, it is the goal to retrofit as many parking lots as possible with either subsurface storage or bioretention. However, private land owners should not necessarily be expected to bear the entire cost of this approach; municipalities should consider funding the additional cost of these changes either directly or through tax incentives.

The River Conservation Plans (RCPs) recommend the following:

- Holy Sepulchre Cemetery to Ralph Morgan Park: Incorporate stormwater filtration devices.
- Abington Country Club to Township Line Road: The stormwater management facilities for the parking lots should be examined to see if BMPs are being used to help reduce runoff.

Treatment Wetlands: Onsite and Regional (CS13) Related Goals: 1, 2, 3, 4, 7 Related Indicators: 1, 10, 11, 13, 19			
What	Who	Where	When
Create or enhance wetlands to treat as much runoff as possible in Philadelphia and Montgomery County.	Municipalities.	See Figure 8.4 for proposed sites.	Medium term: 5-15 years.

Wetland creation and enhancement has benefits in terms of habitat, water quality, and water quantity. These benefits as well as proposed sites are discussed extensively under Option BM6, in Section 8.2.3.

8.3.5 Monitoring and Reporting

Monitoring, Reporting, and Further Study (CMR) Related Goals: 7 Related Indicators: 16, 17, 19			
What	Who	Where	When
Monitoring of implementation and benefits for all Target C options.	City of Philadelphia and Municipalities.	Watershed-wide.	Annually beginning after the first year of implementation is initiated

The preceding are a series of implementation options identified as initial measures geared toward meeting Target C. This Target will be more difficult to achieve than Targets A and B as it entails meeting all water quality standards during wet weather, as well as eliminating all flooding. Based on the extensive modeling analysis carried out for Tookany/Tacony-Frankford Creek to date, an initial goal of a 20-25% reduction in stormwater flows and stormwater/CSO related pollutant loads has been identified as a challenging but achievable goal.

The suggested approach to full achievement of Target C goals is through the use of adaptive management while utilizing stepped implementation with interim targets for reducing wet weather pollutant loads and stormwater flows. During implementation, monitoring must continuously assess the effectiveness of the program. Based on monitoring results of each option, recommendations will be made for future implementation. It is expected that changes to the approach, or potentially even to the desired results, will occur as measures are implemented monitored.

Section 9
Cost and Institutional Analysis

This section presents cost estimates for the various recommended "management options," and for the full set of Implementation Guidelines (from Section 8). Those cost estimates are then broken down by county and by municipality within the TTF Watershed. Finally, the section outlines the primary roles and responsibilities for the various levels of stakeholders in the implementation of the TTFIWMP.

9.1 Estimated Cost of Implementation

Planning-level costs have been developed for many of the recommended options. Because costs are highly dependent on site specific conditions as well as the extent to which implementation occurs, costs included in this section are only approximate. These costs are useful, however, in providing order of magnitude funding needs, and also as a comparison to potential costs associated with more traditional approaches to CSO control, such as large scale storage tanks designed to reach the 85% capture goal. Planning level costs are provided for each of the options discussed under the three Targets.

The combination of structural BMPs and implementation percentages in this section are suggested as a feasible plan that will equal or exceed the 20% discharge reduction target. The exact combination of BMPs implemented in each area of the watershed will be determined by local municipalities or by a government or institutional body to be chosen at a later time.

Order-of-magnitude, planning-level cost estimates are shown in Tables 9.1 through 9.4. For structural stormwater BMPs, cost estimates are based on an assumed "feasible implementation" percentage shown in Table 7.5 (in Section 7.2.3) and also Table 8.13 (Section 8.3).

Table 9.1 Planning-Level Cost Estimates for Target A Options

	Total		Philadelphia		Montgomery County	
	Annual Cost	One-Time	Annual Cost	One-Time	Annual Cost	One-Time
Regulatory Approaches						
AR1 On-Lot Disposal (Septic System) Management	$50,000				$50,000	
AR2 Pet Waste, Litter, and Dumping Ordinances[1]						
Public Education and Volunteer Programs (AP1-3)	$1,005,000		$814,044		$190,644	
Municipal Measures						
AM1-4 Sewer Evaluation, Cleaning, and Rehabilitation[2]	$909,000	$41,121,000	$455,000	$20,592,000	$454,000	$20,529,000
AM5 Illicit Discharge, Detection, and Elimination (IDD&E)		$6,022,000				$6,022,000
AM6 Stream Cleanup and Maintenance	$107,000	$96,000	$24,000	$21,000	$83,000	$75,000
AO1 Enhancing Stream Corridor Recreational and Cultural Resources[1]						
AMR Monitoring, Reporting, and Further Study[3]	$17,000		$17,000			
Total Cost for Target A Options	$2,088,000	$47,239,000	$1,310,044	$20,613,000	$777,644	$26,626,000
Cost per acre for Target A Options	$99	$2,246	$108	$1,693	$88	$3,008

1 - Already in place in most locations, or costs difficult to quantify.

2 - Includes CMOM, NMCs, inspection and cleaning, and rehabilitation of combined and sanitary sewers.

3 - Field monitoring cost.

Table 9.2 Planning-level Costs for Target B Options

	Total		Philadelphia		Montgomery County	
	Annual Cost	**One-Time**	**Annual Cost**	**One-Time**	**Other Counties**	**One-Time**
Channel Stability and Aquatic Habitat Restoration						
BM1 Bed Stabilization and Habitat Restoration[1]	$3,000	$8,131,000	$1,000	$4,066,000	$1,000	$4,066,000
BM2 Bank Stabilization and Habitat Restoration[1]	$3,000	$8,131,000	$1,000	$4,066,000	$1,000	$4,066,000
BM3 Channel Realignment and Relocation[1]	$3,000	$8,131,000	$1,000	$4,066,000	$1,000	$4,066,000
BM4 Plunge Pool Removal[2]						
BM5 Improvement of Fish Passage[3]						
Lowland and Upland Restoration and Enhancement						
BM6 Wetland Creation and Enhancement[2]						
BM7 Invasive Species Management[2]						
BM8 Biofiltration[2]						
BM9 Reforestation[4]						
BMR Monitoring, Reporting, and Further Study[5]	$17,000		$17,000			
Total Cost for Target B Options	$26,000	$24,393,000	$20,000	$12,198,000	$3,000	$12,198,000
Cost per acre for Target B Options	$1.2	$1,160	$1.6	$1,002	$0.3	$1,378

1 - Based on restoration of high-priority reaches at $700/ft. If actual cost is lower, medium priority reaches may also be restored.

2 - Cost considered under options BM1, BM2, and BM3.

3 - Not evaluated; recommended as a longer-term option.

4 - Cost included in Target V urban tree canopy cost.

5 - Field monitoring cost.

Table 9.3 Planning-level Costs for Target C Options

	Total		Philadelphia		Montgomery County	
	Annual Cost	**One-Time**	**Annual Cost**	**One-Time**	**Annual Cost**	**One-Time**
Regulatory Approaches						
CR2 Requiring Better Site Design in Redevelopment[1]		$300,000		$100,000		$200,000
CR3, CR6 Stormwater and Floodplain Management[1]		$300,000		$100,000		$200,000
CR4 Industrial Stormwater Pollution Prevention[2]						
CR5 Construction Stormwater Pollution Prevention[2]						
Municipal Measures						
CM1 Sanitary Sewer Overflow Detection[3]						
CM2 Sanitary Sewer Overflow Elimination: Structural Measures[3]						
CM3 Reduction of Stormwater Inflow and Infiltration to Sanitary Sewers[3]						
CM4 Combined Sewer Overflow (CSO) Control Program[4]		$2,400,000		$2,400,000		
CM5 Catch Basin and Storm Inlet Maintenance	$816,000		$545,000		$271,000	
CM6 Street Sweeping	$135,000		$45,000		$90,000	
CM7 Responsible Landscaping Practices on Public Lands[2]						
CM9 Responsible Bridge and Roadway Maintenance[2]						

1 - Estimated cost for ordinance development.

2 - Already in place in most locations, or costs difficult to quantify.

3 - Cost included in options AM1-5.

4 - Includes real time control cost only; other aspects of program included in options AM1-5.

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Table 9.3 Planning-level Costs for Target C Options (continued)

	Total		Philadelphia		Montgomery County	
	Annual Cost	One-Time	Annual Cost	One-Time	Annual Cost	One-Time
Stormwater Management						
Source Control Measures						
CS1 Reducing Effective Impervious Cover Through Better Site Design[5]						
CS2 Porous Pavement and Subsurface Storage[5]		$30,689,000		$10,985,000		$19,705,000
CS3 Green Rooftops[5]	$100,000	$1,000,000	$100,000	$1,000,000		
CS4 Rain Barrels and Cisterns[5]		$622,000		$424,000		$199,000
CS5 Increasing Urban Tree Canopy[5]	$2,000,000	$20,000,000	$1,000,000	$10,000,000	$1,000,000	$10,000,000
Onsite and Regional Stormwater Control Facilities						
CS6 Maintaining/Retrofitting Existing Stormwater Structures[5]	$140,000	$14,000	$70,000	$7,000	$70,000	$7,000
CS8 Retrofitting Existing Sewer Inlets with Dry Wells[5]		$454,000		$454,000		
CS9 Residential Dry Wells and Rain Gardens[5]		$8,476,000		$5,346,000		$3,130,000
CS12 Bioretention and Porous Media Filtration[5]		$7,910,000		$2,831,000		$5,079,000
CS13 Treatment Wetlands: Onsite and Regional[5]	$850,000	$4,562,000	$425,000	$2,281,000	$425,000	$2,281,000
Use Review and Attainability Analysis		$100,000		$100,000		
CMR Monitoring, Reporting, and Further Study	$17,000		$17,000			
Total Cost for Target C Options	$4,058,000	$76,827,000	$2,202,000	$36,028,000	$1,856,000	$40,801,000
Cost per acre for Target C Options	$193	$3,653	$181	$2,958	$210	$4,610

1 - Estimated cost for ordinance development.

2 - Already in place in most locations, or costs difficult to quantify.

3 - Cost included in options AM1-5.

4 - Includes real time control cost only; other aspects of program included in options AM1-5.

5 - Implementation levels taken from Section 8, Implementation Guidelines.

Table 9.4 Total Watershed Plan Cost

Total		Philadelphia		Montgomery County	
Annual Cost	One-Time	Annual Cost	One-Time	Annual Cost	One-Time
$6,172,000	$148,459,000	$3,532,000	$68,839,000	$2,637,000	$79,625,000
$290/ac	$7,060/ac	$290/ac	$5,650/ac	$300/ac	$9,000/ac

9.2 Distribution of Costs by Political Boundary

In addition to total estimated costs associated with the TTFIWMP, it is useful to express the costs on an annual basis and in the context of acreage and number of households affected. Presenting costs this way allows comparison to existing wastewater infrastructure-related costs supported by users and taxpayers. Those cost estimates are presented by county and by municipality, below.

9.2.1 Distribution of Costs by County

Table 9.5 compares projected costs on a per-acre basis and per-household basis in the City of Philadelphia and outside the City of Philadelphia. The table shows costs on an annual basis, using a 20-year period to pay off the capital costs. Philadelphia pays approximately 50% of the total annual cost (line 3), while representing approximately 60% of the watershed area. On a per-acre basis, costs within Philadelphia are approximately 70% of costs outside the City. This difference occurs because of the greater land area and length of stream outside Philadelphia. (An illustrative distribution of costs among municipalities in the watershed is shown in Section 9.2.2.)

Table 9.5 Affordability Impact by County

	Philadelphia	Montgomery County
(1) One-Time Cost (Annualized)	$3,338,000	$3,875,000
(2) Annual Cost	$2,598,733	$2,268,386
(3) Total Annual Cost Associated with WMP	$5,936,733	$6,143,386
(4) Cost per acre in watershed	$487	$694
(5) 2000 Median Household Income	$30,746	$59,621
(6) Estimated Annual Sewer User Charge*	$343	$250
(7) WMP cost per household in watershed (in entire municipalities)	$52.53 ($10.06)	$258.93 ($157.00)
(8) WMP cost as % of mean household income in watershed (in entire municipalities)	0.17% (0.03%)	0.43% (0.26%)
(9) Existing sewer cost + WMP cost in watershed (entire municipalities)	1.59% (1.15%)	0.62% (0.46%)

* *The sewer user charge in Philadelphia includes a stormwater collection and treatment fee. Stormwater-related charges outside Philadelphia were not investigated.*

In addition to showing costs per unit area, it is useful to express costs on a per-household basis. Line 7 in Table 9.5 expresses cost per household, assuming only households inside the watershed boundaries would be required to pay. This comparison is made because improvements occur, and citizens benefit, primarily within the watershed boundaries. Expressed in this manner, the cost is greater for households outside Philadelphia (line 7, outside parentheses); because of greater population density within the urban watershed, there are more households to distribute the cost among inside the City. Line 8 of Table 9.5 expresses the per-household cost inside the watershed boundary as a percentage of mean household income (line 8, outside parentheses).

While expressing costs in terms of households inside the watershed boundary allows direct comparison between communities, it is also useful to express costs on the basis of all households within the boundaries of municipalities that intersect the watershed. Currently, most funding and institutional mechanisms occur on a municipal basis. For example, a given township may use a percentage of all water and sewer bills paid to finance improvements related to the TTFIWMP, including bills paid by households outside the TTF watershed boundary.

The numbers in parentheses on lines 7 through 9 of Table 9.5 present the costs in terms of all residents of municipalities intersecting the watershed. These costs are lowest in Philadelphia because it has the greatest number of households; all households paying sewer bills will pay approximately 0.03% of household income to support the TTFIWMP, compared to 0.26% for the remaining communities. Compared to the other municipalities, Philadelphia has many more households to spread the cost of the TTFIWMP over, but will ultimately have additional watersheds that will require management activities. Over time and on a regional basis, watershed management costs are expected to approach 0.3% to 0.5% of mean household income within affected communities.

The costs associated with the TTFIWMP are generally incremental to existing maintenance and management activities associated with water-related infrastructure. Therefore, it is useful to add the TTFIWMP cost to current wastewater charges paid by households to obtain an approximate measure of the total annual cost of watershed and water-related infrastructure management. These costs, shown in the final line of Table 9.5, range from approximately 0.6% to 1.6% of mean household income regionally.

9.2.2 Distribution of Costs by Municipality

Tables 9.6 and 9.7, below, provide data to assist communities in placing projected TTFIWMP costs in a local context. Table 9.6 expresses estimated costs for communities per acre and per household inside the watershed boundaries; Table 9.7 presents costs within the boundaries of all municipalities that intersect the watershed. For the purposes of this illustrative example of cost distribution, general, watershed-related costs for communities outside of Philadelphia are apportioned according to the percentage of the watershed area within each municipality's jurisdiction.

These cost tables are but one illustration of a possible cost distribution, and are provided to aid municipalities in deciding what funding and institutional mechanisms may be most appropriate given local conditions.

Table 9.6 Affordability Impact by Municipality – Rate Payers in TTF Watershed

	Abington	Cheltenham	Jenkintown	Philadelphia	Rockledge
Municipality area in watershed (ac)	2,712	5,691	367	12,178	81
Area of municipality in watershed (% of municipality total)	27%	98%	99%	13%	37%
Households in municipality and watershed	7,147	14,218	2,013	113,022	348
Annual cost associated with TTFWMP	$807,899	$1,695,749	$109,277	$3,532,000	$24,075
Cost per acre (within watershed)	$297.95	$297.95	$297.95	$290.03	$297.95
Cost per household (within watershed)	$113.04	$119.27	$54.29	$31.25	$69.18
Median household income ($/year)	$59,921	$61,713	$47,743	$30,746	$47,958
Cost per household (% of MHI)	0.19%	0.19%	0.11%	0.10%	0.14%

Table 9.7 Affordability Impact by Municipality – All Rate Payers in Municipality

	Abington	Cheltenham	Jenkintown	Philadelphia	Rockledge
Municipality area (ac)	9,893	5,779	369	91,287	219
Watershed area in municipality (ac)	2,712	5,691	367	12,178	81
Watershed area in municipality (% of watershed total)	12.9%	27.1%	1.7%	57.9%	0.4%
Households in municipality	21,690	14,346	2,035	590,071	1,060
Annual cost associated with TTFIWMP	$807,899	$1,695,749	$109,277	$3,532,000	$24,075
Cost per acre (whole municipality)	$81.66	$293.42	$296.36	$38.69	$109.91
Cost per household (whole municipality)	$37.25	$118.20	$53.70	$5.99	$22.71
Median household income ($/year)	$59,921	$61,713	$47,743	$30,746	$47,958
Cost per household (% of MHI)	0.06%	0.19%	0.11%	0.02%	0.05%

9.3 Institutional Analysis

The primary purpose of Section 9 of this plan is to provide recommendations and guidance to stakeholders - primarily state, county, and other government agencies, municipalities, non-government organizations, land owners, and individuals - on ways to better manage the water resources of Tookany/Tacony-Frankford Creek. Everyone in the watershed communities can contribute in numerous ways to the protection of water resources.

Both government and non-government organizations will play a role in the successful implementation of the Tookany/Tacony-Frankford Integrated Watershed Management Plan. The primary roles are outlined below.

9.3.1 PA DEP Role

Two agencies of the Commonwealth of Pennsylvania are directly and indirectly involved in watershed planning in the TTF Watershed: the Department of Environmental Protection (PA DEP) and the Department of Conservation and Natural Resources (DCNR). Achievement of Watershed Plan goals through local implementation will require continued support through funding and integration of the various existing state level stormwater management and runoff related programs. Particular attention should be paid to the following programs:

- Act 167 Plans
- Phase II Stormwater permits
- Act 537 / CMOM Plans
- Construction Stormwater Pollution Prevention
- Industrial Stormwater Pollution Prevention
- Watershed monitoring and performance reporting
- Watershed permitting opportunities

A critical PA DEP role will be activities required under Section 303(d) of the Clean Water Act and the EPA's Water Quality Planning and Management Regulations (40 CFR Part 130). PA DEP will need to actively administer the water quality standards process for portions of the Tookany/Tacony-Frankford Creek in the near future. PA DEP should be active in encouraging municipalities to carry out the requirements of Phase II stormwater permits and Act 167 requirements. This plan provides the blueprint for effectively integrating both programs, and addressing water quantity and quality goals.

9.3.2 PWD Role

PWD, as the primary author of this plan, plays a central role in its implementation, as well as in continued monitoring to chart improvements to water quality. PWD will take a lead role in implementing a variety of the recommendations, including;

- Stream restoration
- Improvement of fish passage
- CSO Control

- Green rooftop demonstrations
- Stormwater BMP installation
- Organization of stakeholder participation
- Monitoring

9.3.3 Municipal Role

Municipalities can play a key role in the implementation of recommendations through the incorporation of water resource strategies into their land use planning and governance functions. Because of the authorities contained in the Pennsylvania Municipalities Planning Code (MPC), municipalities are one of the two main foci of implementation efforts (PWD being the other). Enabled by the MPC, municipalities are the focal point to address runoff from redeveloped and existing developed lands, to address problems associated with sanitary sewer collection systems, to enhance recreational opportunities, and to protect natural resources from the effects of land disturbance.

The most fundamental roles recommended for municipalities are to consider undertaking a comprehensive review of their existing land use regulations, policies, and requirements to identify where they may be unnecessarily causing impacts to water resources, and to undertake the necessary actions needed to eliminate SSOs and sanitary sewer leaks.

The primary actions recommended for municipalities include: encouraging disconnection of roof leaders from storm sewers, reduction of expansive paved (impervious) parking lot requirements and replacement of asphalt with porous paving surfaces or the installation of bioretention structures to handle parking lot stormwater runoff, repair and maintenance of leaking sanitary sewers, and the elimination of SSOs. Municipalities also might consider creating an Environmental Advisory Council (EAC), which is possible under Pennsylvania General Assembly enabling legislation - Act 148 of 1973. The EAC could then participate in the implementation of the plan, and help to coordinate the approach among all the municipalities within the watershed.

9.3.4 County Role

An important role of Montgomery County is to conduct the necessary comprehensive stormwater management studies to:

- Complete an Act 167 stormwater plan that is consistent with and furthers the achievement of the goals and objectives of the TTFIWMP.
- Work with municipalities to update Act 537 plans.

In addition, the Montgomery County Conservation District has several important responsibilities within the watershed, including:

- Chapter 102 Erosion Control: Administer the State's program to control sediment pollution from earth disturbance activities.
- National Pollution Discharge Elimination System (NPDES): Process applications and seek compliance towards stormwater discharge permits for Construction Activities.

- Chapter 105 Waterways and Wetlands General Permitting: Assist applicants with permit information. Process general permits for work within wetlands and streams.

These are important elements in coordinating Act 167 planning requirements with Phase II of the NPDES Stormwater Program.

9.3.5 Non-Government Organization Role

The Tookany/Tacony-Frankford Watershed Partnership will be critical to the successful implementation of the TTFIWMP. As noted in the introduction to Section 9, this newly incorporated watershed organization has formed with the purpose of implementing the recommendations of the TTFIWMP. With representatives of the two counties, several municipalities, and various non-profit organizations making up the Board of Directors of this organization, the vehicle for coordination and collaboration now exists.

Some of the primary functions of the newly formed organization could include:

- Creating a watershed-wide implementation plan and receiving approval from watershed municipalities. This approval includes obtaining signatures from municipalities followed by a letter of support from PA DEP.
- Overseeing the continued implementation of basic, essential services required of all municipalities by stormwater permits (e.g., sewer system maintenance).
- Overseeing continued monitoring, sampling, data analysis, and reporting on both the water quality and biology of the system using the established indicators.
- Providing public participation and public education opportunities (both workshops and other types of participatory programs).
- Exploring innovative solutions to long-term operation and maintenance of stormwater management facilities.
- Requiring that projects within the watershed area applying for state funding (Growing Greener, DCNR) must be reviewed and shown to be consistent with the TTFIWMP. The organization would review all submitted projects and apply a rating scale for consistency with the plan.
- Encouraging the idea of applying for federal funding for regional projects (e.g., stream restoration, regional wetlands); however, most smaller-scale projects would be funded locally. Public funding for major infrastructure projects on private land could be explored.

Another role for the new organization would be created if the State sets up a watershed-based permitting experiment in the watershed. The organization could then function as a Watershed Compliance Association (WCA). A WCA is a Commonwealth-created non-profit entity comprised of public and private entities that hold individual NPDES permits or General Permits to discharge to the creeks. A WCA is specifically created to implement watershed based permitting. The WCA would constitute a point of contact between PA DEP and its co-permittee members on issues related to the group permit for the parameter(s) of concern, once a TMDL is established in the watershed. If the WCA exceeds its parameter limit (load) for the year, the

Association would be out of compliance, and any co-permittee member that exceeds its individual load limit would also be out of compliance and subject to enforcement action. Through the group approach, however, pollution trading can be easily implemented.

9.3.6 Land Owners' Role

Voluntary watershed stewardship by all land owners can contribute significantly toward the protection and restoration of the Tookany/Tacony-Frankford Watershed while simultaneously minimizing the need for additional regulatory controls. Recommended roles for land owners include:

- Implementing "watershed stewardship" practices in their landscape and outdoor housekeeping practices.
- Disconnecting roof leaders and installing rain barrels or dry wells.
- Considering pervious solutions for driveways.
- Joining and supporting the activities of the TTF Watershed Partnership.

Appendix A: Glossary of Terms

Acute	Describing an effect or response, such as toxicity, that is measured or occurs over a relatively short amount of time; not chronic.
Adaptive management	Process of continually monitoring progress and adjusting the approach.
Algae	Any of a number of several groups of single-celled or multi-cellular organisms, all of which lack leaves, roots, flowers, and other organ structures that characterize higher plants.
Ammonia/ Ammonium	A Nitrogen-containing molecule that exists naturally in both gaseous (NH3) and ionized (NH_4+) forms. The gaseous form is corrosive and toxic, while the ionized form is a usable source of nitrogen for plant growth. Ammonia may be produced by decomposition of nitrogen-containing molecules such as proteins.
Anthropogenic	Man-made or human in origin; influenced by mankind.
Aquatic	Relating to water, particularly freshwater.
Aquifer	An underground geologic feature containing water.
Autotroph/ Autotrophic	Describing organisms that can produce their own food, such as plants, algae or certain specialized bacteria.
Bankfull discharge	The high flow stage of a fluvial system distinguished by the highest stage elevation a stream can reach before spilling over.
Baseflow	Flow in a stream that is not influenced by precipitation.
Basic	Alkaline; containing oxide or hydroxyl ions; not acidic.
Benthic	Used to describe aquatic organisms living at the bottom of a body of water.
Benthic macroinvertebrates	Aquatic insect larvae that live on stream bottom. Because of a short lifespan and relative immobility, they reflect the chemical and physical characteristics of a stream and chronic sources of pollution.
Bioassessment	An evaluation technique that uses measures of the structure, condition, or distribution of biological communities.
Bioindicator	An organism that exhibits sensitivity or tolerance of environmental conditions and may be used in assessing an environmental condition, such as water pollution.

Biotic	Living, relating to life or biology.
BMP	Best Management Practice – Also called a "management option," a BMP is a technique, measure, or structural control that addresses one or more objectives (e.g., a detention basin that gets built, an ordinance that gets passed, and an educational program that gets implemented).
BOD	Biological or biochemical oxygen demand, an empirical test procedure that measures the ability of a water sample to deplete oxygen.
Cadmium (Cd)	A toxic heavy metal element.
Calcium (Ca)	A metallic element found in limestone and numerous naturally occurring compounds.
$CaCO_3$	Calcium carbonate
CCD	County Conservation District
CCTV	Closed Circuit Television
Channelization	The process of modifying the natural course of a stream in order to make it flow into or along a restricted path.
Chlorophyll	Any of a group of green pigments necessary for photosynthesis, concentrations of which are used as a surrogate measurement of producer biomass.
Chl-*a*	Chlorophyll-α, a form of chlorophyll that is found universally in autotrophic organisms.
Chromium (Cr)	A heavy metal element, occurring naturally in trivalent [CrIII] and hexavalent [CrIV] forms. The latter form is highly toxic.
Chronic	Describing an effect or response, such as toxicity, that occurs or can be measured over a relatively long period of time; not acute.
Clay	Inorganic sediment particles smaller than 0.002 mm.
CO_3^{2-}	Carbonate ion
Cobble	A stream particle with diameter between 64 and 256 mm.
Coliform	Of or relating to the bacilli (bacteria) that inhabit the intestines of warm-blooded animals.
Conductance/ Conductivity	A measure of the ability of a water sample to conduct an electric current; a measure of dissolved ionic strength.

Copper	An essential metallic nutrient that can be toxic in relatively small concentrations.
Criterion	An established standard, such as concentration of a pollutant, that is limited or regulated by law.
CSO	Combined Sewer Overflow
CSS	Combined Sewer System
Culvert	A metal, concrete, or plastic pipe that allows water to flow under a road or any other obstruction.
CWA	Clean Water Act – Federal Amendment that authorizes EPA to implement pollution control programs and set water quality standards for all contaminants in surface waters. "The Act made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions. It also funded the construction of sewage treatment plants under the construction grants program and recognized the need for planning to address the critical problems posed by nonpoint source pollution." (EPA website)
CWA Section 104(b)(3) Program	Promotes the coordination and acceleration of research, investigations, experiments, training, demonstrations, surveys, and studies relating to the causes, effects, extent, prevention, reduction and elimination of pollution.
CWA Section 208 Wastewater Planning	Intended to encourage and facilitate the development and implementation of area-wide waste treatment management plans.
CWA Section 319(b) Non-point Source Management Program	Designed to address mine drainage, agricultural runoff, construction/urban runoff, hydrologic and habitat modifications, on-lot wastewater systems, and silviculture.
DCIA	Directly Connected Impervious Area
Decomposition	Decay; process through which a complex substance, such as dead organic matter, is broken down into smaller molecules.
Defective lateral	A plumbing problem in which a lateral pipe is damaged, potentially leading to sanitary waste in a storm sewer and the receiving water body.
Designation/ Designated Use	Describing the uses a waterbody is intended to support, such as stocking trout for recreational fishing.

Diatom	Single-celled algae of the class bacillariophyceae, having a cell wall composed of silica. Diatoms are primary producers in streams and lakes.
Diffusion	Spontaneous, random movement of molecules that tends to result in equalization of concentrations over time as net movement occurs from areas of greater concentration to areas of lower concentration.
Diluent/Dilutant	A thinning agent, such as water, which reduces the concentration of a solution. Pollution may be diluted by streamwater.
Dilute/Dilution	The process through which a solution is made less concentrated through the addition of a diluent/dilutant.
Discharge	Flow; a measure of the volume of water flowing through a defined area in a given time. Discharge is often abbreviated as Q, and measured in cubic feet per second (cfs).
Dissolve	Cause to pass into solution. In laboratory testing, substances may be considered dissolved if they pass through a 0.45 µm filter.
Diurnal	Relating to or occurring in a 24-hour period; daily.
DO	Dissolved Oxygen
Drainage area	The area of land that drains to a particular body of water or site on a waterbody.
DRBC	Delaware River Basin Commission
DVRPC	Delaware Valley Regional Planning Commission
DWO	Dry-Weather Outlet - connector pipe between a CSO regulator and interceptor sewer.
Dynamic	Relating to conditions that change or are in motion; not static.
E. coli	A common rod-shaped bacterium that is found in the intestinal tract of warm blooded animals. Used as an indicator of contamination by feces/sewage.
EACs	Environmental Advisory Councils
Ecoregion	A relatively large area of land characterized by a unique set of communities, physical, and climatological characteristics.
Ecosystem	A collection of living things and their environment.
Effluent	Outflow of liquid waste, such as discharge from a sewage treatment plant.

Empirical	Of or related to direct observation; not theoretical.
Encapsulated	Enclosed or covered, such a stream that has been built into a sewer.
Endogenous	Coming from or produced wholly from within, such as an enzyme produced by bacteria.
EPA	U.S. Environmental Protection Agency
Epifaunal	Of or relating to stream surfaces upon which attached algae and other living things may grow or find shelter.
Equilibrium	A steady state or condition in which opposing influences balance one another out.
Erosion	The process by which soil particles are removed or displaced, usually by wind or water.
Estuary	A body of water intermediate between an ocean and river, usually tidal and highly productive.
Eutrophic	Characterized by abundant or overabundant life, such as a stream or river that is nutrient enriched and has dense growth of algae or aquatic vegetation.
Eutrophication	The process through which a waterbody comes to have an overabundance of life, usually caused by nutrient enrichment.
FGM	Fluvial Geomorphology is the study of a stream's interactions with the local climate, geology, topography, vegetation, and land use; the study of how a river carves its channel within its landscape.
Fluvial	Of or relating to flowing waters, especially rivers.
Floatables	Waterborne waste material and debris (e.g., plastics, polystyrene, paper) that float at or below the water surface.
GIS	Geographic Information Systems
H_2CO_3	Carbonic acid
Hardness	A measure of the concentration of calcium and magnesium ions in water.
HCO_3-	Bicarbonate ion
Heterotrophic	Describes organisms that cannot synthesize their own food through photosynthesis or other chemical means.
Hilsenhoff Biotic	A biological index of stream health that employs a scale of sensitivity of

Index (HBI) macroinvertebrates to organic pollution.

HNO_3 Nitric acid, a source of atmospheric nitrogen pollution and acid rain.

Hydraulic Of or relating to forces exerted by a fluid, often water, under pressure.

Hydrograph A graphical representation of the change in stage or discharge of a stream as a function of time.

Hydrolysis A chemical reaction in which water reacts with another molecule, often resulting in new compounds. The breakdown of urea is a hydrolytic reaction.

IDD&E Illicit Discharge, Detection, and Elimination – one of the six minimum control measures required of permittees under the Phase II NPDES Stormwater Regulations. Program steps include developing maps of municipal separate storm sewer system outfalls and receiving waterbodies; prohibiting illicit discharges via PA DEP-approved ordinance; implementing an IDD&E Program that includes a field screening program and procedures, and elimination of illicit discharges; conducting public awareness and reporting program. A similar program is being followed by PWD in the Long Term Control Plan (LTCP) for CSOs.

Illicit connection An illegal sewer connection, particularly connection of a sanitary sewer, household or industrial waste pipe to a storm sewer. Illicit connections may result in sewage or other pollution inputs to receiving waterbodies.

Impairment Weakening, damage, or instability, such as the effects caused by pollution.

Impervious Incapable of being penetrated, such as a surface that does not absorb water.

Index/Indices A number, ratio, or value on a scale of measurement that can reveal differences between observations or reveal changes over time. Numerous indices are used to assess the health of aquatic communities, such as the Hilsenhoff Biotic Index or HBI.

Infrastructure The basic system of utilities and services needed to support a society. Structures such as culverts, pipes, bridges, dams, and flood control measures can cause instability of streams and affect aquatic habitats.

Insoluble Unable to pass into solution.

Instantaneous Immediate; occurring, such as a change, quickly. Some continuous water quality parameters are observed instantaneously.

Invertebrates	Animals, such as insects and crustaceans, that lack backbones (vertebrae).
IPM	Integrated Pest Management
Iron (Fe)	A common metallic element; an essential nutrient that may be toxic in relatively large concentrations. Iron can cause problems with taste and color of drinking water.
Kjeldahl nitrogen test	A laboratory procedure for determining the concentration of ammonia and organically-bound nitrogen in a water sample.
Larva/larvae	Immature life stage of an invertebrate, such as a beetle or fly. Many insects that have aquatic larval stages are used as bioindicators of water pollution.
LID	Low-Impact Development (similar to "better site design" and "conservation site design").
LTCP	Long-Term CSO Control Plan – part of the EPA's CSO Control Policy for regulation of CSOs under NPDES that guides municipalities, state, and federal permitting agencies in reaching full compliance with the CWA.
Macroinvertebrates	Macroinvertebrates are invertebrate animals that can be seen without the aid of a microscope.
Macronutrient	A nutrient, such as nitrogen or phosphorus, needed in relatively large amounts for biological growth.
Magnesium (Mg)	A common cation that contributes to hardness in water.
Mainstem	The main flow or central channel of a stream drainage network into which tributaries flow.
Manganese (Mn)	A relatively common metallic element; an essential nutrient that may be toxic in relatively large concentrations.
Mean/ Arithmetic mean	Average; a measure of the central tendency of a set of numbers equal to the sum of all members of a set divided by the number of members of the set.
Median	In descriptive statistics, the value in a set of numbers for which half the members of the set are greater and half are smaller. In some instances, the median value may be more informative than the arithmetic mean if a small number of extreme values tends to skew the mean.
Metabolism	All the biochemical processes exhibited by a living organism.

Model	A useful representation, such as a computer simulation, that can be used to simplify and study systems and processes.
MPC	Municipalities Planning Code
MS4	Municipal Separate Storm Sewer System
NH_3	Ammonia (gaseous, un-ionized)
NH_4+	Ammonium ion
Nitrate (NO_3)	An oxidized form of nitrogen; an essential plant nutrient. Elevated nitrate concentration may result in eutrophication of water bodies and in very great concentrations may be toxic (see methemoglobinemia).
Nitrification	The process of converting ammonia to nitrite and nitrate in the presence of oxygen, especially by the action of naturally occurring bacteria.
Nitrite (NO_2-)	An oxidized ion of nitrogen; an intermediate form in the reaction that converts ammonia to nitrate. Nitrite is usually not available for plant growth.
Nitrogen	A macronutrient needed for biological growth. Inert nitrogen gas makes up a large portion of the Earth's atmosphere.
NOAA	National Oceanic and Atmospheric Administration
Nonferrous	Not containing iron; especially metals and alloys that do not contain iron.
Nonparametric statistics	A collection of statistical analysis tools, used when the data to be analyzed do not meet the assumptions of parametric statistics, such as homogeneity of variances.
Non-point source pollution	Pollution that comes from a diffuse source such as atmospheric deposition, stormwater runoff from pasture and crop land, or individual on-lot domestic sewage systems discharging through shallow groundwater.
Non-structural BMPs	These BMPs will require no operation or maintenance. Examples are use of open space and vegetated buffers in development design, minimization of soil disturbance and compaction during construction, and minimization of directly-connected impervious areas.
NPDES	National Pollutant Discharge Elimination System
NPDES Phase I	The stormwater management component of the NPDES program instituted in 1990, which addressed the storm runoff sources most threatening to water quality. Under this phase, industrial activity, and construction sites within large communities (population 100,000 or more) are required to obtain permits for the stormwater leaving the site.

NPDES Phase II Additional stormwater management regulations enacted in 1999, applying to smaller communities and construction sites.

NRCS Natural Resource Conservation Service

NTU Nephelometric turbidity units; a unit of measure describing the light scattering properties of a water sample.

Nutrient An element or molecule needed for biological growth. When nutrients such as phosphorus are present in great concentrations, biological growth (algae in particular) can become overabundant, causing problems for aquatic ecosystems.

OLDS On-Lot sewage Disposal Systems

O&M Operations and Maintenance

OOW PWD's Office of Watersheds

Orthophosphate (OPO_4) A dissolved, inorganic form of phosphorus, available as a nutrient for plant growth; soluble reactive phosphorus.

Outfall A pipe or other structure that discharges flow, such as treated sewage effluent or stormwater, to receiving waters.

Oxidation Chemical process in which a molecule or atom reacts with oxygen or generally, a reaction in which an atom loses electrons and increases in valence state; the opposite of a reduction reaction.

Oxygen An element, common in Earth's atmosphere and dissolved in water, necessary for most forms of complex animal and plant life.

PA Act 167 Stormwater Management Act

PA Act 537 Sewage Facilities Planning Act

PA DCNR Pennsylvania Department of Conservation and Natural Resources

PA DEP Pennsylvania Department of Environmental Protection

Parameter A chemical constituent or physical characteristic of water quality (e.g., dissolved oxygen is a chemical constituent, temperature is a physical characteristic).

Parametric statistics A collection of powerful statistical tools that assume certain qualities of the data being analyzed, such as homogeneity of variances.

Parasite	A functional feeding group of aquatic organisms characterized by feeding usually upon bodily fluids of other organisms, rather than direct predation and consumption. The organism that is fed upon need not die due to the effects of feeding
PEC	Pennsylvania Environmental Council
PFBC	Pennsylvania Fish and Boat Commission
Phosphate	An oxidized form of phosphorus, which may be organic or inorganic. Inorganic phosphates are generally more likely to be available as nutrients for biological growth.
Photosynthesis	A set of chemical reactions in which plants and other organisms, such as blue-green algae, can synthesize their own food using light and inorganic carbon. Photosynthetic activity in water increases dissolved oxygen concentration during daylight hours.
Physicochemical	Physical and chemical properties of water; a term used to group water quality parameters of interest.
Phytoplankton	Collectively, algae suspended in water; a group or growth form of algae defined by passive or active suspension in the water column.
PO_4	Phosphate
Point source	Pollution discharged from a single point, defined in the CWA as "any discernable, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, vessel, or other floating craft from which pollutants are or may be discharged."
Potassium (K)	An elemental macronutrient required for biological growth.
POTW	Publicly Owned Treatment Works
PRD	Planned Residential Development
Predator	A functional feeding group of aquatic organisms characterized by actively feeding upon captured prey.
Productivity	A measure of the amount of biological growth that occurs in an ecosystem.
PWD	Philadelphia Water Department
QA/QC	Quality Assurance/Quality Control

RBP	(Rapid Bioassessment Protocol) A standard method developed by the EPA to assess aquatic health through fish and macroinvertebrate diversity (EPA website).
RBPIII	(Rapid Bioassessment Protocol III) EPA approved technique for evaluating macroinvertebrate communities of a river or stream.
RBPV	(Rapid Bioassessment Protocol V) EPA approved technique for evaluating the fish communities of a river or stream.
RCP	PA DCNR's Rivers Conservation Planning Program.
Reach	A segment of a stream as defined by the study being undertaken.
Reference	A condition or value used for comparison. Many types of biological assessment techniques require comparison to references.
Regulator	In sewer infrastructure, a physical gate, valve, or other control structure that routes flow between two or more receiving pipes, usually one of which terminates in a CSO.
Respiration	Biological metabolic process in which a large molecule is broken into smaller pieces to yield usable energy. Aerobic respiration, the efficient respiration reaction favored by complex living things, requires oxygen.
Riffle	A reach of stream that is characterized by shallow, fast moving water broken by the presence of rocks and boulders.
Riparian	Related to, within, or near a river or its banks.
Riparian corridor	The area of land along the bank or shoreline of a body of water (EPA website).
Riparian woodlands	Woodlands that grow within the riparian corridor.
RTC	Real Time Control - a dynamic system of hydraulic controls to provide additional storage and reduce overflows from a combined sewer system.
Run	A reach of stream that is characterized by smooth flowing water.
Runoff	Generally, precipitation that is not absorbed by surfaces or evaporated, but allowed to flow over the surface to a receiving body of water.
Sediment	Particles, especially inorganic soil particles, that settle upon stream surfaces.
SEO	Sewage Enforcement Officers (designated by PA DEP).

Sinuosity	A measure of the degree to which a stream, viewed from above, deviates from a linear path, expressed as the ratio of stream length between two points divided by the valley length, or point-to-point distance between the same two points.
Significant	When describing the results of scientific or experimental study, describes a comparison or relationship that has been determined to be more likely real than related to randomness or chance to a stated degree of confidence.
Silt/Siltation	Inorganic sediment particles between 3.9 and 62.5 µm in diameter. also the process of being covered by or embedded in silt.
Soluble/Solubility	The quality or state of being able to pass into solution. In water chemistry analysis, a substance may be considered soluble or dissolved if it passes through a 0.45 µm filter.
Sonde	A continuous water quality monitoring instrument.
Species	The level of biological taxonomic classification at which living things are separated from one another by the ability to reproduce yielding fertile offspring.
SSA	Separate-Sewered Area stormwater runoff
SSO	Sanitary Sewer Overflow
STORET	U.S. EPA's water quality database (STOrage and RETrieval).
Stormwater Management Program Protocol ("Protocol")	PA DEP guidance for implementing the requirements of the NPDES Phase II stormwater regulations.
Structural BMPs	These BMPs will require proper operation and maintenance. Examples include wet ponds, grassed swales, infiltration basins and bioretention areas.
SWMM	Storm Water Management Model
TDR	Transfer of Development Rights
Temporal	Of or relating to time, such as a change observed over time.
TIGER	Topologically Integrated Geographic Encoding and Referencing (U.S. Census database).
TMDL program	Total Maximum Daily Load program - EPA/PA DEP program for limiting and allocating discharges of a pollutant within a watershed.

Toxic/toxicity	Describing a substance that is harmful, able to cause injury or death; also the concentration at which a substance may cause injury or death.
Transpiration	The process by which water vapor passes through the membrane or pores of plants to the atmosphere.
Trophic	Describing or relating to food, food type, or the process through which a living thing acquires food.
TSS	Total Suspended Solids
TTFIWMP	The Tookany/Tacony-Frankford Integrated Watershed Management Plan.
Turbidity	A measure of the light scattering properties of water.
UA	Urban Areas
UAA	Use Attainability Analysis
Unimpaired	Natural, unmolested; describing an unaltered or undisturbed state.
USDA	United States Department of Agriculture
USGS	United States Geological Survey
Velocity	A vector quantity that describes speed in a stated direction or along an axis.
Vertebrate	A complex living thing having a backbone (vertebrae).
Violation	An instance or time period during which a regulated water quality parameter was exceeded.
Watershed	The area of land draining to a stream, river, or other water body. Watershed boundaries are established where any precipitation falling within the boundary will drain to a single water body. Precipitation falling outside the boundary will drain to a different watershed. These boundaries are typically formed on high elevation ridges. The water bodies formed from the watershed drainage are usually at the lowest elevation in the watershed. Watersheds can also be called drainage basins.
WLA	Waste Load Allocation
WMP	Watershed Management Plan
WQS	Water Quality Standards
WRAS	PA DEP's Watershed Restoration Action Strategy

OPPORTUNITIES FOR YOUR INVOLVEMENT

16. Would you like to participate in any of the following activities? Check those that interest you.
___Monitor water quality in the creek.
___Volunteer in the parks to plant trees, pick up trash, or fix trails.
___Participate in planning meetings.
___Educate others about watershed issues.
___Take a guided walk along the creek.

17. If you checked any lines above, or if you would like to stay informed about future watershed-related events, please provide the following information.

Name: ______________________

Organization: ______________________

Address: ______________________

City/State/Zip: ______________________

Phone: ______________________

Email: ______________________

The Tacony-Frankford River Conservation Plan is a collaborative project of Philadelphia citizens, community groups, and public agencies. Key organizers of the plan include the Philadelphia Water Department, Frankford Group Ministry, Fairmount Park Commission, Heritage Conservancy, and the Pennsylvania Environmental Council, with funding provided by the Pennsylvania Department of Conservation & Natural Resources.

Upstream of the Tacony-Frankford Creek, Montgomery County citizens and officials are creating a conservation plan for the **Tookany Creek.**

Together, these river conservation plans will provide a community-based vision for improving the entire Tookany-Tacony-Frankford Watershed. To learn more about how you can participate in the **Tookany/Tacony-Frankford Watershed Partnership**, contact the Pennsylvania Environmental Council at 215-563-0250, or visit www.phillywater.org (Go to "Watershed Partnerships" link).

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Public Survey

Tacony-Frankford River Conservation Plan

Philadelphia Residents: Do you live within the boundaries of the **Tacony-Frankford Watershed?** (see map below). If yes, please fill out and return this survey. Thank you!

A **watershed** is all the land that drains rain into a specific body of water, such as a creek.

Philadelphia Neighborhoods in the Tacony-Frankford Watershed:

Bridesburg	Frankford	Oak Lane
Cedarbrook	Germantown	Ogontz
Crescentville	Harrowgate	Olney
East Falls	Hunting Park	Rhawnhurst
East Mt. Airy	Juniata Park	Richmond
Fairhill	Lawndale	Tioga
Feltonville	Logan	West Oak Lane
Fernrock	Nicetown	Westside
Fox Chase		

Tacony-Frankford Public Survey

BACKGROUND INFORMATION

Philadelphia Neighborhood: ____________________

Zip code:______________ Age:______

Type of dwelling:
A. Detached house
B. Twin
C. Rowhouse
D. Apartment

Length of residency there:
A. 0 to 1 year
B. 1 to 5 years
C. 5 to 10 years
D. 10 to 20 years
E. > 20 years

YOUR WATERSHED AWARENESS

1. Before reading the cover of this brochure, did you know what a watershed was? (Circle one)
   A. Yes.
   B. No.
   C. I was aware of the term but not entirely sure what it meant.

2. Do you ever think of yourself as a resident of the Tacony-Frankford Watershed?
   A. No, I never thought of myself as a resident of any watershed.
   B. No, I knew that I live in a watershed, but I wasn't sure which one.
   C. Yes.

3. When it rains, where does most of the water drain to from your roof?
   A. Into my driveway/street and down a storm drain.
   B. Into my yard where it absorbs in the soil.
   C. Into the downspout and directly underground to the city sewer system.
   D. Other ____________________
   E. I don't know.

4. In your neighborhood, when water goes into storm drains on the street, where does it go?
   A. Wastewater treatment plant.
   B. Directly to a stream.
   C. Into the ground.
   D. I don't know.

5. During a heavy rain storm, do you ever see flooding in these places? (Circle each place that floods.)
   A. My street.
   B. My driveway.
   C. My yard.
   D. My basement.
   E. Other ______________
   F. No flooding problems.

TACONY-FRANKFORD WATERSHED

6. How close do you live to Tacony-Frankford Creek?
   A. The creek flows next to my property.
   B. Less than 4 blocks away.
   C. More than 4 blocks away.
   D. I don't know.

7. Do you or anyone in your family spend time along Tacony-Frankford Creek? How often?
   A. At least 2-3 times per week.
   B. Once a week.
   C. Once a month.
   D. Several times a year.
   E. Rarely or never (Go to question #9)

8. What activities do you and/or your family do there? (Circle all that apply)
   A. Fishing.
   B. Nature exploration.
   C. Outdoor sports.
   D. Picnic.
   E. Walking.
   F. Other ______________

9. How clean do you think the water is in Tacony-Frankford Creek?
   A. High quality. I would wade or swim in the water.
   B. Moderate quality. I might wade occasionally.
   C. Poor quality. I would never wade or swim.

10. Of all the possible sources of pollution from the entire Tookany/Tacony-Frankford Watershed, which of these sources do you think are a problem? Circle one option for each. 1=major problem, 2=occasional problem, 3=not a problem, ?= don't know.

1 2 3 ? Pollution discharge from factories.
1 2 3 ? Sewage from homes or commercial buildings.
1 2 3 ? Trash and litter from careless people.
1 2 3 ? Stormwater runoff from streets/parking lots.
1 2 3 ? Animal waste from dogs, geese, etc.
1 2 3 ? Lawn fertilizers and herbicides.
1 2 3 ? Sediment from eroding creek banks.
1 2 3 ? Illegal dumping.
1 2 3 ? Other ____________________

11. If money were used to enhance or improve Tacony-Frankford Creek and its surrounding communities, which of these changes would you recommend as important? Circle one number for each. 1= very important, 2=somewhat important, 3=not important.

1 2 3 Less litter.
1 2 3 Cleaner water.
1 2 3 Less flooding.
1 2 3 Better trails along the creek.
1 2 3 More recreational facilities (ballfields, play grounds, etc.)
1 2 3 More native trees and shrubs on stream banks.
1 2 3 Increased safety and security in parks.
1 2 3 More environmental education programs.
1 2 3 Preservation of historic buildings.
1 2 3 More public art near or about the creek.
1 2 3 More cultural events along the creek.
1 2 3 Other ____________________

ACTIONS IN YOUR NEIGHBORHOOD

12. All of the following actions can harm water quality in streams. Put a check next to actions you have observed in your neighborhood.

___Leaving dog waste on lawns/streets.
___Car-washing with detergents that go into streets.
___Leaky motor oil or antifreeze from cars.
___Dumping fluids or trash into storm drains.
___Over-use of lawn fertilizers or herbicides.
___Riding ATVs in the parks, tearing up soil/plants.
___Dumping tires or other trash into vacant lots/parks.
___Dumping leaves or grass clippings in the creek.
___Other ____________________

13. Do you think *most* people in your neighborhood know these actions pollute streams? YES NO

14. Do you know where to report illegal dumping? YES NO

(You can report to the Philadelphia Police Environmental Response Unit, 215-685-3097, *or* the PA Department of Environmental Protection, 610-832-6014.)

15. Have you ever helped with any watershed protection activities? If so, what? (for example, picking up trash, planting trees, putting "no dumping" signs on storm drains, etc.)

____

____

____

CONTINUE →

Appendix C

TOOKANY/TACONY-FRANKFORD WATERSHED PARTNERSHIP CORPORATE BYLAWS

ARTICLE 1
NAME; PRINCIPAL OFFICE

1.1. **Name**. The name of the nonprofit corporation is Tookany/Tacony-Frankford Watershed Partnership ("Corporation").

1.2. **Principal Office**. The principal office of the Corporation shall be c/o the Pennsylvania Environmental Council (PEC) at 123 Chestnut Street, Suite 401, Philadelphia, PA 19106. The Corporation may also have offices at other places as the Directors may from time to time see fit or the activities of the Corporation may require.

ARTICLE 2
PURPOSES

2.1. **General Purposes.** The Corporation is established in compliance with the Nonprofit Corporation Law of 1988 (the "Act"). The Corporation is established exclusively for charitable, educational and scientific purposes as set forth in the Articles of Incorporation. In pursuing such purposes, the Corporation shall not act so as to impair its eligibility for exemption under Section 501(c) (3) of the Internal Revenue Code of 1986, as amended.

2.2. **Specific Purposes.** The primary purposes of the Corporation are to carry out all activities allowable under Section 501(c)(3) of the Internal Revenue Code (or the corresponding section of any future Internal Revenue Law of the United States), including but not limited to: implement the Integrated Watershed Management Plan for the Tookany/Tacony-Frankford Watershed ("TTF Watershed"); improve stream habitat and integrity of aquatic life; reduce the impact of urbanized flow on living resources; improve dry and wet weather stream quality to reduce the effects on public health and aquatic life; protect and restore stream corridors, buffers, floodplains, and natural habitats including wetlands; identify flood prone areas and decrease flooding; enhance community environmental quality of life; foster community stewardship; and improve inter-municipal, inter-county, state-local and stakeholder cooperation and coordination on a watershed wide basis through dedicated public education and outreach.

ARTICLE 3
MEMBERS

3.1. **Membership Corporation.** The Corporation shall have no members.

3.2. **Honorary Titles.** The Directors may create such classes of membership, such as contributing members or honorary members, as the Directors see fit, but such persons shall not have the rights of members under the Act.

ARTICLE 4
DIRECTORS

4.1. **Powers.** The activities, property, and affairs of the Corporation shall be managed by the Board of Directors ("Board"). Each Director shall possess all powers and undertake duties required for the conduct and management of the business and affairs of the Corporation except as otherwise required by law, these Bylaws, or a resolution duly adopted by the Board. The Board may adopt such rules and regulations as may be required by regulatory authorities.

4.2. **Categories of Board Membership.**

(a) The Board of Directors shall consist of not less than eleven (11) and not more than twenty-four (24) persons. Board members shall represent a specific Board category as defined herein.

(b) *Appointed Board Members:*

Each of the following entities ("Eligible Appointing Entities") shall be entitled to appoint one member of the Board of Directors: Montgomery County Board of Commissioners, Abington Township, Cheltenham Township, Jenkintown Borough, Rockledge Borough, Philadelphia Water Department, Fairmount Park Commission, Philadelphia City Planning Commission, the Mayor's Office of the City of Philadelphia, and the Office of the President of City Council (Philadelphia).

(c) *Elected Board Members*:

The *Elected Direc*tors shall be elected by the Board in accordance with procedures established in these Bylaws. The *Elected Directors* shall, whenever possible, represent the following constituencies: non-profit organizations, large businesses, small businesses, universities, civic organizations, and individuals who are stakeholders of TTF Watershed.

4.3. **Term of Office.**

(a) The members of the initial Board of Directors shall include both *Appointed Directors* and *Elected Directors. Appointed Directors* shall be appointed by their respective Eligible Appointing Entities; *Elected Directors* shall be appointed by the Incorporator at the First Organizational Meeting of the Board. The initial Directors shall be assigned an initial Board term of one (1) year, two (2) years, or three (3) years.

(b) Thereafter, as the initial terms of the initial Board Directors conclude, Directors shall be appointed or elected to the Board at the Corporation's Annual Meeting. Directors shall be appointed or elected to fill specific categories of Board membership in accordance with these Bylaws.

(c) Upon the conclusion of the initial terms as described in Section 4.3(a), all Directors shall serve a three-year term. The terms of the Directors shall be fixed so that the term of one-third of such Directors shall expire at each Annual Meeting of the Corporation.

(d) No Director may serve more than six consecutive years (not including the initial term).

4.4. **Appointment of the *Appointed Directors*.**

(a) Not less than thirty (30) days before the First Organizational Meeting, the Eligible Appointing Entities shall submit to the Incorporator their respective appointments for Directors ("*Appointed Directors*"). Eligible Appointing Entities shall only appoint professionals or staff of the Eligible Appointing Entities, or those who provide professional services to the jurisdiction of the Eligible Appointing Entities. During the First Organizational Meeting, the Incorporator shall announce and seat the *Appointed Directors*.

(b) Thereafter, not less than thirty (30) days before each Annual Meeting, the Eligible Appointing Entities shall appoint the number of nominees equal to the number of directorships that are vacant or will become vacant at the time of the Annual Meeting. These Eligible Appointing Entities shall submit to the Secretary of the Board their appointments for *Appointed Directors.* The Secretary shall immediately inform the Board of Directors of these appointments. During the Annual Meeting, the Board of Directors shall announce and seat the *Appointed Directors*.

4.5. **Nomination and Election of the *Elected Directors*.**

(a) During the First Organizational Meeting, the Incorporator shall announce and seat the first *Elected Directors*.

(b) Thereafter, not less than sixty (60) days prior to each Annual Meeting, the President shall send written notice to the members of the Board announcing the number of Directors to be elected, declaring that the nominations of candidates for election as Director are open, and calling for nominations. Nominations will be directed though a Nominations Committee appointed by the Board President.

Not less than thirty (30) days before the Annual Meeting, the Nominations Committee shall submit to the Secretary of the Board its nominations. After nominations have been made, the President shall declare the nominations closed, and thereafter no further nominations may be made.

(c) During the Annual Meeting, the voting procedure followed shall be such that a separate vote is taken for each directorship to be filled. Each directorship shall be filled by majority vote of the Directors voting (a quorum must be present).

d) Upon demand of any three Directors in attendance, elections shall be conducted by written ballot; otherwise all ballots will be cast by voice vote only.

4.6. **Removal.**

(a) The Board, by a majority vote, may make a recommendation for removal of an *Appointed Director*. After a lawfully conducted vote to recommend removal is affirmed, the President shall contact the Eligible Appointing Entity that appointed this Director and discuss matters concerning removal of this Director and appointment of a new Director by the Eligible Appointing Entity. The Eligible Appointing Entity shall make the final decision concerning the removal of this *Appointed Director.*

(b) Any *Elected Director* may be removed from office, without the assignment of any cause, by a majority vote of the Board, whenever in the judgment of the Board the best interest of the Corporation will be served.

(c) Votes in accordance with the above Section 4.6 (a) and (b) shall be conducted at a duly convened meeting of the Board. The written notice of the intention to consider removal of such Director shall be included in the notice of the meeting. No Director shall be removed without having the opportunity to be heard at such meeting, but no formal hearing procedure need be followed.

4.7 **Vacancies.**

(a) When a directorship of an *Appointed Director* becomes vacant during the period between Annual Meetings of the Corporation, the President shall inform the affected Eligible Appointing Entity to appoint a new Director to fill such vacancy until the next Annual Meeting.

(b) When any directorship of an *Elected Director* becomes vacant during the period between Annual Meetings of the Corporation, the Board may elect a new Director to fill such vacancy until the next Annual Meeting. The vacancy shall be filled with a Director from the same type of organization, business, civic interest, or individual interests as set forth in Section 4.2 (c).

4.8. **Resignation**. Any Director may resign at any time by giving written notice to the Corporation. The resignation shall be effective upon receipt by the President (or in the case that the President elects to resign or is not available, receipt by the Board of Directors), or at such subsequent time as may be specified in the notice of resignation.

4.9. **Director Compensation.** Directors shall not be compensated for their service on the Board, although they may be reimbursed for reasonable and necessary expenses incurred for the benefit of the Corporation. Reimbursement shall require the submission of expense vouchers and receipts.

4.10. **Conflict of Interest.**

(a) No contract or transaction between the Corporation and its Directors or Officers or between the Corporation and any other corporation, partnership, association, organization, or governmental agency in which one or more of its Directors or Officers have a financial interest shall be void or voidable if:

(1) the material facts as to the relationship or interest and as to the contract or transaction are disclosed to the Board of Directors, and are authorized in good faith by the affirmative vote of a majority of disinterested Directors; and

(2) the contract or transaction is fair to the Corporation as of the time it is authorized by the Board of Directors.

(b) In making the above determination, the affected Director or Officer shall withdraw from the meeting in which this matter is discussed for as long as this matter remains under consideration. Should the matter be brought to a vote, the affected Director shall neither be present nor cast a vote.

ARTICLE 5

MEETINGS

5.1. **Annual Meetings.**

(a) The Annual Meeting of the Directors shall be held during the month of May of each year at the offices of one of the Directors or at such other location as agreed upon by the Directors at least two (2) weeks prior to the Annual Meeting. If all of the Directors agree, the Annual Meeting may be held during a month other than May as determined at least two (2) weeks prior to the Annual Meeting.

(b) At the Annual Meeting, the Board shall be organized for the succeeding year, including the official recognition of appointment of the *Appointed Directors* and the election of the *Elected Directors* by vote of the remaining Directors, to fill the positions of those whose terms expire at that time, as well as review and adoption of the annual budget, and consideration of such other matters as may properly come before the Board.

5.2. **Regular Meetings.** The Board of Directors shall meet according to a schedule it determines, provided that it meets at least four times a year, and without an interval of more than four months between any two meetings. Each Director shall receive timely advance notice of meetings, in accordance with these Bylaws.

5.3. **Special Meetings.** Special meetings may be called by the President or by any five Directors calling for the meeting by contacting the President.

5.4. **Telephone Communication.** Members of the Board of Directors may participate in any meeting of the Board through the use of conference telephone or similar communication equipment that enables all participants in the meeting to hear each other at the same time. Such participation shall constitute presence in person at the meeting.

5.5. **Quorum and Voting**.

(a) Two-thirds of the Directors seated shall constitute a quorum for amendment of the Articles of Incorporation or the Bylaws; issues relating to the sale, lease, or purchase of real estate; and removal or suspension of any Officer at any Board meeting, whether annual, regular, or special. For matters mentioned above, if a quorum is present, the act of two-thirds of Directors voting shall be an act of the Board of Directors.

(b) For all other matters, unless specifically stated by resolution of the Board, a majority of the Directors seated shall constitute a quorum. If a quorum is present, the act of a majority of Directors voting shall be an act of the Board of Directors, except as otherwise expressly provided in these Bylaws or required by law.

5.6. **Notice**. Notice shall be given in writing to each Director of each Annual, regular, or special meeting of the Directors. Such notice shall be delivered by hand, by mail, or by facsimile or electronic mail at least ten (10) days before the day named for the Annual, regular or special meeting. The notice shall state the date, time, place, and purpose of the meeting, including the agenda, if one has been established or required by these Bylaws.

5.7. **Waiver of Notice.** A written waiver signed by a Director, or attendance by a Director at any Annual, regular, or special meeting, shall be deemed equivalent to appropriate notice and shall be considered consent to the holding of the meeting.

5.8. **Proxy Votes**. A Director is allowed to vote by proxy, if necessary. Every proxy shall be executed in writing by the Director or by his or her duly authorized representative and filed with the Secretary of the Corporation. A proxy statement shall indicate the specific matters on which the proxy is authorized to vote. A Director's proxy who is entitled to vote at the meeting shall vote only in the matters specified in the proxy statement executed by the Director and only for that specific meeting. A vote by proxy that exceeds the authority specified in the proxy statement is invalid. A proxy shall be revocable at will, notwithstanding any other agreement or any provision in the proxy to the contrary, but the revocation of a proxy shall not be effective until notice thereof has been given to the Secretary of the Corporation. A proxy shall not be revoked by the death or incapacity of the maker unless before the vote is counted or the authority is exercised, written notice of such death or incapacity is given to the Secretary of the Corporation.

ARTICLE 6
OFFICERS

6.1. **Officers.** The officers of the Corporation shall be a President, Vice-President, Treasurer, Secretary, and an Executive Director, and such other officers as the Board of Directors may from time to time elect. The duties of the officers of the Corporation shall be as provided in the Bylaws, except as modified from time to time by the Board.

6.2. **Election and Term.** Officers may be elected for more than one office and serve for consecutive terms. The Officers (except for Executive Director) shall be elected by a majority vote of the Board at the Annual Meeting of Directors and shall serve for a term of one (1) year and until their successors are elected and qualified, or until death, resignation, or removal.

6.3. **Qualification of Officers.** The President, Vice-President, Secretary, and Treasurer must be at least 18 years of age and shall be members of the Board of the Corporation.

6.4. **President.** The President shall preside at meetings of the Board, shall have general responsibility for dealing with questions of policy related to the Corporation's affairs, and shall be responsible for calling meetings of the Board and for assuring adequate communication between the operating staff of the Corporation and the Board on matters of policy and financial concerns.

6.5. **Vice-President.** The Vice-President shall perform such duties as may from time to time be assigned by the Board of Directors or designated by the President. In the case of the death, disability, or absence of the President, the Vice-President shall fulfill all the duties and be vested with all powers and responsibilities of the President.

6.6. **Secretary.** The Secretary shall keep a book of minutes of all meetings of the Board, shall direct the issue of all notices required by law or requested from time to time by the Board of Directors or by the President, and shall perform such other duties as are incident to the office of Secretary. The Secretary shall be the custodian of the seal of this Corporation and all books, records, and papers of this Corporation, except those documents in the charge of the Treasurer, or of some other person authorized to have custody and possession thereof by a resolution of the Board of Directors.

6.7. **Treasurer.** The Treasurer serves as the principal financial advisor to the Board of Directors in planning, directing, and appraising the effectiveness of the Corporation's fiscal operations. The Treasurer shall ensure full and accurate accountability and control of the receipts and disbursements of the Corporation's assets. The Treasurer shall perform such other duties as may be assigned by the Board of Directors or as are incidental to the office. The Treasurer shall agree to be bonded as deemed necessary by the Board of Directors.

6.8. **Executive Director.** The position of Executive Director is a paid position within the Corporation. The Executive Director shall be appointed or dismissed by the Board of Directors, on such terms and conditions as the Board of Directors deems appropriate. The Executive Director shall be an ex-officio member of the Board of Directors, shall direct all operations of the Corporation, shall supervise all personnel, and shall have control and management of its business and affairs, all subject to the direction of the Board of Directors. The Board shall evaluate the performance of the Executive Director annually, against a set of written, agreed upon goals and objectives.

ARTICLE 7
COMMITTEES

7.1. **Establishment.**

(a) The Board of Directors may, if set forth in these Bylaws or by resolution, establish one or more committees and give them such powers and authority as the Board shall deem appropriate.

(b) Committees shall have and shall exercise authority as prescribed by the Board of Directors. The creation of a committee shall not operate to relieve the Board of Directors, or any individual Director, of the responsibility imposed by law. No committee shall have the authority of the Board to conduct any of the following:

(1) The filling of vacancies of the Board;
(2) The adoption, amendment, or repeal of the Bylaws;
(3) The amendment or repeal of any resolution of the Board; and
(4) Action on matters committed by the Bylaws or by resolution of the Board to another committee of the Board, or to the full Board.

7.2. **Executive Committee**.

(a) The members of the Executive Committee shall be the Officers who are elected by the Board at the Annual Meeting. This shall include the President (who shall serve as chair of the Committee), Vice-President, Secretary, and Treasurer. In addition, the Executive Committee shall include one additional Director. Such additional member shall be elected to the Executive Committee at each Annual Meeting following the election of Directors and Officers, and shall serve for one year or until his/her successor is seated to this Committee.

(b) The Executive Committee shall have power and authority to take actions on behalf of the Board of Directors for emergencies and other urgent business matters that occur between meetings of the Board. The Executive Committee shall not be authorized to conduct the standard and usual business of the Board. All actions taken by the Executive Committee shall be reported at the next meeting of the Board and shall be binding on the Board only when approved by formal vote of the Board or when so authorized previously by the Board and delegated to the Executive Committee.

ARTICLE 8
DISSOLUTION

8.1. **Distribution of Assets.** Upon dissolution of the Corporation, the Board of Directors shall, after paying or making provision for the payment of all the liabilities of the Corporation, dispose of all of the assets of the Corporation exclusively for the purpose of the Corporation in such manner, or to such organization or organizations organized and operated exclusively for charitable, educational, or scientific purposes as shall at the time qualify as an exempt organization or organizations under Section 501(c)(3) of the Internal Revenue Code of 1986 (or the corresponding provision of any future United State Internal Revenue Law), as the Board of Directors shall determine. Any such assets not so disposed of shall be disposed of by a Court of competent jurisdiction of the County in which the principal office of the Corporation is then located, exclusively for such purposes or to such organization or organizations, as said Court shall determine, which are organized and operated exclusively for such purposes.

ARTICLE 9
AMENDMENTS

9.1. **Amendments.**

(a) The Directors may, by a two-thirds vote of those present in person at any duly called meeting at which a quorum is present as set forth in Article 5.5(a) of these Bylaws, alter, amend, or repeal the Articles of Incorporation or these Bylaws or any portion thereof. Provided, however, that no such alteration, amendment, or repeal should impair the Corporation's eligibility for exemption under Section 501(c) (3) of the Internal Revenue Code of 1986.

(b) Written notice as to the substance and effect of any proposed amendment to the Articles of Incorporation or these Bylaws shall be given or mailed to each Director not less than ten (10) days prior to the meeting of the Board at which such proposed amendment is submitted to a vote.

ARTICLE 10
OPERATIONS

10.1. **Execution of Documents.** Except as otherwise provided by law or resolution of the Board of Directors, checks, drafts, promissory notes, orders for payment of money, other evidences of indebtedness of this Corporation, contracts, leases, or other instruments executed in the name of and on behalf of the Corporation may be signed by any Officer or any Director. If the amount of indebtedness or obligation on any single document mentioned in this Article is two thousand dollars ($2,000) or above, such document shall be executed by two people who have authority to sign (Officer or Director) in order to be binding on the Corporation.

10.2. **Corporate Seal.** The Corporation may have a corporate seal containing the name of the Corporation, the year of incorporation, and such other details as may be approved by the Board of Directors.

10.3. **Books and Records.** The Corporation shall keep correct and complete books and records of account, and will also keep minutes of the proceedings of its Board of Directors and Committees. The Corporation will keep at its registered office the original or a copy of its Articles of Incorporation as filed with the Secretary of State of the Commonwealth of Pennsylvania, and the original or a copy of these Bylaws, including amendments, certified by the Secretary of the Corporation

10.4. **Fiscal Year.** The fiscal year of the Corporation shall begin on July 1 and end on June 30 of each year.

ARTICLE 11
LIABILITY AND INDEMNIFICATION

11.1. **Liability.** General Rule. A Director shall not be personally liable for monetary damages as a Director for any action taken, or any failure to take action, unless:

(a) the Director has breached or failed to perform the duties of Director in accordance with the standard of conduct contained in section 5712 of the Act, "Standard of care and justifiable reliance"; and

(b) The breach or failure to perform constitutes self-dealing, willful misconduct, or recklessness.

Provided, however, the foregoing provision shall not apply to (1) the responsibility or liability of a Director pursuant to any criminal statute or (2) the liability of a Director for the payments of taxes pursuant to local, state, or federal law.

11.2. **Insurance.** The Corporation may purchase and maintain insurance on behalf of any person who is or was a Director, Officer, or employee of the Corporation or is or was serving at the request of the Corporation as a representative of another domestic or foreign corporation for profit or not-for-profit, partnership, joint venture, trust, governmental agency, or other enterprise against any liability asserted against him or her and incurred by him or her in any such capacity, or arising out of his or her status as such, whether or not the Corporation would have the power to indemnify him or her against that liability under the Act.

11.3. **Indemnification.**

(a) The Corporation shall reimburse any Director, Officer, or other representative of the Corporation (each, a "Representative") for any expenses that are actually and reasonably incurred by him or her in connection with any lawsuit or action in which the performance of his or her duties as a Representative is in question ("Reimbursable Costs") if he or she is successful in defending himself or herself against the lawsuit or action as demonstrated by a judgment in his or her favor on the merits of the claim.

(b) Subject to paragraph (c) below, the Board has discretion to decide, by a unanimous vote, whether to reimburse a Representative for Reimbursable Costs in those instances where a judgment in his or her favor on the merits of the claim is not reached and, therefore, he or she is not entitled to mandatory indemnification pursuant to paragraph (a) above, but where the Representative acted in good faith and in a manner he or she reasonably believed to be in, or not opposed to, the best interests of the Corporation or, with respect to a criminal proceeding, had no reasonable cause to believe that his or her conduct was unlawful. The Corporation may only reimburse the Reimbursable Costs up to the limit amount that its insurance covers.

(c) Under no circumstances may the Corporation reimburse a Representative for Reimbursable Costs if a court determines that his or her behavior in connection with the lawsuit or action at issue constituted willful misconduct or recklessness.

ADOPTED BY THE BOARD OF DIRECTORS ON ____________________.

____ ____________________

President, Date
Board of Directors

____

Secretary,
Board of Directors
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Appendix D: Potential Sources of Funding

SOURCE OF ASSISTANCE	PROGRAM NAME	CONTACT NUMBER	BRIEF DESCRIPTION OF PROGRAM
DCED	Communities of Opportunity		Provides grants to municipalities, redevelopment authorities and housing authorities for community revitalization, economic development, and low-income housing development and rehabilitation.
DCED & Governor's Office	Community Revitalization Program		Very broad grant program. Officially intended to promote community stability, increase tax bases and improve quality of life. Applications may be made by municipalities, authorities, economic development organizations and non-profit corporations. Public/non-profit/profit partnerships are encouraged. Generally can be used for infrastructure, community revitalization, building rehabilitation, demolition of blighted structures, public safety, and crime prevention.
DCED in cooperation with PA DEP	Industrial Sites Reuse Program, PA ("Brownfields")		Provides grants of up to 75% and low interest loans for assessment of environmental contamination and remediation work at former industrial sites. Available to private companies, non-profit economic development agencies or authorities that own the land. Mainly targeted towards cities. Financing is not available to the company that caused the contamination.
DCED	Intermunicipal Projects Grants		Promotes cooperation between neighboring municipalities so as to foster increased efficiency and effectiveness in the delivery of municipal services at the local level.
DCED	Land Use Planning and Technical Assistance Program		Assists local governments and counties to prepare comprehensive plans, downtown plans, special community development studies and development regulations. Typically provides 50% of the eligible costs.
DCED	Shared Municipal Services		Provides modest-sized 50/50 matching grants to promote cooperation among municipalities, in order to increase the efficiency of public services. Two or more municipalities may apply, or a council of governments.
DCNR	Community Conservation Partnership Grant Program		Funds a wide variety of recreation, greenway, rivers conservation and open space preservation activities with 50% matching grants. Four main categories of grants are: Planning and Technical Assistance, Acquisition Projects, Development Projects, Federally Funded Projects

SOURCE OF ASSISTANCE	PROGRAM NAME	CONTACT NUMBER	BRIEF DESCRIPTION OF PROGRAM
DCNR	Conservation Corps, PA.		Provides funding for work crews for community projects, such as trail improvements.
DCNR	Keystone Rec., Park & Cons. Program - Land Trust Grants		Grants to well-established non-profit land trusts and conservancies to plan for and acquire critical natural areas. Land that is acquired must be open to the public.
DCNR	Keystone Rec., Park & Cons. Program - Community Grants		Provides 50% matching grants to municipalities to fund: overall planning for park and recreation, master plans for individual parks, acquisition of parkland and nature preserves, countywide natural area inventories, and rehabilitation and improvements to public recreation areas. Grants up to $20,000, without a local match, are available for material and design costs in small municipalities.
DCNR	Pennsylvania Forest Stewardship/Stream ReLeaf Program	717-787-2106	Cost-Share (75%) assistance for riparian zone protection or improvement projects: streambank restoration, fencing and crossings.
DCNR	Rivers Conservation Program	717-787-2316	Conserve and enhance river resources by offering planning grants, technical assistance, implementation grants, development grants, and acquisition grants.
DCNR	Urban Forestry Grants		Provides grants for tree planting projects. Is also a Federal "America the Beautiful" grant program for tree planting.
DEP	Coastal Zone Management Program	717-787-5259	Grants for planning and construction in the Lake Erie and the Delaware Estuary Coastal Zones.
DEP	Environmental Stewardship and Watershed Protection Grant Program	717-787-5259	Grants focus on nonpoint source pollution and watersheds: acid mine drainage abatement, mine cleanup efforts, well plugging, planning and implementing local watershed-based conservation efforts (formerly WRAP+WRPA).
DEP Bureau of Waterways Engineering	Flood Protection Program, PA		Offers design and construction of flood protection projects. The project must be deemed economically justifiable under the state capital budget process.
DEP	Nonpoint Source Management (EPA 319) Program	717-787-5259	Grants for planning and nonpoint source pollution control projects.
DEP	PA Environmental Education Grants Program	717-772-1828	Provides financial support for projects that design, demonstrate or disseminate environmental education practices, methods or techniques.

SOURCE OF ASSISTANCE	PROGRAM NAME	CONTACT NUMBER	BRIEF DESCRIPTION OF PROGRAM
DEP	Pennsylvania Wetland Replacement Project	717-787-6827	Grants for restoring wetlands, riparian corridors and other aquatic systems within the Commonwealth.
DEP	Sewage Facility Planning Grants		Grants to pay up to 50% of the costs to prepare a new sewage facilities plan or update an existing plan, under State Act 537 of 1966.
DEP	Stormwater Management Program	717-772-4048	Watershed planning for stormwater control (counties) and implementation of programs at local levels (municipalities).
DEP	Stream Bank Fencing Program	717-783-7577	To improve water quality and reduce soil erosion by constructing one or two strand fences to limit livestock access streams.
DEP	Stream Improvement Program (SIP)	717-787-3411	Assistance through the construction of small projects to prevent flooding, restore natural stream channels and to stabilize banks.
Federal Emergency Management Agency	Flood Hazard Mitigation Grant Program		Provides 75% funding to relieve imminent hazards from flooding, such as voluntary buy-outs and demolitions of highly flood-prone properties.
National Fish and Wildlife Foundation	Chesapeake Bay Small Watershed Grants Program	202-857-0166	This program supports communities undertaking small-scale watershed projects. Grants range from $1,000 to $35,000 to local governments and community groups for education and demonstration projects to protect watersheds.
National Park Service	Rivers, Trails and Conservation Assistance Program	215-597-1581	The National Park Service works with communities to conserve land and river resources and provides funding for various projects dealing with the conservation of these resources including the development of trails and greenways.
PACD	Nonpoint Source Pollution Education Mini Project Grant	717-238-7223	Small grants for Pennsylvania-based, grassroots educational projects that address nonpoint source watershed concepts.

SOURCE OF ASSISTANCE	PROGRAM NAME	CONTACT NUMBER	BRIEF DESCRIPTION OF PROGRAM
PA Infrastructure Investment Authority and PA DEP Bureau of Water Supply Management--Involves both U.S. EPA and State funds	PENNVEST		Offers low interest loans for construction and improvement of drinking water and wastewater systems. Outright grants may be available for highly distressed communities. Mainly intended for public systems, but some private systems may be approved. Water projects are funded through the Drinking Water Revolving Loan Fund. Sewage projects are funded through the Clean Water Revolving Fund. In addition, PennVest is authorized to provide loans for projects to control existing stormwater problems, such as separating stormwater from sanitary sewage. The "Advance Funding Program" provides low-interest loans for feasibility studies and engineering of systems if the utility cannot fund such work itself.
Pennsylvania Department of Community and Economic Development		888-223-6837	Financial assistance may include: preparing environmental protection or physical development strategies or special studies that will support comprehensive land use planning. The application of advanced technology such as Geographic Information Systems (GIS).
The William Penn Foundation Philadelphia, PA		215-988-1830	Grants to preserve natural areas, including environmental education and planning within the foundation’s geographic area (primarily southeastern Pennsylvania).
U.S Department of the Interior U.S. Fish and Wildlife Service North America Waterfowl and Wetlands Office (NAWWO)		703-358-1784	The North American Wetlands Conservation Act of 1989 provides matching grants to carry out wetlands conservation projects in the United States, Canada, and Mexico. Both the Standard and Small Grants Programs help deliver funding to on-the-ground projects through protection, restoration, or enhancement of an array of wetland habitats.
U.S. Environmental Protection Agency Office of Wetlands, Oceans, and Watersheds		202-260-4538	EPA establishes a cooperative agreement with one or more nonprofit organization(s) or other eligible entities to support watershed partnership organizational development and long-term effectiveness. Funding supports organizational development and capacity building for watershed partnerships with diverse membership.

SOURCE OF ASSISTANCE	PROGRAM NAME	CONTACT NUMBER	BRIEF DESCRIPTION OF PROGRAM
U.S. Environmental Protection Agency Office of Wetlands, Oceans, and Watersheds		202-260-8076	This Five-Star Program seeks to support restoration projects in 500 watersheds by 2005, a key action of the Clean Water Action Plan. Competitive projects will have a strong on-the-ground habitat restoration component that provides long-term ecological, educational, and/or socioeconomic benefits to the people and their community.
U.S. EPA	Brownfields Program		Grants for a very limited number of pilot demonstration projects for cleanup of contaminated underused industrial sites.
U.S. EPA	Sustainable Development Challenge Grants (SDCG)	206-553-2634	Grants to support communities in establishing partnerships to encourage environmentally and economically sustainable practices.

Tookany/Tacony-Frankford Integrated Watershed Management Plan (TTFIWMP)
5-Year Implementation Plan 2006 – 2011
PWD commitment $18,000,000

This Implementation Plan (IP) builds upon an already significant body of work developed by the Philadelphia Water Department in cooperation with the Tookany/Tacony-Frankford Watershed Partnership. The Tookany/Tacony-Frankford Integrated Watershed Management Plan (TTFIWMP) was completed in the winter of 2005. This planning effort incorporated both regulatory and non-regulatory programs including the Phase I and Phase II stormwater regulations, the PA Act 537 sewage facilities planning program, the PA Act 167 stormwater management program, EPA's Combined Sewer Overflow (CSO) Control Policy and PA DCNR's River Conservation Planning program while also combining the ideas and concerns of watershed stakeholders in order to create a comprehensive vision for restoring this region.

The TTFIWMP included guidelines for implementing the management options identified by our watershed partners for areas outside the City of Philadelphia over the upcoming 20 year planning horizon. Implementation projects and initiatives within the guidelines have undergone intensive screening to determine that they are both cost-effective and feasible under the specific conditions found in the Tookany/Tacony-Frankford Creek watershed.

This implementation plan is designed to provide a more detailed blueprint for implementation of projects within the City of Philadelphia during the initial five-year period (2006-2011), though many projects have already been initiated. This plan represents the first steps in the simultaneous implementation of projects related to Targets A, B, and C. These environmental targets were established to guide the overall implementation strategies while always keeping our eyes on the long-term goals of the program.

Note that each project being implemented will require a feasibility study, followed by conceptual, preliminary, and final design reports that will provide successively more detail.

Planning, Outreach & Reporting

PWD Commitment: $1,000,000

It is imperative that the existing Tookany/Tacony-Frankford Watershed Partnership not only continue to function as a driving force within the watershed, but that it also evolve into an implementation oriented entity to take on the responsibility of executing many of the projects identified during the integrated planning process. These projects have been identified for implementation over a 20 year period, broken into five-year increments. Progress must be tracked and reported in order to illustrate progression as implementation moves forward.

P-1. Maintain Watershed Partnership

In the summer of 2005, the Tookany/Tacony-Frankford Watershed Partnership filed incorporation papers with the federal government in order to evolve its organizational structure from that of a loose alliance of stakeholders into a formal, 501(c)3 non-profit organization. The Partnership has a mission focused on implementation of the plan, and is now structurally aligned to do so. PWD will take part in the new organization, as well as move forward with its own implementation plan. PWD will support the newly formed organization in developing and carrying out future implementation efforts.

Priority Tasks	**Projected Timeline:**
1. Establish Permanent 501c3 Watershed Organization:	End of 2005
2. Develop and secure funding for project implementation: PWD will assist the TTF Partnership in the pursuit of funding for individual project implementation	Begin in 2006
3. Identify and incorporate high-priority/"Marketing" messages from the TTFIWMP Produce a document containing a short list of high-priority messages (e.g., litter and dumping, good housekeeping practices for homes and businesses, etc.) to be included in all community relations work to help support the goals of the plan. (Should include a plan for distribution of the messages, including targeted groups and means of distribution)	2006
4. Incorporate high-priority/"Marketing" messages in all outreach activities: Work interdepartmentally with PWD to incorporate messages in outreach materials. Additionally work with TTF Partnership to achieve the goals for distribution	2006 - 2011

P-2. Track WMP programs and progress

Develop and maintain a performance tracking system for plan progress. This system would track projects and monitored improvements using the indicators from the TTFIWMP.

Priority Tasks	Projected Timeline:
1. Inventory all TTF projects and initiatives related to TTFIWMP implementation, create database of information:	Begin in 2006
2. Utilize database as the clearinghouse for implementation project related information (budget, lead contact, status etc.):	2006-2011
3. Utilize for annual reporting purposes:	Begin in 2007

P-3. Annual report

CDM and OOW staff will collaborate to produce an annual report at the end of each fiscal year.

Priority Tasks	Projected Timeline:
1. Update status of each task proposed in this implementation plan:	Annually, begin 2007
(a) Write recommendations for moving each task forward in the following year:	Annually, begin 2007
2. Initiate Watershed Indicator Status Update:	Biannually, begin 2008
(a) Evaluate all 21 Watershed Indicators, document any changes:	Biannually, begin 2008
(b) Write memo documenting status changes for sharing with watershed partners:	Biannually, begin 2008
3. Update the list of projects proposed, in progress, or completed in the given year:	Annually, begin 2007
4. Monitor status and results for any projects that have been completed within the given year:	Annually, begin 2007

P-4. Update WMP and supporting technical documentation

The TTFIWMP will be updated at the end of the permit cycle. Information in the annual reports will be consolidated, progress will be assessed, and a new 5-year implementation plan will be produced.

Priority Tasks	Projected Timeline:
1. Evaluate Biological Monitoring Data collected in 2010: PWD Biological monitoring program is scheduled to be updated every five years. (Last program update was 2005)	2011
2. Evaluate accomplishments and recommendations of each Annual Report:	2010 - 2011
3. Evaluate Watershed Indicators, update with new information:	Biannually, begin 2008
4. Update TTFIWMP with new information:	2011

Target A

PWD Commitment: $9,100,000

This target is designed to help achieve water quality standards in the stream during dry weather periods. The focus is on the elimination of sources of sewage discharge during dry weather, as well as trash removal and litter prevention.

A-1. Sewer Rehabilitation and Maintenance

Sewers must be assessed to identify segments in need of rehabilitation, particularly where leakage is directly flowing into the stream. In separate sewered areas, a detection program for potential cross-connections is needed in order to eliminate dry weather flows.

Maintenance of sewers includes activities required to keep the system functioning as it was originally designed and constructed. Any reinvestment in the system, including routine maintenance, capital improvements for repair or rehabilitation, inspection activities, and monitoring activities are generally classified as maintenance.

Priority Tasks	**Projected Timeline:**
1. Continue PWD Sewer Inspection and Cleaning Program: a. Identify Sewers in need of Rehabilitation: b. Initiate Sewer repairs: c. Create a memorandum with map showing all problem areas identified: d. Provide information from the stream assessment regarding exposed and/or leaking sewers to sewer maintenance: e. Track and document sewer repairs:	2006 – 2011

A-2. Source Controls

Runoff pollution has severely impacted the stream. Ordinances must be evaluated, updated and enforced in order to ensure the reduction of pollutant sources such as pet waste and dumping. Street sweeping, inlet maintenance and additional NPDES related measures must be enforced.

Priority Tasks	Projected Timeline:
1. Implement 6 Minimum Control Measures for NPDES Stormwater Phase II:	2006 - 2011
2. Continue PWD Inlet Cleaning & Maintenance Program: (a) Work with Inlet Maintenance team to develop an ongoing schedule of maintenance for this watershed area:	2006 - 2011
3. Continue City of Philadelphia Street Sweeping Program: (a) Meet with Philadelphia Streets Department to gather information regarding current street sweeping programs and scheduling: (b) Work with the Philadelphia Streets Department to develop a city-wide schedule of sweeping:	2006 - 2011
4. Review Enforcement of City of Philadelphia Pet Waste Disposal and Litter/Dumping Related Ordinances: (a) Develop recommendations for improvement: (b) Discuss changes with implementing agencies: (c) Identify access points with the Fairmount Park Commission: (d) Monitor progress:	Mid-2006 2007 Mid-2007 2007 2008 - 2011
5. Continue and expand upon outreach and assistance programs to other municipalities: (a) Outreach to municipalities regarding status of plan implementation: (b) Workshops and programs to share information about Stormwater BMPs:	2006 – 2011
6. Continue the efforts of the Philadelphia Inter-Governmental Scrap and Tire Yard Task Force: Program response to complaints about operation of scrap metal and auto salvage businesses operating in violation of regulations	2006 – 2011

A-3. Stream Clean-up

Target A is also associated with improving the esthetic quality of the stream so that it can be viewed and treasured as a resource. Stream clean-ups are a way to achieve this while also involving residents and volunteers in the process.

The Waterways Restoration Unit was created in order to assist with the removal of litter and heavy debris from streams, maintain habitat improvements (fish ladders, FGM, elimination of plunge pools).

Priority Tasks	**Projected Timeline:**
1. Continue the efforts of the Waterways Restoration Unit: (a) Inspect and assess the condition of sewerage infrastructure along streams: (b) Identify, prioritize, & maintain a list of obstructions, aesthetic nuisances, and debris removal needs: (c) Develop and maintain a corrective action plan: (d) Investigate ROW complaints and update action plan:	2006 - 2011

Target B

PWD Commitment: $2,300,000

This target is focused on improving the in-stream conditions of the Tookany/Tacony-Frankford Creek. Implementation projects are aimed at habitat improvements as well as measures to provide the opportunity for organisms to avoid high velocities during storms. Improvements to the number, health, and diversity of the benthic invertebrate and fish species are anticipated as a result of these measures.

B-1. Stream Restoration

A high priority is placed on the creation of a restoration master plan for the Tookany/Tacony-Frankford Watershed. The plan will include recommendations from the wetland assessment program, information from the stream assessments, WRU activities, and input from the Fairmount Park Commission. The resulting document could be as simple as a large map showing outlines and key elevations for all the projects together – which would then become a check list for the creation of a detailed design for a given reach. A schedule should be outlined for high priority locations in stream restoration.

Priority Tasks	**Projected Timeline:**
1. Develop an FGM-based stream restoration master plan:	Mid-2006 through 2007
(a) Demonstration Project #1 – Mill Run at 7th and Cheltenham: Include bank revetment and channel modifications to the stormwater outfall. The goal is to clear the concrete pad at the outfall and re-grade 90 linear feet of the natural channel bottom and stabilize the stream banks.	2006
(b) Demonstration Project #2 – Awbury Arboretum: This multi-phased project includes; riparian buffer restoration , wetland restoration, meadow enhancement, stream daylighting, and stormwater diversion	2005-2007
(c) Demonstration Project #3 – Whitaker Ave: Include stream bank stabilization using soil bioengineering, and natural channel design measures that protect infrastructure and the environment	2006-2008
(d) Develop specific projects for large-scale restoration: Conceptual design of large scale stream restoration should be developed based on recommendations of FGM study	2008 - 2011

B-2. Wetlands Restoration and Construction

There are currently several large projects taking place (Riverfront development along the Delaware River, and the Airport expansion) that will require significant mitigation of wetlands and open water. Stream restoration provides an ideal opportunity to provide projects that serve as mitigation for the planned development projects, and that fit within the overall goals of the watershed plan.

Priority Tasks	Projected Timeline:
1. Complete Wetland Master Plan – including prioritization of restoration opportunities: (a) Initiate Demonstration Project #1: i. Design Demonstration Project #1: ii. Construct Demonstration Project #1:	2006 - 2011

B-3. Protect & Enhance Riparian Corridors

It is imperative that PWD and the TTF Watershed Partnership continue to work closely with the Fairmount Park Commission in order to meet the mutual goal of protecting and enhancing the riparian corridor along the Tookany/Tacony-Frankford Creek.

