Fulton County Planning Commission

Phase II Act 167 County-Wide Stormwater Management Plan

JUNE 2010

Ayr Township

Belfast Township

Bethel Township

Brush Creek Township

Dublin Township

Licking Creek Township

McConnellsburg Borough

Taylor Township

Thompson Township

Todd Township

Union Township

Valley-Hi Borough

Wells Township

Prepared by:

HRG

Herbert, Rowland & Grubic, Inc.

Engineering & Related Services

PROFESSIONAL ENGINEER'S CERTIFICATION

FULTON COUNTY
PHASE II ACT 167 COUNTY-WIDE
STORMWATER MANAGEMENT PLAN
FULTON COUNTY, PENNSYLVANIA

I, Matthew S. Bonanno, P.E., do hereby certify pursuant to the penalties of 18 Pa C.S.A. Section 4904 to the best of my knowledge, information, and belief, that the information contained in the accompanying plan for the Phase II Act 167 County-Wide Stormwater Management Plan for Fulton County has been prepared in accordance with accepted engineering practice.

SIGNED: ____________________________________

DATE: ____________________________________

Engineer's Stamp

ACKNOWLEDGEMENTS

The Fulton County Planning Commission would like to thank the following individuals, municipalities, and agencies for their assistance and support of this project:

FULTON COUNTY COMMISSIONERS

BONNIE MELLOTT KEEFER, CHAIR
DAVID R. HOOVER, II
CRAIG C. CUTCHALL

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION

BARRY NEWMAN
RUTH SITLER

FULTON COUNTY STAFF

STEVEN J. THOMAS – PROJECT MANAGER
MARY K. SEVILLE – PLANNING & MAPPING DIRECTOR
DANIEL H. SWAIN, JR. – CHIEF CLERK

FULTON COUNTY WATERSHED PLAN ADVISORY COMMITTEE

AYR TOWNSHIP	MARLIN E. HARR GARY HOPKINS
BELFAST TOWNSHIP	RICHARD HARR WILLIAM R. SHIVES
BETHEL TOWNSHIP	RAY POWELL
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VALLEY-HI BOROUGH	NELSON K. GOTHIE
WELLS TOWNSHIP	TINA R. FORD

FULTON COUNTY BUILDER'S ASSOCIATION
JOSEPH HAGERTY
JEFF FISHER

FULTON COUNTY CONSERVATION DISTRICT
SELEEN SHIVES
SCOTT ALEXANDER

FRIENDS OF THE LITTLE AUGHWICK WATERSHED GROUP
DERRICK WINEGARDNER

PENNSYLVANIA DEPARTMENT OF TRANSPORTATION
MICHELE C. JACOBY

PROFESSIONAL ENGINEERING CONSULTANT

HERBERT, ROWLAND & GRUBIC, INC.
MATT BONANNO, P.E. – PROJECT MANAGER
AL BAIN, P.E. – PROJECT ENGINEER
BRAD NEWLIN, P.E. – PROJECT ENGINEER

HRG Project Number: R004214.0428

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INTRODUCTION

In compliance with the Pennsylvania Stormwater Management Act, Act 167, the Fulton County Planning Commission (FCPC) has produced this County-Wide Plan for all watersheds and lands contained within the borders of Fulton County. This Stormwater Management Plan serves as a framework and information resource to assist all thirteen (13) municipalities within Fulton County in planning for and managing the potential increased stormwater runoff associated with development and future population growth.

In 2008, Fulton County decided to pursue the creation of a Stormwater Management Plan (Plan) that would encompass and provide coverage for the entire County. The Plan is intended to provide consistent stormwater management standards that address the adverse impacts of increased runoff from development.

This Plan contains several features that are different from the previously completed watershed-wide Cove Creek Act 167 Stormwater Management Plan (1993). These features are incorporated into this County-Wide Plan for several reasons:

1. Pennsylvania Department of Environmental Protection's (PADEP) approach to Act 167 planning has changed from an individual watershed by watershed planning effort to County–Wide planning. This approach provides increased cost effectiveness by completing one (1) plan for a given county rather than numerous watershed plans. This approach also contributes to multi-municipal planning and cooperation.

2. The only other Act 167 Plan that exists in Fulton County is the Cove Creek Watershed Plan (1993), which covers Ayr, Thompson and Todd Townships and McConnellsburg Borough. The creation of this County-Wide Plan will not only provide the other nine (9) municipalities in Fulton County with a stormwater management plan, but it will also serve as the update to the existing plan for the above mentioned municipalities. Once the County-Wide plan is adopted, the 1993 Cove Creek Watershed Plan will become obsolete, and a single plan will cover the entire county.

3. Detailed hydrologic modeling, the foundation of PADEP's Act 167 plans previously completed throughout Pennsylvania, is now conducted only in key watersheds determined to merit such an effort. The Phase I – Scope of Study identified the key watersheds in Fulton County (Cove Creek and Licking Creek) that, during Phase II, had detailed hydrologic modeling performed. The hydrologic modeling is performed to coordinate the timing of peak discharges from individual subwatersheds within the overall watershed. The concept is used to prevent the "overlap" of subwatersheds peak discharges downstream. These "overlaps" are then managed to ensure that no significant increases in peak discharges occur within the entire Cove Creek and Licking Creek watersheds.

4. This Plan incorporates the stormwater volume control guidance found in the Pennsylvania Stormwater Best Management Practices Manual – December 2006 (BMP Manual). This is a relatively new concept in stormwater management techniques. Volume control is now considered a performance standard that must be met at all applicable development sites. Typically volume control may be met via infiltration, evapotranspiration, or capture/reuse methods. Stormwater volumes would be treated by applicable Best Management Practices (BMPs) on a site-specific basis. A volume control concept was previously mentioned in the 1993 Cove Creek Plan; however this concept was merely guidance and a recommendation, not a mandatory performance standard. Implementing the volume control guidance from the BMP Manual, will ensure that the Plan, local ordinances based on the Model Ordinance, and the National Pollutant Discharge Elimination System (NPDES) post-construction stormwater management standards are uniform and consistent. Ideally, this consistency will result in less confusion and variation on the part of designers and regulators, and will provide a more efficient stormwater management plan review process for new development in all municipalities.

5. PADEP has recently revised their policy to include addressing existing Total Maximum Daily Loads (TMDLs) in new Act 167 plans. TMDLs are typically established along impaired waterways in accordance with Section 303(d) of the Federal Clean Water Act (CWA), and are determined using hydrologic and hydraulic computer models. Although Fulton County has 44-miles of impaired stream segments, none of them have established TMDLs, therefore no additional criteria has been included in this Plan.