Priority Tasks	Projected Timeline:
1. Assist Fairmount Park Commission with Restoration Projects: PWD can offer assistance through project prioritization with the FGM and wetlands assessment data, project design and pursuit of funding	2006 - 2011
2. Invasive species controls: The FPC ES&ED has implemented invasive species control program in Fairmount Park portion of the stream corridor; recommended that initiative be expanded to the remaining natural areas of the corridor.	2006 - 2011
3. Assist Fairmount Park Commission with volunteer clean-up programs: Work with TTF Partnership to support clean-up efforts	2006 - 2011

Target C

PWD Commitment: $5,600,000

This target is designed to improve water quality standards in the stream during wet weather periods. These projects are designed to reduce and improve the quality of storm water discharges and to reduce CSOs.

C-1. CSO Controls

The use of Real Time Control is designed to utilize the maximum in-system storage capacity of the sewer system by using a computer controlled CSO outfall/regulator gate that uses level monitors to control the position of the dry-weather outlet (DWO) gate and tide gate at each location. This allows the capture and delivery to the treatment works of flow at the maximum rate at which it can be treated.

Priority Tasks	Projected Timeline:
1. Real Time Control Implementation	2006 - 2011

C-2. Stormwater Management Regulations

Act 167 Stormwater Management Planning is currently underway within this watershed area. The resulting model ordinance will allow for watershed-wide management of stormwater runoff. The city of Philadelphia must implement and enforce regulations city-wide to reflect the ordinance adopted by their Montgomery County counterparts in the watershed.

Priority Tasks	Projected Timeline:
1. Work with Montgomery County on completion of Act 167 Stormwater Management Planning and creation of model ordinance for the TTF Watershed:	2006 - 2008
2. Enforce new city-wide stormwater regulations:	2006 - 2011
3. Establish review procedures and staff for implementation of Urban Stormwater BMP manual:	2006
4. Complete SW Rate Structure Review and make Recommendations: (Cost of stormwater management should be fully reflected in rates charged to homeowners, businesses, and land owners in the form of stormwater fees.)	2006 - 2010
5. Begin implementing city-wide SW Rate Structure Improvements:	2010

C-3. Stormwater BMP Projects

"Model" Stormwater BMP demonstration projects will be designed and constructed illustrating the various types of on-site stormwater management techniques that can be applied in urban areas. The goal is to provide local examples of BMPs recommended under the new stormwater regulations that reduce the volume of runoff entering the sewer system as well as reduce the pollutant loads within the runoff whenever possible.

Initial load reduction targets for parameters such as stormwater flow, metals, total suspended solids, and bacteria have been set at 20%, with the goal of continuous reassessment of the load reduction target as projects are implemented.

Priority Tasks	Projected Timeline:
1. Complete BMP implementation plan, site list & prioritization of projects:	2006 - 2008
2. Demonstration Projects:	
(a) Martin Luther King Jr. High School: Will result in detaining and/or infiltrating first 1.5 inches of runoff from parking lots, thus diverting nearly 2.5 million gallons of runoff from combined sewer system each year	2006 - 2011
(b) Bureau of Laboratory Services Low Impact Development (LID) Retrofit Project: This retrofit could include the implementation of multiple BMPs, including an infiltration trench, cisterns, a green roof, and a bioretention system.	2006 - 2011
(c) Implement Demonstration Project #3: Demonstration projects will include the implementation of BMPs such as median infiltration, porous pavement or green roof technology.	2006 - 2011
(d) Implement Demonstration Project #4:	2006 - 2011
(e) Implement Demonstration Project #5:	2006 - 2011
(f) Implement inlet & roof leader disconnect project (Located at Awbury Arboretum):	2006 - 2011
(g) Initiate a Targeted Rain Barrel Program PWD and the TTF Partnership have already conducted a Rain Barrel Pilot Project. Based upon successes and lessons learned, a second program would be targeted to an individual sewershed and monitored for the reduction of stormwater contribution.	2006 - 2011

Priority Tasks	**Projected Timeline:**
(h) Initiate and/or invigorate TreeVitalize program in the TTF Watershed	2006 - 2007
i. Set 5 year goals for tree planting	2007 - 2008
ii. Plant trees	2008 - 2011
3. Initiate incentive grant programs for stormwater BMP implementation city-wide	2007 - 2010

References

Association of Metropolitan Sewerage Agencies. 2002. *Preparation of integrated water quality monitoring and assessment reports*: recommendations for Clean Water Act § 303(d) and §305(b) methodologies and reporting. Available from http://www.amsa-cleanwater.org/advocacy/wqmar/finallisting.pdf, pp.16-38.

Angermeier, Paul L. and Isaac J. Schlosser. 1989. Species-area relationships for stream fishes, *Ecology*, 70 (5), pp. 1450-1462.

Angell, J.L., Clement, M. and Smullen, J.T., Innovative GIS techniques to improve hydrologic modeling for CSO permit compliance, Part 2, pp. 655-666.

Ball, J. 1982. Stream classification guidelines for Wisconsin, Wisconsin Department of Natural Resources Technical Bulletin, Wisconsin Department of Natural Resources. Madison, Wisconsin.

Baltimore County Department of Environmental Protection and Resource Management. 1999. Hydrologic, hydraulic and geomorphological assessment of streams in the Piedmont region of Maryland.

Bannerman, R. 1999. Sweeping Water Clean, *American Sweeper Magazine, Huntsville, AL.Vol. 7,* Number 1.

Barbour, M. T., J. Gerritsen, B. D. Snyder and J. B. Stribling. 1999. Rapid bioassessment protocols for use in streams and wadeable rivers: periphyton, benthic macroinvertebrates, and fish. US Environmental Protection Agency, Office of Water, EPA/841/B-99-002, Washington, DC.

Barbour, M. T., J. B. Stribling, and J. R. Carr. 1995. The multimetric approach for establishing biocriteria and measuring biological condition, *Biological assessment and criteria: tools for water resource planning and decision making*, ed. W. S. Davis and T. P. Simon, Lewis Publishers, Boca Raton, FL. pp. 63-80.

Barnes, H.H. Jr. 1967. Roughness characteristics of natural channels, U.S. Geological Survey Water-Supply Paper, U.S. Geological Survey, 1849.

Brigham Young University, Environmental Research Laboratory. 2000. “Surface water modeling system version 7.0 tutorials.” EMS-I, Provo, UT.

Brower, J., J. Zar and C. VanEnde. 1990. *Field and laboratory methods for general ecology*. 3rd Ed. WM C. Brown, Dubuque, Iowa.

Camp, Dresser and McKee (CDM). 1992. “Watershed Management Model User’s Manual, *Version 2.0*”, Prepared for the Florida Department of Environmental Regulation, Tallahassee, FL.

Camp, Dresser and McKee (CDM). 1998. “Users Manual: Watershed Management Model, *Version 4.1*”, Prepared for USEPA Region 5, Rouge River National Wet Weather Demonstration Project.

Carpenter, D.H. 1983. Characteristics of streamflow in Maryland Department of Natural Resources, Maryland Geological Survey.

Center for Watershed Protection. "An eight-step approach to stormwater retrofitting: how to get them implemented", Retrieved June 6, 2002 from http://www.lib.duke.edu/libguide/bib_webpage.htm.

Center for Watershed Protection. "Site planning model development principles", Retrieved June 6, 2002 from http://www.cwp.org/22_principles.htm.

Center for Watershed Protection. "Elements of a smart watershed program", Retrieved June 6, 2002 from http://www.cwp.org/SMART_WATERSHED_PROGRAM.htm.

Center for Watershed Protection. 1996. "Urban watershed management – a workshop for innovative urban watershed restoration and protection".

Charbeneau, R.J. and Barrett, M.E. 1998. Evaluation of methods for estimating stormwater pollutant loads, *Water Environment Research*, *70*, No. 7, pp 1295-1302.

Chow, V.T. 1959. *Open-channel hydraulics*, McGraw-Hill, Inc., New York, p. 680.

Claytor, R. 1999. Center for Watershed Protection, New Developments in Street Sweeper Technology, *Watershed Protection Techniques, Vol. 3*, Number 1. Ellicott City, MD.

Collier, Michael and Robert H. Webb, and John C. Schmidt. 2000. Dams and rivers, a primer on the downstream effects of dams, U.S. Geological Survey, *Circular 1126*.

Dillon, P.J. 1975. The phosphorous budget of Cameron Lake, Ontario: The importance of flushing rate to the degree of eutrophy in lakes, *Limnol. Oceanogr, 19* pp. 28-39.

Dillow, Jonathan J.A. 1996. Technique for estimating magnitude and frequency of peak flows in Maryland, U.S. Geological Survey.

Donigian, A. S. and Huber, W. C. 1990. USEPA Office of Research and Development, Modeling of Nonpoint Source Water Quality in Urban and Non-Urban Areas, Contract No. 68-03-3513, WA No. 29, 115.

Dunster, J. and Dunster, K. 1996. Dictionary of Natural Resource Management: *Stream Corridor Restoration: Principles, Processes and Practices*, University of British Columbia.

Edwards, E.A., G. Gebhart, and O.E. Maughan. 1983. U.S. Department of the Interior, Fish and Wildlife Service, Habitat suitability information: Smallmouth bass, FWS/OBS- 82/10.36. 47 pp.

Fairmount Park Commission. 1999. Tacony Creek Park master plan, Natural Land restoration master plan, *Vol. 2*, Park-specific master plans.

Gloucester County Planning Department. 1994. Still Run watershed stormwater management plan.

Halliwell, D. B., R. W. Langdon, R. A., J. P. Kurtenbach, and R. A. Jacobson. 1999. Classification of freshwater fish species of the northeastern United States for use in the development of IBIs: *Assessing the sustainability and biological integrity of water resources using fish communities*, ed. T. P. Simon, CRC Press, Boca Raton, FL, pp. 301-337.

The Heritage Conservancy. 2003. Tookany Creek Watershed Management Plan.

Hilsenhoff, V.L. 1987. An improved index of organic stream pollution, *The Great Lakes Entomologist*, 10(1): 31-39.

Hudson, J. 1986. U.S. Environmental Protection Agency, Forecasting onsite soil adsorption system failure rates, EPA/600/2-86/060, Cincinnati, OH.

Jaworski, N. A. 1997. Section VIII – Multiple lakes and special topics limnological characteristics of the Potomac Estuary, North American Project – A Study of U.S. Water Bodies, EPA-600/3-77-086, ed. L. Seyb and K. Randolph, U.S. EPA-Corvallis.

Karr, E. A., K. D. Fausch, P. L. Angermeier, P. R. Yant, and I. J. Schlosser. 1986. "Assessing biological integrity in running waters: A method and its rationale", Special publication 5. Illinois Natural History Survey.

King, I. et al. 1997. U.S. Army Corps of Engineers, Waterways Experiment Station Hydraulics Laboratory, Users guide to RMA WES- *version 4.3*.

Lane, Emory W. 1955. Design of stable channels, *Transactions*, American Society of Civil Engineers, *Vol. 120*, Paper No. 2776.

Larsen, D.P. and Mercier, H.T. 1976. Phosphorous retention capacity of lakes, *Jour. Fish. Res. Bd*. Canada, *33*, pp. 1742-1750.

Lee, G.F. and Jones, A.R. 1981. Application of the OECD eutrophication modeling approach to estuaries: *Estuaries and Nutrient*, ed. Neilson and Cronin, Humana Press, Clifton, NJ, 549-568.

Leopold, L.B., Wolman, M.G., and J.P. Miller. 1964. *Fluvial processes in geomorphology*. W.H. Freeman and Company, San Francisco, CA.

Limerinos, J.T. 1970. Determination of the Manning coefficient from measured bed roughness in natural channels, U.S. Geological Survey Water-Supply Paper, U.S. Geological Survey, 1898-B.

Manning, M.J., Farrow, D.R.G., and Arnold, F.D. 1977. National pollutant discharge inventory, publicly owned treatment works in coastal areas of the US, National Oceanic and Atmospheric Administration (NOAA), Rockville, MD.

Mays, Larry W. 1999. *Hydraulic design handbook*, McGraw-Hill, New York.

McCuen, R.H. 1989. *Hydrologic analysis and design*, Prentice-Hall Inc., 15: 724-730.

Merritt, R.W., and K.W. Cummins. 1996. *An introduction to the aquatic insects of North America*. Third Edition. Kendall/Hunt Publishing Co., Dubuque, Iowa.

National Oceanic and Atmospheric Administration (NOAA), Technical paper no. 40 rainfall frequency atlas of the eastern United States for duration from 30 minutes to 24 hours and return periods from 1 to 100 years, available from http://www.erh.noaa.gov/hq/Tp40s.htm.

Nizeyimana, E., Evans, B.M., Anderson, M.C., Petersen, G.W., DeWalle, D., Sharpe, W., Swistock, B. 1997. *Quantification of NPS pollution loads within Pennsylvania watershed*, prepared for PA DEP by Environmental Resources Research Institute of the Pennsylvania State University.

Ohio Environmental Protection Agency. 1987. Biological criteria for the protection of aquatic life*: Vol. 1-4,* Ohio EPA, Division of Water Quality Monitoring and Assessment, Surface Water Section, Columbus, Ohio.

Overton, D. E. and M. R. Meadows. 1976. *Stormwater modeling*. Academic Press, New York.

PADEP. 2001. Designing Your Monitoring Program, A Technical Handbook for Community-Based Monitoring in Pennsylvania, available from http://www.dep.state.pa.us/dep/deputate/watermgt/wc/subjects/cvmp/initiatives/cvmp_HdBook.htm.

PADEP. 2004. 2004 Integrated List of All Waters, a list of impaired streams and lakes as required by 303(d), available from http://www.dep.state.pa.us/dep/deputate/watermgt/wqp/wqstandards/303dreport.htm#List.

Peckarsky, B. L., P. R. Fraissinet, M. A. Penton, and D. J. Conklin, Jr. 1990. *Freshwater macroinvertebrates of northeastern North America*, Comstock Publishing Assoc, Ithaca, NY. P. 442.

Philadelphia Water Department. 2000. Tacony-Frankford preliminary characterization report from http://www.phillywater.org/Tacony-Frankford/TechnologyCenter/Documents/Reports/reports.htm.

Plafkin, J. L., M. T. Barbour, K. D. Porter, S. K. Gross, and R. M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers Benthic macroinvertebrates and fish, EPA/440/4-89-001, Office of Water, US Environmental Protection Agency, Washington, DC.

Platts, W. S., W. F. Megahan, and G. W. Minshall. 1983. Methods for evaluating Stream, riparian, and biotic conditions, General Report INT-138, U. S. Department of Agriculture, U. S. Forest Service, Ogden, Utah.

Proceedings of the Water Environment Federation 71st Annual Conference and Exposition, Vol. 2. 1998.

Rast, W. and Lee, G.F. 1978. Summary analysis of the North American (US portion) OECD eutrophication project, Nutrient loading – lake response relationships and trophic state indices, EPA-600/3-78-008, USEPA, Office of Research and Development, 454 pages.

Rabeni, Charles F., and Robert B. Jacobson. 1993. The importance of fluvial hydraulics to fish-habitat restoration in low-gradient alluvial streams, *Freshwater Biology*, 29: 211-220.

Rosgen, D. L. 1994. *A classification of natural rivers*, Catena, 22:169-199.

Rosgen, D.L. 2001. A practical method of computing streambank erosion rate. Federal Interagency Sedimentation Conference 2001.

Rosgen, D.L. 1996. A*pplied river morphology*. Wildland Hydrology, Pagosa Springs, CO.

A Clean Sweep Now Possible, Runoff Report, *The Terrene Institute, Alexandria*, VA. Vol. 6 No. 4, July/August 1998.

Sawyer, C.N. 1947. Fertilization of lakes by agricultural and urban drainage, *Journal of New England Water Works Association*. 61:109-127.

Schueler, T. 1995. Environmental land planning series, Site planning for urban stream protection, for Metropolitan Washington Council of Governments, Washington D.C., December. Pub. No. 95708.

Schueler, T. 1987. Controlling urban runoff - a practical manual for planning and designing urban best management practices, Metropolitan Washington Council of Government, DC, pp 202.

Schueler, T.R. 1995. The architecture of urban stream buffers, *Watershed Protection Techniques*, 1:4.

Proceedings of Engineering Hydrology Symposium, ASCE, San Fransico, July 1993, edited by Schueler T.R., Perfomance of stormwater ponds and wetland systems, pp. 747.

Smith, V.H. 1976. Storm-derived losses of phosphorus and their significance to annual phosphorus export from two New Jersey watersheds, Masters Thesis, 115 pages, Rutgers University, New Brunswick, NJ.

Smullen, J.T., Shallcross, A.L. and Cave, K.A. 1999. Updating the U.S. nationwide urban runoff quality database, *Water Science and Technology*, *39*, No. 12, pp. 9-16.

Stankowski, S.J. 1974. Magnitude and frequency of floods in New Jersey with effects of urbanization, Special report 38, U.S. Geological Survey, Trenton, New Jersey.

Tookany/Tacony-Frankford Creek Watershed Partnership 2004. Final Report Tacony-Frankford Creek River Conservation Plan from http://www.phillywater.org/Tacony-Frankford/River%20Conservation%20Plan/RCP.htm.

Thurston H.W., Goddard H.C., Szlag D., and Lemberg B., Controlling Storm-Water Runoff with Tradable Allowances for Impervious Surfaces, Journal of Water Resources Planning and Management; ASCE (September/October 2003), pp 409 – 418.

Tuffey, T.J. and Baker, H. 1975. The plight of the urban reservoir: A case study, *WaterResources Bulletin*, 11, No. 3, pp.575-583.

Proceeding No. 20, American Water Resources Association. 1975. edited by Tuffey, T.J. and Trama, F.B. , Temporal variations in tributary phosphorus loads, in urbanization and water quality control, pp.140-152.

U.S. Army Corps of Engineers, Hydrologic Engineering Center. 1998. *HEC-5*,simulation of flood control and conservation systems, Appendix on water quality analysis, Davis, CA.

U.S. Army Corps of Engineers, Hydrologic Engineering Center March 1995. HECDSS, Data storage system, User’s guide and utility program manuals, Davis, CA.

U.S. Department of Agriculture. 1986. Urban hydrology for Small Watersheds TR-55, Natural Resources Conservation Service, Technical Release 55.

U.S. Environmental Protection Agency’s Draft framework for watershed-based trading. 1996. EPA 800-R096-001, Office of Water, Washington D.C.

U.S. Environmental Protection Agency. 1997. Monitoring Consortiums: A Cost-Effective Means to Enhancing Watershed Data Collection and Analysis. U.S. Environmental Protection Agency, Washington, DC.

U.S. Environmental Protection Agency and the Delaware Department of Natural Resources and Environmental Council. January 1999. Christina River Watershed Stream Restoration Study, NPS Project 98-8.

U.S. Environmental Protection Agency. 2002. Exfiltration in sewer systems (EPA/600/R-01/034), available from http://www.epa.gov/ORD/NRMRL/Pubs/600R01034/600R01034.htm.

U.S. Environmental Protection Agency. 2003. Watershed-Based National Pollutant Discharge Elimination System (NPDES) Permitting Implementation Guidance (EPA 833-B-03-004), available from http://cfpub.epa.gov/npdes/wqbasedpermitting/wspermitting.cfm.

U.S. Environmental Protection Agency. SWMM RUNOFF for hydrology and loading, available from http://www.ccee.orst.edu/swmm/, http://www.epa.gov/ceampubl/swmm.htm.

U.S. Environmental Protection Agency. EXTRAN for stream hydrodynamics loading, available from http://www.ccee.orst.edu/swmm/, http://www.epa.gov/ceampubl/swmm.htm.

U.S. Environmental Protection Agency. WASP for instream and reservoir water quality modeling, available from (http://www.epa.gov/ceampubl/wasp.htm).

U.S. Water Resources Council. 1982. Guidelines for determining flood flow frequency, Revised Bulletin 17B.

Upper Perkiomen Watershed Coalition, Upper Perkiomen Watershed Coalition Conservation Plan, Retrieved September 5, 2002 available from http://www.phillywater.org/Schuylkill/Watershed/watershed_history.htm.

Vollenweider, R.A. and Dillon, P.J. 1974. The application of the phosphorus loading concept to eutrophication research, National Research Council Canada., NRC Associate Committee on Scientific Criteria for Environmental Quality, NRCC No. 13690.

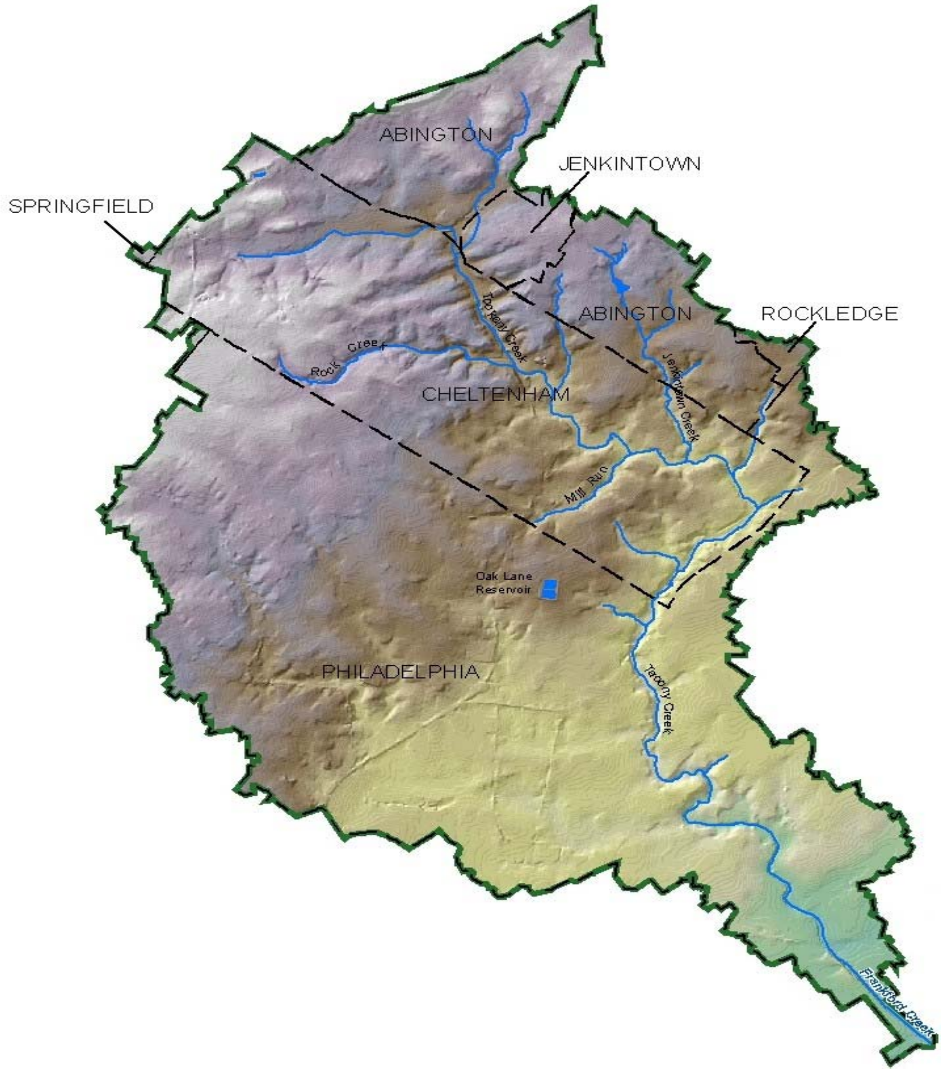
Warwick, John J. 2002. Impacts of urban land use on macro invertebrate communities in southeastern Wisconsin streams, *Journal of the American Water Resources Association*. Allen Press, Inc. Lawrence, Kansas. 38(4): 1041-1051.

Winer, R. 2000. “National Pollutant Removal Performance Database for Stormwater Treatment Practices: 2nd Edition”, Center for Watershed Protection. Ellicott City, MD.

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.

TOOKANY/TACONY-FRANKFORD WATERSHED ACT 167
STORMWATER MANAGEMENT PLAN



VOLUME III – TECHNICAL APPENDIX

MONTGOMERY AND PHILADELPHIA COUNTIES, PENNSYLVANIA

BLE PROJECT NO. 2004-1621-00

TOOKANY/TACONY-FRANKFORD WATERSHED ACT 167
STORMWATER MANAGEMENT PLAN

MONTGOMERY & PHILADELPHIA COUNTIES, PENNSYLVANIA

VOLUME III – TECHNICAL APPENDIX

BLE PROJECT NO. 2004-1621-00

PREPARED FOR:

PHILADELPHIA WATER DEPARTMENT
Office of Watersheds
1101 Market Street, 4th Floor
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VOLUME III – TECHNICAL APPENDIX