In order for the Act 167 planning process to be successful and effective, the cooperation and coordination of the individual municipalities involved is essential. Since this Act 167 stormwater management planning effort affects all municipalities in Fulton County, it was important for each municipality to be involved in the planning process. Act 167 encourages public participation and requires municipal participation in the planning process for the municipalities by establishing a Watershed Plan Advisory Committee (WPAC). The committee was comprised of representatives from the thirteen (13) municipalities, as well as the Fulton County Conservation District, Fulton County Builder's Association, PennDOT, and other concerned organizations and citizens.

By coordinating with local governments and managing stormwater in consideration of overall watershed hydrology, this Plan helps to prevent stormwater management problems and improve water quality within and beyond municipal boundaries. By implementing new ordinances or revising existing local municipal ordinances and regulations to comply with the standards and performance standards set forth within this Plan, municipalities will help identify, address, minimize, or eliminate the negative impacts of increased stormwater runoff. Further, a central coordinated effort involving all municipalities within Fulton County will ensure that the criteria and standards established by the Plan will be implemented uniformly throughout each watershed and municipality. Uniform and county-wide implementation of this Plan is critical to its success.

SUMMARY PLANNING APPROACH

It is important to note that this County-Wide Plan features a stormwater management strategy that is consistent with the Pennsylvania Comprehensive Stormwater Management Policy and the BMP Manual. Although this strategy still employs detailed hydrologic modeling to determine release rate percentages to control storm events for the Cove Creek and Licking Creek watersheds, it does not provide detailed modeling for all watersheds contained within Fulton County. The existing Cove Creek Watershed Plan only determined release rates for the 2-year and 10-year storm events.

The revised stormwater management concepts in the BMP Manual acknowledge the importance of addressing higher frequency, lower intensity storm events. The reduction in total runoff volume for the 2-year storm event required by the volume controls of this Plan will effectively manage smaller storms and may provide some peak flow reductions for less frequent, larger storm events. This management strategy, coupled with the application of a 100 percent release rate for un-modeled areas is anticipated to provide overall, effective stormwater management throughout Fulton County.

The peak rate standard for un-modeled watershed areas will be that post-construction peak discharge rates be less than or equal to pre-construction levels for 1-year, 2-year, 10-year, 25-year, 50-year, and 100-year storms events. This represents a 100 percent release rate.

The peak rate standard for modeled watershed areas (Cove Creek and Licking Creek) will be that post-construction peak discharge rates be less than or equal to pre-construction levels for 1-year, 2-year, 10-year, 25-year, 50-year, and 100-year storms events according to the release rate map (Plate #12).

Volume controls are required in all areas of Fulton County.

Plan Goals, Objectives And Recommendations

GENERAL PLAN GOALS

Comprehensive stormwater management planning addresses the full range of hydrologic and hydraulic impacts from cumulative land development within a watershed rather than simply considering and addressing site-specific peak flows. The principal purposes of the Plan are to protect public health, safety, and welfare. It does so by addressing the impacts of future land development and to recommend measures to control accelerated runoff to prevent increased flood damages or additional water quality degradation.

The overall objective of this Plan is to provide an approach for comprehensive stormwater management throughout Fulton County. The Plan is intended to enable every municipality in the County to meet the intent of Act 167 through the following goals:

- 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 the Commonwealth
- Manage accelerated runoff and erosion and sedimentation problems close to their source, by regulating activities that cause these problems
- Preserve the natural drainage systems as much as possible
- Maintain groundwater recharge, to prevent degradation of surface and groundwater quality, and to otherwise protect water resources
- Maintain existing flows and quality of streams and watercourses
- Preserve and restore the flood-carrying capacity of streams and prevent scour and erosion of stream banks and streambeds

- Manage stormwater impacts close to the runoff source, with a minimum of structures and a maximum use of natural processes

- Provide procedures, performance standards, and design criteria for stormwater planning and management

- Provide proper operations and maintenance of all temporary and permanent stormwater management facilities and Best Management Practices (BMPs) that are constructed and implemented

- Provide standards that are consistent with the NPDES permit requirements

ACT 167 REQUIRED PLAN CONTENTS

The PA Stormwater Management Act, Section 5 (b) & (c) lists requirements that each Stormwater Management Plan shall contain. The following is a listing of the requirements and how each requirement is addressed in this Plan.

TABLE 1: ACT 167 REQUIRED PLAN CONTENTS

ACT 167 REQUIRED PLAN CONTENTS
(5.b.1) a survey of existing runoff characteristics in small as well as large storms, including the impact of soils, slopes, vegetation and existing development
– refer to the County Description Section and the HMS Models for Cove Creek and Licking Creek
(5.b.2) a survey of existing significant obstructions and their capacities
– refer to Appendix C (Problem Area Documentation) of the Plan
(5.b.3) an assessment of projected and alternative land development patterns in the watershed, and the potential impact of runoff quantity, velocity and quality
– refer to the County Description Section, Plate #6 (Future Land Use Coverage – County-Wide), and the HMS Models for Cove Creek and Licking Creek
(5.b.4) an analysis of present and projected development in flood hazard areas, and its sensitivity to damages from future flooding or increased runoff
– refer to the County Description Section (Table #8), Plate #6 (Future Land Use Coverage – County-Wide) and the Existing Municipal Regulations/Related Plans Section
(5.b.5) a survey of existing drainage problems and proposed solutions
– refer to Appendix C (Problem Area Documentation) of the Plan
(5.b.6) a review of existing and proposed storm water collection systems and their impacts
– refer to Plate #4 (Problem Area Location and Existing Stormwater Systems) for a general location of existing storm water collection systems. These systems may be inventoried in future plan updates as GPS technology becomes more commonly used at the municipal/county level.
(5.b.7) an assessment of alternative runoff control techniques and their efficiency in the particular watershed
– refer to the Goals of Sound Stormwater Management Planning Section and the Technical Standards Section of the Plan