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APPENDIX A

SWMM MODEL OUTPUTS

FINAL SWMM INPUT


```
[TITLE]
NELL     Model    1998
Runoff   Data     Set
         Tacony-Frankford          Open     Channel Model
         See      notes    at      end      regarding        weir     assumptions      and      pipe     replacement.
xys=TACexXYS.xys
*==========================================================================================

[OPTIONS]
 FLOW_UNITS              CFS
 INFILTRATION            GREEN_AMPT
 FLOW_ROUTING            DYNWAVE
 START_DATE              01/01/2004
 START_TIME              00:00:00
 REPORT_START_DATE       01/01/2004
 REPORT_START_TIME       00:00:00
 END_DATE                01/02/2004
 END_TIME                00:00:00
 SWEEP_START             1/1
 SWEEP_END               12/31
 DRY_DAYS                0
 REPORT_STEP             0:05:00
 WET_STEP                0:05:00
 DRY_STEP                1:00:00
 ROUTING_STEP            0:00:01
 ALLOW_PONDING           NO
 INERTIAL_DAMPING        PARTIAL
 VARIABLE_STEP           0.75
 LENGTHENING_STEP        1
 MIN_SURFAREA            12.566
 NORMAL_FLOW_LIMITED     NO
 SKIP_STEADY_STATE       NO
 IGNORE_RAINFALL         NO

[FILES]
 USE HOTSTART "C:\Tacony\SWMM\Werfel5-24-07\dwf.hsf"

[EVAPORATION]
;;Type          Parameters
;;-------------------------
 MONTHLY        0.07    0.07    0.07    0.15    0.18    0.21    0.22    0.19    0.14    0.09    0.07    0.07

[RAINGAGES]
;;               Rain       Recd.  Snow   Data       Source              Station     Rain
;;Name           Type       Freq.  Catch  Source     Name                ID          Units
;;----------------------------------------------------------------------------------------
 GAGE7           VOLUME     0:15   1      FILE       "C:\Tacony\SWMM\Werfel5-24-07\SWMMInput\RG_50IDF.txt" 1
      IN
 GAGE8           VOLUME     0:15   1      FILE       "C:\Tacony\SWMM\Werfel5-24-07\SWMMInput\RG_50IDF.txt" 1
      IN
 GAGE10          VOLUME     0:15   1      FILE       "C:\Tacony\SWMM\Werfel5-24-07\SWMMInput\RG_50IDF.txt" 1
      IN
 GAGE11          VOLUME     0:15   1      FILE       "C:\Tacony\SWMM\Werfel5-24-07\SWMMInput\RG_50IDF.txt" 1
      IN
 GAGE13          VOLUME     0:15   1      FILE       "C:\Tacony\SWMM\Werfel5-24-07\SWMMInput\RG_50IDF.txt" 1
      IN
 GAGE14          VOLUME     0:15   1      FILE       "C:\Tacony\SWMM\Werfel5-24-07\SWMMInput\RG_50IDF.txt" 1
      IN
 GAGE18          VOLUME     0:15   1      FILE       "C:\Tacony\SWMM\Werfel5-24-07\SWMMInput\RG_50IDF.txt" 1
      IN
 GAGE19          VOLUME     0:15   1      FILE       "C:\Tacony\SWMM\Werfel5-24-07\SWMMInput\RG_50IDF.txt" 1
      IN

[SUBCATCHMENTS]
;;                                                 Total    Pcnt.             Pcnt.    Curb     Snow
;;Name           Raingage         Outlet           Area     Imperv   Width    Slope    Length   Pack
;;------------------------------------------------------------------------------------------------
 CHEWSTA         GAGE19           TT14-284         5.16     48.663   1042.8   0.313    0

 CHEWSTB         GAGE19           TT14-284         8.6      12.87    1346.4   0.313    0

 CLEARVIEW       GAGE19           TT14-291         2.98     61.911   793.1    0.313    0

;     *        gutter/p        d/s       type      width    length   slope    left     right    manning dfull
starting
 F03-1           GAGE7            TF03-132         71.66    44.154   3887.4   0.24     0

 F03-2           GAGE7            TF03-108         71.66    44.154   3887.4   0.24     0

 F04-B1          GAGE13           TF04-122         86.18    52.893   4262.5   0.24     0

 F04-B2          GAGE13           TF04-115         86.18    52.893   4262.5   0.24     0

 F04-B3          GAGE13           TF04-136         86.18    52.893   4262.5   0.24     0

 F05             GAGE13           TF05-108         24.21    62.451   2259.4   0.181    0

 F06             GAGE13           TF06-014         46.26    73.017   3122.9   0.181    0

 F07             GAGE13           TF07-120         83.1     73.53    4185.5   0.181    0

 F08-1           GAGE13           TF08-106         28.49    79.164   2450.8   0.181    0

 F08-2           GAGE13           TF08-210         28.49    79.164   2450.8   0.181    0

 F09             GAGE13           TF09-108         4.14     89.127   933.9    0.181    0
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F10	GAGE13	TF10-124	68.23	69.03	3792.8	0.181	0
F11-A1	GAGE13	TF11-144	87.89	61.875	4304.3	0.181	0
F11-A2	GAGE13	TF11-124	87.89	61.875	4304.3	0.181	0
F11-B1	GAGE13	TF11-174	82.74	57.735	4176.7	0.181	0
F11-B2	GAGE13	TF11-160	82.74	57.735	4176.7	0.181	0
F12	GAGE13	TF12-106	34.45	54.495	2695	0.181	0
F13	GAGE13	TF13-110	44.52	72.009	3063.5	0.181	0
F14	GAGE14	TF14-105	25.09	28.233	2300.1	0.181	0
G2	GAGE10	G4	69.31	29.097	3822.5	0.2	0
MR2a	GAGE19	MR2	198.69	37.476	6472.4	0.234	0
MR2b	GAGE8	MR2	25.75	35.406	2329.8	0.234	0
MS64	GAGE11	MS66	21.75	17.334	2141.7	0.274	0
MS76	GAGE11	MS74	25.58	8.172	2322.1	0.454	0
Non-B6	GAGE10	B6	16.81	0.144	7718.524	0.793	0
Non-B8	GAGE10	B8	43.57	0.162	20005.722	0.616	0
Non-del1	GAGE13	TF-12851	14.25	0.576	6543.064	0.311	0
Non-del2	GAGE13	TF-14039	4.86	0.576	2231.526	0.311	0
Non-del3	GAGE13	TF-07706	206.08	0.576	94624.255	0.311	0
Non-MS100	GAGE8	TF-27181	14.99	0.603	6882.854	0.759	0
Non-MS102	GAGE8	TF-25711	13.87	0.792	6368.582	0.931	0
Non-MS104	GAGE8	TF-23971	20.56	0.765	9440.387	0.68	0
Non-MS106	GAGE7	TF-22376	26.3	0.657	12075.976	0.611	0
Non-MS108	GAGE7	TF-20596	112.94	0.432	51857.839	0.596	0
Non-MS110	GAGE7	TF-19127	82.74	0.864	37991.118	0.615	0
Non-MS112	GAGE7	TF-18956	23.74	0.801	10900.527	0.796	0
Non-MS114	GAGE7	TF-18081	20.84	0.864	9568.955	0.672	0
Non-MS118	GAGE7	TF-15181	43.54	0.819	19991.95	0.663	0
Non-MS120	GAGE7	TF-14444	5.35	0.891	2456.52	0.81	0
Non-MS122	GAGE7	TF-14039	8.06	0.333	3700.851	0.714	0
Non-MS76	GAGE8	TF-32061	1.51	0.756	693.341	1.115	0
Non-MS78	GAGE8	TF-32061	12.05	0.81	5532.912	0.994	0
Non-MS80	GAGE8	TF-30666	15.27	0.612	7011.411	0.405	0
Non-MS86	GAGE8	TF-30301	5.71	0.603	2621.817	0.797	0
Non-MS88	GAGE8	TF-30221	9.77	0.468	4486.02	1.184	0
Non-MS90	GAGE8	TF-29001	19.61	0.558	9004.182	0.903	0
Non-MS92	GAGE8	TF-28165	11.64	0.486	5344.658	0.832	0
Non-MS94	GAGE8	TF-27356	12.44	0.783	5711.981	0.853	0
Non-MSr92	GAGE8	TF-30666	5.34	0.756	2451.933	0.525	0
R15-A	GAGE8	TR15-210	793.32	59.067	12932.7	0.285	0
R18	GAGE13	IT15-022	58.59	64.242	3514.5	0.181	0
SubCatchA2	GAGE11	A2	52.01	32.922	3311	0.187	0
SubCatchB10	GAGE10	B10	10.71	19.107	1502.6	0.666	0
SubCatchB2	GAGE10	B2	155.64	18.819	5728.8	0.197	0
SubCatchB4	GAGE10	B4	31.28	16.308	2568.5	0.39	0
SubCatchB6	GAGE10	B6	28.8	23.895	2464	0.316	0
SubCatchB8	GAGE10	B8	42.23	30.888	2984.3	0.326	0
SubCatchC2	GAGE10	C2	107.16	20.52	4753.1	0.262	0
SubCatchD2	GAGE10	D2	75.85	24.84	3998.5	0.414	0

SubCatchD4	GAGE10	D4	6.52	17.28	1172.6	0.865	0
SubCatchEJ2	GAGE10	EJ2	140.81	22.968	5448.3	0.423	0
SubCatchEJ4	GAGE10	EJ4	145.5	31.437	5538.5	0.319	0
SubCatchG10	GAGE10	G10	105.03	25.407	4705.8	0.241	0
SubCatchG4	GAGE10	G4	72.3	24.948	3903.9	0.289	0
SubCatchG6	GAGE10	G6	72.43	19.521	3907.2	0.398	0
SubCatchG8	GAGE10	G8	25.69	17.955	2327.6	0.438	0
SubCatchH10	GAGE19	H10	118.81	12.78	5005	0.504	0
SubCatchH12	GAGE19	H12	48.17	16.596	3186.7	0.696	0
SubCatchH14	GAGE19	H14	97.45	16.506	4533.1	0.607	0
SubCatchH2	GAGE19	H2	151.26	28.242	5647.4	0.239	0
SubCatchH4	GAGE19	H4	22.27	12.618	2167	0.245	0
SubCatchH6	GAGE19	H6	83.46	35.505	4194.3	0.257	0
SubCatchH8	GAGE19	H8	193.18	16.578	6382.2	0.443	0
SubCatchI10	GAGE19	I10	35.92	23.769	2752.2	0.791	0
SubCatchI12	GAGE19	I12	213.8	42.021	6713.3	0.466	0
SubCatchI2	GAGE19	I2	126.41	34.254	5162.3	0.41	0
SubCatchI4	GAGE19	I4	226.63	47.061	6912.4	0.376	0
SubCatchI6	GAGE19	I6	43.98	24.696	3044.8	0.72	0
SubCatchI8	GAGE19	I8	49.96	17.874	3245	0.725	0
SubCatchJ10	GAGE10	J10	12.17	12.042	1601.6	0.4	0
SubCatchJ12	GAGE10	J12	42.1	16.695	2978.8	0.371	0
SubCatchJ14	GAGE10	J14	74.72	25.821	3968.8	0.325	0
SubCatchJ16	GAGE10	J16	33.78	30.447	2668.6	0.47	0
SubCatchJ18	GAGE10	J18	34.48	28.908	2696.1	0.435	0
SubCatchJ2	GAGE10	J2	81.93	25.776	4155.8	0.451	0
SubCatchJ20	GAGE10	J20	101.98	24.687	4636.5	0.38	0
SubCatchJ4	GAGE10	J4	89.45	11.322	4342.8	0.495	0
SubCatchJ6	GAGE10	J6	62.74	29.34	3636.6	0.463	0
SubCatchJ8	GAGE10	J8	57.45	42.75	3480.4	0.426	0
SubCatchJ9	GAGE10	J9	58.51	35.856	3512.3	0.409	0
SubCatchK2	GAGE19	K2	162.54	29.916	5854.2	0.588	0
SubCatchK4	GAGE19	K4	36.58	20.961	2777.5	0.543	0
SubCatchL2	GAGE19	L2	268.75	43.371	7527.3	0.508	0
SubCatchL4	GAGE19	L4	76.82	34.542	4024.9	0.553	0
SubCatchM2	GAGE19	M2	95.14	28.971	4479.2	0.318	0
SubCatchMC_1	GAGE19	MC_1	203.14	4.5	6544.34	0.9	0
SubCatchMC_2	GAGE8	MC_2	9093.43	4.5	43785.5	0.9	0
SubCatchMR10	GAGE8	MR10	51.25	18.243	3286.8	0.439	0
SubCatchMR4	GAGE8	MR4	129.71	25.083	5229.4	0.273	0
SubCatchMR6	GAGE8	MR6	133.85	19.449	5311.9	0.374	0
SubCatchMR8	GAGE8	MR8	44.29	16.119	3055.8	0.471	0
SubCatchMS10	GAGE19	MS10	119.61	41.436	5021.5	0.551	0
SubCatchMS12	GAGE19	MS12	78.32	39.699	4063.4	0.653	0
SubCatchMS14	GAGE19	MS14	138.3	33.885	5399.9	0.476	0
SubCatchMS16	GAGE19	MS16	446.65	42.804	9704.2	0.463	0
SubCatchMS18	GAGE19	MS18	29.65	30.123	2500.3	0.52	0
SubCatchMS2	GAGE19	MS2	168.84	22.698	5966.4	0.472	0

SubCatchMS20	GAGE19	MS20	235.38	36.963	7044.4	0.49	0
SubCatchMS22	GAGE19	MS22	62.01	50.553	3615.7	0.515	0
SubCatchMS24	GAGE19	MS24	61.82	48.618	3610.2	0.584	0
SubCatchMS26	GAGE19	MS26	251.03	39.492	7275.4	0.704	0
SubCatchMS28	GAGE19	MS28	129.11	47.412	5217.3	0.548	0
SubCatchMS30	GAGE19	MS30	135.37	23.931	5342.7	0.558	0
SubCatchMS32	GAGE19	MS32	97.48	22.653	4533.1	0.593	0
SubCatchMS34	GAGE19	MS34	85.91	22.401	4255.9	0.493	0
SubCatchMS36	GAGE19	MS36	41.21	34.173	2948	0.484	0
SubCatchMS38	GAGE19	MS38	112.57	26.325	4871.9	0.36	0
SubCatchMS4	GAGE19	MS4	243.5	26.37	7165.4	0.614	0
SubCatchMS40	GAGE19	MS40	526.4	29.034	10534.7	0.336	0
SubCatchMS42	GAGE8	MS42	160.75	21.033	5821.2	0.347	0
SubCatchMS44	GAGE8	MS44	136.56	16.371	5365.8	0.376	0
SubCatchMS46	GAGE8	MS46	49.72	15.39	3237.3	0.434	0
SubCatchMS50	GAGE8	MS50	20.37	12.6	2072.4	0.529	0
SubCatchMS52	GAGE11	MS52	78.56	13.788	4070	0.441	0
SubCatchMS54	GAGE11	MS54	13.48	12.006	1686.3	0.451	0
SubCatchMS56	GAGE10	MS56	53.76	16.839	3367.1	0.399	0
SubCatchMS58	GAGE10	MS58	69.53	15.012	3829.1	0.47	0
SubCatchMS6	GAGE19	MS6	25.4	35.757	2314.4	0.543	0
SubCatchMS60	GAGE11	MS60	97.5	19.611	4534.2	0.263	0
SubCatchMS62	GAGE11	MS62	34.98	13.842	2715.9	0.342	0
SubCatchMS70	GAGE11	MS70	58.08	18.828	3499.1	0.369	0
SubCatchMS72	GAGE11	MS72	38.95	14.166	2865.5	0.312	0
SubCatchMS74	GAGE11	MS74	231.63	19.935	6988.3	0.338	0
SubCatchMS8	GAGE19	MS8	237.66	35.847	7078.5	0.572	0
SubCatchN2	GAGE11	N2	112.44	18.18	4868.6	0.375	0
SubCatchTR15-302	GAGE8	TR15-302	11.08	48.33	1527.9	0.285	0
SubCatchTR15-310	GAGE8	TR15-310	8.33	44.298	1325.5	0.285	0
SubCatchTR15-314	GAGE8	TR15-314	4.96	36.288	1023	0.285	0
SubCatchTR15-320	GAGE8	TR15-320	14.88	38.043	1771	0.285	0
SubCatchTR15-322	GAGE8	TR15-322	11.51	30.96	1557.6	0.285	0
SubCatchTR15-340	GAGE8	TR15-340	3.8	4.5	888.8	0.9	0
SubCatchTR15-340B	GAGE8	TR15-340B	10	4.5	1453.1	0.9	0
SubCatchTR15-342B	GAGE8	TR15-342B	4.9	4.5	1018.6	0.9	0
SubCatchTR15-358	GAGE8	TR15-358	11.7	4.5	1568.6	0.9	0
SubCatchTR15-366	GAGE8	TR15-366	2.2	4.5	684.2	0.9	0
SubCatchTR15-366B	GAGE8	TR15-366B	14.8	4.5	1763.3	0.9	0
SubCatchTR15-368	GAGE19	TR15-368	18.2	4.5	1958	0.9	0
SubCatchTR15-370B	GAGE19	TR15-370B	10.1	4.5	1458.6	0.9	0
SubCatchTR15-372C	GAGE19	TR15-372C	8.6	4.5	1343.1	0.9	0
SubCatchTR15-376C	GAGE19	TR15-376C	9.1	4.5	1384.9	0.9	0
SubCatchTR15-378B	GAGE19	TR15-378B	6.4	4.5	1159.4	0.9	0
SubCatchTR15-386	GAGE19	TR15-386	3.4	4.5	843.7	0.9	0
SubCatchTR15-390	GAGE19	TR15-390	8.4	4.5	1333.2	0.9	0
SubCatchTR15-392	GAGE19	TR15-392	48.6	4.5	3202.1	0.9	0
SubCatchTR15-408	GAGE19	TR15-408	5.4	4.5	1068.1	0.9	0

SubCatchTR15-412A	GAGE19	TR15-412A	14.5	4.5	1749	0.9	0
SubCatchTR15-414	GAGE19	TR15-414	14.2	4.5	1732.5	0.9	0
SubCatchTR15-414A	GAGE19	TR15-414A	27	4.5	2388.1	0.9	0
SubCatchTR15-438	GAGE19	TR15-438	30.4	4.5	2532.2	0.9	0
SubCatchTR15-604	GAGE8	TR15-604	19.78	35.991	2041.6	0.285	0
SubCatchTR15-604A	GAGE8	TR15-604A	13.07	39.042	1659.9	0.285	0
SubCatchTR15-606A	GAGE8	TR15-606A	14	37.737	1718.2	0.285	0
SubCatchTR15-612A	GAGE8	TR15-612A	13.92	41.634	1712.7	0.285	0
SubCatchTR15-614A	GAGE8	TR15-614A	12.82	41.697	1644.5	0.285	0
SubCatchTR15-618	GAGE8	TR15-618	11.14	55.746	1532.3	0.285	0
SubCatchTR15-704	GAGE8	TR15-704	7.49	40.977	1256.2	0.285	0
SubCatchTR15-710	GAGE8	TR15-710	8.71	39.366	1355.2	0.285	0
SubCatchTR15-716	GAGE8	TR15-716	24.43	47.448	2269.3	0.285	0
SubCatchTR15B1-366	GAGE8	TR15B1-366	15	4.5	1777.6	0.9	0
SubCatchTR15B1-380	GAGE19	TR15B1-380	16.5	4.5	1867.8	0.9	0
T01-A	GAGE19	TR15-224	106.25	4.5	4733.3	0.9	0
T01-A-S	GAGE19	H4	106.25	40.248	4733.3	0.257	0
T01-B1	GAGE19	TT01-124	77.39	41.679	4039.2	0.222	0
T01-B2	GAGE19	TT01-118	77.39	41.679	4039.2	0.222	0
T03-A	GAGE8	TT03-112	49.06	65.421	3216.4	0.315	0
T03-B	GAGE8	TT03-108	49.06	65.421	3216.4	0.315	0
T04-A	GAGE8	TT04-108	28.06	47.826	2432.1	0.303	0
T04-B	GAGE8	TT04-106	38.03	77.058	2831.4	0.303	0
T05	GAGE8	TT05-102	50.73	52.902	3270.3	0.283	0
T-050-01-S	GAGE14	TF-01133	33.43	46.656	2654.3	0.132	0
T-050-02-S	GAGE14	TF-02905	7.6	28.305	1266.1	0.132	0
T-055-01	GAGE13	IF05-010	4.2	4.5	940.5	0.9	0
T-055-01-S	GAGE13	TF-10561	4.2	61.497	940.5	0.132	0
T-056-01	GAGE13	IF11-008	10.53	6.3	1490.5	0.9	0
T-056-01-S	GAGE13	TF-07706	10.53	59.49	1490.5	0.132	0
T-056-02	GAGE13	IF12-000	16.89	6.3	1886.5	0.9	0
T-056-02-S	GAGE13	TF-05871	16.89	54.936	1886.5	0.132	0
T-056-03	GAGE13	IF12-004	19.3	4.5	2018.5	0.9	0
T-056-03-S	GAGE13	TF-05871	19.33	55.314	2018.5	0.132	0
T-056-04	GAGE13	IF12-000	36.28	6.3	2765.4	0.9	0
T-056-04-S	GAGE13	TF-05871	36.28	52.641	2765.4	0.132	0
T-056-05	GAGE14	IF12-008	52.1	4.5	3314.3	0.9	0
T-056-05-S	GAGE14	TF-05301	52.09	49.968	3314.3	0.132	0
T-056-06	GAGE14	IF12-016	6.38	6.3	1159.4	0.9	0
T-056-06-S	GAGE14	TF-04125	6.38	52.191	1159.4	0.132	0
T-056-07-S	GAGE14	TF-03285	11.63	44.19	1566.4	0.132	0
T-056-08	GAGE14	IF12-016	18.95	6.3	1998.7	0.9	0
T-056-08-S	GAGE14	TF-03285	18.95	56.52	1998.7	0.132	0
T-056-09	GAGE14	IF14-000	59.23	4.5	3534.3	0.9	0
T-056-09-S	GAGE14	TF-05301	59.23	54.522	3534.3	0.132	0
T-063-01-S	GAGE7	TF-22686	1.02	53.82	464.2	0.37	0
T-063-02	GAGE7	IT13-008	19.95	4.5	2050.4	0.9	0
T-063-02-S	GAGE7	TF-18081	19.95	38.304	2050.4	0.587	0

T-063-03-S	GAGE13	TF-13836	6.09	43.596	1133	0.528	0
T-063-04	GAGE13	IF04-000	6.75	6.3	1192.4	0.9	0
T-063-04-S	GAGE13	TF-12911	6.75	65.871	1192.4	0.405	0
T-063-05	GAGE13	IF04-004	9.42	6.3	1409.1	0.9	0
T-063-05-S	GAGE13	TF-12291	9.42	60.291	1409.1	0.405	0
T-063-06	GAGE13	IF05-000	4.13	6.3	932.8	0.9	0
T-063-06-S	GAGE13	TF-12291	4.13	64.719	932.8	0.132	0
T06-A1	GAGE8	TT06-140	58.1	62.703	3500.2	0.184	0
T06-A2	GAGE8	TT06-136	58.1	62.703	3500.2	0.184	0
T06-B1	GAGE11	TT06-118	58.1	62.703	3500.2	0.184	0
T06-B2	GAGE11	TT06-112	58.1	62.703	3500.2	0.184	0
T06-C1	GAGE11	TT06-122	58.1	62.703	3500.2	0.184	0
T06-C2	GAGE11	TT06-124	58.1	62.703	3500.2	0.184	0
T07	GAGE8	TT07-102	22.37	50.409	2171.4	0.375	0
T-071-01	GAGE8	IT07-004	1.79	4.5	613.8	0.9	0
T-071-01-S	GAGE8	TF-25841	1.79	27.657	613.8	0.442	0
T-079-01	GAGE8	IT00-018	186.42	4.5	6268.9	0.9	0
T-079-01-S	GAGE8	TF-32061	186.42	45.495	6268.9	0.447	0
T-079-02	GAGE8	IT00-018	15.81	4.5	1826	0.9	0
T-079-02-S	GAGE8	TF-30221	15.81	38.592	1826	0.447	0
T-080-01	GAGE11	IT00-000	47.59	4.5	3168	0.9	0
T-080-01-S	GAGE11	MS70	47.59	32.607	3168	0.312	0
T-080-02	GAGE11	IT00-000	38.18	4.5	2836.9	0.9	0
T-080-02-S	GAGE11	MS73	38.18	40.491	2836.9	0.338	0
T-080-03	GAGE11	IT00-000	11.11	4.5	1530.1	0.9	0
T-080-03-S	GAGE11	MS74	11.11	27.666	1530.1	0.454	0
T-088-01-S	GAGE8	MR2	466.49	34.245	9917.6	0.234	0
T-089-01	GAGE11	IT00-000	31.87	4.5	2591.6	0.9	0
T-089-01-S	GAGE11	MS62	31.87	26.865	2591.6	0.274	0
T-089-02	GAGE11	IT00-000	18.77	4.5	1988.8	0.9	0
T-089-02-S	GAGE11	MS60	18.77	24.975	1988.8	0.342	0
T-089-03	GAGE11	IT00-002	41.07	4.5	2942.5	0.9	0
T-089-03-S	GAGE11	MS59	41.07	28.026	2942.5	0.263	0
T-089-04	GAGE11	IT00-002	206.59	4.5	6600	0.9	0
T-089-04-S	GAGE11	A2	206.59	35.703	6600	0.187	0
T08-A1	GAGE8	TT08-186	65.22	61.659	3708.1	0.285	0
T08-A2	GAGE8	TT08-182	65.22	61.659	3708.1	0.285	0
T08-A3	GAGE8	TT08-176	65.22	61.659	3708.1	0.285	0
T08-B1	GAGE8	TT08-204	65.22	61.659	3708.1	0.285	0
T08-B2	GAGE8	TT08-166	65.22	61.659	3708.1	0.285	0
T08-B3	GAGE8	TT08-153	65.22	61.659	3708.1	0.285	0
T08-C1	GAGE8	TT08-130	65.22	61.659	3708.1	0.285	0
T08-C2	GAGE8	TT08-115	65.22	61.659	3708.1	0.285	0
T08-C3	GAGE8	TT08-110	65.22	61.659	3708.1	0.285	0
T08-D1A	GAGE8	TT08-216	65.22	61.659	3708.1	0.285	0
T08-D1B	GAGE8	TT08-214	65.22	61.659	3708.1	0.285	0
T08-D2	GAGE8	TT08-246	65.22	61.659	3708.1	0.285	0
T08-D3	GAGE8	TT08-264	65.22	61.659	3708.1	0.285	0

T08-E1A	GAGE8	TT08-138	65.22	61.659	3708.1	0.285	0
T08-E1B	GAGE8	TT08-130	65.22	61.659	3708.1	0.285	0
T-096-01	GAGE19	TR15-234	26.75	4.5	2374.9	0.9	0
T-096-01-S	GAGE19	H2	26.75	43.425	2374.9	0.239	0
T-097-01	GAGE19	TR15-234	47.03	4.5	3149.3	0.9	0
T-097-01-S	GAGE19	H2	47.03	32.481	3149.3	0.245	0
T-097-02	GAGE19	TR15-234	16.55	4.5	1867.8	0.9	0
T-097-02-S	GAGE19	H2	16.55	18.846	1867.8	0.245	0
T-098-01	GAGE10	IT00-002	40.72	4.5	2930.4	0.9	0
T-098-01-S	GAGE10	B4	40.72	29.898	2930.4	0.316	0
T-098-02	GAGE10	IT00-002	2.85	4.5	775.5	0.9	0
T-098-02-S	GAGE10	B4	2.85	26.973	775.5	0.316	0
T-098-03	GAGE10	IT00-002	45.87	4.5	3109.7	0.9	0
T-098-03-S	GAGE10	B4	45.87	33.66	3109.7	0.316	0
T09-A	GAGE8	TT09-304	16.52	66.816	1866.7	0.285	0
T09-B	GAGE8	TT09-402	16.52	66.816	1866.7	0.285	0
T10	GAGE8	TT10-110	60.3	60.147	3565.1	0.239	0
T11	GAGE7	TT11-102	39.53	64.206	2886.4	0.239	0
T12	GAGE7	TT12-104	7.95	45.279	1294.7	0.395	0
T13a	GAGE7	TT13-122	55.18	69.03	3411.1	0.164	0
T13b	GAGE7	TT13-110	55.18	69.03	3411.1	0.164	0
T14-A1A	GAGE7	TT14-048	73.8	53.568	3944.6	0.313	0
T14-A1B	GAGE7	TT14-046	73.8	53.568	3944.6	0.313	0
T14-A1C	GAGE7	TT14-034	73.8	53.568	3944.6	0.313	0
T14-A2A	GAGE7	TT14-022	73.8	53.568	3944.6	0.313	0
T14-A2B	GAGE7	TT14-016	73.8	53.568	3944.6	0.313	0
T14-A2C	GAGE7	TT14-007	73.8	53.568	3944.6	0.313	0
T14-B1A	GAGE7	TT14-908	65.43	61.893	3714.7	0.313	0
T14-B1B	GAGE7	TT14-906	65.43	61.893	3714.7	0.313	0
T14-B1C	GAGE7	TT14-904	65.43	61.893	3714.7	0.313	0
T14-B1D	GAGE7	TT14-902	65.43	61.893	3714.7	0.313	0
T14-B1E	GAGE7	TT14-030	65.43	61.893	3714.7	0.313	0
T14-C1	GAGE8	TT14-070	64.58	66.924	3689.4	0.313	0
T14-C2	GAGE8	TT14-068	64.58	66.924	3689.4	0.313	0
T14-C3	GAGE8	TT14-064	64.58	66.924	3689.4	0.313	0
T14-D1	GAGE8	TT14-108	40.58	44.784	2924.9	0.313	0
T14-D2	GAGE18	TT14-107	40.58	44.784	2924.9	0.313	0
T14-E1	GAGE8	TT14-082	50.96	61.065	3278	0.313	0
T14-E2	GAGE8	TT14-078	50.96	61.065	3278	0.313	0
T14-E3	GAGE8	TT14-076	50.96	61.065	3278	0.313	0
T14-F	GAGE8	TT14-107	23.81	27.783	2240.7	0.313	0
T14-G	GAGE8	TT14-202	55.6	65.151	3424.3	0.313	0
T14-H	GAGE8	TT14-110	2.18	57.384	677.6	0.313	0
T14-J1	GAGE18	TT14-308	73.92	65.232	3947.9	0.313	0
T14-J4	GAGE18	TT14-304	73.92	65.232	3947.9	0.313	0
T14-K1	GAGE18	TT14-126	94.86	55.269	4472.6	0.313	0
T14-K2	GAGE18	TT14-120	94.86	55.269	4472.6	0.313	0
T14-K3	GAGE18	TT14-118	94.86	55.269	4472.6	0.313	0

T14-K4	GAGE18	TT14-200	94.86	55.269	4472.6	0.313	0
T14-L1	GAGE8	TT14-414	58.37	62.703	3507.9	0.313	0
T14-L2	GAGE8	TT14-412	58.37	62.703	3507.9	0.313	0
T14-M1	GAGE8	TT14-226	69.9	61.236	3839	0.313	0
T14-M2	GAGE18	TT14-224	69.9	61.236	3839	0.313	0
T14-N1A	GAGE8	TT14-513	71.78	50.58	3890.7	0.313	0
T14-N1B	GAGE8	TT14-511A	71.78	50.58	3890.7	0.313	0
T14-N1C	GAGE19	TT14-511	71.78	50.58	3890.7	0.313	0
T14-N1D	GAGE19	TT14-509B	71.78	50.58	3890.7	0.313	0
T14-N2A	GAGE19	TT14-526	71.78	50.58	3890.7	0.313	0
T14-N2B	GAGE19	TT14-524	71.78	50.58	3890.7	0.313	0
T14-N2C	GAGE19	TT14-520	71.78	50.58	3890.7	0.313	0
T14-N2D	GAGE19	TT14-510	71.78	50.58	3890.7	0.313	0
T14-N3A	GAGE19	TT14-582	71.78	50.58	3890.7	0.313	0
T14-N3B	GAGE19	TT14-560	71.78	50.58	3890.7	0.313	0
T14-N3C	GAGE19	TT14-584	71.78	50.58	3890.7	0.313	0
T14-N3D	GAGE19	TT14-558	71.78	50.58	3890.7	0.313	0
T14-N4A	GAGE19	TT14-599	71.78	50.58	3890.7	0.313	0
T14-N4B	GAGE19	TT14-598	71.78	50.58	3890.7	0.313	0
T14-N4C	GAGE19	TT14-597	71.78	50.58	3890.7	0.313	0
T14-N4D	GAGE19	TT14-594	71.78	50.58	3890.7	0.313	0
T14-N5A	GAGE19	TT14-740	71.78	50.58	3890.7	0.313	0
T14-N5B	GAGE19	TT14-742	71.78	50.58	3890.7	0.313	0
T14-N5C	GAGE19	TT14-722	71.78	50.58	3890.7	0.313	0
T14-N5D	GAGE19	TT14-720	71.78	50.58	3890.7	0.313	0
T14-P1	GAGE18	TT14-242	54.8	40.986	3399	0.313	0
T14-P2	GAGE18	TT14-240	54.8	40.986	3399	0.313	0
T14-P3	GAGE18	TT14-238	54.8	40.986	3399	0.313	0
T14-P4	GAGE19	TT14-256	54.8	40.986	3399	0.313	0
T14-P5	GAGE19	TT14-252	54.8	40.986	3399	0.313	0
T14-P6	GAGE19	TT14-248	54.8	40.986	3399	0.313	0
T14-R1A	GAGE18	TT14-266	56.83	49.176	3461.7	0.313	0
T14-R1B	GAGE18	TT14-264	56.83	49.176	3461.7	0.313	0
T14-R1C	GAGE18	TT14-263	56.83	49.176	3461.7	0.313	0
T14-R2A	GAGE19	TT14-826	56.83	49.176	3461.7	0.313	0
T14-R2B	GAGE19	TT14-824	56.83	49.176	3461.7	0.313	0
T14-R3A	GAGE19	TT14-830	56.83	49.176	3461.7	0.313	0
T14-R3B	GAGE19	TT14-828	56.83	49.176	3461.7	0.313	0
T14-T	GAGE18	TT14-112	6.05	76.014	1129.7	0.313	0
T14-U	GAGE8	TT14-112	13.49	70.182	1686.3	0.313	0
T15a	GAGE7	TT15-034	48.76	56.529	3206.5	0.313	0
T15b	GAGE7	TT15-022	48.76	56.529	3206.5	0.313	0
T15C	GAGE7	TT15-034	48.76	56.529	3206.5	0.313	0
T15D	GAGE7	TT15-022	48.76	56.529	3206.5	0.313	0
TR15-332-A	GAGE8	TR15-332	3.5	4.5	861.3	0.9	0
TR15-332-B	GAGE8	TR15-332	13.5	4.5	1686.3	0.9	0
TR15-332-C	GAGE8	TR15-332	23.2	4.5	2211	0.9	0
TR15-332-D	GAGE8	TR15-332	23.2	4.5	2211	0.9	0

TR15-332-E	GAGE8	TR15-332	31.6	4.5	2581.7	0.9	0
TR15-344-A	GAGE8	TR15-344	2	4.5	644.6	0.9	0
TR15-344-B	GAGE8	TR15-344	9.9	4.5	1442.1	0.9	0
TR15-352-A	GAGE8	TR15-352	1.7	4.5	591.8	0.9	0
TR15-352-B	GAGE8	TR15-352	11.8	4.5	1579.6	0.9	0
TR15-360B-A	GAGE8	TR15-360B	1.6	4.5	580.8	0.9	0
TR15-360B-B	GAGE8	TR15-360B	9.1	4.5	1388.2	0.9	0
TR15-362-A	GAGE8	TR15-362	2.1	4.5	666.6	0.9	0
TR15-362-B	GAGE8	TR15-362	10.8	4.5	1505.9	0.9	0
TR15-412-A	GAGE19	TR15-412	4.2	4.5	937.2	0.9	0
TR15-412-B	GAGE19	TR15-412	12.4	4.5	1614.8	0.9	0
TR15-426-A	GAGE19	TR15-426	3.8	4.5	898.7	0.9	0
TR15-426-B	GAGE19	TR15-426	11.1	4.5	1530.1	0.9	0
TT14-262A	GAGE19	TT14-262	95.39	52.767	4484.7	0.313	0
TT14-263A	GAGE19	TT14-263	15.18	34.623	1788.6	0.313	0
TT14-264A	GAGE19	TT14-264	22.31	57.609	2169.2	0.313	0
TT14-264B	GAGE19	TT14-264	2.36	45	705.1	0.313	0
TT14-264C	GAGE19	TT14-264	26.03	48.096	2343	0.313	0
TT14-264D	GAGE19	TT14-264	22.1	58.644	2158.2	0.313	0
TT14-264E	GAGE19	TT14-264	2.58	69.066	737	0.313	0
TT14-266A	GAGE19	TT14-266	1.5	75.6	562.1	0.313	0
TT14-266B	GAGE19	TT14-266	3.72	79.11	885.5	0.313	0
TT14-270A	GAGE19	TT14-270	4.5	48.798	973.5	0.313	0
TT14-270B	GAGE19	TT14-270	3.16	32.184	816.2	0.313	0
TT14-272A	GAGE19	TT14-272	3.42	38.943	849.2	0.313	0
TT14-274A	GAGE19	TT14-275	2.06	77.328	658.9	0.313	0
TT14-274B	GAGE19	TT14-275	11.16	55.161	1533.4	0.313	0
TT14-274C	GAGE19	TT14-275	16.62	55.017	1872.2	0.313	0
TT14-278A	GAGE19	TT14-278	5.73	51.363	1098.9	0.313	0
TT14-278B	GAGE19	TT14-278	12.66	51.543	1633.5	0.313	0
TT14-278C	GAGE19	TT14-278	2.63	72.549	744.7	0.313	0
TT14-280A	GAGE19	TT14-280	1.86	56.133	625.9	0.313	0
TT14-282A	GAGE19	TT14-282	39.7	58.896	2893	0.313	0
TT14-284A	GAGE19	TT14-284	2.93	56.826	786.5	0.313	0
TT14-284B	GAGE19	TT14-284	0.54	66.663	337.7	0.313	0
TT14-284C	GAGE19	TT14-284	0.96	78.75	449.9	0.313	0
TT14-286A	GAGE19	TT14-288	2.58	70.119	737	0.313	0
TT14-288A	GAGE19	TT14-288	0.43	75.348	301.4	0.313	0
TT14-288B	GAGE19	TT14-288	6.56	63.792	1175.9	0.313	0
TT14-288C	GAGE19	TT14-288	3.23	38.448	825	0.313	0
TT14-291A	GAGE19	TT14-291	18.01	52.425	1948.1	0.313	0
TT14-291B	GAGE19	TT14-291	5.31	44.748	1058.2	0.313	0
TT14-291C	GAGE19	TT14-291	0.58	83.79	349.8	0.313	0
TT14-291D	GAGE19	TT14-291	85.23	20.475	4239.4	0.313	0
TT14-294A	GAGE19	TT14-294	1.83	40.329	621.5	0.313	0
TT14-294B	GAGE19	TT14-294	0.71	57.042	387.2	0.313	0
TT14-294C	GAGE19	TT14-294	14.06	44.55	1721.5	0.313	0
TT14-296A	GAGE19	TT14-296	0.95	74.844	447.7	0.313	0

TT14-296B	GAGE19	TT14-296	186.53	48.6	6271.1	0.313	0
TT14-602A	GAGE19	TT14-602	1.87	75.078	628.1	0.313	0
TT14-602B	GAGE19	TT14-602	6.34	37.053	1156.1	0.313	0
TT14-602C	GAGE19	TT14-602	36.56	37.539	2776.4	0.313	0
TT14-602D	GAGE19	TT14-602	3.84	48.987	899.8	0.313	0
TT14-606A	GAGE19	TT14-606	2.92	55.791	784.3	0.313	0
TT14-606B	GAGE19	TT14-606	5.34	68.256	1061.5	0.313	0
TT14-610A	GAGE19	TT14-610	0.61	61.965	358.6	0.313	0
TT14-610B	GAGE19	TT14-610	0.83	63.972	418	0.313	0
TT14-610C	GAGE19	TT14-610	53.25	42.795	3350.6	0.313	0
TT14-610D	GAGE19	TT14-610	3.62	43.758	873.4	0.313	0
TT14-612A	GAGE19	TT14-612	2.44	39.834	717.2	0.313	0
TT14-612B	GAGE19	TT14-612	0.78	54.234	405.9	0.313	0
TT14-612C	GAGE19	TT14-612	5.93	62.982	1117.6	0.313	0
TT14-614A	GAGE19	TT14-614	2.31	43.245	697.4	0.313	0
TT14-614B	GAGE19	TT14-614	0.86	52.326	425.7	0.313	0
TT14-614C	GAGE19	TT14-614	4.27	55.647	949.3	0.313	0
TT14-616A	GAGE19	TT14-616	2.34	58.077	702.9	0.313	0
TT14-616B	GAGE19	TT14-616	4.03	52.038	921.8	0.313	0
TT14-618A	GAGE19	TT14-618	13.92	55.665	1712.7	0.313	0
TT14-620A	GAGE19	TT14-620	3.44	56.772	851.4	0.313	0
TT14-620B	GAGE19	TT14-620	92.15	44.712	4407.7	0.313	0
TT14-622A	GAGE19	TT14-622	4.23	57.447	944.9	0.313	0
TT14-624A	GAGE19	TT14-624	3.35	58.833	840.4	0.313	0
TT14-630A	GAGE19	TT14-630	7.68	46.638	1272.7	0.313	0
TT14-636A	GAGE19	TT14-636	1.01	59.706	462	0.313	0
TT14-636B	GAGE19	TT14-636	5.71	48.231	1096.7	0.313	0
TT14-638A	GAGE19	TT14-639	10.09	43.083	1458.6	0.313	0
TT14-639A	GAGE19	TT14-639	1.69	57.519	597.3	0.313	0
TT14-639B	GAGE19	TT14-639	9.75	39.6	1433.3	0.313	0
TT14-640A	GAGE19	TT14-639	3.45	38.871	852.5	0.313	0
TT14-642A	GAGE19	TT14-642	23.64	30.15	2233	0.313	0
TT14-642B	GAGE19	TT14-642	2.13	52.821	669.9	0.313	0
TT14-642C	GAGE19	TT14-642	6.72	40.581	1190.2	0.313	0
TT14-644A	GAGE19	TT14-644	3.41	32.994	848.1	0.313	0
TT14-646A	GAGE19	TT14-646	73.62	46.701	3940.2	0.313	0
TT14-648A	GAGE19	TT14-650	47.84	37.134	3175.7	0.313	0
TT14-648B	GAGE19	TT14-650	3.51	48.978	860.2	0.313	0
TT14-658A	GAGE19	TT14-656	21.95	38.952	2151.6	0.313	0
TT14-658B	GAGE19	TT14-656	9.66	47.52	1426.7	0.313	0
TT14-660A	GAGE19	TT14-660	3.36	40.446	841.5	0.313	0
TT14-666A	GAGE19	TT14-668	6.94	52.263	1210	0.313	0
TT14-668A	GAGE19	TT14-668	3.9	34.155	906.4	0.313	0
TT14-676A	GAGE19	TT14-676	4	40.275	918.5	0.313	0
TT14-684A	GAGE19	TT14-684	3.15	39.996	815.1	0.313	0
TT14-684B	GAGE19	TT14-684	1.19	53.694	500.5	0.313	0
TT14-688A	GAGE19	TT14-688	1.63	49.689	586.3	0.313	0
TT14-688B	GAGE19	TT14-688	0.79	60.381	408.1	0.313	0

TT14-688C	GAGE19	TT14-688	3.25	55.665	828.3	0.313	0
TT14-690A	GAGE19	TT14-692	5.02	45.54	1028.5	0.313	0
TT14-690B	GAGE19	TT14-692	1.03	41.067	466.4	0.313	0
TT14-692A	GAGE19	TT14-692	5.79	41.499	1104.4	0.313	0

[SUBAREAS]

;;Subcatchment	N-Imperv	N-Perv	S-Imperv	S-Perv	PctZero	RouteTo	PctRouted
CHEWSTA	0.015	0.4	0.04	0.25	5	OUTLET	
CHEWSTB	0.015	0.4	0.04	0.25	5	OUTLET	
CLEARVIEW	0.015	0.4	0.04	0.25	5	OUTLET	
F03-1	0.015	0.4	0.1	0.25	5	OUTLET	
F03-2	0.015	0.4	0.1	0.25	5	OUTLET	
F04-B1	0.015	0.4	0.1	0.25	5	OUTLET	
F04-B2	0.015	0.4	0.1	0.25	5	OUTLET	
F04-B3	0.015	0.4	0.1	0.25	5	OUTLET	
F05	0.015	0.4	0.1	0.25	5	OUTLET	
F06	0.015	0.4	0.1	0.25	5	OUTLET	
F07	0.015	0.4	0.1	0.25	5	OUTLET	
F08-1	0.015	0.4	0.1	0.25	5	OUTLET	
F08-2	0.015	0.4	0.1	0.25	5	OUTLET	
F09	0.015	0.4	0.1	0.25	5	OUTLET	
F10	0.015	0.4	0.1	0.25	5	OUTLET	
F11-A1	0.015	0.4	0.1	0.25	5	OUTLET	
F11-A2	0.015	0.4	0.1	0.25	5	OUTLET	
F11-B1	0.015	0.4	0.1	0.25	5	OUTLET	
F11-B2	0.015	0.4	0.1	0.25	5	OUTLET	
F12	0.015	0.4	0.1	0.25	5	OUTLET	
F13	0.015	0.4	0.1	0.25	5	OUTLET	
F14	0.015	0.4	0.1	0.25	5	OUTLET	
G2	0.015	0.3	0.04	0.25	5	OUTLET	
MR2a	0.015	0.3	0.04	0.25	5	OUTLET	
MR2b	0.015	0.3	0.04	0.25	5	OUTLET	
MS64	0.015	0.3	0.04	0.25	5	OUTLET	
MS76	0.015	0.3	0.04	0.25	5	OUTLET	
Non-B6	0.015	0.3	0.04	0.25	5	OUTLET	
Non-B8	0.015	0.3	0.04	0.25	5	OUTLET	
Non-del1	0.015	0.3	0.04	0.25	5	OUTLET	
Non-del2	0.015	0.3	0.04	0.25	5	OUTLET	
Non-del3	0.015	0.3	0.04	0.25	5	OUTLET	
Non-MS100	0.015	0.3	0.04	0.25	5	OUTLET	
Non-MS102	0.015	0.3	0.04	0.25	5	OUTLET	
Non-MS104	0.015	0.3	0.04	0.25	5	OUTLET	
Non-MS106	0.015	0.3	0.04	0.25	5	OUTLET	
Non-MS108	0.015	0.3	0.04	0.25	5	OUTLET	
Non-MS110	0.015	0.3	0.04	0.25	5	OUTLET	
Non-MS112	0.015	0.3	0.04	0.25	5	OUTLET	
Non-MS114	0.015	0.3	0.04	0.25	5	OUTLET	
Non-MS118	0.015	0.3	0.04	0.25	5	OUTLET	
Non-MS120	0.015	0.3	0.04	0.25	5	OUTLET	
Non-MS122	0.015	0.3	0.04	0.25	5	OUTLET	
Non-MS76	0.015	0.3	0.04	0.25	5	OUTLET	
Non-MS78	0.015	0.3	0.04	0.25	5	OUTLET	
Non-MS80	0.015	0.3	0.04	0.25	5	OUTLET	
Non-MS86	0.015	0.3	0.04	0.25	5	OUTLET	
Non-MS88	0.015	0.3	0.04	0.25	5	OUTLET	
Non-MS90	0.015	0.3	0.04	0.25	5	OUTLET	
Non-MS92	0.015	0.3	0.04	0.25	5	OUTLET	
Non-MS94	0.015	0.3	0.04	0.25	5	OUTLET	
Non-MSr92	0.015	0.3	0.04	0.25	5	OUTLET	
R15-A	0.015	0.4	0.04	0.25	5	OUTLET	
R18	0.015	0.4	0.04	0.25	5	OUTLET	
SubCatchA2	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchB10	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchB2	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchB4	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchB6	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchB8	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchC2	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchD2	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchD4	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchEJ2	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchEJ4	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchG10	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchG4	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchG6	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchG8	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchH10	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchH12	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchH14	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchH2	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchH4	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchH6	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchH8	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchI10	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchI12	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchI2	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchI4	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchI6	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchI8	0.015	0.3	0.04	0.25	5	OUTLET	
SubCatchJ10	0.015	0.3	0.04	0.25	5	OUTLET	

SubCatchJ12	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchJ14	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchJ16	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchJ18	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchJ2	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchJ20	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchJ4	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchJ6	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchJ8	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchJ9	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchK2	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchK4	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchL2	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchL4	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchM2	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMC_1	0.015	0.3	0.04	60.5	5	OUTLET
SubCatchMC_2	0.015	0.3	0.04	60.5	5	OUTLET
SubCatchMR10	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMR4	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMR6	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMR8	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS10	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS12	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS14	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS16	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS18	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS2	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS20	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS22	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS24	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS26	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS28	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS30	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS32	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS34	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS36	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS38	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS4	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS40	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS42	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS44	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS46	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS50	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS52	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS54	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS56	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS58	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS6	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS60	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS62	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS70	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS72	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS74	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchMS8	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchN2	0.015	0.3	0.04	0.25	5	OUTLET
SubCatchTR15-302	0.015	0.4	0.04	0.25	5	OUTLET
SubCatchTR15-310	0.015	0.4	0.04	0.25	5	OUTLET
SubCatchTR15-314	0.015	0.4	0.04	0.25	5	OUTLET
SubCatchTR15-320	0.015	0.4	0.04	0.25	5	OUTLET
SubCatchTR15-322	0.015	0.4	0.04	0.25	5	OUTLET
SubCatchTR15-340	0.015	0.3	0.04	60.5	5	OUTLET
SubCatchTR15-340B	0.015	0.3	0.04	60.5	5	OUTLET
SubCatchTR15-342B	0.015	0.3	0.04	60.5	5	OUTLET
SubCatchTR15-358	0.015	0.3	0.04	60.5	5	OUTLET
SubCatchTR15-366	0.015	0.3	0.04	60.5	5	OUTLET
SubCatchTR15-366B	0.015	0.3	0.04	60.5	5	OUTLET
SubCatchTR15-368	0.015	0.3	0.04	60.5	5	OUTLET
SubCatchTR15-370B	0.015	0.3	0.04	60.5	5	OUTLET
SubCatchTR15-372C	0.015	0.3	0.04	60.5	5	OUTLET
SubCatchTR15-376C	0.015	0.3	0.04	60.5	5	OUTLET
SubCatchTR15-378B	0.015	0.3	0.04	60.5	5	OUTLET
SubCatchTR15-386	0.015	0.3	0.04	60.5	5	OUTLET
SubCatchTR15-390	0.015	0.3	0.04	60.5	5	OUTLET
SubCatchTR15-392	0.015	0.3	0.04	60.5	5	OUTLET
SubCatchTR15-408	0.015	0.3	0.04	60.5	5	OUTLET
SubCatchTR15-412A	0.015	0.3	0.04	60.5	5	OUTLET
SubCatchTR15-414	0.015	0.3	0.04	60.5	5	OUTLET
SubCatchTR15-414A	0.015	0.3	0.04	60.5	5	OUTLET
SubCatchTR15-438	0.015	0.3	0.04	60.5	5	OUTLET
SubCatchTR15-604	0.015	0.4	0.04	0.25	5	OUTLET
SubCatchTR15-604A	0.015	0.4	0.04	0.25	5	OUTLET
SubCatchTR15-606A	0.015	0.4	0.04	0.25	5	OUTLET
SubCatchTR15-612A	0.015	0.4	0.04	0.25	5	OUTLET
SubCatchTR15-614A	0.015	0.4	0.04	0.25	5	OUTLET
SubCatchTR15-618	0.015	0.4	0.04	0.25	5	OUTLET
SubCatchTR15-704	0.015	0.4	0.04	0.25	5	OUTLET
SubCatchTR15-710	0.015	0.4	0.04	0.25	5	OUTLET
SubCatchTR15-716	0.015	0.4	0.04	0.25	5	OUTLET
SubCatchTR15B1-366	0.015	0.3	0.04	60.5	5	OUTLET
SubCatchTR15B1-380	0.015	0.3	0.04	60.5	5	OUTLET
T01-A	0.015	0.3	0.04	60.5	5	OUTLET
T01-A-S	0.015	0.3	0.04	0.25	5	OUTLET
T01-B1	0.015	0.4	0.04	0.25	5	OUTLET
T01-B2	0.015	0.4	0.04	0.25	5	OUTLET
T03-A	0.015	0.4	0.04	0.25	5	OUTLET
T03-B	0.015	0.4	0.04	0.25	5	OUTLET

T04-A	0.015	0.4	0.04	0.25	5	OUTLET
T04-B	0.015	0.4	0.04	0.25	5	OUTLET
T05	0.015	0.4	0.04	0.25	5	OUTLET
T-050-01-S	0.015	0.3	0.04	0.25	5	OUTLET
T-050-02-S	0.015	0.3	0.04	0.25	5	OUTLET
T-055-01	0.015	0.3	0.04	60.5	5	OUTLET
T-055-01-S	0.015	0.3	0.04	0.25	5	OUTLET
T-056-01	0.015	0.3	0.04	60.5	5	OUTLET
T-056-01-S	0.015	0.3	0.04	0.25	5	OUTLET
T-056-02	0.015	0.3	0.04	60.5	5	OUTLET
T-056-02-S	0.015	0.3	0.04	0.25	5	OUTLET
T-056-03	0.015	0.3	0.04	60.5	5	OUTLET
T-056-03-S	0.015	0.3	0.04	0.25	5	OUTLET
T-056-04	0.015	0.3	0.04	60.5	5	OUTLET
T-056-04-S	0.015	0.3	0.04	0.25	5	OUTLET
T-056-05	0.015	0.3	0.04	60.5	5	OUTLET
T-056-05-S	0.015	0.3	0.04	0.25	5	OUTLET
T-056-06	0.015	0.3	0.04	60.5	5	OUTLET
T-056-06-S	0.015	0.3	0.04	0.25	5	OUTLET
T-056-07-S	0.015	0.3	0.04	0.25	5	OUTLET
T-056-08	0.015	0.3	0.04	60.5	5	OUTLET
T-056-08-S	0.015	0.3	0.04	0.25	5	OUTLET
T-056-09	0.015	0.3	0.04	60.5	5	OUTLET
T-056-09-S	0.015	0.3	0.04	0.25	5	OUTLET
T-063-01-S	0.015	0.3	0.04	0.25	5	OUTLET
T-063-02	0.015	0.3	0.04	60.5	5	OUTLET
T-063-02-S	0.015	0.3	0.04	0.25	5	OUTLET
T-063-03-S	0.015	0.3	0.04	0.25	5	OUTLET
T-063-04	0.015	0.3	0.04	60.5	5	OUTLET
T-063-04-S	0.015	0.3	0.04	0.25	5	OUTLET
T-063-05	0.015	0.3	0.04	60.5	5	OUTLET
T-063-05-S	0.015	0.3	0.04	0.25	5	OUTLET
T-063-06	0.015	0.3	0.04	60.5	5	OUTLET
T-063-06-S	0.015	0.3	0.04	0.25	5	OUTLET
T06-A1	0.015	0.4	0.04	0.25	5	OUTLET
T06-A2	0.015	0.4	0.04	0.25	5	OUTLET
T06-B1	0.015	0.4	0.04	0.25	5	OUTLET
T06-B2	0.015	0.4	0.04	0.25	5	OUTLET
T06-C1	0.015	0.4	0.04	0.25	5	OUTLET
T06-C2	0.015	0.4	0.04	0.25	5	OUTLET
T07	0.015	0.4	0.04	0.25	5	OUTLET
T-071-01	0.015	0.3	0.04	60.5	5	OUTLET
T-071-01-S	0.015	0.3	0.04	0.25	5	OUTLET
T-079-01	0.015	0.3	0.04	60.5	5	OUTLET
T-079-01-S	0.015	0.3	0.04	0.25	5	OUTLET
T-079-02	0.015	0.3	0.04	60.5	5	OUTLET
T-079-02-S	0.015	0.3	0.04	0.25	5	OUTLET
T-080-01	0.015	0.3	0.04	60.5	5	OUTLET
T-080-01-S	0.015	0.3	0.04	0.25	5	OUTLET
T-080-02	0.015	0.3	0.04	60.5	5	OUTLET
T-080-02-S	0.015	0.3	0.04	0.25	5	OUTLET
T-080-03	0.015	0.3	0.04	60.5	5	OUTLET
T-080-03-S	0.015	0.3	0.04	0.25	5	OUTLET
T-088-01-S	0.015	0.3	0.04	0.25	5	OUTLET
T-089-01	0.015	0.3	0.04	60.5	5	OUTLET
T-089-01-S	0.015	0.3	0.04	0.25	5	OUTLET
T-089-02	0.015	0.3	0.04	60.5	5	OUTLET
T-089-02-S	0.015	0.3	0.04	0.25	5	OUTLET
T-089-03	0.015	0.3	0.04	60.5	5	OUTLET
T-089-03-S	0.015	0.3	0.04	0.25	5	OUTLET
T-089-04	0.015	0.3	0.04	60.5	5	OUTLET
T-089-04-S	0.015	0.3	0.04	0.25	5	OUTLET
T08-A1	0.015	0.4	0.04	0.25	5	OUTLET
T08-A2	0.015	0.4	0.04	0.25	5	OUTLET
T08-A3	0.015	0.4	0.04	0.25	5	OUTLET
T08-B1	0.015	0.4	0.04	0.25	5	OUTLET
T08-B2	0.015	0.4	0.04	0.25	5	OUTLET
T08-B3	0.015	0.4	0.04	0.25	5	OUTLET
T08-C1	0.015	0.4	0.04	0.25	5	OUTLET
T08-C2	0.015	0.4	0.04	0.25	5	OUTLET
T08-C3	0.015	0.4	0.04	0.25	5	OUTLET
T08-D1A	0.015	0.4	0.04	0.25	5	OUTLET
T08-D1B	0.015	0.4	0.04	0.25	5	OUTLET
T08-D2	0.015	0.4	0.04	0.25	5	OUTLET
T08-D3	0.015	0.4	0.04	0.25	5	OUTLET
T08-E1A	0.015	0.4	0.04	0.25	5	OUTLET
T08-E1B	0.015	0.4	0.04	0.25	5	OUTLET
T-096-01	0.015	0.3	0.04	60.5	5	OUTLET
T-096-01-S	0.015	0.3	0.04	0.25	5	OUTLET
T-097-01	0.015	0.3	0.04	60.5	5	OUTLET
T-097-01-S	0.015	0.3	0.04	0.25	5	OUTLET
T-097-02	0.015	0.3	0.04	60.5	5	OUTLET
T-097-02-S	0.015	0.3	0.04	0.25	5	OUTLET
T-098-01	0.015	0.3	0.04	60.5	5	OUTLET
T-098-01-S	0.015	0.3	0.04	0.25	5	OUTLET
T-098-02	0.015	0.3	0.04	60.5	5	OUTLET
T-098-02-S	0.015	0.3	0.04	0.25	5	OUTLET
T-098-03	0.015	0.3	0.04	60.5	5	OUTLET
T-098-03-S	0.015	0.3	0.04	0.25	5	OUTLET
T09-A	0.015	0.4	0.04	0.25	5	OUTLET
T09-B	0.015	0.4	0.04	0.25	5	OUTLET
T10	0.015	0.4	0.04	0.25	5	OUTLET
T11	0.015	0.4	0.04	0.25	5	OUTLET
T12	0.015	0.4	0.04	0.25	5	OUTLET
T13a	0.015	0.4	0.04	0.25	5	OUTLET
T13b	0.015	0.4	0.04	0.25	5	OUTLET

T14-A1A	0.015	0.4	0.04	0.25	5	OUTLET
T14-A1B	0.015	0.4	0.04	0.25	5	OUTLET
T14-A1C	0.015	0.4	0.04	0.25	5	OUTLET
T14-A2A	0.015	0.4	0.04	0.25	5	OUTLET
T14-A2B	0.015	0.4	0.04	0.25	5	OUTLET
T14-A2C	0.015	0.4	0.04	0.25	5	OUTLET
T14-B1A	0.015	0.4	0.04	0.25	5	OUTLET
T14-B1B	0.015	0.4	0.04	0.25	5	OUTLET
T14-B1C	0.015	0.4	0.04	0.25	5	OUTLET
T14-B1D	0.015	0.4	0.04	0.25	5	OUTLET
T14-B1E	0.015	0.4	0.04	0.25	5	OUTLET
T14-C1	0.015	0.4	0.04	0.25	5	OUTLET
T14-C2	0.015	0.4	0.04	0.25	5	OUTLET
T14-C3	0.015	0.4	0.04	0.25	5	OUTLET
T14-D1	0.015	0.4	0.04	0.25	5	OUTLET
T14-D2	0.015	0.4	0.04	0.25	5	OUTLET
T14-E1	0.015	0.4	0.04	0.25	5	OUTLET
T14-E2	0.015	0.4	0.04	0.25	5	OUTLET
T14-E3	0.015	0.4	0.04	0.25	5	OUTLET
T14-F	0.015	0.4	0.04	0.25	5	OUTLET
T14-G	0.015	0.4	0.04	0.25	5	OUTLET
T14-H	0.015	0.4	0.04	0.25	5	OUTLET
T14-J1	0.015	0.4	0.04	0.25	5	OUTLET
T14-J4	0.015	0.4	0.04	0.25	5	OUTLET
T14-K1	0.015	0.4	0.04	0.25	5	OUTLET
T14-K2	0.015	0.4	0.04	0.25	5	OUTLET
T14-K3	0.015	0.4	0.04	0.25	5	OUTLET
T14-K4	0.015	0.4	0.04	0.25	5	OUTLET
T14-L1	0.015	0.4	0.04	0.25	5	OUTLET
T14-L2	0.015	0.4	0.04	0.25	5	OUTLET
T14-M1	0.015	0.4	0.04	0.25	5	OUTLET
T14-M2	0.015	0.4	0.04	0.25	5	OUTLET
T14-N1A	0.015	0.4	0.04	0.25	5	OUTLET
T14-N1B	0.015	0.4	0.04	0.25	5	OUTLET
T14-N1C	0.015	0.4	0.04	0.25	5	OUTLET
T14-N1D	0.015	0.4	0.04	0.25	5	OUTLET
T14-N2A	0.015	0.4	0.04	0.25	5	OUTLET
T14-N2B	0.015	0.4	0.04	0.25	5	OUTLET
T14-N2C	0.015	0.4	0.04	0.25	5	OUTLET
T14-N2D	0.015	0.4	0.04	0.25	5	OUTLET
T14-N3A	0.015	0.4	0.04	0.25	5	OUTLET
T14-N3B	0.015	0.4	0.04	0.25	5	OUTLET
T14-N3C	0.015	0.4	0.04	0.25	5	OUTLET
T14-N3D	0.015	0.4	0.04	0.25	5	OUTLET
T14-N4A	0.015	0.4	0.04	0.25	5	OUTLET
T14-N4B	0.015	0.4	0.04	0.25	5	OUTLET
T14-N4C	0.015	0.4	0.04	0.25	5	OUTLET
T14-N4D	0.015	0.4	0.04	0.25	5	OUTLET
T14-N5A	0.015	0.4	0.04	0.25	5	OUTLET
T14-N5B	0.015	0.4	0.04	0.25	5	OUTLET
T14-N5C	0.015	0.4	0.04	0.25	5	OUTLET
T14-N5D	0.015	0.4	0.04	0.25	5	OUTLET
T14-P1	0.015	0.4	0.04	0.25	5	OUTLET
T14-P2	0.015	0.4	0.04	0.25	5	OUTLET
T14-P3	0.015	0.4	0.04	0.25	5	OUTLET
T14-P4	0.015	0.4	0.04	0.25	5	OUTLET
T14-P5	0.015	0.4	0.04	0.25	5	OUTLET
T14-P6	0.015	0.4	0.04	0.25	5	OUTLET
T14-R1A	0.015	0.4	0.04	0.25	5	OUTLET
T14-R1B	0.015	0.4	0.04	0.25	5	OUTLET
T14-R1C	0.015	0.4	0.04	0.25	5	OUTLET
T14-R2A	0.015	0.4	0.04	0.25	5	OUTLET
T14-R2B	0.015	0.4	0.04	0.25	5	OUTLET
T14-R3A	0.015	0.4	0.04	0.25	5	OUTLET
T14-R3B	0.015	0.4	0.04	0.25	5	OUTLET
T14-T	0.015	0.4	0.04	0.25	5	OUTLET
T14-U	0.015	0.4	0.04	0.25	5	OUTLET
T15a	0.015	0.4	0.04	0.25	5	OUTLET
T15b	0.015	0.4	0.04	0.25	5	OUTLET
T15C	0.015	0.4	0.04	0.25	5	OUTLET
T15D	0.015	0.4	0.04	0.25	5	OUTLET
TR15-332-A	0.015	0.3	0.04	60.5	5	OUTLET
TR15-332-B	0.015	0.3	0.04	60.5	5	OUTLET
TR15-332-C	0.015	0.3	0.04	60.5	5	OUTLET
TR15-332-D	0.015	0.3	0.04	60.5	5	OUTLET
TR15-332-E	0.015	0.3	0.04	60.5	5	OUTLET
TR15-344-A	0.015	0.3	0.04	60.5	5	OUTLET
TR15-344-B	0.015	0.3	0.04	60.5	5	OUTLET
TR15-352-A	0.015	0.3	0.04	60.5	5	OUTLET
TR15-352-B	0.015	0.3	0.04	60.5	5	OUTLET
TR15-360B-A	0.015	0.3	0.04	60.5	5	OUTLET
TR15-360B-B	0.015	0.3	0.04	60.5	5	OUTLET
TR15-362-A	0.015	0.3	0.04	60.5	5	OUTLET
TR15-362-B	0.015	0.3	0.04	60.5	5	OUTLET
TR15-412-A	0.015	0.3	0.04	60.5	5	OUTLET
TR15-412-B	0.015	0.3	0.04	60.5	5	OUTLET
TR15-426-A	0.015	0.3	0.04	60.5	5	OUTLET
TR15-426-B	0.015	0.3	0.04	60.5	5	OUTLET
TT14-262A	0.015	0.4	0.04	0.25	5	OUTLET
TT14-263A	0.015	0.4	0.04	0.25	5	OUTLET
TT14-264A	0.015	0.4	0.04	0.25	5	OUTLET
TT14-264B	0.015	0.4	0.04	0.25	5	OUTLET
TT14-264C	0.015	0.4	0.04	0.25	5	OUTLET
TT14-264D	0.015	0.4	0.04	0.25	5	OUTLET
TT14-264E	0.015	0.4	0.04	0.25	5	OUTLET
TT14-266A	0.015	0.4	0.04	0.25	5	OUTLET

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TT14-266B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-270A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-270B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-272A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-274A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-274B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-274C       0.015     0.4       0.04      0.25      5         OUTLET
TT14-278A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-278B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-278C       0.015     0.4       0.04      0.25      5         OUTLET
TT14-280A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-282A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-284A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-284B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-284C       0.015     0.4       0.04      0.25      5         OUTLET
TT14-286A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-288A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-288B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-288C       0.015     0.4       0.04      0.25      5         OUTLET
TT14-291A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-291B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-291C       0.015     0.4       0.04      0.25      5         OUTLET
TT14-291D       0.015     0.4       0.04      0.25      5         OUTLET
TT14-294A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-294B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-294C       0.015     0.4       0.04      0.25      5         OUTLET
TT14-296A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-296B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-602A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-602B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-602C       0.015     0.4       0.04      0.25      5         OUTLET
TT14-602D       0.015     0.4       0.04      0.25      5         OUTLET
TT14-606A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-606B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-610A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-610B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-610C       0.015     0.4       0.04      0.25      5         OUTLET
TT14-610D       0.015     0.4       0.04      0.25      5         OUTLET
TT14-612A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-612B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-612C       0.015     0.4       0.04      0.25      5         OUTLET
TT14-614A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-614B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-614C       0.015     0.4       0.04      0.25      5         OUTLET
TT14-616A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-616B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-618A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-620A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-620B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-622A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-624A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-630A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-636A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-636B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-638A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-639A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-639B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-640A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-642A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-642B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-642C       0.015     0.4       0.04      0.25      5         OUTLET
TT14-644A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-646A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-648A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-648B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-658A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-658B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-660A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-666A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-668A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-676A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-684A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-684B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-688A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-688B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-688C       0.015     0.4       0.04      0.25      5         OUTLET
TT14-690A       0.015     0.4       0.04      0.25      5         OUTLET
TT14-690B       0.015     0.4       0.04      0.25      5         OUTLET
TT14-692A       0.015     0.4       0.04      0.25      5         OUTLET
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[INFILTRATION]
;;Subcatchment   Suction    HydCon     IMDmax
;;--------------------------------------------------
 CHEWSTA         11.6       0.206      0.324
 CHEWSTB         11.6       0.206      0.324
 CLEARVIEW       11.6       0.206      0.324
 F03-1           11.782     0.19       0.32
 F03-2           11.782     0.19       0.32
 F04-B1          11.782     0.19       0.32
 F04-B2          11.782     0.19       0.32
 F04-B3          11.782     0.19       0.32
 F05             11.782     0.19       0.32
 F06             11.782     0.19       0.32
 F07             11.782     0.19       0.32
 F08-1           11.782     0.19       0.32
 F08-2           11.782     0.19       0.32
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F09	11.782	0.19	0.32
F10	11.782	0.19	0.32
F11-A1	11.782	0.19	0.32
F11-A2	11.782	0.19	0.32
F11-B1	11.782	0.19	0.32
F11-B2	11.782	0.19	0.32
F12	11.782	0.19	0.32
F13	11.782	0.19	0.32
F14	11.782	0.19	0.32
G2	8.188	0.755	0.439
MR2a	11.782	0.19	0.32
MR2b	11.782	0.19	0.32
MS64	10.889	0.266	0.34
MS76	9.779	0.435	0.374
Non-B6	7.433	0.835	0.453
Non-B8	8.132	0.634	0.415
Non-del1	11.782	0.19	0.32
Non-del2	11.782	0.19	0.32
Non-del3	11.782	0.19	0.32
Non-MS100	7.464	0.675	0.42
Non-MS102	7.952	0.768	0.442
Non-MS104	9.044	0.714	0.425
Non-MS106	11.782	0.19	0.32
Non-MS108	9.066	0.576	0.397
Non-MS110	10.992	0.301	0.342
Non-MS112	9.531	0.436	0.373
Non-MS114	9.741	0.372	0.356
Non-MS118	9.425	0.401	0.36
Non-MS120	11.782	0.19	0.32
Non-MS122	11.782	0.19	0.32
Non-MS76	9.35	0.637	0.411
Non-MS78	8.875	0.567	0.405
Non-MS80	10.465	0.328	0.354
Non-MS86	9.006	0.426	0.383
Non-MS88	9.011	0.426	0.383
Non-MS90	9.762	0.362	0.366
Non-MS92	9.738	0.364	0.366
Non-MS94	8.261	0.546	0.402
Non-MSr92	10.994	0.257	0.338
R15-A	11.735	0.194	0.321
R18	11.782	0.19	0.32
SubCatchA2	11.644	0.202	0.323
SubCatchB10	10.112	0.451	0.374
SubCatchB2	11.782	0.19	0.32
SubCatchB4	11.782	0.19	0.32
SubCatchB6	11.243	0.238	0.332
SubCatchB8	11.407	0.256	0.334
SubCatchC2	10.063	0.373	0.364
SubCatchD2	9.156	0.659	0.416
SubCatchD4	8.184	0.675	0.428
SubCatchEJ2	9.669	0.491	0.386
SubCatchEJ4	8.945	0.524	0.398
SubCatchG10	11.782	0.19	0.32
SubCatchG4	10.854	0.325	0.35
SubCatchG6	11.776	0.191	0.321
SubCatchG8	11.782	0.19	0.32
SubCatchH10	9.928	0.436	0.375
SubCatchH12	10.484	0.381	0.362
SubCatchH14	10.257	0.405	0.366
SubCatchH2	11.541	0.21	0.326
SubCatchH4	11.675	0.199	0.323
SubCatchH6	11.667	0.199	0.323
SubCatchH8	11.051	0.289	0.342
SubCatchI10	10.973	0.322	0.347
SubCatchI12	11.782	0.19	0.32
SubCatchI2	11.772	0.19	0.321
SubCatchI4	11.76	0.191	0.321
SubCatchI6	10.144	0.41	0.366
SubCatchI8	9.652	0.511	0.387
SubCatchJ10	10.825	0.278	0.343
SubCatchJ12	11.531	0.212	0.326
SubCatchJ14	10.534	0.381	0.361
SubCatchJ16	10.351	0.374	0.362
SubCatchJ18	10.19	0.401	0.367
SubCatchJ2	11.187	0.252	0.336
SubCatchJ20	11.098	0.264	0.338
SubCatchJ4	9.062	0.54	0.399
SubCatchJ6	10.244	0.468	0.377
SubCatchJ8	10.938	0.314	0.347
SubCatchJ9	11.221	0.262	0.336
SubCatchK2	11.156	0.247	0.335
SubCatchK4	10.559	0.343	0.355
SubCatchL2	11.782	0.19	0.32
SubCatchL4	11.782	0.19	0.32
SubCatchM2	11.782	0.19	0.32
SubCatchMC_1	9.001	1.454	0.374
SubCatchMC_2	9.001	1.454	0.374
SubCatchMR10	10.742	0.298	0.347
SubCatchMR4	11.774	0.191	0.321
SubCatchMR6	11.166	0.283	0.339
SubCatchMR8	10.252	0.445	0.373
SubCatchMS10	11.64	0.202	0.323
SubCatchMS12	11.782	0.19	0.32
SubCatchMS14	11.782	0.19	0.32
SubCatchMS16	11.782	0.19	0.32
SubCatchMS18	11.782	0.19	0.32

SubCatchMS2	11.457	0.232	0.33
SubCatchMS20	11.782	0.19	0.32
SubCatchMS22	11.782	0.19	0.32
SubCatchMS24	11.782	0.19	0.32
SubCatchMS26	11.678	0.208	0.324
SubCatchMS28	11.495	0.225	0.328
SubCatchMS30	10.753	0.334	0.351
SubCatchMS32	8.935	0.582	0.404
SubCatchMS34	11.782	0.19	0.32
SubCatchMS36	11.782	0.19	0.32
SubCatchMS38	11.782	0.19	0.32
SubCatchMS4	10.633	0.306	0.349
SubCatchMS40	11.78	0.19	0.32
SubCatchMS42	11.367	0.234	0.33
SubCatchMS44	11.319	0.23	0.331
SubCatchMS46	10.584	0.302	0.349
SubCatchMS50	10.724	0.28	0.344
SubCatchMS52	8.575	0.633	0.415
SubCatchMS54	10.624	0.296	0.347
SubCatchMS56	10.591	0.312	0.349
SubCatchMS58	10.028	0.427	0.369
SubCatchMS6	9.396	0.487	0.388
SubCatchMS60	11.422	0.226	0.329
SubCatchMS62	11.32	0.229	0.331
SubCatchMS70	9.721	0.499	0.386
SubCatchMS72	10.101	0.408	0.369
SubCatchMS74	10.893	0.302	0.345
SubCatchMS8	11.18	0.248	0.335
SubCatchN2	9.508	0.528	0.393
SubCatchTR15-302	11.735	0.194	0.321
SubCatchTR15-310	11.735	0.194	0.321
SubCatchTR15-314	11.735	0.194	0.321
SubCatchTR15-320	11.735	0.194	0.321
SubCatchTR15-322	11.735	0.194	0.321
SubCatchTR15-340	9.001	1.454	0.374
SubCatchTR15-340B	9.001	1.454	0.374
SubCatchTR15-342B	9.001	1.454	0.374
SubCatchTR15-358	9.001	1.454	0.374
SubCatchTR15-366	9.001	1.454	0.374
SubCatchTR15-366B	9.001	1.454	0.374
SubCatchTR15-368	9.001	1.454	0.374
SubCatchTR15-370B	9.001	1.454	0.374
SubCatchTR15-372C	9.001	1.454	0.374
SubCatchTR15-376C	9.001	1.454	0.374
SubCatchTR15-378B	9.001	1.454	0.374
SubCatchTR15-386	9.001	1.454	0.374
SubCatchTR15-390	9.001	1.454	0.374
SubCatchTR15-392	9.001	1.454	0.374
SubCatchTR15-408	9.001	1.454	0.374
SubCatchTR15-412A	9.001	1.454	0.374
SubCatchTR15-414	9.001	1.454	0.374
SubCatchTR15-414A	9.001	1.454	0.374
SubCatchTR15-438	9.001	1.454	0.374
SubCatchTR15-604	11.735	0.194	0.321
SubCatchTR15-604A	11.735	0.194	0.321
SubCatchTR15-606A	11.735	0.194	0.321
SubCatchTR15-612A	11.735	0.194	0.321
SubCatchTR15-614A	11.735	0.194	0.321
SubCatchTR15-618	11.735	0.194	0.321
SubCatchTR15-704	11.735	0.194	0.321
SubCatchTR15-710	11.735	0.194	0.321
SubCatchTR15-716	11.735	0.194	0.321
SubCatchTR15B1-366	9.001	1.454	0.374
SubCatchTR15B1-380	9.001	1.454	0.374
T01-A	9.001	1.454	0.374
T01-A-S	11.667	0.199	0.323
T01-B1	11.775	0.19	0.321
T01-B2	11.775	0.19	0.321
T03-A	11.75	0.192	0.321
T03-B	11.75	0.192	0.321
T04-A	11.325	0.229	0.331
T04-B	11.325	0.229	0.331
T05	11.467	0.216	0.327
T-050-01-S	11.782	0.19	0.32
T-050-02-S	11.782	0.19	0.32
T-055-01	9.001	1.454	0.374
T-055-01-S	11.782	0.19	0.32
T-056-01	9.001	0.423	0.374
T-056-01-S	11.782	0.19	0.32
T-056-02	9.001	0.423	0.374
T-056-02-S	11.782	0.19	0.32
T-056-03	9.001	1.454	0.374
T-056-03-S	11.782	0.19	0.32
T-056-04	9.001	0.423	0.374
T-056-04-S	11.782	0.19	0.32
T-056-05	9.001	1.454	0.374
T-056-05-S	11.782	0.19	0.32
T-056-06	9.001	0.423	0.374
T-056-06-S	11.782	0.19	0.32
T-056-07-S	11.782	0.19	0.32
T-056-08	9.001	0.423	0.374
T-056-08-S	11.782	0.19	0.32
T-056-09	9.001	1.454	0.374
T-056-09-S	11.782	0.19	0.32
T-063-01-S	11.327	0.28	0.338
T-063-02	9.001	1.454	0.374

T-063-02-S	11.21	0.293	0.341
T-063-03-S	11.782	0.19	0.32
T-063-04	9.001	0.423	0.374
T-063-04-S	11.782	0.19	0.32
T-063-05	9.001	0.423	0.374
T-063-05-S	11.782	0.19	0.32
T-063-06	9.001	0.423	0.374
T-063-06-S	11.782	0.19	0.32
T06-A1	11.764	0.191	0.321
T06-A2	11.764	0.191	0.321
T06-B1	11.764	0.191	0.321
T06-B2	11.764	0.191	0.321
T06-C1	11.764	0.191	0.321
T06-C2	11.764	0.191	0.321
T07	10.55	0.315	0.344
T-071-01	9.001	1.454	0.374
T-071-01-S	9.124	0.416	0.38
T-079-01	9.001	1.454	0.374
T-079-01-S	11.458	0.245	0.332
T-079-02	9.001	1.454	0.374
T-079-02-S	11.458	0.245	0.332
T-080-01	9.001	1.454	0.374
T-080-01-S	10.101	0.408	0.369
T-080-02	9.001	1.454	0.374
T-080-02-S	10.893	0.302	0.345
T-080-03	9.001	1.454	0.374
T-080-03-S	9.779	0.435	0.374
T-088-01-S	11.782	0.19	0.32
T-089-01	9.001	1.454	0.374
T-089-01-S	10.889	0.266	0.34
T-089-02	9.001	1.454	0.374
T-089-02-S	11.422	0.226	0.329
T-089-03	9.001	1.454	0.374
T-089-03-S	11.422	0.226	0.329
T-089-04	9.001	1.454	0.374
T-089-04-S	11.644	0.202	0.323
T08-A1	11.735	0.194	0.321
T08-A2	11.735	0.194	0.321
T08-A3	11.735	0.194	0.321
T08-B1	11.735	0.194	0.321
T08-B2	11.735	0.194	0.321
T08-B3	11.735	0.194	0.321
T08-C1	11.735	0.194	0.321
T08-C2	11.735	0.194	0.321
T08-C3	11.735	0.194	0.321
T08-D1A	11.735	0.194	0.321
T08-D1B	11.735	0.194	0.321
T08-D2	11.735	0.194	0.321
T08-D3	11.735	0.194	0.321
T08-E1A	11.735	0.194	0.321
T08-E1B	11.735	0.194	0.321
T-096-01	9.001	1.454	0.374
T-096-01-S	11.541	0.21	0.326
T-097-01	9.001	1.454	0.374
T-097-01-S	11.675	0.199	0.323
T-097-02	9.001	1.454	0.374
T-097-02-S	11.675	0.199	0.323
T-098-01	9.001	1.454	0.374
T-098-01-S	11.243	0.238	0.332
T-098-02	9.001	1.454	0.374
T-098-02-S	11.243	0.238	0.332
T-098-03	9.001	1.454	0.374
T-098-03-S	11.243	0.238	0.332
T09-A	11.735	0.194	0.321
T09-B	11.735	0.194	0.321
T10	11.724	0.201	0.323
T11	11.724	0.201	0.323
T12	11.782	0.19	0.32
T13a	11.782	0.19	0.32
T13b	11.782	0.19	0.32
T14-A1A	11.6	0.206	0.324
T14-A1B	11.6	0.206	0.324
T14-A1C	11.6	0.206	0.324
T14-A2A	11.6	0.206	0.324
T14-A2B	11.6	0.206	0.324
T14-A2C	11.6	0.206	0.324
T14-B1A	11.6	0.206	0.324
T14-B1B	11.6	0.206	0.324
T14-B1C	11.6	0.206	0.324
T14-B1D	11.6	0.206	0.324
T14-B1E	11.6	0.206	0.324
T14-C1	11.6	0.206	0.324
T14-C2	11.6	0.206	0.324
T14-C3	11.6	0.206	0.324
T14-D1	11.6	0.206	0.324
T14-D2	11.6	0.206	0.324
T14-E1	11.6	0.206	0.324
T14-E2	11.6	0.206	0.324
T14-E3	11.6	0.206	0.324
T14-F	11.6	0.206	0.324
T14-G	11.6	0.206	0.324
T14-H	11.6	0.206	0.324
T14-J1	11.6	0.206	0.324
T14-J4	11.6	0.206	0.324
T14-K1	11.6	0.206	0.324
T14-K2	11.6	0.206	0.324

T14-K3	11.6	0.206	0.324
T14-K4	11.6	0.206	0.324
T14-L1	11.6	0.206	0.324
T14-L2	11.6	0.206	0.324
T14-M1	11.6	0.206	0.324
T14-M2	11.6	0.206	0.324
T14-N1A	11.6	0.206	0.324
T14-N1B	11.6	0.206	0.324
T14-N1C	11.6	0.206	0.324
T14-N1D	11.6	0.206	0.324
T14-N2A	11.6	0.206	0.324
T14-N2B	11.6	0.206	0.324
T14-N2C	11.6	0.206	0.324
T14-N2D	11.6	0.206	0.324
T14-N3A	11.6	0.206	0.324
T14-N3B	11.6	0.206	0.324
T14-N3C	11.6	0.206	0.324
T14-N3D	11.6	0.206	0.324
T14-N4A	11.6	0.206	0.324
T14-N4B	11.6	0.206	0.324
T14-N4C	11.6	0.206	0.324
T14-N4D	11.6	0.206	0.324
T14-N5A	11.6	0.206	0.324
T14-N5B	11.6	0.206	0.324
T14-N5C	11.6	0.206	0.324
T14-N5D	11.6	0.206	0.324
T14-P1	11.6	0.206	0.324
T14-P2	11.6	0.206	0.324
T14-P3	11.6	0.206	0.324
T14-P4	11.6	0.206	0.324
T14-P5	11.6	0.206	0.324
T14-P6	11.6	0.206	0.324
T14-R1A	11.6	0.206	0.324
T14-R1B	11.6	0.206	0.324
T14-R1C	11.6	0.206	0.324
T14-R2A	11.6	0.206	0.324
T14-R2B	11.6	0.206	0.324
T14-R3A	11.6	0.206	0.324
T14-R3B	11.6	0.206	0.324
T14-T	11.6	0.206	0.324
T14-U	11.6	0.206	0.324
T15a	11.6	0.206	0.324
T15b	11.6	0.206	0.324
T15C	11.6	0.206	0.324
T15D	11.6	0.206	0.324
TR15-332-A	9.001	1.454	0.374
TR15-332-B	9.001	1.454	0.374
TR15-332-C	9.001	1.454	0.374
TR15-332-D	9.001	1.454	0.374
TR15-332-E	9.001	1.454	0.374
TR15-344-A	9.001	1.454	0.374
TR15-344-B	9.001	1.454	0.374
TR15-352-A	9.001	1.454	0.374
TR15-352-B	9.001	1.454	0.374
TR15-360B-A	9.001	1.454	0.374
TR15-360B-B	9.001	1.454	0.374
TR15-362-A	9.001	1.454	0.374
TR15-362-B	9.001	1.454	0.374
TR15-412-A	9.001	1.454	0.374
TR15-412-B	9.001	1.454	0.374
TR15-426-A	9.001	1.454	0.374
TR15-426-B	9.001	1.454	0.374
TT14-262A	11.6	0.206	0.324
TT14-263A	11.6	0.206	0.324
TT14-264A	11.6	0.206	0.324
TT14-264B	11.6	0.206	0.324
TT14-264C	11.6	0.206	0.324
TT14-264D	11.6	0.206	0.324
TT14-264E	11.6	0.206	0.324
TT14-266A	11.6	0.206	0.324
TT14-266B	11.6	0.206	0.324
TT14-270A	11.6	0.206	0.324
TT14-270B	11.6	0.206	0.324
TT14-272A	11.6	0.206	0.324
TT14-274A	11.6	0.206	0.324
TT14-274B	11.6	0.206	0.324
TT14-274C	11.6	0.206	0.324
TT14-278A	11.6	0.206	0.324
TT14-278B	11.6	0.206	0.324
TT14-278C	11.6	0.206	0.324
TT14-280A	11.6	0.206	0.324
TT14-282A	11.6	0.206	0.324
TT14-284A	11.6	0.206	0.324
TT14-284B	11.6	0.206	0.324
TT14-284C	11.6	0.206	0.324
TT14-286A	11.6	0.206	0.324
TT14-288A	11.6	0.206	0.324
TT14-288B	11.6	0.206	0.324
TT14-288C	11.6	0.206	0.324
TT14-291A	11.6	0.206	0.324
TT14-291B	11.6	0.206	0.324
TT14-291C	11.6	0.206	0.324
TT14-291D	11.6	0.206	0.324
TT14-294A	11.6	0.206	0.324
TT14-294B	11.6	0.206	0.324
TT14-294C	11.6	0.206	0.324

TT14-296A	11.6	0.206	0.324
TT14-296B	11.6	0.206	0.324
TT14-602A	11.6	0.206	0.324
TT14-602B	11.6	0.206	0.324
TT14-602C	11.6	0.206	0.324
TT14-602D	11.6	0.206	0.324
TT14-606A	11.6	0.206	0.324
TT14-606B	11.6	0.206	0.324
TT14-610A	11.6	0.206	0.324
TT14-610B	11.6	0.206	0.324
TT14-610C	11.6	0.206	0.324
TT14-610D	11.6	0.206	0.324
TT14-612A	11.6	0.206	0.324
TT14-612B	11.6	0.206	0.324
TT14-612C	11.6	0.206	0.324
TT14-614A	11.6	0.206	0.324
TT14-614B	11.6	0.206	0.324
TT14-614C	11.6	0.206	0.324
TT14-616A	11.6	0.206	0.324
TT14-616B	11.6	0.206	0.324
TT14-618A	11.6	0.206	0.324
TT14-620A	11.6	0.206	0.324
TT14-620B	11.6	0.206	0.324
TT14-622A	11.6	0.206	0.324
TT14-624A	11.6	0.206	0.324
TT14-630A	11.6	0.206	0.324
TT14-636A	11.6	0.206	0.324
TT14-636B	11.6	0.206	0.324
TT14-638A	11.6	0.206	0.324
TT14-639A	11.6	0.206	0.324
TT14-639B	11.6	0.206	0.324
TT14-640A	11.6	0.206	0.324
TT14-642A	11.6	0.206	0.324
TT14-642B	11.6	0.206	0.324
TT14-642C	11.6	0.206	0.324
TT14-644A	11.6	0.206	0.324
TT14-646A	11.6	0.206	0.324
TT14-648A	11.6	0.206	0.324
TT14-648B	11.6	0.206	0.324
TT14-658A	11.6	0.206	0.324
TT14-658B	11.6	0.206	0.324
TT14-660A	11.6	0.206	0.324
TT14-666A	11.6	0.206	0.324
TT14-668A	11.6	0.206	0.324
TT14-676A	11.6	0.206	0.324
TT14-684A	11.6	0.206	0.324
TT14-684B	11.6	0.206	0.324
TT14-688A	11.6	0.206	0.324
TT14-688B	11.6	0.206	0.324
TT14-688C	11.6	0.206	0.324
TT14-690A	11.6	0.206	0.324
TT14-690B	11.6	0.206	0.324
TT14-692A	11.6	0.206	0.324

[JUNCTIONS]

;; ;;Name	Invert Elev.	Max. Depth	Init. Depth	Surcharge Depth	Ponded Area
21005	-17.7	517.7	0	0	0
21006	-18.1	518.1	0	0	0
31010	-2.55	502.55	0	0	0
31015	-2.55	502.55	0	0	0
31020	-2.5	502.5	0	0	0
31900	1	499	0	0	0
31915	0.98	499.02	0	0	0
A2	73.55	50	0	0	0
B10	77.82	50	0	0	0
B2	88.6	50	0	0	0
B4	86.1	50	0	0	0
B6	82.89	50	0	0	0
B8	79.14	50	0	0	0
C2	93.93	50	0	0	0
CF04-002	1.5	498.5	0	0	0
CF06-002	-1.74	501.74	0	0	0
CF07-000	-2.27	502.27	0	0	0
CF09-000	-3.77	503.77	0	0	0
CF10-000	-5.82	505.82	0	0	0
CF10-002	-7.7	507.7	0	0	0
CF11-000	-6.3	506.3	0	0	0
CF12-004	-3.2	503.2	0	0	0
CF12-006	-6	506	0	0	0
CF12-016	-7.3	507.3	0	0	0
CF12-020	-8.8	508.8	0	0	0
CF12-024	-10.1	510.1	0	0	0
CF13-000	-6.9	506.9	0	0	0
CF13-004	-11.9	511.9	0	0	0
CF14-000	-4.75	504.75	0	0	0
CT06-000	50.35	449.65	0	0	0
CT07-004	48	452	0	0	0
D2	110.58	50	0	0	0
D4	109.32	50	0	0	0
EJ2	106.23	50	0	0	0
EJ4	99.17	50	0	0	0
F03	37.03	462.97	0	0	0
F04	8.73	491.27	0	0	0
F05	5.55	494.45	0	0	0

F06	-0.93	500.93	0	0	0
F07	-1.6	501.6	0	0	0
F08	-1.01	501.01	0	0	0
F09	-3.6	503.6	0	0	0
F10	-4.92	504.92	0	0	0
F11	-5.59	505.59	0	0	0
F11Z	-5.6	505.6	0	0	0
F12	-0.77	500.77	0	0	0
F13	-6.38	506.38	0	0	0
F13Z	-6.39	506.39	0	0	0
F14	-4.38	504.38	0	0	0
F14Z	-4.39	504.39	0	0	0
G10	105.17	50	0	0	0
G4	112.25	50	0	0	0
G6	109.35	50	0	0	0
G8	107.62	50	0	0	0
H10	118.97	50	0	0	0
H12	116.58	50	0	0	0
H14	113.04	50	0	0	0
H2	135.33	50	0	0	0
H4	132.77	50	0	0	0
H6	128.39	50	0	0	0
H7	123.24	50	0	0	0
H8	122.78	50	0	0	0
I10	130.91	50	0	0	0
I12	127.03	50	0	0	0
I2	142.26	50	0	0	0
I4	138.63	50	0	0	0
I6	135.75	50	0	0	0
I7	134.39	50	0	0	0
I8	133.47	50	0	0	0
IF03-000	16.5	483.5	0	0	0
IF03-002	14.7	485.3	0	0	0
IF03-004	13.3	486.7	0	0	0
IF03-006	4.7	495.3	0	0	0
IF03-010	2.5	497.5	0	0	0
IF04-000	0.1	499.9	0	0	0
IF04-002	-0.6	500.6	0	0	0
IF04-004	-1.3	501.3	0	0	0
IF04-006	-2	502	0	0	0
IF05-000	-2.9	502.9	0	0	0
IF05-002	-3.4	503.4	0	0	0
IF05-004	-4	504	0	0	0
IF05-006	-4.5	504.5	0	0	0
IF05-008	-5	505	0	0	0
IF05-010	-5.4	505.4	0	0	0
IF05-012	-5.8	505.8	0	0	0
IF06-000	-6.1	506.1	0	0	0
IF07-000	-6.2	506.2	0	0	0
IF07-002	-6.6	506.6	0	0	0
IF08-000	-6.9	506.9	0	0	0
IF08-006	-7.1	507.1	0	0	0
IF09-000	-8.7	508.7	0	0	0
IF10-000	-8.9	508.9	0	0	0
IF10-004	-9.5	509.5	0	0	0
IF11-000	-11	511	0	0	0
IF11-002	-11.4	511.4	0	0	0
IF11-006	-12	512	0	0	0
IF11-008	-12.4	512.4	0	0	0
IF11-012	-13	513	0	0	0
IF11-016	-13.6	513.6	0	0	0
IF12-000	-14.1	514.1	0	0	0
IF12-004	-14.5	514.5	0	0	0
IF12-006	-15.1	515.1	0	0	0
IF12-008	-15.4	515.4	0	0	0
IF12-010	-15.8	515.8	0	0	0
IF12-012	-16.2	516.2	0	0	0
IF12-016	-16.6	516.6	0	0	0
IR18-002	16.77	483.23	3	0	0
IR18-004	14.33	485.67	4	0	0
IR18-017	6.5	493.5	10	0	0
IR18-018	5.3	494.7	0	0	0
IR18-020	5.2	494.8	0	0	0
IR18-030	4.6	495.4	0	0	0
IR18-032	4.2	495.8	0	0	0
IR18-040	4	496	0	0	0
IR18-042	3.5	496.5	0	0	0
IR18-046	2.6	497.4	0	0	0
IR18-050	2.4	497.6	0	0	0
IR18-052	2.1	497.9	0	0	0
IR18-056	1.9	498.1	0	0	0
IR18-058	1.8	498.2	0	0	0
IR18-060	1.5	498.5	0	0	0
IR18-062	1.1	498.9	0	0	0
IR18-064	0.8	499.2	0	0	0
IR18-066	0.5	499.5	0	0	0
IR18-068	0.3	499.7	0	0	0
IR18-070	0.27	499.73	0	0	0
IR18-072	-2.5	502.5	0	0	0
IR18-076	5	495	0	0	0
IR18-080	4.5	495.5	0	0	0
IR18-084	4.3	495.7	0	0	0
IR18-086	4.1	495.9	0	0	0
IR18-088	3.8	496.2	0	0	0
IR18-090	3.4	496.6	0	0	0
IR18-092	3.1	496.9	0	0	0

IR18-094	2.8	497.2	0	0	0
IR18-096	2.5	497.5	0	0	0
IR18-098	2.2	497.8	0	0	0
IR18-100	1.9	498.1	0	0	0
IR18-102	1.6	498.4	0	0	0
IR18-104	1.3	498.7	0	0	0
IR18-106	1.27	498.73	0	0	0
IT00-002	59.3	440.7	0	0	0
IT00-004	57.9	442.1	0	0	0
IT00-006	57.2	442.8	0	0	0
IT00-008	56.3	443.7	0	0	0
IT00-010	55.3	444.7	0	0	0
IT00-012	54	446	0	0	0
IT00-014	53.1	446.9	0	0	0
IT00-016	52.9	447.1	0	0	0
IT00-018	52.6	447.4	0	0	0
IT00-022	51.7	448.3	0	0	0
IT03-000	50.6	449.4	0	0	0
IT03-004	49.8	450.2	0	0	0
IT03-006	49.1	450.9	0	0	0
IT03-008	48.4	451.6	0	0	0
IT03-010	47.7	452.3	0	0	0
IT03-012	47.1	452.9	0	0	0
IT03-014	46.5	453.5	0	0	0
IT03-016	45.9	454.1	0	0	0
IT04-000	45.2	454.8	0	0	0
IT05-004	43.7	456.3	0	0	0
IT06-000	42.6	457.4	0	0	0
IT06-004	41.8	458.2	0	0	0
IT06-006	41.2	458.8	0	0	0
IT06-008	40.6	459.4	0	0	0
IT07-000	39.6	460.4	0	0	0
IT07-004	38.6	461.4	0	0	0
IT07-006	38	462	0	0	0
IT07-012	37	463	0	0	0
IT08-000	36	464	0	0	0
IT10-000	33.8	466.2	0	0	0
IT10-002	33.2	466.8	0	0	0
IT10-004	32.6	467.4	0	0	0
IT11-000	31.7	468.3	0	0	0
IT11-002	30.9	469.1	0	0	0
IT11-004	30	470	0	0	0
IT13-000	29.2	470.8	0	0	0
IT13-002	28.4	471.6	0	0	0
IT13-004	27.4	472.6	0	0	0
IT13-006	26.7	473.3	0	0	0
IT13-008	23.7	476.3	0	0	0
IT13-012	22.3	477.7	0	0	0
IT13-014	21.5	478.5	0	0	0
IT13-016	20.3	479.7	0	0	0
IT14-000	19.8	480.2	0	0	0
IT14-004	19.5	480.5	0	0	0
IT15-000	19.1	480.9	0	0	0
IT15-004	18.9	481.1	0	0	0
IT15-006	18.8	481.2	0	0	0
IT15-010	18.6	481.4	0	0	0
IT15-012	18.34	481.66	0	0	0
IT15-014	18.1	481.9	0	0	0
IT15-018	17.7	482.3	0	0	0
IT15-022	17.5	482.5	0	0	0
IT15-024	17.2	482.8	0	0	0
J10	95.25	50	0	0	0
J12	92.85	50	0	0	0
J13	91.79	50	0	0	0
J14	90.23	50	0	0	0
J16	88.03	50	0	0	0
J18	86.12	50	0	0	0
J2	109.38	50	0	0	0
J20	83.13	50	0	0	0
J3A	109.18	50	0	0	0
J3B	108.52	50	0	0	0
J3C	107.16	50	0	0	0
J3D	105.18	50	0	0	0
J4	104.58	50	0	0	0
J6	101.66	50	0	0	0
J7	98.26	50	0	0	0
J8	97.82	50	0	0	0
J9	95.89	50	0	0	0
K2	137.69	50	0	0	0
K4	136.25	50	0	0	0
L2	141.13	50	0	0	0
L4	137.98	50	0	0	0
M2	127.02	50	0	0	0
M4	123.79	50	0	0	0
MC_1	218.7	281.3	0	0	0
MC_2	65	435	0	0	0
MR10	91.75	50	0	0	0
MR12	90.12	50	0	0	0
MR2	100.08	50	0	0	0
MR4	98.2	50	0	0	0
MR6	95.59	50	0	0	0
MR8	93.58	50	0	0	0
MS10	139.37	50	0	0	0
MS12	137.44	50	0	0	0
MS13	136.68	50	0	0	0
MS14	133.33	50	0	0	0

MS16	131.72	50	0	0	0
MS18	129.69	50	0	0	0
MS2	149.48	50	0	0	0
MS20	126.35	50	0	0	0
MS21	125.04	50	0	0	0
MS22	124.26	50	0	0	0
MS24	121.97	50	0	0	0
MS26	119.16	50	0	0	0
MS28	117.28	50	0	0	0
MS30	114.58	50	0	0	0
MS32	110.76	50	0	0	0
MS34	107.93	50	0	0	0
MS36	106.16	50	0	0	0
MS37	102.97	50	0	0	0
MS38	101.32	50	0	0	0
MS4	146.22	50	0	0	0
MS40	97.52	50	0	0	0
MS42	93.57	50	0	0	0
MS44	89.46	50	0	0	0
MS45	88.76	50	0	0	0
MS46	87.25	50	0	0	0
MS50	85.47	50	0	0	0
MS52	83.2	50	0	0	0
MS53	82.72	50	0	0	0
MS54	81.53	50	0	0	0
MS56	79.48	50	0	0	0
MS57	76.61	50	0	0	0
MS58	75.97	50	0	0	0
MS59	72.49	50	0	0	0
MS6	144.39	50	0	0	0
MS60	71.18	50	0	0	0
MS62	68.63	50	0	0	0
MS66	66.85	50	0	0	0
MS70	65.35	50	0	0	0
MS72	63.08	50	0	0	0
MS73	62.05	50	0	0	0
MS74	59.58	50	0	0	0
MS8	140.96	50	0	0	0
N2	65.05	50	0	0	0
N3	63.4	50	0	0	0
N4	62.93	50	0	0	0
OF03-000	39.53	460.47	0	0	0
OF03-004	22	478	0	0	0
OF03-006	20.3	479.7	0	0	0
OF04-000	9.22	490.78	0	0	0
OF05-000	5.68	494.32	0	0	0
OF06-000	-0.62	500.62	0	0	0
OF07-000	-1.47	501.47	0	0	0
OF08-000	-0.99	500.99	0	0	0
OF09-000	-3.31	503.31	0	0	0
OF09-002	-3.65	503.65	0	0	0
OF09-004	-3.65	503.65	0	0	0
OF10-000	-3.98	503.98	0	0	0
OF11-000	-5.3	505.3	0	0	0
OF12-000	1.17	498.83	0	0	0
OF12-002	-2	502	0	0	0
OF12-006	-3.5	503.5	0	0	0
OF12-008	-3.5	503.5	0	0	0
OF12-012	-3.8	503.8	0	0	0
OF12-014	-4	504	0	0	0
OF12-016	-4.1	504.1	0	0	0
OF12-020	-4.3	504.3	0	0	0
OF13-000	-5.02	505.02	0	0	0
OF13-002	-5.8	505.8	0	0	0
OF13-004	-6.2	506.2	0	0	0
OF13-006	-6.5	506.5	0	0	0
OF13-008	-6.8	506.8	0	0	0
OF13-014	-7.2	507.2	0	0	0
OR15-002	100.3	399.7	0	0	0
OR15-004	98.4	401.6	0	0	0
OR15-012	82.9	417.1	0	0	0
OR15-016	67.67	432.33	0	0	0

;	*5	368	2	6	2	*6	0.03	501	0.03	657	*7	0.77	501
-7.22	518	-10.52	524	-11.22	635	-7.22	643	*	0.77	657	*8	0	502
0.78	0	656	0.78	*5	973	2	8	2	*6	0.04	501	0.04	647
*7	1.77	501	-0.12	502	-5.72	511	-12.42	523	-11.82	624	*	-5.72	636
-0.22	646	1.77	647	*8	0	502	1.78	0	646	1.78	*5	3347	2
8	2	*6	0.03	226	0.03	376	*7	10.07	226	2.28	226.1	-4.72	243
-9.52	253	-10.02	347	*	-4.72	358	2.38	375.9	9.87	376	*8	0	227
10.08	0	375	9.88	*5	3800	2	8	2	*6	0.03	251	0.03	470
*7	12.78	251	-0.82	290	-7.52	305	-9.12	359	*	-9.52	416	-0.82	450
7.18	469.9	7.28	470	*8	0	252	12.79	0	469				

OR18-004	12.3	487.7	0	0	0
OR18-010	1.6	498.4	0	0	0
OT01-002	306.6	193.4	0	0	0
OT04-002	51.3	448.7	0	0	0
OT05-002	52.1	447.9	0	0	0
OT05-004	51	449	0	0	0
OT06-000	52.42	447.58	0	0	0
OT06-002	51.55	448.45	0	0	0
OT09-002	60	440	0	0	0
OT09-004	41.2	458.8	0	0	0
R15	102.2	397.8	0	0	0
R15B	103.2	396.8	0	0	0
R18	16.93	483.07	0	0	0
R18W1	16.93	483.07	0	0	0

RF14-000	-3.49	503.49	0	0	0
RT01-000	320.6	179.4	0	0	0
RT03-000	64.16	435.84	0	0	0
RT04-000	53.32	446.68	0	0	0
RT05-000	57.63	442.37	0	0	0
RT07-000	55.44	444.56	0	0	0
RT08-000	44	456	0	0	0
RT09-000	63.98	436.02	0	0	0
RT10-000	42.56	457.44	0	0	0
RT11-000	39.45	460.55	0	0	0
RT12-000	44.1	455.9	0	0	0
RT13-000	37.59	462.41	0	0	0
RT14-000	26.16	473.84	0	0	0
RT15-000	29.98	470.02	0	0	0
T01	320.85	179.15	0	0	0
T14	26.16	473.84	0	0	0
TF-00200	-11.34	225.72	0	0	0
TF-00350	-11.3	225.68	0	0	0
TF-00368	-11.26	241.26	0	0	0
TF-00518	-11.22	225.6	0	0	0
TF-00780	-12.52	226.9	0	0	0
TF-00940	-12.48	226.86	0	0	0
TF-00973	-12.44	226.82	0	0	0
TF-01133	-12.4	226.78	0	0	0
TF-02905	-10.42	239.3	0	0	0
TF03-108	56.8	443.2	0	0	0
TF03-116	59.4	440.6	0	0	0
TF03-124	62.6	437.4	0	0	0
TF03-130	66.1	433.9	0	0	0
TF03-132	67.2	432.8	0	0	0
TF-03135	-10.05	239.33	0	0	0
TF03-136	68.5	431.5	0	0	0
TF03-138	70	430	0	0	0
TF-03285	-10.04	239.32	0	0	0
TF-03347	-10.03	239.31	0	0	0
TF-03497	-10.02	261.9	0	0	0
TF-03605	-9.92	261.9	0	0	0
TF-03755	-9.56	239.84	0	0	0
TF-03800	-9.55	239.83	0	0	0
TF-03950	-9.52	261.9	0	0	0
TF-03975	-8.8	239.48	0	0	0
TF04-102	15.6	484.4	0	0	0
TF04-108	21.9	478.1	0	0	0
TF04-115	29.2	470.8	0	0	0
TF04-120	31.6	468.4	0	0	0
TF04-122	34.8	465.2	0	0	0
TF04-124	39.2	460.8	0	0	0
TF-04125	-8.74	239.42	0	0	0
TF04-125	42	458	0	0	0
TF04-128	49.9	450.1	0	0	0
TF04-136	55.7	444.3	0	0	0
TF04-138	56.1	443.9	0	0	0
TF04-140	57.8	442.2	0	0	0
TF-04177	-8.68	239.36	0	0	0
TF-04239	-8.62	239.3	0	0	0
TF-04301	-8.2	240.68	0	0	0
TF-04406	-8.16	240.64	0	0	0
TF-04556	-8.12	239.3	0	0	0
TF05-108	6.9	493.1	0	0	0
TF05-114	8.1	491.9	0	0	0
TF-05301	-9.92	239.3	0	0	0
TF-05451	-7.7	237.38	0	0	0
TF-05469	-7.66	237.34	0	0	0
TF-05619	-7.62	239.3	0	0	0
TF-05621	-7.52	236.7	0	0	0
TF-05771	-7.41	239.39	0	0	0
TF-05871	-7.36	239.34	0	0	0
TF06-006	2	498	0	0	0
TF06-008	10.9	489.1	0	0	0
TF06-012	30.7	469.3	0	0	0
TF06-014	35.3	464.7	0	0	0
TF06-020	40.4	459.6	0	0	0
TF-06021	-7.32	239.3	0	0	0
TF07-106	1.6	498.4	0	0	0
TF07-110	9	491	0	0	0
TF07-114	22.2	477.8	0	0	0
TF07-120	40	460	0	0	0
TF07-128	48.6	451.4	0	0	0
TF-07706	-7.09	231.57	0	0	0
TF-07826	-7.03	232.31	0	0	0
TF-07842	-6.99	232.27	0	0	0
TF-07962	-6.94	231.42	0	0	0
TF-07966	-6.9	231.38	0	0	0
TF-08086	-6.4	235.78	0	0	0
TF08-106	6.7	493.3	0	0	0
TF-08160	-6.25	235.63	0	0	0
TF08-210	13.7	486.3	0	0	0
TF08-212	16.6	483.4	0	0	0
TF-08280	-6.1	231.38	0	0	0
TF-08346	-8.72	231.4	0	0	0
TF-08831	-6.9	231.68	0	0	0
TF-08911	-6.8	231.18	0	0	0
TF-08974	-6.7	231.08	0	0	0
TF-09054	-6.6	230.98	0	0	0
TF-09061	-7.28	231.06	0	0	0
TF09-108	0.8	499.2	0	0	0

TF-09141	-7.24	231.62	0	0	0
TF-09215	-7.2	231.58	0	0	0
TF-09261	-7.02	236.4	0	0	0
TF-09311	-4.35	228.73	0	0	0
TF-09361	-4.1	236.58	0	0	0
TF-09856	-3.92	233.3	0	0	0
TF-09886	-4.32	233.3	0	0	0
TF-09946	-5.25	235.63	0	0	0
TF-10001	-5.22	235.6	0	0	0
TF-10061	-4.92	233.3	0	0	0
TF10-102	-2.6	502.6	0	0	0
TF10-108	-0.6	500.6	0	0	0
TF10-110	0.5	499.5	0	0	0
TF10-112	4.3	495.7	0	0	0
TF10-118	6.5	493.5	0	0	0
TF10-124	8.3	491.7	0	0	0
TF10-132	10.7	489.3	0	0	0
TF-10561	-2.22	224.2	0	0	0
TF-10681	-2.42	224.4	0	0	0
TF-10706	-1.92	224.4	0	0	0
TF-10731	-1.62	222.2	0	0	0
TF11-104	-4.6	504.6	0	0	0
TF11-108	-3.7	503.7	0	0	0
TF11-116	-2.5	502.5	0	0	0
TF11-124	0	500	0	0	0
TF11-132	2.4	497.6	0	0	0
TF11-140	4.7	495.3	0	0	0
TF11-144	6.1	493.9	0	0	0
TF11-152	8.6	491.4	0	0	0
TF11-160	10.3	489.7	0	0	0
TF11-168	12.8	487.2	0	0	0
TF11-174	13.9	486.1	0	0	0
TF11-176	14.2	485.8	0	0	0
TF-11251	0.5	222.7	0	0	0
TF-11311	0.88	219.9	0	0	0
TF12-104	3.1	496.9	0	0	0
TF12-106	4	496	0	0	0
TF12-110	6.3	493.7	0	0	0
TF-12291	4.68	234.5	0	0	0
TF-12851	6.68	234.5	0	0	0
TF-12911	6.8	218.68	0	0	0
TF-12973	6.98	218.5	0	0	0
TF-13033	7.08	234.5	0	0	0
TF13-106	-3.8	503.8	0	0	0
TF13-110	-2.7	502.7	0	0	0
TF13-118	-0.9	500.9	0	0	0
TF13-122	-0.1	500.1	0	0	0
TF-13405	7.53	234.95	0	0	0
TF-13776	7.98	234.5	0	0	0
TF-13836	10.38	231.4	0	0	0
TF-13898	11.66	230.12	0	0	0
TF-13958	11.68	229.7	0	0	0
TF-14039	11.86	232.7	0	0	0
TF14-105	-1	501	0	0	0
TF14-106	-0.9	500.9	0	0	0
TF-14120	12.04	232.7	0	0	0
TF-14201	12.22	232.7	0	0	0
TF-14282	12.4	232.7	0	0	0
TF-14363	12.55	232.73	0	0	0
TF-14444	12.78	232.7	0	0	0
TF-14544	12.88	234.1	0	0	0
TF-14561	12.9	234.08	0	0	0
TF-14561A	16.28	230.7	0	0	0
TF-14561B	12.91	234.07	0	0	0
TF-14601	16.28	236.2	0	0	0
TF-15181	16.08	236.2	0	0	0
TF-15291	15.97	228.41	0	0	0
TF-15304	15.98	228.4	0	0	0
TF-15414	15.78	246.2	0	0	0
TF-15861	14.88	246.2	0	0	0
TF-18081	24.08	246.2	0	0	0
TF-18956	21.58	248.6	0	0	0
TF-19026	21.37	237.81	0	0	0
TF-19057	21.38	237.8	0	0	0
TF-19127	21.68	248.6	0	0	0
TF-20596	35.48	248.6	0	0	0
TF-21926	33.28	248.6	0	0	0
TF-22026	33.57	224.31	0	0	0
TF-22039	33.58	224.3	0	0	0
TF-22139	33.78	247.6	0	0	0
TF-22376	35.48	247.6	0	0	0
TF-22476	34.37	242.11	0	0	0
TF-22586	34.38	242.1	0	0	0
TF-22686	34.48	247.6	0	0	0
TF-23161	35.08	247.6	0	0	0
TF-23971	39.98	247.6	0	0	0
TF-24071	40.56	245.92	0	0	0
TF-24337	40.57	245.91	0	0	0
TF-24437	40.58	235.2	0	0	0
TF-25391	39.78	235.2	0	0	0
TF-25711	42.28	235.2	0	0	0
TF-25841	43.07	231.61	0	0	0
TF-25907	43.08	231.59	0	0	0
TF-26037	43.38	235.2	0	0	0
TF-27181	46.38	234.4	0	0	0
TF-27281	45.38	235.4	0	0	0

TF-27356	44.68	236.1	0	0	0
TF-27966	47.98	241.8	0	0	0
TF-28031	48.16	241.92	0	0	0
TF-28100	48.22	241.86	0	0	0
TF-28101	48.25	241.83	0	0	0
TF-28165	48.28	241.8	0	0	0
TF-28801	47.68	241.8	0	0	0
TF-29001	47.98	242.3	0	0	0
TF-29061	48.18	257.2	0	0	0
TF-29218	48.38	257	0	0	0
TF-29278	48.98	241.8	0	0	0
TF-30221	53.68	250.4	0	0	0
TF-30301	54.07	228.51	0	0	0
TF-30328	54.08	228.5	0	0	0
TF-30408	55.38	250.4	0	0	0
TF-30411	55.48	250.7	0	0	0
TF-30486	55.88	250.3	0	0	0
TF-30666	55.78	250.4	0	0	0
TF-32061	57.68	252.2	0	0	0
TR15-104	104.3	395.7	0	0	0
TR15-106	106.2	393.8	0	0	0
TR15-110	111.9	388.1	0	0	0
TR15-120	128.3	371.7	0	0	0
TR15-136	155.7	344.3	0	0	0
TR15-148	167.4	332.6	0	0	0
TR15-154	177.2	322.8	0	0	0
TR15-156	181.7	318.3	0	0	0
TR15-158	185.3	314.7	0	0	0
TR15-162	192.4	307.6	0	0	0
TR15-164	194.7	305.3	0	0	0
TR15-166	197.8	302.2	0	0	0
TR15-168	200.5	299.5	0	0	0
TR15-172	204.9	295.1	0	0	0
TR15-174	206.6	293.4	0	0	0
TR15-182	224.5	275.5	0	0	0
TR15-190	241.9	258.1	0	0	0
TR15-204	260.9	239.1	0	0	0
TR15-208	264.1	235.9	0	0	0
TR15-210	267.6	232.4	0	0	0
TR15-212	274.8	225.2	0	0	0
TR15-214	280.3	219.7	0	0	0
TR15-216	289	211	0	0	0
TR15-218	295.9	204.1	0	0	0
TR15-220	302.6	197.4	0	0	0
TR15-222	303.8	196.2	0	0	0
TR15-224	305.1	194.9	0	0	0
TR15-234	308.5	191.5	0	0	0
TR15-240	312.8	187.2	0	0	0
TR15-250	313.8	186.2	0	0	0
TR15-264	317.3	182.7	0	0	0
TR15-302	131.08	368.92	0	0	0
TR15-304	134.57	365.43	0	0	0
TR15-306	137.99	362.01	0	0	0
TR15-308	143.93	356.07	0	0	0
TR15-310	144.3	355.7	0	0	0
TR15-312	144.52	355.48	0	0	0
TR15-314	144.8	355.2	0	0	0
TR15-316	145.7	354.3	0	0	0
TR15-318	146.21	353.79	0	0	0
TR15-320	147.07	352.93	0	0	0
TR15-322	149.05	350.95	0	0	0
TR15-324	150.32	349.68	0	0	0
TR15-326	151.44	348.56	0	0	0
TR15-328	152.92	347.08	0	0	0
TR15-330	154.4	345.6	0	0	0
TR15-332	156.01	343.99	0	0	0
TR15-336	160.06	339.94	0	0	0
TR15-338	163.71	336.29	0	0	0
TR15-340	167.05	332.95	0	0	0
TR15-340B	166.11	333.89	0	0	0
TR15-341	168.12	331.88	0	0	0
TR15-342	169.3	330.7	0	0	0
TR15-342B	167.8	332.2	0	0	0
TR15-344	170.8	329.2	0	0	0
TR15-344B	170.3	329.7	0	0	0
TR15-346	171.5	328.5	0	0	0
TR15-346B	171.41	328.59	0	0	0
TR15-348	174.42	325.58	0	0	0
TR15-348B	172.49	327.51	0	0	0
TR15-350	176.88	323.12	0	0	0
TR15-350B	173.52	326.48	0	0	0
TR15-351B	173.6	326.4	0	0	0
TR15-352	177.28	322.72	0	0	0
TR15-352B	175.41	324.59	0	0	0
TR15-354	178.7	321.3	0	0	0
TR15-354B	177.17	322.83	0	0	0
TR15-356	180.21	319.79	0	0	0
TR15-356B	178.99	321.01	0	0	0
TR15-358	180.88	319.12	0	0	0
TR15-358B	180.84	319.16	0	0	0
TR15-360	181.09	318.91	0	0	0
TR15-360B	182.5	317.5	0	0	0
TR15-362	181.55	318.45	0	0	0
TR15-362B	184.92	315.08	0	0	0
TR15-364	185	315	0	0	0
TR15-364B	187.83	312.17	0	0	0

TR15-366	185.77	314.23	0	0	0
TR15-366B	189.32	310.68	0	0	0
TR15-368	186.15	313.85	0	0	0
TR15-368B	191.47	308.53	0	0	0
TR15-370	187.09	312.91	0	0	0
TR15-370B	193.19	306.81	0	0	0
TR15-370C	197.72	302.28	0	0	0
TR15-372	187.83	312.17	0	0	0
TR15-372C	202.14	297.86	0	0	0
TR15-374	187.63	312.37	0	0	0
TR15-374C	205.93	294.07	0	0	0
TR15-376A	196.01	303.99	0	0	0
TR15-376B	197.5	302.5	0	0	0
TR15-376C	209.48	290.52	0	0	0
TR15-378A	197.07	302.93	0	0	0
TR15-378B	197.31	302.69	0	0	0
TR15-380A	197.79	302.21	0	0	0
TR15-380B	197.51	302.49	0	0	0
TR15-382A	198.77	301.23	0	0	0
TR15-382B	198.14	301.86	0	0	0
TR15-384	198.98	301.02	0	0	0
TR15-386	199.5	300.5	0	0	0
TR15-388	199.93	300.07	0	0	0
TR15-390	200.35	299.65	0	0	0
TR15-392	200.73	299.27	0	0	0
TR15-394	201.23	298.77	0	0	0
TR15-396	201.41	298.59	0	0	0
TR15-398	201.9	298.1	0	0	0
TR15-400	202.28	297.72	0	0	0
TR15-402	205.02	294.98	0	0	0
TR15-404	206	294	0	0	0
TR15-406	207.06	292.94	0	0	0
TR15-408	208	292	0	0	0
TR15-410	208.16	291.84	0	0	0
TR15-412	214.11	285.89	0	0	0
TR15-412A	212.4	287.6	0	0	0
TR15-414	214.96	285.04	0	0	0
TR15-414A	218.4	281.6	0	0	0
TR15-416	216.15	283.85	0	0	0
TR15-418	216.38	283.62	0	0	0
TR15-420	217.43	282.57	0	0	0
TR15-422	218.39	281.61	0	0	0
TR15-424	218.57	281.43	0	0	0
TR15-426	220.08	279.92	0	0	0
TR15-428	222.95	277.05	0	0	0
TR15-430	235.7	264.3	0	0	0
TR15-432	246.76	253.24	0	0	0
TR15-434	250.29	249.71	0	0	0
TR15-436	251.25	248.75	0	0	0
TR15-438	252.8	247.2	0	0	0
TR15-600	145.05	354.95	0	0	0
TR15-602	146.36	353.64	0	0	0
TR15-604	147	353	0	0	0
TR15-604A	156	344	0	0	0
TR15-606	155.41	344.59	0	0	0
TR15-606A	167.39	332.61	0	0	0
TR15-608	163.39	336.61	0	0	0
TR15-608A	167.9	332.1	0	0	0
TR15-610	169.44	330.56	0	0	0
TR15-610A	180.9	319.1	0	0	0
TR15-612	170.13	329.87	0	0	0
TR15-612A	190.07	309.93	0	0	0
TR15-614	174.19	325.81	0	0	0
TR15-614A	190.6	309.4	0	0	0
TR15-616	177.45	322.55	0	0	0
TR15-618	177.86	322.14	0	0	0
TR15-702	145.7	354.3	0	0	0
TR15-704	159.17	340.83	0	0	0
TR15-706	169.61	330.39	0	0	0
TR15-708	175.63	324.37	0	0	0
TR15-710	178.24	321.76	0	0	0
TR15-712	180.77	319.23	0	0	0
TR15-714	183.26	316.74	0	0	0
TR15-716	185.56	314.44	0	0	0
TR15B1-360	182.96	317.04	0	0	0
TR15B1-362	187.25	312.75	0	0	0
TR15B1-364	188.09	311.91	0	0	0
TR15B1-366	188.87	311.13	0	0	0
TR15B1-368	192.07	307.93	0	0	0
TR15B1-370	195.29	304.71	0	0	0
TR15B1-372	198.55	301.45	0	0	0
TR15B1-374	201.28	298.72	0	0	0
TR15B1-376	203.72	296.28	0	0	0
TR15B1-378	206.16	293.84	0	0	0
TR15B1-380	208.77	291.23	0	0	0
TT01-112	328.7	171.3	0	0	0
TT01-118	335.1	164.9	0	0	0
TT01-120	337.4	162.6	0	0	0
TT01-124	352.5	147.5	0	0	0
TT01-128	358.6	141.4	0	0	0
TT03-102	65.7	434.3	0	0	0
TT03-104	72.6	427.4	0	0	0
TT03-106	81.3	418.7	0	0	0
TT03-108	93	407	0	0	0
TT03-112	112.7	387.3	0	0	0
TT03-116	118.9	381.1	0	0	0

TT03-204	93.8	406.2	0	0	0
TT03-206	103	397	0	0	0
TT04-102	55.1	444.9	0	0	0
TT04-104	55.5	444.5	0	0	0
TT04-106	63.9	436.1	0	0	0
TT04-108	79.2	420.8	0	0	0
TT04-110	92.3	407.7	0	0	0
TT05-102	62.2	437.8	0	0	0
TT05-104	86.4	413.6	0	0	0
TT06-106	59.2	440.8	0	0	0
TT06-112	66.9	433.1	0	0	0
TT06-118	76.4	423.6	0	0	0
TT06-122	83.7	416.3	0	0	0
TT06-124	86.6	413.4	0	0	0
TT06-126	89.2	410.8	0	0	0
TT06-128	89.8	410.2	0	0	0
TT06-130	93.6	406.4	0	0	0
TT06-132	94.3	405.7	0	0	0
TT06-136	98.9	401.1	0	0	0
TT06-140	104.7	395.3	0	0	0
TT06-144	109.7	390.3	0	0	0
TT07-102	55.9	444.1	0	0	0
TT07-104	63	437	0	0	0
TT08-110	51.9	448.1	0	0	0
TT08-115	56.7	443.3	0	0	0
TT08-130	62	438	0	0	0
TT08-138	65.8	434.2	0	0	0
TT08-153	72.1	427.9	0	0	0
TT08-166	78.8	421.2	0	0	0
TT08-176	84.7	415.3	0	0	0
TT08-182	86.4	413.6	0	0	0
TT08-186	89.1	410.9	0	0	0
TT08-195	96.1	403.9	0	0	0
TT08-204	83.28	416.72	0	0	0
TT08-207	85.18	414.82	0	0	0
TT08-210	91.8	408.2	0	0	0
TT08-212	94.5	405.5	0	0	0
TT08-214	96.8	403.2	0	0	0
TT08-216	99.76	400.24	0	0	0
TT08-220	103.3	396.7	0	0	0
TT08-221	104.96	395.04	0	0	0
TT08-226	117.92	382.08	0	0	0
TT08-228	121.65	378.35	0	0	0
TT08-231	126.23	373.77	0	0	0
TT08-234	131.23	368.77	0	0	0
TT08-237	136.67	363.33	0	0	0
TT08-240	143.86	356.14	0	0	0
TT08-242	149.6	350.4	0	0	0
TT08-246	160.61	339.39	0	0	0
TT08-250	176.24	323.76	0	0	0
TT08-254	185.87	314.13	0	0	0
TT08-258	195.44	304.56	0	0	0
TT08-264	200.39	299.61	0	0	0
TT09-102	74	426	0	0	0
TT09-108	90.1	409.9	0	0	0
TT09-304	78	422	0	0	0
TT09-314	92.1	407.9	0	0	0
TT09-402	77.2	422.8	0	0	0
TT09-404	78.4	421.6	0	0	0
TT09-412	89.9	410.1	0	0	0
TT09-414	93.1	406.9	0	0	0
TT10-102	67.4	432.6	0	0	0
TT10-104	71.5	428.5	0	0	0
TT10-106	76.1	423.9	0	0	0
TT10-108	78.6	421.4	0	0	0
TT10-110	86.3	413.7	0	0	0
TT10-112	87.7	412.3	0	0	0
TT11-102	42.6	457.4	0	0	0
TT11-104	46.3	453.7	0	0	0
TT12-102	49.4	450.6	0	0	0
TT12-104	54.7	445.3	0	0	0
TT12-106	60.2	439.8	0	0	0
TT13-102	43	457	0	0	0
TT13-104	52.7	447.3	0	0	0
TT13-106	56.6	443.4	0	0	0
TT13-108	58.2	441.8	0	0	0
TT13-110	59.2	440.8	0	0	0
TT13-112	60.3	439.7	0	0	0
TT13-114	63.6	436.4	0	0	0
TT13-116	67.7	432.3	0	0	0
TT13-118	69.1	430.9	0	0	0
TT13-120	70.5	429.5	0	0	0
TT13-122	72.4	427.6	0	0	0
TT13-124	73.9	426.1	0	0	0
TT13-126	75.7	424.3	0	0	0
TT13-130	78.8	421.2	0	0	0
TT13-204	71.9	428.1	0	0	0
TT13-208	75.2	424.8	0	0	0
TT14-007	27.51	472.49	0	0	0
TT14-016	29.7	470.3	0	0	0
TT14-022	31.4	468.6	0	0	0
TT14-030	34.3	465.7	0	0	0
TT14-034	36.4	463.6	0	0	0
TT14-046	43.2	456.8	0	0	0
TT14-048	44.5	455.5	0	0	0
TT14-050	46.3	453.7	0	0	0

TT14-052	47.5	452.5	0	0	0
TT14-054	48.2	451.8	0	0	0
TT14-056	49	451	0	0	0
TT14-058	49.8	450.2	0	0	0
TT14-060	50.6	449.4	0	0	0
TT14-064	52.2	447.8	0	0	0
TT14-068	53.4	446.6	0	0	0
TT14-070	54.6	445.4	0	0	0
TT14-072	56.1	443.9	0	0	0
TT14-074	57.2	442.8	0	0	0
TT14-076	57.6	442.4	0	0	0
TT14-078	59	441	0	0	0
TT14-082	61.4	438.6	0	0	0
TT14-084	62.6	437.4	0	0	0
TT14-086	64.6	435.4	0	0	0
TT14-088	66.3	433.7	0	0	0
TT14-092	68.2	431.8	0	0	0
TT14-094	68.5	431.5	0	0	0
TT14-102	47.7	452.3	0	0	0
TT14-104	50.8	449.2	0	0	0
TT14-106	53.8	446.2	0	0	0
TT14-107	55.4	444.6	0	0	0
TT14-108	58.4	441.6	0	0	0
TT14-110	66.2	433.8	0	0	0
TT14-112	68.2	431.8	0	0	0
TT14-118	79.7	420.3	0	0	0
TT14-120	80.7	419.3	0	0	0
TT14-126	85.7	414.3	0	0	0
TT14-200	68.66	431.34	0	0	0
TT14-202	71.1	428.9	0	0	0
TT14-203	72.2	427.8	0	0	0
TT14-204	72.2	427.8	0	0	0
TT14-205	73.6	426.4	0	0	0
TT14-206	73.8	426.2	0	0	0
TT14-207	74.1	425.9	0	0	0
TT14-208	74.1	425.9	0	0	0
TT14-209	75.8	424.2	0	0	0
TT14-210	75.8	424.2	0	0	0
TT14-211	76.7	423.3	0	0	0
TT14-212	76.6	423.4	0	0	0
TT14-213	77.2	422.8	0	0	0
TT14-214	77.2	422.8	0	0	0
TT14-215	79.4	420.6	0	0	0
TT14-216	79.4	420.6	0	0	0
TT14-217	80.1	419.9	0	0	0
TT14-218	80.3	419.7	0	0	0
TT14-219	80.9	419.1	0	0	0
TT14-220	80.9	419.1	0	0	0
TT14-222	84.3	415.7	0	0	0
TT14-224	85.2	414.8	0	0	0
TT14-226	86.5	413.5	0	0	0
TT14-228	88	412	0	0	0
TT14-230	92.3	407.7	0	0	0
TT14-232	96.58	403.42	0	0	0
TT14-234	99.27	400.73	0	0	0
TT14-236	101.4	398.6	0	0	0
TT14-238	111.8	388.2	0	0	0
TT14-240	119.6	380.4	0	0	0
TT14-242	125.5	374.5	0	0	0
TT14-243	130.89	369.11	0	0	0
TT14-246	135.35	364.65	0	0	0
TT14-248	141.11	358.89	0	0	0
TT14-252	147.27	352.73	0	0	0
TT14-256	152.82	347.18	0	0	0
TT14-258	159.87	340.13	0	0	0
TT14-260	160.22	339.78	0	0	0
TT14-262	161	339	0	0	0
TT14-263	166.61	333.39	0	0	0
TT14-264	180.52	319.48	0	0	0
TT14-266	189.14	310.86	0	0	0
TT14-268	191.54	308.46	0	0	0
TT14-270	194	306	0	0	0
TT14-272	196.5	303.5	0	0	0
TT14-275	199.94	300.06	0	0	0
TT14-278	203.99	296.01	0	0	0
TT14-280	206.74	293.26	0	0	0
TT14-282	209.76	290.24	0	0	0
TT14-284	211.79	288.21	0	0	0
TT14-288	215.75	284.25	0	0	0
TT14-290	218.98	281.02	0	0	0
TT14-291	222.4	277.6	0	0	0
TT14-292	223.89	276.11	0	0	0
TT14-294	225.72	274.28	0	0	0
TT14-296	228.28	271.72	0	0	0
TT14-302	83.9	416.1	0	0	0
TT14-304	85	415	0	0	0
TT14-306	86.1	413.9	0	0	0
TT14-308	87.2	412.8	0	0	0
TT14-310	88	412	0	0	0
TT14-404	73.83	426.17	0	0	0
TT14-406	75.6	424.4	0	0	0
TT14-410	77	423	0	0	0
TT14-412	78.55	421.45	0	0	0
TT14-414	80.95	419.05	0	0	0
TT14-416	82.45	417.55	0	0	0
TT14-418	83.8	416.2	0	0	0

TT14-502	92.58	407.42	0	0	0
TT14-503	92.81	407.19	0	0	0
TT14-503A	93.57	406.43	0	0	0
TT14-503B	96.16	403.84	0	0	0
TT14-504	92.46	407.54	0	0	0
TT14-504A	93.57	406.43	0	0	0
TT14-504B	96.16	403.84	0	0	0
TT14-505	97.43	402.57	0	0	0
TT14-505A	97.64	402.36	0	0	0
TT14-505B	100.06	399.94	0	0	0
TT14-506	97.21	402.79	0	0	0
TT14-506A	97.64	402.36	0	0	0
TT14-506B	100.06	399.94	0	0	0
TT14-507	101.42	398.58	0	0	0
TT14-507A	101.9	398.1	0	0	0
TT14-507B	104.24	395.76	0	0	0
TT14-508	101.42	398.58	0	0	0
TT14-508A	101.9	398.1	0	0	0
TT14-508B	104.24	395.76	0	0	0
TT14-509	105.86	394.14	0	0	0
TT14-509A	106.38	393.62	0	0	0
TT14-509B	108.38	391.62	0	0	0
TT14-510	106	394	0	0	0
TT14-510A	106.38	393.62	0	0	0
TT14-510B	108.38	391.62	0	0	0
TT14-511	110.26	389.74	0	0	0
TT14-511A	110.51	389.49	0	0	0
TT14-512	110.14	389.86	0	0	0
TT14-512A	110.51	389.49	0	0	0
TT14-513	112.24	387.76	0	0	0
TT14-514	112.17	387.83	0	0	0
TT14-516	112.9	387.1	0	0	0
TT14-516P1	112.9	387.1	0	0	0
TT14-518	115.49	384.51	0	0	0
TT14-520	119.34	380.66	0	0	0
TT14-524	123.99	376.01	0	0	0
TT14-526	127.66	372.34	0	0	0
TT14-528	130.32	369.68	0	0	0
TT14-530	133	367	0	0	0
TT14-532	136.71	363.29	0	0	0
TT14-534	139.62	360.38	0	0	0
TT14-536	142.25	357.75	0	0	0
TT14-538	144.88	355.12	0	0	0
TT14-540	147.51	352.49	0	0	0
TT14-542	150.14	349.86	0	0	0
TT14-544	153.09	346.91	0	0	0
TT14-546	156.2	343.8	0	0	0
TT14-550	164.2	335.8	0	0	0
TT14-552	168.7	331.3	0	0	0
TT14-554	171.7	328.3	0	0	0
TT14-556	180.5	319.5	0	0	0
TT14-558	183.16	316.84	0	0	0
TT14-560	185.6	314.4	0	0	0
TT14-562	187.67	312.33	0	0	0
TT14-564	189.5	310.5	0	0	0
TT14-566	192	308	0	0	0
TT14-570	194.18	305.82	0	0	0
TT14-572	195.66	304.34	0	0	0
TT14-574	198.06	301.94	0	0	0
TT14-576	200.24	299.76	0	0	0
TT14-578	202.76	297.24	0	0	0
TT14-582	206.6	293.4	0	0	0
TT14-584	208.57	291.43	0	0	0
TT14-586	210.68	289.32	0	0	0
TT14-588	217.3	282.7	0	0	0
TT14-590	223.52	276.48	0	0	0
TT14-592	229.4	270.6	0	0	0
TT14-594	234.8	265.2	0	0	0
TT14-597	242.2	257.8	0	0	0
TT14-598	244.7	255.3	0	0	0
TT14-599	248.75	251.25	0	0	0
TT14-602	230.1	269.9	0	0	0
TT14-605	232.74	267.26	0	0	0
TT14-606	234.06	265.94	0	0	0
TT14-608	236.1	263.9	0	0	0
TT14-610	238.05	261.95	0	0	0
TT14-612	240	260	0	0	0
TT14-614	243.12	256.88	0	0	0
TT14-616	245.92	254.08	0	0	0
TT14-618	248.62	251.38	0	0	0
TT14-620	251.34	248.66	0	0	0
TT14-622	251.71	248.29	0	0	0
TT14-624	251.98	248.02	0	0	0
TT14-626	253.75	246.25	0	0	0
TT14-628	255.51	244.49	0	0	0
TT14-630	256.91	243.09	0	0	0
TT14-632	257.26	242.74	0	0	0
TT14-634	259.02	240.98	0	0	0
TT14-636	260.84	239.16	0	0	0
TT14-639	263.69	236.31	0	0	0
TT14-642	268.42	231.58	0	0	0
TT14-644	271.72	228.28	0	0	0
TT14-646	274.12	225.88	0	0	0
TT14-650	287.81	212.19	0	0	0
TT14-654	301.78	198.22	0	0	0
TT14-656	303.82	196.18	0	0	0

TT14-660	306.6	193.4	0	0	0
TT14-664	315.44	184.56	0	0	0
TT14-668	323.57	176.43	0	0	0
TT14-672	330.24	169.76	0	0	0
TT14-676	336.53	163.47	0	0	0
TT14-678	338.14	161.86	0	0	0
TT14-682	342.15	157.85	0	0	0
TT14-684	344.01	155.99	0	0	0
TT14-686	345.58	154.42	0	0	0
TT14-688	347.68	152.32	0	0	0
TT14-692	351.06	148.94	0	0	0
TT14-702	252.92	247.08	0	0	0
TT14-704	256.86	243.14	0	0	0
TT14-706	260.5	239.5	0	0	0
TT14-708	262.72	237.28	0	0	0
TT14-710	265.01	234.99	0	0	0
TT14-712	267.25	232.75	0	0	0
TT14-713	268.85	231.15	0	0	0
TT14-716	271.17	228.83	0	0	0
TT14-720	273.38	226.62	0	0	0
TT14-722	276.44	223.56	0	0	0
TT14-724	280.52	219.48	0	0	0
TT14-727	286	214	0	0	0
TT14-728	289.26	210.74	0	0	0
TT14-730	295.31	204.69	0	0	0
TT14-733	299.52	200.48	0	0	0
TT14-734	302.26	197.74	0	0	0
TT14-736	306.26	193.74	0	0	0
TT14-738	310.37	189.63	0	0	0
TT14-740	313.68	186.32	0	0	0
TT14-742	318.04	181.96	0	0	0
TT14-744	323.33	176.67	0	0	0
TT14-746	327.46	172.54	0	0	0
TT14-804	167.8	332.2	0	0	0
TT14-806	175.29	324.71	0	0	0
TT14-807	176.79	323.21	0	0	0
TT14-808	178.43	321.57	0	0	0
TT14-811	186.47	313.53	0	0	0
TT14-812	195.16	304.84	0	0	0
TT14-814	199.05	300.95	0	0	0
TT14-815	201.6	298.4	0	0	0
TT14-816	212.54	287.46	0	0	0
TT14-818	216.7	283.3	0	0	0
TT14-822	220.8	279.2	0	0	0
TT14-824	223.96	276.04	0	0	0
TT14-826	230.17	269.83	0	0	0
TT14-828	238.13	261.87	0	0	0
TT14-830	244.19	255.81	0	0	0
TT14-902	38.1	461.9	0	0	0
TT14-904	39.9	460.1	0	0	0
TT14-906	43.5	456.5	0	0	0
TT14-908	47.3	452.7	0	0	0
TT14-910	50	450	0	0	0
TT15-010	37.1	462.9	0	0	0
TT15-012	39.2	460.8	0	0	0
TT15-016	47	453	0	0	0
TT15-022	58.7	441.3	0	0	0
TT15-024	60.1	439.9	0	0	0
TT15-034	68.7	431.3	0	0	0
TT15-038	73	427	0	0	0

[OUTFALLS]

;;Name	Invert Elev.	Outfall Type	Stage/Table Time Series	Tide Gate
36666	9.98	FREE		NO
TF-00000	-11.42	FIXED	-11 NO	
21007	-18.5	FIXED	-17 NO	
IF13-000	-14	FREE		NO
IF14-000	-14	FREE		NO

[STORAGE]

;;Name	Invert Elev.	Max. Depth	Init. Depth	Shape Curve	Shape Parameters			Ponded Area	Evap. Frac.
CT14-000	21.06	42.24	0	FUNCTIONAL	0	0	50	0	0
IT00-000	59.8	5.7	0	FUNCTIONAL	0	0	50	0	0
CT08-000	41.75	4.55	0	FUNCTIONAL	0	0	30	0	0
OR15-020	50.7	25.4	0	FUNCTIONAL	0	0	30	0	0
CT05-004	52.5	15.6	0	FUNCTIONAL	0	0	30	0	0
CT11-002	35.3	8.3	0	FUNCTIONAL	0	0	30	0	0
CT10-004	36	9.2	0	FUNCTIONAL	0	0	20	0	0
T07	53.31	14.09	0	FUNCTIONAL	0	0	50	0	0
T12	42.93	12.07	0	FUNCTIONAL	0	0	50	0	0
T10	39.5	13.9	0	FUNCTIONAL	0	0	50	0	0
T06	51.56	24.94	0	FUNCTIONAL	0	0	100	0	0
T05	54.88	11.92	0	FUNCTIONAL	0	0	30	0	0
T04	50.64	10.56	0	FUNCTIONAL	0	0	50	0	0
T03	61.24	11.36	0	FUNCTIONAL	0	0	50	0	0
T11	37.5	8.7	0	FUNCTIONAL	0	0	50	0	0
T13	35.1	11.2	0	FUNCTIONAL	0	0	50	0	0
T15	26.32	32.98	0	FUNCTIONAL	0	0	50	0	0
IT09-000	33.9	23.9	0	FUNCTIONAL	0	0	30	0	0
CT06-006	46.2	15.4	0	FUNCTIONAL	0	0	30	0	0
IT05-000	45.1	33.1	0	FUNCTIONAL	0	0	30	0	0
CT04-002	47.7	22	0	FUNCTIONAL	0	0	30	0	0

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TT03-202      71.9     17.1     0     FUNCTIONAL 0     0     100     0     0
TT09-302      76.7     12.3     0     FUNCTIONAL 0     0     100     0     0
T09           61.7     21.5     0     FUNCTIONAL 0     0     100     0     0
T08           44       19       0     FUNCTIONAL 0     0     100     0     0
CT01-000      319.14   15.96    0     FUNCTIONAL 0     0     30      0     0
OF13-012      -7.2     14       0     FUNCTIONAL 0     0     30      0     0
OF13010       -7       16       0     FUNCTIONAL 0     0     30      0     0
CF13-002      -9.3     17.1     0     FUNCTIONAL 0     0     30      0     0
CF14-002      -6.2     14       0     FUNCTIONAL 0     0     30      0     0
CF08-000      -3.11    18.41    0     FUNCTIONAL 0     0     20      0     0
CF05-000      -0.61    17.11    0     FUNCTIONAL 0     0     20      0     0
CF04-000      6.9      13.1     0     FUNCTIONAL 0     0     20      0     0

[CONDUITS]
;;            Inlet      Outlet                 Manning   Inlet    Outlet   Init.
Maximum
;;Name        Node       Node        Length     N         Height   Height   Flow
Flow
;;-----------------------------------------------------------------------------------------
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21006         21006      21007       300        0.014     0        0        0        0
31010         31010      31900       200        0.007     0        0        0        0
31020         31020      31015       200        0.005     0        0        0        0
31900         31900      31915       987        0.035     0        0        0        0
31915         31915      36666       200        0.015     9.02     0        0        0
A2            A2         MS59        493        0.04      0        0        0        0
B10           B10        MS57        562        0.04      0        0        0        0
B2            B2         B4          1159       0.04      0        0        0        0
B4            B4         B6          1492       0.04      0        0        0        0
B6            B6         B8          1738       0.04      0        0        0        0
B8            B8         B10         612        0.04      0        0        0        0
C2            C2         J13         992        0.04      0        0        0        0
CF04-000      CF04-000   CF04-002    200        0.0053    0        0.02     0        0
CF04-002      CF04-002   IF04-000    200        0.0139    0        0.32     0        0
CF05-000      CF05-000   IF05-000    200        0.0133    0        1.45     0        0
CF06-002      CF06-002   F09         207        0.015     0        0.49     0        0
CF07-000      CF07-000   IF07-000    200        0.0125    0        1.21     0        0
CF08-000      CF08-000   IF08-000    200        0.0076    0        1.24     0        0
CF09-000      CF09-000   IF09-000    213        0.018     0        0.79     0        0
CF10-000      CF10-000   CF10-002    200        0.0024    0        1        0        0
CF10-002      CF10-002   IF10-000    200        0.0052    0        0.88     0        0
CF11-000      CF11-000   IF11-000    200        0.0126    0        1.01     0        0
CF12-004      CF12-004   CF12-006    245        0.013     0        0.52     0        0
CF12-006      CF12-006   CF12-016    378        0.017     0        0        0        0
CF12-016      CF12-016   CF12-020    365        0.014     0        0        0        0
CF12-020      CF12-020   CF12-024    360        0.014     0        0        0        0
CF12-024      CF12-024   IF12-000    350        0.014     0        2.68     0        0
CF13-000      CF13-000   CF13-002    200        0.0044    0        2.2      0        0
CF13-002      CF13-002   CF13-004    200        0.0045    0        0.75     0        0
CF13-004      CF13-004   IF13-000    224        0.016     0        0.73     0        0
CF14-000      CF14-000   CF14-002    200        0.004     0        1.4      0        0
CF14-002      CF14-002   IF14-000    200        0.0083    0        7.15     0        0
CT01-000      T01        CT01-000    200        0.0059    0        1.69     0        0
CT01-002      CT01-000   TR15-264    200        0.002     0        0.03     0        0
CT04-002      CT04-002   IT04-000    346        0.017     0        0.71     0        0
CT05-004      CT05-004   IT05-000    200        0.003     0        3.53     0        0
CT06-000      CT06-000   CT06-006    200        0.012     0        1.5      0        0
CT06-006      CT06-006   IT06-000    258        0.013     0        1.04     0        0
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CT07-004	CT07-004	IT07-000	200	0.004	0	2.56	0	0
CT08-000	CT08-000	IT08-000	200	0.008	0	2.6	0	0
CT10-004	CT10-004	IT10-000	200	0.012	0	1.63	0	0
CT11-002	CT11-002	IT11-000	210	0.016	0	2.5	0	0
CT14-000	CT14-000	IT14-000	200	0.012	0	0	0	0
D2	D2	D4	585	0.04	0	0	0	0
D4	D4	J3A	61	0.04	0	0	0	0
EJ2	EJ2	EJ4	3275	0.04	0	0	0	0
EJ4	EJ4	J7	420	0.04	0	0	0	0
F03DWO	F03	IF03-000	200	0.017	0	0.67	0	0
F03W	F03	OF03-000	200	0.0285	3.55	1.03	0	0
F04W	F04	OF04-000	200	0.0224	1.1	0.59	0	0
F04X	F04	CF04-000	200	0.0089	0	1.82	0	0
F05W	F05	OF05-000	200	0.0283	0.63	0.48	0	0
F05X	F05	CF05-000	200	0.007	0	6.15	0	0
F06DWO	F06	CF06-002	359	0.0145	0.41	0.02	0	0
F06W	F06	OF06-000	200	0.0184	0.98	0.65	0	0
F07W	F07	OF07-000	200	0.0219	1.85	1.7	0	0
F07X	F07	CF07-000	200	0.0076	0	0.66	0	0
F08W	F08	OF08-000	200	0.0163	1.43	1.39	0	0
F08X	F08	CF08-000	200	0.0083	0	2.09	0	0
F09W	F09	OF09-000	200	0.0219	1.42	1.11	0	0
F09X	F09	CF09-000	200	0.0044	0	0.16	0	0
F10W1	F10	OF10-000	200	0.0138	1	0.04	0	0
F10W2	F10	OF10-000	200	0.0142	4.92	3.96	0	0
F10X	F10	CF10-000	200	0.0044	0	0.89	0	0
F11W1	F11	OF11-000	200	0.016	6.58	6.27	0	0
F11W2	F11	OF11-000	200	0.029	1.25	0.94	0	0
F11X	F11	F11Z	200	0.0065	0	0	0	0
F11Z	F11Z	CF11-000	200	0.0078	0	0.69	0	0
F12DWO	F12	CF12-004	225	0.0156	0	0	0	0
F12W	F12	OF12-000	200	0.0212	2.65	0.69	0	0
F13W	F13	OF13-000	200	0.0136	1.54	0.16	0	0
F13Z	F13Z	CF13-000	200	0.0044	0	0.5	0	0
F14W	F14	RF14-000	200	0.0185	1.4	0.49	0	0
F14Z	F14Z	CF14-000	200	0.0033	0	0.35	0	0
G10	G10	MS37	1022	0.04	0	0	0	0
G4	G4	G6	1344	0.04	0	0	0	0
G6	G6	G8	804	0.04	0	0	0	0
G8	G8	G10	1135	0.04	0	0	0	0
H10	H10	H12	1108	0.04	0	0	0	0
H12	H12	H14	1643	0.04	0	0	0	0
H14	H14	MS32	1058	0.04	0	0	0	0
H2	H2	H4	1186	0.04	0	0	0	0
H4	H4	H6	2031	0.04	0	0	0	0
H6	H6	H7	2388	0.04	0	0	0	0
H7	H7	H8	216	0.04	0	0	0	0
H8	H8	H10	1767	0.04	0	0	0	0

I10	I10	I12	1803	0.04	0	0	0	0
I12	I12	MS21	919	0.04	0	0	0	0
I2	I2	I4	1682	0.04	0	0	0	0
I4	I4	I6	1336	0.04	0	0	0	0
I6	I6	I7	629	0.04	0	0	0	0
I7	I7	I8	429	0.04	0	0	0	0
I8	I8	I10	1185	0.04	0	0	0	0
IF03-000	IF03-000	IF03-002	305	0.013	0	0	0	0
IF03-002	IF03-002	IF03-004	234	0.013	0	0	0	0
IF03-004	IF03-004	IF03-006	245	0.013	0	0.29	0	0
IF03-006	IF03-006	IF03-010	363	0.014	0	0	0	0
IF03-010	IF03-010	IF04-000	324	0.014	0	0.52	0	0
IF04-000	IF04-000	IF04-002	279	0.013	0	0	0	0
IF04-002	IF04-002	IF04-004	340	0.013	0	0	0	0
IF04-004	IF04-004	IF04-006	332	0.013	0.01	0	0	0
IF04-006	IF04-006	IF05-000	397	0.013	0	0.1	0	0
IF05-000	IF05-000	IF05-002	248	0.013	0	0	0	0
IF05-002	IF05-002	IF05-004	221	0.013	0	0.2	0	0
IF05-004	IF05-004	IF05-006	325	0.013	0	0	0	0
IF05-006	IF05-006	IF05-008	309	0.013	0	0	0	0
IF05-008	IF05-008	IF05-010	314	0.013	0	0	0	0
IF05-010	IF05-010	IF05-012	213	0.013	0	0	0	0
IF05-012	IF05-012	IF06-000	246	0.013	0	0	0	0
IF06-000	IF06-000	IF07-000	200	0.007	0	0	0	0
IF07-000	IF07-000	IF07-002	226	0.013	0	0	0	0
IF07-002	IF07-002	IF08-000	225	0.013	0	0	0	0
IF08-000	IF08-000	IF08-006	200	0.0089	0	0	0	0
IF08-006	IF08-006	IF09-000	200	0.0127	0	0	0	0
IF09-000	IF09-000	IF10-000	200	0.0049	0	0	0	0
IF10-000	IF10-000	IF10-004	219	0.016	0	0	0	0
IF10-004	IF10-004	IF11-000	550	0.016	0	0	0	0
IF11-000	IF11-000	IF11-002	352	0.015	0	0	0	0
IF11-002	IF11-002	IF11-006	433	0.014	0	0	0	0
IF11-006	IF11-006	IF11-008	394	0.013	0	0	0	0
IF11-008	IF11-008	IF11-012	504	0.014	0	0	0	0
IF11-012	IF11-012	IF11-016	440	0.014	0	0	0	0
IF11-016	IF11-016	IF12-000	297	0.013	0	0	0	0
IF12-000	IF12-000	IF12-004	460	0.014	0	0	0	0
IF12-004	IF12-004	IF12-006	596	0.013	0	0.1	0	0
IF12-006	IF12-006	IF12-008	456	0.013	0	0	0	0
IF12-008	IF12-008	IF12-010	468	0.013	0	0	0	0
IF12-010	IF12-010	IF12-012	463	0.013	0	0	0	0
IF12-012	IF12-012	IF12-016	478	0.014	0	0	0	0
IF12-016	IF12-016	21005	423	0.014	0	0.77	0	0
IR18-002	IR18-002	IR18-004	315	0.013	0	0	0	0
IR18-004	IR18-004	IR18-017	1053	0.015	0	5.48	0	0
IR18-017	IR18-017	IR18-018	200	0.0701	0	0	0	0
IR18-018	IR18-018	IR18-020	200	0.008	0	0.02	0	0

IR18-020	IR18-020	IR18-030	529	0.013	0	0	0	0
IR18-030	IR18-030	IR18-032	351	0.013	0	0.01	0	0
IR18-032	IR18-032	IR18-040	200	0.0173	0	0.01	0	0
IR18-040	IR18-040	IR18-042	524	0.014	0	0	0	0
IR18-042	IR18-042	IR18-046	802	0.014	0	0	0	0
IR18-046	IR18-046	IR18-050	370	0.014	0	0	0	0
IR18-050	IR18-050	IR18-052	466	0.013	0	0	0	0
IR18-052	IR18-052	IR18-056	323	0.012	0	0.01	0	0
IR18-056	IR18-056	IR18-058	213	0.013	0	0	0	0
IR18-058	IR18-058	IR18-060	460	0.013	0	0	0	0
IR18-060	IR18-060	IR18-062	556	0.013	0	0	0	0
IR18-062	IR18-062	IR18-064	503	0.013	0	0	0	0
IR18-064	IR18-064	IR18-066	551	0.013	0	0	0	0
IR18-066	IR18-066	IR18-068	349	0.013	0	0	0	0
IR18-068	IR18-068	IR18-070	200	0.004	0	0	0	0
IR18-070	IR18-070	IR18-072	200	0.01	0	0	0	0
IR18-072	IR18-072	31010	200	0.005	0	0	0	0
IR18-076	IR18-076	IR18-080	552	0.014	0	0	0	0
IR18-080	IR18-080	IR18-084	338	0.014	0	0	0	0
IR18-084	IR18-084	IR18-086	327	0.013	0	0	0	0
IR18-086	IR18-086	IR18-088	565	0.013	0	0	0	0
IR18-088	IR18-088	IR18-090	510	0.013	0	0	0	0
IR18-090	IR18-090	IR18-092	504	0.013	0	0	0	0
IR18-092	IR18-092	IR18-094	513	0.013	0	0	0	0
IR18-094	IR18-094	IR18-096	483	0.013	0	0	0	0
IR18-096	IR18-096	IR18-098	490	0.013	0	0	0	0
IR18-098	IR18-098	IR18-100	510	0.013	0	0	0	0
IR18-100	IR18-100	IR18-102	504	0.013	0	0	0	0
IR18-102	IR18-102	IR18-104	504	0.013	0	0	0	0
IR18-104	IR18-104	IR18-106	200	0.008	0.1	0	0	0
IR18-106	IR18-106	31020	200	0.007	0	0	0	0
IT00-000	IT00-000	IT00-002	200	0.006	0	0	0	0
IT00-002	IT00-002	IT00-004	200	0.005	0	1.33	0	0
IT00-004	IT00-004	IT00-006	262	0.013	0	0	0	0
IT00-006	IT00-006	IT00-008	306	0.013	0	0	0	0
IT00-008	IT00-008	IT00-010	350	0.013	0	0	0	0
IT00-010	IT00-010	IT00-012	435	0.013	0	0	0	0
IT00-012	IT00-012	IT00-014	291	0.013	0	0	0	0
IT00-014	IT00-014	IT00-016	200	0.009	0	0	0	0
IT00-016	IT00-016	IT00-018	200	0.01	0	0	0	0
IT00-018	IT00-018	IT00-022	316	0.016	0	0	0	0
IT00-022	IT00-022	IT03-000	385	0.016	0	0	0	0
IT03-000	IT03-000	IT03-004	302	0.016	0	0	0	0
IT03-004	IT03-004	IT03-006	236	0.015	0	0	0	0
IT03-006	IT03-006	IT03-008	263	0.015	0	0	0	0
IT03-008	IT03-008	IT03-010	223	0.015	0	0	0	0
IT03-010	IT03-010	IT03-012	240	0.015	0	0	0	0
IT03-012	IT03-012	IT03-014	207	0.015	0	0	0	0

IT03-014	IT03-014	IT03-016	213	0.015	0	0	0	0
IT03-016	IT03-016	IT04-000	237	0.015	0	0	0	0
IT04-000	IT04-000	IT05-000	200	0.008	0	0	0	0
IT05-000	IT05-000	IT05-004	501	0.016	0	0	0	0
IT05-004	IT05-004	IT06-000	277	0.015	0	0	0	0
IT06-000	IT06-000	IT06-004	304	0.016	0.03	0	0	0
IT06-004	IT06-004	IT06-006	261	0.015	0	0	0	0
IT06-006	IT06-006	IT06-008	255	0.015	0.05	0	0	0
IT06-008	IT06-008	IT07-000	357	0.016	0	0	0	0
IT07-000	IT07-000	IT07-004	395	0.016	0	0	0	0
IT07-004	IT07-004	IT07-006	255	0.015	0	0	0	0
IT07-006	IT07-006	IT07-012	402	0.017	0	0	0	0
IT07-012	IT07-012	IT08-000	200	0.007	0	0.8	0	0
IT08-000	IT08-000	IT09-000	831	0.016	0	0.02	0	0
IT09-000	IT09-000	IT10-000	200	0.006	0	0	0	0
IT10-000	IT10-000	IT10-002	252	0.015	0	0	0	0
IT10-002	IT10-002	IT10-004	226	0.015	0	0.02	0	0
IT10-004	IT10-004	IT11-000	283	0.013	0	0	0	0
IT11-000	IT11-000	IT11-002	250	0.013	0	0	0	0
IT11-002	IT11-002	IT11-004	267	0.013	0	0	0	0
IT11-004	IT11-004	IT13-000	250	0.013	0	0	0	0
IT13-000	IT13-000	IT13-002	269	0.013	0	0	0	0
IT13-002	IT13-002	IT13-004	316	0.013	0	0	0	0
IT13-004	IT13-004	IT13-006	218	0.013	0	0	0	0
IT13-006	IT13-006	IT13-008	929	0.013	0	0	0	0
IT13-008	IT13-008	IT13-012	429	0.014	0	0	0	0
IT13-012	IT13-012	IT13-014	251	0.013	0	0	0	0
IT13-014	IT13-014	IT13-016	389	0.013	0	0	0	0
IT13-016	IT13-016	IT14-000	200	0.013	0	0	0	0
IT14-000	IT14-000	IT14-004	235	0.014	0	0	0	0
IT14-004	IT14-004	IT15-000	705	0.013	0	0	0	0
IT15-000	IT15-000	IT15-004	293	0.014	0	0	0	0
IT15-004	IT15-004	IT15-006	227	0.013	0	0	0	0
IT15-006	IT15-006	IT15-010	373	0.014	0	0	0	0
IT15-010	IT15-010	IT15-012	440	0.013	0	0	0	0
IT15-012	IT15-012	IT15-014	400	0.013	0	0	0	0
IT15-014	IT15-014	IT15-018	536	0.014	0	0	0	0
IT15-018	IT15-018	IT15-022	345	0.014	0	0	0	0
IT15-022	IT15-022	IT15-024	603	0.013	0	0	0	0
IT15-024	IT15-024	R18	350	0.014	0	0.03	0	0
J10	J10	J12	1117	0.04	0	0	0	0
J12	J12	J13	489	0.04	0	0	0	0
J13	J13	J14	726	0.04	0	0	0	0
J14	J14	J16	1017	0.04	0	0	0	0
J16	J16	J18	888	0.04	0	0	0	0
J18	J18	J20	1385	0.04	0	0	0	0
J2	J2	J3A	90	0.04	0	0	0	0
J20	J20	MS53	191	0.04	0	0	0	0

J3A	J3A	J3B	308	0.04	0	0	0	0
J3B	J3B	J3C	630	0.04	0	0	0	0
J3C	J3C	J3D	920	0.04	0	0	0	0
J3D	J3D	J4	280	0.04	0	0	0	0
J4	J4	J6	1352	0.04	0	0	0	0
J6	J6	J7	1575	0.04	0	0	0	0
J7	J7	J8	207	0.04	0	0	0	0
J8	J8	J9	896	0.04	0	0	0	0
J9	J9	J10	293	0.04	0	0	0	0
K2	K2	K4	669	0.04	0	0	0	0
K4	K4	I7	860	0.04	0	0	0	0
L2	L2	L4	1461	0.04	0	0	0	0
L4	L4	MS13	605	0.04	0	0	0	0
M2	M2	M4	1497	0.04	0	0	0	0
M4	M4	H7	254	0.04	0	0	0	0

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MC_1	MC_1	TR15-408	500	0.013	0	1	0	1.5
MC_2	MC_2	IT00-000	500	0.013	0	1	0	24
MR10	MR10	MR12	758	0.04	0	0	0	0
MR12	MR12	MS45	630	0.04	0	0	0	0
MR2	MR2	MR4	871	0.04	0	0	0	0
MR4	MR4	MR6	1210	0.04	0	0	0	0
MR6	MR6	MR8	931	0.04	0	0	0	0
MR8	MR8	MR10	848	0.04	0	0	0	0
MS10	MS10	MS12	896	0.04	0	0	0	0
MS12	MS12	MS13	354	0.04	0	0	0	0
MS13	MS13	MS14	1555	0.04	0	0	0	0
MS14	MS14	MS16	746	0.04	0	0	0	0
MS16	MS16	MS18	941	0.04	0	0	0	0
MS18	MS18	MS20	1550	0.04	0	0	0	0
MS2	MS2	MS4	1512	0.04	0	0	0	0
MS20	MS20	MS21	604	0.04	0	0	0	0
MS21	MS21	MS22	366	0.04	0	0	0	0
MS22	MS22	MS24	1058	0.04	0	0	0	0
MS24	MS24	MS26	1305	0.04	0	0	0	0
MS26	MS26	MS28	873	0.04	0	0	0	0
MS28	MS28	MS30	1250	0.04	0	0	0	0
MS30	MS30	MS32	1775	0.04	0	0	0	0
MS32	MS32	MS34	1310	0.04	0	0	0	0
MS34	MS34	MS36	820	0.04	0	0	0	0
MS36	MS36	MS37	1482	0.04	0	0	0	0
MS37	MS37	MS38	766	0.04	0	0	0	0
MS38	MS38	MS40	1763	0.04	0	0	0	0
MS4	MS4	MS6	850	0.04	0	0	0	0
MS40	MS40	MS42	1829	0.04	0	0	0	0
MS42	MS42	MS44	1906	0.04	0	0	0	0
MS44	MS44	MS45	326	0.04	0	0	0	0
MS45	MS45	MS46	700	0.04	0	0	0	0
MS46	MS46	MS50	828	0.04	0	0	0	0

MS50	MS50	MS52	1050	0.04	0	0	0	0
MS52	MS52	MS53	223	0.04	0	0	0	0
MS53	MS53	MS54	555	0.04	0	0	0	0
MS54	MS54	MS56	950	0.04	0	0	0	0
MS56	MS56	MS57	1330	0.04	0	0	0	0
MS57	MS57	MS58	295	0.04	0	0	0	0
MS58	MS58	MS59	1617	0.04	0	0	0	0
MS59	MS59	MS60	606	0.04	0	0	0	0
MS6	MS6	MS8	1590	0.04	0	0	0	0
MS60	MS60	MS62	1182	0.04	0	0	0	0
MS62	MS62	MS66	827	0.04	0	0	0	0
MS66	MS66	MS70	696	0.04	0	0	0	0
MS70	MS70	MS72	1052	0.04	0	0	0	0
MS72	MS72	MS73	476	0.04	0	0	0	0
MS73	MS73	MS74	1146	0.04	0	0	0	0
MS74	MS74	TF-32061	883	0.04	0	0	0	0
MS8	MS8	MS10	735	0.04	0	0	0	0
N2	N2	N3	762	0.04	0	0	0	0
N3	N3	N4	218	0.04	0	0	0	0
N4	N4	MS73	408	0.04	0	0	0	0
OF03-000	OF03-000	OF03-004	200	0.0145	0	0	0	0
OF03-004	OF03-004	OF03-006	200	0.013	0	0	0	0
OF03-006	OF03-006	TF-13898	200	0.0058	0	0	0	0
OF04-000	OF04-000	TF-12973	200	0.0086	0	0	0	0
OF05-000	OF05-000	TF-12291	200	0.0034	0	0	0	0
OF06-000	OF06-000	TF-09856	200	0.017	0	0	0	0
OF07-000	OF07-000	TF-09856	200	0.0138	0	0	0	0
OF08-000	OF08-000	TF-09215	200	0.0089	0	0	0	0
OF09-000	OF09-000	OF09-002	200	0.0087	0	0	0	0
OF09-002	OF09-002	OF09-004	200	0.02	0.5	0.48	0	0
OF09-004	OF09-004	TF-08974	200	0.0087	0	0	0	0
OF10-000	OF10-000	TF-08911	200	0.0053	0	0	0	0
OF11-000	OF11-000	TF-08160	200	0.0085	0	0	0	0
OF12-000	OF12-000	OF12-002	200	0.015	0	0	0	0
OF12-002	OF12-002	OF12-006	200	0.016	0	0	0	0
OF12-006	OF12-006	OF12-008	200	0.0085	0	0	0	0
OF12-008	OF12-008	OF12-012	200	0.014	0	0	0	0
OF12-012	OF12-012	OF12-014	200	0.013	0	0	0	0
OF12-014	OF12-014	OF12-016	200	0.013	0	0	0	0
OF12-016	OF12-016	OF12-020	200	0.014	0	0	0	0
OF12-020	OF12-020	TF-05871	200	0.014	0	0	0	0
OF13-000	OF13-000	OF13-002	200	0.013	0	0	0	0
OF13-002	OF13-002	OF13-004	200	0.013	0	0	0	0
OF13-004	OF13-004	OF13-006	200	0.013	0	0	0	0
OF13-006	OF13-006	OF13-008	200	0.013	0	0.02	0	0
OF13-008	OF13-008	OF13010	200	0.013	0	0	0	0
OF13010W1	OF13010	OF13-012	200	0.0101	7.83	8.01	0	0
OF13010W2	OF13010	OF13-014	200	0.0287	0.5	0.68	0	0

OF13-012	OF13-012	TF-05301	200	0.016	0	0	0	0
OF13-014	OF13-014	TF-05301	200	0.016	0	0	0	0
OR15-000	R15B	OR15-002	392	0.013	0	0	0	0
OR15-002	OR15-002	OR15-004	223	0.013	0	0	0	0
OR15-004	OR15-004	OR15-012	2230	0.013	0	0	0	0
OR15-012	OR15-012	OR15-016	2228	0.013	0	0	0	0
OR15-016	OR15-016	OR15-020	388	0.013	0	14.35	0	0
OR15-020	OR15-020	TF-28801	200	0.009	3	0	0	0
OR18-004	OR18-004	OR18-010	457	0.017	0	0	0	0
OR18-010	OR18-010	TF-10731	200	0.013	0	0	0	0
OT01-000	RT01-000	OT01-002	1405	0.013	0	0	0	0
OT01-002	OT01-002	H4	930	0.013	0	0	0	0
OT04-002	OT04-002	TF-28031	200	0.005	0	0	0	0
OT05-002	OT05-002	OT05-004	200	0.01	0	0	0	0
OT05-004	OT05-004	TF-27966	205	0.015	0	0	0	0
OT06-000	OT06-000	OT06-002	200	0.0053	0	0	0	0
OT06-002	OT06-002	TF-27181	200	0.0119	0	0	0	0
OT09-002	OT09-002	OT09-004	200	0.008	0	0	0	0
OT09-004	OT09-004	TF-24337	200	0.008	0	0	0	0
R15	R15	TT08-195	767	0.015	0	0	0	0
R15W	R15	R15B	200	0.0452	2	0.98	0	0
R18DWO	R18	IR18-002	200	0.01	0	0.14	0	0
R18EW	R18	R18W1	200	0.012	6.8	6.78	0	0
R18W	R18W1	OR18-004	240	0.016	0	3	0	0
RF14-000	RF14-000	OF13-002	200	0.0091	0	1.86	0	0
RT03-000	RT03-000	TF-30221	200	0.01	0	0	0	0
RT04-000	RT04-000	OT04-002	200	0.004	0	0	0	0
RT05-000	RT05-000	OT05-002	200	0.008	0	0	0	0
RT07-000	RT07-000	TF-25907	200	0.014	0	0	0	0
RT08-000	RT08-000	TF-24437	500	0.004	0	0	0	0
RT09-000	RT09-000	OT09-002	200	0.008	0	0	0	0
RT10-000	RT10-000	TF-24337	200	0.014	0	0	0	0
RT11-000	RT11-000	TF-23161	200	0.006	0	0	0	0
RT12-000	RT12-000	TF-22586	200	0.008	0	0	0	0
RT13-000	RT13-000	TF-22476	200	0.009	0	0	0	0
RT14-000	T14	CT14-000	200	0.014	0	5.09	0	0
RT14-000A	RT14-000	TF-18081	500	0.006	0	0	0	0
RT15-000	RT15-000	TF-18081	437	0.013	0	0	0	0
T01W	T01	RT01-000	200	0.0256	1.125	1.07	0	0
T03DWO	T03	IT03-000	362	0.016	0	1.9	0	0
T03W	T03	RT03-000	200	0.0214	3.54	0.6	0	0
T04DWO	T04	CT04-002	200	0.0089	0	1.13	0	0
T04W	T04	RT04-000	200	0.0184	2.7	0	0	0
T05DWO	T05	CT05-004	200	0.0158	0	0	0	0
T05W	T05	RT05-000	200	0.0168	3.13	0.36	0	0
T06DWO	T06	CT06-000	200	0.0104	0	1.2	0	0
T06W	T06	OT06-000	200	0.0287	3.08	2.16	0	0
T07DWO	T07	CT07-004	200	0.0141	0	0.2	0	0

T07W	T07	RT07-000	200	0.0152	2.46	0.31	0	0
T08DWO	T08	CT08-000	200	0.0104	0	2.24	0	0
T08W	T08	RT08-000	200	0.0479	2	1.98	0	0
T09DWO	T09	IT09-000	200	0.0145	0	22.8	0	0
T09W	T09	RT09-000	200	0.0184	2.37	0.07	0	0
T10DWO	T10	CT10-004	354	0.0148	0	0	0	0
T10W	T10	RT10-000	200	0.0214	3.08	0	0	0
T11DWO	T11	CT11-002	200	0.0082	0	0	0	0
T11W	T11	RT11-000	200	0.0152	2.24	0.27	0	0
T12DWO	T12	IT13-000	274	0.0169	0	2.76	0	0
T12W	T12	RT12-000	200	0.0135	1.61	0.42	0	0
T13DWO	T13	IT13-000	200	0.0103	0	2.51	0	0
T13W	T13	RT13-000	200	0.0188	3.12	0.61	0	0
T14DWO	T14	CT14-000	200	0.014	0	5.09	0	0
T14W	T14	RT14-000	200	0.0657	3	2.98	0	0
T15DWO	T15	IT15-000	200	0.0115	0	6.4	0	0
T15W	T15	RT15-000	200	0.0279	4.41	0.73	0	0
TF-00200	TF-00200	TF-00000	200	0.015	0	0	0	0
TF-00350	TF-00350	TF-00200	200	0.015	0	0	0	0
TF-00368	TF-00368	TF-00350	200	0.015	15.5	15.5	0	0
TF-00518	TF-00518	TF-00368	200	0.015	0	0	0	0
TF-00780	TF-00780	TF-00518	262	0.015	0	0	0	0
TF-00940	TF-00940	TF-00780	200	0.015	0	0	0	0
TF-00973	TF-00973	TF-00940	200	0.015	18.5	18.5	0	0
TF-01133	TF-01133	TF-00973	200	0.015	0	0	0	0
TF-02905	TF-02905	TF-01133	1772	0.015	0	0	0	0
TF03-108	TF03-108	F03	950	0.018	0	2.5	0	0
TF03-116	TF03-116	TF03-108	731	0.018	0	0	0	0
TF03-124	TF03-124	TF03-116	912	0.018	0	0	0	0
TF03-130	TF03-130	TF03-124	945	0.018	0	0	0	0
TF03-132	TF03-132	TF03-130	293	0.015	0	0	0	0
TF-03135	TF-03135	TF-02905	230	0.015	0	0	0	0
TF03-136	TF03-136	TF03-132	329	0.016	0	0	0	0
TF03-138	TF03-138	TF03-136	410	0.015	0	0	0	0
TF-03285	TF-03285	TF-03135	200	0.015	0	0	0	0
TF-03347	TF-03347	TF-03285	200	0.015	24.3	24.3	0	0
TF-03497	TF-03497	TF-03347	200	0.015	0	0	0	0
TF-03605	TF-03605	TF-03497	200	0.015	0	0	0	0
TF-03755	TF-03755	TF-03605	200	0.015	0	0	0	0
TF-03800	TF-03800	TF-03755	200	0.015	21.3	21.3	0	0
TF-03950	TF-03950	TF-03800	200	0.015	0	0	0	0
TF-03975	TF-03975	TF-03950	200	0.015	0	0	0	0
TF04-102	TF04-102	F04	200	0.0125	0	0.49	0	0
TF04-108	TF04-108	TF04-102	625	0.017	0	0	0	0
TF04-115	TF04-115	TF04-108	730	0.018	0	0	0	0
TF04-120	TF04-120	TF04-115	476	0.017	0	0	0	0
TF04-122	TF04-122	TF04-120	462	0.014	0	0	0	0
TF04-124	TF04-124	TF04-122	350	0.014	0	1.84	0	0

TF-04125	TF-04125	TF-03975	200	0.015	0	0	0	0
TF04-125	TF04-125	TF04-124	200	0.0114	0	1.84	0	0
TF04-128	TF04-128	TF04-125	591	0.014	0	1.46	0	0
TF04-136	TF04-136	TF04-128	734	0.018	0	0	0	0
TF04-138	TF04-138	TF04-136	200	0.0079	0	0	0	0
TF04-140	TF04-140	TF04-138	222	0.015	0	0	0	0
TF-04177	TF-04177	TF-04125	200	0.015	22.7	22.7	0	0
TF-04239	TF-04239	TF-04177	200	0.015	0	0	0	0
TF-04301	TF-04301	TF-04239	200	0.015	0	0	0	0
TF-04406	TF-04406	TF-04301	200	0.015	18.1	18.1	0	0
TF-04556	TF-04556	TF-04406	200	0.015	0	0	0	0
TF05-108	TF05-108	F05	500	0.018	0	0.13	0	0
TF05-114	TF05-114	TF05-108	447	0.017	0	0	0	0
TF-05301	TF-05301	TF-04556	745	0.015	0	0	0	0
TF-05451	TF-05451	TF-05301	200	0.015	0	0	0	0
TF-05469	TF-05469	TF-05451	200	0.015	17.7	17.7	0	0
TF-05619	TF-05619	TF-05469	200	0.015	0	0	0	0
TF-05621	TF-05621	TF-05619	200	0.015	0	0	0	0
TF-05771	TF-05771	TF-05621	200	0.015	0	0	0	0
TF-05871	TF-05871	TF-05771	200	0.015	18.8	18.8	0	0
TF06-006	TF06-006	F06	200	0.0138	0	0.31	0	0
TF06-008	TF06-008	TF06-006	298	0.015	0	0	0	0
TF06-012	TF06-012	TF06-008	611	0.016	0	0	0	0
TF06-014	TF06-014	TF06-012	300	0.015	0	0	0	0
TF06-020	TF06-020	TF06-014	862	0.017	0	0	0	0
TF-06021	TF-06021	TF-05871	200	0.015	0	0	0	0
TF07-106	TF07-106	F07	307	0.017	0	0.13	0	0
TF07-110	TF07-110	TF07-106	445	0.016	0	0	0	0
TF07-114	TF07-114	TF07-110	460	0.016	0	0	0	0
TF07-120	TF07-120	TF07-114	624	0.017	0	0	0	0
TF07-128	TF07-128	TF07-120	1140	0.018	0	0	0	0
TF-07706	TF-07706	TF-06021	1685	0.015	0	0	0	0
TF-07826	TF-07826	TF-07706	200	0.015	0	0	0	0
TF-07842	TF-07842	TF-07826	200	0.015	13.5	13.5	0	0
TF-07962	TF-07962	TF-07842	200	0.015	0	0	0	0
TF-07966	TF-07966	TF-07962	200	0.015	0	0	0	0
TF-08086	TF-08086	TF-07966	200	0.015	0	0	0	0
TF08-106	TF08-106	F08	512	0.017	0	0.02	0	0
TF-08160	TF-08160	TF-08086	200	0.015	30.5	30.5	0	0
TF08-210	TF08-210	F08	881	0.019	0	1.97	0	0
TF08-212	TF08-212	TF08-210	200	0.0074	0	0	0	0
TF-08280	TF-08280	TF-08160	200	0.015	0	0	0	0
TF-08346	TF-08346	TF-08280	200	0.015	0	0	0	0
TF-08831	TF-08831	TF-08346	485	0.015	0	0	0	0
TF-08911	TF-08911	TF-08831	200	0.015	0	0	0	0
TF-08974	TF-08974	TF-08911	200	0.015	20.2	20.2	0	0
TF-09054	TF-09054	TF-08974	200	0.015	0	0	0	0
TF-09061	TF-09061	TF-09054	200	0.015	0	0	0	0

TF09-108	TF09-108	F09	543	0.018	0	0.46	0	0
TF-09141	TF-09141	TF-09061	200	0.015	0	0	0	0
TF-09215	TF-09215	TF-09141	200	0.015	18.7	18.7	0	0
TF-09261	TF-09261	TF-09215	200	0.015	0	0	0	0
TF-09311	TF-09311	TF-09261	200	0.015	2.88	0	0	0
TF-09361	TF-09361	TF-09311	200	0.015	0	0	0	0
TF-09856	TF-09856	TF-09361	495	0.015	0	0	0	0
TF-09886	TF-09886	TF-09856	200	0.015	0	0	0	0
TF-09946	TF-09946	TF-09886	200	0.015	0	0	0	0
TF-10001	TF-10001	TF-09946	200	0.015	24.5	24.5	0	0
TF-10061	TF-10061	TF-10001	200	0.015	0	0	0	0
TF10-102	TF10-102	F10	200	0.0107	0	1.17	0	0
TF10-108	TF10-108	TF10-102	526	0.017	0	0.03	0	0
TF10-110	TF10-110	TF10-108	243	0.015	0	0	0	0
TF10-112	TF10-112	TF10-110	200	0.0111	0	0	0	0
TF10-118	TF10-118	TF10-112	387	0.017	0	0	0	0
TF10-124	TF10-124	TF10-118	350	0.017	0	0	0	0
TF10-132	TF10-132	TF10-124	485	0.018	0	0	0	0
TF-10561	TF-10561	TF-10061	500	0.015	0	0	0	0
TF-10681	TF-10681	TF-10561	200	0.015	0	0	0	0
TF-10706	TF-10706	TF-10681	200	0.015	0	0	0	0
TF-10731	TF-10731	TF-10706	200	0.015	0	0	0	0
TF11-104	TF11-104	F11	570	0.014	0	0.24	0	0
TF11-108	TF11-108	TF11-104	390	0.014	0	0	0	0
TF11-116	TF11-116	TF11-108	405	0.018	0	0	0	0
TF11-124	TF11-124	TF11-116	685	0.018	0	0	0	0
TF11-132	TF11-132	TF11-124	700	0.018	0	0	0	0
TF11-140	TF11-140	TF11-132	641	0.018	0	0	0	0
TF11-144	TF11-144	TF11-140	387	0.016	0	0	0	0
TF11-152	TF11-152	TF11-144	728	0.018	0	0	0	0
TF11-160	TF11-160	TF11-152	465	0.018	0	0	0	0
TF11-168	TF11-168	TF11-160	705	0.018	0	0	0	0
TF11-174	TF11-174	TF11-168	332	0.017	0	0	0	0
TF11-176	TF11-176	TF11-174	200	0.0098	0	0	0	0
TF-11251	TF-11251	TF-10731	520	0.015	13.2	13.2	0	0
TF-11311	TF-11311	TF-11251	200	0.015	0	0	0	0
TF12-104	TF12-104	F12	485	0.016	0	1.97	0	0
TF12-106	TF12-106	TF12-104	215	0.015	0	0	0	0
TF12-110	TF12-110	TF12-106	464	0.016	0	0	0	0
TF-12291	TF-12291	TF-11311	980	0.015	0	0	0	0
TF-12851	TF-12851	TF-12291	560	0.015	0	0	0	0
TF-12911	TF-12911	TF-12851	200	0.015	0	0	0	0
TF-12973	TF-12973	TF-12911	200	0.015	15.2	15.2	0	0
TF-13033	TF-13033	TF-12973	200	0.015	0	0	0	0
TF13-106	TF13-106	F13	521	0.015	0	0.84	0	0
TF13-110	TF13-110	TF13-106	295	0.016	0	0	0	0
TF13-118	TF13-118	TF13-110	505	0.018	0	0	0	0
TF13-122	TF13-122	TF13-118	247	0.016	0	0	0	0

TF-13405	TF-13405	TF-13033	372	0.015	0	0	0	0
TF-13776	TF-13776	TF-13405	371	0.015	0	0	0	0
TF-13836	TF-13836	TF-13776	200	0.015	0	0	0	0
TF-13898	TF-13898	TF-13836	200	0.015	28.9	30.2	0	0
TF-13958	TF-13958	TF-13898	200	0.015	0	0	0	0
TF-14039	TF-14039	TF-13958	200	0.015	0	0	0	0
TF14-105	TF14-105	F14	501	0.017	0	0.89	0	0
TF14-106	TF14-106	TF14-105	200	0.0132	0	0	0	0
TF-14120	TF-14120	TF-14039	200	0.015	0	0	0	0
TF-14201	TF-14201	TF-14120	200	0.015	0	0	0	0
TF-14282	TF-14282	TF-14201	200	0.015	0	0	0	0
TF-14363	TF-14363	TF-14282	200	0.015	0	0	0	0
TF-14444	TF-14444	TF-14363	200	0.015	0	0	0	0
TF-14544	TF-14544	TF-14444	200	0.015	0	0	0	0
; *C1	'TFB-14561'	'TF-14561'	'TF-14544'	0.015	12 0	0	0	200
0 0	0 14561	0.001						
TF-14561	TF-14561	TF-14544	200	0.015	16.78	16.8	0	0
TF-14561A	TF-14561A	TF-14561B	200	0.015	2.5	5.84	0	0
TF-14561B	TF-14561B	TF-14561	200	0.015	0	0	0	0
TF-14601	TF-14601	TF-14561A	200	0.015	0	0	0	0
TF-15181	TF-15181	TF-14601	580	0.015	0	0	0	0
TF-15291	TF-15291	TF-15181	200	0.015	0	0	0	0
TF-15304	TF-15304	TF-15291	200	0.015	15.6	15.6	0	0
TF-15414	TF-15414	TF-15304	200	0.015	0	0	0	0
TF-15861	TF-15861	TF-15414	447	0.015	0	0	0	0
TF-18081	TF-18081	TF-15861	2220	0.015	0	0	0	0
TF-18956	TF-18956	TF-18081	875	0.015	0	0	0	0
TF-19026	TF-19026	TF-18956	200	0.015	0	0	0	0
TF-19057	TF-19057	TF-19026	200	0.015	17	17	0	0
TF-19127	TF-19127	TF-19057	200	0.015	0	0	0	0
TF1B08160	TF-08160	TF-08086	200	0.05	0	0	0	0
TF-20596	TF-20596	TF-19127	1469	0.015	0	0	0	0
TF-21926	TF-21926	TF-20596	1330	0.015	0	0	0	0
TF-22026	TF-22026	TF-21926	200	0.015	0	0	0	0
TF-22039	TF-22039	TF-22026	200	0.015	0	0	0	0
TF-22139	TF-22139	TF-22039	200	0.015	0	0	0	0
TF-22376	TF-22376	TF-22139	237	0.015	0	0	0	0
TF-22476	TF-22476	TF-22376	200	0.015	0	0	0	0
TF-22586	TF-22586	TF-22476	200	0.015	0	0	0	0
TF-22686	TF-22686	TF-22586	200	0.015	0	0	0	0
TF-23161	TF-23161	TF-22686	475	0.015	0	0	0	0
TF-23971	TF-23971	TF-23161	810	0.015	0	0	0	0
TF-24071	TF-24071	TF-23971	200	0.015	0	0	0	0
TF-24337	TF-24337	TF-24071	266	0.015	0	0	0	0
TF-24437	TF-24437	TF-24337	200	0.015	0	0	0	0
TF-25391	TF-25391	TF-24437	954	0.015	0	0	0	0
TF-25711	TF-25711	TF-25391	320	0.015	0	0	0	0
TF-25841	TF-25841	TF-25711	200	0.015	0	0	0	0
TF-25907	TF-25907	TF-25841	200	0.015	16	16	0	0

TF-26037	TF-26037	TF-25907	200	0.015	0	0	0	0
TF-27181	TF-27181	TF-26037	1144	0.015	0	0	0	0
TF-27281	TF-27281	TF-27181	200	0.015	2.8	1.8	0	0
TF-27356	TF-27356	TF-27281	200	0.015	0	0	0	0
TF-27966	TF-27966	TF-27356	610	0.015	0	0	0	0
TF-28031	TF-28031	TF-27966	200	0.015	0	0	0	0
TF-28100	TF-28100	TF-28031	200	0.015	21	21	0	0
TF-28101	TF-28101	TF-28100	200	0.015	0	0	0	0
TF-28165	TF-28165	TF-28101	200	0.015	0	0	0	0
TF-28801	TF-28801	TF-28165	636	0.015	0	0	0	0
TF-29001	TF-29001	TF-28801	200	0.015	0	0	0	0
TF-29061	TF-29061	TF-29001	200	0.015	0	0	0	0
TF-29218	TF-29218	TF-29061	159	0.015	56.7	56.7	0	0
TF-29278	TF-29278	TF-29218	200	0.015	0	0	0	0
TF2B08160	TF-08160	TF-08086	200	0.05	0	0	0	0
TF-30221	TF-30221	TF-29278	943	0.015	0	0	0	0
TF-30301	TF-30301	TF-30221	200	0.015	0	0	0	0
TF-30328	TF-30328	TF-30301	200	0.015	13.2	13.2	0	0
TF-30408	TF-30408	TF-30328	200	0.015	0	0	0	0
TF-30411	TF-30411	TF-30408	200	0.015	0	0	0	0
TF-30486	TF-30486	TF-30411	200	0.015	1.6	0	0	0
TF-30666	TF-30666	TF-30486	200	0.015	0	0	0	0
TF-32061	TF-32061	TF-30666	1395	0.015	0	0	0	0
TFB-00368	TF-00368	TF-00350	200	0.045	0	0	0	0
TFB-00973	TF-00973	TF-00940	200	0.045	0	0	0	0
TFB-03347	TF-03347	TF-03285	200	0.045	0	0	0	0
TFB-03800	TF-03800	TF-03755	200	0.045	0	0	0	0
TFB-04177	TF-04177	TF-03755	200	0.045	0	0	0	0
TFB-04406	TF-04406	TF-04301	200	0.045	0	0	0	0
TFB-05469	TF-05469	TF-05451	200	0.05	0	0	0	0
TFB-05871	TF-05871	TF-05771	200	0.045	0	0	0	0
TFB-07842	TF-07842	TF-07826	200	0.048	0	0	0	0
TFB-08974	TF-08974	TF-08911	200	0.045	0	0	0	0
TFB-09215	TF-09215	TF-09141	200	0.045	0	0	0	0
TFB-10001	TF-10001	TF-09946	200	0.043	0	0	0	0
TFB-11251	TF-11251	TF-10731	520	0.038	0	0	0	0
TFB-12973	TF-12973	TF-12911	200	0.035	0	0	0	0

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;          *C1   'TFB-00368'    'TF-00368'     'TF-00350'     0        12    0         0     0       200
0          0     0        368   0.001    *C1   'TFB-00973'    'TF-00973'     'TF-00940'      0       12
0          0     0        200   0        0     0        973   0.001    *C1   'TFB-03347'     'TF-03347'
'TF-03285'       0        12    0        0     0        200   0        0     0        3347   0.001   *C1
'TFB-03800'      'TF-03800'     'TF-03755'     0        12    0        0     0        200    0       0
0          3800  0.001    *C1   'TFB-04177'    'TF-04177'     'TF-04125'     0        12     0       0
0          200   0        0     0        4177  0.001    *C1   'TFB-04406'    'TF-04406'      'TF-04301'
0          12    0        0     0        200   0        0     0        4406  0.001    *C1    'TFB-05469'
'TF-05469'       'TF-05451'     0        12    0        0     0        200   0        0
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TFB-13898	TF-13898	TF-13836	200	0.035	0.5	1.6	0	0
TFB-14561	TF-14561	TF-14544	200	0.035	0	0	0	0
TFB-15304	TF-15304	TF-15291	200	0.035	0	0	0	0
TFB-19057	TF-19057	TF-19026	200	0.035	0	0	0	0
TFB-25907	TF-25907	TF-25841	200	0.035	0	0	0	0
TFB-28100	TF-28100	TF-28031	200	0.035	0	0	0	0

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;       *C1     'TFB-15304'     'TF-15304'      'TF-15291'      0       12      0       0       0       200
0       0       0       15304   0.001   *C1     'TFB-19057'     'TF-19057'      'TF-19026'      0       12
0       0       0       200     0       0       0       19057   0.001   *C1     'TFB-25907'     'TF-25907'
'TF-25841'      0       12      0       0       0       200     0       0       0       25907   0.001   *C1
'TFB-28100'     'TF-28100'      'TF-28031'      0       12      0       0       0       200     0       0
0       28100   0.001
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TFB-29218A	TF-29218	TF-29061	159	0.045	0	0	0	0
TFB-29218B	TF-29218	TF-29061	159	0.045	3.3	3.3	0	0
TFB-30328A	TF-30328	TF-30301	200	0.033	0	0	0	0
TFB-30328B	TF-30328	TF-30301	200	0.033	0.8	0.8	0	0
TFB-30328C	TF-30328	TF-30301	200	0.033	0.8	0.8	0	0
TR15-104	TR15-104	R15	200	0.014	0	0	0	0
TR15-106	TR15-106	TR15-104	235	0.015	0	0	0	0
TR15-110	TR15-110	TR15-106	392	0.015	0	0	0	0
TR15-120	TR15-120	TR15-110	1163	0.015	0.5	0	0	0
TR15-136	TR15-136	TR15-120	2007	0.013	0	0	0	0
TR15-148	TR15-148	TR15-136	1450	0.013	0	0	0	0
TR15-154	TR15-154	TR15-148	745	0.013	0	0	0	0
TR15-156	TR15-156	TR15-154	349	0.013	0	0	0	0
TR15-158	TR15-158	TR15-156	276	0.013	0	0	0	0
TR15-162	TR15-162	TR15-158	452	0.013	0	0	0	0
TR15-164	TR15-164	TR15-162	200	0.012	0	0	0	0
TR15-166	TR15-166	TR15-164	292	0.013	0	0	0	0
TR15-168	TR15-168	TR15-166	205	0.013	0	0	0	0
TR15-172	TR15-172	TR15-168	424	0.013	0	0	0	0
TR15-174	TR15-174	TR15-172	200	0.01	0	0	0	0
TR15-182	TR15-182	TR15-174	1185	0.013	0	0	0	0
TR15-190	TR15-190	TR15-182	1145	0.013	0	0	0	0
TR15-204	TR15-204	TR15-190	1630	0.013	0	0	0	0
TR15-208	TR15-208	TR15-204	520	0.013	0	0	0	0
TR15-210	TR15-210	TR15-208	325	0.013	0	0	0	0
TR15-212	TR15-212	TR15-210	300	0.015	0	0	0	0
TR15-214	TR15-214	TR15-212	230	0.015	0	0	0	0
TR15-216	TR15-216	TR15-214	360	0.015	0	0	0	0
TR15-218	TR15-218	TR15-216	290	0.015	0	0	0	0
TR15-220	TR15-220	TR15-218	280	0.015	0	0	0	0
TR15-222	TR15-222	TR15-220	300	0.015	0	0	0	0
TR15-224	TR15-224	TR15-222	310	0.015	0	0	0	0
TR15-234	TR15-234	TR15-224	1180	0.013	0	0	0	0
TR15-240	TR15-240	TR15-234	825	0.013	0	0	0	0
TR15-250	TR15-250	TR15-240	500	0.013	0	0	0	0
TR15-264	TR15-264	TR15-250	1333	0.013	0	0	0	0
TR15-302	TR15-302	TR15-120	135	0.015	0	0	0	0
TR15-304	TR15-304	TR15-302	235	0.015	0	0	0	0
TR15-306	TR15-306	TR15-304	230	0.015	0	0	0	0
TR15-308	TR15-308	TR15-306	400	0.015	0	0	0	0
TR15-310	TR15-310	TR15-308	200	0.0053	0	0	0	0
TR15-312	TR15-312	TR15-310	200	0.00411	0	0	0	0
TR15-314	TR15-314	TR15-312	94	0.013	0	0	0	0
TR15-316	TR15-316	TR15-314	200	0.013	0	0	0	0
TR15-318	TR15-318	TR15-316	182	0.013	0	0	0	0

TR15-320	TR15-320	TR15-318	308	0.013	0	0	0	0
TR15-322	TR15-322	TR15-320	705	0.013	0	0	0	0
TR15-324	TR15-324	TR15-322	435	0.013	0	0	0	0
TR15-326	TR15-326	TR15-324	385	0.013	0	0	0	0
TR15-328	TR15-328	TR15-326	470	0.013	0	0	0	0
TR15-330	TR15-330	TR15-328	467	0.013	0	0	0	0
TR15-332	TR15-332	TR15-330	510	0.013	0	0	0	0
TR15-336	TR15-336	TR15-332	256.7	0.013	0	0	0	0
TR15-338	TR15-338	TR15-336	231	0.013	0	0	0	0
TR15-340	TR15-340	TR15-338	189	0.013	0	0	0	0
TR15-340B	TR15-340B	TR15-338	36	0.013	0	1.29	0	0
TR15-341	TR15-341	TR15-340	50	0.013	0	0	0	0
TR15-342	TR15-342	TR15-341	196.27	0.013	0	0	0	0
TR15-342B	TR15-342B	TR15-340B	200	0.00379	0	1.39	0	0
TR15-344	TR15-344	TR15-342	250.44	0.013	0	0	0	0
TR15-344B	TR15-344B	TR15-342B	231.73	0.013	0	0.3	0	0
TR15-346	TR15-346	TR15-344	87.42	0.013	0	0	0	0
TR15-346B	TR15-346B	TR15-344B	186.83	0.013	0	0	0	0
TR15-348	TR15-348	TR15-346	315	0.013	0	0	0	0
TR15-348B	TR15-348B	TR15-346B	180	0.013	0	0	0	0
TR15-350	TR15-350	TR15-348	265	0.013	0	0	0	0
TR15-350B	TR15-350B	TR15-348B	171.4	0.013	0	0	0	0
TR15-351B	TR15-351B	TR15-350B	200	0.00344	0	0	0	0
TR15-352	TR15-352	TR15-350	67	0.013	0	0.16	0	0
TR15-352B	TR15-352B	TR15-351B	185	0.013	0	0	0	0
TR15-354	TR15-354	TR15-352	407	0.013	0	0	0	0
TR15-354B	TR15-354B	TR15-352B	180	0.013	0	0	0	0
TR15-356	TR15-356	TR15-354	434	0.013	0	0	0	0
TR15-356B	TR15-356B	TR15-354B	186.8	0.013	0	0	0	0
TR15-358	TR15-358	TR15-356	194	0.013	0	0	0	0
TR15-358B	TR15-358B	TR15-356B	115	0.013	0	0	0	0
TR15-360	TR15-360	TR15-358	60	0.013	0	0	0	0
TR15-360B	TR15-360B	TR15-358B	103	0.013	0	0	0	0
TR15-362	TR15-362	TR15-360	65.5	0.013	0	0	0	0
TR15-362B	TR15-362B	TR15-360B	166	0.013	0	0	0	0
TR15-364	TR15-364	TR15-362	170.5	0.013	0	0	0	0
TR15-364B	TR15-364B	TR15-362B	200	0.013	0	0	0	0
TR15-366	TR15-366	TR15-364	184.5	0.013	0	0	0	0
TR15-366B	TR15-366B	TR15-364B	73.3	0.013	0	0	0	0
TR15-368	TR15-368	TR15-366	52.2	0.013	0	0	0	0
TR15-368B	TR15-368B	TR15-366B	225.7	0.013	0	0	0	0
TR15-370	TR15-370	TR15-368	143	0.013	0	0	0	0
TR15-370B	TR15-370B	TR15-368B	222.2	0.013	0	0	0	0
TR15-370C	TR15-370C	TR15-368	158	0.013	0	7.07	0	0
TR15-372	TR15-372	TR15-370	122	0.013	0	0	0	0
TR15-372C	TR15-372C	TR15-370C	160	0.013	0	0	0	0
TR15-374	TR15-374	TR15-372	200	0.00421	0	0	0	0
TR15-374C	TR15-374C	TR15-372C	122	0.013	0	0	0	0

TR15-376A	TR15-376A	TR15-374	204.5	0.013	0	7.07	0	0
TR15-376B	TR15-376B	TR15-374	150.9	0.013	0	7.33	0	0
TR15-376C	TR15-376C	TR15-374C	112	0.013	0	0	0	0
TR15-378A	TR15-378A	TR15-376A	181.5	0.013	0	0	0	0
TR15-378B	TR15-378B	TR15-376B	146.7	0.013	0	0	0	0
TR15-380A	TR15-380A	TR15-378A	75	0.013	0	0	0	0
TR15-380B	TR15-380B	TR15-378B	35	0.013	0	0	0	0
TR15-382A	TR15-382A	TR15-380A	216	0.013	0	0	0	0
TR15-382B	TR15-382B	TR15-380B	180	0.013	0	0	0	0
TR15-384A	TR15-384	TR15-382A	45	0.013	0	0	0	0
TR15-384B	TR15-384	TR15-382B	205.6	0.013	0	0	0	0
TR15-386	TR15-386	TR15-384	107	0.013	0	0	0	0
TR15-388	TR15-388	TR15-386	215	0.013	0	0	0	0
TR15-390	TR15-390	TR15-388	239	0.013	0	0	0	0
TR15-392	TR15-392	TR15-390	128	0.013	0	0	0	0
TR15-394	TR15-394	TR15-392	172	0.013	0	0	0	0
TR15-396	TR15-396	TR15-394	60	0.013	0	0	0	0
TR15-398	TR15-398	TR15-396	165	0.013	0	0	0	0
TR15-400	TR15-400	TR15-398	130	0.013	0	0	0	0
TR15-402	TR15-402	TR15-400	420	0.013	0	0	0	0
TR15-404	TR15-404	TR15-402	150	0.013	0	0	0	0
TR15-406	TR15-406	TR15-404	163	0.013	0	0	0	0
TR15-408	TR15-408	TR15-406	144	0.013	0	0	0	0
TR15-410	TR15-410	TR15-408	52	0.013	0	0	0	0
TR15-412	TR15-412	TR15-410	154	0.013	0	0	0	0
TR15-412A	TR15-412A	TR15-410	30	0.013	0	0	0	0
TR15-414	TR15-414	TR15-412	189	0.013	0	0	0	0
TR15-414A	TR15-414A	TR15-412A	150	0.013	0	0	0	0
TR15-416	TR15-416	TR15-414	215	0.013	0	0	0	0
TR15-418	TR15-418	TR15-416	44	0.013	0	0	0	0
TR15-420	TR15-420	TR15-418	209	0.013	0	0	0	0
TR15-422	TR15-422	TR15-420	193	0.013	0	0	0	0
TR15-424	TR15-424	TR15-422	41.3	0.013	0	0	0	0
TR15-426	TR15-426	TR15-424	235	0.013	0	0	0	0
TR15-428	TR15-428	TR15-426	147	0.013	0	0	0	0
TR15-430	TR15-430	TR15-428	232	0.013	0	0	0	0
TR15-432	TR15-432	TR15-430	217	0.013	0	0	0	0
TR15-434	TR15-434	TR15-432	157	0.013	0	0	0	0
TR15-436	TR15-436	TR15-434	193	0.013	0	0	0	0
TR15-438	TR15-438	TR15-436	263	0.013	0	0	0	0
TR15-600	TR15-600	TR15-312	175	0.013	0	0	0	0
TR15-602	TR15-602	TR15-600	200	0.0046	0	0	0	0
TR15-604	TR15-604	TR15-602	50	0.013	0	0	0	0
TR15-604A	TR15-604A	TR15-602	216	0.013	0	0	0	0
TR15-606	TR15-606	TR15-604	278	0.013	0	0	0	0
TR15-606A	TR15-606A	TR15-604A	240	0.013	0	0	0	0
TR15-608	TR15-608	TR15-606	264	0.013	0	0	0	0
TR15-608A	TR15-608A	TR15-606A	200	0.00305	0	0	0	0

TR15-610	TR15-610	TR15-608	200	0.013	0	0	0	0
TR15-610A	TR15-610A	TR15-608A	250	0.013	0	0	0	0
TR15-612	TR15-612	TR15-610	53	0.013	0	0	0	0
TR15-612A	TR15-612A	TR15-610A	192	0.013	0	0	0	0
TR15-614	TR15-614	TR15-612	267	0.013	0	0	0	0
TR15-614A	TR15-614A	TR15-612A	50	0.013	0	0	0	0
TR15-616	TR15-616	TR15-614	225	0.013	0	0	0	0
TR15-618	TR15-618	TR15-616	200	0.00528	0	0	0	0
TR15-702	TR15-702	TR15-310	50	0.013	0	0	0	0
TR15-704	TR15-704	TR15-702	235	0.013	0	0	0	0
TR15-706	TR15-706	TR15-704	182	0.013	0	0	0	0
TR15-708	TR15-708	TR15-706	105	0.013	0	0	0	0
TR15-710	TR15-710	TR15-708	70	0.013	0	0	0	0
TR15-712	TR15-712	TR15-710	230	0.013	0	0	0	0
TR15-714	TR15-714	TR15-712	227	0.013	0	0	0	0
TR15-716	TR15-716	TR15-714	210	0.013	0	0	0	0
TR15B1-360	TR15B1-360	TR15-358	30	0.013	0	0	0	0
TR15B1-362	TR15B1-362	TR15B1-360	200	0.013	0	0	0	0
TR15B1-364	TR15B1-364	TR15B1-362	198	0.013	0	0	0	0
TR15B1-366	TR15B1-366	TR15B1-364	186	0.013	0	0	0	0
TR15B1-368	TR15B1-368	TR15B1-366	150	0.013	0	0	0	0
TR15B1-370	TR15B1-370	TR15B1-368	151	0.013	0	0	0	0
TR15B1-372	TR15B1-372	TR15B1-370	153	0.013	0	0	0	0
TR15B1-374	TR15B1-374	TR15B1-372	128	0.013	0	0	0	0
TR15B1-376	TR15B1-376	TR15B1-374	125	0.013	0	0	0	0
TR15B1-378	TR15B1-378	TR15B1-376	125	0.013	0	0	0	0
TR15B1-380	TR15B1-380	TR15B1-378	133.4	0.013	0	0	0	0
TT01-112	TT01-112	T01	893	0.013	0	0	0	0
TT01-118	TT01-118	TT01-112	726	0.015	0	0	0	0
TT01-120	TT01-120	TT01-118	200	0.01	0	0	0	0
TT01-124	TT01-124	TT01-120	436	0.015	0	0	0	0
TT01-128	TT01-128	TT01-124	577	0.015	0	0	0	0
TT03-102	TT03-102	T03	200	0.006	0	2.79	0	0
TT03-104	TT03-104	TT03-102	210	0.013	0	0	0	0
TT03-106	TT03-106	TT03-104	261	0.013	0	0	0	0
TT03-108	TT03-108	TT03-106	243	0.013	0	0	0	0
TT03-112	TT03-112	TT03-108	601	0.015	0	0	0	0
TT03-116	TT03-116	TT03-112	472	0.015	0	0	0	0
TT03-202	TT03-202	TT03-102	200	0.013	0	0.41	0	0
TT03-204	TT03-204	TT03-202	289	0.013	0	12.74	0	0
TT03-206	TT03-206	TT03-204	270	0.013	0	0	0	0
TT04-102	TT04-102	T04	295	0.015	0	2.1	0	0
TT04-104	TT04-104	TT04-102	200	0.006	0	0.14	0	0
TT04-106	TT04-106	TT04-104	200	0.013	0	0	0	0
TT04-108	TT04-108	TT04-106	317	0.013	0	0	0	0
TT04-110	TT04-110	TT04-108	308	0.013	0	0	0	0
TT05-102	TT05-102	T05	200	0.008	0	2.6	0	0
TT05-104	TT05-104	TT05-102	371	0.015	0	0	0	0

TT06-106	TT06-106	T06	606	0.013	0	2.07	0	0
TT06-112	TT06-112	TT06-106	699	0.013	0	0	0	0
TT06-118	TT06-118	TT06-112	726	0.013	0	0	0	0
TT06-122	TT06-122	TT06-118	598	0.013	0	0	0	0
TT06-124	TT06-124	TT06-122	237	0.015	0	0.57	0	0
TT06-126	TT06-126	TT06-124	260	0.015	0	0	0	0
TT06-128	TT06-128	TT06-126	200	0.008	0	0	0	0
TT06-130	TT06-130	TT06-128	268	0.015	0	0	0	0
TT06-132	TT06-132	TT06-130	200	0.008	0	0	0	0
TT06-136	TT06-136	TT06-132	573	0.015	0	0	0	0
TT06-140	TT06-140	TT06-136	577	0.015	0	0	0	0
TT06-144	TT06-144	TT06-140	505	0.015	0	0	0	0
TT07-102	TT07-102	T07	200	0.01	0	2.01	0	0
TT07-104	TT07-104	TT07-102	200	0.014	0	0	0	0
TT08-110	TT08-110	T08	2046	0.013	0	0	0	0
TT08-115	TT08-115	TT08-110	861	0.013	0	0	0	0
TT08-130	TT08-130	TT08-115	1078	0.015	0	0	0	0
TT08-138	TT08-138	TT08-130	795	0.015	0	0	0	0