ACT 167 REQUIRED PLAN CONTENTS
(5.b.8) an identification of existing and proposed State, Federal and local flood control projects located in the watershed and their design capacities
– N/A - No significant existing or proposed flood control projects were identified by the WPAC members
(5.b.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 or proposed institutional arrangements to implement and operate the facilities
– to be completed as part of a future plan update, after (5.b.6) is completed and as GPS technology becomes more commonly used at the municipal/county level
(5.b.10) an identification of flood plains within the watershed
– refer to the County Description (Floodplain Data) Section of the Plan
(5.b.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
– refer to the Technical Standards Section of the Plan
(5.b.12) priorities for implementation of action within each plan
– refer to the Plan Review, Implementation & Update Procedures Section of the Plan. The provisions and standards of the Model Ordinance must be adopted by the municipalities within 6-months of approval of the Plan by PADEP. Other information contained with the Plan should be considered recommendations only and can be implemented as funding become available.
(5.b.13) provisions for periodically reviewing, revising and updating the plan
– refer to the Plan Review, Implementation & Update Procedures Section of the Plan
(5.c.1) provisions as are reasonably necessary to manage storm water such that development or activities in each municipality within the watershed do not adversely affect health, safety and property in other municipalities within the watershed and in basins to which the watershed is tributary
– refer to the Technical Standards Section of the Plan and the Model Ordinance
(5.c.2) consider and be consistent with other existing municipal, county, regional and State environmental and land use plans
– refer to the Existing Municipal Regulations/Related Plans Section of the Plan

SPECIFIC COUNTY GOALS

The following specific goals were designed to enhance and protect existing water quality within Fulton County and to manage increased stormwater associated with development within Fulton County. These goals were compiled using the Phase I – Scope of Study documentation as well as the Fulton County Joint Comprehensive Plan (2007). Additionally, the County compiled feedback from the two (2) Watershed Plan Advisory Committee meetings held during Phase I. Each goal listed is accompanied by recommended objectives to achieve the stated goal.

1. Keep Water in Fulton County

Fulton County sits at the headwaters of the Potomac and Susquehanna River Basins. Because of the geographic location and recent development, more and more rainwater is being conveyed downstream and not replenished back into underground aquifers. The County wishes to create stormwater management regulations that encourage infiltration to replenish groundwater resources. The following objectives are recommended:

A. Develop stormwater management design criteria that encourage infiltration.
- *Volume Control Standards*

B. Develop regulations that encourage the post-construction hydrology to mimic the pre-construction hydrology to the maximum extent practicable.
- *Volume Control Standards, Rate Control Standards & Model Ordinance*

C. Utilize and preserve the existing natural surface drainage and groundwater systems.
- *Volume Control Standards*

2. Improve and Maintain Water and Stream Quality

The natural habitat of aquatic life and the quality of streams are very important to the residents of Fulton County. The County's approach to water quality is two-fold. The first approach is to maintain water quality in all streams that are not deemed impaired, especially in streams classified as High Quality (HQ) or Exceptional Value (EV). The second approach is to attempt to improve the quality of streams that are deemed impaired by PADEP. The County would also like to preserve and improve the stream characteristics related to flows, banks, and capacity. The following recommendations have been formed with this two-pronged approach in mind.

A. Develop stormwater management design criteria that improves water quality prior to discharging into streams.
- *Water Quality Impairments and Recommendation Section of the Plan*

B. Strive to prevent erosion, to the maximum extent practicable, of stream banks and beds.
- *Volume Control Standards*

C. Encourage stream-bank restoration and preservation projects.

- Water Quality Impairments and Recommendation Section and Potential Funding Sources Section of the Plan

D. Preserve, and where needed, restore the flood-carrying capacity of streams.

- Volume Control Standards, Peak Rate Standards and Additional Recommendations Section of the Plan

3. Address Existing Stormwater Problems

In Phase I, Fulton County municipalities and other WPAC members completed a multi-page questionnaire that solicited input on specific problems areas throughout Fulton County. Respondents identified 27 problem areas and 4 significant obstructions. In May 2009, County Planning staff and Herbert, Rowland & Grubic, Inc. (HRG) staff conducted a two-day field study of the identified problem areas. A total of 31 problem areas are included in the Phase II Plan (some problem areas from Phase I were deleted/combined and all of the significant obstructions were relabeled as problem areas.) After field notes, photographs, and calculations were taken, a Problem Area Documentation Report was compiled for each municipality. Fulton County would like to work towards correcting the problems outlined in the documentation of that report as funding and resources become available.

A. Develop conceptual solutions to the problem areas outlined in the documentation.

- Fulton County Significant Problem Areas Section & Appendix C of the Plan

B. Develop stormwater management standards to prevent the existing problems from re-occurring once corrected.

- Volume Control Standards, Rate Control Standards & Model Ordinance

C. Provide education to elected officials and developers on the problem areas and how these problems can be avoided in future development.

- Fulton County Significant Problem Areas Section & Appendix C of the Plan

D. Provide a list of funding sources that Fulton County or the municipalities can use as a resource guide to attempt to obtain funds to fix existing problem areas.

- Potential Funding Sources Section of the Plan

4. Address Flooding in the Area Surrounding the Borough of McConnellsburg

The Borough of McConnellsburg and surrounding area is one of the more flood-prone locations in Fulton County. During significant rainfall events, the Borough will often experience roadway and building flooding from contributing upstream runoff from Todd and/or Ayr Townships. The County is hopeful that the regional approach to stormwater planning will assist the Borough and adjoining townships in addressing stormwater issues.

A. Provide stormwater management design criteria to the Borough of McConnellsburg and surrounding municipalities that encourages infiltration.
- Volume Control Standards

B. Set regulations to require that the peak rate of runoff for post-construction is less than or equal to the peak rate of runoff for pre-construction.
- Cove Creek Release Rates

C. Identify stormwater management criteria within the Borough and immediate area that promotes the minimization of creation of new impervious surfaces.
- Additional Recommendations Section of the Plan and Model Ordinance

5. Manage Stormwater Runoff Caused by Development

Development is an inevitable occurrence in all neighborhoods and communities. Since development can not be prohibited, the best approach is to carefully and strategically plan for and properly manage the effects of it. A key component of managing the effects of development is regulating stormwater runoff after the development has occurred. The County intends to manage development-related stormwater impacts close to the source with the minimum use of structural control methods.

A. Educate the public, developers, and designers on the benefits and proper application of the recommended BMPs.
- Reference BMP Manual

B. Promote the use of non-structural BMPs to control runoff.
- Reference BMP Manual and Economic Impact of Stormwater Requirements Section of the Plan

C. Encourage developers to minimize the amount of impervious surfaces on site.
- Additional Recommendations Section of the Plan

D. **Establish consistent criteria and performance standards for all new development.**

   - Technical Standards Section of the Plan

E. **Require proper design, operation and maintenance of stormwater controls.**

   - Model Ordinance

Goals of Sound Stormwater Management Planning

Historic stormwater management strategies were primarily designed to collect stormwater runoff and remove it from a site as quickly as possible, typically through a series of inlets and pipes that emptied into the nearest receiving stream. The

underlying philosophy of this approach was to "collect and remove". This approach had numerous shortcomings. It ignored water quality, did not emphasize infiltration for groundwater recharge, and did not consider the adverse impacts of increased volumes and peak rates of stormwater on downstream channel morphology, aquatic habitat, and flood frequency. Current stormwater management philosophy, including the Act 167 planning, recognizes that stormwater is a natural resource and should be managed as such. This new philosophy seeks to manage stormwater runoff so the adverse impacts listed above are considered and addressed appropriately and proactively. The goal is to retain, to the maximum extent practical, the existing hydrology of the individual watersheds and individual development sites, including groundwater recharge, water quality and stream flow patterns.