TT08-153	TT08-153	TT08-138	1336	0.015	0	0	0	0
TT08-166	TT08-166	TT08-153	1377	0.015	0	0	0	0
TT08-176	TT08-176	TT08-166	1035	0.015	0	0	0	0
TT08-182	TT08-182	TT08-176	328	0.015	0	0	0	0
TT08-186	TT08-186	TT08-182	802	0.015	0	0	0	0
TT08-195	TT08-195	TT08-186	1169	0.015	0	0	0	0
TT08-204	TT08-204	TT08-166	240	0.015	0	2.54	0	0
TT08-207	TT08-207	TT08-204	237	0.016	0	0	0	0
TT08-210	TT08-210	TT08-207	332	0.016	0	0	0	0
TT08-212	TT08-212	TT08-210	262	0.015	0	0	0	0
TT08-214	TT08-214	TT08-212	230	0.015	0	0	0	0
TT08-216	TT08-216	TT08-214	300	0.015	0	0	0	0
TT08-220	TT08-220	TT08-216	357.5	0.016	0	0	0	0
TT08-221	TT08-221	TT08-220	200	0.0136	0	0	0	0
TT08-226	TT08-226	TT08-221	265	0.017	0	0	0	0
TT08-228	TT08-228	TT08-226	249	0.015	0	0	0	0
TT08-231	TT08-231	TT08-228	305	0.016	0	0	0	0
TT08-234	TT08-234	TT08-231	333	0.016	0	0	0	0
TT08-237	TT08-237	TT08-234	311	0.016	0	0	0	0
TT08-240	TT08-240	TT08-237	248	0.016	0	0	0	0
TT08-242	TT08-242	TT08-240	198	0.015	0	0	0	0
TT08-246	TT08-246	TT08-242	380	0.016	0	0	0	0
TT08-250	TT08-250	TT08-246	355	0.016	0	0	0	0
TT08-254	TT08-254	TT08-250	321	0.016	0	0	0	0
TT08-258	TT08-258	TT08-254	319	0.016	0	0	0	0
TT08-264	TT08-264	TT08-258	498	0.017	0	0	0	0
TT09-102	TT09-102	T09	193	0.015	0	1.77	0	0
TT09-108	TT09-108	TT09-102	900	0.015	0	0	0	0
TT09-302	TT09-302	TT09-102	205	0.015	0	0	0	0
TT09-304	TT09-304	TT09-302	200	0.008	0	0	0	0

TT09-314	TT09-314	TT09-304	750	0.015	0	0	0	0
TT09-402	TT09-402	TT09-102	225	0.015	0	0	0	0
TT09-404	TT09-404	TT09-402	200	0.008	0	0	0	0
TT09-412	TT09-412	TT09-404	625	0.015	0	0	0	0
TT09-414	TT09-414	TT09-412	200	0.014	0	0	0	0
TT10-102	TT10-102	T10	230	0.015	0	2.33	0	0
TT10-104	TT10-104	TT10-102	200	0.014	0	0	0	0
TT10-106	TT10-106	TT10-104	200	0.015	0	0	0	0
TT10-108	TT10-108	TT10-106	200	0.014	0	0	0	0
TT10-110	TT10-110	TT10-108	1168	0.015	0	0	0	0
TT10-112	TT10-112	TT10-110	240	0.015	0	0	0	0
TT11-102	TT11-102	T11	210	0.015	0	1.79	0	0
TT11-104	TT11-104	TT11-102	247	0.015	0	0	0	0
TT12-102	TT12-102	T12	234	0.013	0	1.28	0	0
TT12-104	TT12-104	TT12-102	201	0.013	0	0	0	0
TT12-106	TT12-106	TT12-104	201	0.013	0	0	0	0
TT13-102	TT13-102	T13	200	0.014	0	2.41	0	0
TT13-104	TT13-104	TT13-102	300	0.015	0	0	0	0
TT13-106	TT13-106	TT13-104	420	0.015	0	0	0	0
TT13-108	TT13-108	TT13-106	200	0.014	0	0	0	0
TT13-110	TT13-110	TT13-108	200	0.008	0	0	0	0
TT13-112	TT13-112	TT13-110	200	0.013	0	0	0	0
TT13-114	TT13-114	TT13-112	200	0.014	0	0	0	0
TT13-116	TT13-116	TT13-114	230	0.015	0	0	0	0
TT13-118	TT13-118	TT13-116	200	0.009	0	0	0	0
TT13-120	TT13-120	TT13-118	210	0.015	0	0	0	0
TT13-122	TT13-122	TT13-120	200	0.015	0	0	0	0
TT13-124	TT13-124	TT13-122	200	0.014	0	0	0	0
TT13-126	TT13-126	TT13-124	220	0.015	0	0	0	0
TT13-130	TT13-130	TT13-126	380	0.015	0	0	0	0
TT13-204	TT13-204	TT13-116	283	0.015	0	0	0	0
TT13-208	TT13-208	TT13-204	249	0.015	0	0	0	0
TT14-007	TT14-007	T14	955	0.015	0	0	0	0
TT14-016	TT14-016	TT14-007	1089	0.016	0	0	0	0
TT14-022	TT14-022	TT14-016	989	0.015	0	0	0	0
TT14-030	TT14-030	TT14-022	1547	0.016	0	0	0	0
TT14-034	TT14-034	TT14-030	688	0.014	0	0	0	0
TT14-046	TT14-046	TT14-034	2055	0.018	0	0.05	0	0
TT14-048	TT14-048	TT14-046	390	0.013	0	0.05	0	0
TT14-050	TT14-050	TT14-048	406	0.013	0	0.14	0	0
TT14-052	TT14-052	TT14-050	293	0.013	0	0	0	0
TT14-054	TT14-054	TT14-052	200	0.013	0	0	0	0
TT14-056	TT14-056	TT14-054	200	0.013	0	0	0	0
TT14-058	TT14-058	TT14-056	200	0.013	0	0	0	0
TT14-060	TT14-060	TT14-058	216	0.013	0	0	0	0
TT14-064	TT14-064	TT14-060	394	0.013	0	0	0	0
TT14-068	TT14-068	TT14-064	301	0.015	0	0	0	0
TT14-070	TT14-070	TT14-068	293	0.015	0	0	0	0

TT14-072	TT14-072	TT14-070	374	0.015	0	0	0	0
TT14-074	TT14-074	TT14-072	200	0.015	0	0	0	0
TT14-076	TT14-076	TT14-074	200	0.012	0	0	0	0
TT14-078	TT14-078	TT14-076	275	0.015	0	0	0	0
TT14-082	TT14-082	TT14-078	416	0.015	0	0	0	0
TT14-084	TT14-084	TT14-082	229	0.015	0	0	0	0
TT14-086	TT14-086	TT14-084	353	0.013	0	0	0	0
TT14-088	TT14-088	TT14-086	329	0.015	0	0	0	0
TT14-092	TT14-092	TT14-088	388	0.015	0	0	0	0
TT14-094	TT14-094	TT14-092	300	0.013	0	0	0	0
TT14-102	TT14-102	TT14-048	475	0.013	0	0.8	0	0
TT14-104	TT14-104	TT14-102	1200	0.013	0	0	0	0
TT14-106	TT14-106	TT14-104	1165	0.013	0	0	0	0
TT14-107	TT14-107	TT14-106	690	0.013	0	0	0	0
TT14-108	TT14-108	TT14-107	455	0.013	0	0	0	0
TT14-110	TT14-110	TT14-108	1220	0.013	0	0	0	0
TT14-112	TT14-112	TT14-110	310	0.013	0	0	0	0
TT14-118	TT14-118	TT14-200	400	0.017	0	6.34	0	0
TT14-120	TT14-120	TT14-118	200	0.012	0	0	0	0
TT14-126	TT14-126	TT14-120	702	0.015	0	0	0	0
TT14-200A	TT14-200	TT14-094	200	0.0105	0	0	0	0
TT14-200B	TT14-200	TT14-094	200	0.0105	0	0	0	0
TT14-200C	TT14-200	TT14-094	200	0.0105	0	0	0	0
TT14-200D	TT14-200	TT14-112	200	0.0101	0	0	0	0
TT14-200E	TT14-200	TT14-112	200	0.0101	0	0	0	0
TT14-200F	TT14-200	TT14-112	200	0.0101	0	0	0	0
TT14-202	TT14-202	TT14-200	200	0.0103	0	0.54	0	0
TT14-203	TT14-203	TT14-202	200	0.0118	0	0	0	0
TT14-204	TT14-204	TT14-202	200	0.0118	0	0	0	0
TT14-205	TT14-205	TT14-203	200	0.0083	0	1.27	0	0
TT14-206	TT14-206	TT14-204	200	0.0083	0	1.27	0	0
TT14-207	TT14-207	TT14-205	310	0.013	0	0	0	0
TT14-208	TT14-208	TT14-206	310	0.013	0	0	0	0
TT14-209	TT14-209	TT14-207	200	0.0122	0	1.43	0	0
TT14-210	TT14-210	TT14-208	200	0.0122	0	1.43	0	0
TT14-211	TT14-211	TT14-209	200	0.0088	0	0.7	0	0
TT14-212	TT14-212	TT14-210	200	0.0088	0	0.7	0	0
TT14-213	TT14-213	TT14-211	200	0.0104	0	0	0	0
TT14-214	TT14-214	TT14-212	200	0.0104	0	0	0	0
TT14-215	TT14-215	TT14-213	240	0.013	0	1.5	0	0
TT14-216	TT14-216	TT14-214	240	0.013	0	1.5	0	0
TT14-217	TT14-217	TT14-215	200	0.0111	0	0.54	0	0
TT14-218	TT14-218	TT14-216	200	0.0111	0	0.54	0	0
TT14-219	TT14-219	TT14-217	208	0.013	0	0	0	0
TT14-220	TT14-220	TT14-218	208	0.013	0	0	0	0
TT14-221	TT14-222	TT14-219	232	0.013	0	1.56	0	0
TT14-222	TT14-222	TT14-220	232	0.013	0	1.56	0	0
TT14-222B	TT14-222	TT14-219	232	0.013	0	1.56	0	0

TT14-224	TT14-224	TT14-222	200	0.005	0	0	0	0
TT14-226	TT14-226	TT14-224	365	0.013	0	0	0	0
TT14-228	TT14-228	TT14-226	420	0.013	0	0	0	0
TT14-230	TT14-230	TT14-228	200	0.012	0	2.21	0	0
TT14-232	TT14-232	TT14-230	470	0.013	0	0	0	0
TT14-234	TT14-234	TT14-232	440	0.013	0	0	0	0
TT14-236	TT14-236	TT14-234	480	0.013	0	0	0	0
TT14-238	TT14-238	TT14-236	535	0.013	0	0	0	0
TT14-240	TT14-240	TT14-238	540	0.013	0	0	0	0
TT14-242	TT14-242	TT14-240	350	0.013	0	0	0	0
TT14-243	TT14-243	TT14-242	360	0.013	0	0	0	0
TT14-246	TT14-246	TT14-243	330	0.016	0	0	0	0
TT14-248	TT14-248	TT14-246	430	0.015	0	0	0	0
TT14-252	TT14-252	TT14-248	460	0.016	0	0	0	0
TT14-256	TT14-256	TT14-252	440	0.016	0	0	0	0
TT14-258	TT14-258	TT14-256	200	0.015	0	0	0	0
TT14-260	TT14-260	TT14-258	375	0.015	0	0	0	0
TT14-262	TT14-262	TT14-260	820	0.015	0	0	0	0
TT14-263	TT14-263	TT14-262	424	0.015	0	0.1	0	0
TT14-264	TT14-264	TT14-263	1070	0.015	0	0	0	0
TT14-266	TT14-266	TT14-264	730	0.015	0	0	0	0
TT14-268	TT14-268	TT14-266	240	0.015	0	0	0	0
TT14-270	TT14-270	TT14-268	245.5	0.015	0	0	0	0
TT14-272	TT14-272	TT14-270	250	0.015	0	0	0	0
TT14-275	TT14-275	TT14-272	344	0.016	0	0	0	0
TT14-278	TT14-278	TT14-275	405	0.016	0	0	0	0
TT14-280	TT14-280	TT14-278	275	0.015	0	0	0	0
TT14-282	TT14-282	TT14-280	305	0.015	0.03	0	0	0
TT14-284	TT14-284	TT14-282	203	0.015	0	0	0	0
TT14-288	TT14-288	TT14-284	402	0.016	0	0	0	0
TT14-290	TT14-290	TT14-288	336	0.015	0	0	0	0
TT14-291	TT14-291	TT14-290	356	0.015	0	0	0	0
TT14-292	TT14-292	TT14-291	204	0.015	0	0	0	0
TT14-294	TT14-294	TT14-292	251	0.015	0	0	0	0
TT14-296	TT14-296	TT14-294	350	0.015	0	0	0	0
TT14-302	TT14-302	TT14-118	300	0.015	0	3.1	0	0
TT14-304	TT14-304	TT14-302	290	0.015	0	0	0	0
TT14-306	TT14-306	TT14-304	285	0.015	0	0	0	0
TT14-308	TT14-308	TT14-306	305	0.015	0	0	0	0
TT14-310	TT14-310	TT14-308	210	0.015	0	0	0	0
TT14-404	TT14-404	TT14-094	245	0.013	0	4.16	0	0
TT14-406	TT14-406	TT14-404	355	0.013	0	0	0	0
TT14-410	TT14-410	TT14-406	280	0.013	0	0	0	0
TT14-412	TT14-412	TT14-410	310	0.013	0	0	0	0
TT14-414	TT14-414	TT14-412	480	0.013	0	0	0	0
TT14-416	TT14-416	TT14-414	300	0.013	0	0	0	0
TT14-418	TT14-418	TT14-416	270	0.013	0	0	0	0
TT14-502	TT14-502	TT14-228	200	0.0075	0	2.21	0	0

TT14-503	TT14-503	TT14-502	200	0.0055	0	0	0	0
TT14-503A	TT14-503A	TT14-503	226	0.013	0	0	0	0
TT14-503B	TT14-503B	TT14-503A	255	0.013	0	1.57	0	0
TT14-504	TT14-504	TT14-502	200	0.0055	0.3	0	0	0
TT14-504A	TT14-504A	TT14-504	226	0.013	0	0	0	0
TT14-504B	TT14-504B	TT14-504A	255	0.013	0	1.57	0	0
TT14-505	TT14-505	TT14-503B	200	0.0067	0	1.03	0	0
TT14-505A	TT14-505A	TT14-505	200	0.0121	0	0	0	0
TT14-505B	TT14-505B	TT14-505A	244	0.013	0	1.3	0	0
TT14-506	TT14-506	TT14-504B	200	0.0067	0	1.03	0	0
TT14-506A	TT14-506A	TT14-506	200	0.0121	0	0	0	0
TT14-506B	TT14-506B	TT14-506A	244	0.013	0	1.3	0	0
TT14-507	TT14-507	TT14-505B	200	0.0074	0	1.33	0	0
TT14-507A	TT14-507A	TT14-507	200	0.0123	0	0	0	0
TT14-507B	TT14-507B	TT14-507A	234	0.013	0	1.47	0	0
TT14-508	TT14-508	TT14-506B	200	0.0074	0	1.33	0	0
TT14-508A	TT14-508A	TT14-508	200	0.0123	0	0	0	0
TT14-508B	TT14-508B	TT14-508A	234	0.013	0	1.47	0	0
TT14-509	TT14-509	TT14-507B	200	0.0113	0	1.5	0	0
TT14-509A	TT14-509A	TT14-509	200	0.0088	0	0	0	0
TT14-509B	TT14-509B	TT14-509A	246	0.013	0	1.5	0	0
TT14-510	TT14-510	TT14-508B	200	0.0113	0	1.5	0	0
TT14-510A	TT14-510A	TT14-510	200	0.0088	0	0	0	0
TT14-510B	TT14-510B	TT14-510A	200	0.0144	0	1.51	0	0
TT14-511	TT14-511	TT14-509B	200	0.0066	0	1.5	0	0
TT14-511A	TT14-511A	TT14-511	189	0.013	0	0	0	0
TT14-512	TT14-512	TT14-510B	200	0.0066	0	1.5	0	0
TT14-512A	TT14-512A	TT14-512	200	0.0126	0	0	0	0
TT14-513	TT14-513	TT14-511A	200	0.0116	0	1.5	0	0
TT14-514	TT14-514	TT14-512A	200	0.0116	0	1.5	0	0
TT14-516	TT14-516	TT14-514	200	0.008	0	0	0	0
TT14-516P1	TT14-516P1	TT14-513	200	0.008	0	0	0	0
TT14-518	TT14-518	TT14-516	235	0.015	0	0	0	0
TT14-520	TT14-520	TT14-518	380	0.015	0	0	0	0
TT14-524	TT14-524	TT14-520	465	0.016	0	0	0	0
TT14-526	TT14-526	TT14-524	295	0.015	0	0	0	0
TT14-528	TT14-528	TT14-526	205	0.015	0	0	0	0
TT14-530	TT14-530	TT14-528	195	0.015	0	0	0	0
TT14-532	TT14-532	TT14-530	270	0.015	0	0	0	0
TT14-534	TT14-534	TT14-532	220	0.015	0	0	0	0
TT14-536	TT14-536	TT14-534	200	0.015	0	0	0	0
TT14-538	TT14-538	TT14-536	200	0.015	0	0	0	0
TT14-540	TT14-540	TT14-538	200	0.015	0	0	0	0
TT14-542	TT14-542	TT14-540	200	0.015	0	0	0	0
TT14-544	TT14-544	TT14-542	195	0.015	0	0	0	0
TT14-546	TT14-546	TT14-544	210	0.015	0	0	0	0
TT14-550	TT14-550	TT14-546	540	0.015	0	0	0	0
TT14-552	TT14-552	TT14-550	225	0.015	0	0	0	0

TT14-554	TT14-554	TT14-552	200	0.015	0	0	0	0
TT14-556	TT14-556	TT14-554	600	0.015	0	0	0	0
TT14-558	TT14-558	TT14-556	255	0.015	0	0	0	0
TT14-560	TT14-560	TT14-558	240	0.015	0	0	0	0
TT14-562	TT14-562	TT14-560	220	0.015	0	0	0	0
TT14-564	TT14-564	TT14-562	195	0.015	0	0	0	0
TT14-566	TT14-566	TT14-564	235	0.015	0	0	0	0
TT14-570	TT14-570	TT14-566	280	0.016	0	0	0	0
TT14-572	TT14-572	TT14-570	305	0.015	0	0	0	0
TT14-574	TT14-574	TT14-572	215	0.015	0	0	0	0
TT14-576	TT14-576	TT14-574	195	0.015	0	0	0	0
TT14-578	TT14-578	TT14-576	225	0.015	0	0	0	0
TT14-582	TT14-582	TT14-578	380	0.015	0	0	0	0
TT14-584	TT14-584	TT14-582	270	0.015	0	0	0	0
TT14-586	TT14-586	TT14-584	440	0.015	0	0	0	0
TT14-588	TT14-588	TT14-586	265	0.013	0	0	0	0
TT14-590	TT14-590	TT14-588	266	0.013	0	0	0	0
TT14-592	TT14-592	TT14-590	324	0.013	0	0	0	0
TT14-594	TT14-594	TT14-592	291	0.013	0	0	0	0
TT14-597	TT14-597	TT14-594	398	0.014	0	0	0	0
TT14-598	TT14-598	TT14-597	200	0.012	0	0	0	0
TT14-599	TT14-599	TT14-598	233	0.013	0	0	0	0
TT14-602	TT14-602	TT14-296	249	0.015	0	0	0	0
TT14-605	TT14-605	TT14-602	396	0.014	0	1.14	0	0
TT14-606	TT14-606	TT14-605	245	0.013	0	0	0	0
TT14-608	TT14-608	TT14-606	260	0.015	0	0	0	0
TT14-610	TT14-610	TT14-608	295	0.015	0	0	0	0
TT14-612	TT14-612	TT14-610	295	0.015	0	0	0	0
TT14-614	TT14-614	TT14-612	376	0.015	0	0.26	0	0
TT14-616	TT14-616	TT14-614	250	0.015	0	0	0	0
TT14-618	TT14-618	TT14-616	210	0.015	0	0	0	0
TT14-620	TT14-620	TT14-618	311	0.015	0	0	0	0
TT14-622	TT14-622	TT14-620	200	0.0099	0	0	0	0
TT14-624	TT14-624	TT14-622	200	0.0085	0	0	0	0
TT14-626	TT14-626	TT14-624	200	0.0104	0	1.23	0	0
TT14-628	TT14-628	TT14-626	200	0.0106	0	1.23	0	0
TT14-630	TT14-630	TT14-628	200	0.0053	0	1.23	0	0
TT14-632	TT14-632	TT14-630	200	0.0089	0	0	0	0
TT14-634	TT14-634	TT14-632	200	0.0091	0	1.23	0	0
TT14-636	TT14-636	TT14-634	200	0.0118	0	1.22	0	0
TT14-639	TT14-639	TT14-636	255	0.016	0	0	0	0
TT14-642	TT14-642	TT14-639	430	0.016	0	0	0	0
TT14-644	TT14-644	TT14-642	210	0.015	0	2.08	0	0
TT14-646	TT14-646	TT14-644	218	0.015	0	0	0	0
TT14-650	TT14-650	TT14-646	280	0.016	0	0.19	0	0
TT14-654	TT14-654	TT14-650	290	0.016	0	0	0	0
TT14-656	TT14-656	TT14-654	200	0.013	0	0	0	0
TT14-660	TT14-660	TT14-656	280	0.016	0	0	0	0

TT14-664	TT14-664	TT14-660	257.5	0.016	0	1.48	0	0
TT14-668	TT14-668	TT14-664	284.5	0.016	0	0	0	0
TT14-672	TT14-672	TT14-668	315	0.016	0	0	0	0
TT14-676	TT14-676	TT14-672	311	0.016	0	0	0	0
TT14-678	TT14-678	TT14-676	200	0.013	0	0	0	0
TT14-682	TT14-682	TT14-678	300	0.016	0	0	0	0
TT14-684	TT14-684	TT14-682	200	0.0134	0	0	0	0
TT14-686	TT14-686	TT14-684	200	0.0082	0	0.99	0	0
TT14-688	TT14-688	TT14-686	215	0.015	0	0	0	0
TT14-692	TT14-692	TT14-688	348	0.016	0	0	0	0
TT14-702	TT14-702	TT14-599	275	0.013	0	0	0	0
TT14-704	TT14-704	TT14-702	340	0.013	0	0	0	0
TT14-706	TT14-706	TT14-704	314	0.013	0	0	0	0
TT14-708	TT14-708	TT14-706	300	0.013	0	0	0	0
TT14-710	TT14-710	TT14-708	309	0.013	0	0	0	0
TT14-712	TT14-712	TT14-710	302.5	0.013	0	0	0	0
TT14-713	TT14-713	TT14-712	216	0.013	0	0	0	0
TT14-716	TT14-716	TT14-713	374	0.014	0	0	0	0
TT14-720	TT14-720	TT14-716	362	0.014	0	0	0	0
TT14-722	TT14-722	TT14-720	264	0.013	0	0	0	0
TT14-724	TT14-724	TT14-722	352	0.013	0	0	0	0
TT14-727	TT14-727	TT14-724	471	0.014	0	0	0	0
TT14-728	TT14-728	TT14-727	201	0.013	0	0	0	0
TT14-730	TT14-730	TT14-728	373.5	0.013	0	0	0	0
TT14-733	TT14-733	TT14-730	362	0.014	0	0	0	0
TT14-734	TT14-734	TT14-733	203	0.013	0	0	0	0
TT14-736	TT14-736	TT14-734	296	0.013	0	0	0	0
TT14-738	TT14-738	TT14-736	304.5	0.013	0	0	0	0
TT14-740	TT14-740	TT14-738	192.5	0.015	0	0	0	0
TT14-742	TT14-742	TT14-740	253.5	0.015	0	0	0	0
TT14-744	TT14-744	TT14-742	307.5	0.015	0	0	0	0
TT14-746	TT14-746	TT14-744	240	0.015	0	0	0	0
TT14-804	TT14-804	TT14-262	540	0.014	0	0.25	0	0
TT14-806	TT14-806	TT14-804	346	0.013	0	4.69	0	0
TT14-807	TT14-807	TT14-806	200	0.0113	0.03	0	0	0
TT14-808	TT14-808	TT14-807	200	0.011	0	0	0	0
TT14-811	TT14-811	TT14-808	447	0.014	0	0	0	0
TT14-812	TT14-812	TT14-811	374.5	0.013	0	0	0	0
TT14-814	TT14-814	TT14-812	480	0.013	0	0	0	0
TT14-815	TT14-815	TT14-814	490	0.013	0	0	0	0
TT14-816	TT14-816	TT14-815	310.75	0.013	0	0	0	0
TT14-818	TT14-818	TT14-816	396	0.013	0	0	0	0
TT14-822	TT14-822	TT14-818	236	0.016	0	0.43	0	0
TT14-824	TT14-824	TT14-822	270	0.015	0	0	0	0
TT14-826	TT14-826	TT14-824	530	0.015	0	0	0	0
TT14-828	TT14-828	TT14-826	336	0.013	0	0	0	0
TT14-830	TT14-830	TT14-828	327.5	0.013	0	0	0	0
TT14-902	TT14-902	TT14-030	215	0.015	0	2.16	0	0

TT14-904	TT14-904	TT14-902	220	0.015	0	0	0	0
TT14-906	TT14-906	TT14-904	280	0.015	0	0	0	0
TT14-908	TT14-908	TT14-906	290	0.015	0	0	0	0
TT14-910	TT14-910	TT14-908	210	0.015	0	0	0	0
TT15-010	TT15-010	T15	352	0.013	0	3.58	0	0
TT15-012	TT15-012	TT15-010	222	0.013	0	0	0	0
TT15-016	TT15-016	TT15-012	651	0.015	0	0	0	0
TT15-022	TT15-022	TT15-016	822	0.015	0	0	0	0
TT15-024	TT15-024	TT15-022	200	0.011	0	0	0	0
TT15-034	TT15-034	TT15-024	1082	0.015	0	0	0	0
TT15-038	TT15-038	TT15-034	532	0.015	0	0	0	0

[ORIFICES]

;;Name	Inlet Node	Outlet Node	Type	Invert Height	Disch. Coeff.	Flap Gate
ORIFICE1@F13-F13Z	F13	F13Z	SIDE	0	0.7	NO
ORIFICE2@F14-F14Z	F14	F14Z	SIDE	0	0.7	NO
ORIFICE3@21005-21006	21005	21006	SIDE	0	0.6	NO

[XSECTIONS]

;;Link	Type	Geom1	Geom2	Geom3	Geom4	Barrels
21006	CIRCULAR	4.5	0	0	0	1
31010	RECT_CLOSED	5	6.5	0	0	1
31020	RECT_CLOSED	5	5.5	0	0	1
31900	RECT_CLOSED	7.5	6.5	0	0	1
31915	RECT_CLOSED	7.5	9.75	0	0	1
A2	TRAPEZOIDAL	30	20	0.5	0.5	1
B10	TRAPEZOIDAL	30	26	0.5	0.5	1
B2	TRAPEZOIDAL	30	16	0.5	0.5	1
B4	TRAPEZOIDAL	30	14	0.5	0.5	1
B6	TRAPEZOIDAL	30	25	0.5	0.5	1
B8	TRAPEZOIDAL	30	24	0.5	0.5	1
C2	TRAPEZOIDAL	30	16	0.5	0.5	1
CF04-000	CIRCULAR	1.5	0	0	0	1
CF04-002	CIRCULAR	1.67	0	0	0	1
CF05-000	CIRCULAR	1	0	0	0	1
CF06-002	RECT_CLOSED	3.25	2.17	0	0	1
CF07-000	CIRCULAR	1.17	0	0	0	1
CF08-000	CIRCULAR	1	0	0	0	1
CF09-000	CIRCULAR	0.83	0	0	0	1
CF10-000	CIRCULAR	1	0	0	0	1
CF10-002	CIRCULAR	1.17	0	0	0	1
CF11-000	CIRCULAR	2	0	0	0	1
CF12-004	CIRCULAR	1	0	0	0	1
CF12-006	CIRCULAR	1.25	0	0	0	1
CF12-016	CIRCULAR	1.25	0	0	0	1
CF12-020	CIRCULAR	1.25	0	0	0	1
CF12-024	CIRCULAR	1.25	0	0	0	1
CF13-000	CIRCULAR	0.83	0	0	0	1
CF13-002	CIRCULAR	0.83	0	0	0	1
CF13-004	CIRCULAR	1	0	0	0	1
CF14-000	CIRCULAR	0.83	0	0	0	1
CF14-002	CIRCULAR	0.83	0	0	0	1
CT01-000	RECT_CLOSED	0.83	1.33	0	0	1
CT01-002	CIRCULAR	1.5	0	0	0	1
CT04-002	CIRCULAR	1	0	0	0	1
CT05-004	CIRCULAR	1	0	0	0	1
CT06-000	CIRCULAR	2	0	0	0	1
CT06-006	CIRCULAR	2	0	0	0	1
CT07-004	CIRCULAR	1	0	0	0	1
CT08-000	CIRCULAR	2	0	0	0	1
CT10-004	CIRCULAR	0.83	0	0	0	1
CT11-002	CIRCULAR	0.83	0	0	0	1
CT14-000	RECT_CLOSED	3	6	0	0	1
D2	TRAPEZOIDAL	30	13	0.5	0.5	1
D4	TRAPEZOIDAL	30	13	0.5	0.5	1
EJ2	TRAPEZOIDAL	30	12	0.5	0.5	1
EJ4	TRAPEZOIDAL	30	15	0.5	0.5	1
F03DWO	CIRCULAR	1	0	0	0	1
F03W	RECT_CLOSED	5.95	5	0	0	1
F04W	RECT_CLOSED	4.15	5.75	0	0	1
F04X	RECT_CLOSED	1.5	2.67	0	0	1
F05W	RECT_CLOSED	5.87	4	0	0	1
F05X	RECT_CLOSED	1.33	1.33	0	0	1
F06DWO	CIRCULAR	1.25	0	0	0	1
F06W	RECT_CLOSED	3.08	4.04	0	0	1
F07W	RECT_CLOSED	4	4.5	0	0	1
F07X	RECT_CLOSED	1.5	1.5	0	0	1
F08W	RECT_CLOSED	2.57	3.75	0	0	1
F08X	RECT_CLOSED	1.5	2	0	0	1
F09W	RECT_CLOSED	4	1.96	0	0	1
F09X	RECT_CLOSED	0.67	0.67	0	0	1
F10W1	RECT_CLOSED	2	3	0	0	1

F10W2	RECT_CLOSED	2.1	5.42	0	0	1
F10X	RECT_CLOSED	0.67	0.67	0	0	1
F11W1	RECT_CLOSED	2.5	12.5	0	0	1
F11W2	RECT_CLOSED	5.5	6.5	0	0	1
F11X	RECT_CLOSED	1	1.5	0	0	1
F11Z	RECT_CLOSED	1.04	3.17	0	0	1
F12DWO	CIRCULAR	1	0	0	0	1
F12W	RECT_CLOSED	3.82	3.21	0	0	1
F13W	RECT_CLOSED	1.96	5.75	0	0	1
F13Z	RECT_CLOSED	0.52	0.92	0	0	1
F14W	RECT_CLOSED	3.1	4	0	0	1
F14Z	RECT_CLOSED	0.29	0.85	0	0	1
G10	TRAPEZOIDAL	30	21	0.5	0.5	1
G4	TRAPEZOIDAL	30	18	0.5	0.5	1
G6	TRAPEZOIDAL	30	18	0.5	0.5	1
G8	TRAPEZOIDAL	30	20	0.5	0.5	1
H10	TRAPEZOIDAL	30	26	0.5	0.5	1
H12	TRAPEZOIDAL	30	28	0.5	0.5	1
H14	TRAPEZOIDAL	30	33	0.5	0.5	1
H2	TRAPEZOIDAL	30	18	0.5	0.5	1
H4	TRAPEZOIDAL	30	34	0.5	0.5	1
H6	TRAPEZOIDAL	30	19	0.5	0.5	1
H7	TRAPEZOIDAL	30	18	0.5	0.5	1
H8	TRAPEZOIDAL	30	22	0.5	0.5	1
I10	TRAPEZOIDAL	30	18	0.5	0.5	1
I12	TRAPEZOIDAL	30	20	0.5	0.5	1
I2	TRAPEZOIDAL	30	20	0.5	0.5	1
I4	TRAPEZOIDAL	30	21	0.5	0.5	1
I6	TRAPEZOIDAL	30	18	0.5	0.5	1
I7	TRAPEZOIDAL	30	21	0.5	0.5	1
I8	TRAPEZOIDAL	30	17	0.5	0.5	1
IF03-000	CIRCULAR	1.67	0	0	0	1
IF03-002	CIRCULAR	1.67	0	0	0	1
IF03-004	CIRCULAR	1.67	0	0	0	1
IF03-006	CIRCULAR	1.67	0	0	0	1
IF03-010	CIRCULAR	1.67	0	0	0	1
IF04-000	CIRCULAR	2.5	0	0	0	1
IF04-002	CIRCULAR	2.5	0	0	0	1
IF04-004	CIRCULAR	2.5	0	0	0	1
IF04-006	CIRCULAR	2.5	0	0	0	1
IF05-000	CIRCULAR	2.5	0	0	0	1
IF05-002	CIRCULAR	2.5	0	0	0	1
IF05-004	CIRCULAR	2.5	0	0	0	1
IF05-006	CIRCULAR	2.5	0	0	0	1
IF05-008	CIRCULAR	2.5	0	0	0	1
IF05-010	CIRCULAR	2.5	0	0	0	1
IF05-012	CIRCULAR	2.5	0	0	0	1
IF06-000	CIRCULAR	2.5	0	0	0	1
IF07-000	CIRCULAR	3	0	0	0	1
IF07-002	CIRCULAR	3	0	0	0	1
IF08-000	CIRCULAR	3	0	0	0	1
IF08-006	CIRCULAR	3	0	0	0	1
IF09-000	CIRCULAR	3	0	0	0	1
IF10-000	CIRCULAR	3.5	0	0	0	1
IF10-004	CIRCULAR	3.5	0	0	0	1
IF11-000	CIRCULAR	4	0	0	0	1
IF11-002	CIRCULAR	4	0	0	0	1
IF11-006	CIRCULAR	4	0	0	0	1
IF11-008	CIRCULAR	4	0	0	0	1
IF11-012	CIRCULAR	4	0	0	0	1
IF11-016	CIRCULAR	4	0	0	0	1
IF12-000	CIRCULAR	4.5	0	0	0	1
IF12-004	CIRCULAR	4.5	0	0	0	1
IF12-006	CIRCULAR	4.5	0	0	0	1
IF12-008	CIRCULAR	4.5	0	0	0	1
IF12-010	CIRCULAR	4.5	0	0	0	1
IF12-012	CIRCULAR	4.5	0	0	0	1
IF12-016	CIRCULAR	4.5	0	0	0	1
IR18-002	RECT_CLOSED	10	2.715	0	0	1
IR18-004	RECT_CLOSED	10	8.5	0	0	1
IR18-017	CIRCULAR	6.5	0	0	0	1
IR18-018	CIRCULAR	6.5	0	0	0	1
IR18-020	CIRCULAR	6.5	0	0	0	1
IR18-030	CIRCULAR	6.5	0	0	0	1
IR18-032	CIRCULAR	6.5	0	0	0	1
IR18-040	CIRCULAR	6.5	0	0	0	1
IR18-042	CIRCULAR	6.5	0	0	0	1
IR18-046	CIRCULAR	6.5	0	0	0	1
IR18-050	CIRCULAR	6.5	0	0	0	1
IR18-052	CIRCULAR	6.5	0	0	0	1
IR18-056	CIRCULAR	6.5	0	0	0	1
IR18-058	CIRCULAR	6.5	0	0	0	1
IR18-060	CIRCULAR	6.5	0	0	0	1
IR18-062	CIRCULAR	6.5	0	0	0	1
IR18-064	CIRCULAR	6.5	0	0	0	1
IR18-066	CIRCULAR	6.5	0	0	0	1
IR18-068	CIRCULAR	6.5	0	0	0	1
IR18-070	CIRCULAR	6.5	0	0	0	1
IR18-072	RECT_CLOSED	5	6.5	0	0	1
IR18-076	CIRCULAR	5.5	0	0	0	1
IR18-080	CIRCULAR	5.5	0	0	0	1
IR18-084	CIRCULAR	5.5	0	0	0	1
IR18-086	CIRCULAR	5.5	0	0	0	1
IR18-088	CIRCULAR	5.5	0	0	0	1
IR18-090	CIRCULAR	5.5	0	0	0	1
IR18-092	CIRCULAR	5.5	0	0	0	1

IR18-094	CIRCULAR	5.5	0	0	0	1
IR18-096	CIRCULAR	5.5	0	0	0	1
IR18-098	CIRCULAR	5.5	0	0	0	1
IR18-100	CIRCULAR	5.5	0	0	0	1
IR18-102	CIRCULAR	5.5	0	0	0	1
IR18-104	CIRCULAR	5.5	0	0	0	1
IR18-106	CIRCULAR	5.5	0	0	0	1
IT00-000	CIRCULAR	3	0	0	0	1
IT00-002	CIRCULAR	3	0	0	0	1
IT00-004	CIRCULAR	3	0	0	0	1
IT00-006	CIRCULAR	3	0	0	0	1
IT00-008	CIRCULAR	3	0	0	0	1
IT00-010	CIRCULAR	3	0	0	0	1
IT00-012	CIRCULAR	3	0	0	0	1
IT00-014	CIRCULAR	3	0	0	0	1
IT00-016	CIRCULAR	3	0	0	0	1
IT00-018	CIRCULAR	3.5	0	0	0	1
IT00-022	CIRCULAR	3.5	0	0	0	1
IT03-000	CIRCULAR	3.5	0	0	0	1
IT03-004	CIRCULAR	3.5	0	0	0	1
IT03-006	CIRCULAR	3.5	0	0	0	1
IT03-008	CIRCULAR	3.5	0	0	0	1
IT03-010	CIRCULAR	3.5	0	0	0	1
IT03-012	CIRCULAR	3.5	0	0	0	1
IT03-014	CIRCULAR	3.5	0	0	0	1
IT03-016	CIRCULAR	3.5	0	0	0	1
IT04-000	CIRCULAR	3.5	0	0	0	1
IT05-000	CIRCULAR	3.5	0	0	0	1
IT05-004	CIRCULAR	3.5	0	0	0	1
IT06-000	CIRCULAR	4	0	0	0	1
IT06-004	CIRCULAR	4	0	0	0	1
IT06-006	CIRCULAR	4	0	0	0	1
IT06-008	CIRCULAR	4	0	0	0	1
IT07-000	CIRCULAR	4	0	0	0	1
IT07-004	CIRCULAR	4	0	0	0	1
IT07-006	CIRCULAR	4	0	0	0	1
IT07-012	CIRCULAR	5	0	0	0	1
IT08-000	CIRCULAR	5	0	0	0	1
IT09-000	CIRCULAR	5	0	0	0	1
IT10-000	CIRCULAR	5	0	0	0	1
IT10-002	CIRCULAR	5	0	0	0	1
IT10-004	CIRCULAR	5	0	0	0	1
IT11-000	CIRCULAR	5	0	0	0	1
IT11-002	CIRCULAR	5	0	0	0	1
IT11-004	CIRCULAR	5	0	0	0	1
IT13-000	CIRCULAR	5	0	0	0	1
IT13-002	CIRCULAR	5	0	0	0	1
IT13-004	CIRCULAR	5	0	0	0	1
IT13-006	CIRCULAR	5	0	0	0	1
IT13-008	CIRCULAR	5	0	0	0	1
IT13-012	CIRCULAR	5	0	0	0	1
IT13-014	CIRCULAR	5	0	0	0	1
IT13-016	CIRCULAR	5	0	0	0	1
IT14-000	CIRCULAR	8.5	0	0	0	1
IT14-004	CIRCULAR	8.5	0	0	0	1
IT15-000	CIRCULAR	8.5	0	0	0	1
IT15-004	CIRCULAR	8.5	0	0	0	1
IT15-006	CIRCULAR	8.5	0	0	0	1
IT15-010	CIRCULAR	8.5	0	0	0	1
IT15-012	CIRCULAR	8.5	0	0	0	1
IT15-014	CIRCULAR	8.5	0	0	0	1
IT15-018	CIRCULAR	8.5	0	0	0	1
IT15-022	CIRCULAR	8.5	0	0	0	1
IT15-024	CIRCULAR	8.5	0	0	0	1
J10	TRAPEZOIDAL	30	19	0.5	0.5	1
J12	TRAPEZOIDAL	30	19	0.5	0.5	1
J13	TRAPEZOIDAL	30	22	0.5	0.5	1
J14	TRAPEZOIDAL	30	17	0.5	0.5	1
J16	TRAPEZOIDAL	30	17	0.5	0.5	1
J18	TRAPEZOIDAL	30	18	0.5	0.5	1
J2	TRAPEZOIDAL	30	13	0.5	0.5	1
J20	TRAPEZOIDAL	30	21	0.5	0.5	1
J3A	TRAPEZOIDAL	30	130	0.5	0.5	1
J3B	TRAPEZOIDAL	30	17	0.5	0.5	1
J3C	TRAPEZOIDAL	30	350	0.5	0.5	1
J3D	TRAPEZOIDAL	30	14	0.5	0.5	1
J4	TRAPEZOIDAL	30	16	0.5	0.5	1
J6	TRAPEZOIDAL	30	14	0.5	0.5	1
J7	TRAPEZOIDAL	30	19	0.5	0.5	1
J8	TRAPEZOIDAL	30	19	0.5	0.5	1
J9	TRAPEZOIDAL	30	19	0.5	0.5	1
K2	TRAPEZOIDAL	30	15	0.5	0.5	1
K4	TRAPEZOIDAL	30	15	0.5	0.5	1
L2	TRAPEZOIDAL	30	14	0.5	0.5	1
L4	TRAPEZOIDAL	30	15	0.5	0.5	1
M2	TRAPEZOIDAL	30	24	0.5	0.5	1
M4	TRAPEZOIDAL	30	30	0.5	0.5	1
MC_1	RECT_CLOSED	5	5	0	1.5	1
MC_2	RECT_CLOSED	5	5	0	24	1
MR10	TRAPEZOIDAL	30	25	0.5	0.5	1
MR12	TRAPEZOIDAL	30	21	0.5	0.5	1
MR2	TRAPEZOIDAL	30	24	0.5	0.5	1
MR4	TRAPEZOIDAL	30	28	0.5	0.5	1
MR6	TRAPEZOIDAL	30	28	0.5	0.5	1
MR8	TRAPEZOIDAL	30	26	0.5	0.5	1
MS10	TRAPEZOIDAL	30	18	0.5	0.5	1

MS12	TRAPEZOIDAL	30	16	0.5	0.5	1
MS13	TRAPEZOIDAL	30	18	0.5	0.5	1
MS14	TRAPEZOIDAL	30	20	0.5	0.5	1
MS16	TRAPEZOIDAL	30	26	0.5	0.5	1
MS18	TRAPEZOIDAL	30	24	0.5	0.5	1
MS2	TRAPEZOIDAL	30	19	0.5	0.5	1
MS20	TRAPEZOIDAL	30	20	0.5	0.5	1
MS21	TRAPEZOIDAL	30	20	0.5	0.5	1
MS22	TRAPEZOIDAL	30	28	0.5	0.5	1
MS24	TRAPEZOIDAL	30	28	0.5	0.5	1
MS26	TRAPEZOIDAL	30	22	0.5	0.5	1
MS28	TRAPEZOIDAL	30	28	0.5	0.5	1
MS30	TRAPEZOIDAL	30	30	0.5	0.5	1
MS32	TRAPEZOIDAL	30	33	0.5	0.5	1
MS34	TRAPEZOIDAL	30	31	0.5	0.5	1
MS36	TRAPEZOIDAL	30	45	0.5	0.5	1
MS37	TRAPEZOIDAL	30	35	0.5	0.5	1
MS38	TRAPEZOIDAL	30	32	0.5	0.5	1
MS4	TRAPEZOIDAL	30	20	0.5	0.5	1
MS40	TRAPEZOIDAL	30	32	0.5	0.5	1
MS42	TRAPEZOIDAL	30	38	0.5	0.5	1
MS44	TRAPEZOIDAL	30	53	0.5	0.5	1
MS45	TRAPEZOIDAL	30	48	0.5	0.5	1
MS46	TRAPEZOIDAL	30	55	0.5	0.5	1
MS50	TRAPEZOIDAL	30	48	0.5	0.5	1
MS52	TRAPEZOIDAL	30	47	0.5	0.5	1
MS53	TRAPEZOIDAL	30	46	0.5	0.5	1
MS54	TRAPEZOIDAL	30	35	0.5	0.5	1
MS56	TRAPEZOIDAL	30	35	0.5	0.5	1
MS57	TRAPEZOIDAL	30	43	0.5	0.5	1
MS58	TRAPEZOIDAL	30	47	0.5	0.5	1
MS59	TRAPEZOIDAL	30	50	0.5	0.5	1
MS6	TRAPEZOIDAL	30	21	0.5	0.5	1
MS60	TRAPEZOIDAL	30	61	0.5	0.5	1
MS62	TRAPEZOIDAL	30	52	0.5	0.5	1
MS66	TRAPEZOIDAL	30	40	0.5	0.5	1
MS70	TRAPEZOIDAL	30	50	0.5	0.5	1
MS72	TRAPEZOIDAL	30	38	0.5	0.5	1
MS73	TRAPEZOIDAL	30	42	0.5	0.5	1
MS74	TRAPEZOIDAL	30	60	0.5	0.5	1
MS8	TRAPEZOIDAL	30	21	0.5	0.5	1
N2	TRAPEZOIDAL	30	20	0.5	0.5	1
N3	TRAPEZOIDAL	30	80	0.5	0.5	1
N4	TRAPEZOIDAL	30	20	0.5	0.5	1
OF03-000	CIRCULAR	7	0	0	0	1
OF03-004	RECT_CLOSED	5.5	6	0	0	1
OF03-006	RECT_CLOSED	5.5	6.5	0	0	1
OF04-000	CIRCULAR	5.25	0	0	0	1
OF05-000	RECT_CLOSED	4.5	4	0	0	1
OF06-000	CIRCULAR	4.5	0	0	0	1
OF07-000	CIRCULAR	4.5	0	0	0	1
OF08-000	CIRCULAR	4	0	0	0	1
OF09-000	RECT_CLOSED	3.25	2.17	0	0	1
OF09-002	RECT_CLOSED	3.5	4	0	0	1
OF09-004	RECT_CLOSED	3.25	2.17	0	0	1
OF10-000	CIRCULAR	7	0	0	0	1
OF11-000	RECT_CLOSED	8.5	9.5	0	0	1
OF12-000	CIRCULAR	4.5	0	0	0	1
OF12-002	CIRCULAR	4.5	0	0	0	1
OF12-006	RECT_CLOSED	3.5	4.5	0	0	1
OF12-008	RECT_CLOSED	5	4.5	0	0	1
OF12-012	RECT_CLOSED	5	4.5	0	0	1
OF12-014	RECT_CLOSED	5	4.5	0	0	1
OF12-016	RECT_CLOSED	5.5	5	0	0	1
OF12-020	RECT_CLOSED	5.5	5	0	0	1
OF13-000	RECT_CLOSED	4.5	6.5	0	0	1
OF13-002	RECT_CLOSED	5	8	0	0	1
OF13-004	RECT_CLOSED	5	8	0	0	1
OF13-006	RECT_CLOSED	5	8	0	0	1
OF13-008	RECT_CLOSED	6	9	0	0	1
OF13010W1	RECT_CLOSED	1.25	10	0	0	1
OF13010W2	RECT_CLOSED	6	10	0	0	1
OF13-012	RECT_CLOSED	7	10	0	0	1
OF13-014	RECT_CLOSED	7	10	0	0	1
OR15-000	RECT_CLOSED	9.5	9.5	0	0	1
OR15-002	RECT_CLOSED	9.5	9	0	0	1
OR15-004	CIRCULAR	11	0	0	0	1
OR15-012	CIRCULAR	11	0	0	0	1
OR15-016	CIRCULAR	11	0	0	0	1
OR15-020	RECT_CLOSED	11	14	0	0	1
OR18-004	CIRCULAR	6	0	0	0	1
OR18-010	CIRCULAR	8	0	0	0	1
OT01-000	CIRCULAR	6	0	0	0	1
OT01-002	CIRCULAR	6	0	0	0	1
OT04-002	CIRCULAR	4	0	0	0	1
OT05-002	CIRCULAR	3.5	0	0	0	1
OT05-004	CIRCULAR	4	0	0	0	1
OT06-000	RECT_CLOSED	7.6	10.3	0	0	1
OT06-002	RECT_CLOSED	7.6	10.3	0	0	1
OT09-002	CIRCULAR	4	0	0	0	1
OT09-004	CIRCULAR	4	0	0	0	1
R15	CIRCULAR	10	0	0	0	1
R15W	RECT_CLOSED	7.88	24	0	0	1
R18DWO	RECT_CLOSED	8.5	8	0	0	1
R18EW	RECT_CLOSED	1.81	48	0	0	1
R18W	RECT_CLOSED	7.58	6	0	0	1

RF14-000	CIRCULAR	3.5	0	0	0	1
RT03-000	CIRCULAR	5	0	0	0	1
RT04-000	CIRCULAR	4	0	0	0	1
RT05-000	CIRCULAR	3.5	0	0	0	1
RT07-000	CIRCULAR	3	0	0	0	1
RT08-000	RECT_CLOSED	12.13	12.13	0	0	1
RT09-000	CIRCULAR	4	0	0	0	1
RT10-000	CIRCULAR	5	0	0	0	1
RT11-000	CIRCULAR	3	0	0	0	1
RT12-000	CIRCULAR	2	0	0	0	1
RT13-000	CIRCULAR	5	0	0	0	1
RT14-000	RECT_CLOSED	3	5	0	0	1
RT14-000A	RECT_CLOSED	21.17	25	0	0	1
RT15-000	RECT_CLOSED	5.5	7.54	0	0	1
T01W	RECT_CLOSED	4.37	6	0	0	1
T03DWO	CIRCULAR	1	0	0	0	1
T03W	RECT_CLOSED	4.25	3.54	0	0	1
T04DWO	CIRCULAR	1	0	0	0	1
T04W	RECT_CLOSED	3.4	2.83	0	0	1
T05DWO	CIRCULAR	1	0	0	0	1
T05W	RECT_CLOSED	2.97	2.48	0	0	1
T06DWO	RECT_CLOSED	2	3	0	0	1
T06W	RECT_CLOSED	4.5	9	0	0	1
T07DWO	CIRCULAR	1	0	0	0	1
T07W	RECT_CLOSED	2.55	2.12	0	0	1
T08DWO	RECT_CLOSED	1.58	5	0	0	1
T08W	RECT_CLOSED	10.5	16.9	0	0	1
T09DWO	CIRCULAR	0.83	0	0	0	1
T09W	RECT_CLOSED	3.4	2.83	0	0	1
T10DWO	CIRCULAR	0.83	0	0	0	1
T10W	RECT_CLOSED	4.25	3.54	0	0	1
T11DWO	CIRCULAR	0.83	0	0	0	1
T11W	RECT_CLOSED	2.55	2.12	0	0	1
T12DWO	CIRCULAR	0.83	0	0	0	1
T12W	RECT_CLOSED	1.7	2.24	0	0	1
T13DWO	CIRCULAR	0.83	0	0	0	1
T13W	RECT_CLOSED	3.04	3.36	0	0	1
T14DWO	RECT_CLOSED	3	5	0	0	1
T14W	RECT_CLOSED	18.2	24.25	0	0	1
T15DWO	CIRCULAR	1.67	0	0	0	1
T15W	RECT_CLOSED	4.67	7.54	0	0	1
TF-00200	IRREGULAR	200	0	0	0	1
TF-00350	IRREGULAR	350	0	0	0	1
TF-00368	IRREGULAR	368	0	0	0	1
TF-00518	IRREGULAR	518	0	0	0	1
TF-00780	IRREGULAR	780	0	0	0	1
TF-00940	IRREGULAR	940	0	0	0	1
TF-00973	IRREGULAR	973	0	0	0	1
TF-01133	IRREGULAR	1133	0	0	0	1
TF-02905	IRREGULAR	2905	0	0	0	1
TF03-108	CIRCULAR	7	0	0	0	1
TF03-116	CIRCULAR	7	0	0	0	1
TF03-124	CIRCULAR	7	0	0	0	1
TF03-130	CIRCULAR	6.5	0	0	0	1
TF03-132	CIRCULAR	6	0	0	0	1
TF-03135	IRREGULAR	3135	0	0	0	1
TF03-136	CIRCULAR	5	0	0	0	1
TF03-138	CIRCULAR	4.5	0	0	0	1
TF-03285	IRREGULAR	3285	0	0	0	1
TF-03347	IRREGULAR	3347	0	0	0	1
TF-03497	IRREGULAR	3497	0	0	0	1
TF-03605	IRREGULAR	3605	0	0	0	1
TF-03755	IRREGULAR	3755	0	0	0	1
TF-03800	IRREGULAR	3800	0	0	0	1
TF-03950	IRREGULAR	3950	0	0	0	1
TF-03975	IRREGULAR	3975	0	0	0	1
TF04-102	CIRCULAR	5.25	0	0	0	1
TF04-108	CIRCULAR	5.75	0	0	0	1
TF04-115	CIRCULAR	5.75	0	0	0	1
TF04-120	CIRCULAR	6	0	0	0	1
TF04-122	RECT_CLOSED	7.5	4.5	0	0	1
TF04-124	RECT_CLOSED	7.5	4.5	0	0	1
TF-04125	IRREGULAR	4125	0	0	0	1
TF04-125	RECT_CLOSED	7.5	4.5	0	0	1
TF04-128	RECT_CLOSED	5.5	4.5	0	0	1
TF04-136	RECT_CLOSED	5.5	4.5	0	0	1
TF04-138	CIRCULAR	4.25	0	0	0	1
TF04-140	CIRCULAR	4	0	0	0	1
TF-04177	IRREGULAR	4177	0	0	0	1
TF-04239	IRREGULAR	4239	0	0	0	1
TF-04301	IRREGULAR	4301	0	0	0	1
TF-04406	IRREGULAR	4406	0	0	0	1
TF-04556	IRREGULAR	4556	0	0	0	1
TF05-108	RECT_CLOSED	4	4.5	0	0	1
TF05-114	CIRCULAR	4.25	0	0	0	1
TF-05301	IRREGULAR	5301	0	0	0	1
TF-05451	IRREGULAR	5451	0	0	0	1
TF-05469	IRREGULAR	5469	0	0	0	1
TF-05619	IRREGULAR	5619	0	0	0	1
TF-05621	IRREGULAR	5621	0	0	0	1
TF-05771	IRREGULAR	5771	0	0	0	1
TF-05871	IRREGULAR	5871	0	0	0	1
TF06-006	CIRCULAR	3.5	0	0	0	1
TF06-008	CIRCULAR	3.5	0	0	0	1
TF06-012	RECT_CLOSED	2.33	3.5	0	0	1
TF06-014	RECT_CLOSED	2.33	3.5	0	0	1

TF06-020	RECT_CLOSED	2.33	3.5	0	0	1
TF-06021	IRREGULAR	6021	0	0	0	1
TF07-106	CIRCULAR	4.5	0	0	0	1
TF07-110	CIRCULAR	4	0	0	0	1
TF07-114	CIRCULAR	4	0	0	0	1
TF07-120	CIRCULAR	4	0	0	0	1
TF07-128	CIRCULAR	4	0	0	0	1
TF-07706	IRREGULAR	7706	0	0	0	1
TF-07826	IRREGULAR	7826	0	0	0	1
TF-07842	IRREGULAR	7842	0	0	0	1
TF-07962	IRREGULAR	7962	0	0	0	1
TF-07966	IRREGULAR	7966	0	0	0	1
TF-08086	IRREGULAR	8086	0	0	0	1
TF08-106	RECT_CLOSED	2.33	3.5	0	0	1
TF-08160	IRREGULAR	8160	0	0	0	1
TF08-210	RECT_CLOSED	2.33	3.5	0	0	1
TF08-212	RECT_CLOSED	2.33	3.5	0	0	1
TF-08280	IRREGULAR	8280	0	0	0	1
TF-08346	IRREGULAR	8346	0	0	0	1
TF-08831	IRREGULAR	8831	0	0	0	1
TF-08911	IRREGULAR	8911	0	0	0	1
TF-08974	IRREGULAR	8974	0	0	0	1
TF-09054	IRREGULAR	9054	0	0	0	1
TF-09061	IRREGULAR	9061	0	0	0	1
TF09-108	RECT_CLOSED	3.25	2.17	0	0	1
TF-09141	IRREGULAR	9141	0	0	0	1
TF-09215	IRREGULAR	9215	0	0	0	1
TF-09261	IRREGULAR	9261	0	0	0	1
TF-09311	IRREGULAR	9311	0	0	0	1
TF-09361	IRREGULAR	9361	0	0	0	1
TF-09856	IRREGULAR	9856	0	0	0	1
TF-09886	IRREGULAR	9886	0	0	0	1
TF-09946	IRREGULAR	9946	0	0	0	1
TF-10001	IRREGULAR	10001	0	0	0	1
TF-10061	IRREGULAR	10061	0	0	0	1
TF10-102	CIRCULAR	7	0	0	0	1
TF10-108	CIRCULAR	4.5	0	0	0	1
TF10-110	CIRCULAR	4	0	0	0	1
TF10-112	CIRCULAR	4	0	0	0	1
TF10-118	CIRCULAR	4	0	0	0	1
TF10-124	CIRCULAR	4	0	0	0	1
TF10-132	CIRCULAR	3.5	0	0	0	1
TF-10561	IRREGULAR	10561	0	0	0	1
TF-10681	IRREGULAR	10681	0	0	0	1
TF-10706	IRREGULAR	10706	0	0	0	1
TF-10731	IRREGULAR	10731	0	0	0	1
TF11-104	RECT_CLOSED	8.5	9.5	0	0	1
TF11-108	RECT_CLOSED	8.5	9.5	0	0	1
TF11-116	CIRCULAR	8.5	0	0	0	1
TF11-124	CIRCULAR	8.5	0	0	0	1
TF11-132	CIRCULAR	8.5	0	0	0	1
TF11-140	CIRCULAR	8.5	0	0	0	1
TF11-144	CIRCULAR	8	0	0	0	1
TF11-152	CIRCULAR	7.5	0	0	0	1
TF11-160	CIRCULAR	7	0	0	0	1
TF11-168	CIRCULAR	5	0	0	0	1
TF11-174	CIRCULAR	4.5	0	0	0	1
TF11-176	CIRCULAR	3.5	0	0	0	1
TF-11251	IRREGULAR	11251	0	0	0	1
TF-11311	IRREGULAR	11311	0	0	0	1
TF12-104	CIRCULAR	4.5	0	0	0	1
TF12-106	CIRCULAR	4	0	0	0	1
TF12-110	CIRCULAR	3	0	0	0	1
TF-12291	IRREGULAR	12291	0	0	0	1
TF-12851	IRREGULAR	12851	0	0	0	1
TF-12911	IRREGULAR	12911	0	0	0	1
TF-12973	IRREGULAR	12973	0	0	0	1
TF-13033	IRREGULAR	13033	0	0	0	1
TF13-106	RECT_CLOSED	4.5	4	0	0	1
TF13-110	CIRCULAR	4.5	0	0	0	1
TF13-118	CIRCULAR	4	0	0	0	1
TF13-122	CIRCULAR	3.5	0	0	0	1
TF-13405	IRREGULAR	13405	0	0	0	1
TF-13776	IRREGULAR	13776	0	0	0	1
TF-13836	IRREGULAR	13836	0	0	0	1
TF-13898	IRREGULAR	13898	0	0	0	1
TF-13958	IRREGULAR	13958	0	0	0	1
TF-14039	IRREGULAR	14039	0	0	0	1
TF14-105	CIRCULAR	3.5	0	0	0	1
TF14-106	RECT_CLOSED	2.5	3.5	0	0	1
TF-14120	IRREGULAR	14120	0	0	0	1
TF-14201	IRREGULAR	14201	0	0	0	1
TF-14282	IRREGULAR	14282	0	0	0	1
TF-14363	IRREGULAR	14363	0	0	0	1
TF-14444	IRREGULAR	14444	0	0	0	1
TF-14544	IRREGULAR	14544	0	0	0	1
TF-14561	IRREGULAR	14561	0	0	0	1
TF-14561A	IRREGULAR	14563	0	0	0	1
TF-14561B	IRREGULAR	14562	0	0	0	1
TF-14601	IRREGULAR	14601	0	0	0	1
TF-15181	IRREGULAR	15181	0	0	0	1
TF-15291	IRREGULAR	15291	0	0	0	1
TF-15304	IRREGULAR	15304	0	0	0	1
TF-15414	IRREGULAR	15414	0	0	0	1
TF-15861	IRREGULAR	15861	0	0	0	1
TF-18081	IRREGULAR	18081	0	0	0	1

TF-18956	IRREGULAR	18956	0	0	0	1
TF-19026	IRREGULAR	19026	0	0	0	1
TF-19057	IRREGULAR	19057	0	0	0	1
TF-19127	IRREGULAR	19127	0	0	0	1
TF1B08160	RECT_CLOSED	17	50	0	0	1
TF-20596	IRREGULAR	20596	0	0	0	1
TF-21926	IRREGULAR	21926	0	0	0	1
TF-22026	IRREGULAR	22026	0	0	0	1
TF-22039	IRREGULAR	22039	0	0	0	1
TF-22139	IRREGULAR	22139	0	0	0	1
TF-22376	IRREGULAR	22376	0	0	0	1
TF-22476	IRREGULAR	22476	0	0	0	1
TF-22586	IRREGULAR	22586	0	0	0	1
TF-22686	IRREGULAR	22686	0	0	0	1
TF-23161	IRREGULAR	23161	0	0	0	1
TF-23971	IRREGULAR	23971	0	0	0	1
TF-24071	IRREGULAR	24071	0	0	0	1
TF-24337	IRREGULAR	24337	0	0	0	1
TF-24437	IRREGULAR	24437	0	0	0	1
TF-25391	IRREGULAR	25391	0	0	0	1
TF-25711	IRREGULAR	25711	0	0	0	1
TF-25841	IRREGULAR	25841	0	0	0	1
TF-25907	IRREGULAR	25907	0	0	0	1
TF-26037	IRREGULAR	26037	0	0	0	1
TF-27181	IRREGULAR	27181	0	0	0	1
TF-27281	IRREGULAR	27281	0	0	0	1
TF-27356	IRREGULAR	27356	0	0	0	1
TF-27966	IRREGULAR	27966	0	0	0	1
TF-28031	IRREGULAR	28031	0	0	0	1
TF-28100	IRREGULAR	28100	0	0	0	1
TF-28101	IRREGULAR	28101	0	0	0	1
TF-28165	IRREGULAR	28165	0	0	0	1
TF-28801	IRREGULAR	28801	0	0	0	1
TF-29001	IRREGULAR	29001	0	0	0	1
TF-29061	IRREGULAR	29061	0	0	0	1
TF-29218	IRREGULAR	29218	0	0	0	1
TF-29278	IRREGULAR	29278	0	0	0	1
TF2B08160	RECT_CLOSED	17	50	0	0	1
TF-30221	IRREGULAR	30221	0	0	0	1
TF-30301	IRREGULAR	30301	0	0	0	1
TF-30328	IRREGULAR	30328	0	0	0	1
TF-30408	IRREGULAR	30408	0	0	0	1
TF-30411	IRREGULAR	30411	0	0	0	1
TF-30486	IRREGULAR	30486	0	0	0	1
TF-30666	IRREGULAR	30666	0	0	0	1
TF-32061	IRREGULAR	32061	0	0	0	1
TFB-00368	RECT_CLOSED	11.7	134	0	0	1
TFB-00973	RECT_CLOSED	13.9	124	0	0	1
TFB-03347	RECT_CLOSED	19.7	122	0	0	1
TFB-03800	RECT_CLOSED	18.6	165	0	0	1
TFB-04177	RECT_CLOSED	18.4	113	0	0	1
TFB-04406	RECT_CLOSED	14.7	114.5	0	0	1
TFB-05469	RECT_CLOSED	13.4	137.5	0	0	1
TFB-05871	RECT_CLOSED	14.3	117.5	0	0	1
TFB-07842	RECT_CLOSED	13.9	120	0	0	1
TFB-08974	RECT_CLOSED	25.1	81	0	0	1
TFB-09215	RECT_CLOSED	24.8	79	0	0	1
TFB-10001	RECT_CLOSED	21.5	100	0	0	1
TFB-11251	RECT_CLOSED	11	61	0	0	1
TFB-12973	RECT_CLOSED	19.8	61	0	0	1
TFB-13898	RECT_CLOSED	25	57.32	0	0	1
TFB-14561	RECT_CLOSED	11.3	104	0	0	1
TFB-15304	RECT_CLOSED	17.6	105	0	0	1
TFB-19057	RECT_CLOSED	12.7	46	0	0	1
TFB-25907	RECT_CLOSED	12.4	75	0	0	1
TFB-28100	RECT_CLOSED	10	64	0	0	1
TFB-29218A	ARCH	21.68	27	0	0	1
TFB-29218B	ARCH	17.52	24	0	0	1
TFB-30328A	TRAPEZOIDAL	5.565	24	0.616	1.233	1
TFB-30328B	TRAPEZOIDAL	10.292	31	0.954	1.073	1
TFB-30328C	TRAPEZOIDAL	7.005	25	1.29	0.806	1
TR15-104	CIRCULAR	9.5	0	0	0	1
TR15-106	CIRCULAR	9.5	0	0	0	1
TR15-110	CIRCULAR	9.5	0	0	0	1
TR15-120	CIRCULAR	9	0	0	0	1
TR15-136	CIRCULAR	8	0	0	0	1
TR15-148	CIRCULAR	8	0	0	0	1
TR15-154	CIRCULAR	7.5	0	0	0	1
TR15-156	CIRCULAR	7.5	0	0	0	1
TR15-158	CIRCULAR	7.5	0	0	0	1
TR15-162	CIRCULAR	7.5	0	0	0	1
TR15-164	CIRCULAR	7	0	0	0	1
TR15-166	CIRCULAR	7	0	0	0	1
TR15-168	CIRCULAR	7	0	0	0	1
TR15-172	CIRCULAR	7	0	0	0	1
TR15-174	CIRCULAR	7	0	0	0	1
TR15-182	CIRCULAR	6.5	0	0	0	1
TR15-190	CIRCULAR	6.5	0	0	0	1
TR15-204	CIRCULAR	6	0	0	0	1
TR15-208	CIRCULAR	6	0	0	0	1
TR15-210	CIRCULAR	6	0	0	0	1
TR15-212	CIRCULAR	5.5	0	0	0	1
TR15-214	CIRCULAR	5.5	0	0	0	1
TR15-216	CIRCULAR	4	0	0	0	1
TR15-218	CIRCULAR	4	0	0	0	1
TR15-220	CIRCULAR	3	0	0	0	1

TR15-222	RECT_CLOSED	3	2	0	0	1
TR15-224	RECT_CLOSED	2.5	1.67	0	0	1
TR15-234	CIRCULAR	1.5	0	0	0	1
TR15-240	CIRCULAR	1.5	0	0	0	1
TR15-250	CIRCULAR	1.5	0	0	0	1
TR15-264	CIRCULAR	1.5	0	0	0	1
TR15-302	CIRCULAR	6.5	0	0	0	1
TR15-304	CIRCULAR	6.5	0	0	0	1
TR15-306	CIRCULAR	6.5	0	0	0	1
TR15-308	CIRCULAR	6.5	0	0	0	1
TR15-310	CIRCULAR	6.5	0	0	0	1
TR15-312	CIRCULAR	6.5	0	0	0	1
TR15-314	CIRCULAR	3	0	0	0	1
TR15-316	CIRCULAR	3	0	0	0	1
TR15-318	CIRCULAR	3	0	0	0	1
TR15-320	CIRCULAR	3	0	0	0	1
TR15-322	CIRCULAR	3	0	0	0	1
TR15-324	CIRCULAR	3	0	0	0	1
TR15-326	CIRCULAR	3	0	0	0	1
TR15-328	CIRCULAR	3	0	0	0	1
TR15-330	CIRCULAR	3	0	0	0	1
TR15-332	CIRCULAR	3	0	0	0	1
TR15-336	CIRCULAR	2	0	0	0	1
TR15-338	CIRCULAR	2	0	0	0	1
TR15-340	CIRCULAR	2	0	0	0	1
TR15-340B	CIRCULAR	1	0	0	0	1
TR15-341	CIRCULAR	2	0	0	0	1
TR15-342	CIRCULAR	2	0	0	0	1
TR15-342B	CIRCULAR	1	0	0	0	1
TR15-344	CIRCULAR	2	0	0	0	1
TR15-344B	CIRCULAR	1	0	0	0	1
TR15-346	CIRCULAR	2	0	0	0	1
TR15-346B	CIRCULAR	1	0	0	0	1
TR15-348	CIRCULAR	2	0	0	0	1
TR15-348B	CIRCULAR	1	0	0	0	1
TR15-350	CIRCULAR	2	0	0	0	1
TR15-350B	CIRCULAR	1	0	0	0	1
TR15-351B	CIRCULAR	1	0	0	0	1
TR15-352	CIRCULAR	2	0	0	0	1
TR15-352B	CIRCULAR	1	0	0	0	1
TR15-354	CIRCULAR	2	0	0	0	1
TR15-354B	CIRCULAR	1	0	0	0	1
TR15-356	CIRCULAR	2	0	0	0	1
TR15-356B	CIRCULAR	1	0	0	0	1
TR15-358	CIRCULAR	2	0	0	0	1
TR15-358B	CIRCULAR	1	0	0	0	1
TR15-360	CIRCULAR	2	0	0	0	1
TR15-360B	CIRCULAR	1	0	0	0	1
TR15-362	CIRCULAR	1.666	0	0	0	1
TR15-362B	CIRCULAR	1	0	0	0	1
TR15-364	CIRCULAR	1	0	0	0	1
TR15-364B	CIRCULAR	1	0	0	0	1
TR15-366	CIRCULAR	1	0	0	0	1
TR15-366B	CIRCULAR	1	0	0	0	1
TR15-368	CIRCULAR	1	0	0	0	1
TR15-368B	CIRCULAR	1	0	0	0	1
TR15-370	CIRCULAR	1	0	0	0	1
TR15-370B	CIRCULAR	1	0	0	0	1
TR15-370C	CIRCULAR	0.833	0	0	0	1
TR15-372	CIRCULAR	1	0	0	0	1
TR15-372C	CIRCULAR	0.833	0	0	0	1
TR15-374	CIRCULAR	1.5	0	0	0	1
TR15-374C	CIRCULAR	0.833	0	0	0	1
TR15-376A	CIRCULAR	1.25	0	0	0	1
TR15-376B	CIRCULAR	1	0	0	0	1
TR15-376C	CIRCULAR	0.833	0	0	0	1
TR15-378A	CIRCULAR	1.25	0	0	0	1
TR15-378B	CIRCULAR	1	0	0	0	1
TR15-380A	CIRCULAR	1.25	0	0	0	1
TR15-380B	CIRCULAR	1	0	0	0	1
TR15-382A	CIRCULAR	1.25	0	0	0	1
TR15-382B	CIRCULAR	1.5	0	0	0	1
TR15-384A	CIRCULAR	1.25	0	0	0	1
TR15-384B	CIRCULAR	1.5	0	0	0	1
TR15-386	CIRCULAR	1.5	0	0	0	1
TR15-388	CIRCULAR	1.5	0	0	0	1
TR15-390	CIRCULAR	1.5	0	0	0	1
TR15-392	CIRCULAR	1.5	0	0	0	1
TR15-394	CIRCULAR	1.5	0	0	0	1
TR15-396	CIRCULAR	1.5	0	0	0	1
TR15-398	CIRCULAR	1.5	0	0	0	1
TR15-400	CIRCULAR	1.5	0	0	0	1
TR15-402	CIRCULAR	1.5	0	0	0	1
TR15-404	CIRCULAR	1.5	0	0	0	1
TR15-406	CIRCULAR	1.5	0	0	0	1
TR15-408	CIRCULAR	1.5	0	0	0	1
TR15-410	CIRCULAR	1.5	0	0	0	1
TR15-412	CIRCULAR	1	0	0	0	1
TR15-412A	CIRCULAR	1	0	0	0	1
TR15-414	CIRCULAR	1	0	0	0	1
TR15-414A	CIRCULAR	1	0	0	0	1
TR15-416	CIRCULAR	1	0	0	0	1
TR15-418	CIRCULAR	1	0	0	0	1
TR15-420	CIRCULAR	1	0	0	0	1
TR15-422	CIRCULAR	1	0	0	0	1
TR15-424	CIRCULAR	1	0	0	0	1

TR15-426	CIRCULAR	1	0	0	0	1
TR15-428	CIRCULAR	1	0	0	0	1
TR15-430	CIRCULAR	1	0	0	0	1
TR15-432	CIRCULAR	1	0	0	0	1
TR15-434	CIRCULAR	1	0	0	0	1
TR15-436	CIRCULAR	1	0	0	0	1
TR15-438	CIRCULAR	1	0	0	0	1
TR15-600	CIRCULAR	3	0	0	0	1
TR15-602	CIRCULAR	3	0	0	0	1
TR15-604	CIRCULAR	3	0	0	0	1
TR15-604A	CIRCULAR	3.5	0	0	0	1
TR15-606	CIRCULAR	3	0	0	0	1
TR15-606A	CIRCULAR	3.5	0	0	0	1
TR15-608	CIRCULAR	3	0	0	0	1
TR15-608A	CIRCULAR	3	0	0	0	1
TR15-610	CIRCULAR	3	0	0	0	1
TR15-610A	CIRCULAR	3	0	0	0	1
TR15-612	CIRCULAR	3	0	0	0	1
TR15-612A	CIRCULAR	3	0	0	0	1
TR15-614	CIRCULAR	3	0	0	0	1
TR15-614A	CIRCULAR	3	0	0	0	1
TR15-616	CIRCULAR	3	0	0	0	1
TR15-618	CIRCULAR	3	0	0	0	1
TR15-702	CIRCULAR	3	0	0	0	1
TR15-704	CIRCULAR	3	0	0	0	1
TR15-706	CIRCULAR	3	0	0	0	1
TR15-708	CIRCULAR	3	0	0	0	1
TR15-710	CIRCULAR	3	0	0	0	1
TR15-712	CIRCULAR	3	0	0	0	1
TR15-714	CIRCULAR	3	0	0	0	1
TR15-716	CIRCULAR	3	0	0	0	1
TR15B1-360	CIRCULAR	0.8333	0	0	0	1
TR15B1-362	CIRCULAR	0.8333	0	0	0	1
TR15B1-364	CIRCULAR	0.8333	0	0	0	1
TR15B1-366	CIRCULAR	0.8333	0	0	0	1
TR15B1-368	CIRCULAR	0.8333	0	0	0	1
TR15B1-370	CIRCULAR	0.8333	0	0	0	1
TR15B1-372	CIRCULAR	0.8333	0	0	0	1
TR15B1-374	CIRCULAR	0.8333	0	0	0	1
TR15B1-376	CIRCULAR	0.8333	0	0	0	1
TR15B1-378	CIRCULAR	0.8333	0	0	0	1
TR15B1-380	CIRCULAR	0.8333	0	0	0	1
TT01-112	RECT_CLOSED	5	5	0	0	1
TT01-118	CIRCULAR	5.5	0	0	0	1
TT01-120	CIRCULAR	5.5	0	0	0	1
TT01-124	CIRCULAR	5	0	0	0	1
TT01-128	CIRCULAR	5	0	0	0	1
TT03-102	CIRCULAR	5	0	0	0	1
TT03-104	CIRCULAR	4.5	0	0	0	1
TT03-106	CIRCULAR	4.5	0	0	0	1
TT03-108	CIRCULAR	4.5	0	0	0	1
TT03-112	CIRCULAR	4.5	0	0	0	1
TT03-116	CIRCULAR	3.5	0	0	0	1
TT03-202	CIRCULAR	4	0	0	0	1
TT03-204	CIRCULAR	3.5	0	0	0	1
TT03-206	CIRCULAR	3.5	0	0	0	1
TT04-102	CIRCULAR	4	0	0	0	1
TT04-104	CIRCULAR	3	0	0	0	1
TT04-106	CIRCULAR	2.5	0	0	0	1
TT04-108	CIRCULAR	2.5	0	0	0	1
TT04-110	CIRCULAR	2.25	0	0	0	1
TT05-102	CIRCULAR	3.5	0	0	0	1
TT05-104	CIRCULAR	3	0	0	0	1
TT06-106	CIRCULAR	7	0	0	0	1
TT06-112	CIRCULAR	7	0	0	0	1
TT06-118	CIRCULAR	6.5	0	0	0	1
TT06-122	CIRCULAR	6	0	0	0	1
TT06-124	CIRCULAR	5.5	0	0	0	1
TT06-126	CIRCULAR	5.5	0	0	0	1
TT06-128	CIRCULAR	5.5	0	0	0	1
TT06-130	CIRCULAR	5	0	0	0	1
TT06-132	CIRCULAR	5	0	0	0	1
TT06-136	CIRCULAR	5	0	0	0	1
TT06-140	CIRCULAR	4.5	0	0	0	1
TT06-144	CIRCULAR	3.5	0	0	0	1
TT07-102	CIRCULAR	3	0	0	0	1
TT07-104	CIRCULAR	3	0	0	0	1
TT08-110	CIRCULAR	12.5	0	0	0	1
TT08-115	CIRCULAR	12	0	0	0	1
TT08-130	CIRCULAR	13.5	0	0	0	1
TT08-138	CIRCULAR	13	0	0	0	1
TT08-153	CIRCULAR	12.5	0	0	0	1
TT08-166	CIRCULAR	12	0	0	0	1
TT08-176	CIRCULAR	11.5	0	0	0	1
TT08-182	CIRCULAR	11	0	0	0	1
TT08-186	CIRCULAR	11	0	0	0	1
TT08-195	CIRCULAR	10.5	0	0	0	1
TT08-204	CIRCULAR	6	0	0	0	1
TT08-207	CIRCULAR	6	0	0	0	1
TT08-210	CIRCULAR	5.5	0	0	0	1
TT08-212	CIRCULAR	5.5	0	0	0	1
TT08-214	CIRCULAR	5.5	0	0	0	1
TT08-216	CIRCULAR	5.5	0	0	0	1
TT08-220	CIRCULAR	5	0	0	0	1
TT08-221	CIRCULAR	4.5	0	0	0	1
TT08-226	CIRCULAR	4.5	0	0	0	1

TT08-228	CIRCULAR	4.5	0	0	0	1
TT08-231	CIRCULAR	4.5	0	0	0	1
TT08-234	CIRCULAR	4	0	0	0	1
TT08-237	CIRCULAR	4	0	0	0	1
TT08-240	CIRCULAR	3.5	0	0	0	1
TT08-242	CIRCULAR	3.5	0	0	0	1
TT08-246	RECT_CLOSED	3.5	3.5	0	0	1
TT08-250	RECT_CLOSED	3	3	0	0	1
TT08-254	RECT_CLOSED	3	3	0	0	1
TT08-258	RECT_CLOSED	3	3	0	0	1
TT08-264	RECT_CLOSED	3	3	0	0	1
TT09-102	CIRCULAR	4	0	0	0	1
TT09-108	RECT_CLOSED	2	3	0	0	1
TT09-302	RECT_CLOSED	2.5	1.67	0	0	1
TT09-304	RECT_CLOSED	2.5	1.67	0	0	1
TT09-314	RECT_CLOSED	2.5	1.67	0	0	1
TT09-402	RECT_CLOSED	3	2	0	0	1
TT09-404	RECT_CLOSED	2.5	1.67	0	0	1
TT09-412	RECT_CLOSED	2.5	1.67	0	0	1
TT09-414	RECT_CLOSED	2.25	1.5	0	0	1
TT10-102	CIRCULAR	5	0	0	0	1
TT10-104	CIRCULAR	5	0	0	0	1
TT10-106	CIRCULAR	5	0	0	0	1
TT10-108	CIRCULAR	5	0	0	0	1
TT10-110	CIRCULAR	4.5	0	0	0	1
TT10-112	CIRCULAR	4	0	0	0	1
TT11-102	CIRCULAR	3	0	0	0	1
TT11-104	CIRCULAR	3	0	0	0	1
TT12-102	CIRCULAR	2	0	0	0	1
TT12-104	CIRCULAR	1.5	0	0	0	1
TT12-106	CIRCULAR	1.5	0	0	0	1
TT13-102	CIRCULAR	4.75	0	0	0	1
TT13-104	CIRCULAR	4.75	0	0	0	1
TT13-106	CIRCULAR	4.75	0	0	0	1
TT13-108	CIRCULAR	4.75	0	0	0	1
TT13-110	CIRCULAR	4.5	0	0	0	1
TT13-112	CIRCULAR	4.5	0	0	0	1
TT13-114	CIRCULAR	4.5	0	0	0	1
TT13-116	CIRCULAR	4.5	0	0	0	1
TT13-118	CIRCULAR	4	0	0	0	1
TT13-120	CIRCULAR	4	0	0	0	1
TT13-122	CIRCULAR	4	0	0	0	1
TT13-124	CIRCULAR	4	0	0	0	1
TT13-126	CIRCULAR	3.5	0	0	0	1
TT13-130	CIRCULAR	3.5	0	0	0	1
TT13-204	CIRCULAR	3.5	0	0	0	1
TT13-208	CIRCULAR	3.5	0	0	0	1
TT14-007	RECT_CLOSED	21	24	0	0	1
TT14-016	RECT_CLOSED	21	24	0	0	1
TT14-022	RECT_CLOSED	21	24	0	0	1
TT14-030	RECT_CLOSED	21	24	0	0	1
TT14-034	RECT_CLOSED	19	22	0	0	1
TT14-046	RECT_CLOSED	18	21	0	0	1
TT14-048	RECT_CLOSED	18	21	0	0	1
TT14-050	CIRCULAR	17.5	0	0	0	1
TT14-052	CIRCULAR	17.5	0	0	0	1
TT14-054	CIRCULAR	17.5	0	0	0	1
TT14-056	CIRCULAR	17.5	0	0	0	1
TT14-058	RECT_CLOSED	24	13.5	0	0	1
TT14-060	CIRCULAR	17.5	0	0	0	1
TT14-064	CIRCULAR	17.5	0	0	0	1
TT14-068	CIRCULAR	17.5	0	0	0	1
TT14-070	CIRCULAR	17.25	0	0	0	1
TT14-072	CIRCULAR	17.25	0	0	0	1
TT14-074	CIRCULAR	16	0	0	0	1
TT14-076	CIRCULAR	15	0	0	0	1
TT14-078	CIRCULAR	14	0	0	0	1
TT14-082	CIRCULAR	14	0	0	0	1
TT14-084	CIRCULAR	14	0	0	0	1
TT14-086	CIRCULAR	14	0	0	0	1
TT14-088	CIRCULAR	14	0	0	0	1
TT14-092	CIRCULAR	14	0	0	0	1
TT14-094	RECT_CLOSED	14	14	0	0	1
TT14-102	RECT_CLOSED	15	17	0	0	1
TT14-104	RECT_CLOSED	12	21	0	0	1
TT14-106	RECT_CLOSED	12	21	0	0	1
TT14-107	RECT_CLOSED	16	17	0	0	1
TT14-108	RECT_CLOSED	16	17	0	0	1
TT14-110	RECT_CLOSED	16	17	0	0	1
TT14-112	RECT_CLOSED	16	14	0	0	1
TT14-118	CIRCULAR	8	0	0	0	1
TT14-120	CIRCULAR	8	0	0	0	1
TT14-126	CIRCULAR	7.5	0	0	0	1
TT14-200A	RECT_CLOSED	6	10.17	0	0	1
TT14-200B	RECT_CLOSED	6	11.5	0	0	1
TT14-200C	RECT_CLOSED	6	10.17	0	0	1
TT14-200D	RECT_CLOSED	6	9.17	0	0	1
TT14-200E	RECT_CLOSED	6	10.75	0	0	1
TT14-200F	RECT_CLOSED	6	9.17	0	0	1
TT14-202	RECT_CLOSED	15	20	0	0	1
TT14-203	RECT_CLOSED	15	20	0	0	1
TT14-204	RECT_CLOSED	15	20	0	0	1
TT14-205	RECT_CLOSED	15	20	0	0	1
TT14-206	RECT_CLOSED	15	20	0	0	1
TT14-207	RECT_CLOSED	15	20	0	0	1
TT14-208	RECT_CLOSED	15	20	0	0	1

TT14-209	RECT_CLOSED	15	20	0	0	1
TT14-210	RECT_CLOSED	15	20	0	0	1
TT14-211	RECT_CLOSED	15	20	0	0	1
TT14-212	RECT_CLOSED	15	20	0	0	1
TT14-213	RECT_CLOSED	15	20	0	0	1
TT14-214	RECT_CLOSED	15	20	0	0	1
TT14-215	RECT_CLOSED	15	20	0	0	1
TT14-216	RECT_CLOSED	15	20	0	0	1
TT14-217	RECT_CLOSED	15	20	0	0	1
TT14-218	RECT_CLOSED	15	20	0	0	1
TT14-219	RECT_CLOSED	15	20	0	0	1
TT14-220	RECT_CLOSED	15	20	0	0	1
TT14-221	RECT_CLOSED	15	20	0	0	1
TT14-222	RECT_CLOSED	15	20	0	0	1
TT14-222B	RECT_CLOSED	15	20	0	0	1
TT14-224	RECT_CLOSED	15	17	0	0	1
TT14-226	RECT_CLOSED	15	17	0	0	1
TT14-228	RECT_CLOSED	15	17	0	0	1
TT14-230	RECT_CLOSED	13	22	0	0	1
TT14-232	RECT_CLOSED	13	22	0	0	1
TT14-234	RECT_CLOSED	13	22	0	0	1
TT14-236	RECT_CLOSED	13	22	0	0	1
TT14-238	RECT_CLOSED	13	21.5	0	0	1
TT14-240	RECT_CLOSED	13	21.5	0	0	1
TT14-242	RECT_CLOSED	13	21.5	0	0	1
TT14-243	RECT_CLOSED	13	21.5	0	0	1
TT14-246	CIRCULAR	9.5	0	0	0	1
TT14-248	CIRCULAR	9.5	0	0	0	1
TT14-252	CIRCULAR	9.5	0	0	0	1
TT14-256	CIRCULAR	9.5	0	0	0	1
TT14-258	CIRCULAR	12	0	0	0	1
TT14-260	CIRCULAR	12	0	0	0	1
TT14-262	CIRCULAR	12	0	0	0	1
TT14-263	CIRCULAR	9	0	0	0	1
TT14-264	CIRCULAR	8.5	0	0	0	1
TT14-266	CIRCULAR	8.5	0	0	0	1
TT14-268	CIRCULAR	8.5	0	0	0	1
TT14-270	CIRCULAR	8.5	0	0	0	1
TT14-272	CIRCULAR	8.5	0	0	0	1
TT14-275	CIRCULAR	8.5	0	0	0	1
TT14-278	CIRCULAR	8.25	0	0	0	1
TT14-280	CIRCULAR	8.25	0	0	0	1
TT14-282	CIRCULAR	8.25	0	0	0	1
TT14-284	CIRCULAR	8.25	0	0	0	1
TT14-288	CIRCULAR	8.25	0	0	0	1
TT14-290	CIRCULAR	8.25	0	0	0	1
TT14-291	CIRCULAR	8.25	0	0	0	1
TT14-292	CIRCULAR	8.25	0	0	0	1
TT14-294	CIRCULAR	8.25	0	0	0	1
TT14-296	CIRCULAR	8.25	0	0	0	1
TT14-302	CIRCULAR	6.5	0	0	0	1
TT14-304	CIRCULAR	6.5	0	0	0	1
TT14-306	CIRCULAR	6.5	0	0	0	1
TT14-308	CIRCULAR	6.5	0	0	0	1
TT14-310	CIRCULAR	6.5	0	0	0	1
TT14-404	RECT_CLOSED	6	5	0	0	1
TT14-406	RECT_CLOSED	6	5	0	0	1
TT14-410	RECT_CLOSED	6	5	0	0	1
TT14-412	RECT_CLOSED	6	5	0	0	1
TT14-414	RECT_CLOSED	6	5	0	0	1
TT14-416	RECT_CLOSED	6	5	0	0	1
TT14-418	RECT_CLOSED	6	5	0	0	1
TT14-502	RECT_CLOSED	14	9.5	0	0	1
TT14-503	RECT_CLOSED	14	9.5	0	0	1
TT14-503A	RECT_CLOSED	14	9.5	0	0	1
TT14-503B	RECT_CLOSED	14	9.5	0	0	1
TT14-504	RECT_CLOSED	14	9.5	0	0	1
TT14-504A	RECT_CLOSED	14	9.5	0	0	1
TT14-504B	RECT_CLOSED	14	9.5	0	0	1
TT14-505	RECT_CLOSED	14	9.5	0	0	1
TT14-505A	RECT_CLOSED	14	9.5	0	0	1
TT14-505B	RECT_CLOSED	14	9.5	0	0	1
TT14-506	RECT_CLOSED	14	9.5	0	0	1
TT14-506A	RECT_CLOSED	14	9.5	0	0	1
TT14-506B	RECT_CLOSED	14	9.5	0	0	1
TT14-507	RECT_CLOSED	14	9.5	0	0	1
TT14-507A	RECT_CLOSED	14	9.5	0	0	1
TT14-507B	RECT_CLOSED	14	9.5	0	0	1
TT14-508	RECT_CLOSED	14	9.5	0	0	1
TT14-508A	RECT_CLOSED	14	9.5	0	0	1
TT14-508B	RECT_CLOSED	14	9.5	0	0	1
TT14-509	RECT_CLOSED	14	9.5	0	0	1
TT14-509A	RECT_CLOSED	14	9.5	0	0	1
TT14-509B	RECT_CLOSED	14	9.5	0	0	1
TT14-510	RECT_CLOSED	14	9.5	0	0	1
TT14-510A	RECT_CLOSED	14	9.5	0	0	1
TT14-510B	RECT_CLOSED	14	9.5	0	0	1
TT14-511	RECT_CLOSED	14	9.5	0	0	1
TT14-511A	RECT_CLOSED	14	9.5	0	0	1
TT14-512	RECT_CLOSED	14	9.5	0	0	1
TT14-512A	RECT_CLOSED	14	9.5	0	0	1
TT14-513	RECT_CLOSED	14	9.5	0	0	1
TT14-514	RECT_CLOSED	14	9.5	0	0	1
TT14-516	RECT_CLOSED	14	9.5	0	0	1
TT14-516P1	RECT_CLOSED	14	9.5	0	0	1
TT14-518	CIRCULAR	10	0	0	0	1

TT14-520	CIRCULAR	10	0	0	0	1
TT14-524	CIRCULAR	10	0	0	0	1
TT14-526	CIRCULAR	9.5	0	0	0	1
TT14-528	CIRCULAR	9.5	0	0	0	1
TT14-530	CIRCULAR	9.5	0	0	0	1
TT14-532	CIRCULAR	9	0	0	0	1
TT14-534	CIRCULAR	9	0	0	0	1
TT14-536	CIRCULAR	9	0	0	0	1
TT14-538	CIRCULAR	9	0	0	0	1
TT14-540	CIRCULAR	9	0	0	0	1
TT14-542	CIRCULAR	9	0	0	0	1
TT14-544	CIRCULAR	9	0	0	0	1
TT14-546	CIRCULAR	9	0	0	0	1
TT14-550	CIRCULAR	8.5	0	0	0	1
TT14-552	CIRCULAR	8.5	0	0	0	1
TT14-554	CIRCULAR	8.5	0	0	0	1
TT14-556	CIRCULAR	8.5	0	0	0	1
TT14-558	CIRCULAR	8.5	0	0	0	1
TT14-560	CIRCULAR	8.5	0	0	0	1
TT14-562	CIRCULAR	8.5	0	0	0	1
TT14-564	CIRCULAR	8.5	0	0	0	1
TT14-566	CIRCULAR	8.5	0	0	0	1
TT14-570	CIRCULAR	8.5	0	0	0	1
TT14-572	CIRCULAR	8.5	0	0	0	1
TT14-574	CIRCULAR	8.5	0	0	0	1
TT14-576	CIRCULAR	8.5	0	0	0	1
TT14-578	CIRCULAR	8.5	0	0	0	1
TT14-582	CIRCULAR	8.5	0	0	0	1
TT14-584	CIRCULAR	8.5	0	0	0	1
TT14-586	CIRCULAR	8.5	0	0	0	1
TT14-588	RECT_CLOSED	8	7	0	0	1
TT14-590	RECT_CLOSED	8	7.5	0	0	1
TT14-592	RECT_CLOSED	8	7.5	0	0	1
TT14-594	RECT_CLOSED	8	7.5	0	0	1
TT14-597	RECT_CLOSED	8	7.5	0	0	1
TT14-598	RECT_CLOSED	8	7.5	0	0	1
TT14-599	RECT_CLOSED	8	7.5	0	0	1
TT14-602	CIRCULAR	8.25	0	0	0	1
TT14-605	RECT_CLOSED	10	9	0	0	1
TT14-606	RECT_CLOSED	11.5	8	0	0	1
TT14-608	CIRCULAR	7.5	0	0	0	1
TT14-610	CIRCULAR	7.5	0	0	0	1
TT14-612	CIRCULAR	7.5	0	0	0	1
TT14-614	CIRCULAR	7.5	0	0	0	1
TT14-616	CIRCULAR	7.5	0	0	0	1
TT14-618	CIRCULAR	7.5	0	0	0	1
TT14-620	CIRCULAR	7.5	0	0	0	1
TT14-622	RECT_CLOSED	12	8	0	0	1
TT14-624	RECT_CLOSED	10.5	7	0	0	1
TT14-626	RECT_CLOSED	10.5	7	0	0	1
TT14-628	RECT_CLOSED	10.5	7	0	0	1
TT14-630	RECT_CLOSED	10.5	7	0	0	1
TT14-632	RECT_CLOSED	10.5	7	0	0	1
TT14-634	RECT_CLOSED	10.5	7	0	0	1
TT14-636	RECT_CLOSED	10.5	7	0	0	1
TT14-639	CIRCULAR	7	0	0	0	1
TT14-642	CIRCULAR	6	0	0	0	1
TT14-644	CIRCULAR	6	0	0	0	1
TT14-646	CIRCULAR	6	0	0	0	1
TT14-650	CIRCULAR	4	0	0	0	1
TT14-654	CIRCULAR	4	0	0	0	1
TT14-656	CIRCULAR	4	0	0	0	1
TT14-660	CIRCULAR	4	0	0	0	1
TT14-664	CIRCULAR	3.5	0	0	0	1
TT14-668	CIRCULAR	3.5	0	0	0	1
TT14-672	CIRCULAR	3.5	0	0	0	1
TT14-676	CIRCULAR	3.5	0	0	0	1
TT14-678	RECT_CLOSED	3.5	2.333	0	0	1
TT14-682	RECT_CLOSED	3.5	3.5	0	0	1
TT14-684	RECT_CLOSED	3.5	2.333	0	0	1
TT14-686	RECT_CLOSED	3.5	2.333	0	0	1
TT14-688	RECT_CLOSED	3.5	2.333	0	0	1
TT14-692	RECT_CLOSED	3.5	3.5	0	0	1
TT14-702	RECT_CLOSED	8	7.5	0	0	1
TT14-704	RECT_CLOSED	8	7.5	0	0	1
TT14-706	RECT_CLOSED	8	7.5	0	0	1
TT14-708	RECT_CLOSED	8	7.5	0	0	1
TT14-710	RECT_CLOSED	8	7.5	0	0	1
TT14-712	RECT_CLOSED	8	7.5	0	0	1
TT14-713	RECT_CLOSED	8	7.5	0	0	1
TT14-716	RECT_CLOSED	7.5	7.5	0	0	1
TT14-720	RECT_CLOSED	7.5	7.5	0	0	1
TT14-722	RECT_CLOSED	7.5	7.5	0	0	1
TT14-724	RECT_CLOSED	7.5	6	0	0	1
TT14-727	RECT_CLOSED	7.5	6	0	0	1
TT14-728	RECT_CLOSED	7.5	6	0	0	1
TT14-730	RECT_CLOSED	7.5	6	0	0	1
TT14-733	RECT_CLOSED	6	5	0	0	1
TT14-734	RECT_CLOSED	6	5	0	0	1
TT14-736	RECT_CLOSED	6	5	0	0	1
TT14-738	RECT_CLOSED	6	5	0	0	1
TT14-740	CIRCULAR	5	0	0	0	1
TT14-742	CIRCULAR	5	0	0	0	1
TT14-744	CIRCULAR	5	0	0	0	1
TT14-746	CIRCULAR	5	0	0	0	1
TT14-804	RECT_CLOSED	7	8	0	0	1

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TT14-806          RECT_CLOSED  6.5      8          0          0          1
TT14-807          RECT_CLOSED  6.5      8          0          0          1
TT14-808          RECT_CLOSED  6        8          0          0          1
TT14-811          RECT_CLOSED  6        8          0          0          1
TT14-812          RECT_CLOSED  6        6.5        0          0          1
TT14-814          RECT_CLOSED  6        8          0          0          1
TT14-815          RECT_CLOSED  6        7          0          0          1
TT14-816          RECT_CLOSED  5        5          0          0          1
TT14-818          RECT_CLOSED  5        5          0          0          1
TT14-822          CIRCULAR     5        0          0          0          1
TT14-824          CIRCULAR     5        0          0          0          1
TT14-826          CIRCULAR     3.5      0          0          0          1
TT14-828          CIRCULAR     4.5      0          0          0          1
TT14-830          CIRCULAR     4        0          0          0          1
TT14-902          CIRCULAR     7        0          0          0          1
TT14-904          CIRCULAR     7        0          0          0          1
TT14-906          CIRCULAR     7        0          0          0          1
TT14-908          CIRCULAR     7        0          0          0          1
TT14-910          CIRCULAR     7        0          0          0          1
TT15-010          CIRCULAR     5.5      0          0          0          1
TT15-012          CIRCULAR     5.5      0          0          0          1
TT15-016          CIRCULAR     5.5      0          0          0          1
TT15-022          CIRCULAR     5        0          0          0          1
TT15-024          CIRCULAR     4        0          0          0          1
TT15-034          CIRCULAR     4        0          0          0          1
TT15-038          CIRCULAR     4        0          0          0          1
ORIFICE1@F13-F13Z RECT_CLOSED  0.65      0.81       0          0
ORIFICE2@F14-F14Z RECT_CLOSED  0.44      0.5        0          0
ORIFICE3@21005-21006 CIRCULAR     4.38498   0          0          0

[TRANSECTS]
;;--------------------------------------------------------------------------------------------

;Natural       Channel ID:     200
NC 0.085    0.085     0.03
X1 200                14        500      658      0.0      0.0      0.0      0        0
GR 100      0         14.38     1        4.28     2        4.28     500      0.78     501
GR -7.22    518       -10.52    524      -11.22   635      -7.22    643      0.78     657
GR 4.28     658       4.28      1158     14.38    1159     100      1160

;Natural       Channel ID:     350
NC 0.074    0.074     0.03
X1 350                14        500      658      0.0      0.0      0.0      0        0
GR 100      0         14.38     1        4.28     2        4.28     500      0.78     501
GR -7.22    518       -10.52    524      -11.22   635      -7.22    643      0.78     657
GR 4.28     658       4.28      1158     14.38    1159     100      1160

;Natural       Channel ID:     368
NC 0.02     0.02      0.02
X1 368               10        0        1160     0.0      0.0      0.0      0        0
GR 100      0         14.38     1        4.28     2        4.28     500      7.48     501
GR 7.48     657       4.28      658      4.28     1158     14.38    1159     100      1160

;Natural       Channel ID:     518
NC 0.074    0.074     0.03
X1 518                14        500      658      0.0      0.0      0.0      0        0
GR 100      0         14.38     1        4.28     2        4.28     500      0.78     501
GR -7.22    518       -10.52    524      -11.22   635      -7.22    643      0.78     657
GR 4.28     658       4.28      1158     14.38    1159     100      1160

;Natural       Channel ID:     780
NC 0.085    0.085     0.03
X1 780                16        500      648      0.0      0.0      0.0      0        0
GR 100      0         14.38     1        6.08     2        6.08     500      1.78     501
GR -0.12    502       -5.72     511      -12.42   523      -11.82   624      -5.72    636
GR -0.22    646       1.78      647      6.08     648      6.08     1294     14.38    1295
GR 100      1296

;Natural       Channel ID:     940
NC 0.1      0.1       0.04
X1 940                16        500      648      0.0      0.0      0.0      0        0
GR 100      0         14.38     1        6.08     2        6.08     500      1.78     501
GR -0.12    502       -5.72     511      -12.42   523      -11.82   624      -5.72    636
GR -0.22    646       1.78      647      6.08     648      6.08     1294     14.38    1295
GR 100      1296

;Natural       Channel ID:     973
NC 0.02     0.02      0.02
X1 973                10        0        1296     0.0      0.0      0.0      0        0
GR 100      0         14.38     1        6.08     2        6.08     500      10.38    501
GR 10.38    647       6.08      648      6.08     1294     14.38    1295     100      1296

;Natural       Channel ID:     1133
NC 0.1      0.1       0.04
X1 1133               16        500      648      0.0      0.0      0.0      0        0
GR 100      0         14.38     1        6.08     2        6.08     500      1.78     501
GR -0.12    502       -5.72     511      -12.42   523      -11.82   624      -5.72    636
GR -0.22    646       1.78      647      6.08     648      6.08     1294     14.38    1295
GR 100      1296

;Natural       Channel ID:     2905
NC 0.085    0.085     0.03
X1 2905               29        238      360      0.0      0.0      0.0      0        0
GR 100      0         25.48     0.1      20.18    13       20.98    34       20.38    60
GR 13.58    89        11.68     208      11.18    220      -4.42    238      -7.82    244
GR -10.42   250       -9.82     257      -9.02    267      -9.32    276      -10.42   288
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GR -9.32     301      -9.22     315      -9.42     329      -10.22    341      -7.82     351
GR -1.62     360      4.28      377      4.08      378      12.28     391      13.28     460
GR 13.88     466      17.48     478      28.88     498      100       499

;Natural       Channel ID:      3135
NC 0.085     0.085    0.03
X1 3135               29        238      360       0.0      0.0       0.0      0         0
GR 100       0        25.48     0.1      20.18     13       20.98     34       20.38     60
GR 13.58     89       13.68     208      13.18     220      -4.42     238      -7.82     244
GR -10.42    250      -9.82     257      -9.02     267      -9.32     276      -10.42    288
GR -9.32     301      -9.22     315      -9.42     329      -10.22    341      -7.82     351
GR -1.62     360      13.28     377      13.08     378      13.28     391      13.28     460
GR 13.88     466      17.48     478      28.88     498      100       499

;Natural       Channel ID:      3285
NC 0.085     0.085    0.03
X1 3285               18        225      377       0.0      0.0       0.0      0         0
GR 100       0        25.88     1        20.58     13       21.38     34       20.78     60
GR 14.98     85       14.48     225      2.28      226      -4.72     243      -9.52     253
GR -10.02    347      -4.72     358      2.38      376      14.28     377      15.18     470
GR 17.98     478      29.28     498      100       499

;Natural       Channel ID:      3347
NC 0.02      0.02     0.02
X1 3347               14        0        499       0.0      0.0       0.0      0         0
GR 100       0        25.88     1        20.58     13       21.38     34       20.78     60
GR 14.98     85       14.48     225      17.58     226      17.38     376      14.28     377
GR 15.18     470      17.98     478      29.28     498      100       499

;Natural       Channel ID:      3497
NC 0.085     0.085    0.03
X1 3497               29        238      360       0.0      0.0       0.0      0         0
GR 100       0        51.88     0.1      28.78     1        21.38     34       20.78     60
GR 13.98     89       11.08     208      4.58      220      -4.02     238      -7.42     244
GR -10.02    250      -9.42     257      -8.62     267      -8.92     276      -10.02    288
GR -8.92     301      -8.82     315      -9.02     329      -9.82     341      -7.42     351
GR -1.22     360      4.68      377      4.48      378      12.68     391      13.68     460
GR 14.28     466      17.88     478      29.28     498      100       499

;Natural       Channel ID:      3605
NC 0.085     0.085    0.03
X1 3605               29        238      360       0.0      0.0       0.0      0         0
GR 100       0        51.88     0.1      28.78     1        21.38     34       20.78     60
GR 13.98     89       11.08     208      4.58      220      -4.02     238      -7.42     244
GR -10.02    250      -9.42     257      -8.62     267      -8.92     276      -10.02    288
GR -8.92     301      -8.82     315      -9.02     329      -9.82     341      -7.42     351
GR -1.22     360      4.68      377      4.48      378      12.68     391      13.68     460
GR 14.28     466      17.88     478      29.28     498      100       499

;Natural       Channel ID:      3755
NC 0.085     0.085    0.03
X1 3755               17        250      471       0.0      0.0       0.0      0         0
GR 100       0        30.28     1        28.08     100      25.88     150      20.98     250
GR 12.78     251      -0.82     290      -7.52     305      -9.12     359      -9.52     416
GR -0.82     450      7.18      470      12.98     471      11.78     520      18.48     538
GR 29.78     558      100       559

;Natural       Channel ID:      3800
NC 0.02      0.02     0.02
X1 3800               12        0        559       0.0      0.0       0.0      0         0
GR 100       0        30.28     1        28.08     100      25.88     150      20.98     250
GR 23.68     251      15.68     470      12.98     471      11.78     520      18.48     538
GR 29.78     558      100       559

;Natural       Channel ID:      3950
NC 0.085     0.085    0.03
X1 3950               29        208      391       0.0      0.0       0.0      0         0
GR 100       0        52.38     0.1      29.28     1        21.88     34       21.28     60
GR 14.48     89       11.58     208      11.58     220      -3.52     238      -6.92     244
GR -9.52     250      -8.92     257      -8.12     267      -8.42     276      -9.52     288
GR -8.42     301      -8.32     315      -8.52     329      -9.32     341      -6.92     351
GR -0.72     360      11.58     377      11.58     378      13.18     391      14.18     460
GR 14.78     466      18.38     478      29.78     498      100       499

;Natural       Channel ID:      3975
NC 0.085     0.085    0.033
X1 3975               29        744      851       0.0      0.0       0.0      0         0
GR 100       0        17.08     40       13.68     215      6.68      510      7.58      615
GR 7.28      717      5.98      720      -2.62     737      -6.02     744      -8.62     750
GR -8.02     757      -7.82     760      -7.32     765      -7.22     767      -7.52     776
GR -8.62     788      -7.62     802      -7.42     815      -7.62     829      -8.42     841
GR -6.02     851      0.18      860      6.08      877      14.08     891      14.98     960
GR 15.68     966      19.28     978      30.68     998      100       999

;Natural       Channel ID:      4125
NC 0.085     0.085    0.03
X1 4125               15        675      826       0.0      0.0       0.0      0         0
GR 100       0        17.18     1        14.08     575      14.78     675      2.48      676
GR -3.22     691      -8.62     711      -7.42     788      -3.22     808      3.88      825
GR 15.48     826      16.68     920      19.18     927      30.68     948      100       949

;Natural       Channel ID:      4177
NC 0.085     0.085    0.03
X1 4177               11        0        949       0.0      0.0       0.0      0         0
GR 100       0        17.18     1        14.08     575      14.78     675      18.08     676
GR 18.58     825      15.48     826      16.68     920      19.18     927      30.68     948
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GR 100      949

;Natural     Channel ID:     4239
NC 0.085    0.085     0.03
X1 4239               29        744      851      0.0     0.0      0.0     0       0
GR 100      0         17.08     40       13.68    215     6.68     510     7.58    615
GR 7.28     717       5.98      720      -2.62    737     -6.02    744     -8.62   750
GR -8.02    757       -7.82     760      -7.32    765     -7.22    767     -7.52   776
GR -8.62    788       -7.62     802      -7.42    815     -7.62    829     -8.42   841
GR -6.02    851       0.18      860      6.08     877     14.08    891     14.98   960
GR 15.68    966       19.28     978      30.68    998     100      999

;Natural     Channel ID:     4301
NC 0.085    0.085     0.03
X1 4301               14        720      875      0.0     0.0      0.0     0       0
GR 100      0         14.48     2        10.88    720     6.98     721     0.08    737
GR -8.12    754       -7.82     830      0.08     856     6.38     874     10.28   875
GR 9.98     942       21.08     978      32.48    998     100      999

;Natural     Channel ID:     4406
NC 0.02     0.02      0.02
X1 4406               10        1        999      0.0     0.0      0.0     0       0
GR 100      1         14.48     2        10.88    720     14.28    721     13.68   874
GR 10.28    875       9.98      942      21.08    978     32.48    998     100     999

;Natural     Channel ID:     4556
NC 0.085    0.085     0.03
X1 4556               29        744      851      0.0     0.0      0.0     0       0
GR 100      0         17.58     40       14.18    215     7.18     510     8.08    615
GR 7.78     717       6.48      720      -2.12    737     -5.52    744     -8.12   750
GR -7.52    757       -7.32     760      -6.82    765     -6.72    767     -7.02   776
GR -8.12    788       -7.12     802      -6.92    815     -7.12    829     -7.92   841
GR -5.52    851       0.68      860      6.58     877     14.58    891     15.48   960
GR 16.18    966       19.78     978      31.18    998     100      999

;Natural     Channel ID:     5301
NC 0.085    0.085     0.03
X1 5301               29        720      877      0.0     0.0      0.0     0       0
GR 100      0         15.78     40       12.38    215     5.38     510     6.28    615
GR 5.98     717       4.68      720      -3.92    737     -7.32    744     -9.92   750
GR -9.32    757       -9.12     760      -8.62    765     -8.52    767     -8.82   776
GR -9.92    788       -8.92     802      -8.72    815     -8.92    829     -9.72   841
GR -7.32    851       -1.12     860      4.78     877     12.78    891     13.68   960
GR 14.38    966       17.98     978      29.38    998     100      999

;Natural     Channel ID:     5451
NC 0.085    0.085     0.04
X1 5451               18        720      879      0.0     0.0      0.0     0       0
GR 100      0         17.18     1        10.08    510     10.08    720     5.88    721
GR 5.88     723       -1.82     724      -7.22    734     -7.62    857     -1.82   868
GR 1.08     874       5.88      875      5.88     878     10.08    879     10.08   960
GR 18.28    978       29.68     998      100      999

;Natural     Channel ID:     5469
NC 0.04     0.04      0.04
X1 5469               10        0        979      0.0     0.0      0.0     0       0
GR 100      0         17.18     1        10.08    510     10.08    720     12.88   721
GR 12.88    878       10.08     879      10.08    960     18.28    978     100     979

;Natural     Channel ID:     5619
NC 0.085    0.085     0.03
X1 5619               29        720      877      0.0     0.0      0.0     0       0
GR 100      0         18.08     40       14.68    215     7.68     510     8.58    615
GR 8.28     717       6.98      720      -1.62    737     -5.02    744     -7.62   750
GR -7.02    757       -6.82     760      -6.32    765     -6.22    767     -6.52   776
GR -7.62    788       -6.62     802      -6.42    815     -6.62    829     -7.42   841
GR -5.02    851       1.18      860      7.08     877     15.08    891     15.98   960
GR 16.68    966       20.28     978      31.68    998     100      999

;Natural     Channel ID:     5621
NC 0.085    0.085     0.03
X1 5621               29        720      877      0.0     0.0      0.0     0       0
GR 100      0         15.58     40       12.18    215     5.18     510     6.08    615
GR 5.78     717       4.48      720      -4.12    737     -7.52    744     -10.12  750
GR -9.52    757       -9.32     760      -8.82    765     -8.72    767     -9.02   776
GR -10.12   788       -9.12     802      -8.92    815     -9.12    829     -9.92   841
GR -7.52    851       -1.32     860      4.58     877     12.58    891     13.48   960
GR 14.18    966       17.78     978      29.18    998     100      999

;Natural     Channel ID:     5771
NC 0.085    0.085     0.03
X1 5771               15        725      882      0.0     0.0      0.0     0       0
GR 100      0         18.48     40       11.48    356     11.48    725     0.08    726
GR -1.32    733       -6.22     763      -7.32    843     -1.32    875     0.38    881
GR 11.48    882       11.48     948      20.48    979     31.98    998     100     999

;Natural     Channel ID:     5871
NC 0.04     0.04      0.04
X1 5871               10        39       998      0.0     0.0      0.0     0       0
GR 100      39        18.48     40       11.48    356     11.48    725     15.38   726
GR 15.38    881       11.48     882      11.48    948     20.48    979     100     998

;Natural     Channel ID:     6021
NC 0.085    0.085     0.03
X1 6021               29        720      877      0.0     0.0      0.0     0       0
GR 100      0         18.38     40       14.98    215     7.98     510     8.88    615
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GR 8.58     717      7.28     720      -1.32    737      -4.72    744      -7.32    750
GR -6.72    757      -6.52    760      -6.02    765      -5.92    767      -6.22    776
GR -7.32    788      -6.32    802      -6.12    815      -6.32    829      -7.12    841
GR -4.72    851      1.48     860      7.38     877      15.38    891      16.28    960
GR 16.98    966      20.58    978      31.98    998      100      999

;Natural      Channel ID:    7706
NC 0.085    0.085    0.03
X1 7706              28       0.1      1243     0.0      0.0      0.0      0        0
GR 100      0        18.98    0.1      14.38    224      11.88    402      9.78     514
GR 9.75     698      9.7      804      9.65     960      9.58     961      -4.62    962
GR -5.22    963      -5.22    973      -5.62    988      -6.72    1003     -6.92    1018
GR -5.02    1033     -5.32    1048     -5.12    1062     -4.62    1063     9.58     1064
GR 8.58     1065     17.68    1080     17.98    1085     18.98    1130     19.78    1190
GR 20.38    1209     24.48    1243     100      1244

;Natural      Channel ID:    7826
NC 0.085    0.085    0.03
X1 7826              22       0.1      1239     0.0      0.0      0.0      0        0
GR 100      0        18.98    0.1      14.38    224      11.88    402      9.78     514
GR 9.68     698      9.58     804      9.48     904      9.18     1004     5.18     1004.1
GR -6.12    1004.2   -6.02    1023.6   -6.02    1023.7   -6.52    1058.6   -6.92    1093.6
GR -6.92    1093.7   -6.12    1124     8.28     1124.1   12.28    1124.2   13.28    1174
GR 25.28    1239     100      1240

;Natural      Channel ID:    7842
NC 0.02     0.02     0.02
X1 7842              19       0.1      1239     0.0      0.0      0.0      0        0
GR 100      0        18.98    0.1      14.38    224      11.88    402      9.78     514
GR 9.68     698      9.58     804      9.48     904      9.18     1004     9.18     1004.1
GR 9.68     1023.6   15.58    1023.7   17.38    1093.6   11.48    1093.7   12.28    1124.1
GR 12.28    1124.2   13.28    1174     25.28    1239     100      1240

;Natural      Channel ID:    7962
NC 0.085    0.085    0.03
X1 7962              28       0.1      1243     0.0      0.0      0.0      0        0
GR 100      0        18.98    0.1      14.38    224      11.88    402      9.78     514
GR 9.75     698      9.7      804      9.65     960      9.58     961      -4.62    962
GR -5.22    963      -5.22    973      -5.62    988      -6.72    1003     -6.92    1018
GR -5.02    1033     -5.32    1048     -5.12    1062     -4.62    1063     9.58     1064
GR 8.58     1065     17.68    1080     17.98    1085     18.98    1130     19.78    1190
GR 20.38    1209     24.48    1243     100      1244

;Natural      Channel ID:    7966
NC 0.085    0.085    0.03
X1 7966              28       0.1      1243     0.0      0.0      0.0      0        0
GR 100      0        18.98    0.1      14.38    224      11.88    402      9.78     514
GR 9.7      698      9.65     804      9.6      960      9.58     961      -4.62    962
GR -5.22    963      -5.22    973      -5.62    988      -6.72    1003     -6.92    1018
GR -5.02    1033     -5.32    1048     -5.12    1062     -4.62    1063     9.58     1064
GR 8.58     1065     17.68    1080     17.98    1085     18.98    1130     19.78    1190
GR 20.38    1209     24.48    1243     100      1244

;Natural      Channel ID:    8086
NC 0.085    0.085    0.03
X1 8086              10       1        1243     0.0      0.0      0.0      0        0
GR 100      0        29.38    1        24.38    2        24.38    956      -5.52    957
GR -6.12    1065     24.38    1066     24.38    1235     25.68    1243     100      1244

;Natural      Channel ID:    8160
NC 0.03     0.03     0.03
X1 8160              20       1        1243     0.0      0.0      0.0      0        0
GR 100      0        29.38    1        24.38    2        24.38    956      24.38    957
GR 24.38    967      24.38    983      24.38    998      24.38    1008     24.38    1009
GR 24.38    1014     24.38    1015     24.38    1025     24.38    1040     24.38    1056
GR 24.38    1065     24.38    1066     24.38    1235     25.68    1243     100      1244

;Natural      Channel ID:    8280
NC 0.085    0.085    0.03
X1 8280              28       0.1      1243     0.0      0.0      0.0      0        0
GR 100      0        19.78    0.1      15.18    224      12.68    402      10.58    514
GR 10.48    698      10.45    804      10.4     960      10.38    961      -3.82    962
GR -4.42    963      -4.42    973      -4.82    988      -5.92    1003     -6.12    1018
GR -4.22    1033     -4.52    1048     -4.32    1062     -3.82    1063     10.38    1064
GR 9.38     1065     18.48    1080     18.78    1085     19.78    1130     20.58    1190
GR 21.18    1209     25.28    1243     100      1244

;Natural      Channel ID:    8346
NC 0.085    0.085    0.03
X1 8346              28       0.1      1243     0.0      0.0      0.0      0        0
GR 100      0        17.18    0.1      12.58    224      10.08    402      7.98     514
GR 7.95     698      7.9      804      7.85     960      7.78     961      -6.42    962
GR -7.02    963      -7.02    973      -7.42    988      -8.52    1003     -8.72    1018
GR -6.82    1033     -7.12    1048     -6.92    1062     -6.42    1063     7.78     1064
GR 6.78     1065     15.88    1080     16.18    1085     17.18    1130     17.98    1190
GR 18.58    1209     22.68    1243     100      1244

;Natural      Channel ID:    8831
NC 0.085    0.085    0.03
X1 8831              28       0.1      1243     0.0      0.0      0.0      0        0
GR 100      0        19.28    0.1      14.68    224      12.18    402      10.08    514
GR 9.98     698      9.95     804      9.9      960      9.88     961      -4.32    962
GR -4.92    963      -4.92    973      -5.32    988      -6.42    1003     -6.62    1018
GR -4.72    1033     -5.02    1048     -4.82    1062     -4.32    1063     9.88     1064
GR 8.88     1065     17.98    1080     18.28    1085     19.28    1130     20.08    1190
GR 20.68    1209     24.78    1243     100      1244
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;Natural      Channel ID:    8911
 NC 0.085   0.085    0.03
 X1 8911             12       970     1053    0.0     0.0     0.0     0       0
 GR 100     0        24.38    969     13.58   970     -2.62   971     -4.42   1012
 GR -6.62   1030     -6.62    1052    13.68   1053    13.78   1153    14.98   1253
 GR 24.38   1254     100      1255

;Natural      Channel ID:    8974
 NC 0.02    0.02     0.02
 X1 8974             10       968     1255    0.0     0.0     0.0     0       0
 GR 100     968      24.38    969     18.58   970     18.38   971     18.28   1052
 GR 13.68   1053     13.78    1153    14.98   1253    24.38   1254    100     1255

;Natural      Channel ID:    9054
 NC 0.085   0.085    0.03
 X1 9054             12       969     1254    0.0     0.0     0.0     0       0
 GR 100     0        24.38    969     13.58   970     -2.62   971     -4.42   1012
 GR -6.62   1030     -6.62    1052    13.68   1053    13.78   1153    14.98   1253
 GR 24.38   1254     100      1255

;Natural      Channel ID:    9061
 NC 0.085   0.085    0.02
 X1 9061             12       969     1254    0.0     0.0     0.0     0       0
 GR 100     0        23.78    969     12.98   970     -3.22   971     -5.02   1012
 GR -7.22   1030     -7.22    1052    13.08   1053    13.18   1153    14.38   1253
 GR 23.78   1254     100      1255

;Natural      Channel ID:    9141
 NC 0.085   0.085    0.03
 X1 9141             14       874     1257    0.0     0.0     0.0     0       0
 GR 100     0        24.38    874     13.98   875     13.88   975     -3.12   976
 GR -4.42   1009     -7.22    1032    -4.42   1051    4.68    1055    14.68   1056
 GR 14.78   1156     15.98    1256    24.38   1257    100     1258

;Natural      Channel ID:    9215
 NC 0.03    0.03     0.03
 X1 9215             11       873     1258    0.0     0.0     0.0     0       0
 GR 100     873      24.38    874     11.48   875     13.88   975     13.89   976
 GR 13.99   1055     14.68    1056    14.78   1156    15.98   1256    24.38   1257
 GR 100     1258

;Natural      Channel ID:    9261
 NC 0.085   0.085    0.025
 X1 9261             19       817     1151    0.0     0.0     0.0     0       0
 GR 100     0        29.38    817     24.38   818     19.38   819     14.68   820
 GR 14.58   916      -3.22    920     -3.82   930     -5.02   944     -6.02   954
 GR -6.12   964      -6.12    974     -7.02   984     -6.42   994     15.38   999
 GR 15.58   1053     15.88    1150    29.38   1151    100     1152

;Natural      Channel ID:    9311
 NC 0.085   0.085    0.055
 X1 9311             10       911     1151    0.0     0.0     0.0     0       0
 GR 100     0        24.38    911     11.88   912     -1.22   913     -1.22   1008
 GR 11.98   1009     14.68    1053    15.98   1150    24.38   1151    100     1152

;Natural      Channel ID:    9361
 NC 0.085   0.085    0.025
 X1 9361             16       915     1151    0.0     0.0     0.0     0       0
 GR 100     0        27.48    915     17.68   916     -0.12   920     -0.72   930
 GR -1.92   944      -2.92    954     -3.02   964     -3.02   974     -3.92   984
 GR -3.32   994      18.48    999     17.78   1053    18.98   1150    32.48   1151
 GR 100     1152

;Natural      Channel ID:    9856
 NC 0.085   0.085    0.025
 X1 9856             27       194     823     0.0     0.0     0.0     0       0
 GR 100     0        28.18    0.1     25.78   106     23.58   194     20.88   274
 GR 19.98   275      19.48    310     13.78   375     13.38   605     3.28    630
 GR -1.02   631      -1.12    632     -3.22   640     -3.52   646     -2.72   654
 GR -3.02   662      -3.62    670     -3.92   677     -3.42   683     -2.62   690
 GR 3.38    691      14.28    719     21.98   823     20.08   1013    18.68   1109
 GR 29.38   1110     100      1111

;Natural      Channel ID:    9886
 NC 0.085   0.085    0.03
 X1 9886             27       194     823     0.0     0.0     0.0     0       0
 GR 100     0        27.78    0.1     25.38   106     23.18   194     20.48   274
 GR 19.58   275      19.08    310     13.38   375     12.98   605     2.88    630
 GR -1.42   631      -1.52    632     -3.62   640     -3.92   646     -3.12   654
 GR -3.42   662      -4.02    670     -4.32   677     -3.82   683     -3.02   690
 GR 2.98    691      13.88    719     21.58   823     19.68   1013    18.28   1109
 GR 28.98   1110     100      1111

;Natural      Channel ID:    9946
 NC 0.085   0.085    0.03
 X1 9946             24       358     1058    0.0     0.0     0.0     0       0
 GR 100     0        30.38    358     29.38   359     20.68   360     20.88   460
 GR 21.68   560      15.68    561     15.18   562     6.68    622     16.08   623
 GR 16.08   627      -5.22    628     -5.22   688     16.48   689     16.48   693
 GR 6.18    694      16.18    755     16.88   756     22.88   757     21.88   857
 GR 20.68   957      19.28    1057    29.38   1058    100     1059

;Natural      Channel ID:    10001
 NC 0.03    0.03     0.03
 X1 10001            13       358     1059    0.0     0.0     0.0     0       0
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GR 100      358     29.38   359     20.68   360     20.88   460     21.68   560
GR 25.98    561     27.18   756     22.88   757     21.88   857     20.68   957
GR 19.28    1057    29.38   1058    100     1059

;Natural      Channel ID:      10061
NC 0.085    0.085   0.03
X1 10061            27      310     823     0.0     0.0     0.0     0       0
GR 100      0       27.18   0.1     24.78   106     22.58   194     20      274
GR 20       275     20      310     20      375     20      605     2.28    630
GR -2.02    631     -2.12   632     -4.22   640     -4.52   646     -3.72   654
GR -4.02    662     -4.62   670     -4.92   677     -4.42   683     -3.62   690
GR 2.38     691     13.28   719     20.98   823     19.08   1013    17.68   1109
GR 28.38    1110    100     1111

;Natural      Channel ID:      10561
NC 0.085    0.085   0.03
X1 10561            15      605     719     0.0     0.0     0.0     0       0
GR 100      0       13.78   410     13.38   605     3.88    630     -1.12   631
GR -1.32    637     -1.32   650     -1.52   660     -1.32   669     -2.12   680
GR -2.22    690     3.88    691     14.28   719     21.98   823     100     824

;Natural      Channel ID:      10681
NC 0.085    0.085   0.03
X1 10681            19      400     707     0.0     0.0     0.0     0       0
GR 100      0       11.18   400     11.18   500     10.48   567     12.88   598
GR 13.58    615     15.18   620     0.18    621     -0.02   648     -2.22   649
GR -2.22    655     -0.02   656     0.18    681     15.28   682     14.18   683
GR 14.68    688     18.98   707     21.98   823     100     824

;Natural      Channel ID:      10706
NC 0.085    0.085   0.03
X1 10706            15      410     823     0.0     0.0     0.0     0       0
GR 100      0       14.28   410     13.88   605     4.38    630     -0.62   631
GR -0.82    637     -0.82   650     -1.02   660     -0.82   669     -1.62   680
GR -1.72    690     4.38    691     14.78   719     22.48   823     100     824

;Natural      Channel ID:      10731
NC 0.085    0.085   0.03
X1 10731            13      0.1     176     0.0     0.0     0.0     0       0
GR 100      0       11.58   0.1     11.58   30      12.08   37      20.58   59
GR -1.62    60      -1.62   100     0.58    121     19.48   122     19.68   134
GR 20.38    142     19.38   176     100     177

;Natural      Channel ID:      11251
NC 0.01     0.01    0.01
X1 11251            22      0.1     176     0.0     0.0     0.0     0       0
GR 100      0       14.18   0.1     14.18   30      14.68   37      23.18   59
GR 23.18    60      22.98   66      22.78   73      22.58   80      22.58   81
GR 22.28    87      22.08   94      21.88   101     21.88   102     21.78   108
GR 21.98    115     22.08   121     22.08   122     22.28   134     22.98   142
GR 21.98    176     100     177

;Natural      Channel ID:      11311
NC 0.025    0.025   0.03
X1 11311            14      135     380     0.0     0.0     0.0     0       0
GR 100      0       12.98   135     12.78   205     12.68   234     12.58   235
GR 3.48     236     1.78    255     0.88    267     1.78    280     2.28    295
GR 11.38    296     19.18   310     20.78   380     100     381

;Natural      Channel ID:      12291
NC 0.03     0.03    0.03
X1 12291            18      100     819     0.0     0.0     0.0     0       0
GR 100      0       16.68   100     16.58   205     16.48   234     16.38   235
GR 7.28     236     5.58    255     4.68    267     5.58    280     6.08    295
GR 15.18    296     22.98   310     24.58   380     24.18   431     26.38   484
GR 29.08    552     39.18   819     100     820

;Natural      Channel ID:      12851
NC 0.03     0.03    0.03
X1 12851            18      100     819     0.0     0.0     0.0     0       0
GR 100      0       23.7    100     23.6    205     23.5    234     23.4    235
GR 9.28     236     7.58    255     6.68    267     7.58    280     8.08    295
GR 17.18    296     24.98   310     26.58   380     26.18   431     28.38   484
GR 31.08    552     41.18   819     100     820

;Natural      Channel ID:      12911
NC 0.03     0.03    0.03
X1 12911            11      100     498     0.0     0.0     0.0     0       0
GR 100      0       23.78   100     23.48   135     22.58   235     8.58    236
GR 6.88     266     8.08    297     22.08   298     22.48   398     25.48   498
GR 100      499

;Natural      Channel ID:      12973
NC 0.02     0.02    0.02
X1 12973            13      100     498     0.0     0.0     0.0     0       0
GR 100      99      23.78   100     23.48   135     22.58   235     22.58   236
GR 22.48    245     22.28   266     22.18   287     22.08   297     22.08   298
GR 22.48    398     25.48   498     100     499

;Natural      Channel ID:      13033
NC 0.03     0.03    0.03
X1 13033            18      100     310     0.0     0.0     0.0     0       0
GR 100      0       40      100     25      205     18.88   234     18.78   235
GR 9.68     236     7.98    255     7.08    267     7.98    280     8.48    295
GR 17.58    296     25.38   310     26.98   380     26.58   431     28.78   484
GR 31.48    552     41.58   819     100     820
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;Natural          Channel ID:     13405
NC 0.03     0.03        0.03
X1 13405                18          100       310       0.0       0.0       0.0       0         0
GR 100      0           30.28       100       25.88     205       19.78     234       19.68     235
GR 10.58    236         8.88        255       7.98      267       8.88      280       9.38      295
GR 18.48    296         26.28       310       27.88     380       27.48     431       29.68     484
GR 32.38    552         42.48       819       100       820

;Natural          Channel ID:     13776
NC 0.03     0.03        0.03
X1 13776                18          100       310       0.0       0.0       0.0       0         0
GR 100      0           30.28       100       25.88     205       19.78     234       19.68     235
GR 10.58    236         8.88        255       7.98      267       8.88      280       9.38      295
GR 18.48    296         26.28       310       27.88     380       27.48     431       29.68     484
GR 32.38    552         42.48       819       100       820

;Natural          Channel ID:     13836
NC 0.035    0.035       0.03
X1 13836                12          200       265       0.0       0.0       0.0       0         0
GR 100      0           41.48       1         40.68     100       40.88     200       12.18     201
GR 12.18    232         12.18       264       40.88     265       40.58     365       41.48     465
GR 41.78    565         100         566

;Natural          Channel ID:     13898
NC 0.02     0.02        0.02
X1 13898                14          0         566       0.0       0.0       0.0       0         0
GR 100      0           41.48       1         40.68     100       40.88     200       42.18     201
GR 42.18    204         42.18       232       42.18     261       42.18     264       40.88     265
GR 40.58    365         41.48       465       41.78     565       100       566

;Natural          Channel ID:     13958
NC 0.035    0.035       0.03
X1 13958                13          234       296       0.0       0.0       0.0       0         0
GR 100      0           41.38       200       31.38     229       23.48     234       23.38     235
GR 13.38    236         12.58       255       11.68     267       12.58     280       13.08     295
GR 22.18    296         41.38       335       100       336

;Natural          Channel ID:     14039
NC 0.035    0.035       0.03
X1 14039                17          693       762       0.0       0.0       0.0       0         0
GR 100      0           44.56       625       34.56     650       18.56     690       18.56     693
GR 13.16    695         12.76       705       12.26     717       11.86     729       13.06     739
GR 13.06    749         13.56       754       13.16     760       18.46     762       19.76     765
GR 44.56    880         100         881

;Natural          Channel ID:     14120
NC 0.035    0.035       0.03
X1 14120                22          693       762       0.0       0.0       0.0       0         0
GR 60       0           44.74       515       28.04     605       27.64     610       24.14     621
GR 20.74    631         19.04       670       18.74     674       18.74     690       18.74     693
GR 13.34    695         12.94       705       12.44     717       12.04     729       13.24     739
GR 13.24    749         13.74       754       13.34     760       18.64     762       19.94     765
GR 44.74    880         60          881

;Natural          Channel ID:     14201
NC 0.035    0.035       0.03
X1 14201                22          693       762       0.0       0.0       0.0       0         0
GR 100      0           44.92       415       28.22     505       27.82     610       24.32     621
GR 20.92    631         19.22       670       18.92     674       18.92     690       18.92     693
GR 13.52    695         13.12       705       12.62     717       12.22     729       13.42     739
GR 13.42    749         13.92       754       13.52     760       18.82     762       20.12     765
GR 44.92    880         100         881

;Natural          Channel ID:     14282
NC 0.035    0.035       0.03
X1 14282                22          693       762       0.0       0.0       0.0       0         0
GR 60       0           45.1        280       28.4      365       28        610       24.5      621
GR 21.1     631         19.4        670       19.1      674       19.1      690       19.1      693
GR 13.7     695         13.3        705       12.8      717       12.4      729       13.6      739
GR 13.6     749         14.1        754       13.7      760       19        762       20.3      765
GR 45.1     880         60          881

;Natural          Channel ID:     14363
NC 0.035    0.035       0.03
X1 14363                22          693       762       0.0       0.0       0.0       0         0
GR 60       0           45.28       160       28.58     245       28.18     610       24.68     621
GR 21.28    631         19.58       670       19.28     674       19.28     690       19.28     693
GR 13.88    695         13.48       705       12.98     717       12.58     729       13.78     739
GR 13.78    749         14.28       754       13.88     760       19.18     762       20.48     765
GR 45.28    880         60          881

;Natural          Channel ID:     14444
NC 0.035    0.035       0.03
X1 14444                22          631       765       0.0       0.0       0.0       0         0
GR 100      0           45.48       55        28.78     140       28.38     610       24.88     621
GR 21.48    631         19.78       670       19.48     674       19.48     690       19.48     693
GR 14.08    695         13.68       705       13.18     717       12.78     729       13.98     739
GR 13.98    749         14.48       754       14.08     760       19.38     762       20.68     765
GR 45.48    880         100         881

;Natural          Channel ID:     14544
NC 0.035    0.035       0.03
X1 14544                15          670       775       0.0       0.0       0.0       0         0
GR 60       0           34.68       50        34.68     220       30.68     420       31.48     470
GR 32.68    520         31.48       570       29.68     620       32.28     670       19.78     671
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GR 19.78    774     32.58   775     34.98   825     46.98   850     60      851

;Natural      Channel ID:    14561
NC 0.02     0.02    0.02
X1 14561            21      0       851     0.0     0.0     0.0     0       0
GR 50       0       34.68   5       34.68   220     30.68   420     31.48   470
GR 32.68    520     31.48   570     29.68   620     32.28   670     33.48   671
GR 34.08    695     34.08   696     34.58   722     34.18   747     34.18   748
GR 33.98    761     33.78   774     32.58   775     34.98   825     46.98   850
GR 50       851

;Natural      Channel ID:    14562
NC 0.085    0.085   0.03
X1 14562            33      389     849     0.0     0.0     0.0     0       0
GR 60       0       33.28   0.1     32.18   59      29.78   83      29.78   223
GR 29.78    389     26.58   430     26.58   480     26.58   519     26.58   565
GR 26.58    599     26.58   627     26.58   638     26.58   660     28.58   683
GR 27.58    694     27.78   710     25.28   735     18.58   746     16.58   751
GR 16.78    760     16.88   770     16.48   778     17.18   788     16.78   801
GR 16.58    811     16.38   820     16.28   829     18.58   838     30.78   849
GR 31.98    875     52.48   904     60      905

;Natural      Channel ID:    14563
NC 0.085    0.085   0.03
X1 14563            33      389     875     0.0     0.0     0.0     0       0
GR 60       0       33.28   0.1     32.18   59      29.78   83      29.78   223
GR 29.78    389     26.58   430     26.58   480     26.58   519     26.58   565
GR 26.58    599     26.58   627     26.58   638     26.58   660     28.58   683
GR 27.58    694     27.78   710     25.28   735     18.78   746     18.78   751
GR 18.78    760     18.78   770     18.78   778     18.78   788     18.78   801
GR 18.78    811     18.78   820     18.78   829     18.78   838     18.78   849
GR 31.98    875     52.48   904     60      905

;Natural      Channel ID:    14601
NC 0.085    0.085   0.03
X1 14601            33      389     849     0.0     0.0     0.0     0       0
GR 60       0       33.28   0.1     32.18   59      29.78   83      29.78   223
GR 29.78    389     26.58   430     26.58   480     26.58   519     26.58   565
GR 26.58    599     26.58   627     26.58   638     26.58   660     28.58   683
GR 27.58    694     27.78   710     25.28   735     18.58   746     16.58   751
GR 16.78    760     16.88   770     16.48   778     17.18   788     16.78   801
GR 16.58    811     16.38   820     16.28   829     18.58   838     30.78   849
GR 31.98    875     52.48   904     60      905

;Natural      Channel ID:    15181
NC 0.085    0.085   0.03
X1 15181            33      389     849     0.0     0.0     0.0     0       0
GR 60       0       33.08   0.1     31.98   59      29.58   83      29.58   223
GR 29.58    389     26.38   430     26.38   480     26.38   519     26.38   565
GR 26.38    599     26.38   627     26.38   638     26.38   660     28.38   683
GR 27.38    694     27.58   710     25.08   735     18.38   746     16.38   751
GR 16.58    760     16.68   770     16.28   778     16.98   788     16.58   801
GR 16.38    811     16.18   820     16.08   829     18.38   838     30.58   849
GR 31.78    875     52.28   904     60      905

;Natural      Channel ID:    15291
NC 0.085    0.085   0.03
X1 15291            19      660     767     0.0     0.0     0.0     0       0
GR 100      0       44.38   270     34.78   405     36.98   505     35.78   510
GR 35.98    560     36.78   660     24.98   661     19.68   675     16.68   690
GR 15.98    730     19.68   760     21.98   766     36.78   767     31.58   817
GR 31.68    838     37.58   891     43.48   953     100     954

;Natural      Channel ID:    15304
NC 0.02     0.02    0.02
X1 15304            15      0       954     0.0     0.0     0.0     0       0
GR 50       0       44.38   270     34.78   405     36.98   505     35.78   510
GR 35.98    560     36.78   660     37.98   661     37.98   766     36.78   767
GR 31.58    817     31.68   838     37.58   891     43.48   953     50      954

;Natural      Channel ID:    15414
NC 0.085    0.085   0.03
X1 15414            25      550     652     0.0     0.0     0.0     0       0
GR 70       0       50.18   0.1     41.88   122     41.48   141     37.98   198
GR 32.98    272     32.98   335     32.98   360     32.98   530     32.98   543
GR 32.98    550     29.98   563     19.78   575     17.08   585     15.78   592
GR 16.08    597     18.88   605     19.78   610     28.38   634     32.88   652
GR 40.58    667     46.68   697     53.18   748     61.98   807     70      808

;Natural      Channel ID:    15861
NC 0.085    0.085   0.03
X1 15861            25      550     652     0.0     0.0     0.0     0       0
GR 70       0       49.28   0.1     40.98   122     40.58   141     37.08   198
GR 32.08    272     32.08   335     32.08   360     32.08   530     32.08   543
GR 32.08    550     29.08   563     18.88   575     16.18   585     14.88   592
GR 15.18    597     17.98   605     18.88   610     27.48   634     31.98   652
GR 39.68    667     45.78   697     52.28   748     61.08   807     70      808

;Natural      Channel ID:    18081
NC 0.085    0.085   0.03
X1 18081            25      550     652     0.0     0.0     0.0     0       0
GR 80       0       58.48   0.1     50.18   122     49.78   141     46.28   198
GR 41.28    272     41.28   335     41.28   360     41.28   530     41.28   543
GR 41.28    550     38.28   563     28.08   575     25.38   585     24.08   592
GR 24.38    597     27.18   605     28.08   610     36.68   634     41.18   652
GR 48.88    667     54.98   697     61.48   748     70.28   807     80      808
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;Natural        Channel ID:     18956
 NC 0.085      0.085      0.03
 X1 18956                 31        44        330       0.0       0.0       0.0       0         0
 GR 80         0          59.18     0.1       46.18     38        43.48     44        34.68     54
 GR 31.38      60         31.68     85        31.68     88        30.18     97        29.58     133
 GR 29.48      191        25.38     198       24.38     211       22.98     220       22.18     227
 GR 21.58      232        21.98     237       22.88     245       22.88     250       24.38     251
 GR 33.58      262        32.48     265       33.08     297       36.98     317       37.78     330
 GR 49.98      385        59.38     399       57.48     406       58.28     451       70.18     478
 GR 80         479

;Natural        Channel ID:     19026
 NC 0.085      0.085      0.03
 X1 19026                 14        200       253       0.0       0.0       0.0       0         0
 GR 70         0          58.98     1         43.18     44        38.38     50        38.48     100
 GR 41.08      200        24.78     201       21.38     226       24.58     252       41.68     253
 GR 41.18      346        49.68     385       59.18     399       70        400

;Natural        Channel ID:     19057
 NC 0.02       0.02       0.02
 X1 19057                 16        0         400       0.0       0.0       0.0       0         0
 GR 70         0          58.98     1         43.18     44        38.38     50        38.48     100
 GR 41.08      200        45.08     201       45.08     210       45.08     226       45.08     243
 GR 45.08      252        41.68     253       41.18     346       49.68     385       59.18     399
 GR 70         400

;Natural        Channel ID:     19127
 NC 0.085      0.085      0.03
 X1 19127                 31        211       251       0.0       0.0       0.0       0         0
 GR 80         0          80        0.1       80        38        80        44        34.78     54
 GR 80         60         80        85        80        88        80        97        80        133
 GR 80         191        25.48     198       24.48     211       23.08     220       22.28     227
 GR 21.68      232        22.08     237       22.98     245       22.98     250       24.48     251
 GR 80         262        80        265       80        297       80        317       80        330
 GR 80         385        80        399       80        406       80        451       80        478
 GR 80         479

;Natural        Channel ID:     20596
 NC 0.085      0.085      0.03
 X1 20596                 31        211       251       0.0       0.0       0.0       0         0
 GR 90         0          73.08     0.1       60.08     38        57.38     44        48.58     54
 GR 45.28      60         45.58     85        45.58     88        44.08     97        43.48     133
 GR 43.38      191        39.28     198       38.28     211       36.88     220       36.08     227
 GR 35.48      232        35.88     237       36.78     245       36.78     250       38.28     251
 GR 47.48      262        46.38     265       46.98     297       50.88     317       51.68     330
 GR 63.88      385        73.28     399       71.38     406       72.18     451       84.08     478
 GR 90         479

;Natural        Channel ID:     21926
 NC 0.085      0.085      0.03
 X1 21926                 31        211       251       0.0       0.0       0.0       0         0
 GR 90         0          70.88     0.1       57.88     38        55.18     44        46.38     54
 GR 43.08      60         43.38     85        43.38     88        41.88     97        41.28     133
 GR 41.18      191        37.08     198       36.08     211       34.68     220       33.88     227
 GR 33.28      232        33.68     237       34.58     245       34.58     250       36.08     251
 GR 45.28      262        44.18     265       44.78     297       48.68     317       49.48     330
 GR 61.68      385        71.08     399       69.18     406       69.98     451       81.88     478
 GR 90         479

;Natural        Channel ID:     22026
 NC 0.085      0.085      0.03
 X1 22026                 20        76        125       0.0       0.0       0.0       0         0
 GR 70         0          57.88     1         54.88     2         51.88     12        57.88     13
 GR 57.88      21         51.88     24        46.88     25        34.78     54        34.78     69
 GR 57.88      70         57.88     76        33.58     78        34.78     123       57.88     125
 GR 57.88      131        44.38     132       45.88     150       57.88     151       70        151

;Natural        Channel ID:     22039
 NC 0.085      0.085      0.03
 X1 22039                 20        76        125       0.0       0.0       0.0       0         0
 GR 120        0          57.88     1         54.88     2         51.88     12        57.88     13
 GR 57.88      21         51.88     24        46.88     25        34.78     54        34.78     69
 GR 57.88      70         57.88     76        33.58     78        34.78     123       57.88     125
 GR 57.88      131        44.38     132       45.88     150       57.88     151       120       152

;Natural        Channel ID:     22139
 NC 0.085      0.085      0.03
 X1 22139                 25        594       635       0.0       0.0       0.0       0         0
 GR 90         0          71.98     0.1       67.48     234       63.18     506       46.48     543
 GR 42.48      578        39.48     593       36.68     594       33.78     595       34.78     615
 GR 35.88      625        36.68     635       41.08     644       42.88     665       43.48     733
 GR 46.18      811        47.18     834       50.68     840       62.18     855       65.98     866
 GR 69.58      885        74.68     941       80.48     1001      81.38     1085      90        1086

;Natural        Channel ID:     22376
 NC 0.085      0.085      0.03
 X1 22376                 25        594       635       0.0       0.0       0.0       0         0
 GR 90         0          73.68     0.1       69.18     234       64.88     506       48.18     543
 GR 44.18      578        41.18     593       38.38     594       35.48     595       36.48     615
 GR 37.58      625        38.38     635       42.78     644       44.58     665       45.18     733
 GR 47.88      811        48.88     834       52.38     840       63.88     855       67.68     866
 GR 71.28      885        76.38     941       82.18     1001      83.08     1085      90        1086

;Natural        Channel ID:     22476
 NC 0.085      0.085      0.03
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X1 22476            12        2         87        0.0       0.0       0.0       0         0
GR 90       0       68.98     1         46.38     2         35.98     16        34.38     41
GR 35.48    65      42.48     87        42.98     110       47.38     223       64.68     328
GR 76.48    329     90        330

;Natural     Channel ID:      22586
NC 0.085    0.085   0.03
X1 22586            12        2         87        0.0       0.0       0.0       0         0
GR 90       0       68.98     1         46.38     2         35.98     16        34.38     41
GR 35.48    65      42.48     87        42.98     110       47.38     223       64.68     328
GR 76.48    329     90        330

;Natural     Channel ID:      22686
NC 0.085    0.085   0.03
X1 22686            25        594       635       0.0       0.0       0.0       0         0
GR 90       0       72.68     0.1       68.18     234       63.88     506       47.18     543
GR 43.18    578     40.18     593       37.38     594       34.48     595       35.48     615
GR 36.58    625     37.38     635       41.78     644       43.58     665       44.18     733
GR 46.88    811     47.88     834       51.38     840       62.88     855       66.68     866
GR 70.28    885     75.38     941       81.18     1001      82.08     1085      90        1086

;Natural     Channel ID:      23161
NC 0.085    0.085   0.03
X1 23161            25        594       635       0.0       0.0       0.0       0         0
GR 90       0       73.28     0.1       68.78     234       64.48     506       47.78     543
GR 43.78    578     40.78     593       37.98     594       35.08     595       36.08     615
GR 37.18    625     37.98     635       42.38     644       44.18     665       44.78     733
GR 47.48    811     48.48     834       51.98     840       63.48     855       67.28     866
GR 70.88    885     75.98     941       81.78     1001      82.68     1085      90        1086

;Natural     Channel ID:      23971
NC 0.085    0.085   0.03
X1 23971            25        594       635       0.0       0.0       0.0       0         0
GR 90       0       78.18     0.1       73.68     234       69.38     506       52.68     543
GR 48.68    578     45.68     593       42.88     594       39.98     595       40.98     615
GR 42.08    625     42.88     635       47.28     644       49.08     665       49.68     733
GR 52.38    811     53.38     834       56.88     840       68.38     855       72.18     866
GR 75.78    885     80.88     941       86.68     1001      87.58     1085      90        1086

;Natural     Channel ID:      24071
NC 0.085    0.085   0.03
X1 24071            19        480       561       0.0       0.0       0.0       0         0
GR 90       0       83.48     1         78.48     300       53.58     301       50.58     341
GR 50.58    381     61.58     382       61.58     390       47.58     391       47.58     470
GR 62.58    471     62.58     479       46.18     480       41.08     511       40.58     535
GR 40.58    560     81.48     561       86.48     900       90        901

;Natural     Channel ID:      24337
NC 0.085    0.085   0.03
X1 24337            19        480       561       0.0       0.0       0.0       0         0
GR 90       0       83.48     1         78.48     300       53.58     301       50.58     341
GR 50.58    381     61.58     382       61.58     390       47.58     391       47.58     470
GR 62.58    471     62.58     479       46.18     480       41.08     511       40.58     535
GR 40.58    560     81.48     561       86.48     900       90        901

;Natural     Channel ID:      24437
NC 0.085    0.085   0.03
X1 24437            26        109       155       0.0       0.0       0.0       0         0
GR 90       0       69.88     0.1       55.38     28        46.58     51        45.78     65
GR 46.58    74      48.58     88        48.08     100       42.78     109       40.78     112
GR 40.88    118     40.88     123       41.08     131       41.48     140       40.58     150
GR 42.78    155     51.28     176       47.68     299       47.18     381       52.68     414
GR 52.78    429     56.58     438       67.98     491       72.48     527       75.78     593
GR 90       594

;Natural     Channel ID:      25391
NC 0.085    0.085   0.03
X1 25391            26        109       155       0.0       0.0       0.0       0         0
GR 140      0       69.08     0.1       54.58     28        45.78     51        44.98     65
GR 45.78    74      47.78     88        47.28     100       41.98     109       39.98     112
GR 40.08    118     40.08     123       40.28     131       40.68     140       39.78     150
GR 41.98    155     50.48     176       46.88     299       46.38     381       51.88     414
GR 51.98    429     55.78     438       67.18     491       71.68     527       74.98     593
GR 140      594

;Natural     Channel ID:      25711
NC 0.085    0.085   0.03
X1 25711            26        109       155       0.0       0.0       0.0       0         0
GR 140      0       71.58     0.1       57.08     28        48.28     51        47.48     65
GR 48.28    74      50.28     88        49.78     100       44.48     109       42.48     112
GR 42.58    118     42.58     123       42.78     131       43.18     140       42.28     150
GR 44.48    155     52.98     176       49.38     299       48.88     381       54.38     414
GR 54.48    429     58.28     438       69.68     491       74.18     527       77.48     593
GR 140      594

;Natural     Channel ID:      25841
NC 0.085    0.085   0.03
X1 25841            18        85        201       0.0       0.0       0.0       0         0
GR 90       0       71.98     1         59.08     25        59.88     85        50.88     86
GR 44.48    118     43.88     121       43.08     142       43.88     164       44.88     167
GR 56.98    200     60.98     201       65.18     301       66.48     401       69.28     487
GR 70.18    491     74.68     527       90        528

;Natural     Channel ID:      25907
NC 0.02     0.02    0.025
X1 25907            13        0         528       0.0       0.0       0.0       0         0
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GR 140      0        71.98     1        59.08    25       59.88    85       64.08    86
GR 65.18    200      60.98     201      65.18    301      66.48    401      69.28    487
GR 70.18    491      74.68     527      140      528

;Natural      Channel ID:      26037
NC 0.085    0.085    0.03
X1 26037             26        0.1      491      0.0      0.0      0.0      0        0
GR 90       0        72.68     0.1      58.18    28       49.38    51       48.58    65
GR 49.38    74       51.38     88       50.88    100      45.58    109      44.38    112
GR 43.68    118      43.68     123      43.88    131      44.28    140      43.38    150
GR 45.58    155      54.08     176      50.48    299      49.98    381      55.48    414
GR 55.58    429      59.38     438      70.78    491      75.28    527      78.58    593
GR 90       594

;Natural      Channel ID:      27181
NC 0.085    0.085    0.03
X1 27181             21        89       463      0.0      0.0      0.0      0        0
GR 90       0        76.78     89       67.28    109      56.68    127      53.88    153
GR 47.18    168      46.88     188      46.98    208      47.18    228      46.98    253
GR 46.38    273      46.38     278      47.18    283      52.78    285      52.98    297
GR 55.88    360      57.28     379      57.68    406      67.78    413      80.78    463
GR 90       464

;Natural      Channel ID:      27281
NC 0.085    0.085    0.03
X1 27281             19        89       463      0.0      0.0      0.0      0        0
GR 90       0        76.78     89       67.28    109      56.68    127      53.68    156
GR 49.88    170      48.18     202      48.48    232      48.38    269      53.08    274
GR 52.98    297      48.38     320      48.38    332      55.88    360      57.28    379
GR 57.68    406      67.78     413      80.78    463      90       464

;Natural      Channel ID:      27356
NC 0.085    0.085    0.03
X1 27356             23        89       463      0.0      0.0      0.0      0        0
GR 90       0        76.78     89       67.28    109      56.68    127      53.68    156
GR 53.58    211      48.78     216      47.38    223      47.58    231      45.88    239
GR 45.78    244      44.68     251      45.98    258      46.88    265      48.78    270
GR 53.08    274      52.98     297      55.88    360      57.28    379      57.68    406
GR 67.78    413      80.78     463      90       464

;Natural      Channel ID:      27966
NC 0.085    0.085    0.03
X1 27966             22        203      418      0.0      0.0      0.0      0        0
GR 100      0        82.48     0.1      82.48    7        78.38    30       76.88    68
GR 74.18    203      57.68     236      56.58    263      50.38    265      47.98    268
GR 50.38    285      50.38     297      49.98    309      50.38    321      50.38    328
GR 58.38    348      61.38     378      63.58    405      71.28    418      82.48    442
GR 89.78    470      100       471

;Natural      Channel ID:      28031
NC 0.085    0.085    0.03
X1 28031             14        320      386      0.0      0.0      0.0      0        0
GR 100      0        77.28     20       74.68    120      72.08    220      69.48    320
GR 48.78    321      48.28     353      48.78    385      69.88    386      69.28    465
GR 71.58    470      82.78     492      90.08    520      100      521

;Natural      Channel ID:      28100
NC 0.02     0.02     0.025
X1 28100             16        19       521      0.0      0.0      0.0      0        0
GR 100      19       77.28     20       74.68    120      72.08    220      69.48    320
GR 74.48    321      74.58     341      74.68    365      74.78    370      74.88    385
GR 69.88    386      69.28     465      71.58    470      82.78    492      90.08    520
GR 100      521

;Natural      Channel ID:      28101
NC 0.085    0.085    0.03
X1 28101             14        320      386      0.0      0.0      0.0      0        0
GR 100      0        77.28     20       74.68    120      72.08    220      69.48    320
GR 48.78    321      48.28     353      48.78    385      69.88    386      69.28    465
GR 71.58    470      82.78     492      90.08    520      100      521

;Natural      Channel ID:      28165
NC 0.085    0.085    0.03
X1 28165             22        203      418      0.0      0.0      0.0      0        0
GR 100      0        82.78     0.1      82.78    7        78.68    30       77.18    68
GR 74.48    203      57.98     236      56.88    263      50.68    265      48.28    268
GR 50.68    285      50.68     297      50.28    309      50.68    321      50.68    328
GR 58.68    348      61.68     378      63.88    405      71.58    418      82.78    442
GR 90.08    470      100       471

;Natural      Channel ID:      28801
NC 0.085    0.085    0.03
X1 28801             22        203      418      0.0      0.0      0.0      0        0
GR 100      0        82.18     0.1      82.18    7        78.08    30       76.58    68
GR 73.88    203      57.38     236      56.28    263      50.08    265      47.68    268
GR 50.08    285      50.08     297      49.68    309      50.08    321      50.08    328
GR 58.08    348      61.08     378      63.28    405      70.98    418      82.18    442
GR 89.48    470      100       471

;Natural      Channel ID:      29001
NC 0.085    0.085    0.03
X1 29001             22        203      418      0.0      0.0      0.0      0        0
GR 100      0        82.98     0.1      82.98    7        78.88    30       77.38    68
GR 74.68    203      58.18     236      57.08    263      50.88    265      48.48    268
GR 50.88    285      50.88     297      50.48    309      50.88    321      50.88    328
GR 58.88    348      61.88     378      64.08    405      71.78    418      82.98    442
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GR 90.28     470       100       471

;Natural       Channel ID:     29061
NC 0.085     0.085     0.03
X1 29061               10        250       303       0.0       0.0       0.0       0         0
GR 110       0         105.38    1         105.38    250       48.68     251       48.68     273
GR 51.98     278       51.98     302       105.38    303       105.38    553       110       554

;Natural       Channel ID:     29218
NC 0.018     0.018     0.018
X1 29218               17        0         554       0.0       0.0       0.0       0         0
GR 120       0         105.38    1         105.38    250       105.38    251       105.38    255
GR 105.38    262       105.38    268       105.38    273       105.38    274       105.38    279
GR 105.38    284       105.38    290       105.38    297       105.38    302       105.38    303
GR 105.38    553       120       554

;Natural       Channel ID:     29278
NC 0.085     0.085     0.03
X1 29278               22        236       405       0.0       0.0       0.0       0         0
GR 100       0         83.48     0.1       83.48     7         79.38     30        77.88     68
GR 75.18     203       58.68     236       57.58     263       51.38     265       48.98     268
GR 51.38     285       51.38     297       50.98     309       51.38     321       51.38     328
GR 59.38     348       62.38     378       64.58     405       72.28     418       83.48     442
GR 90.78     470       100       471

;Natural       Channel ID:     30221
NC 0.085     0.085     0.03
X1 30221               26        369       436       0.0       0.0       0.0       0         0
GR 110       0         104.08    0.1       98.78     22        89.48     45        88.48     61
GR 80.08     126       80.78     152       79.48     187       70.28     247       59.98     272
GR 60.38     359       55.28     369       54.88     386       53.68     402       53.88     432
GR 55.28     436       59.68     439       63.08     594       68.18     605       69.18     663
GR 68.58     692       71.78     711       78.68     724       82.18     751       88.88     764
GR 110       765

;Natural       Channel ID:     30301
NC 0.085     0.085     0.03
X1 30301               21        360       442       0.0       0.0       0.0       0         0
GR 100       0         81.18     152       79.88     187       70.68     247       67.08     260
GR 67.88     360       54.08     361       54.08     382       54.28     388       54.88     413
GR 54.88     419       54.88     441       68.58     442       67.58     543       69.18     642
GR 69.58     663       68.98     692       72.18     711       79.08     724       82.58     751
GR 100       752

;Natural       Channel ID:     30328
NC 0.015     0.015     0.015
X1 30328               30        151       752       0.0       0.0       0.0       0         0
GR 140       151       81.18     152       79.88     187       70.68     247       67.28     260
GR 67.88     360       70.58     361       70.68     365       70.88     371       71.08     377
GR 71.18     382       71.38     388       71.58     393       71.78     400       71.78     407
GR 71.68     413       71.58     419       71.48     424       71.38     430       71.28     436
GR 71.28     441       68.58     442       67.58     542       69.18     642       69.58     663
GR 68.98     692       72.18     711       79.08     724       82.58     751       140       752

;Natural       Channel ID:     30408
NC 0.063     0.063     0.028
X1 30408               26        369       436       0.0       0.0       0.0       0         0
GR 100       0         105.78    0.1       100.48    22        91.18     45        90.18     61
GR 81.78     126       82.48     152       81.18     187       71.98     247       61.68     272
GR 62.08     359       56.98     369       56.58     386       55.38     402       55.58     432
GR 56.98     436       61.38     439       64.78     594       69.88     605       70.88     663
GR 70.28     692       73.48     711       80.38     724       83.88     751       90.58     764
GR 100       765

;Natural       Channel ID:     30411
NC 0.06      0.06      0.025
X1 30411               31        359       445       0.0       0.0       0.0       0         0
GR 110       0         106.18    0.1       100.88    22        91.58     45        90.58     61
GR 82.18     126       82.88     152       81.58     187       72.38     247       62.08     272
GR 60.18     350       56.18     359       55.48     370       56.28     383       55.68     392
GR 55.88     397       55.78     408       56.08     416       56.08     423       56.28     434
GR 56.18     445       62.68     458       65.18     594       70.28     605       71.28     663
GR 70.68     692       73.88     711       80.78     724       84.28     751       90.98     764
GR 110       765

;Natural       Channel ID:     30486
NC 0.061     0.061     0.028
X1 30486               29        370       430       0.0       0.0       0.0       0         0
GR 110       0         106.18    0.1       100.88    22        91.58     45        90.58     61
GR 82.18     126       82.88     152       81.58     187       72.38     247       62.08     272
GR 62.48     359       61.38     370       57.78     371       57.68     384       57.58     396
GR 57.48     410       57.48     421       57.58     429       61.58     430       61.78     439
GR 65.18     594       70.28     605       71.28     663       70.68     692       73.88     711
GR 80.78     724       84.28     751       90.98     764       110       765

;Natural       Channel ID:     30666
NC 0.06      0.06      0.035
X1 30666               26        369       436       0.0       0.0       0.0       0         0
GR 110       0         106.18    0.1       100.88    22        91.58     45        90.58     61
GR 82.18     126       82.88     152       81.58     187       72.38     247       62.08     272
GR 62.48     359       57.38     369       56.98     386       55.78     402       55.98     432
GR 57.38     436       61.78     439       65.18     594       70.28     605       71.28     663
GR 70.68     692       73.88     711       80.78     724       84.28     751       90.98     764
GR 110       765

;Natural       Channel ID:     32061
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NC 0.06     0.06       0.035
X1 32061               23        567       620       0.0      0.0       0.0       0         0
GR 120      0          109.88    0.1       113.18    22       110.08    95        102.78    162
GR 98.08    194        90.78     229       78.08     268      65.78     310       65.18     492
GR 64.88    551        63.48     562       58.88     567      58.28     580       58.08     592
GR 57.68    604        58.88     620       64.08     631      68.08     655       75.78     680
GR 88.58    720        99.48     775       120       776

[LOSSES]
;;Link              Inlet      Outlet     Average    Flap Gate
;;-------------------------------------------------------------
  F03W              0          0          0          YES
  F04W              0          0          0          YES
  F05W              0          0          0          YES
  F06W              0          0          0          YES
  F07W              0          0          0          YES
  F08W              0          0          0          YES
  F09W              0          0          0          YES
  F10W1             0          0          0          YES
  F10W2             0          0          0          YES
  F11W1             0          0          0          YES
  F11W2             0          0          0          YES
  F12W              0          0          0          YES
  F13W              0          0          0          YES
  F14W              0          0          0          YES
  OF03-000          0          0          0          YES
  OF03-004          0          0          0          YES
  OF03-006          0          0          0          YES
  OF04-000          0          0          0          YES
  OF05-000          0          0          0          YES
  OF06-000          0          0          0          YES
  OF07-000          0          0          0          YES
  OF08-000          0          0          0          YES
  OF09-000          0          0          0          YES
  OF09-002          0          0          0          YES
  OF09-004          0          0          0          YES
  OF10-000          0          0          0          YES
  OF11-000          0          0          0          YES
  OF12-000          0          0          0          YES
  OF12-002          0          0          0          YES
  OF12-006          0          0          0          YES
  OF12-008          0          0          0          YES
  OF12-012          0          0          0          YES
  OF12-014          0          0          0          YES
  OF12-016          0          0          0          YES
  OF12-020          0          0          0          YES
  OF13-000          0          0          0          YES
  OF13-002          0          0          0          YES
  OF13-004          0          0          0          YES
  OF13-006          0          0          0          YES
  OF13-008          0          0          0          YES
  OF13010W1         0          0          0          YES
  OF13010W2         0          0          0          YES
  OF13-012          0          0          0          YES
  OF13-014          0          0          0          YES
  RF14-000          0          0          0          YES
  TFB-30328A        0          0          0          YES
  TFB-30328B        0          0          0          YES
  TFB-30328C        0          0          0          YES

[CONTROLS]
;;----------------------------------------------
RULE      ORIFICE1A
IF        NODE     F13Z     DEPTH    >        1.98
THEN      ORIFICE ORIFICE1@F13-F13Z           setting =        0.27
PRIORITY           1

RULE      ORIFICE1B
IF        NODE     F13Z     DEPTH    <=       1.5
THEN      ORIFICE ORIFICE1@F13-F13Z           setting =        1
PRIORITY           2

RULE      ORIFICE2A
IF        NODE     F14Z     DEPTH    >        0.98
THEN      ORIFICE ORIFICE2@F14-F14Z           setting =        0.45
PRIORITY           1

RULE      ORIFICE2B
IF        NODE     F14Z     DEPTH    <=       0.75
THEN      ORIFICE ORIFICE2@F14-F14Z           setting =        1
PRIORITY           2

RULE      ORIFICE3A
IF        NODE     IF12-016          DEPTH    >       4
THEN      ORIFICE ORIFICE3@21005-21006        setting =        0.2
PRIORITY           1

RULE      ORIFICE3B
IF        NODE     IF12-016          DEPTH    <=      3
THEN      ORIFICE ORIFICE3@21005-21006        setting =        1
PRIORITY           2
```

```
[DWF]
;;                                      Average      Time
;;Node              Parameter           Value        Patterns
;;-----------------------------------------------------------
  A2                FLOW                0.139243872
  B10               FLOW                0.139243872
  B2                FLOW                0.139243872
  B4                FLOW                0.139243872
  B6                FLOW                0.139243872
  B8                FLOW                0.139243872
  C2                FLOW                0.139243872
  CF12-016          FLOW                0.0008
  D2                FLOW                0.094097824
  D4                FLOW                0.094097824
  EJ2               FLOW                0.094097824
  EJ4               FLOW                0.094097824
  G10               FLOW                0.139243872
  G4                FLOW                0.139243872
  G6                FLOW                0.139243872
  G8                FLOW                0.139243872
  H10               FLOW                0.139243872
  H12               FLOW                0.139243872
  H14               FLOW                0.139243872
  H2                FLOW                0.356230264
  H4                FLOW                0.356230264
  H6                FLOW                0.356230264
  H7                FLOW                0.139243872
  H8                FLOW                0.139243872
  I10               FLOW                0.203109171
  I12               FLOW                0.203109171
  I2                FLOW                0.203109171
  I4                FLOW                0.203109171
  I6                FLOW                0.203109171
  I7                FLOW                0.203109171
  I8                FLOW                0.203109171
  IF04-000          FLOW                0.0004
  IF04-004          FLOW                0.0415
  IF05-000          FLOW                0.0498
  IF05-010          FLOW                0.0058
  IF12-000          FLOW                0.0018
  IF12-012          FLOW                0.0142
  IT00-018          FLOW                0.933798413
  IT13-008          FLOW                0.013726257
  IT15-022          FLOW                0.652346187
  J10               FLOW                0.139243872
  J12               FLOW                0.139243872
  J13               FLOW                0.139243872
  J14               FLOW                0.139243872
  J16               FLOW                0.139243872
  J18               FLOW                0.139243872
  J2                FLOW                0.094097824
  J20               FLOW                0.139243872
  J3A               FLOW                0.094097824
  J3B               FLOW                0.094097824
  J3C               FLOW                0.094097824
  J3D               FLOW                0.094097824
  J4                FLOW                0.094097824
  J6                FLOW                0.094097824
  J7                FLOW                0.094097824
  J8                FLOW                0.094097824
  J9                FLOW                0.139243872
  K2                FLOW                0.203109171
  K4                FLOW                0.203109171
  L2                FLOW                0.203109171
  L4                FLOW                0.203109171
  M2                FLOW                0.139243872
  M4                FLOW                0.139243872
  MC_2              FLOW                12.6238532
  MR10              FLOW                0.139243872
  MR12              FLOW                0.139243872
  MR2               FLOW                0.139243872
  MR4               FLOW                0.139243872
```