Under natural, undisturbed conditions, watershed hydrology reaches a state of equilibrium. That is, the watershed, its ground and surface water supplies, resulting stream morphology, and water quality are in balance with the existing rainfall and runoff patterns. This equilibrium is displayed by stable channels with minimal erosion, adequate groundwater recharge, adequate base flows, relatively infrequent flooding, high water quality, and as a result of all these conditions, healthy in-stream biological communities. Streams continue to meander, but the lateral movement is so slow and steady that there is no significant impact on the channel flora and fauna.

The goals of the recommended stormwater management requirements and criteria developed for this Plan are to maintain or restore the following six (6) elements of watershed response to stormwater runoff in as close to a natural condition as possible:

Stable Channels – In a natural watershed, the channels of the stream network have adapted themselves, in terms of size, slope, and shape, to the amount of runoff delivered to the stream by its contributing watershed. Typically, the main channel will be large enough to accommodate the runoff from a storm, the magnitude of which will occur approximately every two (2) years. Disturbances in the watershed, including development, disrupt this equilibrium. With development, typically more stormwater runoff reaches the streams more often. This results in the channel attempting to resize itself. This resizing manifests itself in channel instability, bed and bank erosion, shifting sediment deposits, increased localized flooding, and other associated water quality problems. Channel instability may also adversely impact adjacent property and infrastructure.

Groundwater Recharge – In an undisturbed watershed, runoff is minimal relative to the magnitude of the storm event. Natural ground cover, undisturbed and un-compacted soils, and uneven terrain provide an excellent environment for maximum infiltration to occur. When development occurs, these factors are minimized or removed, causing more rainfall to become runoff that flows into receiving streams. Consequently, less water is retained in the watershed to replenish groundwater supplies.

Base Flows – Loss of groundwater recharge, as described above, leads to insufficient groundwater available to replenish streams during dry weather. As a result, streams that may have an adequate base flow during dry weather under natural conditions may have minimal flow or become completely dry in developed watersheds. Thermal degradation of the waterbody often accompanies the reduction of base flow originating from the groundwater. The base flow in undeveloped watersheds is generally much cooler than surface water sources. The increase in water temperature can be detrimental to many ecological communities.

Flooding – As previously mentioned, the main stream channel in an undisturbed watershed typically can accommodate the runoff from a storm with approximately a two (2) year return period. As the watershed becomes developed, this volume of stormwater runoff delivered to the stream will occur more frequently. Until the channel reaches a new equilibrium, this increase of runoff will result in overbank flows. It is important to realize that this equilibrium may take many years to be attained once the new runoff patterns are in place. In watersheds with continuous development and a constant addition of new impervious surfaces, a new equilibrium may not be reached. Additionally, floodplain encroachment and in-stream sediment deposits from channel erosion may exacerbate flooding frequency, depths, and damage levels.

Water Quality – Stormwater runoff from developed surfaces may carry a wide variety of contaminants. Pesticides, herbicides, fertilizers, automotive fluids, hydrocarbons, sediment, detergents, bacteria, and other contaminants that are picked up on land surfaces are carried into streams by stormwater runoff. The increased temperatures of stormwater runoff can also cause significant temperatures increases in receiving waters, which can be particularly harmful during warmer months and periods of low flow. Contaminants, temperatures changes, and sediment from in-channel erosion can have an adverse impact on the quality of the stream and the stream habitat.

Stream Biology – Biological communities reflect the overall ecological health of a stream. The composition and density of organisms in aquatic communities responds proportionately to stressors placed on their habitat. Communities integrate the stresses over time and provide an ecological measure of fluctuating environmental conditions. The adverse impacts of improperly managed runoff and increased pollution are evident in the biological changes in impacted streams. When biological communities within a waterbody degrade, the overall ecological integrity of the stream diminishes.

It is important to understand that watershed hydrology, rainfall, stormwater runoff and all of the above characteristics are interconnected. The implications of this concept are far reaching. How watersheds are managed has a direct impact on the water resources of the watershed. Any decision that affects land use has implications for stormwater management and, in turn, impacts the quality of the available water resources. The quality of water resources has an effect on the quality of life, and also has economic consequences. Maintaining and understanding watershed hydrology is essential to maintaining the water resources for all watersheds in Fulton County.

The current philosophy of stormwater management is reflected in the required standards. The philosophy, and thus the standards, reflects an attempt to manage stormwater in such a way as to maintain the watershed hydrology as near to existing conditions as possible, while still allowing development to continue in a controlled, environmentally sound manner.

As mentioned, the traditional approach to stormwater management was to collect the runoff and deliver it as quickly as possible, via a system of inlets and pipes, to the nearest receiving waters. It is generally acknowledged that this approach is not an effective way to manage stormwater. An increased volume of stormwater that is delivered quickly to receiving waters has a very detrimental affect on channel morphology and causes many of the negative impacts described above. As stormwater management concepts progressed, this traditional approach was later replaced with stormwater management standards that managed only peak runoff flows, requiring that the post-development peak discharge had to be less than or equal to the estimated pre-development peak. More recent innovations included:

- Establishing release rates to ensure that the post-development peak discharge would not, due to streamflow travel times, inadvertently cause downstream peak flows to significantly increase.

- Requiring some control at the runoff source to promote filtering of storm runoff to improve the quality of the stormwater discharge.

- Providing Best Management Practices to address water quality.

- Promoting the infiltration of stormwater for groundwater recharge.

- Controlling the volume of runoff to ensure that the runoff volume after development more closely matched the volume prior to development for design storm events.

It is also important to realize that stormwater-generated problems tend to be watershed wide; which means that problems generated in an upstream area can, and do, create problems downstream.

Two (2) points are emphasized regarding the need for a stormwater management approach that incorporates the total hydrologic cycle:

- Standards must be implemented diligently by all municipalities within Fulton County. A failure to implement the standards undermines the holistic approach to stormwater management.