MR6	FLOW	0.139243872
MR8	FLOW	0.139243872
MS10	FLOW	0.203109171
MS12	FLOW	0.203109171
MS13	FLOW	0.203109171
MS14	FLOW	0.203109171
MS16	FLOW	0.203109171
MS18	FLOW	0.203109171
MS2	FLOW	0.203109171
MS20	FLOW	0.203109171
MS21	FLOW	0.203109171
MS22	FLOW	0.203109171
MS24	FLOW	0.203109171
MS26	FLOW	0.203109171
MS28	FLOW	0.203109171
MS30	FLOW	0.139243872
MS32	FLOW	0.139243872
MS34	FLOW	0.139243872
MS36	FLOW	0.139243872
MS37	FLOW	0.139243872
MS38	FLOW	0.139243872
MS4	FLOW	0.203109171
MS40	FLOW	0.139243872
MS42	FLOW	0.139243872
MS44	FLOW	0.139243872
MS45	FLOW	0.139243872
MS46	FLOW	0.139243872
MS50	FLOW	0.139243872
MS52	FLOW	0.139243872
MS53	FLOW	0.139243872
MS54	FLOW	0.139243872
MS56	FLOW	0.139243872
MS57	FLOW	0.139243872
MS58	FLOW	0.139243872
MS59	FLOW	0.139243872
MS6	FLOW	0.203109171
MS60	FLOW	0.139243872
MS62	FLOW	0.139243872
MS66	FLOW	0.139243872
MS70	FLOW	0.139243872
MS72	FLOW	0.139243872
MS73	FLOW	0.139243872
MS74	FLOW	0.139243872
MS8	FLOW	0.203109171
N2	FLOW	0.139243872
N3	FLOW	0.139243872
N4	FLOW	0.139243872
OR18-004	FLOW	0.01
TF03-132	FLOW	0.3204
TF04-115	FLOW	0.0077
TF04-122	FLOW	1.4738
TF04-136	FLOW	0.8515
TF05-108	FLOW	0.5706
TF06-006	FLOW	0.0093
TF06-014	FLOW	0.4154
TF07-120	FLOW	1.3756
TF08-106	FLOW	0.4852
TF09-108	FLOW	0.0004
TF-09856	FLOW	0.0442
TF-09886	FLOW	0.0442
TF-09946	FLOW	0.0442
TF-10001	FLOW	0.0442
TF-10061	FLOW	0.0442
TF10-124	FLOW	0.2764
TF-10561	FLOW	0.0442
TF-10681	FLOW	0.0442
TF-10706	FLOW	0.0442
TF-10731	FLOW	0.0442
TF11-124	FLOW	0.0077
TF11-132	FLOW	0.1454
TF11-144	FLOW	1.433
TF11-160	FLOW	0.0665
TF11-174	FLOW	1.928
TF-11251	FLOW	0.0442
TF-11311	FLOW	0.0442
TF12-106	FLOW	0.0393
TF-12291	FLOW	0.0442
TF-12851	FLOW	0.0442
TF-12911	FLOW	0.0442
TF-12973	FLOW	0.0442
TF-13033	FLOW	0.0442
TF13-110	FLOW	0.1529
TF-13405	FLOW	0.0442
TF-13776	FLOW	0.0442
TF-13836	FLOW	0.0442
TF-13898	FLOW	0.0442
TF-13958	FLOW	0.0442
TF-14039	FLOW	0.0442
TF14-105	FLOW	0.1233
TF-14120	FLOW	0.0442
TF-14201	FLOW	0.0442
TF-14282	FLOW	0.0442
TF-14363	FLOW	0.0442
TF-14444	FLOW	0.0442
TF-14544	FLOW	0.0442
TF-14561	FLOW	0.0442

TF-14561A	FLOW	0.0442
TF-14561B	FLOW	0.0442
TF-14601	FLOW	0.0442
TF-15181	FLOW	0.0442
TF-15291	FLOW	0.0442
TF-15304	FLOW	0.0442
TF-15414	FLOW	0.0442
TF-15861	FLOW	0.0442
TF-18081	FLOW	0.0442
TF-18956	FLOW	0.0442
TF-19026	FLOW	0.0442
TF-19057	FLOW	0.0442
TF-19127	FLOW	0.0442
TF-20596	FLOW	0.0442
TF-21926	FLOW	0.0442
TF-22026	FLOW	0.0442
TF-22039	FLOW	0.0442
TF-22139	FLOW	0.0442
TF-22376	FLOW	0.0442
TF-22476	FLOW	0.0442
TF-22586	FLOW	0.0442
TF-22686	FLOW	0.0442
TF-23161	FLOW	0.0442
TF-23971	FLOW	0.0442
TF-24071	FLOW	0.0442
TF-24337	FLOW	0.0442
TF-24437	FLOW	0.0442
TF-25391	FLOW	0.0442
TF-25711	FLOW	0.0442
TF-25841	FLOW	0.0442
TF-25907	FLOW	0.0442
TF-26037	FLOW	0.0442
TF-27181	FLOW	0.0442
TF-27281	FLOW	0.0442
TF-27356	FLOW	0.0442
TF-27966	FLOW	0.0442
TF-28031	FLOW	0.0442
TF-28100	FLOW	0.0442
TF-28101	FLOW	0.0442
TF-28165	FLOW	0.0442
TF-28801	FLOW	0.0442
TF-29001	FLOW	0.0442
TF-29061	FLOW	0.0442
TF-29218	FLOW	0.0442
TF-29278	FLOW	0.0442
TF-30221	FLOW	0.0442
TF-30301	FLOW	0.0442
TF-30328	FLOW	0.0442
TF-30408	FLOW	0.0442
TF-30411	FLOW	0.0442
TF-30486	FLOW	0.0442
TF-30666	FLOW	0.0442
TF-32061	FLOW	0.0442
TR15-210	FLOW	6.163322104
TR15-224	FLOW	0.800775883
TR15-234	FLOW	0.389918762
TR15-302	FLOW	0.07979841
TR15-310	FLOW	0.032803428
TR15-314	FLOW	0.012097718
TR15-320	FLOW	0.04583174
TR15-322	FLOW	0.038852287
TR15-332	FLOW	0.445521736
TR15-340	FLOW	0.010236531
TR15-340B	FLOW	0.024893382
TR15-342B	FLOW	0.005583562
TR15-344	FLOW	0.023497491
TR15-352	FLOW	0.087941105
TR15-358	FLOW	0.031640186
TR15-360B	FLOW	0.044203201
TR15-362	FLOW	0.074912793
TR15-366	FLOW	0.014656851
TR15-366B	FLOW	0.063280372
TR15-368	FLOW	0.112601838
TR15-370B	FLOW	0.042109365
TR15-372C	FLOW	0.048623521
TR15-376C	FLOW	0.082124894
TR15-378B	FLOW	0.069561879
TR15-386	FLOW	0.037456397
TR15-390	FLOW	0.0270087
TR15-392	FLOW	0.043971481
TR15-408	FLOW	0.845802383
TR15-412	FLOW	0.160899391
TR15-412A	FLOW	0.145912856
TR15-414	FLOW	0.202455009
TR15-414A	FLOW	0.205364934
TR15-426	FLOW	0.173714537
TR15-438	FLOW	0.369048013
TR15-604	FLOW	0.048158224
TR15-604A	FLOW	0.05769681
TR15-606A	FLOW	0.0369911
TR15-612A	FLOW	0.057929458
TR15-614A	FLOW	0.060953888
TR15-618	FLOW	0.089336996
TR15-704	FLOW	0.019775116
TR15-710	FLOW	0.0221016
TR15-716	FLOW	0.130981064

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TR15B1-366          FLOW            0.062815075
TR15B1-380          FLOW            0.042574662
TT01-124            FLOW            1.347034387
TT03-112            FLOW            1.073809593
TT04-106            FLOW            0.005350914
TT04-108            FLOW            0.129009799
TT05-104            FLOW            0.268
TT06-140            FLOW            1.970764817
TT07-102            FLOW            0.22473838
TT08-186            FLOW            8.353939684
TT09-304            FLOW            0.378518989
TT10-110            FLOW            0.337805515
TT11-102            FLOW            0.407134746
TT12-104            FLOW            0.071190418
TT13-122            FLOW            1.498953809
TT14-048            FLOW            1.752428907
TT14-058            FLOW            0.014853398
TT14-070            FLOW            1.553858838
TT14-082            FLOW            1.592245828
TT14-107            FLOW            0.01186507
TT14-108            FLOW            0.220550708
TT14-110            FLOW            0.006746804
TT14-112            FLOW            0.10352855
TT14-126            FLOW            2.707206359
TT14-202            FLOW            0.480186351
TT14-226            FLOW            0.948740282
TT14-242            FLOW            1.244901728
TT14-262            FLOW            0.5765028
TT14-263            FLOW            0.045366443
TT14-264            FLOW            0.483468332
TT14-266            FLOW            1.659713872
TT14-270            FLOW            0.027219866
TT14-272            FLOW            0.01628539
TT14-275            FLOW            0.200542943
TT14-278            FLOW            0.116556861
TT14-280            FLOW            0.023497491
TT14-282            FLOW            0.387359629
TT14-284            FLOW            0.042342014
TT14-288            FLOW            0.080031059
TT14-291            FLOW            0.331524007
TT14-294            FLOW            0.149592938
TT14-296            FLOW            1.172082771
TT14-308            FLOW            1.194184371
TT14-414            FLOW            0.740985237
TT14-513            FLOW            9.054444095
TT14-602            FLOW            0.187979928
TT14-606            FLOW            0.065141559
TT14-610            FLOW            0.264986557
TT14-612            FLOW            0.05327649
TT14-614            FLOW            0.049088818
TT14-616            FLOW            0.05327649
TT14-618            FLOW            0.067468044
TT14-620            FLOW            0.381776067
TT14-622            FLOW            0.042109365
TT14-624            FLOW            0.024428085
TT14-630            FLOW            0.067468044
TT14-636            FLOW            0.059325349
TT14-639            FLOW            0.080729004
TT14-642            FLOW            0.092128777
TT14-644            FLOW            0.018146577
TT14-646            FLOW            0.350135881
TT14-650            FLOW            0.142613485
TT14-660            FLOW            0.150290883
TT14-668            FLOW            0.053509138
TT14-676            FLOW            0.0221016
TT14-684            FLOW            0.0221016
TT14-688            FLOW            0.031407538
TT14-692            FLOW            0.047460279
TT14-818            FLOW            0.004332241
TT14-908            FLOW            2.104537662
TT15-034            FLOW            0.614424493
IT00-000            FLOW            1.911333719

[REPORT]
 INPUT      NO
 CONTROLS   NO

[TAGS]