- Stormwater runoff can not be properly managed by stormwater management regulations alone. As discussed above, the quantity, quality and impacts of stormwater on receiving streams are directly related to land use decisions. Thinking beyond stormwater management and considering the impact of other regulatory mechanisms such as zoning, subdivision and land development, buffer and floodplain ordinances is very important. As this section attempts to clarify, the issue of stormwater management is not simply an issue of removing excess water from developed areas; it is an issue of resource management. The issue is entwined with land use decisions and has social and economic implications. To maximize the effectiveness of a stormwater management program, a holistic approach is needed. Stormwater management should be considered in any decision that affects how land is used.

County Description

GENERAL COUNTY DESCRIPTION

Fulton County is approximately 439.8-square miles in area (approximately 278,000-acres) and is located in the Appalachian Mountains of south central Pennsylvania along the Maryland State line. The primary land covers in Fulton County are agriculture and woodlands which gives the County a pristine, rural appeal. Fulton County is located at the top of the Potomac and Susquehanna headwaters, both of which drain into the Chesapeake Bay Watershed. The streams and wildlife areas in those watersheds add to the quality of life that the County residents have come to appreciate.

Fulton County shares common boundaries with Bedford, Franklin and Huntingdon Counties. Ray's Hill Mountain provides the common boundary between Fulton and Bedford Counties on the west, while the Majestic Cove and Tuscarora Mountains separate Fulton County from Franklin County on the east. Huntingdon County bounds Fulton County on the north while the Mason-Dixon Line between Pennsylvania and Maryland bounds the County on the south. The County is bisected by the Pennsylvania Turnpike across the north and by Interstate 70 in the southwest.

Fulton County records show that the settlement of the County began as early as 1719. Fulton County was created on April 19, 1851 from a portion of Bedford County. The County's name was chosen in recognition of Robert Fulton of Lancaster, Pennsylvania, inventor who pioneered the use of the steamboat. In 1786, Daniel McConnell laid out the town of McConnellsburg, which was then incorporated as a borough on March 26, 1814. The County seat is the Borough of McConnellsburg. In 1993, McConnellsburg's historic district was recognized by the United States Department of the Interior and was listed in the National Register of Historic Places.

According to the 2000 Census, Fulton County has an estimated population of 14,261. A predominantly rural area, Fulton County's average of 33.3-people per square mile is well below the state average of 274-people per square mile. Fulton County has not seen the major population booms that the surrounding Counties and States have experienced, which allows Fulton County to preserve its original rural characteristics. The United States Census Bureau listed the County's population in 1885 as 7,564. In 2000, that population had only increased to 14,261, a difference of only 6,697 people over a time period of 115-years.

A majority of the County residents reside around McConnellsburg Borough, which is the main population center of the County. The County also has a handful of villages and hamlets where people live, some of which are Warfordsburg, Needmore, Harrisonville, Hustontown, and Fort Littleton. The three top employers in Fulton County (JLG Industries, the Fulton County Medical Center, and Central Fulton School District) are all located around the Borough of McConnellsburg. While a large portion of Fulton County is farmland, the largest employer by industry is manufacturing.

In addition to providing places to work and live, Fulton County is host to a variety of recreational and cultural resources. Tourism has become a major activity and source of revenue based on the significant hunting, fishing, and camping resources, as well as the water- and snow-based recreational activities available. Significant acreage in the County is protected from development due to state forests, national, regional and state parks, and state game lands. There are approximately 50,000-acres of Pennsylvania State Forest land with lakes and streams that are replete with game and fish. Table 2 provides estimated acreages of Protected Land in Fulton County:

TABLE 2: PROTECTED LAND IN FULTON COUNTY

NAME	AREA (ACRES)	SOURCE
Buchanan State Forest*	75,000	Department of Conservation and Natural Resources
Cowans Gap State Park	1,085	Department of Conservation and Natural Resources
Meadow Ground Lake	204	PA Fish and Boat Commission
Buck Valley Park	13	Fulton County Joint Comprehensive Plan, 2007
McConnellsburg Lions Club Park	10	Fulton County Joint Comprehensive Plan, 2007
Wells Tannery Community Park	6	Fulton County Joint Comprehensive Plan, 2007
State Game Lands	13,706	PA Game Commission
Alexander Farm & Clevenger Farm (Farmland Preservation)	189	Fulton County Planning Commission

** The Buchanan State Forest extends over three (3) counties in Pennsylvania*

Cowans Gap State Park serves as an excellent example of a recreational resource in the County. The 1,085-acre facility is nestled in a scenic valley of the Tuscarora Mountains and offers a variety of activities including hunting, fishing, swimming, and camping. Other regional facilities in the area include Buchanan State Forest, Meadow Grounds Lake, and all or part of State Game Land numbers 49, 53, 65, 81, and 124 (PA Game Commission). Meadow Ground Lake, a 204-acre lake located within State Game Land number 53 offers fishing and boating opportunities.

Over the past few years, Fulton County has seen itself become a desirable location for people looking to relocate. The rural appeal of the County draws people from Philadelphia, Pittsburgh, Baltimore, Washington, D.C. and beyond. The residents of the County are proud of their heritage and communities. Numerous festivals and social events are held throughout the year expounding that heritage. Given the current development trends, the rural heritage that Fulton County residents have come to love will continue for many years.

POLITICAL JURISDICTIONS

In Pennsylvania, much of the governmental control is on the local level, i.e. municipalities. As such, municipalities are the primary agencies to regulate stormwater through land use controls. Fulton County is comprised of 13 municipalities. The political jurisdictions include 11 townships and two (2) boroughs as listed in Table 3:

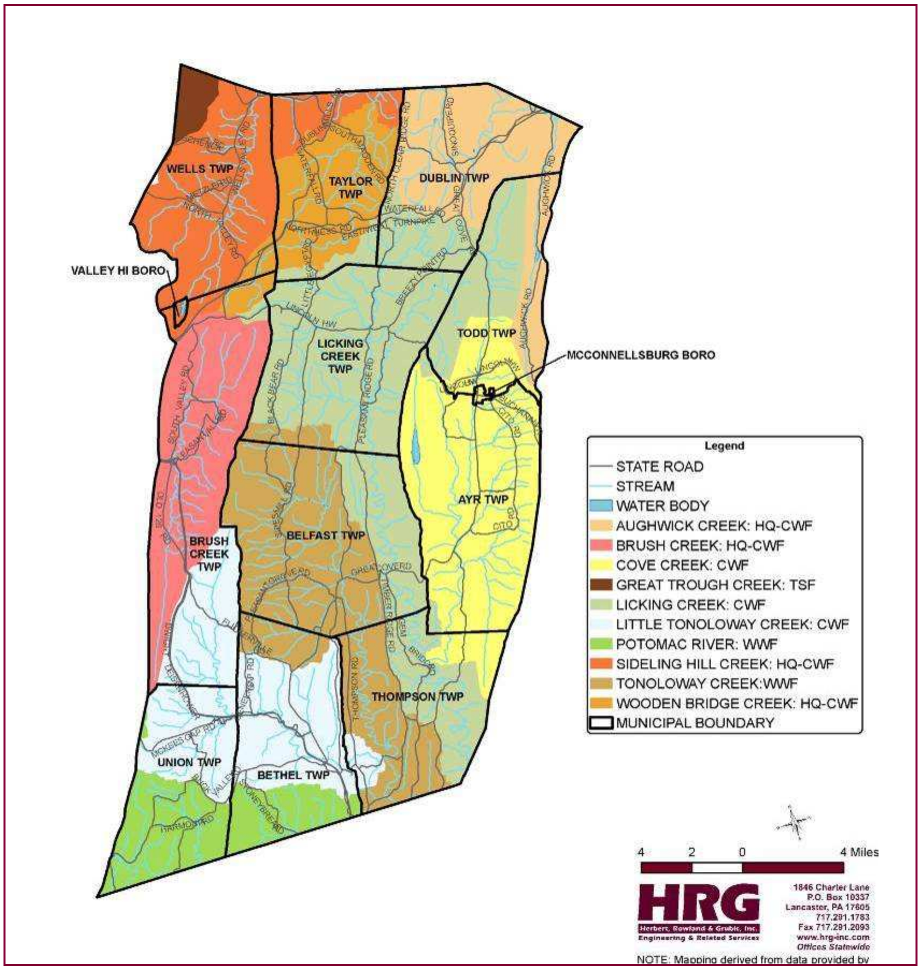


TABLE 3: POLITICAL JURISDICTIONS IN FULTON COUNTY

TOWNSHIPS		BOROUGHS
Ayr Township	Taylor Township	McConnellsburg Borough*
Belfast Township	Thompson Township	Valley-Hi Borough
Bethel Township	Todd Township	
Brush Creek Township	Union Township	
Dublin Township	Wells Township	
Licking Creek Township		

** County Seat*

TRANSPORTATION

Fulton County is centrally located in southern Pennsylvania with easy accessibility to Interstate Routes 68, 70 and 81 plus the Pennsylvania Turnpike. There are major thoroughfares and crossroads that provide a critical transportation and commuting link for County residents and for the significant tourist trade that takes advantage of summer and winter attractions in the County.

GENERAL DEVELOPMENT PATTERNS

The general development patterns are critical to stormwater management planning. While development is important to the County, the impacts of development could have a negative effect on the existing infrastructure as well as the environment. Development causes increases in stormwater runoff that must be managed properly. Identifying and predicting the major development patterns is the first step to managing their effects on stormwater runoff.

Fulton County has maintained a lower population density than its contiguous and neighboring counties. Fulton County's 2007 Joint Comprehensive Plan anticipates a continuation of the low population growth trend and identifies areas in the County that are more likely to experience increased development, due to their location and proximity to population centers. Fulton County's population increased at a rate of 2.97 percent between 1990 and 2000, and was slightly lower than the growth rate in Pennsylvania of 3.40 percent (United States Census Bureau, 2000). However, the County's population is expected to increase in coming decades. Growth pressures are expected to be felt along the Maryland State border, especially along Interstate-70.

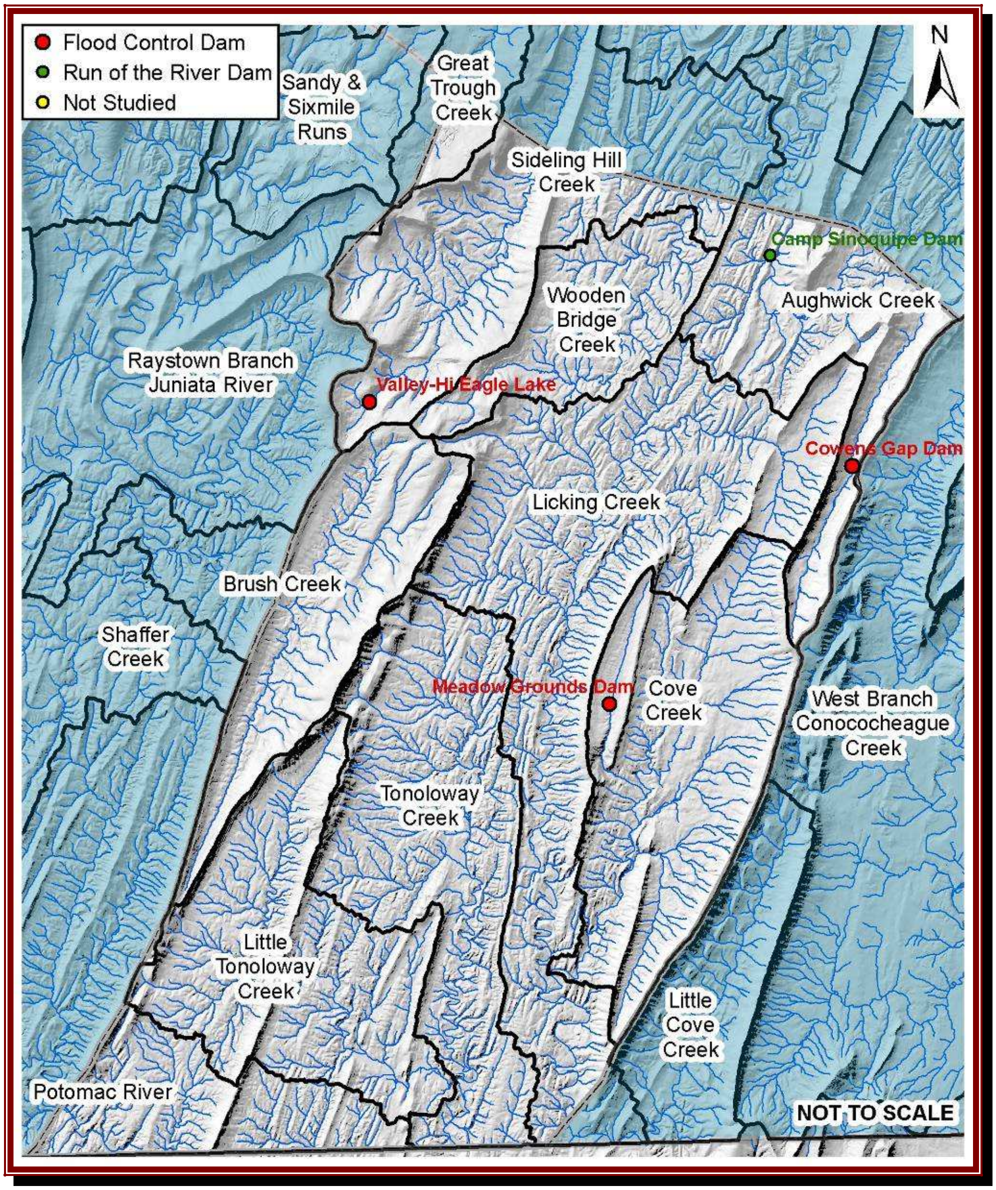
The total number of housing units increased in every municipality in the County between 1980 and 2000, with the exception of McConnellsburg Borough. The percentage increase in the number of housing units has been greater than the percentage increase in population, demonstrating the effect of declining household size. There is very little diversity in housing unit types offered in the County. The majority of the housing units are single family detached dwellings. The second most common type of housing unit is the mobile home. In addition, there are very few multi-unit structures in the County.