[MAP]
 DIMENSIONS         2666778.850     244074.458      2737684.850     301389.396
 UNITS              None

[COORDINATES]
;;Node              X-Coord         Y-Coord
  21005             2716357.470     251006.440
  21006             2716475.000     250897.000
  31010             2714995.250     250694.766
  31015             2715014.183     250708.389
  31020             2715035.250     250734.766
  31900             2714935.250     250634.766
  31915             2714955.250     250654.766
  A2                2712805.354     275301.593
  B10               2711632.690     277075.976
  B2                2713168.923     281664.050
  B4                2712865.949     280527.897
```

B6	2712547.826	279300.852
B8	2712008.857	277548.871
C2	2708995.697	281858.566
CF04-002	2713051.000	259785.000
CF06-002	2713669.450	256554.710
CF07-000	2713456.960	256943.460
CF09-000	2713637.040	256348.280
CF10-000	2713523.260	256204.930
CF10-002	2713511.970	256214.730
CF11-000	2714227.910	255937.380
CF12-004	2713650.410	254107.620
CF12-006	2713881.910	254311.380
CF12-016	2714182.960	254312.880
CF12-020	2714540.670	254172.940
CF12-024	2714869.440	253994.800
CF13-000	2716403.910	254527.690
CF13-004	2716405.420	254475.360
CF14-000	2716492.420	254137.330
CT06-000	2707207.823	266400.271
CT07-004	2707085.537	265273.792
D2	2705532.738	288465.528
D4	2705874.495	288123.771
EJ2	2708225.786	286497.006
EJ4	2707350.887	284282.418
F03	2712902.844	260240.919
F04	2713046.000	259806.000
F05	2713066.000	258489.000
F06	2713717.900	256953.700
F07	2713453.120	256956.470
F08	2713340.590	256461.170
F09	2713651.760	256348.020
F10	2713535.060	256198.810
F11	2714284.570	255860.360
F11Z	2714257.580	255926.280
F12	2713413.390	253938.400
F13	2716397.670	254538.110
F13Z	2716402.940	254539.490
F14	2716489.520	254125.920
F14Z	2716489.630	254150.860
G10	2704077.801	282004.066
G4	2703554.001	285263.263
G6	2703815.901	283924.664
G8	2704106.901	283109.865
H10	2697966.805	283197.165
H12	2699014.405	283459.065
H14	2700353.004	282818.865
H2	2691644.500	282534.930
H4	2692413.830	281835.310
H6	2694329.308	282207.766
H7	2695697.007	283255.365
H8	2696308.107	283517.265
I10	2700735.504	291822.521
I12	2699624.172	290406.468
I2	2702157.531	296214.076
I4	2702103.757	294726.324
I6	2701327.019	293680.716
I7	2700986.450	293328.197
I8	2700980.475	292933.853
IF03-000	2712902.844	260174.496
IF03-002	2712803.208	260091.466
IF03-004	2712753.390	260008.436
IF03-006	2712686.966	259925.406
IF03-010	2712620.542	259825.770
IF04-000	2712853.350	259690.840
IF04-002	2713024.550	259485.540
IF04-004	2713191.340	259162.370
IF04-006	2713104.910	258854.330
IF05-000	2712931.180	258478.310
IF05-002	2712826.130	258265.880
IF05-004	2712717.690	258042.890
IF05-006	2712795.790	257714.010
IF05-008	2713037.070	257510.410
IF05-010	2713273.970	257323.990
IF05-012	2713462.550	257175.810
IF06-000	2713570.140	256989.530
IF07-000	2713567.850	256923.960
IF07-002	2713436.190	256646.420
IF08-000	2713385.730	256472.670
IF08-006	2713393.410	256409.310
IF09-000	2713473.080	256203.730
IF10-000	2713484.310	256169.230
IF10-004	2713699.910	256108.850
IF11-000	2714213.570	255824.790
IF11-002	2714410.190	255624.250
IF11-006	2714750.180	255331.720
IF11-008	2714860.010	254997.810
IF11-012	2714843.490	254527.810
IF11-016	2714911.220	254050.530
IF12-000	2715141.850	253828.930
IF12-004	2714910.320	253467.120
IF12-006	2715267.160	252976.010
IF12-008	2715536.060	252603.190
IF12-010	2715749.380	252198.700
IF12-012	2715965.420	251792.520
IF12-016	2716084.547	251506.181
IR18-002	2711372.500	257380.234

IR18-004	2711632.000	257279.609
IR18-017	2711580.750	256184.109
IR18-018	2711685.000	255997.484
IR18-020	2711652.250	256014.781
IR18-030	2712037.750	255650.063
IR18-032	2712330.500	255408.453
IR18-040	2712481.250	255248.922
IR18-042	2712736.750	254834.734
IR18-046	2713148.250	254148.047
IR18-050	2713364.250	253853.156
IR18-052	2713621.500	253420.328
IR18-056	2713781.500	253136.719
IR18-058	2713899.000	252958.688
IR18-060	2714121.500	252586.094
IR18-062	2714418.750	252087.531
IR18-064	2714669.250	251647.922
IR18-066	2714972.750	251143.891
IR18-068	2714952.500	250787.563
IR18-070	2714966.500	250731.375
IR18-072	2714975.250	250674.766
IR18-076	2711897.250	255729.078
IR18-080	2712319.500	255389.734
IR18-084	2712532.750	255131.313
IR18-086	2712707.000	254854.656
IR18-088	2713006.750	254364.125
IR18-090	2713287.250	253959.500
IR18-092	2713550.500	253513.422
IR18-094	2713818.000	253055.906
IR18-096	2714063.250	252649.188
IR18-098	2714313.500	252226.109
IR18-100	2714572.500	251786.125
IR18-102	2714807.250	251386.531
IR18-104	2715090.500	250904.703
IR18-106	2715092.027	250864.078
IT00-002	2707543.308	270595.135
IT00-004	2707393.980	270414.035
IT00-006	2707326.390	270326.167
IT00-008	2707321.750	270207.688
IT00-010	2707189.000	269933.281
IT00-012	2706990.750	269521.938
IT00-014	2706853.500	269312.563
IT00-016	2706762.500	269332.438
IT00-018	2706650.250	269374.313
IT00-022	2706490.750	269099.594
IT03-000	2706338.250	268751.781
IT03-004	2706240.500	268243.188
IT03-006	2706294.000	268000.406
IT03-008	2706350.000	267793.656
IT03-010	2706424.500	267537.406
IT03-012	2706423.500	267536.094
IT03-014	2706484.000	267326.375
IT03-016	2706540.750	267124.906
IT04-000	2706692.151	266925.518
IT05-004	2706953.000	266432.500
IT06-000	2707179.750	266286.625
IT06-004	2707240.000	266004.188
IT06-006	2707218.750	265738.938
IT06-008	2707199.000	265494.344
IT07-000	2707146.267	265046.053
IT07-004	2707221.750	264799.844
IT07-006	2707128.500	264563.906
IT07-012	2706797.000	264367.063
IT08-000	2706778.000	264334.375
IT10-000	2706770.500	263529.313
IT10-002	2706861.500	263329.594
IT10-004	2707080.500	263190.344
IT11-000	2707158.000	262906.625
IT11-002	2707216.750	262707.906
IT11-004	2707296.750	262453.250
IT13-000	2707381.500	262177.594
IT13-002	2707537.000	261973.172
IT13-004	2707809.500	261847.094
IT13-006	2708031.000	261793.266
IT13-008	2708483.250	261021.250
IT13-012	2708506.000	260601.922
IT13-014	2708412.000	260390.281
IT13-016	2708391.750	260061.266
IT14-000	2708530.000	259892.625
IT14-004	2708731.500	259815.313
IT15-000	2709156.250	259324.703
IT15-004	2709433.000	259139.281
IT15-006	2709669.500	259107.469
IT15-010	2710060.250	259055.641
IT15-012	2710689.000	258972.406
IT15-014	2710894.250	258944.063
IT15-018	2711393.250	258804.547
IT15-022	2711343.500	258429.938
IT15-024	2711265.250	257844.109
J10	2707733.655	282970.070
J12	2708297.298	282178.666
J13	2708326.398	281538.466
J14	2708500.998	280374.467
J16	2708850.197	279617.868
J18	2709141.197	278773.968
J2	2706011.198	288082.760
J20	2709375.689	277935.786

J3A	2705942.847	288082.760
J3B	2705792.473	287440.256
J3C	2706052.209	286920.785
J3D	2706065.879	286702.060
J4	2706175.242	286346.633
J6	2706817.745	285307.690
J7	2707186.843	284132.045
J8	2707118.492	283339.168
J9	2707501.260	283188.795
K2	2700018.515	294433.554
K4	2700353.110	293895.813
L2	2693174.402	291444.126
L4	2693572.709	290035.660
M2	2694439.619	284572.487
M4	2695182.499	283910.860
MC_1	2697631.000	277738.000
MC_2	2707408.088	270844.224
MR10	2706027.499	276736.970
MR12	2706289.399	277435.369
MR2	2703001.102	274496.271
MR4	2703583.101	274787.271
MR6	2704630.700	275136.471
MR8	2705445.500	276038.570
MS10	2692903.409	288726.161
MS12	2693572.709	289424.560
MS13	2693951.008	289831.960
MS14	2695318.707	289511.860
MS16	2696046.207	289482.760
MS18	2697192.385	289402.684
MS2	2689494.825	287300.249
MS20	2698506.864	289808.978
MS21	2699098.380	289761.178
MS22	2699198.693	289354.776
MS24	2699210.300	288414.569
MS26	2699686.208	287300.249
MS28	2700069.255	286476.117
MS30	2700301.405	285268.937
MS32	2701487.903	282993.465
MS34	2701837.102	282353.266
MS36	2702622.802	282091.366
MS37	2703583.101	281101.966
MS38	2703435.737	280067.790
MS4	2690237.705	288391.354
MS40	2704456.101	279326.868
MS42	2705503.700	278221.069
MS44	2706085.699	278861.268
MS45	2706638.599	277813.669
MS46	2707104.199	277784.569
MS50	2707505.320	277941.470
MS52	2708180.898	277639.069
MS53	2709257.465	277366.162
MS54	2709827.089	277366.162
MS56	2710052.789	277419.900
MS57	2710729.890	277688.590
MS58	2711440.095	276300.470
MS59	2712429.495	275020.071
MS6	2691061.837	288321.709
MS60	2712022.095	274496.271
MS62	2711178.196	273623.272
MS66	2710363.396	273332.272
MS70	2709752.297	273099.472
MS72	2709344.897	272080.973
MS73	2709024.797	271760.873
MS74	2708279.413	271008.829
MS8	2692292.309	288406.061
N2	2708268.198	273244.972
N3	2708066.530	273024.780
N4	2708241.140	272812.590
OF03-000	2712487.695	260390.373
OF03-004	2712288.423	260290.737
OF03-006	2712154.000	260283.000
OF04-000	2712981.270	259919.810
OF05-000	2713045.920	258516.270
OF06-000	2713681.820	256948.760
OF07-000	2713519.160	256982.090
OF08-000	2713409.140	256459.510
OF09-000	2713654.730	256306.170
OF09-002	2713678.660	256250.520
OF09-004	2713641.350	256246.430
OF10-000	2713538.010	256222.530
OF11-000	2714318.060	255785.220
OF12-000	2713602.390	253956.680
OF12-002	2713636.380	254078.820
OF12-006	2713869.940	254261.120
OF12-008	2713907.340	254289.870
OF12-012	2714225.820	254276.930
OF12-014	2714474.410	254180.250
OF12-016	2714676.280	254093.360
OF12-020	2714904.060	253939.670
OF13-000	2716355.080	254387.410
OF13-002	2716404.100	254266.950
OF13-004	2716283.260	254013.400
OF13-006	2716152.970	253793.750
OF13-008	2715989.460	253660.470
OF13-014	2715405.650	253434.580
OR15-002	2701284.203	268210.676

OR15-004	2701575.203	268065.176
OR15-012	2704630.700	267424.977
OR15-016	2705929.700	267883.600
OR18-004	2711550.750	257438.875
OR18-010	2711953.000	257708.500
OT01-002	2690607.172	280821.407
OT04-002	2706624.107	266994.520
OT05-002	2706564.140	266864.568
OT05-004	2706613.237	266886.213
OT06-000	2707268.647	266370.839
OT06-002	2707286.306	266319.825
OT09-002	2706825.383	263623.754
OT09-004	2706825.383	263887.811
R15	2700876.803	268647.176
R15B	2701196.903	268588.976
R18	2711392.500	257400.234
R18W1	2711412.500	257420.234
RF14-000	2716439.980	254171.170
RT01-000	2690281.285	280765.540
RT03-000	2706172.109	269000.953
RT04-000	2706598.231	267001.229
RT05-000	2706539.770	266846.931
RT07-000	2707074.250	265112.688
RT08-000	2706708.024	263968.496
RT09-000	2706664.014	263535.735
RT10-000	2707067.435	263821.797
RT11-000	2707211.504	262907.540
RT12-000	2707422.435	262379.545
RT13-000	2707356.626	262144.309
RT14-000	2708481.750	259931.359
RT15-000	2709130.516	259338.433
T01	2690141.619	280709.674
T14	2708383.643	259907.874
TF-00200	2718824.531	247877.224
TF-00350	2718434.845	248242.555
TF-00368	2718203.468	248473.932
TF-00518	2718008.625	248705.308
TF-00780	2717789.426	248912.329
TF-00940	2717618.938	249192.417
TF-00973	2717509.339	249350.727
TF-01133	2717326.673	249569.926
TF-02905	2717095.297	249923.079
TF03-108	2712682.860	261594.610
TF03-116	2712437.877	261785.274
TF03-124	2712238.605	262001.152
TF03-130	2712022.728	262283.453
TF03-132	2712105.757	262549.149
TF-03135	2716705.610	250446.721
TF03-136	2712388.059	262814.844
TF03-138	2712637.148	263063.934
TF-03285	2716291.300	251798.200
TF-03347	2716255.700	251846.000
TF-03497	2716170.600	251965.800
TF-03605	2716108.000	252053.800
TF-03755	2716022.000	252180.500
TF-03800	2715995.200	252217.900
TF-03950	2715910.700	252335.700
TF-03975	2715892.800	252357.400
TF04-102	2713166.540	259656.200
TF04-108	2713485.130	260208.070
TF04-115	2713799.566	260240.919
TF04-120	2713450.841	260672.675
TF04-122	2713683.324	261021.400
TF04-124	2713550.476	261237.277
TF-04125	2715803.200	252473.900
TF04-125	2713666.718	261486.367
TF04-128	2713550.476	261702.244
TF04-136	2713517.264	262001.152
TF04-138	2713450.841	262399.695
TF04-140	2713699.930	262549.149
TF-04177	2715771.000	252514.600
TF-04239	2715732.600	252566.600
TF-04301	2715700.700	252619.800
TF-04406	2715634.000	252699.600
TF-04556	2715533.100	252817.800
TF05-108	2713374.360	258720.320
TF05-114	2713457.120	259078.080
TF-05301	2714985.200	253336.200
TF-05451	2714877.000	253439.400
TF-05469	2714865.900	253453.400
TF-05619	2714766.500	253566.100
TF-05621	2714765.200	253567.700
TF-05771	2714666.400	253679.200
TF-05871	2714606.700	253762.100
TF06-006	2713988.820	256878.870
TF06-008	2714114.410	257144.530
TF06-012	2714380.230	257737.420
TF06-014	2714500.050	258004.670
TF06-020	2714884.080	258799.580
TF-06021	2714503.900	253868.500
TF07-106	2713210.050	256869.560
TF07-110	2712827.540	256776.190
TF07-114	2712386.600	256763.500
TF07-120	2711768.540	256770.490
TF07-128	2710687.880	256757.160
TF-07706	2713911.700	255412.100

TF-07826	2713808.400	255471.000
TF-07842	2713794.600	255483.100
TF-07962	2713683.900	255529.500
TF-07966	2713679.600	255531.100
TF-08086	2713573.600	255584.000
TF08-106	2712814.770	256352.840
TF-08160	2713503.300	255606.800
TF08-210	2712501.170	256264.490
TF08-212	2712454.300	256250.340
TF-08280	2713393.100	255655.500
TF-08346	2713332.500	255678.900
TF-08831	2712915.600	255925.500
TF-08911	2712864.300	255990.800
TF-08974	2712823.900	256042.700
TF-09054	2712774.600	256105.200
TF-09061	2712770.400	256111.100
TF09-108	2713927.290	256757.680
TF-09141	2712739.900	256188.500
TF-09215	2712738.200	256266.900
TF-09261	2712746.700	256312.800
TF-09311	2712764.600	256359.400
TF-09361	2712787.900	256402.800
TF-09856	2712889.900	256839.400
TF-09886	2712870.200	256863.700
TF-09946	2712832.200	256913.700
TF-10001	2712797.000	256957.000
TF-10061	2712761.900	257004.900
TF10-102	2713464.360	256041.100
TF10-108	2712900.590	255942.860
TF10-110	2712701.400	255899.410
TF10-112	2712627.430	255850.460
TF10-118	2712316.590	255618.090
TF10-124	2712037.590	255408.190
TF10-132	2711646.190	255115.860
TF-10561	2712362.300	257306.500
TF-10681	2712265.800	257377.200
TF-10706	2712245.700	257393.200
TF-10731	2712226.900	257408.900
TF11-104	2714713.880	256320.210
TF11-108	2714896.110	256660.120
TF11-116	2715187.370	256900.220
TF11-124	2715758.980	257241.450
TF11-132	2716284.730	257549.350
TF11-140	2716506.338	257766.630
TF11-144	2716838.458	257916.084
TF11-152	2717170.577	258131.962
TF11-160	2717685.362	258364.445
TF11-168	2717801.604	258696.565
TF11-174	2717917.845	258895.836
TF11-176	2718083.905	258812.806
TF-11251	2712101.700	257858.600
TF-11311	2712130.300	257911.900
TF12-104	2713036.610	253758.490
TF12-106	2712893.600	253920.130
TF12-110	2712582.850	254284.530
TF-12291	2712450.140	258861.313
TF-12851	2712271.700	259349.100
TF-12911	2712239.800	259397.800
TF-12973	2712199.700	259447.600
TF-13033	2712159.300	259493.400
TF13-106	2716462.320	254979.400
TF13-110	2716402.060	255295.690
TF13-118	2716305.570	255784.580
TF13-122	2716260.320	256021.800
TF-13405	2711875.000	259650.000
TF-13776	2711683.199	259846.685
TF-13836	2711498.900	259843.200
TF-13898	2711440.497	259846.685
TF-13958	2711374.300	259842.400
TF-14039	2711292.900	259846.600
TF14-105	2716916.570	253762.220
TF14-106	2717031.470	253598.420
TF-14120	2711217.200	259874.400
TF-14201	2711145.200	259908.600
TF-14282	2711071.200	259944.300
TF-14363	2710992.400	259959.500
TF-14444	2710911.500	259957.400
TF-14544	2710801.100	259934.300
TF-14561	2710783.800	259931.100
TF-14561A	2710758.800	259926.100
TF-14561B	2710770.800	259929.100
TF-14601	2710744.400	259923.300
TF-15181	2710184.600	259819.000
TF-15291	2710075.900	259809.200
TF-15304	2710063.500	259808.500
TF-15414	2709953.900	259788.500
TF-15861	2709509.800	259838.400
TF-18081	2709280.348	260869.541
TF-18956	2709457.976	261453.946
TF-19026	2709636.700	261540.900
TF-19057	2709644.400	261572.000
TF-19127	2709764.158	262028.038
TF-20596	2708983.000	262301.600
TF-21926	2707859.100	261990.600
TF-22026	2707763.800	262019.900
TF-22039	2707750.000	262024.500

TF-22139	2707649.300	262038.500
TF-22376	2707491.100	262190.900
TF-22476	2707465.700	262309.500
TF-22586	2707409.800	262404.800
TF-22686	2707454.980	262642.142
TF-23161	2707331.200	262963.500
TF-23971	2706945.100	263601.900
TF-24071	2706935.300	263701.400
TF-24337	2706909.200	263966.000
TF-24437	2706986.500	264030.900
TF-25391	2707419.300	264736.400
TF-25711	2707402.035	265009.849
TF-25841	2707379.067	265157.392
TF-25907	2707358.600	265245.700
TF-26037	2707373.500	265376.200
TF-27181	2707227.500	266469.100
TF-27281	2707152.300	266534.200
TF-27356	2707028.993	266716.845
TF-27966	2706801.700	267114.300
TF-28031	2706755.200	267160.800
TF-28100	2706700.400	267202.200
TF-28101	2706677.072	267225.945
TF-28165	2706661.000	267253.100
TF-28801	2706440.700	267841.200
TF-29001	2706353.090	267980.784
TF-29061	2706365.019	268116.521
TF-29218	2706317.800	268251.300
TF-29278	2706308.800	268312.800
TF-30221	2706719.100	269155.200
TF-30301	2706941.125	269197.409
TF-30328	2706792.427	269237.963
TF-30408	2706801.400	269322.200
TF-30411	2706800.200	269318.400
TF-30486	2706826.900	269394.200
TF-30666	2706853.258	269758.409
TF-32061	2707799.514	270089.839
TR15-104	2700818.603	268938.175
TR15-106	2700731.303	269287.375
TR15-110	2700522.750	269561.063
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TR15-136	2697879.505	270480.474
TR15-148	2698228.705	271440.774
TR15-154	2698112.305	272226.473
TR15-156	2697792.205	272662.973
TR15-158	2697443.006	272779.373
TR15-162	2697152.006	272779.373
TR15-164	2696948.306	272779.373
TR15-166	2697006.506	273128.572
TR15-168	2696977.406	273419.572
TR15-172	2696453.606	273477.772
TR15-174	2696482.706	274234.372
TR15-182	2695900.707	275311.071
TR15-190	2695153.370	276590.484
TR15-204	2694430.354	277266.347
TR15-208	2694244.750	278097.719
TR15-210	2694164.250	278421.406
TR15-212	2694084.500	278729.219
TR15-214	2694018.500	278971.844
TR15-216	2693932.000	279327.625
TR15-218	2693856.250	279621.250
TR15-220	2693781.250	279911.688
TR15-222	2693698.500	280225.781
TR15-224	2693610.500	280537.063
TR15-234	2692637.250	281199.406
TR15-240	2691892.250	280841.531
TR15-250	2691353.750	280551.625
TR15-264	2690709.594	280197.566
TR15-302	2700109.050	270736.690
TR15-304	2700136.210	270968.330
TR15-306	2700263.210	271157.640
TR15-308	2700436.550	271502.710
TR15-310	2700443.730	271524.280
TR15-312	2700452.520	271533.870
TR15-314	2700403.800	271635.310
TR15-316	2700391.020	271830.210
TR15-318	2700417.370	272007.540
TR15-320	2700487.470	272308.910
TR15-322	2700787.710	272940.720
TR15-324	2700848.500	273373.590
TR15-326	2700903.760	273754.880
TR15-328	2701305.320	273918.820
TR15-330	2701500.570	274340.640
TR15-332	2701715.490	274802.260
TR15-336	2701484.560	274962.810
TR15-338	2701294.370	275094.840
TR15-340	2701146.620	275038.250
TR15-340B	2701269.480	275110.620
TR15-341	2701091.090	275053.280
TR15-342	2700884.120	275097.980
TR15-342B	2701249.060	275088.630
TR15-344	2700656.010	275034.140
TR15-344B	2701093.570	275082.350
TR15-346	2700565.080	275010.000
TR15-346B	2700879.980	275126.330
TR15-348	2700287.210	275015.770
TR15-348B	2700702.500	275079.210

TR15-350	2700003.300	275019.390
TR15-350B	2700536.020	275033.660
TR15-351B	2700521.990	275034.590
TR15-352	2699945.250	274993.090
TR15-352B	2700358.540	275039.940
TR15-354	2699889.920	274592.170
TR15-354B	2700182.640	275039.940
TR15-356	2699430.940	274595.790
TR15-356B	2700002.020	275044.650
TR15-358	2699303.050	274728.230
TR15-358B	2699868.520	275063.500
TR15-360	2699274.020	274769.040
TR15-360B	2699782.140	275094.910
TR15-362	2699234.110	274807.140
TR15-362B	2699604.660	275093.340
TR15-364	2699049.720	274832.260
TR15-364B	2699408.340	275079.210
TR15-366	2698886.720	274850.050
TR15-366B	2699353.370	275087.060
TR15-368	2698843.260	274839.180
TR15-368B	2699133.490	275120.040
TR15-370	2698854.120	274940.930
TR15-370B	2698927.740	275146.740
TR15-370C	2698831.030	274714.390
TR15-372	2698869.030	275081.410
TR15-372C	2698808.410	274528.900
TR15-374	2698874.760	275135.310
TR15-374C	2698796.520	274398.550
TR15-376A	2698664.910	275141.200
TR15-376B	2698894.940	275285.360
TR15-376C	2698778.580	274290.870
TR15-378A	2698489.250	275167.730
TR15-378B	2698917.820	275415.950
TR15-380A	2698429.720	275198.970
TR15-380B	2698883.430	275419.630
TR15-382A	2698462.730	275437.110
TR15-382B	2698696.740	275445.420
TR15-384	2698485.120	275474.840
TR15-386	2698485.710	275587.420
TR15-388	2698518.130	275819.080
TR15-390	2698547.610	276029.520
TR15-392	2698423.230	276058.400
TR15-394	2698287.070	276164.500
TR15-396	2698272.920	276221.680
TR15-398	2698295.320	276385.550
TR15-400	2698299.450	276515.820
TR15-402	2698082.530	276873.620
TR15-404	2697965.220	276966.750
TR15-406	2697814.410	277028.130
TR15-408	2697694.060	277106.220
TR15-410	2697646.110	277089.880
TR15-412	2697500.020	277129.540
TR15-412A	2697633.220	277062.330
TR15-414	2697556.980	277521.360
TR15-414A	2697577.030	276939.030
TR15-416	2697587.600	277734.150
TR15-418	2697569.540	277767.910
TR15-420	2697399.940	277885.690
TR15-422	2697235.840	277996.400
TR15-424	2697207.410	278017.420
TR15-426	2697008.810	278148.380
TR15-428	2696877.850	278239.050
TR15-430	2696696.520	278362.810
TR15-432	2696509.440	278495.210
TR15-434	2696385.670	278580.120
TR15-436	2696240.320	278686.610
TR15-438	2696027.850	278836.750
TR15-600	2700621.920	271541.220
TR15-602	2700646.170	271550.320
TR15-604	2700693.300	271537.250
TR15-604A	2700750.760	271714.020
TR15-606	2700993.970	271490.480
TR15-606A	2700897.090	271819.550
TR15-608	2701236.180	271383.580
TR15-608A	2700962.230	271844.610
TR15-610	2701398.270	271303.000
TR15-610A	2701145.980	271998.290
TR15-612	2701463.360	271273.330
TR15-612A	2701233.450	272214.830
TR15-614	2701692.200	271163.080
TR15-614A	2701241.190	272262.210
TR15-616	2701904.270	271063.090
TR15-618	2701936.080	271052.840
TR15-702	2700405.120	271548.320
TR15-704	2700157.500	271626.570
TR15-706	2699956.830	271689.160
TR15-708	2699823.360	271729.660
TR15-710	2699813.230	271783.050
TR15-712	2699845.450	272003.060
TR15-714	2699876.750	272236.860
TR15-716	2699850.970	272422.810
TR15B1-360	2699279.790	274707.740
TR15B1-362	2699421.300	274564.230
TR15B1-364	2699408.260	274405.680
TR15B1-366	2699380.470	274198.550
TR15B1-368	2699365.320	274069.730

TR15B1-370	2699345.110	273905.540
TR15B1-372	2699322.380	273771.670
TR15B1-374	2699294.590	273597.380
TR15B1-376	2699441.090	273607.480
TR15B1-378	2699607.810	273637.790
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TT01-112	2689696.250	280580.500
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TT01-128	2688228.500	281675.313
TT03-102	2705913.753	268940.566
TT03-104	2705825.250	268795.156
TT03-106	2705564.000	268780.938
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TT03-204	2705806.250	268475.438
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TT05-102	2706475.500	266766.250
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TT06-118	2709147.500	267766.156
TT06-122	2709186.883	268022.816
TT06-124	2709128.293	268276.702
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TT06-128	2709108.250	268566.094
TT06-130	2709236.750	268782.719
TT06-132	2709276.250	268838.844
TT06-136	2709597.250	269311.594
TT06-140	2709924.500	269786.031
TT06-144	2710199.500	270202.938
TT07-102	2706893.224	265137.149
TT07-104	2706853.750	265073.938
TT08-110	2704863.500	262652.580
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TT08-130	2703030.202	262477.980
TT08-138	2701575.203	262710.780
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TT09-314	2705647.750	263378.094
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TT13-114	2706202.000	261553.938

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TT14-074	2699392.704	260237.282
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TT14-078	2698927.105	260295.482
TT14-082	2698665.205	260324.582
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TT14-086	2698141.405	260382.782
TT14-088	2697821.305	260382.782
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TT14-728	2689542.137	277329.218
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TT14-736	2689070.605	278680.944
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TT14-812	2689750.000	266968.500
TT14-814	2689500.000	266968.500
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TT14-824	2688250.000	266968.500
TT14-826	2688000.000	266968.500
TT14-828	2687750.000	266968.500
TT14-830	2687500.000	266968.500
TT14-902	2704197.500	258483.781
TT14-904	2704018.750	258334.875
TT14-906	2703804.250	258164.891
TT14-908	2703514.750	258100.172
TT14-910	2703300.750	258050.797
TT15-010	2709839.597	257589.184
TT15-012	2709664.997	257065.384
TT15-016	2709257.597	256948.984
TT15-022	2709082.997	256570.685
TT15-024	2708006.298	256628.885
TT15-034	2707744.398	255464.885
TT15-038	2707191.499	255523.085
36666	2714306.601	250057.034
TF-00000	2720565.943	246208.878
21007	2716575.000	250797.000
IF13-000	2716444.600	254270.150
IF14-000	2716444.600	254270.150
CT14-000	2708559.198	258956.883
IT00-000	2707924.059	270652.069
CT08-000	2706211.338	263990.734
OR15-020	2706288.000	267782.781
CT05-004	2706607.958	266818.110
CT11-002	2706898.732	262882.927
CT10-004	2707052.765	263330.357
T07	2706918.528	265213.062
T12	2707500.528	262414.403
T10	2707206.799	263521.065
T06	2707239.216	266432.645
T05	2706547.228	266786.950
T04	2706572.355	267007.937
T03	2706089.010	268823.757

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 T11            2707265.478     262765.568
 T13            2707346.899     262166.080
 T15            2709121.839     259323.509
 IT09-000       2706605.335     264115.194
 CT06-006       2707194.088     266351.219
 IT05-000       2706669.500     266860.406
 CT04-002       2706566.605     266933.185
 TT03-202       2705937.750     268733.000
 TT09-302       2706448.250     263558.719
 T09            2706465.971     263983.165
 T08            2706465.971     263058.965
 CT01-000       2690355.774     280169.633
 OF13-012       2715596.760     253334.770
 OF13010        2715784.840     253491.120
 CF13-002       2716411.180     254497.810
 CF14-002       2716477.170     254182.370
 CF08-000       2713344.570     256463.200
 CF05-000       2713134.561     258390.470
 CF04-000       2713047.460     259798.850

[VERTICES]
;;Link          X-Coord         Y-Coord

[Polygons]
;;Subcatchment  X-Coord         Y-Coord
 CHEWSTA        2690055.000     269009.000
 CHEWSTA        2690055.000     269009.000
 CHEWSTA        2690055.000     268943.056
 CHEWSTA        2690055.000     268943.056
 CHEWSTB        2690055.000     269009.000
 CHEWSTB        2690055.000     269009.000
 CHEWSTB        2690055.000     269009.000
 CHEWSTB        2690055.000     269009.000
 CLEARVIEW      2689758.000     269539.600
 CLEARVIEW      2689758.000     269539.600
 CLEARVIEW      2689758.000     269519.000
 CLEARVIEW      2689758.000     269519.000
 F03-1          2711234.646     263597.981
 F03-1          2711316.272     263597.981
 F03-1          2711316.272     263493.032
 F03-1          2711234.646     263493.032
 F03-2          2712574.284     261603.046
 F03-2          2712735.624     261603.046
 F03-2          2712735.624     261583.913
 F03-2          2712574.284     261583.913
 F04-B1         2714141.587     262225.428
 F04-B1         2714254.631     262225.428
 F04-B1         2714254.631     262208.631
 F04-B1         2714141.587     262208.631
 F04-B2         2714163.113     261174.864
 F04-B2         2714399.165     261174.864
 F04-B2         2714399.165     261033.995
 F04-B2         2714163.113     261033.995
 F04-B3         2713769.794     262300.724
 F04-B3         2713829.338     262300.724
 F04-B3         2713829.338     262199.758
 F04-B3         2713769.794     262199.758
 F05            2713569.983     258664.110
 F05            2713592.285     258664.110
 F05            2713592.285     258621.650
 F05            2713569.983     258621.650
 F06            2714156.394     258042.871
 F06            2714542.710     258042.871
 F06            2714542.710     257596.262
 F06            2714156.394     257596.262
 F07            2711710.832     256948.357
 F07            2711840.576     256948.357
 F07            2711840.576     256762.804
 F07            2711710.832     256762.804
 F08-1          2712735.624     256514.776
 F08-1          2712830.202     256514.776
 F08-1          2712830.202     256299.830
 F08-1          2712735.624     256299.830
 F08-2          2712417.848     256299.830
 F08-2          2712501.462     256299.830
 F08-2          2712501.462     255753.056
 F08-2          2712417.848     255753.056
 F09            2713917.936     256762.804
 F09            2714156.394     256762.804
 F09            2714156.394     256514.776
 F09            2713917.936     256514.776
 F10            2712016.860     255409.754
 F10            2712039.074     255409.754
 F10            2712039.074     255340.690
 F10            2712016.860     255340.690
 F11-A1         2716420.084     259260.806
 F11-A1         2716825.076     259260.806
 F11-A1         2716825.076     259228.317
 F11-A1         2716420.084     259228.317
 F11-A2         2715625.228     257267.470
 F11-A2         2715776.668     257267.470
 F11-A2         2715776.668     257225.674
 F11-A2         2715625.228     257225.674
 F11-B1         2717849.010     258384.465
 F11-B1         2718152.740     258384.465
 F11-B1         2718152.740     258111.941
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F11-B1	2717849.010	258111.941
F11-B2	2717048.296	259070.043
F11-B2	2717326.070	259070.043
F11-B2	2717326.070	258954.112
F11-B2	2717048.296	258954.112
F12	2712869.450	254060.138
F12	2712908.632	254060.138
F12	2712908.632	253865.410
F12	2712869.450	253865.410
F13	2716335.604	255340.690
F13	2716419.076	255340.690
F13	2716419.076	255116.962
F13	2716335.604	255116.962
F14	2716677.128	253788.904
F14	2717063.618	253788.904
F14	2717063.618	253762.148
F14	2716677.128	253762.148
G2	2704083.139	287976.509
G2	2704138.915	287976.509
G2	2704138.915	287860.925
G2	2704083.139	287860.925
MR2a	2702632.950	274961.120
MR2a	2702685.070	274961.120
MR2a	2702685.070	274894.478
MR2a	2702632.950	274894.478
MR2b	2702186.302	274699.971
MR2b	2702186.302	274699.971
MR2b	2702186.302	274699.971
MR2b	2702186.302	274699.971
MS64	2710834.778	273178.169
MS64	2710881.414	273178.169
MS64	2710881.414	273078.975
MS64	2710834.778	273078.975
MS76	2708427.309	270345.269
MS76	2708459.511	270345.269
MS76	2708459.511	270345.269
MS76	2708427.309	270345.269
Non-B6	2713130.936	279225.531
Non-B6	2713176.614	279225.531
Non-B6	2713176.614	279224.685
Non-B6	2713130.936	279224.685
Non-B8	2713310.430	278445.233
Non-B8	2713351.198	278445.233
Non-B8	2713351.198	278372.129
Non-B8	2713310.430	278372.129
Non-del1	2711984.271	259184.337
Non-del1	2712013.155	259184.337
Non-del1	2712013.155	259052.819
Non-del1	2711984.271	259052.819
Non-del2	2711226.087	259686.149
Non-del2	2711287.239	259686.149
Non-del2	2711287.239	259684.109
Non-del2	2711226.087	259684.109
Non-del3	2713911.700	255753.056
Non-del3	2713917.936	255753.056
Non-del3	2713917.936	255412.100
Non-del3	2713911.700	255412.100
Non-MS100	2707389.775	266483.063
Non-MS100	2707398.185	266483.063
Non-MS100	2707398.185	266382.868
Non-MS100	2707389.775	266382.868
Non-MS102	2707784.149	265195.949
Non-MS102	2707790.731	265195.949
Non-MS102	2707790.731	265029.297
Non-MS102	2707784.149	265029.297
Non-MS104	2706942.172	263653.353
Non-MS104	2706965.260	263653.353
Non-MS104	2706965.260	263562.491
Non-MS104	2706942.172	263562.491
Non-MS106	2707699.002	262258.971
Non-MS106	2707737.288	262258.971
Non-MS106	2707737.288	262185.210
Non-MS106	2707699.002	262185.210
Non-MS108	2710424.375	262668.995
Non-MS108	2710607.355	262668.995
Non-MS108	2710607.355	262523.455
Non-MS108	2710424.375	262523.455
Non-MS110	2710894.709	261944.746
Non-MS110	2711006.521	261944.746
Non-MS110	2711006.521	261919.966
Non-MS110	2710894.709	261919.966
Non-MS112	2710668.314	261296.024
Non-MS112	2710697.096	261296.024
Non-MS112	2710697.096	261229.140
Non-MS112	2710668.314	261229.140
Non-MS114	2709077.470	260967.100
Non-MS114	2709113.800	260967.100
Non-MS114	2709113.800	260891.968
Non-MS114	2709077.470	260891.968
Non-MS118	2710024.896	259731.050
Non-MS118	2710273.742	259731.050
Non-MS118	2710273.742	259661.370
Non-MS118	2710024.896	259661.370
Non-MS120	2710820.333	259807.387
Non-MS120	2710976.837	259807.387
Non-MS120	2710976.837	259728.139

Non-MS120	2710820.333	259728.139
Non-MS122	2711218.998	260251.292
Non-MS122	2711239.238	260251.292
Non-MS122	2711239.238	260206.972
Non-MS122	2711218.998	260206.972
Non-MS76	2707066.479	270954.535
Non-MS76	2707066.479	270954.535
Non-MS76	2707066.479	270954.535
Non-MS76	2707066.479	270954.535
Non-MS78	2707171.000	270901.500
Non-MS78	2707191.300	270901.500
Non-MS78	2707191.300	270888.000
Non-MS78	2707171.000	270888.000
Non-MS80	2706960.957	269692.750
Non-MS80	2706988.885	269692.750
Non-MS80	2706988.885	269661.850
Non-MS80	2706960.957	269661.850
Non-MS86	2707180.609	269356.300
Non-MS86	2707242.365	269356.300
Non-MS86	2707242.365	269295.362
Non-MS86	2707180.609	269295.362
Non-MS88	2706741.202	269106.089
Non-MS88	2706776.062	269106.089
Non-MS88	2706776.062	269018.369
Non-MS88	2706741.202	269018.369
Non-MS90	2706550.424	268288.230
Non-MS90	2706588.334	268288.230
Non-MS90	2706588.334	268187.025
Non-MS90	2706550.424	268187.025
Non-MS92	2706604.470	267240.599
Non-MS92	2706634.160	267240.599
Non-MS92	2706634.160	267195.042
Non-MS92	2706604.470	267195.042
Non-MS94	2706922.196	266605.597
Non-MS94	2706933.018	266605.597
Non-MS94	2706933.018	266544.215
Non-MS94	2706922.196	266544.215
Non-MSr92	2706786.244	270193.539
Non-MSr92	2706798.610	270193.539
Non-MSr92	2706798.610	270107.326
Non-MSr92	2706786.244	270107.326
R15-A	2694156.822	278427.844
R15-A	2694299.150	278427.844
R15-A	2694299.150	278404.687
R15-A	2694156.822	278404.687
R18	2711313.140	258449.287
R18	2711405.660	258449.287
R18	2711405.660	258372.900
R18	2711313.140	258372.900
SubCatchA2	2713431.671	277088.853
SubCatchA2	2713464.317	277088.853
SubCatchA2	2713464.317	277025.285
SubCatchA2	2713431.671	277025.285
SubCatchB10	2711715.226	277547.675
SubCatchB10	2711808.096	277547.675
SubCatchB10	2711808.096	277335.115
SubCatchB10	2711715.226	277335.115
SubCatchB2	2713747.538	282820.433
SubCatchB2	2713788.650	282820.433
SubCatchB2	2713788.650	282700.897
SubCatchB2	2713747.538	282700.897
SubCatchB4	2711876.595	281422.881
SubCatchB4	2711876.595	281422.881
SubCatchB4	2711876.595	281304.852
SubCatchB4	2711876.595	281304.852
SubCatchB6	2712376.535	280509.499
SubCatchB6	2712415.007	280509.499
SubCatchB6	2712415.007	280391.959
SubCatchB6	2712376.535	280391.959
SubCatchB8	2712787.619	277783.259
SubCatchB8	2712799.247	277783.259
SubCatchB8	2712799.247	277765.883
SubCatchB8	2712787.619	277765.883
SubCatchC2	2710279.343	283405.185
SubCatchC2	2710336.683	283405.185
SubCatchC2	2710336.683	283309.723
SubCatchC2	2710279.343	283309.723
SubCatchD2	2704450.105	289219.972
SubCatchD2	2704646.849	289219.972
SubCatchD2	2704646.849	289160.136
SubCatchD2	2704450.105	289160.136
SubCatchD4	2705456.448	288360.444
SubCatchD4	2705527.006	288360.444
SubCatchD4	2705527.006	287941.780
SubCatchD4	2705456.448	287941.780
SubCatchEJ2	2707941.467	288409.452
SubCatchEJ2	2708127.335	288409.452
SubCatchEJ2	2708127.335	288084.156
SubCatchEJ2	2707941.467	288084.156
SubCatchEJ4	2709509.140	285510.619
SubCatchEJ4	2709512.446	285510.619
SubCatchEJ4	2709512.446	285268.805
SubCatchEJ4	2709509.140	285268.805
SubCatchG10	2705675.534	282804.001
SubCatchG10	2705739.266	282804.001
SubCatchG10	2705739.266	282717.329

SubCatchG10	2705675.534	282717.329
SubCatchG4	2702680.545	286415.295
SubCatchG4	2702780.109	286415.295
SubCatchG4	2702780.109	286086.587
SubCatchG4	2702680.545	286086.587
SubCatchG6	2703029.443	285158.453
SubCatchG6	2703087.387	285158.453
SubCatchG6	2703087.387	284910.117
SubCatchG6	2703029.443	284910.117
SubCatchG8	2703172.144	283873.149
SubCatchG8	2703272.772	283873.149
SubCatchG8	2703272.772	283762.107
SubCatchG8	2703172.144	283762.107
SubCatchH10	2696907.081	282778.588
SubCatchH10	2697047.731	282778.588
SubCatchH10	2697047.731	282684.542
SubCatchH10	2696907.081	282684.542
SubCatchH12	2698540.742	284294.469
SubCatchH12	2698556.868	284294.469
SubCatchH12	2698556.868	284253.259
SubCatchH12	2698540.742	284253.259
SubCatchH14	2699031.551	282454.200
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SubCatchH14	2699055.459	282252.332
SubCatchH14	2699031.551	282252.332
SubCatchH2	2690648.467	283654.405
SubCatchH2	2690909.755	283654.405
SubCatchH2	2690909.755	283554.725
SubCatchH2	2690648.467	283554.725
SubCatchH4	2692413.830	281867.842
SubCatchH4	2692442.198	281867.842
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SubCatchH4	2692413.830	281835.310
SubCatchH6	2693894.398	282168.374
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SubCatchH6	2693894.398	282079.374
SubCatchH8	2693788.845	283643.690
SubCatchH8	2693880.371	283643.690
SubCatchH8	2693880.371	283623.640
SubCatchH8	2693788.845	283623.640
SubCatchI10	2700491.487	292906.369
SubCatchI10	2700537.377	292906.369
SubCatchI10	2700537.377	292196.549
SubCatchI10	2700491.487	292196.549
SubCatchI12	2702110.461	291069.406
SubCatchI12	2702125.817	291069.406
SubCatchI12	2702125.817	290512.582
SubCatchI12	2702110.461	290512.582
SubCatchI2	2701257.098	298527.181
SubCatchI2	2701370.772	298527.181
SubCatchI2	2701370.772	297044.621
SubCatchI2	2701257.098	297044.621
SubCatchI4	2703546.570	297690.239
SubCatchI4	2703617.118	297690.239
SubCatchI4	2703617.118	296944.647
SubCatchI4	2703546.570	296944.647
SubCatchI6	2701324.077	294934.703
SubCatchI6	2701389.711	294934.703
SubCatchI6	2701389.711	294386.499
SubCatchI6	2701324.077	294386.499
SubCatchI8	2700093.886	293744.242
SubCatchI8	2700114.270	293744.242
SubCatchI8	2700114.270	292788.764
SubCatchI8	2700093.886	292788.764
SubCatchJ10	2707398.628	282533.904
SubCatchJ10	2707458.502	282533.904
SubCatchJ10	2707458.502	282388.494
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SubCatchJ12	2707725.716	281639.844
SubCatchJ12	2707776.734	281639.844
SubCatchJ12	2707776.734	281432.316
SubCatchJ12	2707725.716	281432.316
SubCatchJ14	2709747.026	281175.385
SubCatchJ14	2709873.968	281175.385
SubCatchJ14	2709873.968	281086.747
SubCatchJ14	2709747.026	281086.747
SubCatchJ16	2708089.544	280050.644
SubCatchJ16	2708245.362	280050.644
SubCatchJ16	2708245.362	279588.950
SubCatchJ16	2708089.544	279588.950
SubCatchJ18	2708499.554	279046.360
SubCatchJ18	2708545.006	279046.360
SubCatchJ18	2708545.006	278878.290
SubCatchJ18	2708499.554	278878.290
SubCatchJ2	2706576.463	289257.111
SubCatchJ2	2706730.941	289257.111
SubCatchJ2	2706730.941	289177.677
SubCatchJ2	2706576.463	289177.677
SubCatchJ20	2710517.887	280024.270
SubCatchJ20	2710582.461	280024.270
SubCatchJ20	2710582.461	279982.930
SubCatchJ20	2710517.887	279982.930
SubCatchJ4	2706162.526	287763.620
SubCatchJ4	2706379.342	287763.620
SubCatchJ4	2706379.342	287226.254

SubCatchJ4	2706162.526	287226.254
SubCatchJ6	2705782.707	285822.435
SubCatchJ6	2705856.921	285822.435
SubCatchJ6	2705856.921	285722.525
SubCatchJ6	2705782.707	285722.525
SubCatchJ8	2706050.440	284731.575
SubCatchJ8	2706108.658	284731.575
SubCatchJ8	2706108.658	284571.457
SubCatchJ8	2706050.440	284571.457
SubCatchJ9	2706625.300	283377.519
SubCatchJ9	2706654.762	283377.519
SubCatchJ9	2706654.762	283246.137
SubCatchJ9	2706625.300	283246.137
SubCatchK2	2699148.246	296358.241
SubCatchK2	2699299.460	296358.241
SubCatchK2	2699299.460	295938.463
SubCatchK2	2699148.246	295938.463
SubCatchK4	2699673.866	294178.045
SubCatchK4	2699693.976	294178.045
SubCatchK4	2699693.976	293888.427
SubCatchK4	2699673.866	293888.427
SubCatchL2	2692772.153	292941.989
SubCatchL2	2692856.985	292941.989
SubCatchL2	2692856.985	292198.117
SubCatchL2	2692772.153	292198.117
SubCatchL4	2692558.627	291108.286
SubCatchL4	2692582.997	291108.286
SubCatchL4	2692582.997	290828.150
SubCatchL4	2692558.627	290828.150
SubCatchM2	2693564.260	285381.723
SubCatchM2	2693666.712	285381.723
SubCatchM2	2693666.712	284877.571
SubCatchM2	2693564.260	284877.571
SubCatchMC_1	2697598.618	277786.736
SubCatchMC_1	2697631.888	277786.736
SubCatchMC_1	2697631.888	277711.624
SubCatchMC_1	2697598.618	277711.624
SubCatchMC_2	2707243.653	270962.234
SubCatchMC_2	2707280.732	270962.234
SubCatchMC_2	2707280.732	270911.253
SubCatchMC_2	2707243.653	270911.253
SubCatchMR10	2705371.784	277056.864
SubCatchMR10	2705489.526	277056.864
SubCatchMR10	2705489.526	276984.706
SubCatchMR10	2705371.784	276984.706
SubCatchMR4	2701849.537	275847.949
SubCatchMR4	2701999.267	275847.949
SubCatchMR4	2701999.267	275705.391
SubCatchMR4	2701849.537	275705.391
SubCatchMR6	2704258.759	276373.432
SubCatchMR6	2704478.843	276373.432
SubCatchMR6	2704478.843	276227.508
SubCatchMR6	2704258.759	276227.508
SubCatchMR8	2706139.203	275689.857
SubCatchMR8	2706206.795	275689.857
SubCatchMR8	2706206.795	275456.085
SubCatchMR8	2706139.203	275456.085
SubCatchMS10	2692863.829	286870.343
SubCatchMS10	2693052.115	286870.343
SubCatchMS10	2693052.115	286467.495
SubCatchMS10	2692863.829	286467.495
SubCatchMS12	2693482.428	287908.651
SubCatchMS12	2693578.536	287908.651
SubCatchMS12	2693578.536	287890.981
SubCatchMS12	2693482.428	287890.981
SubCatchMS14	2694773.670	287823.208
SubCatchMS14	2695207.098	287823.208
SubCatchMS14	2695207.098	287804.672
SubCatchMS14	2694773.670	287804.672
SubCatchMS16	2696541.426	294260.784
SubCatchMS16	2696588.148	294260.784
SubCatchMS16	2696588.148	294134.078
SubCatchMS16	2696541.426	294134.078
SubCatchMS18	2696411.272	289703.428
SubCatchMS18	2696599.270	289703.428
SubCatchMS18	2696599.270	289687.480
SubCatchMS18	2696411.272	289687.480
SubCatchMS2	2688309.404	285870.344
SubCatchMS2	2688335.532	285870.344
SubCatchMS2	2688335.532	285549.700
SubCatchMS2	2688309.404	285549.700
SubCatchMS20	2697564.262	291052.306
SubCatchMS20	2697728.694	291052.306
SubCatchMS20	2697728.694	290764.414
SubCatchMS20	2697564.262	290764.414
SubCatchMS22	2699812.611	290227.095
SubCatchMS22	2699838.385	290227.095
SubCatchMS22	2699838.385	289852.141
SubCatchMS22	2699812.611	289852.141
SubCatchMS24	2698487.789	288677.426
SubCatchMS24	2698516.697	288677.426
SubCatchMS24	2698516.697	288639.226
SubCatchMS24	2698487.789	288639.226
SubCatchMS26	2697354.486	287250.062
SubCatchMS26	2697398.146	287250.062
SubCatchMS26	2697398.146	286746.846

SubCatchMS26	2697354.486	286746.846
SubCatchMS28	2701059.699	287545.868
SubCatchMS28	2701075.301	287545.868
SubCatchMS28	2701075.301	287472.500
SubCatchMS28	2701059.699	287472.500
SubCatchMS30	2698934.777	285934.402
SubCatchMS30	2698998.309	285934.402
SubCatchMS30	2698998.309	285648.146
SubCatchMS30	2698934.777	285648.146
SubCatchMS32	2701179.976	285034.718
SubCatchMS32	2701233.604	285034.718
SubCatchMS32	2701233.604	284853.136
SubCatchMS32	2701179.976	284853.136
SubCatchMS34	2700909.295	282026.826
SubCatchMS34	2701135.311	282026.826
SubCatchMS34	2701135.311	281806.706
SubCatchMS34	2700909.295	281806.706
SubCatchMS36	2701864.505	281203.965
SubCatchMS36	2701926.099	281203.965
SubCatchMS36	2701926.099	281174.567
SubCatchMS36	2701864.505	281174.567
SubCatchMS38	2704991.517	281647.773
SubCatchMS38	2705142.883	281647.773
SubCatchMS38	2705142.883	281196.360
SubCatchMS38	2704991.517	281196.360
SubCatchMS4	2688369.290	288932.475
SubCatchMS4	2688414.934	288932.475
SubCatchMS4	2688414.934	288871.693
SubCatchMS4	2688369.290	288871.693
SubCatchMS40	2699503.662	279273.852
SubCatchMS40	2699580.022	279273.852
SubCatchMS40	2699580.022	279121.464
SubCatchMS40	2699503.662	279121.464
SubCatchMS42	2703480.991	277752.847
SubCatchMS42	2703627.011	277752.847
SubCatchMS42	2703627.011	277583.491
SubCatchMS42	2703480.991	277583.491
SubCatchMS44	2706469.418	280597.336
SubCatchMS44	2706633.180	280597.336
SubCatchMS44	2706633.180	280500.797
SubCatchMS44	2706469.418	280500.797
SubCatchMS46	2707664.276	279327.984
SubCatchMS46	2707708.120	279327.984
SubCatchMS46	2707708.120	279209.352
SubCatchMS46	2707664.276	279209.352
SubCatchMS50	2707496.788	277944.282
SubCatchMS50	2707522.792	277944.282
SubCatchMS50	2707522.792	277918.556
SubCatchMS50	2707496.788	277918.556
SubCatchMS52	2708782.705	276233.199
SubCatchMS52	2708859.489	276233.199
SubCatchMS52	2708859.489	276134.941
SubCatchMS52	2708782.705	276134.941
SubCatchMS54	2709115.516	277711.624
SubCatchMS54	2709129.854	277711.624
SubCatchMS54	2709129.854	277677.990
SubCatchMS54	2709115.516	277677.990
SubCatchMS56	2709925.624	278028.452
SubCatchMS56	2710030.226	278028.452
SubCatchMS56	2710030.226	277944.282
SubCatchMS56	2709925.624	277944.282
SubCatchMS58	2711532.460	276801.337
SubCatchMS58	2711755.130	276801.337
SubCatchMS58	2711755.130	276672.603
SubCatchMS58	2711532.460	276672.603
SubCatchMS6	2690308.971	287920.958
SubCatchMS6	2690376.251	287920.958
SubCatchMS6	2690376.251	287785.366
SubCatchMS6	2690308.971	287785.366
SubCatchMS60	2709893.921	275379.348
SubCatchMS60	2709901.673	275379.348
SubCatchMS60	2709901.673	275359.194
SubCatchMS60	2709893.921	275359.194
SubCatchMS62	2711049.142	274540.799
SubCatchMS62	2711190.850	274540.799
SubCatchMS62	2711190.850	274509.943
SubCatchMS62	2711049.142	274509.943
SubCatchMS70	2709920.787	274152.619
SubCatchMS70	2709933.007	274152.619
SubCatchMS70	2709933.007	274141.525
SubCatchMS70	2709920.787	274141.525
SubCatchMS72	2709897.776	272471.797
SubCatchMS72	2709956.018	272471.797
SubCatchMS72	2709956.018	272388.548
SubCatchMS72	2709897.776	272388.548
SubCatchMS74	2706318.499	272549.465
SubCatchMS74	2706318.499	272549.465
SubCatchMS74	2706318.499	272543.681
SubCatchMS74	2706318.499	272543.681
SubCatchMS8	2690755.313	286792.989
SubCatchMS8	2691193.689	286792.989
SubCatchMS8	2691193.689	286642.237
SubCatchMS8	2690755.313	286642.237
SubCatchN2	2706924.337	274894.052
SubCatchN2	2706993.061	274894.052
SubCatchN2	2706993.061	274796.890

SubCatchN2	2706924.337	274796.890
SubCatchTR15-302	2700104.970	270757.046
SubCatchTR15-302	2700128.430	270757.046
SubCatchTR15-302	2700128.430	270618.076
SubCatchTR15-302	2700104.970	270618.076
SubCatchTR15-310	2700419.772	271529.468
SubCatchTR15-310	2700461.226	271529.468
SubCatchTR15-310	2700461.226	271443.112
SubCatchTR15-310	2700419.772	271443.112
SubCatchTR15-314	2700387.930	271666.794
SubCatchTR15-314	2700419.772	271666.794
SubCatchTR15-314	2700419.772	271630.066
SubCatchTR15-314	2700387.930	271630.066
SubCatchTR15-320	2700461.226	272354.470
SubCatchTR15-320	2700525.382	272354.470
SubCatchTR15-320	2700525.382	272280.890
SubCatchTR15-320	2700461.226	272280.890
SubCatchTR15-322	2700765.540	273000.032
SubCatchTR15-322	2700819.026	273000.032
SubCatchTR15-322	2700819.026	272930.482
SubCatchTR15-322	2700765.540	272930.482
SubCatchTR15-340	2701139.198	275057.774
SubCatchTR15-340	2701180.172	275057.774
SubCatchTR15-340	2701180.172	275035.784
SubCatchTR15-340	2701139.198	275035.784
SubCatchTR15-340B	2701267.392	275117.972
SubCatchTR15-340B	2701395.688	275117.972
SubCatchTR15-340B	2701395.688	275101.194
SubCatchTR15-340B	2701267.392	275101.194
SubCatchTR15-342B	2701244.338	275091.142
SubCatchTR15-342B	2701255.836	275091.142
SubCatchTR15-342B	2701255.836	275087.688
SubCatchTR15-342B	2701244.338	275087.688
SubCatchTR15-358	2699261.686	274752.538
SubCatchTR15-358	2699323.178	274752.538
SubCatchTR15-358	2699323.178	274721.942
SubCatchTR15-358	2699261.686	274721.942
SubCatchTR15-366	2698860.644	274894.478
SubCatchTR15-366	2698899.160	274894.478
SubCatchTR15-366	2698899.160	274843.528
SubCatchTR15-366	2698860.644	274843.528
SubCatchTR15-366B	2699323.178	275087.688
SubCatchTR15-366B	2699364.210	275087.688
SubCatchTR15-366B	2699364.210	275057.774
SubCatchTR15-366B	2699323.178	275057.774
SubCatchTR15-368	2698822.704	274843.528
SubCatchTR15-368	2698860.644	274843.528
SubCatchTR15-368	2698860.644	274819.956
SubCatchTR15-368	2698822.704	274819.956
SubCatchTR15-370B	2698921.788	275216.488
SubCatchTR15-370B	2698937.788	275216.488
SubCatchTR15-370B	2698937.788	275136.096
SubCatchTR15-370B	2698921.788	275136.096
SubCatchTR15-372C	2698803.094	274596.440
SubCatchTR15-372C	2698808.646	274596.440
SubCatchTR15-372C	2698808.646	274524.610
SubCatchTR15-372C	2698803.094	274524.610
SubCatchTR15-376C	2698754.832	274354.122
SubCatchTR15-376C	2698786.968	274354.122
SubCatchTR15-376C	2698786.968	274283.748
SubCatchTR15-376C	2698754.832	274283.748
SubCatchTR15-378B	2698899.160	275433.730
SubCatchTR15-378B	2698921.788	275433.730
SubCatchTR15-378B	2698921.788	275359.046
SubCatchTR15-378B	2698899.160	275359.046
SubCatchTR15-386	2698448.222	275608.052
SubCatchTR15-386	2698510.470	275608.052
SubCatchTR15-386	2698510.470	275511.208
SubCatchTR15-386	2698448.222	275511.208
SubCatchTR15-390	2698510.470	276041.072
SubCatchTR15-390	2698624.166	276041.072
SubCatchTR15-390	2698624.166	275999.208
SubCatchTR15-390	2698510.470	275999.208
SubCatchTR15-392	2698381.992	276094.640
SubCatchTR15-392	2698448.222	276094.640
SubCatchTR15-392	2698448.222	276041.072
SubCatchTR15-392	2698381.992	276041.072
SubCatchTR15-408	2697657.556	277115.548
SubCatchTR15-408	2697730.608	277115.548
SubCatchTR15-408	2697730.608	277079.886
SubCatchTR15-408	2697657.556	277079.886
SubCatchTR15-412A	2697631.888	277079.886
SubCatchTR15-412A	2697657.556	277079.886
SubCatchTR15-412A	2697657.556	277056.864
SubCatchTR15-412A	2697631.888	277056.864
SubCatchTR15-414	2697522.804	277579.732
SubCatchTR15-414	2697565.000	277579.732
SubCatchTR15-414	2697565.000	277453.764
SubCatchTR15-414	2697522.804	277453.764
SubCatchTR15-414A	2697565.000	276984.706
SubCatchTR15-414A	2697598.618	276984.706
SubCatchTR15-414A	2697598.618	276867.612
SubCatchTR15-414A	2697565.000	276867.612
SubCatchTR15-438	2695996.890	278878.290
SubCatchTR15-438	2696079.982	278878.290
SubCatchTR15-438	2696079.982	278597.200

SubCatchTR15-438	2695996.890	278597.200
SubCatchTR15-604	2700687.330	271545.950
SubCatchTR15-604	2700716.284	271545.950
SubCatchTR15-604	2700716.284	271529.468
SubCatchTR15-604	2700687.330	271529.468
SubCatchTR15-604A	2700716.284	271720.012
SubCatchTR15-604A	2700765.540	271720.012
SubCatchTR15-604A	2700765.540	271666.794
SubCatchTR15-604A	2700716.284	271666.794
SubCatchTR15-606A	2700878.436	271851.330
SubCatchTR15-606A	2700909.858	271851.330
SubCatchTR15-606A	2700909.858	271797.650
SubCatchTR15-606A	2700878.436	271797.650
SubCatchTR15-612A	2701231.680	272233.782
SubCatchTR15-612A	2701236.546	272233.782
SubCatchTR15-612A	2701236.546	272127.332
SubCatchTR15-612A	2701231.680	272127.332
SubCatchTR15-614A	2701236.546	272280.890
SubCatchTR15-614A	2701244.338	272280.890
SubCatchTR15-614A	2701244.338	272233.782
SubCatchTR15-614A	2701236.546	272233.782
SubCatchTR15-618	2701880.040	271119.304
SubCatchTR15-618	2702050.448	271119.304
SubCatchTR15-618	2702050.448	271050.536
SubCatchTR15-618	2701880.040	271050.536
SubCatchTR15-704	2700128.430	271630.066
SubCatchTR15-704	2700221.900	271630.066
SubCatchTR15-704	2700221.900	271591.812
SubCatchTR15-704	2700128.430	271591.812
SubCatchTR15-710	2699804.074	271797.650
SubCatchTR15-710	2699828.326	271797.650
SubCatchTR15-710	2699828.326	271750.620
SubCatchTR15-710	2699804.074	271750.620
SubCatchTR15-716	2699828.326	272427.614
SubCatchTR15-716	2699888.682	272427.614
SubCatchTR15-716	2699888.682	272354.470
SubCatchTR15-716	2699828.326	272354.470
SubCatchTR15B1-366	2699364.210	274230.730
SubCatchTR15B1-366	2699388.758	274230.730
SubCatchTR15B1-366	2699388.758	274181.414
SubCatchTR15B1-366	2699364.210	274181.414
SubCatchTR15B1-380	2699746.154	273662.866
SubCatchTR15B1-380	2699768.472	273662.866
SubCatchTR15B1-380	2699768.472	273621.588
SubCatchTR15B1-380	2699746.154	273621.588
T01-A	2693606.912	280578.998
T01-A	2693626.800	280578.998
T01-A	2693626.800	280502.057
T01-A	2693606.912	280502.057
T01-A-S	2692344.164	281835.310
T01-A-S	2692413.830	281835.310
T01-A-S	2692413.830	281759.380
T01-A-S	2692344.164	281759.380
T01-B1	2688649.155	282224.377
T01-B1	2688701.905	282224.377
T01-B1	2688701.905	282041.542
T01-B1	2688649.155	282041.542
T01-B2	2689154.250	281852.593
T01-B2	2689247.256	281852.593
T01-B2	2689247.256	281596.312
T01-B2	2689154.250	281596.312
T03-A	2704551.376	269345.563
T03-A	2704802.324	269345.563
T03-A	2704802.324	269265.545
T03-A	2704551.376	269265.545
T03-B	2705240.509	268563.066
T03-B	2705329.817	268563.066
T03-B	2705329.817	268466.428
T03-B	2705240.509	268466.428
T04-A	2708420.599	267912.395
T04-A	2708476.180	267912.395
T04-A	2708476.180	267859.920
T04-A	2708420.599	267859.920
T04-B	2708647.037	267752.837
T04-B	2708695.837	267752.837
T04-B	2708695.837	267708.562
T04-B	2708647.037	267708.562
T05	2706355.729	266868.651
T05	2706407.549	266868.651
T05	2706407.549	266811.795
T05	2706355.729	266811.795
T-050-01-S	2717746.384	250658.424
T-050-01-S	2717869.592	250658.424
T-050-01-S	2717869.592	249436.614
T-050-01-S	2717746.384	249436.614
T-050-02-S	2718053.073	249502.412
T-050-02-S	2718256.441	249502.412
T-050-02-S	2718256.441	249320.818
T-050-02-S	2718053.073	249320.818
T-055-01	2713224.392	257596.262
T-055-01	2713312.746	257596.262
T-055-01	2713312.746	257313.496
T-055-01	2713224.392	257313.496
T-055-01-S	2712322.556	257313.496
T-055-01-S	2712417.848	257313.496
T-055-01-S	2712417.848	257267.470

T-055-01-S	2712322.556	257267.470
T-056-01	2714234.559	255689.025
T-056-01	2714406.669	255689.025
T-056-01	2714406.669	255133.277
T-056-01	2714234.559	255133.277
T-056-01-S	2713743.688	255412.100
T-056-01-S	2713911.700	255412.100
T-056-01-S	2713911.700	255409.754
T-056-01-S	2713743.688	255409.754
T-056-02	2715141.850	253865.410
T-056-02	2715299.534	253865.410
T-056-02	2715299.534	253828.930
T-056-02	2715141.850	253828.930
T-056-02-S	2714542.710	253762.148
T-056-02-S	2714606.700	253762.148
T-056-02-S	2714606.700	253762.100
T-056-02-S	2714542.710	253762.100
T-056-03	2714880.134	253585.112
T-056-03	2714940.272	253585.112
T-056-03	2714940.272	253388.568
T-056-03	2714880.134	253388.568
T-056-03-S	2714606.700	253762.100
T-056-03-S	2714708.024	253762.100
T-056-03-S	2714708.024	253585.112
T-056-03-S	2714606.700	253585.112
T-056-04	2715047.860	253828.930
T-056-04	2715141.850	253828.930
T-056-04	2715141.850	253788.904
T-056-04	2715047.860	253788.904
T-056-04-S	2714606.700	253762.100
T-056-04-S	2714606.700	253762.100
T-056-04-S	2714606.700	253762.100
T-056-04-S	2714606.700	253762.100
T-056-05	2715299.534	252896.394
T-056-05	2715625.228	252896.394
T-056-05	2715625.228	252525.616
T-056-05	2715299.534	252525.616
T-056-05-S	2714985.200	253388.568
T-056-05-S	2715047.860	253388.568
T-056-05-S	2715047.860	253336.200
T-056-05-S	2714985.200	253336.200
T-056-06	2715407.285	250935.041
T-056-06	2715617.105	250935.041
T-056-06	2715617.105	250201.955
T-056-06	2715407.285	250201.955
T-056-06-S	2715776.668	252525.616
T-056-06-S	2715943.080	252525.616
T-056-06-S	2715943.080	252068.480
T-056-06-S	2715776.668	252068.480
T-056-07-S	2717328.876	251933.586
T-056-07-S	2717373.180	251933.586
T-056-07-S	2717373.180	251663.306
T-056-07-S	2717328.876	251663.306
T-056-08	2716543.975	249345.290
T-056-08	2716599.335	249345.290
T-056-08	2716599.335	249307.454
T-056-08	2716543.975	249307.454
T-056-08-S	2716208.260	251798.200
T-056-08-S	2716291.300	251798.200
T-056-08-S	2716291.300	251610.940
T-056-08-S	2716208.260	251610.940
T-056-09	2716419.076	254561.214
T-056-09	2716473.760	254561.214
T-056-09	2716473.760	254060.138
T-056-09	2716419.076	254060.138
T-056-09-S	2714940.272	253336.200
T-056-09-S	2714985.200	253336.200
T-056-09-S	2714985.200	252896.394
T-056-09-S	2714940.272	252896.394
T-063-01-S	2707324.382	262748.877
T-063-01-S	2707352.777	262748.877
T-063-01-S	2707352.777	262535.407
T-063-01-S	2707324.382	262535.407
T-063-02	2708423.910	261080.963
T-063-02	2708499.554	261080.963
T-063-02	2708499.554	260988.760
T-063-02	2708423.910	260988.760
T-063-02-S	2709203.742	261142.043
T-063-02-S	2709205.458	261142.043
T-063-02-S	2709205.458	261120.383
T-063-02-S	2709203.742	261120.383
T-063-03-S	2711505.470	259675.025
T-063-03-S	2711637.642	259675.025
T-063-03-S	2711637.642	259659.145
T-063-03-S	2711505.470	259659.145
T-063-04	2712576.137	259538.468
T-063-04	2712615.385	259538.468
T-063-04	2712615.385	259455.919
T-063-04	2712576.137	259455.919
T-063-04-S	2711670.664	259239.453
T-063-04-S	2711802.524	259239.453
T-063-04-S	2711802.524	259172.447
T-063-04-S	2711670.664	259172.447
T-063-05	2713345.792	259552.071
T-063-05	2713534.940	259552.071
T-063-05	2713534.940	259393.776

T-063-05	2713345.792	259393.776
T-063-05-S	2712047.034	258965.888
T-063-05-S	2712047.472	258965.888
T-063-05-S	2712047.472	258902.360
T-063-05-S	2712047.034	258902.360
T-063-06	2712843.114	258770.130
T-063-06	2712969.726	258770.130
T-063-06	2712969.726	258738.918
T-063-06	2712843.114	258738.918
T-063-06-S	2712778.001	258947.051
T-063-06-S	2712850.385	258947.051
T-063-06-S	2712850.385	258872.655
T-063-06-S	2712778.001	258872.655
T06-A1	2709789.380	269815.219
T06-A1	2709925.624	269815.219
T06-A1	2709925.624	269656.713
T06-A1	2709789.380	269656.713
T06-A2	2709527.800	269336.681
T06-A2	2709602.150	269336.681
T06-A2	2709602.150	269255.738
T06-A2	2709527.800	269255.738
T06-B1	2709129.854	267787.294
T06-B1	2709223.300	267787.294
T06-B1	2709223.300	267720.219
T06-B1	2709129.854	267720.219
T06-B2	2708667.822	267210.853
T06-B2	2708815.900	267210.853
T06-B2	2708815.900	267156.175
T06-B2	2708667.822	267156.175
T06-C1	2710370.287	267394.181
T06-C1	2710503.287	267394.181
T06-C1	2710503.287	267245.308
T06-C1	2710370.287	267245.308
T06-C2	2710116.680	268724.252
T06-C2	2710288.180	268724.252
T06-C2	2710288.180	268649.402
T06-C2	2710116.680	268649.402
T07	2706965.260	265126.436
T07	2707026.500	265126.436
T07	2707026.500	265066.398
T07	2706965.260	265066.398
T-071-01	2707008.431	264990.365
T-071-01	2707041.181	264990.365
T-071-01	2707041.181	264879.063
T-071-01	2707008.431	264879.063
T-071-01-S	2707592.964	265314.063
T-071-01-S	2707600.404	265314.063
T-071-01-S	2707600.404	265213.279
T-071-01-S	2707592.964	265213.279
T-079-01	2706628.060	269685.961
T-079-01	2706632.360	269685.961
T-079-01	2706632.360	269628.086
T-079-01	2706628.060	269628.086
T-079-01-S	2704977.737	271232.661
T-079-01-S	2705020.337	271232.661
T-079-01-S	2705020.337	271224.407
T-079-01-S	2704977.737	271224.407
T-079-02	2706061.318	269594.731
T-079-02	2706131.176	269594.731
T-079-02	2706131.176	269557.099
T-079-02	2706061.318	269557.099
T-079-02-S	2706668.043	269290.037
T-079-02-S	2706687.003	269290.037
T-079-02-S	2706687.003	269280.517
T-079-02-S	2706668.043	269280.517
T-080-01	2707970.318	270790.848
T-080-01	2707970.318	270790.848
T-080-01	2707970.318	270790.848
T-080-01	2707970.318	270790.848
T-080-01-S	2710600.645	271791.536
T-080-01-S	2710624.465	271791.536
T-080-01-S	2710624.465	271753.520
T-080-01-S	2710600.645	271753.520
T-080-02	2709487.817	270280.651
T-080-02	2709489.795	270280.651
T-080-02	2709489.795	270229.905
T-080-02	2709487.817	270229.905
T-080-02-S	2709555.485	270891.213
T-080-02-S	2709599.909	270891.213
T-080-02-S	2709599.909	270826.335
T-080-02-S	2709555.485	270826.335
T-080-03	2707760.371	270826.432
T-080-03	2707760.371	270826.432
T-080-03	2707760.371	270826.432
T-080-03	2707760.371	270826.432
T-080-03-S	2709139.405	269857.862
T-080-03-S	2709149.733	269857.862
T-080-03-S	2709149.733	269834.690
T-080-03-S	2709139.405	269834.690
T-088-01-S	2702455.680	274973.908
T-088-01-S	2702632.950	274973.908
T-088-01-S	2702632.950	274961.120
T-088-01-S	2702455.680	274961.120
T-089-01	2707660.736	270839.740
T-089-01	2707660.736	270839.740
T-089-01	2707660.736	270827.358

T-089-01	2707660.736	270827.358
T-089-01-S	2711466.037	272581.385
T-089-01-S	2711588.753	272581.385
T-089-01-S	2711588.753	272569.961
T-089-01-S	2711466.037	272569.961
T-089-02	2707445.996	270927.721
T-089-02	2707450.109	270927.721
T-089-02	2707450.109	270927.721
T-089-02	2707445.996	270927.721
T-089-02-S	2712409.665	273566.564
T-089-02-S	2712565.725	273566.564
T-089-02-S	2712565.725	273563.580
T-089-02-S	2712409.665	273563.580
T-089-03	2707715.045	270447.843
T-089-03	2707719.365	270447.843
T-089-03	2707719.365	270447.843
T-089-03	2707715.045	270447.843
T-089-03-S	2713665.469	274680.510
T-089-03-S	2713754.319	274680.510
T-089-03-S	2713754.319	274603.032
T-089-03-S	2713665.469	274603.032
T-089-04	2707529.074	270730.355
T-089-04	2707529.074	270730.355
T-089-04	2707529.074	270730.355
T-089-04	2707529.074	270730.355
T-089-04-S	2715652.682	276898.865
T-089-04-S	2715666.502	276898.865
T-089-04-S	2715666.502	276866.075
T-089-04-S	2715652.682	276866.075
T08-A1	2700819.026	267064.475
T08-A1	2700878.436	267064.475
T08-A1	2700878.436	266987.150
T08-A1	2700819.026	266987.150
T08-A2	2700770.012	266663.524
T08-A2	2700808.362	266663.524
T08-A2	2700808.362	266616.296
T08-A2	2700770.012	266616.296
T08-A3	2700898.227	266386.070
T08-A3	2700909.783	266386.070
T08-A3	2700909.783	266357.930
T08-A3	2700898.227	266357.930
T08-B1	2700525.324	264592.499
T08-B1	2700555.504	264592.499
T08-B1	2700555.504	264515.586
T08-B1	2700525.324	264515.586
T08-B2	2700557.913	266330.123
T08-B2	2700599.461	266330.123
T08-B2	2700599.461	266145.967
T08-B2	2700557.913	266145.967
T08-B3	2700706.024	264147.050
T08-B3	2700757.532	264147.050
T08-B3	2700757.532	263889.397
T08-B3	2700706.024	263889.397
T08-C1	2702691.329	263979.687
T08-C1	2702714.681	263979.687
T08-C1	2702714.681	263902.509
T08-C1	2702691.329	263902.509
T08-C2	2704019.350	263945.265
T08-C2	2704031.170	263945.265
T08-C2	2704031.170	263866.869
T08-C2	2704019.350	263866.869
T08-C3	2704749.300	264162.981
T08-C3	2704872.120	264162.981
T08-C3	2704872.120	264120.356
T08-C3	2704749.300	264120.356
T08-D1A	2698992.470	265312.000
T08-D1A	2699068.500	265312.000
T08-D1A	2699068.500	265227.220
T08-D1A	2698992.470	265227.220
T08-D1B	2699466.280	265378.000
T08-D1B	2699594.940	265378.000
T08-D1B	2699594.940	265312.000
T08-D1B	2699466.280	265312.000
T08-D2	2698262.896	266304.650
T08-D2	2698314.600	266304.650
T08-D2	2698314.600	266280.931
T08-D2	2698262.896	266280.931
T08-D3	2697871.258	266721.813
T08-D3	2698098.464	266721.813
T08-D3	2698098.464	266678.569
T08-D3	2697871.258	266678.569
T08-E1A	2702050.448	263866.869
T08-E1A	2702252.788	263866.869
T08-E1A	2702252.788	263809.794
T08-E1A	2702050.448	263809.794
T08-E1B	2703289.836	263871.541
T08-E1B	2703327.020	263871.541
T08-E1B	2703327.020	263854.416
T08-E1B	2703289.836	263854.416
T-096-01	2692637.250	281199.406
T-096-01	2692692.250	281199.406
T-096-01	2692692.250	281080.550
T-096-01	2692637.250	281080.550
T-096-01-S	2688742.112	283255.365
T-096-01-S	2688742.112	283255.365
T-096-01-S	2688742.112	283255.365

T-096-01-S	2688742.112	283255.365
T-097-01	2692637.250	281249.481
T-097-01	2692637.250	281249.481
T-097-01	2692637.250	281199.406
T-097-01	2692637.250	281199.406
T-097-01-S	2690338.636	282091.879
T-097-01-S	2690579.386	282091.879
T-097-01-S	2690579.386	282090.853
T-097-01-S	2690338.636	282090.853
T-097-02	2692545.750	281199.406
T-097-02	2692637.250	281199.406
T-097-02	2692637.250	281199.406
T-097-02	2692545.750	281199.406
T-097-02-S	2691644.500	282534.930
T-097-02-S	2691644.500	282534.930
T-097-02-S	2691644.500	282534.930
T-097-02-S	2691644.500	282534.930
T-098-01	2707450.789	270755.264
T-098-01	2707450.789	270755.264
T-098-01	2707450.789	270755.264
T-098-01	2707450.789	270755.264
T-098-01-S	2714112.410	281512.563
T-098-01-S	2714134.174	281512.563
T-098-01-S	2714134.174	281512.563
T-098-01-S	2714112.410	281512.563
T-098-02	2707013.894	270611.796
T-098-02	2707030.574	270611.796
T-098-02	2707030.574	270581.262
T-098-02	2707013.894	270581.262
T-098-02-S	2712953.294	280044.569
T-098-02-S	2712953.294	280044.569
T-098-02-S	2712953.294	280005.965
T-098-02-S	2712953.294	280005.965
T-098-03	2707341.800	270816.407
T-098-03	2707341.800	270816.407
T-098-03	2707341.800	270787.580
T-098-03	2707341.800	270787.580
T-098-03-S	2714387.388	279997.692
T-098-03-S	2714495.442	279997.692
T-098-03-S	2714495.442	279997.692
T-098-03-S	2714387.388	279997.692
T09-A	2705267.061	263278.600
T09-A	2705405.725	263278.600
T09-A	2705405.725	262898.009
T09-A	2705267.061	262898.009
T09-B	2706353.999	264000.638
T09-B	2706365.699	264000.638
T09-B	2706365.699	263971.756
T09-B	2706353.999	263971.756
T10	2710623.157	265578.865
T10	2710665.707	265578.865
T10	2710665.707	265265.096
T10	2710623.157	265265.096
T11	2707553.300	263181.900
T11	2707591.254	263181.900
T11	2707591.254	262871.823
T11	2707553.300	262871.823
T12	2707702.508	262770.857
T12	2707725.716	262770.857
T12	2707725.716	262594.190
T12	2707702.508	262594.190
T13a	2705901.392	260391.898
T13a	2705972.364	260391.898
T13a	2705972.364	260296.171
T13a	2705901.392	260296.171
T13b	2707024.385	259929.124
T13b	2707033.305	259929.124
T13b	2707033.305	259878.008
T13b	2707024.385	259878.008
T14-A1A	2703901.790	260534.941
T14-A1A	2704043.088	260534.941
T14-A1A	2704043.088	260433.723
T14-A1A	2703901.790	260433.723
T14-A1B	2704805.249	258838.947
T14-A1B	2704973.961	258838.947
T14-A1B	2704973.961	258431.758
T14-A1B	2704805.249	258431.758
T14-A1C	2703743.569	259597.553
T14-A1C	2703771.655	259597.553
T14-A1C	2703771.655	259535.313
T14-A1C	2703743.569	259535.313
T14-A2A	2705385.004	259063.893
T14-A2A	2705450.278	259063.893
T14-A2A	2705450.278	258975.307
T14-A2A	2705385.004	258975.307
T14-A2B	2706439.829	258774.346
T14-A2B	2706465.607	258774.346
T14-A2B	2706465.607	258678.963
T14-A2B	2706439.829	258678.963
T14-A2C	2707522.792	259759.000
T14-A2C	2707553.300	259759.000
T14-A2C	2707553.300	259702.104
T14-A2C	2707522.792	259702.104
T14-B1A	2701702.371	255949.622
T14-B1A	2701789.723	255949.622
T14-B1A	2701789.723	255879.118

T14-B1A	2701702.371	255879.118
T14-B1B	2702573.169	255855.581
T14-B1B	2702754.723	255855.581
T14-B1B	2702754.723	255777.861
T14-B1B	2702573.169	255777.861
T14-B1C	2703380.486	255686.471
T14-B1C	2703509.786	255686.471
T14-B1C	2703509.786	255634.496
T14-B1C	2703380.486	255634.496
T14-B1D	2703904.124	255865.634
T14-B1D	2704001.694	255865.634
T14-B1D	2704001.694	255767.808
T14-B1D	2703904.124	255767.808
T14-B1E	2704560.807	256063.432
T14-B1E	2704633.975	256063.432
T14-B1E	2704633.975	255921.545
T14-B1E	2704560.807	255921.545
T14-C1	2701717.829	260788.435
T14-C1	2701735.207	260788.435
T14-C1	2701735.207	260766.121
T14-C1	2701717.829	260766.121
T14-C2	2702017.983	260754.406
T14-C2	2702138.123	260754.406
T14-C2	2702138.123	260682.972
T14-C2	2702017.983	260682.972
T14-C3	2702366.873	260517.172
T14-C3	2702453.245	260517.172
T14-C3	2702453.245	260490.550
T14-C3	2702366.873	260490.550
T14-D1	2698314.600	261251.538
T14-D1	2698381.992	261251.538
T14-D1	2698381.992	261203.047
T14-D1	2698314.600	261203.047
T14-D2	2697878.980	258671.012
T14-D2	2697879.334	258671.012
T14-D2	2697879.334	258665.118
T14-D2	2697878.980	258665.118
T14-E1	2698624.166	261763.225
T14-E1	2698754.832	261763.225
T14-E1	2698754.832	261698.913
T14-E1	2698624.166	261698.913
T14-E2	2699068.500	261698.913
T14-E2	2699196.394	261698.913
T14-E2	2699196.394	261657.659
T14-E2	2699068.500	261657.659
T14-E3	2699404.114	261657.659
T14-E3	2699422.620	261657.659
T14-E3	2699422.620	261627.826
T14-E3	2699404.114	261627.826
T14-F	2698809.000	261170.531
T14-F	2698822.704	261170.531
T14-F	2698822.704	261080.963
T14-F	2698809.000	261080.963
T14-G	2696918.244	262141.081
T14-G	2696979.224	262141.081
T14-G	2696979.224	262088.050
T14-G	2696918.244	262088.050
T14-H	2697146.750	261572.713
T14-H	2697339.358	261572.713
T14-H	2697339.358	261552.780
T14-H	2697146.750	261552.780
T14-J1	2695609.112	259032.544
T14-J1	2695694.756	259032.544
T14-J1	2695694.756	259021.344
T14-J1	2695609.112	259021.344
T14-J4	2696469.550	261513.669
T14-J4	2696486.600	261513.669
T14-J4	2696486.600	261485.583
T14-J4	2696469.550	261485.583
T14-K1	2692377.496	261276.072
T14-K1	2692419.996	261276.072
T14-K1	2692419.996	261255.734
T14-K1	2692377.496	261255.734
T14-K2	2696486.600	262088.050
T14-K2	2696539.350	262088.050
T14-K2	2696539.350	262043.334
T14-K2	2696486.600	262043.334
T14-K3	2696539.350	262043.334
T14-K3	2696620.250	262043.334
T14-K3	2696620.250	262003.553
T14-K3	2696539.350	262003.553
T14-K4	2697016.386	262003.553
T14-K4	2697039.750	262003.553
T14-K4	2697039.750	261888.488
T14-K4	2697016.386	261888.488
T14-L1	2697065.750	264217.022
T14-L1	2697082.550	264217.022
T14-L1	2697082.550	264162.981
T14-L1	2697065.750	264162.981
T14-L2	2697039.750	263782.934
T14-L2	2697065.750	263782.934
T14-L2	2697065.750	263776.538
T14-L2	2697039.750	263776.538
T14-M1	2694786.398	262587.869
T14-M1	2695102.564	262587.869
T14-M1	2695102.564	262517.727

T14-M1	2694786.398	262517.727
T14-M2	2695962.516	263809.794
T14-M2	2695996.890	263809.794
T14-M2	2695996.890	263782.934
T14-M2	2695962.516	263782.934
T14-N1A	2696080.594	266978.006
T14-N1A	2696103.294	266978.006
T14-N1A	2696103.294	266961.075
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T14-N1B	2696198.475	266493.023
T14-N1B	2696288.075	266493.023
T14-N1B	2696288.075	266442.945
T14-N1B	2696198.475	266442.945
T14-N1C	2695883.261	266746.430
T14-N1C	2695903.561	266746.430
T14-N1C	2695903.561	266676.465
T14-N1C	2695883.261	266676.465
T14-N1D	2695838.108	266521.734
T14-N1D	2695869.300	266521.734
T14-N1D	2695869.300	266305.559
T14-N1D	2695838.108	266305.559
T14-N2A	2696732.658	268555.631
T14-N2A	2696801.258	268555.631
T14-N2A	2696801.258	268520.281
T14-N2A	2696732.658	268520.281
T14-N2B	2696399.800	267675.944
T14-N2B	2696446.850	267675.944
T14-N2B	2696446.850	267554.138
T14-N2B	2696399.800	267554.138
T14-N2C	2697625.215	267299.202
T14-N2C	2697735.211	267299.202
T14-N2C	2697735.211	267275.187
T14-N2C	2697625.215	267275.187
T14-N2D	2695923.817	265902.104
T14-N2D	2695942.417	265902.104
T14-N2D	2695942.417	265495.748
T14-N2D	2695923.817	265495.748
T14-N3A	2694348.896	272779.368
T14-N3A	2694401.946	272779.368
T14-N3A	2694401.946	272694.477
T14-N3A	2694348.896	272694.477
T14-N3B	2694506.600	271365.188
T14-N3B	2694553.754	271365.188
T14-N3B	2694553.754	271317.231
T14-N3B	2694506.600	271317.231
T14-N3C	2694181.255	273642.623
T14-N3C	2694395.803	273642.623
T14-N3C	2694395.803	273514.744
T14-N3C	2694181.255	273514.744
T14-N3D	2695269.166	271509.999
T14-N3D	2695366.160	271509.999
T14-N3D	2695366.160	271442.506
T14-N3D	2695269.166	271442.506
T14-N4A	2692946.296	274862.997
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T14-N4A	2693002.296	274846.805
T14-N4A	2692946.296	274846.805
T14-N4B	2693527.060	274849.818
T14-N4B	2693540.260	274849.818
T14-N4B	2693540.260	274740.508
T14-N4B	2693527.060	274740.508
T14-N4C	2693138.348	274427.407
T14-N4C	2693146.948	274427.407
T14-N4C	2693146.948	274380.897
T14-N4C	2693138.348	274380.897
T14-N4D	2692109.008	274153.325
T14-N4D	2692199.508	274153.325
T14-N4D	2692199.508	274025.016
T14-N4D	2692109.008	274025.016
T14-N5A	2687819.721	278885.240
T14-N5A	2687869.521	278885.240
T14-N5A	2687869.521	278633.824
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T14-N5B	2687195.212	279288.418
T14-N5B	2687236.612	279288.418
T14-N5B	2687236.612	279268.018
T14-N5B	2687195.212	279268.018
T14-N5C	2690611.299	277618.471
T14-N5C	2690673.459	277618.471
T14-N5C	2690673.459	277480.061
T14-N5C	2690611.299	277480.061
T14-N5D	2691075.000	276600.468
T14-N5D	2691129.700	276600.468
T14-N5D	2691129.700	276525.516
T14-N5D	2691075.000	276525.516
T14-P1	2694299.150	266894.600
T14-P1	2694506.600	266894.600
T14-P1	2694506.600	266816.075
T14-P1	2694299.150	266816.075
T14-P2	2694753.200	266759.219
T14-P2	2694836.500	266759.219
T14-P2	2694836.500	266721.813
T14-P2	2694753.200	266721.813
T14-P3	2694836.500	266280.931
T14-P3	2695038.056	266280.931
T14-P3	2695038.056	266261.600

T14-P3	2694836.500	266261.600
T14-P4	2692419.459	267343.652
T14-P4	2692523.011	267343.652
T14-P4	2692523.011	267330.796
T14-P4	2692419.459	267330.796
T14-P5	2692860.550	266954.081
T14-P5	2692944.222	266954.081
T14-P5	2692944.222	266928.719
T14-P5	2692860.550	266928.719
T14-P6	2693132.508	266928.719
T14-P6	2693401.602	266928.719
T14-P6	2693401.602	266907.456
T14-P6	2693132.508	266907.456
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T14-R1A	2690906.400	267479.000
T14-R1B	2691045.000	267309.000
T14-R1B	2691045.000	267309.000
T14-R1B	2691045.000	267280.425
T14-R1B	2691045.000	267280.425
T14-R1C	2691129.700	267138.500
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T14-R1C	2691144.250	267064.475
T14-R1C	2691129.700	267064.475
T14-R2A	2687985.600	266968.500
T14-R2A	2688100.000	266968.500
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T14-R2A	2687985.600	266968.500
T14-R2B	2688100.000	266968.500
T14-R2B	2688259.200	266968.500
T14-R2B	2688259.200	266968.500
T14-R2B	2688100.000	266968.500
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T14-R3A	2687532.000	266968.500
T14-R3A	2687488.600	266968.500
T14-R3B	2687707.400	266968.500
T14-R3B	2687840.400	266968.500
T14-R3B	2687840.400	266954.081
T14-R3B	2687707.400	266954.081
T14-T	2697082.550	261888.488
T14-T	2697089.750	261888.488
T14-T	2697089.750	261826.594
T14-T	2697082.550	261826.594
T14-U	2697089.750	261826.594
T14-U	2697146.750	261826.594
T14-U	2697146.750	261814.341
T14-U	2697089.750	261814.341
T15a	2707078.750	257215.156
T15a	2707084.810	257215.156
T15a	2707084.810	256948.357
T15a	2707078.750	256948.357
T15b	2708873.687	255958.390
T15b	2708875.127	255958.390
T15b	2708875.127	255870.349
T15b	2708873.687	255870.349
T15C	2706646.290	256876.587
T15C	2706649.740	256876.587
T15C	2706649.740	256866.069
T15C	2706646.290	256866.069
T15D	2709849.614	256622.091
T15D	2709852.174	256622.091
T15D	2709852.174	256612.791
T15D	2709849.614	256612.791
TR15-332-A	2701715.490	274802.260
TR15-332-A	2701715.490	274802.260
TR15-332-A	2701715.490	274802.260
TR15-332-A	2701715.490	274802.260
TR15-332-B	2701692.252	274802.260
TR15-332-B	2701715.490	274802.260
TR15-332-B	2701715.490	274794.304
TR15-332-B	2701692.252	274794.304
TR15-332-C	2701715.490	274802.260
TR15-332-C	2701715.490	274802.260
TR15-332-C	2701715.490	274802.260
TR15-332-C	2701715.490	274802.260
TR15-332-D	2701715.490	274804.212
TR15-332-D	2701766.366	274804.212
TR15-332-D	2701766.366	274802.260
TR15-332-D	2701715.490	274802.260
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TR15-332-E	2701715.490	274802.260
TR15-332-E	2701715.490	274802.260
TR15-344-A	2700656.010	275035.784
TR15-344-A	2700666.946	275035.784
TR15-344-A	2700666.946	275034.140
TR15-344-A	2700656.010	275034.140
TR15-344-B	2700611.754	275034.140
TR15-344-B	2700656.010	275034.140
TR15-344-B	2700656.010	275029.664
TR15-344-B	2700611.754	275029.664
TR15-352-A	2699945.250	274993.090
TR15-352-A	2699980.042	274993.090
TR15-352-A	2699980.042	274973.908

TR15-352-A	2699945.250	274973.908
TR15-352-B	2699888.682	275006.526
TR15-352-B	2699945.250	275006.526
TR15-352-B	2699945.250	274993.090
TR15-352-B	2699888.682	274993.090
TR15-360B-A	2699782.140	275094.910
TR15-360B-A	2699788.472	275094.910
TR15-360B-A	2699788.472	275091.142
TR15-360B-A	2699782.140	275091.142
TR15-360B-B	2699768.472	275101.194
TR15-360B-B	2699782.140	275101.194
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TR15-362-A	2699196.394	274807.140
TR15-362-A	2699234.110	274807.140
TR15-362-A	2699234.110	274804.212
TR15-362-A	2699196.394	274804.212
TR15-362-B	2699234.110	274819.956
TR15-362-B	2699261.686	274819.956
TR15-362-B	2699261.686	274807.140
TR15-362-B	2699234.110	274807.140
TR15-412-A	2697339.358	277241.204
TR15-412-A	2697500.020	277241.204
TR15-412-A	2697500.020	277129.540
TR15-412-A	2697339.358	277129.540
TR15-412-B	2697500.020	277129.540
TR15-412-B	2697522.804	277129.540
TR15-412-B	2697522.804	277115.548
TR15-412-B	2697500.020	277115.548
TR15-426-A	2697008.810	278189.516
TR15-426-A	2697016.386	278189.516
TR15-426-A	2697016.386	278148.380
TR15-426-A	2697008.810	278148.380
TR15-426-B	2696979.224	278148.380
TR15-426-B	2697008.810	278148.380
TR15-426-B	2697008.810	278028.452
TR15-426-B	2696979.224	278028.452
TT14-262A	2691183.850	266987.150
TT14-262A	2691403.750	266987.150
TT14-262A	2691403.750	266968.500
TT14-262A	2691183.850	266968.500
TT14-263A	2691144.250	267156.175
TT14-263A	2691183.850	267156.175
TT14-263A	2691183.850	267138.500
TT14-263A	2691144.250	267138.500
TT14-264A	2690985.600	267309.000
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TT14-270A	2690688.600	267819.000
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TT14-270A	2690748.000	267787.294
TT14-270A	2690688.600	267787.294
TT14-270B	2690748.000	267852.650
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TT14-270B	2690776.960	267819.000
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TT14-272A	2690688.600	267940.475
TT14-272A	2690530.200	267940.475
TT14-274A	2690451.000	268329.000
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TT14-692A	2685897.000	276291.744
TT14-692A	2685897.000	276149.000

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  TT14-692A            2685897.000         276149.000

[SYMBOLS]
;;Gage                 X-Coord             Y-Coord


[BACKDROP]
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[PROFILES]
;;Name                 Links
;;--------------------------------------------------
 "test                "   TF-29278  TF-29218  TF-29061
```

APPENDIX B

OBSTRUCTION CAPACITY SUMMARY FORMS (FORM B)

Total # Box Culverts / Box Bridges 101
Total # Elliptical Culverts 4
Total # Circular Culverts 28
Total # Arch Culvert / Arch Birdges 13

TOTAL 146

Map ID.		Shape (✓)				
		Culvert			Bridge	
#	Capacity (CFS)	□	O	⬭	⌒	⊓
TFbri032	**99499**					X
TFbri031	**22045**					X
TFbri029	**25456**					X
TFbri030	**47434**					X
TFbri028	**6971**					X
TFbri008	**2998**					X
TFbri009	**5394**					X
TFbri006	**7724**					X
TFbri007	**4287**					X
TFbri002	**9737**					X
TFbri003	**6772**					X
TFbri004	**6300**					X
TFbri005	**19550**					X
TFbri001	**909**					X
TFbri020	**2789**					X
TFbri021	**8662**					X
TFbri022	**7551**					X
TFbri023	**7281**					X
TFbri024	**44**					X
TFbri026	**5000**					X
TFbri025	**4933**					X
TFbri017	**4902**					X
TFbri018	**5034**					X
TFbri019	**8413**					X
TFbri015	**2742**					X
TFbri016	**294347**					X
TFbri027	**1258**					X
TFbri010	**4251**					X
TFbri012	**2142**					X
TFbri013	**1889**					X
TFbri011	**1970**					X
TFbri014	**3267**				X	
TFbri103	**317249**				X	
TFculv48	**195**		X			
TFculv49	**195**		X			
TFculv45	**1420**	X				
TFculv46	**383**	X				
TFculv47	**402**	X				
TFculv50	**1867**	X				

TFculv51	**4172**	X				
TFculv52	**805**	X				
TFculv53	**1342**	X				
TFculv60	**35**		X			
TFculv54	**267**				X	
TFculv55	**297**				X	
TFculv56	**152**	X				
TFculv57	**233**		X			
TFculv58	**218**	X				
TFculv59	**468**	X				
TFculv62	**444**	X				
TFculv65	**415**	X				
TFculv61	**468**	X				
TFculv63	**232**			X		
TFculv64	**1558**	X				
TFculv70	**116**		X			
TFculv66	**1600**	X				
TFculv67	**400**		X			
TFculv68	**339**		X			
TFculv69	**578**				X	
TFculv76	**4961**					X
TFculv71	**35**					X
TFculv72	**79**	X				
TFculv73	**1073**	X				
TFculv74	**1716**	X				
TFculv75	**1797**	X				
TFculv32	**1544**	X				
TFculv78	**5576**					X
TFculv77	**5577**					X
TFculv79	**8707**					X
TFculv83	**35**		X			
TFculv81	**198**		X			
TFculv80	**115**		X			
TFculv89	**96**		X			
TFculv84	**354**	X				
TFculv85	**224**	X				
TFculv86	**291**		X			
TFculv87	**262**		X			
TFculv92	**35**		X			
TFculv93b	**471**	X				
TFculv93c	**283**		X			
TFculv90a	**376**	X				
TFculv90b	**138**		X			
TFculv90c	**590**	X				
TFculv91	**293**		X			
TFculv99	**35**		X			
TFculv101	**98**		X			
TFculv98	**306**		X			
TFculv97	**4962**	X				
TFculv100	**9087**				X	
TFculv102	**5452**				X	
TFculv103	**5756**				X	

TFculv105	16863	X				
TFculv104	24112					X
TFculv106	26089	X				
TFculv01	160	X				
TFculv02	83	X				
TFculv03	354	X				
TFculv04	570	X				
TFculv05	96		X			
TFculv08	96		X			
TFculv09	531	X				
TFculv10	614	X				
TFculv11	346					X
TFculv12	433	X				
TFculv14	1195	X				
TFculv16	1771	X				
TFculv19	179			X		
TFculv18	2954				X	
TFculv23	255			X		
TFculv22	258				X	
TFculv20	1289				X	
TFculv21	1053	X				
TFculv28	1742	X				
TFculv24	1263	X				
TFculv25	1263	X				
TFculv27	1226	X				
TFculv26	190					X
TFculv29	33		X			
TFculv30	1549	X				
TFculv33	6474					X
TFculv37	259	X				
TFculv38	364	X				
TFculv39	383	X				
TFculv35	326	X				
TFculv36	326	X				
TFculv43	1982					X
TFculv44	984					X
TFculv40	2440					X
TFculv41	2169	X				
TFculv42	1404	X				
TFculv17	1458					X
TFculv06	50		X			
TFculv07	52		X			
TFculv15	72		X			
TFculv31	1504				X	
TFculv13	46	X				
TFculv88	1081				X	
TFculv94	190	X				
TFculv95	184		X			
TFculv96	350	X				
TFculv82	188		X			
TFculv13a	188			X		
TFculv49a	169	X				

TFbri012a	**2207**					X
TFbri019a	**5478**					X
TFbri031a	**9685**					X

FORM B - OBSTRUCTION DATA COLLECTION

SHEET _________ OF _________

Municipal Stream Obstruction Data

Watershed:

Municipality/County:

Records completed by: _______________

Field work personnel: _______________

Date(s): _______________

T= Amount of fill
D= Diameter
HT = Height
W = Width
PW = Pier Width

Material
msry = Stone Masonry Structure
CMP = Corrugated Metal Pipe
CPP = Corrugated Polyethylene Pipe
BCCMP = Bituminous Coated CMP
RCP = Reinforced Concrete Pipe
SP = Steel Pipe

Inlet Conditions
HW = Headwall
WW = Wingwall
SW = Sidewall

Map ID.	Owner or Address Of Obstruction	Capacity (CFS)	Area (Sq. Ft.)	Nos. of?	Opening: Type: Part of Bridge?	Culvert Purpose	Shape (✓): Culvert □	Culvert ○	Culvert ⬭	Bridge ⌒	Bridge ⊓	Measurements: T (ft)	D (ft)	HT (ft)	W (ft)	PW (ft)	skew angle	MATERIAL / INLET CONDITION	NOTES
TFbri032	GPS Point #1a start, GPS Point #1b end - under Wyoming St.	99499	6000	1	X						X	5.0		30.0	200.0			Concrete/ Good	FIELD VERIFIED
TFbri031	GPS Point #20 - Golf cart bridge, sides not channeled, but water must flow around support post in middle o	22045	1800	1	X						X	0.0		30.0	60.0			Concrete/Metal/Good	FIELD VERIFIED
TFbri029	GPS Point #1a at start, GPS Point #1b at end - Under Tabor Rd.	25456	900	2	X						X	5.0		15.0	60.0			Concrete/ Good	FIELD VERIFIED; each opening is 30 ft.
TFbri030	GPS Point #31a start, GPS Point #31b end - under Whitaker Ave.	47434	3000	1	X						X	5.0		25.0	120.0		45.0	Concrete and Metal/ Good	FIELD VERIFIED; 46 ft. is over water
TFbri028	GPS Point #23a start, GPS Point #23b end	6971	600	1	X						X	3.0		12.0	50.0			Concrete/ Good	FIELD VERIFIED
TFbri008	GPS Point #1a - Bridge DSL and GPS Point #1b - Bridge DSR	2998	316	1	X						X	2.0		8.0	39.5		5.0	Metal/ Good	FIELD VERIFIED
TFbri009	GPS Point #5a start, GPS Point #5b end - Church Road	5394	460	1	X						X	3.5		10.0	46.0		15.0	Concrete/ Good	FIELD VERIFIED
TFbri006	GPS Point #17 - At High School Road, dam "T-bones" with bridge	7724	636	1	X						X	3.5		12.0	53.0		80.0	Concrete/ Good	FIELD VERIFIED
TFbri007	GIS Point #26 - Bridge at Mill Road - concrete slab bottom starts 20' US of bridge - entered manually	4287	350	1	X						X	4.0		10.0	35.0		10.0	Concrete/ Good	FIELD VERIFIED
TFbri002	GPS Point #4 - Just below confluence - Midpoint of bridge	9737	795	1	X						X	3.0		15.0	53.0			Steel/ Good	FIELD VERIFIED
TFbri003	GPS Point #13 - Footbridge attached to beginning of Channelized Bank	6772	420	1	X						X	2.0		42.0	10.0			Stone and Metal/ Good	FIELD VERIFIED
TFbri004	GIS Point #25 - On the Central Avenue Bridge - entered manually	6300	440	1	X						X	6.0		11.0	40.0			Concrete/ Good	FIELD VERIFIED
TFbri005	GIS Point #29 - Ryers Avenue Bridge - Column in Center splits the flow in two - entered manually	19550	1400	1	X						X	5.0		14.0	100.0			Concrete/ Good	FIELD VERIFIED
TFbri001	GIS Point #16 - Laurel Rd Bridge - entered manually	909	105	1	X						X	2.0		5.0	21.0			Concrete/ Good	FIELD VERIFIED
TFbri020	GPS Point #3 - Bridge midpoint	2789	360	1	X						X	0.0		12.0	30.0			Stone, Wood, Metal/ Good	FIELD VERIFIED
TFbri021	GPS Point #10 - Bridge Midpoint - Ashmead Road	8662	605	1	X						X	6.0		11.0	55.0			Concrete and Stone/ Good	FIELD VERIFIED
TFbri022	GPS Point #15 - Bridge Midpoint - flow only on right side	7551	720	1	X						X	2.0		12.0	60.0			Concrete and Metal/ Good	FIELD VERIFIED
TFbri023	GPS Point #18 golf course	7281	633	1	X						X	3.0		11.5	55.0			Concrete and Metal/ Good	FIELD VERIFIED
TFbri024	GPS Point #21 - Bridge Midpoint - middle of golf course - Golf Cart Bridge	44	14	1	X						X	0.0		2.0	7.0			Concrete/ Good	BRIDGE WASHED AWAY 6/29/06
TFbri026	GPS Point #24 - Bridge Midpoint - Adam's Ave	5000	500	1	X						X	2.0		10.0	50.0			Concrete and Metal/ Good	FIELD VERIFIED
TFbri025	GIS Point #22 - Bridge Midpoint - monitoring site TF-03 check cross section - entered manually	4933	520	1	X						X	2.0		8.0	65.0			Concrete and Metal/ Good	FIELD VERIFIED
TFbri017	GPS Point #5 - bridge midpoint - for Old York Rd. Ice Rink	4902	452	1	X						X	2.0		13.5	33.5		0.0	Metal and Concrete/ Good	FIELD VERIFIED
TFbri018	GPS Point #9 - bridge midpoint - Church Rd Bridge	5034	480	1	X						X	2.0		12.0	40.0		0.0	Concrete/ Good	FIELD VERIFIED; Square to 7 feet, arch from 7 to 15.5 feet
TFbri019	GPS Point #13 - bridge midpoint - Old York Road Bridge	8413	718	1	X						X	2.0		17.5	41.0		0.0	Concrete/ Good	FIELD VERIFIED
TFbri015	GPS Point #4 - Bridge Middle- by SEPTA parking lot	2742	265	1	X						X	2.0		11.5	23.0		0.0	Wood/ Poor and Stone/ Good	FIELD VERIFIED
TFbri016	GIS Point #36 - Washington Lane overpass - entered manually	294347	3800	5	X						X	2.0		38.0	100.0			Concrete and Stone/ Good	FIELD VERIFIED
TFbri027	GPS Point #28a start, GPS Point #28b end - Coventry Ave	1258	137	1	X						X	2.0		7.0	19.5		30.0	Stone/ Good	FIELD VERIFIED
TFbri010	GPS Point #8 - Rice Mill Rd with concrete abutment through the middle	4251	221	2	X						X	2.0		8.5	26.0	2.0	10.0	Concrete/ Good	FIELD VERIFIED; Adjacent to pump station
TFbri012	GPS Point #17a start and GPS Point #17b end - RR tracks crossing	2142	209	1	X						X	2.0		11.0	19.0		0.0	Stone and Concrete/ Good	FIELD VERIFIED
TFbri013	GPS Point #19a start, GPS Point #19b end - Bridge/driveway to generators with concrete abutment in the mi	1889	104	2	X						X	2.0		6.5	16.0		45.0	Concrete/ Fair	FIELD VERIFIED
TFbri011	GPS Point #24 - bridge middle	1970	206	1	X						X	2.0		8.25	25.0			Stone/ Fair	FIELD VERIFIED
TFculv76	GPS Point #8a start, GPS Point #8b end; Washington Ave.	4961	375	1		X					X	2.0		25.0	15.0			Concrete and Stone/ Good	FIELD VERIFIED
TFculv71	GPS Point #23a start, GPS Point #23b end	35	10	1		X					X	0.0		2.5	4.0			Stone/ Fair	FIELD VERIFIED; Pond
TFculv78	GPS Point #3a start, GPS Point #3b end - Harrison Avenue	5576	520	1		X					X	2.0		13.0	40.0			Concrete/ Good	FIELD VERIFIED
TFculv77	GPS Point #18a start, GPS Point #18b end - New Second Street	5577	480	1		X					X	3.0		12.0	40.0		30.0	Concrete/ Good	FIELD VERIFIED
TFculv79	GPS Point #43a start, GPS Point #43b end	8707	540	1		X					X	8.0		12.0	45.0		45.0	Stone/ Good	FIELD VERIFIED
TFculv104	GPS Point #16a start, GPS Point #16b end - Under Castor Ave. - bottom channelized	24112	1525	1		X					X	5.0		25.0	61.0			Concrete and Steel/ Good	FIELD VERIFIED; Next to a gauging station
TFculv11	GPS Point #2 start and GPS Point #3 end - Under Franklin Rd	346	40	1		X					X	2.0		5.0	8.0			Stone and Brick/ Good	FIELD VERIFIED
TFculv26	GPS Point #3a start and GPS Point #3b is end - failed dam at end - southeast @ Waverly Rd	190	20	1		X					X	2.0		8.0	2.5		30.0	Concrete/ Good	FIELD VERIFIED
TFculv33	GPS Point #29a start, GPS Point #29b end - Church Rd	6474	476	1		X					X	4.0		17.0	28.0		0.0	Concrete/ Good	FIELD VERIFIED
TFculv43	GPS Point #6a start and GPS Point #6b end - Bridge @ Granite Rd.	1982	189	1		X					X	3.0		7.0	27.0		60.0	Concrete/ Good	FIELD VERIFIED
TFculv44	GPS Point #9a start and GPS Point #9b end	984	96	1		X					X	3.0		6.0	16.0		0.0	Concrete/ Good	FIELD VERIFIED
TFculv40	GPS Point #16a start, GPS Point #16b end	2440	210	1		X					X	3.0		12.0	17.5		20.0	Stone/ Good	FIELD VERIFIED
TFculv17	GPS Point #13 - Bridge / Confluence - 20' DS Right of dam / bridge	1458	136	1		X					X	3.0		8.0	17.0		10.0	Stone	FIELD VERIFIED
TFbri012a	Street off of Glenside Ave	2207	230	1	X						X	2.0		8.5	27.0		0.0	Metal and Stone/ Good	Point collected and mapped by Borton-Lawson
TFbri019a	Shoemaker Street	5478	440	1	X						X	4.0		11.0	40.0		10.0	Stone/ Poor	Point collected and mapped by Borton-Lawson
TFbri031a	Wingohocking Street	9685	754	1	X						X	4.0		13.0	58.0			Concrete/ Good	Point collected and mapped by Borton-Lawson
TFculv45	GPS Point #20a start - GPS Point #20b end - Forrest Ave	1420	120	1		X	X					4.0		8.0	15.0			Concrete/ Good	FIELD VERIFIED

TFculv46	GPS Point #26a start - GPS Point #26b end - Manor Rd.	383	32	1		X	X					5.0		4.5	7.0			Concrete/ Good	FIELD VERIFIED
TFculv47	GPS Point #33a start, GPS Point #33b end	402	48	1		X	X					2.0		4.0	12.0		0.0	Concrete/ Good	FIELD VERIFIED
TFculv50	GPS Point #11a start, GPS Point #11b end - Church Road	1867	150	1		X	X					5.0		6.0	25.0		10.0	Concrete/ Good	FIELD VERIFIED
TFculv51	GPS Point #20a start - GPS Point #20b end	4172	245	2		X	X					1.5		7.0	35.0	1.0		Corregated Metal/ Good	FIELD VERIFIED - EACH OPENING SAME DIMENSIONS
TFculv52	GPS Point #21a start, GPS Point #21b end - under Township Line and Jenkintown Roads	805	90	1		X	X					2.0		6.0	15.0		60.0	Concrete/ Good	FIELD VERIFIED
TFculv53	GPS Point #24a start, GPS Point #24b end - under Township Line and Jenkintown Roads	1342	155	1		X	X					2.0		5.0	31.0	1.0	20.0	Concrete/ Good	FIELD VERIFIED
TFculv56	GPS Point #26a start, GPS Point #26b end	152	18	1		X	X					2.0		5.0	3.5		0.0	Stone/ Poor	FIELD VERIFIED
TFculv58	GPS Point #29a start, GPS Point #29b end	218	25	1		X	X					2.0		5.5	4.5		0.0	Stone/ Fair	FIELD VERIFIED
TFculv59	GPS Point #33a start, GPS Point #33b end	468	48	1		X	X					3.0		4.0	12.0		45.0	Concrete/ Good	FIELD VERIFIED
TFculv62	GPS Point #1a start, GPS Point #1b end	444	47	1		X	X					2.5		5.5	8.5			Concrete/ Good	FIELD VERIFIED
TFculv65	GPS Point #8a start, GIS Point #8b end - entered manually - Under Cadawalder Ave.	415	45	1		X	X					2.5		4.5	10.0		45.0	Concrete/ Fair	FIELD VERIFIED
TFculv61	GPS Point #16a start, GPS Point #16b end - Under Osceola Ave.	468	50	1		X	X					2.5		5.0	10.0		60.0	Concrete/ Poor	FIELD VERIFIED
TFculv64	GPS Point #34a start, GPS Point #34b end - Under Cedar Rd.	1558	162	1		X	X					2.5		6.0	27.0		20.0	Concrete/ Good	FIELD VERIFIED
TFculv66	GPS Point #18a start, GPS Point #18b end	1600	160	1		X	X					2.0		10.0	16.0			Concrete/ Good	FIELD VERIFIED
TFculv72	GPS Point #25a start, GPS Point #25b end	79	10	1		X	X					2.0		2.5	4.0			Stone/ Good	FIELD VERIFIED; Blocked - creates pond
TFculv73	GPS Point #34a start, GPS Point #34b end - Dell Lane	1073	120	1		X	X					2.0		6.0	20.0			Concrete/ Good	FIELD VERIFIED
TFculv74	GPS Point #38a start, GPS Point #38b end	1716	160	1		X	X					3.0		8.0	20.0			Concrete/ Good	FIELD VERIFIED
TFculv75	GPS Point #44a start, GPS Point #44b end	1797	182	1		X	X					2.5		7.0	26.0			Concrete/ Good	FIELD VERIFIED
TFculv32	GPS Point #32 on 9/2/04 start, GPS Point #49a end on 10/29/04 end - confluence with main stem and H-trib	1544	112	1		X	X					6.0		8.0	14.0			Concrete and Stone/ Good	FIELD VERIFIED
TFculv84	GPS Point #12a start, GPS Point #12b end	354	28	1		X	X					5.0		7.0	4.0			Concrete/ Good	FIELD VERIFIED - V-NOTCH, 6' TOP, 2' BOTTOM
TFculv85	GPS Point #19a start, GPS Point #19b end - Under Highland Ave - bed channelized for 40' after culvert, ther	224	20	1		X	X					4.0		5.0	4.0			Concrete/ Good	FIELD VERIFIED
TFculv93b	GPS Point #6a s, GPS Point #6b end -Two pipes - Under Baeder Rd.	471	41	1		X	X					4.5		4.5	9.0			Concrete and Stone/ Good	FIELD VERIFIED - BOX PART OF DOUBLE CULVERT
TFculv90a	GPS Point #13a start, GPS Point #13b end - Three pipes - Under Jenkintown Rd.	376	42	1		X	X					2.0		6.0	7.0			Concrete/ Good	FIELD VERIFIED - BOX 1 OF TRIPLE CULVERT
TFculv90c	GPS Point #13a start, GPS Point #13b end - Three pipes - Under Jenkintown Rd.	590	66	1		X	X					2.0		6.0	11.0			Concrete/Good	FIELD VERIFIED - BOX 2 OF TRIPLE CULVERT
TFculv97	GPS Point #18 end - Under Adams Ave.	4962	120	3		X	X					6.0		8.0	15.0			Stone/ Good	FIELD VERIFIED
TFculv105	GPS Point #3a start, GPS Point #3b end - Under "I" St.	16863	1100	1		X	X					5.0		22.0	50.0			Stone/ Good	FIELD VERIFIED
TFculv106	GPS Point #12a start - Three pipes	26089	1650	1		X	X					5.0		25.0	66.0			Concrete/ Good	FIELD VERIFIED
TFculv01	GPS Point #2 start - GPS Point #3 end - Under Jefferson Street	160	25	1		X	X					1.0		3.5	7.0		0.0	Concrete/ Fair	FIELD VERIFIED
TFculv02	GPS Point #8 start, GPS Point #16 end - Triple Barrel	83	14	1		X	X					1.0		2.0	7.0		0.0	Stone/ Fair	FIELD VERIFIED; Partially Obstructed(BLE Note)
TFculv03	GIS point #18 - entered manually - culvert midpoint under Laurel Ave	354	50	1		X	X					1.0		5.0	10.0			Brick/ Good	FIELD VERIFIED
TFculv04	GIS Point #19 - Manually entered - Confluence of Trib A and MS Tacony - approx. 10' US from Main Stem -	570	52	1		X	X					3.5		6.5	8.0			Concrete/ Good	FIELD VERIFIED
TFculv09	GIS Point #20 - start - entered manually - GIS Point #25 - end - entered manually	531	59	1		X	X					2.0		6.5	9.0		15.0	Concrete/ Good	FIELD VERIFIED
TFculv10	GPS Point #21 start, GPS Point #19 end - Trib B is culverted Under Cottman Ave.	614	63	1		X	X					2.0		9.0	7.0			Stone/ Good	FIELD VERIFIED
TFculv12	GPS Point #5 start - Beecher Road	433	50	1		X	X					2.0		5.0	10.0			Stone/ Good	FIELD VERIFIED
TFculv14	GIS Point #12 - entered manually - Trib B at Tookany Creek Parkway	1195	96	1		X	X					5.0		6.0	16.0			Stone/ Good	FIELD VERIFIED
TFculv16	GPS Point #2 - mdpt of culvert - confluence of Jenkintown Creek and Tacony Main Stem	1771	132	1		X	X					6.0		6.0	22.0			Concrete and Stone/ Good	FIELD VERIFIED
TFculv21	GPS Point #14 - Springhouse Rd Culvert	1053	108	1		X	X					2.0		9.0	12.0			Concrete/ Good	FIELD VERIFIED; Stone headwalls/ concrete deck
TFculv28	GPS Point #7a start - at Easton Road	1742	189	1		X	X					2.0		7.0	27.0			Concrete/ Good	FIELD VERIFIED
TFculv24	GPS Point #1a end and GPS Point #1b start - Southeast @ Bickley Rd	1263	135	1		X	X					2.0		7.5	18.0			Concrete/ Good	FIELD VERIFIED; TFculv24 and 25 are the same bridge
TFculv25	GPS Point #2a start and GPS Point #2b end - 75' from Bickly Rd	1263	135	1		X	X					2.0		7.5	18.0			Concrete/ Good	FIELD VERIFIED; TFculv24 and 25 are the same bridge
TFculv27	GPS Point #4a start and GPS Point #4b end	1226	128	1		X	X					2.0		8.5	15.0			Concrete and Stone/ Good	FIELD VERIFIED; Culver(not bridge) goes under lawn
TFculv30	GIS Point #31 start, GIS Point #32 end - starts at Glenside Ave - Adjacent to Rice's Mill Rd.	1549	168	1		X	X					2.0		7.0	24.0		0.0	Concrete/ Good	FIELD VERIFIED
TFculv37	GPS Point #1a start, GPS Point #1b end - Glenside Ave	259	32	1		X	X					2.0		3.5	9.0		20.0	Concrete and Stone/ Good	FIELD VERIFIED
TFculv38	GPS Point #4a start, GPS Point #4b end - Montier St. & Lynnewood Ave	364	43	1		X	X					2.0		4.5	9.5		20.0	Concrete/ Good	FIELD VERIFIED
TFculv39	GPS Point #9a start, GPS Point #9b end - Waverly Ave Bridge	383	45	1		X	X					2.0		4.5	10.0		30.0	Concrete and Stone/ Good	FIELD VERIFIED; crack in bridge wall
TFculv35	GPS Point #10a start, GPS Point #10b end	326	38	1		X	X					2.0		4.5	8.5		0.0	Stone/ Good	FIELD VERIFIED
TFculv36	GPS Point #15a start, GPS Point #15b end	326	38	1		X	X					2.0		4.5	8.5		0.0	Stone/ Fair	FIELD VERIFIED
TFculv41	GPS Point #33a start and GPS Point #33b end	2169	198	1		X	X					3.0		9.0	22.0		45.0	Concrete/ Good	FIELD VERIFIED
TFculv42	GPS Point #40a start and GPS Point #40b end - Ashbourne Rd.	1404	144	1		X	X					2.0		9.0	16.0		0.0	Concrete/ Good	FIELD VERIFIED
TFculv13	GPS Point #8 - Broken bridge over creek, flow is diverted around bridge through culvert	46	12	1		X	X					0.0		3.0	4.0			Concrete/ Poor	B-L could not find
TFculv94	GPS Point #9a start, GPS Point #9b end	190	30	1		X	X					1.0		3.0	10.0			Stone/ Good	FIELD VERIFIED
TFculv96	GPS Point #12	350	35	1		X	X					2.0		10.0	3.5			Concrete	FIELD VERIFIED
TFculv49a	Township Line Road	169	21	1		X	X					2.0		3.0	7.0		10.0	Concrete/ Good	Point collected and mapped by Borton-Lawson

FORM B - OBSTRUCTION DATA COLLECTION

SHEET ________ OF ________

Municipal Stream Obstruction Data

Watershed:

Municipality/County:

Records completed by: ______________

Field work personnel: ______________

Date(s): ______________________

T= Amount of fill
D= Diameter
HT = Height
W = Width
PW = Pier Width

Material
msry = Stone Masonry Structure
CMP = Corrugated Metal Pipe
CPP = Corrugated Polyethylene Pipe
BCCMP = Bituminous Coated CMP
RCP = Reinforced Concrete Pipe
SP = Steel Pipe

Inlet Conditions
HW = Headwall
WW = Wingwall
SW = Sidewall

Map ID.	Owner or Address Of Obstruction	Capacity (CFS)	Area (Sq. Ft.)	Nos. of?	Opening: Type		Opening: Shape (✓)					Measurements						MATERIAL / INLET CONDITION	NOTES
					Part of Bridge?	Culvert Purpose	Culvert □	Culvert O	Culvert ⬭	Bridge ∩	Bridge ⊓	T (ft)	D (ft)	HT (ft)	W (ft)	PW (ft)	skew angle		
TFculv48	GPS Point #4a start - GPS Point #4b end; Off Township Line Road	195.03	15.90	1		X		X				4.5	4.5				10.0	Concrete/ Good	FIELD VERIFIED
TFculv49	GPS Point #6a start - GPS Point #6b end; Off Township Line Road	195.03	15.90	1		X		X				4.5	4.5				10.0	Stone/ Good	FIELD VERIFIED
TFculv60	GPS Point #6a start, GPS Point #6b end	35.02	7.07	1		X		X					3.0					Corregated Metal	B-L could not find
TFculv57	GPS Point #27a start, GPS Point #27b end	232.61	23.76	1		X		X				2.0	5.5				0.0	Concrete/ Fair	FIELD VERIFIED
TFculv70	GPS Point #5a start, GPS Point #5b end	116.19	12.57	1		X		X				2.0	4.0					Corregated Metal/ Good	B-L could not find
TFculv67	GPS Point #28a start, GPS Point #28b end - corner of Rock Creek Rd. and Lorimer Dr.	400.48	38.48	1		X		X				2.0	7.0					Concrete/ Good	FIELD VERIFIED
TFculv68	GPS Point #32a start, GPS Point #32b end - Under Arboretum Rd.	338.64	33.18	1		X		X				2.0	6.5					Concrete/ Good	FIELD VERIFIED
TFculv83	GPS Point #7a start, GIS Point #7b end - entered manually	35.25	7.07	1		X		X					3.0					Stone and Brick/ Good	B-L could not find
TFculv81	GPS Point #15a start, GPS Point #15b end - Two pipes	198.07	28.27	1		X		X					6.0					Corregated Metal/ Good	B-L could not find
TFculv80	GPS Point #18 start, GPS Point #1 end on 11/2/04 - unnamed trib - corner of Hilldale and Parkview Ro	114.77	12.57	1		X		X				2.0	4.0					Concrete/ Poor	FIELD VERIFIED
TFculv89	GPS Point #7a start, GPS Point #7b end - Smells badly - Under Front Street	95.94	12.57	1		X		X				1.0	4.0					Concrete/ Good	FIELD VERIFIED
TFculv86	GPS Point #30a start, GPS Point #30b end - Two pipes	290.57	12.57	2		X		X				4.0	4.0					Concrete and Corregated Metal/ Good	FIELD VERIFIED
TFculv87	GPS Point #34a start, GPS Point #34b end - Two pipes - Under Running Brook Rd	261.84	12.57	2		X		X				3.0	4.0					Concrete and Corregated Metal/ Good	FIELD VERIFIED
TFculv92	GPS Point #4a start, GPS Point #4b end - Smelly, oily	35.25	7.07	1		X		X					3.0					Concrete/ Good	B-L could not find
TFculv93c	GPS Point #6a s, GPS Point #6b end -Two pipes - Under Baeder Rd.	282.74	28.27	1		X		X				2.0	6.0					Concrete and Stone/ Good	FIELD VERIFIED - CIRC. PART OF DOUBLE CULVERT
TFculv90b	GPS Point #13a start, GPS Point #13b end - Three pipes - Under Jenkintown Rd.	138.29	12.57	1		X		X				3.5	4.0					Concrete/Good	FIELD VERIFIED - CIRC. PART OF TRIPLE CULVERT
TFculv91	GPS Point #17a start, GIS Point #17b end - entered manually	293.19	38.48	1		X		X					7.0					Concrete/ Good	B-L could not find
TFculv99	GPS Point #1a start, GPS Point #1b start	35.44	4.91	1		X		X				1.25	2.5					Concrete/ Good	FIELD VERIFIED
TFculv101	GPS Point #4a start, GPS Point #4b end - Very little water entering culvert, much flow leaving	98.30	9.62	1		X		X				3.0	3.5					Concrete/ Good	FIELD VERIFIED
TFculv98	GPS Point #15a start, GPS Point #15b start - Under Highland Ave.	305.74	19.63	1		X		X				8.0	5.0					Concrete/ Good	FIELD VERIFIED
TFculv05	GPS Point #6	95.94	12.57	1		X		X				1.0	4.0					Concrete/ Fair	FIELD VERIFIED
TFculv08	GPS Point #16	95.94	12.57	1		X		X				1.0	4.0					Concrete/ Good	FIELD VERIFIED
TFculv29	GPS Point #9a start, GPS Point #9b end - headwaters unknown trib at Waverly Road	33.24	4.91	1		X		X				1.0	2.5					Fair	FIELD VERIFIED; small creek, 30 inch pipe
TFculv06	GPS Point #8 start GPS Point #10 end of Culvert 2 that split under Church Rd.	49.98	7.07	1		X		X				1.0	3.0					Concrete/ Good	FIELD VERIFIED
TFculv07	GPS Point #8a start GPS Point #9 end of Culvert 1 that split under Church Rd.	51.83	9.62	1		X		X				0.0	3.5					Concrete	FIELD VERIFIED
TFculv15	GIS Point #20 - entered manually - At Cottman Ave confluence with Jenkintown Creek	71.88	12.57	1		X		X				0.0	4.0					Corregated Metal/ Good	FIELD VERIFIED
TFculv95	GPS Point #10	183.80	7.07	3		X		X				2.0	3.0					Concrete and Stone/ Good	FIELD VERIFIED
TFculv82	GPS Point #20a start, GPS Point #20b end - pipe coming out of outfall	188.03	19.63	1		X		X				2.0	5.0					Concrete/ Good	FIEDL VERIFIED

FORM B - OBSTRUCTION DATA COLLECTION

SHEET _________ OF _________

Municipal Stream Obstruction Data

Watershed:

Municipality/County:

Records completed by: ______________

Field work personnel: ______________

Date(s): ______________________

T= Amount of fill
D= Diameter
HT = Height
W = Width
PW = Pier Width

Material
msry = Stone Masonry Structure
CMP = Corrugated Metal Pipe
CPP = Corrugated Polyethylene Pipe
BCCMP = Bituminous Coated CMP
RCP = Reinforced Concrete Pipe
SP = Steel Pipe

Inlet Conditions
HW = Headwall
WW = Wingwall
SW = Sidewall

					Opening							Measurements							
					Type		Shape (✓)												
Map ID.	Owner or Address Of Obstruction	Capacity (CFS)	Area (Sq. Ft.)	Nos. of?	Part of Bridge?	Culvert Purpose	Culvert □	Culvert O	Culvert ⬭	Bridge ⌒	Bridge ⊓	T (ft)	D (ft)	HT (ft)	W (ft)	PW (ft)	skew angle	MATERIAL / INLET CONDITION	NOTES
TFculv63	GPS Point #26a start, GPS Point #26b end	231.50	24.74	1		X			X			2.0		4.5	7.0			Concrete/Good	FIELD VERIFIED
TFculv19	GPS Point #1 start at Doe Lane - GPS Point #2 end	179.33	19.63	1		X			X			2.0	-	4.0	6.3		60.0	Concrete/ Good	FIELD VERIFIED
TFculv23	GIS Point #4b - entered manually - start at Waverly Rd, next to far cemetery entrance - GIS Point #4a - end at Waverly	255.46	30.24	1		X			X			1.0	-	5.5	7.0			Corregated Metal/ Good	FIELD VERIFIED
TFculv13a	Forrest Street over East Brook	188.50	18.85	1		X			X			2.0		6.0	4.0		0.0	Concrete/ Good	Point collected and mapped by Borton-Lawson

FORM B - OBSTRUCTION DATA COLLECTION

SHEET ________ OF ________

Municipal Stream Obstruction Data

Watershed:

Municipality/County:

Records completed by: ______________

Field work personnel: ______________

Date(s): ________________________

T= Amount of fill
D= Diameter
HT = Height
W = Width
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Material
msry = Stone Masonry Structure
CMP = Corrugated Metal Pipe
CPP = Corrugated Polyethylene Pipe
BCCMP = Bituminous Coated CMP
RCP = Reinforced Concrete Pipe
SP = Steel Pipe

Inlet Conditions
HW = Headwall
WW = Wingwall
SW = Sidewall

Map ID.	Owner or Address Of Obstruction	Capacity (CFS)	Area (Sq. Ft.)	Nos. of?	Opening: Type: Part of Bridge?	Culvert Purpose	Shape (✓): Culvert: □	○	⬭	Bridge: ⌒	⊓	Measurements: T (ft)	D (ft)	HT (ft)	W (ft)	PW (ft)	skew angle	MATERIAL / INLET CONDITION	NOTES
TFbri014	GPS Point #25a start and GPS Point #25b end	3267.44	273.48	1	X					X		2.0		11.0	31.0		45.0	Concrete/ Good	FIELD VERIFIED
TFbri103	Listed as TFculv103 as going under Roosevelt Blvd. This is actually the bridge.	317249.01	3849.60	3	X					X		10.0		60.0	80.0				FIELD VERIFIED - NOT ORIGINALLY MAPPED
TFculv54	GPS Point #11a start, GPS Point#11b end	267.09	26.47	1		X				X		2.0	-	6.0	5.5		0.0	Stone/ Good	FIELD VERIFIED
TFculv55	GPS Point #22a start, GPS Point #22b end - Under Crosswick Rd	296.61	32.08	1		X				X		2.0	0.0	4.0	10.0		30.0	Stone/ Good	FIELD VERIFIED
TFculv69	GPS Point #33a start, GPS Point #33b end - Under Greenwood Ave - 2' drop d/s side of culvert	578.30	54.14	1		X				X		2.0	-	7.5	9.0			Stone/ Good	FIELD VERIFIED; Silted in
TFculv100	GPS Point #24a start, GPS Point #24b end	9087.07	300.75	2		X				X		4.0	-	15.0	25.0		10.0	Concrete/ Good	FIELD VERIFIED; 1 opening is 27' W & 19' H and 1 is 27'W & 12'H
TFculv102	GPS Point #11a start, GPS Point #11b end - Rising Sun Ave.	5452.24	360.90	1		X				X		4.0	-	15.0	30.0			Concrete and Stone/ Good	FIELD VERIFIED
TFculv103	GPS Point #23a start, GPS Point #23b end - Under Roosevelt Blvd.	5755.65	320.80	1		X				X		6.0	-	20.0	20.0			Concrete/ Good	FIELD VERIFIED - ACTUALLY IN PARK NEAR ROOSE. BLVD.
TFculv18	GIS Point #0 - entered manually - culvert m - US side under 309 overpass	2953.85	182.86	1		X				X		4.0	-	19.0	12.0		60.0	Concrete/ Good	FIELD VERIFIED
TFculv22	GIS Point #20 start - entered manually, GIS Point #27 end - entered manually - Church Rd	258.20	32.48	1		X				X		1.0	-	4.5	9.0		0.0	Concrete and Stone - Corregated/ Good	FIELD VERIFIED
TFculv20	GIS Point #11 - entered manually - Middle - Limekiln Pike	1289.06	109.47	1		X				X		2.0	-	10.5	13.0			Concrete/ Good	FIELD VERIFIED
TFculv31	GPS Point #24 - RR track crossing	1503.61	134.74	1		X				X		1.0	-	12.0	14.0		0.0	Stone and Brick/ Fair	FIELD VERIFIED
TFculv88	GPS Point #39	1081.04	78.60	1		X				X		5.0	-	7.0	14.0			Stone/ Good	FIELD VERIFIED

APPENDIX C

DATA COLLECTION FORMS
(FORMS A, C – J, O)

FORM A-I STORMWATER PROBLEM AREAS- PHASE I

FORM A-II STORMWATER PROBLEM AREAS- PHASE II

FORM C EXISTING FLOOD CONTROL PROJECTS

FORM D PROPOSED FLOOD CONTROL PROJECTS

FORM E EXISTING STORMWATER CONTROL FACILITIES

FORM F PROPOSED STORMWATER CONTROL FACILITIES

FORM G EXISTING STORMWATER COLLECTION SYSTEM

FORM H PROPOSED STORMWATER COLLECTION SYSTEMS

FORM I PRESENT & PROJECTED DEVELOPMENT IN THE FLOOD HAZARD AREA

FORM J WATER QUALITY PROBLEM AREAS

FORM O OUTFALL DATA

FORM A - STORM WATER PROBLEM AREAS SHEET________ OF ________

WATERSHED	FORM COMPLETED BY	Before Filling Out Form, See Instructions On Back
Name: Michael Powers	Name: S. Demko	
Municipality: Abington Twp	Telephone:	For County Use:
County: Montgomery	Date: 4/3/06	

MAP NO. *	A- 1	A- 2	A- 3	A-	A-	A-	A-	A-	A-	A-	A-	A-
Types of Storm Water Problems												
Flooding	✓	✓										
Accelerated Erosion			✓									
Sedimentation												
Landslide												
Groundwater												
Water Pollution												
Other (Explain)												
Explanation Line No. (On Back)												
Cause (s)												
Storm Water Volume	✓	✓	✓									
Storm Water Velocity												
Storm Water Direction												
Water Obstruction												
Other (Explain)												
Explanation Line No. (On Back)												
Frequency												
Year Most Recent Occurred												
Year First Known Occurred												
Regularity												
More Than 1 Year												
Less Than 1 Year												
Only During Agnes												
Duration (If Applicable)												
Less Than 1 Day												
1 Day + (Enter Days)												
Property Damage												
Loss of Life/Vital Services												
Private												
More Than One Owner												
Types of Properties												
Number of Properties												
Public (List Types)												
Explanation Line No. (On Back)												
Solutions												
Suggested												
Explanation Line No. (On Back)												
Formally Proposed												
Explanation Line No. (On Back)												

* Include Map ID No. if found on any other form listing proposed facilities.