IMPOUNDMENTS

There are a number of small and large lakes and ponds throughout the County. Some of the major impoundments include:

TABLE 4: MAJOR IMPOUNDMENTS IN FULTON COUNTY

MUNICIPALITY	*IMPOUNDMENT NAME*
Ayr Township	Meadow Grounds Dam
Dublin Township	Camp Sinoquipe Dam
Todd Township	Cowans Gap Dam
Valley-Hi Borough	Valley-Hi Eagle Dam



TOPOGRAPHY

The region lies within the Ridge and Valley Section of the Appalachian Mountains. Typical of the Ridge and Valley region, the County has a series of small narrow, flat valleys surrounded by ridges running northeast and southwest. Sideling Hill is the principal mountain within the County boundaries with a peak elevation of 2,345-feet. Topography of the region is categorized by steep, high, generally narrow mountainous ridges and rolling intermountain valleys. Big Mount, on the Tuscarora Mountain, represents the highest point with an elevation of 2,440-feet. The lowest point is where Great Tonoloway Creek crosses the Pennsylvania-Maryland State line at an elevation of 420-feet.

WATER RESOURCES

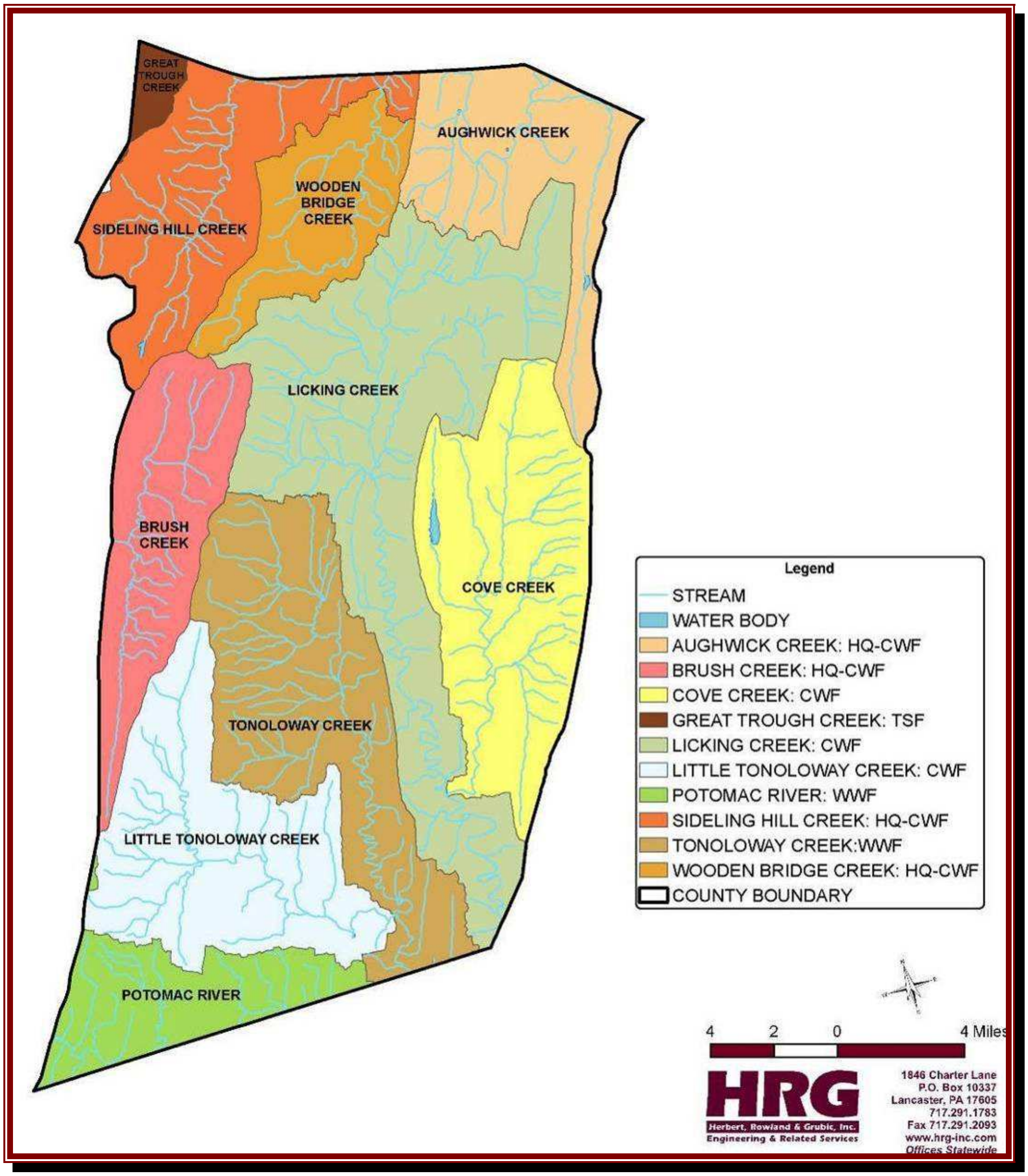
Fulton County is located entirely within the Chesapeake Bay watershed. Fulton County lies in the headwaters of both the Susquehanna and Potomac River watersheds. The northern third and western edge of Fulton County drain north to the Juniata River and eventually the Susquehanna River. The larger streams draining to the Susquehanna watershed (in Fulton County) include Brush Creek, Sideling Hill Creek, Wooden Bridge Creek, and Aughwick Creek. The other two-thirds of Fulton County drain largely to Licking Creek, Tonoloway Creek, and Little Tonoloway Creek, which are all tributaries of the Potomac River.