△ **FORM C** - EXISTING FLOOD CONTROL PROJECT SHEET ________ OF ________

WATERSHED	FORM COMPLETED BY	TYPICAL TYPES OF FLOOD CONTROL PROJECTS
Name: ________	Name: ________	Channel Excavation / Widening; Levee; Dams
Municipality: ________	Telephone: ________	Channel Realignment; Gabions; Floodwall
County: ________	Date: ________	Rock Riprap; Pipe Channel; Concrete Lining

For County Use:

Map ID No.	Type of Flood Control Project	Year Constr Built	Expected Life Yrs.	Design Flood Frequency Yrs.	Design Flood Discharge C.F.S.	Owner Name, Address, and Phone
C-						
C-	N/A					
C-						
C-						
C-						
C-						
C-						

FORM D - PROPOSED FLOOD CONTROL PROJECT SHEET ________ OF ________

WATERSHED	FORM COMPLETED BY	TYPICAL TYPES OF FLOOD CONTROL PROJECTS
Name: ________	Name: ________	Channel Excavation / Widening; Levee; Dams
Municipality: ________	Telephone: ________	Channel Realignment; Gabions; Floodwall
County: ________	Date: ________	Rock Riprap; Pipe Channel; Concrete Lining

For County Use:

Map ID No.	Type of Flood Control Project	Study Phase Begun			Year Constr. Planned	Projected Compltn. Date	Expected Life Yrs.	Design Flood		Map ID No. Form A*	Owner Name, Address, and Phone
		YES		N0				Frequency Yrs.	Discharge C.F.S.		
		Prelim.	Final								
D-											
D-											
D-	N/A										
D-											
D-											
D-											
D-											

* Enter the storm water problem area's Map ID No., if the proposed project will solve or reduce any / all of an identified drainage problem.

FORM E - EXISTING STORM WATER CONTROL FACILITIES

SHEET ________ OF ________

WATERSHED	FORM COMPLETED BY	Definition of Storm Water Control Facility
Name: Mike Powers Municipality: Abington Twp County: Mont Co.	Name: S. Demko Telephone: Date: 4/3/06	A natural / man-made device or structure specifically designed and / or utilized to reduce the rate and / or volume of storm water runoff from a site or sites.

For County Use:

Map ID No.	Type of Storm Water Control Facility	Year Built	Contact Person	Address and Phone	Comments
E- 1	Detention Basin		Mike Powers	1176 Old York Rd Abington	
E- 2	" "	1950's	"	" "	
E- 3	" "	1980's	"	"	
E- 4	" "	1950's	"	"	
E- 5	" "	1960's	"	"	
E- 6	" "	"	"	"	
E- 7	[illegible] Channel widening				
E- 8	Constructed wetland				
E- 9	Underground Storage				
E- 10	Detention Basin				
E- 11	Detention Basin				
E-					
E-					
E-					
E-					
E-					
E-					
E-					
E-					
E-					
E-					
E-					

TYPICAL TYPES OF STORM WATER CONTROL FACILITIES

- Detention / Retention Basin
- Natural Pond or Wetland
- Parking Lot Pondling
- Roof-Top Storage
- Semi-Pervious Paving
- Infiltration Device (Seepage /Recharge Basin or Underground Tank)

FORM F - PROPOSED STORM WATER CONTROL FACILITIES

SHEET ________ OF ________

WATERSHED	FORM COMPLETED BY	DEFINITION
Name: Nikk Powers Municipality: Clinton Twp County: Mon Co	Name: ________ Telephone: ________ Date: ________	Storm Water Control Facility A natural / man-made device or structure specifically designed and / or utilized to reduce the rate and / or volume of storm water runoff from a site or sites.

For County Use:

Map ID No.	Type of Storm Water Control Facility	Proposed Constr. Dates Start	End	Map No. Form A*	Contact Person Name, Address and Phone	Comments
F- 1						
F-						
F-						
F-						
F-						
F-						
F-						
F-						
F-						
F-						
F-						

* Enter the storm water problem area's Map ID No., if the proposed project will solve or reduce any / all of an identified drainage problem.

TYPICAL TYPES OF STORM WATER CONTROL FACILITIES

Detention / Retention Basin
Natural Pond or Wetland
Parking Lot Pondling

Roof-Top Storage
Semi-Pervious Paving
Infiltration Device (Seepage / Recharge Basin or Underground Tank)

FORM G - EXISTING STORM WATER COLLECTION SYSTEMS SHEET __________ OF __________

WATERSHED	FORM COMPLETED BY	INSTRUCTIONS
Name: ______ Municipality: ______ County: ______	Name: ______ Telephone: ______ Date: ______	Diagram each system on the appropriate map. Establish map points to show changes in system elements, pipe size, or pipe direction. (If unknown, outline the system extent.) Complete this form only where specific information on construction is available. Use a separate form for each system. Identify the points within a system consecutively (ex. G-1,G-2,G-3). Start the first point in each additional system 20 numbers higher. For example, G-3 ends one system, so G-23 begins the next. See Sample Diagrams & Form on Reverse.

Map I.D. No.		System's Elements (x)			Measurements *				Material	Year Constr.	Design Data Available	Contact Person Name and Phone	Name of Final Ownership and Maintenance Responsibility
					Pipe	Channel / Swale							
From	To	Pipe	Open Channel	Swale	D	TW	B	Depth					
G-	G-												
G-	G-							Sewer					
G-	G-					Storm							
G-	G-		See										
G-	G-							Map					
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												

* See measurement key on reverse side.

FORM H - PROPOSED STORM WATER COLLECTION SYSTEMS SHEET ________ OF ________

WATERSHED	FORM COMPLETED BY	INSTRUCTIONS
Name: ________ Municipality: ________ County: ________	Name: ________ Telephone: ________ Date: ________	On the map for proposed storm water collection systems, diagram each proposed system. Indicate a map point to show changes in system elements, pipe size, pipe direction and connections to existing systems. For proposed additions to existing systems, diagram only the additions and their connection point into the existing system. Complete a separate form for each proposed, new system and one for each existing system having one or more proposed additions. Identify the points within a system consecutively (ex. H-1, H-2, H-3). Start the first point in each additional system 20 numbers higher (if H-3 ends one system, begin the next with H-23). Be sure to show the point where proposed additions connect into existing systems, using the map point number from the existing system form and map. See Sample Diagrams and Form on Reverse.

Map I.D. No.		System's Elements (x)			Measurements *				Material	Map I.D. Nos.** Form A	Proposed Const. Dates		Design Data Avail.	Contact Person Name and Phone	Name of Final Ownership and Maintenance Responsibility
					Pipe	Open Channel / Swale									
From	To	Pipe	Open Channel	Swale	D	TW	B	Depth			Start	End			
H-	H-														
H-	H-														
H-	H-														
H-	H-			N/A											
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														

* See measurement key on reverse side. ** Enter the storm water problem areas' Map I.D. Nos., if proposed project will solve or reduce any / all of the drainage problems.

FORM I - PRESENT & PROJECTED DEVELOPMENT IN THE FLOOD HAZARD AREA

SHEET ________ OF ________

WATERSHED	FORM COMPLETED BY	DEFINITION
Name: ________ Municipality: ________ County: ________	Name: ________ Telephone: ________ Date: ________	FLOOD HAZARD AREA: A NORMALLY DRY LAND AREA THAT HAS BEEN OR IS SUSCEPTABLE TO BEING INUNDATED BY THE 100-YEAR FLOOD.
For County Use:		

Map ID No.	TYPE OF DEVELOPMENT	Year Built	Contact Person Name, Address and Phone	Comments
I -				
I -				
I -				
I -	N/A			
I -				
I -				
I -				
I -				
I -				

FORM J - WATER QUALITY PROBLEM AREAS SHEET_______ OF _______

WATERSHED	FORM COMPLETED BY
Name:	Name:
Municipality:	Telephone:
County:	Date:

SITE	J-	J-	J-	J-	J-	J-	J-	J-	J-	J-	J-	J-
Types of Water Quality Problems												
High Community Tolerence												
High Temperature												
High Turbidity												
Hydrocarbon Pollution		N/A										
Low Community Diversity												
Low Dissolved Oxygen												
Low pH												
Nutrient Enrichment												
Poor Habitat												
Other/Explanation Line No.												
Potential Cause(s)												
Agriculture												
Construction Site												
Erosion												
Lake Discharge												
STP Outfall												
Other/Explanation Line No.												
Frequency												
Year Most Recent Occurence												
Year First Known Occurence												
Source of Information												
BWA Streamwatch												
County Water Quality Study												
Driveby												
UCCD Complaint Investigation												
Other/Explanation Line No.												

EXPLANATION LINES

1
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Township of Cheltenham

Montgomery County, Pennsylvania

Administration Building
8230 Old York Road
Elkins Park, PA 19027-1589

Phone: 215 887-1000
FAX: 215 887-1561
Website: cheltenhamtownship.org

BORTON LAWSON
SRB
✓ PAD
MJW
ADMIN
LJS
WSB
MAR 28 2007
☐ CORRESPONDENCE
☐ AGREEMENT
☐ CONTRACT/DESIGN
PROJECT NO

March 26, 2007

Mr. Paul DeBarry, P.E.
Project Manager
Borton-Lawson
3893 Adler Place, Suite 100
Bethlehem, PA 18017

Dear Mr. DeBarry:

In follow-up to our January 24, 2007 Act 167 Watershed Planning Advisory Committee meeting, we are forwarding to you copies of the respective engineering plan sheets depicting the stormwater management facility designs for the following land development projects in Cheltenham Township:

1. Drawing No. C1001 Sheet 3 of 7, Record Plan Arcadia University Brubaker Hall Expansion Site Plan, 450 South Easton Road, prepared by Pennoni Associates, Inc. dated December 18, 2006.
2. Drawing C1001, Sheet 2 of 5, Arcadia University Site Plan for 16 Forsythe Avenue, prepared by Pennoni Associates, Inc. dated June 19, 2006.
3. Drawing C1001, Sheet 2 of 5, Arcadia University Site Plan for 330 Bickley Road, prepared by Pennoni Associates, Inc.dated June 19, 2006.
4. Drawing C1001, Sheet 3 of 9, Medical Office Parking Proposed Site Plan located at 100, 104 and 106 Cottman Street, prepared by Pennoni Associates, Inc. dated January 5, 2006.
5. Drawing C1001, Sheet 3 of 10, Arcadia University Parking lot #5 Renovations Site Plan, prepared by Pennoni Associates, Inc. dated March 10, 2006.
6. Drawing L2.1, Site Material Plan for Additions and Alterations to Myers Elementary School, 7609 Montgomery Avenue, Elkins Park, prepared by Hayes Large Architects, LLC, dated February 3, 2006.

7. Drawing C0101, Record Plan of Breyer Court prepared by Pennoni Associates, Inc. dated June 1, 2001.
8. Utility Plan for the Record Plan of Nolan Self Storage-36, Township Line Road, prepared by Carroll Engineering Corporation dated September 16, 2005.
9. Cheltenham Township Development Application No. 04-20B, Drawing C100, Final Land Development Plan of Park View at Cheltenham, Washington Lane, prepared by Gladnick Wright Salmeda dated May 13, 2005.
10. Cheltenham Township Development Application No. 04-01, Site Plan Land Development Plan of 426 West Laurel Avenue Condominiums, prepared by TEI Consulting Engineers, dated January 5, 2004.
11. Drawing C0101, Overall Campus Site Plan of Arcadia Parking Lot / Kuch Center Expansion, prepared by Pennoni Associates, Inc. dated January 1, 2003.
12. Cheltenham Township Development Application Nos. 05-14A & 05-14B, Record Plan of J. C. Melrose County Club Site Improvements – Phase I: Pedestrian Tunnel, 7600 Tookany Creek Parkway, prepared by P.M.D. Construction Consulting LLC, dated November 28, 2005 and September 9, 2005 respectively.
13. Overall Site Plan of Ashbourne Country Club Phase 1, prepared by Bohler Engineering, Inc., dated June 15, 2005.

If you need additional information, please do not hesitate to contact me at the Township Administration Building, (215) 887-6200, x112.

Sincerely,

Bryan T. Havir, P.P., AICP
Assistant Township Manager

BTH/kli
Enclosures
cc: David G. Kraynik, Township Manager
David M. Lynch, P.E., P.L.S., Director, Engineering, Zoning & Inspections
Rudy Kastenhuber, Public Works Coordinator
Joanne Dahme, Philadelphia Water Department

FORM A - STORM WATER PROBLEM AREAS SHEET________ OF ________

WATERSHED	FORM COMPLETED BY	Before Filling Out Form, See Instructions On Back
Name: Bryan Havic	Name: S. Dembo	
Municipality: Cheltenham	Telephone:	For County Use:
County: Montgomery	Date: 4/10/06	

MAP NO. *	A- 1	A- 2	A-3	A- 4	A- 5	A- 6	A- 7	A-8	A- 9	A- 10	A- 11	A- 12	A- 13	A- 14
Types of Storm Water Problems														
Flooding	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓
Accelerated Erosion	✓	✓								✓	✓	✓		
Sedimentation	✓													
Landslide														
Groundwater														
Water Pollution														
Other (Explain)														
Explanation Line No. (On Back)														
Cause (s)														
Storm Water Volume														
Storm Water Velocity														
Storm Water Direction														
Water Obstruction														
Other (Explain)														
Explanation Line No. (On Back)														
Frequency														
Year Most Recent Occurred														
Year First Known Occurred														
Regularity														
More Than 1 Year														
Less Than 1 Year														
Only During Agnes														
Duration (If Applicable)														
Less Than 1 Day														
1 Day + (Enter Days)														
Property Damage														
Loss of Life/Vital Services														
Private														
More Than One Owner														
Types of Properties														
Number of Properties														
Public (List Types)														
Explanation Line No. (On Back)														
Solutions														
Suggested														
Explanation Line No. (On Back)														
Formally Proposed														
Explanation Line No. (On Back)														

* Include Map ID No. if found on any other form listing proposed facilities.

△ **FORM C** - EXISTING FLOOD CONTROL PROJECT SHEET ________ OF ________

WATERSHED	FORM COMPLETED BY	TYPICAL TYPES OF FLOOD CONTROL PROJECTS
Name: Harri / Kastenkulke Municipality: Cheltenham County: Montgomery	Name: S. Wenk Telephone: Date: 4/10/06	Channel Excavation / Widening, Channel Realignment, Rock Riprap Levee, Gabions, Pipe Channel Dams, Floodwall, Concrete Lining
For County Use:		

Map ID No.	Type of Flood Control Project	Year Constr Built	Expected Life Yrs.	Design Flood Frequency Yrs.	Design Flood Discharge C.F.S.	Owner Name, Address, and Phone
C- 1	Spill-way; Diversion Channel - DEP					
C-						
C-						
C-						
C-						
C-						
C-						

FORM D - PROPOSED FLOOD CONTROL PROJECT

SHEET ________ OF ________

WATERSHED	FORM COMPLETED BY	TYPICAL TYPES OF FLOOD CONTROL PROJECTS
Name: ________ Municipality: ________ County: ________	Name: ________ Telephone: ________ Date: ________	Channel Excavation / Widening Channel Realignment Rock Riprap Levee Gabions Pipe Channel Dams Floodwall Concrete Lining

For County Use:

Map ID No.	Type of Flood Control Project	Study Phase Begun			Year Constr. Planned	Projected Compltn. Date	Expected Life Yrs.	Design Flood		Map ID No. Form A*	Owner Name, Address, and Phone
		YES		N0				Frequency Yrs.	Discharge C.F.S.		
		Prelim.	Final								
D-											
D-											
D-	N/A										
D-											
D-											
D-											
D-											

* Enter the storm water problem area's Map ID No., if the proposed project will solve or reduce any / all of an identified drainage problem.

FORM E - EXISTING STORM WATER CONTROL FACILITIES

SHEET ________ OF ________

WATERSHED	FORM COMPLETED BY	DEFINITION
Name: Bryan Haver Rudy Kastenhuber Municipality: Cheltenham County: Montgomery	Name: S. Demko Telephone: Date: 4/10/06	Storm Water Control Facility A natural / man-made device or structure specifically designed and / or utilized to reduce the rate and / or volume of storm water runoff from a site or sites.
For County Use:		

Map ID No.	Type of Storm Water Control Facility	Year Built	Contact Person Name, Address and Phone	Comments
E- ~~0~~	[illegible]			
E- 1	Detention Basin			
E- 2	Detention Basin			
E- 3	" "			
E- 4	" "			
E- 5	Infiltration Device - Seepage Basin/Underground			
E- 6	underground system			
E- 7	" "			
E- 8	underground system			
E-				
E-				

TYPICAL TYPES OF STORM WATER CONTROL FACILITIES

Detention / Retention Basin

Natural Pond or Wetland

Parking Lot Pondling

Roof-Top Storage

Semi-Pervious Paving

Infiltration Device (Seepage / Recharge Basin or Underground Tank)

FORM F - PROPOSED STORM WATER CONTROL FACILITIES

SHEET ________ OF ________

WATERSHED	FORM COMPLETED BY	DEFINITION
Name: Harn/Kastenhuber Municipality: Cheltenham County: Montgomery	Name: J. Alimba Telephone: Date: 4/10/06	Storm Water Control Facility A natural / man-made device or structure specifically designed and / or utilized to reduce the rate and / or volume of storm water runoff from a site or sites.

For County Use:

Map ID No.	Type of Storm Water Control Facility	Proposed Constr. Dates Start	Proposed Constr. Dates End	Map No. Form A*	Contact Person Name, Address and Phone	Comments
F- 1	Seepage Underground Basin System					
F- 2	" "					
F- 3	Infiltration device: Seepage Basin - Underground					
F- 4	Infiltration device					
F- 5	Underground System					
F-						
F-						
F-						
F-						
F-						
F-						

* Enter the storm water problem area's Map ID No., if the proposed project will solve or reduce any / all of an identified drainage problem.

TYPICAL TYPES OF STORM WATER CONTROL FACILITIES

Detention / Retention Basin
Natural Pond or Wetland
Parking Lot Pondling

Roof-Top Storage
Semi-Pervious Paving
Infiltration Device (Seepage / Recharge Basin or Underground Tank)

FORM G - EXISTING STORM WATER COLLECTION SYSTEMS SHEET __________ OF __________

WATERSHED	FORM COMPLETED BY	INSTRUCTIONS
Name: ______	Name: ______	Diagram each system on the appropriate map. Establish map points to show changes in system elements, pipe size, or pipe direction. (If unknown, outline the system extent.) Complete this form only where specific information on construction is available. Use a separate form for each system. Identify the points within a system consecutively (ex. G-1,G-2,G-3). Start the first point in each additional system 20 numbers higher. For example, G-3 ends one system, so G-23 begins the next. See Sample Diagrams & Form on Reverse.
Municipality: ______	Telephone: ______	
County: ______	Date: ______	

Map I.D. No.		System's Elements (x)			Measurements *				Material	Year Constr.	Design Data Available	Contact Person Name and Phone	Name of Final Ownership and Maintenance Responsibility
					Pipe	Channel / Swale							
From	To	Pipe	Open Channel	Swale	D	TW	B	Depth					
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												

See CD Rom
Storm Sewers

* See measurement key on reverse side.

FORM H - PROPOSED STORM WATER COLLECTION SYSTEMS

SHEET __________ OF __________

WATERSHED	FORM COMPLETED BY
Name: ____________	Name: ____________
Municipality: ____________	Telephone: ____________
County: ____________	Date: ____________

INSTRUCTIONS

On the map for proposed storm water collection systems, diagram each proposed system. Indicate a map point to show changes in system elements, pipe size, pipe direction and connections to existing systems. For proposed additions to existing systems, diagram only the additions and their connection point into the existing system. Complete a separate form for each proposed, new system and one for each existing system having one or more proposed additions. Identify the points within a system consecutively (ex. H-1, H-2, H-3). Start the first point in each additional system 20 numbers higher (if H-3 ends one system, begin the next with H-23). Be sure to show the point where proposed additions connect into existing systems, using the map point number from the existing system form and map. See Sample Diagrams and Form on Reverse.

Map I.D. No.		System's Elements (x)			Measurements *				Material	Map I.D. Nos.** Form A	Proposed Const. Dates		Design Data Avail.	Contact Person Name and Phone	Name of Final Ownership and Maintenance Responsibility
					Pipe	Open Channel / Swale									
From	To	Pipe	Open Channel	Swale	D	TW	B	Depth			Start	End			
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														

N/A

* See measurement key on reverse side. ** Enter the storm water problem areas' Map I.D. Nos., if proposed project will solve or reduce any / all of the drainage problems.

FORM I - PRESENT & PROJECTED DEVELOPMENT IN THE FLOOD HAZARD AREA

SHEET __________ OF __________

WATERSHED	FORM COMPLETED BY	DEFINITION
Name: ____________	Name: ____________	FLOOD HAZARD AREA:
Municipality: ____________	Telephone: ____________	A NORMALLY DRY LAND AREA THAT HAS BEEN OR IS SUSCEPTABLE TO BEING INUNDATED BY THE 100-YEAR FLOOD.
County: ____________	Date: ____________	

For County Use:

Map ID No.	TYPE OF DEVELOPMENT	Year Built	Contact Person Name, Address and Phone	Comments
I -				
I -				
I -	N/A			
I -				
I -				
I -				
I -				
I -				
I -				

FORM J - WATER QUALITY PROBLEM AREAS SHEET_______ OF _______

WATERSHED	FORM COMPLETED BY
Name: ________	Name: ________
Municipality: ________	Telephone: ________
County: ________	Date: ________

SITE	J-	J-	J-	J-	J-	J-	J-	J-	J-	J-	J-	J-
Types of Water Quality Problems												
High Community Tolerence												
High Temperature												
High Turbidity												
Hydrocarbon Pollution												
Low Community Diversity												
Low Dissolved Oxygen												
Low pH												
Nutrient Enrichment												
Poor Habitat												
Other/Explanation Line No.												
Potential Cause(s)												
Agriculture												
Construction Site												
Erosion												
Lake Discharge												
STP Outfall												
Other/Explanation Line No.												
Frequency												
Year Most Recent Occurence												
Year First Known Occurence												
Source of Information												
BWA Streamwatch												
County Water Quality Study												
Driveby												
UCCD Complaint Investigation												
Other/Explanation Line No.												

EXPLANATION LINES

1	
2	
3	
4	
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6	
7	
8	
9	
10	

LETTER OF TRANSMITTAL

Pennoni

PENNONI ASSOCIATES INC.
CONSULTING ENGINEERS

Doylestown Commerce Center
2005 S. Easton Rd. Suite 100
Doylestown, PA 18901
Tel: 215 - 345 - 4591
Fax: 215 - 345 - 7853

TO: Borton-Lawson
3893 Adler Place
Suite 100
Bethlehem PA 18017

DATE	2/20/07	**JOB NO.**	JENK
ATTENTION	Stephanie Demko		
RE:	Jenkintown Borough		

WE ARE SENDING YOU ☒ Attached ☐ Under separate cover via __________ the following items:
☐ Shop Drawings ☐ Prints ☐ Plans ☐ Samples ☐ Specifications
☐ Copy of Letter ☐ Change Order ☐ __________

LIST OF ITEMS TRANSMITTED

COPIES	DATE	NO:	DESCRIPTION
1			Stormwater Data for Act 167 of the Tookany Creek

THESE ARE TRANSMITTED as checked below:

☐ For approval ☐ Approved as submitted ☐ Resubmit _____ copies for approval
☒ For your use ☐ Approved as noted ☐ Submit _____ copies for distribution
☐ As requested ☐ Returned for corrections ☐ Return _____ corrected prints
☐ For review and comment ☐ __________
☐ FOR BIDS DUE __________ ☐ PRINTS RETURNED AFTER LOAN TO US

REMARKS Please find the enlcosed information as requested in your email on Monday, February 19th. Please let us know if you have any questions.

Greta Martin Washington
Project Engineer

COPY TO __________

SIGNED: C Martin for Greta Martin Washington

If enclosures are not as noted, kindly notify us at once.

BORTON LAWSON
SRB
PAD
MJW
ADMIN
LJS
WSB
FEB 21 2007
☐ CORRESPONDENCE
☐ AGREEMENTS
☐ CONSULTANTS
PROJECT NO.

Steph Demko

TR501 10/2005

STORMWATER DATA

FOR

ACT 167 STUDY

OF THE

TOOKANY CREEK

BOROUGH OF JENKINTOWN, MONTGOMERY COUNTY

PENNONI ASSOCIATES INC.
2005 S. EASTON ROAD, SUITE 100
DOYLESTOWN, PA 18901
(215) 345-4591

FORM A - STORM WATER PROBLEM AREAS SHEET ________ OF ________

WATERSHED	FORM COMPLETED BY	Before Filling Out Form, See Instructions On Back
Name: Tookany	Name: Pennoni	
Municipality: JENKINTOWN	Telephone: 215-345-4591	For County Use:
County: MONTGOMERY	Date: MAY 2006	

MAP NO. *	A-1	A-2	A-3	A-4	A-5	A-	A-	A-	A-	A-	A-	A-
Types of Storm Water Problems												
Flooding	X	X	X	X	X							
Accelerated Erosion												
Sedimentation												
Landslide												
Groundwater												
Water Pollution												
Other (Explain)												
Explanation Line No. (On Back)												
Cause (s)												
Storm Water Volume	X	X	X	X	X							
Storm Water Velocity												
Storm Water Direction		X	X	X	X							
Water Obstruction	X											
Other (Explain)												
Explanation Line No. (On Back)												
Frequency												
Year Most Recent Occurred	2005											
Year First Known Occurred	1960	1920	1920	1920	?							
Regularity												
More Than 1 Year												
Less Than 1 Year	X	X	X	X	X							
Only During Agnes												
Duration (If Applicable)												
Less Than 1 Day	X	X	X	X	X							
1 Day + (Enter Days)												
Property Damage												
Loss of Life/Vital Services												
Private	X											
More Than One Owner	X											
Types of Properties												
Number of Properties												
Public (List Types)	X	X	X	X	X							
Explanation Line No. (On Back)												
Solutions												
Suggested												
Explanation Line No. (On Back)												
Formally Proposed												
Explanation Line No. (On Back)												

STREET FLOODING

* Include Map ID No. if found on any other form listing proposed facilities.

Collapsed PIPE which traverses private property. PIPE Runs under Existing Dwellings.

FORM C - EXISTING FLOOD CONTROL PROJECT

SHEET ________ OF ________

WATERSHED	FORM COMPLETED BY	TYPICAL TYPES OF FLOOD CONTROL PROJECTS
Name: TOOKANY Municipality: JENKINTOWN County: MONTGOMERY	Name: Pennoni Telephone: 215.345.4591 Date: MAY 2006	Channel Excavation / Widening Channel Realignment Rock Riprap Levee Gabions Pipe Channel Dams Floodwall Concrete Lining

For County Use:

Map ID No.	Type of Flood Control Project	Year Constr Built	Expected Life Yrs.	Design Flood Frequency Yrs.	Design Flood Discharge C.F.S.	Owner Name, Address, and Phone
C-	NO EXISTING		FLOOD	CONTROL		PROJECTS
C-						
C-						
C-						
C-						
C-						
C-						

FORM D - PROPOSED FLOOD CONTROL PROJECT

SHEET ________ OF ________

WATERSHED	FORM COMPLETED BY	TYPICAL TYPES OF FLOOD CONTROL PROJECTS
Name: Tookany Municipality: JENKINTOWN PA County: MONTGOMERY	Name: Pennoni Telephone: 215 · 345 · 4591 Date: MAY 2006	Channel Excavation / Widening, Channel Realignment, Rock Riprap Levee, Gabions, Pipe Channel Dams, Floodwall, Concrete Lining
For County Use:		

Map ID No.	Type of Flood Control Project	Study Phase Begun YES Prelim.	Study Phase Begun YES Final	Study Phase Begun NO	Year Constr. Planned	Projected Complt n. Date	Expected Life Yrs.	Design Flood Frequency Yrs.	Design Flood Discharge C.F.S.	Map ID No. Form A*	Owner Name, Address, and Phone
D-	NO PROPOSED FLOOD CONTROL PROJECTS										
D-											
D-											
D-											
D-											
D-											
D-											

* Enter the storm water problem area's Map ID No., if the proposed project will solve or reduce any / all of an identified drainage problem.

FORM E - EXISTING STORM WATER CONTROL FACILITIES

SHEET ________ OF ________

WATERSHED

Name: Tookany
Municipality: JENKINTOWN
County: MONTGOMERY

FORM COMPLETED BY

Name: Pennoni
Telephone: 215 . 345 . 4591
Date: MAY 2006

Definition of Storm Water Control Facility
A natural / man-made device or structure specifically designed and / or utilized to reduce the rate and / or volume of storm water runoff from a site or sites.

For County Use:

Map ID No.	Type of Storm Water Control Facility	Year Built	Contact Person	Address and Phone	Comments
E- 1	UNDERGROUND			WEST AVE.	
E- 2	UNDERGROUND	2000		435 Johnson St.	PRIVATE
E- 3	UNDERGROUND	2006		SUMMIT & WILLOW	PRIVATE OLD A CLEANERS BLDG
E- 4	DRY WELL STONE CISTERN	1900+/-		YORK Rd	COVERED
E-					
E-					
E-					
E-					
E-					
E-					
E-					
E-					
E-					
E-					
E-					
E-					
E-					
E-					
E-					
E-					
E-					
E-					

TYPICAL TYPES OF STORM WATER CONTROL FACILITIES

- Detention / Retention Basin
- Natural Pond or Wetland
- Parking Lot Pondling
- Roof-Top Storage
- Semi-Pervious Paving
- Infiltration Device (Seepage /Recharge Basin or Underground Tank)

FORM F - PROPOSED STORM WATER CONTROL FACILITIES

SHEET ________ OF ________

WATERSHED	FORM COMPLETED BY	DEFINITION
Name: Tookany Municipality: JENKINTOWN County: MONTGOMERY	Name: Pennoni Telephone: 215 · 345 · 4591 Date: MAY 2006	Storm Water Control Facility A natural / man-made device or structure specifically designed and / or utilized to reduce the rate and / or volume of storm water runoff from a site or sites.

For County Use:

Map ID No.	Type of Storm Water Control Facility	Proposed Constr. Dates Start	Proposed Constr. Dates End	Map No. Form A*	Contact Person Name, Address and Phone	Comments
F- 1	BASIN	N/A	N/A		JENKINTOWN HIGHSCHOOL	IN MASTERPLAN
F-						
F-						
F-						
F-						
F-						
F-						
F-						
F-						
F-						
F-						

* Enter the storm water problem area's Map ID No., if the proposed project will solve or reduce any / all of an identified drainage problem.

TYPICAL TYPES OF STORM WATER CONTROL FACILITIES

Detention / Retention Basin
Natural Pond or Wetland
Parking Lot Pondling

Roof-Top Storage
Semi-Pervious Paving
Infiltration Device (Seepage / Recharge Basin or Underground Tank)

FORM G - EXISTING STORM WATER COLLECTION SYSTEMS

SHEET ________ OF ________

WATERSHED

Name: TOOKANY
Municipality: JENKINTOWN
County: MONTGOMERY

FORM COMPLETED BY

Name: Pennoni
Telephone: 215.345.4591
Date: MAY 2006

INSTRUCTIONS

Diagram each system on the appropriate map. Establish map points to show changes in system elements, pipe size, or pipe direction. (If unknown, outline the system extent.) Complete this form only where specific information on construction is available. Use a separate form for each system. Identify the points within a system consecutively (ex. G-1,G-2,G-3). Start the first point in each additional system 20 numbers higher. For example, G-3 ends one system, so G-23 begins the next. See Sample Diagrams & Form on Reverse.

Map I.D. No.		System's Elements (x)			Measurements *				Material	Year Constr.	Design Data Available	Contact Person Name and Phone	Name of Final Ownership and Maintenance Responsibility
					Pipe	Channel / Swale							
From	To	Pipe	Open Channel	Swale	D	TW	B	Depth					
G-	G-												
G-	G-	See	MAP	& ATTAChed		CD.							
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												
G-	G-												

* See measurement key on reverse side.

FORM H - PROPOSED STORM WATER COLLECTION SYSTEMS

SHEET ______ OF ______

WATERSHED

Name: Tookany
Municipality: JENKINTOWN
County: MONTGOMERY

FORM COMPLETED BY

Name: Pennoni
Telephone: 215.345.4591
Date: MAY 2006

INSTRUCTIONS

On the map for proposed storm water collection systems, diagram each proposed system. Indicate a map point to show changes in system elements, pipe size, pipe direction and connections to existing systems. For proposed additions to existing systems, diagram only the additions and their connection point into the existing system. Complete a separate form for each proposed, new system and one for each existing system having one or more proposed additions. Identify the points within a system consecutively (ex. H-1, H-2, H-3). Start the first point in each additional system 20 numbers higher (if H-3 ends one system, begin the next with H-23). Be sure to show the point where proposed additions connect into existing systems, using the map point number from the existing system form and map. See Sample Diagrams and Form on Reverse.

Map I.D. No.		System's Elements (x)			Measurements *				Material	Map I.D. Nos.**	Proposed Const. Dates		Design Data	Contact Person	Name of Final
					Pipe	Open Channel / Swale								Name and	Ownership and
From	To	Pipe	Open Channel	Swale	D	TW	B	Depth		Form A	Start	End	Avail.	Phone	Maintenance Responsibility
H-	H-														
H-	H-	AS REQUIRED, IN ACCORDANCE W/ JENKINTOWN REDEVELOPMENT PLAN													
H-	H-														
H-	H-			(SEE ATTACHED).											
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														
H-	H-														

* See measurement key on reverse side. ** Enter the storm water problem areas' Map I.D. Nos., if proposed project will solve or reduce any / all of the drainage problems.

Jenkintown Redevelopment Plan

Exhibit B

LEGEND

REDEVELOPMENT AREA

BOROUGH LIMITS

ZONING DISTRICTS ##

ONE WAY STREET

Kise Straw & Kolodner

0 300 600

FORM I - PRESENT & PROJECTED DEVELOPMENT IN THE FLOOD HAZARD AREA

SHEET ________ OF ________

WATERSHED	FORM COMPLETED BY	DEFINITION
Name: Tookany Municipality: JENKINTOWN County: MONTGOMERY	Name: Pennoni Telephone: 215.345.4591 Date: MAY 2006	FLOOD HAZARD AREA: A NORMALLY DRY LAND AREA THAT HAS BEEN OR IS SUSCEPTABLE TO BEING INUNDATED BY THE 100-YEAR FLOOD.

For County Use:

Map ID No.	TYPE OF DEVELOPMENT	Year Built	Contact Person Name, Address and Phone	Comments
I - 1	Train STATION			STATION Parking Floods, FF ~~Parking~~ DOES NOT; Check valve WAS ADDED TO Discharge PIPE TO CONTROL INFLOW INTO BASEMENT.
I -				
I -				
I -				
I -				
I -				
I -				
I -				
I -				

APPENDIX D

INFILL - REDEVELOPMENT CRITERIA

APPENDIX D

INFILL - REDEVELOPMENT CRITERIA

Table of Contents

I. INTRODUCTION

The following is an investigation into methods employed by various municipalities across the nation to address the issue of stormwater management in areas of redevelopment or infill. Ordinances were reviewed from the states of Maryland and Georgia as well as ordinances from the cities of Seattle, WA and Portland, OR and the Chester Creek Watershed in Delaware County, PA. These ordinances were reviewed to determine if there is a consensus on how stormwater runoff from redeveloping areas should be addressed from a water quantity and quality perspective.

II. SUMMARY

The five ordinances reviewed varied significantly in the way stormwater issues were addressed. A brief summary of the stormwater quantity and quality criteria from each ordinance is included in the paragraphs below.

1. Maryland

Runoff Quantity Controls

There are no specific criteria to be met within the ordinance to address recharge, channel protection storage volumes or overbank flood protection volumes unless specified by the approving agency.

Runoff Quality Controls

In areas of redevelopment, there are three options to address stormwater runoff quality:

a. Reduce existing site impervious areas by 20%

b. If site conditions prevent a reduction in impervious areas, provide water quality control for at least 20% of the sites impervious area.

c. A combination of 1 & 2 can be employed for impervious reductions between 0% and 20%. The combination of impervious area reduction and area control by a stormwater management practice must equal or exceed 20%.

Notes: No explanation is provided as to where the 20% impervious area reduction was determined.

2. City of Seattle, WA

Runoff Quantity Controls

For redevelopment sites less than 9,000 sq. feet, the peak discharge rate from pervious and impervious surfaces shall not exceed 0.2 cfs per acre under the 25-year design storm. For redevelopment sites greater than 9,000 sq. feet, the peak discharge rate from pervious and impervious surface shall not exceed 0.15 cfs per acres under the 2-year design storm AND shall not exceed 0.2 cfs per acre under the 25-year design storm.

Runoff Quality Controls

No specific criteria is sited for runoff quality control, however is required to "control the sources of sediment and other contaminants and pollutants that could enter drainage water" by use of temporary and permanent best management practices.

Notes: No explanation is provided as to where the 9,000 sq. foot area limit was determined, or where peak allowable flow rates were developed.

3. City of Portland, OR

Runoff Quantity Controls

Control of on site flows to maintain peak flows at the predevelopment (defined as a site's ground cover prior to development, "i.e. Lewis & Clark days") for the 2-, 5-, and 10-year storm events.

Runoff Quality Controls

Criteria requires a 70% reduction of TSS from runoff generated by a design storm up to and including 0.83 inches of rainfall over a 24-hour period.

4. Georgia

Minimum standards for redevelopment sites are same as standards for new development, as follows:

Runoff Quantity Controls

24-hour extended detention of the 1-year, 24-hour storm event; post-development to predevelopment rate control for the 25-year, 24-hour storm event.

Runoff Quality Controls

Stormwater management systems must be designed to remove 80% of the average post-development TSS load. If facility is designed to capture and treat the water quality volume (defined as the first 1.2 inches of rainfall from a site), the facility is considered adequate.
Notes

"Predevelopment conditions" is not defined in the case of redevelopment, therefore it could not be determined if existing impervious areas are included in the runoff calculations.

5. Chester Creek

Runoff Quantity Controls

Runoff quantity control is accomplished by determining the predevelopment RCN value or Rational "C" value from a provided chart to reflect existing conditions less restrictive than "meadow on B class soils” (Chester Creek soils are primarily HSG ‘B’) based on the percentage of exiting impervious cover. Post-development runoff must then meet predevelopment rates based upon the given release rate criteria for the site.

Runoff Quality Controls

Water quality must be addressed using the following:

a. Infiltration
b. Extended detention
c. Implementation of additional design control

Riparian buffers are required where applicable (404.A.2).

Notes: Chart developed for “Adjusted” RCN or C values is based on the composite value of the impervious and pervious sections as follows:

for RCN Method: %imperv * 98 + %perv * 58 (meadow “B” soils)
for Rational Method: %imperv * 0.95 + %perv * 0.12 (Lawn, sandy soil, avg slope)

III. CONCLUSIONS

An ordinance which addresses development in an area where redevelopment is encouraged should provide the developer with some credit to consider on site exiting impervious conditions when determining the amount of stormwater runoff which should be stored or treated. If no credit is given, and the developer must design to meet pre-existing (i.e. no impervious cover) rates, the standards may discourage the use of redevelopment sites. However, this must be balanced with the desire to improve existing conditions as it relates to improving water quality and reducing potential flood damages to downstream areas.

Of the five ordinances reviewed, the Portland, OR criteria appears to present the most stringent standards to meet by requiring onsite flows for redevelopment sites to be limited to pre-existing (i.e. undeveloped) rates and no credit is given for existing on site impervious cover. The Seattle, WA criteria specifies target flow values which are site independent and again do not consider existing impervious cover. Both of these ordinances are considered to be strict criteria which may discourage redevelopment projects in areas where the developer has an option to use undeveloped sites. In areas where there are little undeveloped available lands and development pressures are high, these ordinances may be considered to reduce downstream flooding and water quality impacts.

Of the remaining ordinances, Georgia, Maryland & Chester Creek, the Georgia and Maryland criteria were not specific enough to determine if existing impervious cover was considered to be part of the predevelopment conditions. However, the Chester Creek ordinance clearly considers existing impervious cover in the determination of predevelopment conditions. The charts developed for the Chester Creek ordinance are based upon assuming that the predevelopment site is underlain by “B” soils, which is somewhat conservative when determining the storage / treatment volumes for post-development runoff, if the site were actually underlain by a “C” or “D” soil. The Chester Creek ordinance also requires that water quality issues be addressed in the form of TSS reductions and groundwater recharge. The approach of this ordinance is more suitable for areas where developer have the option of choosing undeveloped sites for development, rather than redevelopment sites. The water quantity criteria coupled with then currently promoted water quality criteria should both encourage redevelopment projects while improving existing water quality concerns and flooding concerns, to a lesser degree. In areas where downstream flooding is a current problem, additional credits (i.e. exemption from water quantity criteria as in the MD ordinance) may be given to the developer is a reduction in total impervious area can be attained.

APPENDIX

1. Maryland

A. Definition

"Redevelopment" means any construction, alteration, or improvement exceeding 5,000 square feet of land disturbance performed on sites where existing land use is commercial, industrial, institutional, or multifamily residential.

B. When Stormwater Management Is Required

Redevelopment

1. An approving agency shall require that stormwater management be addressed for redevelopment. Proposed redevelopment project designs shall include:
   a. A reduction in impervious area;
   b. The implementation of stormwater management practices; or
   c. A combination of both §D (1) (a) and (b) of this regulation to result in an improvement to water quality.

2. Unless otherwise specified by watershed management plans developed according to §E of this regulation, all redevelopment projects shall reduce existing site impervious area by at least 20 percent.

3. Where site conditions prevent the reduction of impervious area, stormwater management practices shall be implemented to provide water quality control for at least 20 percent of the site's impervious area.

4. When a combination of impervious area reduction and stormwater management practice implementation is used for redevelopment projects, the combination of impervious area reduction and the area controlled by a stormwater management practice shall equal or exceed 20 percent.

5. An approval authority may allow practical alternatives where conditions prevent impervious area reduction or on-site stormwater management. Practical alternatives include, but are not limited to:
   a. Fees paid in an amount specified by the approving agency;
   b. Off-site BMP implementation for a drainage area comparable in size and percent imperviousness to that of the project;
   c. Watershed or stream restoration;
   d. Retrofitting; or
   e. Other practices approved by the appropriate authority.

6. The recharge, channel protection storage volume, and overbank flood protection volume requirements specified in the Design Manual do not apply to redevelopment projects unless specified by the approving agency.

7. On-site or off-site channel protection storage volume requirements as specified in the Design Manual may be imposed if watershed management plans developed according to §E of this regulation indicate that downstream flooding or erosion need to be addressed.

8. Variations of this redevelopment policy shall be approved by the Administration.

C. Redevelopment Provisions That Different From Requirement

An approving agency may develop quantitative waiver and redevelopment provisions for stormwater management that differ from the requirements of this chapter. These provisions shall be developed only as part of an overall watershed management plan. Watershed management plans developed for the purposes of implementing different stormwater management policies for waivers and redevelopment shall:

1. Include detailed hydrologic and hydraulic analyses to determine hydrograph timing;
2. Evaluate both quantity and quality management;
3. Include cumulative impact assessment of watershed development;
4. Identify existing flooding and receiving stream channel conditions;
5. Be conducted at a scale determined by the approving agency; and
6. Specify where on-site or off-site quantitative and qualitative stormwater management practices are to be implemented.

D. References

Title 26 DEPARTMENT OF THE ENVIRONMENT. Subtitle 17 WATER MANAGEMENT. Chapter 02 Stormwater Management. Authority: Environment Article, §4-203, Annotated Code of Maryland. 26.17.02.00.

E. URLs

https://constmail.gov.state.md.us/comar/dsd_web/comar_web/subtitle_chapters/26_Chapters.htm#Subtitle17

2. City of Seattle

A. Definition

All land disturbing activities or addition or replacement of impervious surface are required to comply with this section, even where drainage control review is not required. Exception: Maintenance, repair, or installation of underground or overhead utility facilities, such as, but not limited to, pipes, conduits and vaults, is not required to comply with the provisions of this section.

"Replaced impervious surface" or "replacement of impervious surface" means impervious surface that is removed down to earth material and a new impervious surface is installed.

"New development" means any of the following activities: Structural development, including construction of a new building or other structure; Expansion or alteration of an existing structure that results in an increase in the footprint of the building or structure; Land disturbing activities; Creation or expansion of impervious surface; Demolition; Subdivision and short subdivision of land as defined in RCW58.17.020.

B. When Compliance Is Required

<u>Redevelopment</u>

The portion of the site being redeveloped shall at least comply with the minimum requirements below. Projects exceeding 9,000 square feet of developmental coverage must also comply with the additional requirements. Compliance is required regardless of the type of redevelopment, and regardless of whether or not a permit is required. However, only those projects meeting the review thresholds set forth in Subsection B below must prepare and submit the required plans.

C. Minimum Requirements for All Projects

All projects must comply with the requirements of this subsection. Projects with <u>more than 9,000 square feet</u> of developmental coverage shall also comply with the requirements of additional requirement for larger project below. The Director of Construction and Land Use may also require projects with 9,000 square feet or less of developmental coverage to comply with the requirements set forth in additional requirement for larger project when necessary to accomplish the purposes of this Subtitle. In making this determination, the Director of Construction and Land Use may consider, but not be limited to, the following attributes of the site: location within an Environmentally Critical Area; proximity and tributary to an Environmentally Critical Area; proximity and tributary to an area with known erosion or flooding problems.

1. Discharge Point: The discharge point for drainage water from each site shall be selected as set forth in rules promulgated jointly by the Director of Seattle Public Utilities and the Director of Construction and Land specifying criteria, guidelines and standards for determining drainage discharge points to meet the purposes of this Subtitle. The criteria shall include, but not be limited to, preservation of natural drainage patterns and whether the capacity of the drainage control system is adequate

for the additional volume. For those projects meeting the review threshold, the proposed discharge point shall be identified in the drainage control plan required by paragraph C4 below, for review and approval or disapproval by the Director of Construction and Land Use.

2. Discharge Rate. To the extent practical, the peak drainage water discharge rate from pervious and impervious surfaces on the site shall not exceed 0.2 cubic feet per second per acre under design storm conditions. The Director of Construction and Land Use and the Director of Seattle Public Utilities may jointly promulgate rules modifying the discharge rate requirement for projects which will result in less than 2,000 square feet of new impervious surface. The Director of Construction and Land Use and the Director of Seattle Public Utilities may jointly promulgate rules allowing exceptions to the permissible peak discharge rate for property which discharges water directly to a designated receiving water or directly to a public storm drain which the Director of Seattle Public Utilities determines has sufficient capacity to carry existing and anticipated loads from the point of connection to a receiving water. The design storm used to determine detention volume necessary to obtain the required discharge rate shall be a storm with a statistical probability of occurrence of one in 25 in any given year. If the project is within an environmentally critical area, the design storm requirements of SMC Chapter 25.09, Regulations for Environmentally Critical Areas, shall be applied. The Director of Seattle Public Utilities and the Director of Construction and Land Use shall jointly adopt rules specifying the methods of calculation to determine the discharge rate. Where laws or regulations of the federal government or the State of Washington impose a more stringent requirement, the more stringent requirement shall apply.

3. Control Measures. During new development, redevelopment and land-disturbing activities, best management practices, as further specific din rules promulgated jointly by the Director of Seattle Public Utilities and the Director of Construction and Land Use, shall be used to accomplish the following:

   a. Control erosion and the transport of sediment from the site through measures such as mulching, matting, covering, silt fences, sediment traps and catch basins, settling ponds and protective berms;

   b. Permanently stabilize exposed soils that are not being actively worked, through such methods as the installation of permanent vegetative cover and installation of slope protective materials; and

   c. Control the introduction of contaminants and pollutants into, and reduce and treat contaminants in drainage water, drainage control facilities, surface water and groundwater, and the public drainage control system by methods such as covering of material stockpiles; proper disposal of hazardous materials; regular cleaning of catch basins, gravel truck loading and heavy equipment areas; spill control for fueling operations; sweeping; and maintaining erosion control protective features described above.

4. Drainage Control Plan. For those projects meeting the review thresholds set forth in Subsection B above and which are less than 9,000 square feet, the applicant shall submit a drainage control plan as set forth in rules promulgated jointly by the Director of Seattle Public Utilities and the Director of Construction and Land Use. Standard designs for drainage control facilities as set forth in the rules may be used. Projects exceeding 9,000 square feet must submit a comprehensive drainage control plan as set forth in Subsection D below. The Director of Construction and Land Use may impose additional requirements, including a comprehensive drainage control plan prepared by a licensed civil engineer, when the project has complex or unusual drainage, or when additional requirements are otherwise necessary to accomplish the purposes of this Subtitle.

5. Memorandum of Drainage Control. The owner(s) of the site shall sign a "memorandum of drainage control" that has been prepared by the Director of Seattle Public Utilities. Completion of the memorandum shall be a condition precedent to issuance of any permit or approval for which a drainage control plan is required. The memorandum shall not be required when the drainage control facility will be owned and operated by the City. A memorandum of drainage control shall include:

   a. The legal description of the site;

   b. A summary of the terms of the drainage control plan, including any known limitations of the drainage control facilities, and an agreement by the owners to implement those terms;

   c. An agreement that the owner(s) shall inform future purchasers and other successors and assignees of the existence of the drainage control facilities and other elements of the drainage control plan, the limitations of the drainage control facilities, and of the requirements for continued inspection and maintenance of the drainage control facilities;

   d. The side sewer permit number and the date and name of the permit or approval for which the drainage control plan is required;

   e. Permission for the City to enter the property for inspection, monitoring, correction, and abatement purposes;

   f. An acknowledgment by the owner(s) that the City is not responsible for the adequacy or performance of the drainage control plan, and a waiver of any and all claims against the City for any harm, loss, or damage related to the plan, or to drainage or erosion on the property, except for claims arising from the City's sole negligence; and

   g. The owner(s)' signatures acknowledged by a notary public. The applicant shall file the memorandum of drainage control with the King County

Department of Records and Elections so as to become part of the King County real property records. The applicant shall give the Director of Seattle Public Utilities proof of filing of the memorandum.

6. Flood-Prone Areas. Sites within flood prone areas must employ measures to minimize the potential for flooding on the site and for the project to increase the risk of floods on adjacent or nearby properties. Flood control measures shall include those set forth in other titles of the Seattle Municipal Code and rules promulgated there under, including but not limited to, SMC Chapter 25.06 (Floodplain Development) and Chapter 25.09 (Environmentally Critical Areas), and in rules promulgated jointly by the Director of Seattle Public Utilities and the Director of Construction and Land Use to meet the purposes of this subsection.

7. Natural Drainage Patterns. Natural drainage patterns shall be maintained.

8. Obstruction of Watercourses. Watercourses shall not be obstructed.

D. Additional Requirements for Large Projects

All projects exceeding 9,000 square feet of developmental coverage and those small projects identified by the Director according to subsection C above must comply with the requirements set forth in this subsection. These requirements are in addition to the requirements set forth in Subsection C above. When the Directors develop rules prescribing best management practices for particular purposes, whether or not those rules are adopted by ordinance, BMPs prescribed in the rules shall be the BMPs required for compliance with this Subsection. Best management practices shall include, but not be limited to: maintenance and housekeeping practices such as proper storage of oil barrels and other contaminant sources, covering material stockpiles, proper use and storage of hazardous materials, as well as constructed facilities such as detention tanks, wet ponds, extended detention dry ponds, infiltration, vegetated streambank stabilization, structural stabilization, catch basins, oil/water separators, grassed swales, and constructed wetlands.

1. In addition to detaining a 25-year storm to a release rate of 0.2 cubic feet per second per acre, the peak drainage water discharge rate from projects of more than 9,000 square feet of developmental coverage shall not exceed 0.15 cubic feet per second per acre in a two-year storm;

2. Control the sources of sediment and other contaminants and pollutants that could enter drainage water, including the selection, design and maintenance of temporary and permanent best management practices;

3. Minimize streambank erosion and effects on water quality in streams, including the selection, design and maintenance of temporary and permanent best management practices, where stormwater is discharged directly to a stream or to a conveyance system that discharges to a stream;

4. Minimize the introduction of sediment, heat and other pollutants and contaminants into wetlands, including the selection, design and maintenance of temporary and permanent best management practices, where stormwater discharges directly to a wetland or to a conveyance system that discharges into a wetland;

5. Analyze impacts to off-site water quality resulting from the project. The analysis shall comply with this Subsection and rules promulgated pursuant to this Subsection. The analysis shall provide for mitigation of all surface water quality or sediment quality impacts. The impacts to be evaluated and mitigated shall include at least the following:

   a. Amount of sedimentation;
   b. Streambank erosion;
   c. Discharges to groundwater contributing to recharge zones;
   d. Violations of state or federal surface water, groundwater, or sediment quality standards; and
   e. Spills and other accidental illicit discharges;

6. A schedule shall be provided for inspection and maintenance of proposed temporary and permanent drainage control facilities and other best management practices. The schedule shall meet the requirements of this Subtitle and rules promulgated under this Subtitle.

7. In addition to the requirements described above, for land- disturbing activities and demolition of structures, an erosion/sediment control plan designed to comply with the requirements and purposes of this Subtitle and rules promulgated hereunder shall be submitted and implemented. The erosion/sediment control plan shall be designed to accomplish the following:

   a. Stabilization of exposed soils and sediment trapping;
   b. Delineation of limits on clearing and easements;
   c. Protection of adjacent property;
   d. Appropriate timing and stabilization of sediment trapping measures;
   e. Minimization of erosion on cut-and-fill slopes;
   f. Control of off-site erosion;
   g. Stabilization of temporary conveyance channels and outlets;
   h. Protection of storm drain inlets;
   i. Minimization of transport of sediment by construction vehicles;
   j. Appropriate timing for removal of temporary best management practices;
   k. Control of discharges from construction site dewatering devices to minimize contamination of drainage water; and
   l. Inspection and maintenance of best management practices for erosion/sediment control to insure functioning at design capacity.

8. Comprehensive Drainage Control Plan. A comprehensive drainage control plan to comply with the requirements of this Subtitle and rules promulgated hereunder and to

accomplish the purposes of this Subtitle shall be submitted with the permit application. It shall be prepared by a licensed civil engineer in accordance with standards adopted by the Director of Construction and Land Use.

E. References

Seattle Municipal Code (SMC) SMC 22.800.010- Stormwater, Grading and Drainage Control Code

An ordinance Relating to the Stormwater, Grading, and Drainage Control Code, as adopted by Ordinance 116425 and amended by Ordinances 117432, 117697, 117789, and 118396; amending Chapter 22.800, entitled "Title, Purpose, Scope, and Authority"; amending Chapter 22.801, entitled "Definitions"; amending Chapter 22.802, entitled "Stormwater, Drainage, and Erosion Control"; amending Chapter 22.804, entitled "Grading"; and amending Chapter 22.808, entitled "Administration and Enforcement."

F. URLs

http://clerk.ci.seattle.wa.us/~scripts/nph-brs.exe?s1=22.800&s2=&S3=&Sect4=AND&l=20&Sect1=IMAGE&Sect3=PLURON&Sect5=CODE1&d=CODE&p=1&u=/~public/code1.htm&r=1&Sect6=HITOFF&f=G

http://clerk.ci.seattle.wa.us/~scripts/nph-brs.exe?d=CBOR&s1=119965.ordn.&Sect6=HITOFF&l=20&p=1&u=/~public/cbor2.htm&r=1&f=G

3. City of Portland

G. Definition

Redevelopment: Any development that requires demolition or complete removal of existing structures or impervious surfaces at a site and replacement with new impervious surfaces. Maintenance activities such as top-layer grinding and re-paving are not considered to be redevelopment. Interior remodeling projects and tenant improvements are also not considered to be redevelopment. Utility trenches in streets are not considered redevelopment unless more than 50% of the street width is removed and re-paved.

H. Requirements

Pollution Reduction Requirements

The City of Portland has a citywide pollution reduction requirement for all new development projects with over 500 square feet of impervious development footprint area, and all redevelopment projects redeveloping over 500 square feet of impervious surface. This requirement is 70 percent removal of total suspended solids (TSS) from runoff generated by a design storm up to and including 0.83 inches of rainfall over a 24-hour period (NRCS Type 1A distribution). Appendix B provides a more detailed definition of "70 percent removal of TSS", which is actually a function of influent TSS concentration.

Flow Control Requirements

Flow control requirements are intended to maintain post-development peak flows at their predevelopment levels and to maintain peak flows within the capacity of the conveyance system for most storm events. Specifically, on-site flow control shall be sufficient to maintain peak flows at their predevelopment levels for the 2-year, 5-year, and 10-year runoff events. (Note that for redevelopment projects, predevelopment conditions are defined as undeveloped land- See definition in Section 1.3). Surface retention facilities are required to the maximum extent practicable to control stormwater volumes (see exceptions in Section 1.6).

I. Parking Lots

Surface Parking Lot Requirements

Parking and Loading describes dimensions, landscaping and other requirements for parking lots. Title 33.248: Landscaping and Screening describes planting requirements for parking lots and other site uses. (Also see Chapter 5.0 for a list of approved parking lot trees.) Any new parking lot that creates more than 500 square feet of impervious surface, or any redeveloped parking lot (see definition of redevelopment in Section 1.3) that redevelops more than 500 square feet of impervious surface, must use the landscape area required by the zoning code to manage stormwater from the new or redeveloped area. Existing parking lots required to meet the non-conforming use landscaping requirements under Title 33.258.070, must use simplified approaches where practicable in the newly required landscaped areas. Where it is not practical for runoff to flow into landscaped areas this requirement does not apply. The following exceptions and/or conditions to these requirements may apply. If an exception is claimed, the applicant must still fulfill all other relevant requirements of Chapters 1.0 through 7.0 of this manual.

1. The parking lot or a portion of it is designated as a high-use (see Chapter 4.0, Section 4.11) and is subject to requirements that may conflict with the use of landscaping for stormwater management.

2. Contaminated soil conditions on the site preclude the use of landscape infiltration. In this situation, landscape facilities may be used for stormwater management, but must be lined to prevent infiltration.

3. The parking lot has been approved without landscaping, or has landscaping conditions that conflict with the use of the landscaping for stormwater management. (For example, if landscaping is required in a location that cannot receive stormwater as gravity flow, that portion of the landscaping would not have to be used for stormwater management.) The following simplified approaches from this chapter may be used to meet these requirements:

    a. Vegetated swales
    b. Grassy swales
    c. Vegetated filters
    d. Planter boxes
    e. Vegetated infiltration basins
    f. Sand filters
    g. Soakage trenches (if site soil conditions support their use, and the surface of the trench is not paved over). The appropriate sizing requirements shown on Form SIM shall be used to calculate the area needed for the applied measures. If the landscaped area(s) within the parking lot are not adequately sized to meet the requirements of this chapter, the applicant has the following options:
        i. Increase the landscaped area(s) within the parking lot to accommodate the required stormwater facility size, or
        ii. Use additional stormwater management facilities (which can include non-landscaped approaches) to obtain the required level of management.
    h. Additional disposal measures (e.g., drywells, soakage trenches, off-site storm sewers, drainage ways, or ditches) may be required through building and plumbing codes, as approved by BES and OPDR.

<u>Tips for Parking Lot Design</u>

1. Design the grading to direct stormwater runoff into landscape areas. Depress the landscape areas adjacent to the parking surfaces to allow runoff to enter. See the vegetated swale detail in this chapter for a typical cross-section.

2. Maximize sheet flow opportunities and, if possible, avoid piping that drives the water level down, making it difficult to manage in surface facilities.

3. Provide numerous curb cuts (one every 10 feet) or use tire stops or other means to protect the landscape areas and allow maximum dispersal of the flows.

4. Consider design elements such as berms or trench drains.

5. When possible, situate buildings or fill areas on the high elevations of the site.

6. Make certain the design includes overflow and appropriate disposal methods. Overflow routes must show a safe escape route for the 100-year storm event.

7. Note that the parking lot tree standard is 3 caliper inches, unless the tree is chosen from the approved parking lot tree list, when it can be 2 caliper inches.

J. References

2002 Stormwater Management Manual, Adopted July 1, 1999, Revised September 1, 2002, Environmental Services, City of Portland Clean River Works.

K. URLs

http://www.cleanrivers-pdx.org/tech_resources/2002_swmm.htm

4. Georgia

A. Definitions

Redevelopment is defined as structural development (construction, installation or expansion of a building or other structure), creation or addition of impervious surfaces (creating an additional 5,000 s.f. of impervious area), replacement of impervious surface not part of routine maintenance, and land disturbing activities associated with structural or impervious development. Redevelopment does not include such activities as exterior remodeling.

B. Stormwater Management for Area of New Development and Redevelopment

The focus of this Manual is how to effectively deal with the impacts of urban stormwater runoff through effective and comprehensive stormwater management. Stormwater management involves both the prevention and mitigation of stormwater runoff quantity and quality impacts as described in this chapter through a variety of methods and mechanisms. Volume 2 of this Manual deals with ways that developers in Georgia can effectively implement stormwater management to address the impacts of new development and redevelopment, and both prevent and mitigate problems associated with stormwater runoff. This is accomplished by:

1. Developing land in a way that minimizes its impact on a watershed, and reduces both the amount of runoff and pollutants generated

2. Using the most current and effective erosion and sedimentation control practices during the construction phase of development

3. Controlling stormwater runoff peaks, volumes and velocities to prevent both downstream flooding and streambank channel erosion

4. Treating post-construction stormwater runoff before it is discharged to a waterway Implementing pollution prevention practices to prevent stormwater from becoming contaminated in the first place

5. Using various techniques to maintain groundwater recharge

The goal of a set of minimum stormwater management standards for areas of new development and significant redevelopment is to reduce the impact of post-construction stormwater runoff on the watershed. This can be achieved by (1) maximizing the use of site design and nonstructural methods to reduce the generation of runoff and pollutants; (2) managing and treating stormwater runoff though the use of structural stormwater controls; and (3) implementing pollution prevention practices to limit potential stormwater contaminants.

It should be noted that the standards presented here are recommended for all communities in Georgia. They may be adopted by local jurisdictions as stormwater management development requirements and/or may be modified to meet local or watershed-specific stormwater management goals and objectives. Please consult your local review authority for more information.

The minimum standards for development are designed to assist local governments in complying with regulatory and programmatic requirements for various state and Federal programs including the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit program and the National Flood Insurance Program under FEMA.

C. Additional Requirements

New development or redevelopment in critical or sensitive areas, or as identified through a watershed study or plan, may be subject to additional performance and/or regulatory criteria. Furthermore, these sites may need to utilize or restrict certain structural controls in order to protect a special resource or address certain water quality or drainage problems identified for a drainage area.

D. Georgia Stormwater Management Manual Volume 2 (Technical Handbook)

The following standards are the recommended minimum stormwater management performance requirements for new development or redevelopment sites falling under the applicability criteria in subsection 1.2.2.1. (The word "shall" in brackets is provided for local jurisdictions that wish to adopt these standards as part of their stormwater management ordinances.) A more detailed explanation of each minimum standard is provided in the next subsection.

Minimum Standard #1 – Use of Better Site Design Practices for Stormwater Management
Site designs should preserve the natural drainage and treatment systems and reduce the generation of additional stormwater runoff and pollutants to the fullest extent practicable.

Minimum Standard #2 – Stormwater Runoff Quality
All stormwater runoff generated from a site should [shall] be adequately treated before discharge. Stormwater management systems (which can include both structural stormwater controls and better site design practices) should [must] be designed to remove 80% of the average annual post-development total suspended solids (TSS) load and be able to meet any other additional watershed- or site-specific water quality requirements.

It is presumed that a stormwater management system complies with this performance standard if:

It is sized to capture and treat the prescribed water quality treatment volume, which is defined as the runoff volume resulting from the first 1.2 inches of rainfall from a site; and appropriate structural stormwater controls are selected, designed, constructed, and maintained according to the specific criteria in this Manual. Runoff from hotspot land uses and activities is adequately treated and addressed through the use of appropriate structural stormwater controls and pollution prevention practices.

<u>Minimum Standard #3 – Stream Channel Protection</u>

Stream channel protection should [shall] be provided by using all of the following three approaches: 24-hour extended detention storage of the 1-year, 24-hour return frequency storm event; erosion prevention measures such as energy dissipation and velocity control; and preservation of the applicable stream buffer.

Minimum Standard #4 – Overbank Flood Protection

Downstream overbank flood protection should [shall] be provided by controlling the post-development peak discharge rate to the predevelopment rate for the 25-year, 24-hour return frequency storm event. If control of the 1-year, 24-hour storm (Minimum Standard #3) is exempted, then overbank flood protection should [shall] be provided by controlling the post-development peak discharge rate to the predevelopment rate for the 2-year through the 25-year return frequency storm events.

Minimum Standard #5 – Extreme Flood Protection

Extreme flood protection should [shall] be provided by controlling and/or safely conveying the 100-year, 24-hour return frequency storm event such that flooding is not exacerbated. Existing and future floodplain areas should be preserved as possible.

Minimum Standard #6 – Downstream Analysis

A downstream hydrologic analysis should [shall] be performed to determine if there are any additional impacts in terms of peak flow increase or downstream flooding while meeting Minimum Standards #1 through 5. This analysis should [shall] be performed at the outlet(s) of the site, and downstream at each tributary junction to the point(s) in the conveyance system where the area of the portion of the site draining into the system is less than or equal to 10% of the total drainage area above that point.

Minimum Standard #7 – Groundwater Recharge

Annual groundwater recharge rates should be maintained to the extent practicable through the use of nonstructural methods.

Minimum Standard #8 – Construction Erosion and Sedimentation Control

Erosion and sedimentation control practices shall be utilized during the construction phase or during any land disturbing activities.

Minimum Standard #9 – Stormwater Management System Operation and Maintenance

The stormwater management system, including all structural stormwater controls and conveyances, should [shall] have an operation and maintenance plan to ensure that it continues to function as designed.

Minimum Standard #10 – Pollution Prevention

To the maximum extent practicable, the development project should [shall] implement pollutant prevention practices and have a stormwater pollution prevention plan.

Minimum Standard #11 – Stormwater Management Site Plan

The development project should [shall] prepare a stormwater management site plan for local government review that addresses Minimum Standards #1 through 10.

E. Better Site Design Practice

Reduce the Parking Footprint- Reduction of Impervious Cover

Description: Reduce the overall imperviousness associated with parking lots by providing compact car spaces, minimizing stall dimensions, incorporating efficient parking lanes, parking decks, and using porous paver surfaces or porous concrete in overflow parking areas where feasible and possible.

Key Benefits
Reduces the amount of impervious cover and associated runoff and pollutants generated

Using this practice
Reduce the number of parking spaces
Minimize stall dimensions
Consider parking structures and shared parking
Use alternative porous surface for overflow areas

Discussion
Setting maximums for parking spaces, minimizing stall dimensions, using structured parking, encouraging shared parking and using alternative porous surfaces can all reduce the overall parking footprint and site imperviousness.
Many parking lot designs result in far more spaces than actually required. This problem is exacerbated by a common practice of setting parking ratios to accommodate the highest hourly parking during the peak season. By determining average parking demand instead, a lower maximum number of parking spaces can be set to accommodate most of the demand. Table 1.4.2-2 provides examples of conventional parking requirements and compares them to average parking demand.

TABLE CONVENTIONAL MINIMUM PARKING RATIOS (SOURCE: ITE, 1987; SMITH, 1984; WELLS, 1994)			
Land Use	**Parking Requirement**		**Actual Average Parking Demand**
	Parking Ratio	**Typical Range**	
Single family homes	2 spaces per dwelling unit	1.5–2.5	1.11 spaces per dwelling unit
Shopping center	5 spaces per 1000 ft^2 GFA	4.0–6.5	3.97 per 1000 ft 2 GFA
Convenience store	3.3 spaces per 1000 ft^2 GFA	2.0–10.0	--
Industrial	1 space per 1000 ft^2 GFA	0.5–2.0	1.48 per 1000 ft 2 GFA
Medical/ dental office	5.7 spaces per 1000 t^2 GFA	4.5–10.0	4.11 per 1000 ft^2 GFA
GFA = Gross floor area of a building without storage or utility spaces.			

Another technique to reduce the parking footprint is to minimize the dimensions of the parking spaces. This can be accomplished by reducing both the length and width of the parking stall.

Parking stall dimensions can be further reduced if compact spaces are provided. While the trend toward larger sport utility vehicles (SUVs) is often cited as a barrier to implementing stall minimization techniques, stall width requirements in most local parking codes are much larger than the widest SUV structured parking decks are one method to significantly reduce the overall parking footprint by minimizing surface parking. Figure 1.4.2-20 shows a parking deck used for a commercial development.

Shared parking in mixed-use areas and structured parking are techniques that can further reduce the conversion of land to impervious cover. A shared parking arrangement could include usage of the same parking lot by an office space that experiences peak parking demand during the weekday with a church that experiences parking demands during the weekends and evenings.

Utilizing alternative surfaces such as porous pavers or porous concert is an effective way to reduce the amount of runoff generated by parking lots. They can replace conventional asphalt or concrete in both new developments and redevelopment projects. However, porous pavement surfaces generally require proper installation and more maintenance than conventional asphalt or concrete.

F. References

Georgia Stormwater Management Manual Volume 1: Stormwater Policy guidebook First Edition August 2001, Atlanta Regional Commission

G. URLs

http://www.georgiastormwater.com

5. Center for Watershed Protection (CWP)

A. Definition

“Redevelopment” is the process in which an existing developed area is adaptively reused, rehabilitated, renovated or expanded.

“Infill” is development that occurs on smaller parcels that remain undeveloped but are within or very close to existing urban areas.

B. What Are The Best Incentives To Encourage Redevelopment?

1. Resolving the transportation problems, particularly for suburban commuters.
2. Waterfront development.
3. Shortening/ simplifying the approval process.
4. Unifying codes and ordinances.

C. Other Suggestions

1. Don't forget the temporal scale, e.g. over time redevelopment is very beneficial at the site level.
2. Don't forget the neighborhood based framework. Don't forget environmentally sensitive techniques inside the building.
3. Make it applicable to all areas of different climate, politics and technical expertise.
4. Use a word other than principle.

D. Tools and Techniques for Redevelopment and Infill

<u>Practice Oriented</u>

1. Maintain natural features as part of the landscape at a site and encourage tree planting and other revegetation practices.
2. Manage rooftop runoff through storage, reuse, and/or redirection to pervious surfaces for stormwater management.
3. Use alternative paving materials for parking and other pathways whenever possible and feasible.
4. Provide long term management plans for natural areas, public spaces, stormwater management facilities and lighting.

<u>Program Oriented</u>

1. Promote the rehabilitation of urban streams and the creation and restoration of aquatic corridors.
2. Encourage the use of green parking techniques by providing incentives whenever possible.

3. Monitor and eliminate illicit or unmanaged discharges into streams, lakes and estuaries and foster operation and maintenance practices that prevent or reduce pollutants entering the municipal or natural drainage system.
4. Promote environmental stewardship through outreach and education for the present and the future.
5. Encourage pollution prevention practices for businesses and municipalities to reduce pollutant loads and foster an environmental ethic.

Shared Principles

1. Use appropriate, effective, and economical stormwater management where possible.*
2. Encourage the incorporation of natural features as part of the streetscape.*
3. Master plan redevelopment areas to promote planting practices and provide green spaces (trees, urban parks, and community gardens) in the urban environment.*
4. Encourage the use of open space designs, including reduction of building footprints, preservation of natural areas, and innovative building techniques to reduce the amount of new impervious cover created.*
5. Encourage development designs that integrate new paths, open spaces, and architecture with the existing community.*

*Indicates principles that can be organized under both the Practice and Program.

E. URLs

http://www.cwp.org/index.html

6. Green Roofs for Healthy Cities

<u>Water Benefit (other benefits are not list here)</u>

In summer, green roofs retain 70-100% of the precipitation that falls on them; in winter they retain between 40-50%. A grass roof with a 4-20 cm layer of substrate can hold between 10 and 15 cm of water.

A. Stormwater Retention

Water is stored by the substrate and then taken up by the plants from where it is returned to the atmosphere through transpiration and evaporation.

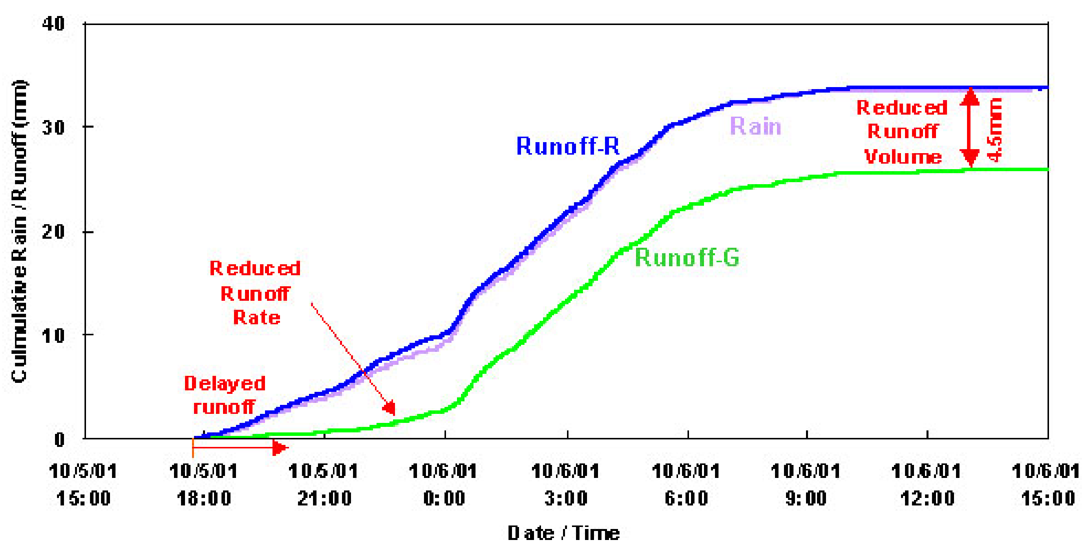
In summer, depending on the plants and growing medium, green roofs retain 70-80% of the precipitation that falls on them; in winter they retain between 25-40%. For example, a grass roof with a 4-20 cm (1.6 - 7.9 inches) layer of growing medium can hold 10-15 cm (3.9 - 5.9 inches) of water.

B. Water Filtration

Green roofs not only retain the rainwater, but also moderate the temperature of the water and act as natural filters for any of the water that happens to run off.

C. Temporal Delay of Stormwater Runoff and Reduced Runoff Volume

Green roofs reduce the amount of stormwater runoff and also delay the time at which runoff occurs, resulting in decreased stress on sewer systems at peak flow periods.



Source: National Research Council's Institute for Research in Construction

The graph above records the cumulative rainfall and runoff from the Green Roof and the Reference Roof during a 34mm (1.3 inches) rain event over a 15h period in October 2001. The green roof delayed runoff and reduced the runoff rate and volume. For more details on this research conducted by the National Research Council's Institute for Research in Construction, see the article on page 7 of the Winter 2002 issue of the Green Roof Infrastructure Monitor.

D. Regulatory/Policy Initiatives

The U.S. Clean Water Act promises to become an important regulatory driver of green roof implementation in the United States. The **Clean Water Act, Section 319 Grant**, addresses Nonpoint Source Pollution and can provide a source of funding for green roofs.
To inquire about receiving Section 319 grant funding for green roof projects contact your **state Nonpoint Source coordinator**. Green roofs can be funded as demonstration projects throughout most states and can be used to mitigate the impacts of stormwater and combined sewer overflows in developed areas.
Two projects funded by this grant include:
Maryland: Montgomery Park, Grant Award: $92, 000.00

Arizona: Riverfront Residence, Grant Award: $33, 875.00

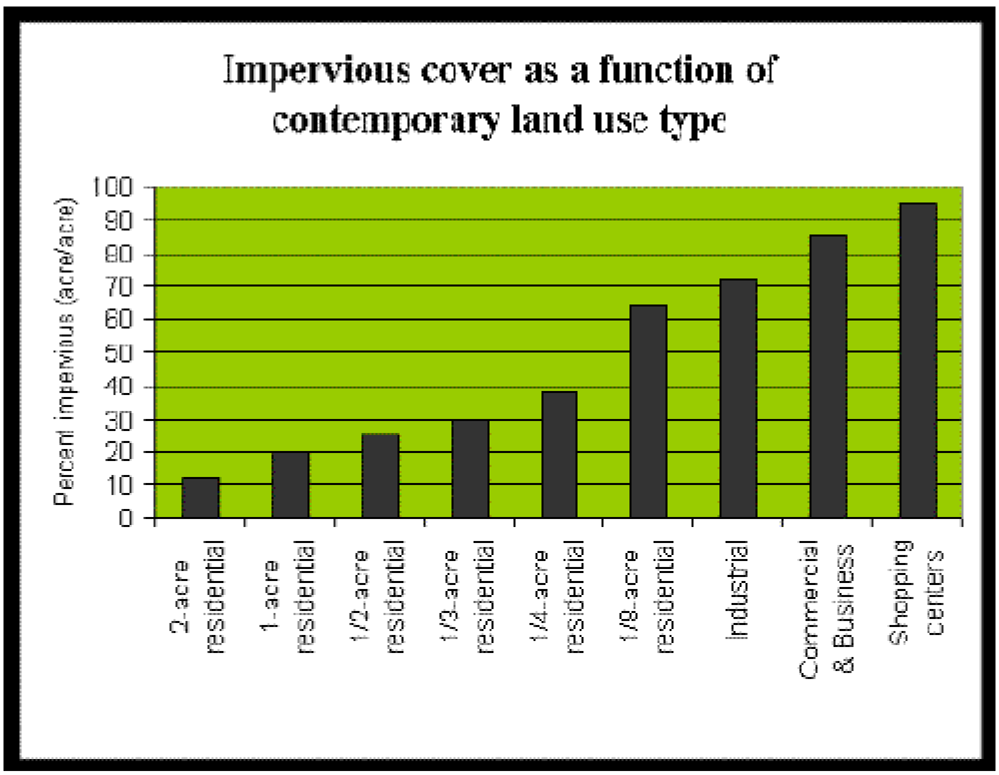
The **City of Seattle** requires that all new municipal buildings be LEED™ certified and green roofs provide an opportunity to gain as many as 5 points under this system. A number of LEED™ certified buildings have green roofs.
The City of Toronto's "Environmental Plan" and draft "Official Plan" both contain policies that encourage the implementation of green roof infrastructure
The City of Chicago passed an **Energy Conservation Ordinance** on June 3, 2001 requiring all new and replaced roofs to meet minimum standards of solar reflectance and emissivity using ASTM testing methods. This requirement, which is being phased in, can be met by installing a green roof system.

E. GreenRoof

Greenroofs reduce the volume of stormwater flowing into streams and drainage channels, resulting in the control of sediment transport and overall soil erosion. According to an article in the November/December 1998 issue of Erosion Control Magazine, the natural carpets provided by greenroofs protect both roofs and the soil below. Nitrogen, phosphorus and toxins can enter a vegetated stream as dissolved substances. Greenroofs' vegetated cover properties of friction, root absorption, clay, and soil organic matter can control these substances from entering a stream corridor (Dramstad, et al, 1996). In February of 1999, the International Erosion Control Association's Conference & Trade Exposition was held in Nashville, TN, and featured a training workshop and special section regarding the benefits and applications of roof greening systems. Thomas Roess of Strodthoff and Behrens GMBH of Germany presented on this subject, and is a frequent lecturer worldwide on greenroof technology.

Vegetation absorbs pollutants from rainwater, and greenroofs provide this same amenity. Heavy metals and nutrients found in stormwater are bound in the soil instead of being discharged into the groundwater or streams or rivers. Over 95% of cadmium, copper and lead and 16% of zinc can be taken out of rainwater. Nitrogen levels can also substantially fall (The London Ecology Unit, 1993).

Perhaps the greatest ecological function a greenroof can provide is its stormwater management capacity. Impervious cover has become a function of contemporary land uses. As a result of new land use practices, cities across the nation have developed over-stressed sewer systems with urgent stormwater management problems. According to analysis of Lansat Satellite data by NASA climate scientists, University of Georgia researchers and others, metro Atlanta is losing 50 acres of tree cover per day. From 1988 to 1998 the 13-county metro area lost approximately 190,000 acres of tree cover to development (Charles Seabrook, 1999). Lost green space is then a by-product of the proverbial asphalt jungle, and the inherent natural processes associated with natural areas are also lost. The chart below from Bruce Ferguson's *Introduction to Stormwater: Concept, Purpose, Design* (1998), shows the amount of impervious cover that development and the new impervious pavements produce.

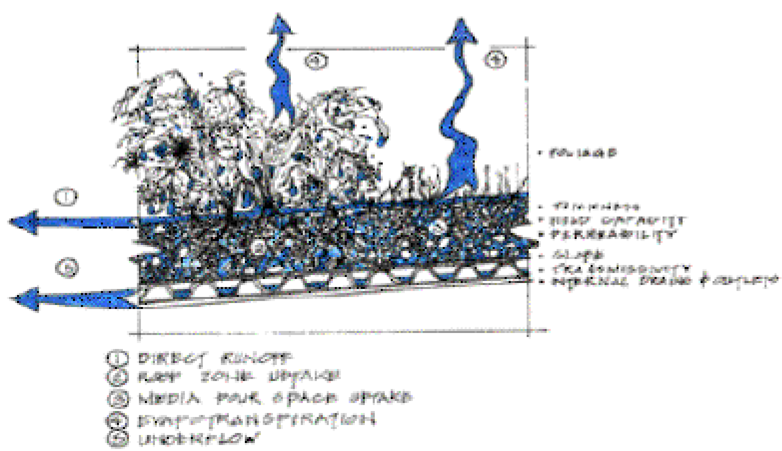


“We are obligated to restore the mechanisms of the earth’s self-maintaining balance. Runoff must be moderated, treated, and returned to its restorative path in the soil,” (Ferguson, 1998).


Source: ZinCo International 3/98 Brochure

On-site stormwater retention and runoff control from expansive roof surface areas of buildings can be accomplished through greenroofs. According to civil engineer Charlie Miller, Principal, of Roofscapes, Inc., “Vegetated roof covers may offer the only practical ‘at-source’ technique for controlling runoff in areas that already are highly urbanized.” The reversal of damage caused by uncontrolled stormwater runoff and Nonpoint Source Pollution is possible within our urbanized watersheds. He believes that the intelligent use of best management practices (BMPs) can result in significant improvements, as well as long-term savings to individuals and municipalities (**www.roofmeadow.com**).

Depending on rain intensity and greenroof soil depths, runoff can be absorbed between 15 to 90 %, thereby considerably reducing runoff and potential pollutants from traditional impervious roofing surfaces. Plants intercept and delay rainfall runoff and the peak flow rate, alleviating combined sewer overflows, and eventually return water to the surrounding atmosphere by evaporation and transpiration. Average runoff absorption rates are between 50 to 60% (**www.roofmeadow.com**).



Courtesy of Roofscapes, Inc.; **www.roofmeadow.com**

The control of stormwater runoff is achieved by mimicking natural processes by intercepting and delaying rainfall runoff. Greater grass & plant diversity provides better plant uptake and simple friction, which creates less erosion, and more water is retained on the greenroof surface. Stormwater Natural Processes Detail from **www.roofmeadow.com**.

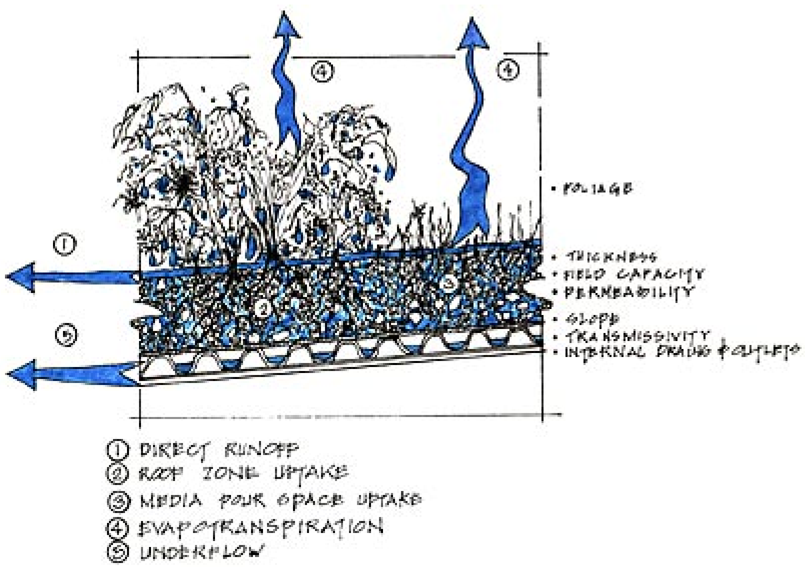
According to Charlie Miller, the installation of greenroofs is “a potential technique for relieving nuisance flooding and reducing hydraulic loads on combined storm sewer systems.” He contends that, “In addition to providing immediate relief for overburdened stormwater management facilities, the deployment of vegetated roof covers can help reduce the overall costs of infrastructure rehabilitation in our older cities.”

Possible impervious coverage restrictions may be reduced for developers who incorporate greenroofs into their site plan. Depending on local ordinances, greenroofs may be installed in lieu of conventional stormwater practices. They can significantly reduce the size, or even completely eliminate the necessity for unsightly, space-wasting, and expensive detention ponds or underground galleries (Roofscapes, Inc., 1998). Although hard to quantify, there is also potential for downstream stormwater treatment savings.

Water Benefit

Control of stormwater runoff is achieved by mimicking the processes that occur in nature, intercepting and delaying rainfall runoff by:

- Capturing and holding precipitation in the plant foliage
- Absorbing water in the root zone
- Slowing the velocity of direct runoff as it infiltrates through the layers of vegetated cover

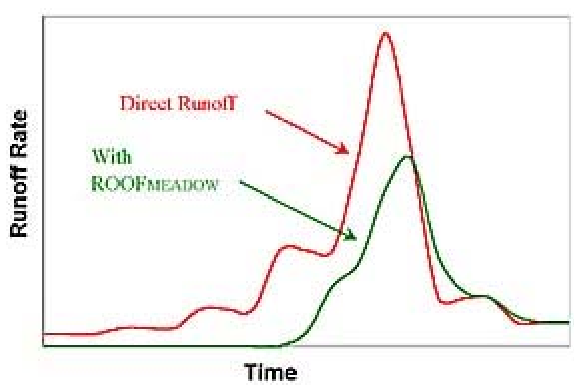


For small rainfall events, little runoff will occur and most of the precipitation will eventually return to the atmosphere by evaporation and transpiration. For larger storms, vegetated roof covers can significantly delay and attenuate the discharge of runoff from roofs.

Vegetated roof covers are effective methods of retarding runoff from roof surfaces during storms:

Compared to many other stormwater management practices, vegetated roof covers are unobtrusive, low maintenance, and reliable management systems. Vegetated roof covers are particularly effective when applied to extensive roofs, such as those that typify commercial and institutional buildings. They can be designed to achieve specified levels of stormwater runoff control, including reductions in:

Total annual runoff volume (reductions of **50 to 60 percent** are common place for vegetated roof covers) Peak runoff rates for selected design storm events



Stormwater runoff for a 3.35-inch, 24-hour rainfall event. This Roofmeadow incorporated a 3-inch deep layer of growth media.
© Roofscapes, Inc.

F. URLs

http://peck.ca/grhcc/
http://greenroofs.com/
http://roofscapes.com

7. Chester

A. Definition (ordinance language)

Redevelopment (in Article II)

Reconstruction of an existing improved, developed property, as of the data of adoption of this Ordinance. This includes all projects creating over 2,000 s.f. of additional impervious cover.

B. Water Quality and Quantity Control Drainage Plan preparation Procedure (Ordinance language)

1. Applicant determines if development meet definition of "Redevelopment" per Article II.
2. If yes, applicant adjust predevelopment RCN or C value based on curves present in Section 401 C and Appendix B.

C. Section 401 C (ordinance language)

The Chester Creek Stormwater Management Plan requires water quality and water quantity controls as illustrated on the flow chart shown in Figure 4-1 and detailed in Section 404. The flow chart illustrates a three-step hierarchical process.

1. Infiltration
2. Extended detention
3. Implementation of additional design control

Must evaluate the outcome of each step before processing to next.
Riparian buffers are required where applicable (404.A.2).

D. Appendix B (report)

Figure B-3 Redevelopment project runoff criteria adjustment for predevelopment conditions

Concern was expressed that imposing the release rate criteria on redevelopment projects might serve as a disincentive for developers. Therefore, an approach was proposed that would reduce the level of control required on redevelopment projects. This was accomplished by developing a chart which allows modification of predevelopment conditions for which the stormwater management plan would be prepared. This chart adjusts the predevelopment RCN value or "C" value to reflect conditions less restrictive than "meadow on B class soils" based on the percentage of exiting impervious cover.

Comment: The figure development is ok. But the goal of "Back to the natural condition" will not be reached.

E. Section 403 C (ordinance language)

Redevelopment projects shall meet peak discharge requirements based on the adjusted runoff control number (RCN) or "C" value illustrated by Figure B-3 in Appendix B.

F. Section 405 B (ordinance language)

For the purpose of predevelopment flow rate determination, undeveloped land shall be considered as "meadow" good condition, type "B" soils, (RCN=58, Rational "C"=0.12) unless the natural ground cover generates a lower curve number or Rational "C" value (i.e., forest). If a proposed development meets the definition of redevelopment as defined in Article II of this Ordinance, the applicant may adjust the predevelopment RCN or "C" value based on the curves presented in Figure B-3.