Being located at the "top of the hill" presents opportunities and hazards for Fulton County's residents. With the vast majority of local streams originating within the County, Fulton County does not inherit the polluted surface water and groundwater that could emanate from upstream neighbors. However, the obvious counterpoint to this advantage is the fact that degraded water bodies and water quality in Fulton County have local origins. Consequently, it becomes important to manage stormwater runoff that is originating in the County properly and efficiently.

PADEP has designated watersheds throughout the state of Pennsylvania for which Act 167 studies would be prepared. The designated watersheds in Fulton County are listed in Table 5:

TABLE 5: PADEP DESIGNATED WATERSHEDS

SUSQUEHANNA RIVER WATERSHED	POTOMAC RIVER WATERSHED
Aughwick Creek	Licking Creek
Wooden Bridge Creek	Little Tonoloway Creek
Sideling Hill Creek	Tonoloway Creek
Brush Creek	Cove Creek
Great Trough Creek	Potomac River



GEOLOGY

Fulton County is situated within the Ridge and Valley physiographic province, which is characterized by folded and faulted sedimentary rocks of early to middle Paleozoic age.

The two (2) principal features of the County's geology are the McConnellsburg Limestone Cove lying along its eastern border, and the Broad Top Coal Field which occupies approximately 8-square miles of its northwest corner, at an elevation of 2,000-feet above mean sea level, and is surrounded by a deep red shale valley.

The limestone area in the McConnellsburg Cove is considered a sensitive geologic feature because of its susceptibility of being dissolved by the action of percolating water. Once large volumes of limestone are dissolved, underground caverns are created, thus increasing the potential for surface collapse or sinkhole development. Consequently, another danger from this condition that arises is the prospect of widespread groundwater pollution.

The McConnellsburg Cove is floored with limestone, and walled in by a mountain of slate with a crest of Medina sandstone all round except on the western side. The limestone floor of the Cove is 2-miles wide and 13-miles long, pointed at the north and south ends. The Fulton County Joint Comprehensive Plan of 2007 states that a little iron ore has been found in it. Fossil ore outcrops run northward into Huntingdon County and southward along Licking Creek into Maryland.

The Broad Top Coal Field is surrounded by Sideling Hill, which is prolonged southward to the Maryland State line, but sends out a long prong south-westward called Town Hill. These mountains are outcrops of Pocono sandstone and contain a number of little coal beds. More workable coal beds are located in Wells Township on the Broad Top. Through the middle of the County passes a broad belt of Catskills, Chemung and Hamilton rocks. At the northern line is a loop of Oriskany sandstone and Lower Helderberg limestone enclosing a Clinton red shale valley with some fossil iron ore circling around the south end of Black-Log Mountain.

The land surface has been created through millions of years of tectonic and weathering forces. The geological characteristics are reflected in terms of groundwater, drainage and excavation conditions. Geological formations are categorized in groups, with 28 present in the County. Table 6 summarizes the information that was complied from the Atlas of Preliminary Geologic Quadrangle Maps of Pennsylvania.

TABLE 6: GEOLOGICAL FORMATIONS IN FULTON COUNTY

SOIL FORMATION	SYMBOL
Catskill Formation	Dck
Pocono Formation	Mp
Mauch Chucnk Formation	Mmc
Rockwell Formation	MDr
Foreknobs Formation	Df
Scherr Formation	Ds
Brallier and Harrell Formations	Dbh
Hamilton Group Formation	Dh
Allegheny Formation	Pa
Bellefonte Formation	Obf
Bloomsburg and Mifflintown Formation, undivided	Sbm
Burgoon Sandstone Formation	Mb
Clinton Group Formation	Sc
Coburn Formation through Loysburg Formation, undivided	Ocl
Irish Valley Member of Catskill Formation	Dciv
Juniata and Bald Eagle Formations, undivided	Ojb
Keyser and Tonoloway Formations, undivided	DSkt
Keyser Formation through Mifflimtown Formation, undivided	DSkm
Keyser Formation through Clinton Group, undivided	DSkc
Nittany and Stonehenge/Larke Formations, undivided	Ons
Nittany Formation	On
Onondaga and Old Part Formations, undivided	Doo
Pottsville Formation	Pp
Reedsville Formation	Or
Rockdale Run Formation	Orr
Shady Grove Formation	Csg
Tuscarora Formation	St
Wills Creek Formation	Swc

SLOPES

The slope of the land not only delineates drainage patterns, but it is an indication of the capability of the land to accommodate different types of development. The County's physical location is a major factor in explaining the slope ranges in throughout the County.

Fulton County's land area is comprised of varying degrees of slope, ranging from nearly level plateaus (1%) to severe slopes (53%). Slopes that are 15% or greater are considered environmentally sensitive due to their increased potential for erosion, low degree of slope stability and difficult access in poor weather conditions. Steep slopes can also be an inhibiting factor in road construction, on-lot wastewater systems, and stormwater management.

The general characteristics, development potentials, and limitations of each category of slope are described as follows:

0-8% slope: *94-square miles; 21.5 percent of the County*. Flat to moderate; capable of all normal development for residential, commercial, and industrial uses; involves minimum amount of earth moving; suited to row crop agriculture, provided that terracing, contour planting, and other conservation practices are followed. In Fulton County, a significant portion of the land in this slope range is wetland and would most likely be restricted from normal use or development.

9-15% slope: *89.2-square miles; 20.5 percent of the County*. Rolling terrain and moderate slopes; generally suited only for residential development; site planning requires considerable skill; care is required in street layout to avoid long sustained gradients; drainage structures must be properly designed and installed to avoid erosion damage; generally suited to growing of pastures with occasional small grain plantings.

16-24% slope: *124.2-square miles; 28.5 percent of the County*. Steep slopes; generally unsuited for most urban development; individual residences may be possible on large lot areas, uneconomical to provide improved streets and utilities; overly expensive to provide public services; foundation problems and erosion usually present; agricultural uses may be limited to pastures and tree farms.

> 24% slope: *129.4-square miles; 29.5 percent of the County*. Severe and precipitous slopes; no development of an intensive nature should be attempted; land not to be cultivated; permanent tree cover should be established and maintained; adaptable to open space uses (recreation, game farms, and watershed protection).

SOILS

A soil's composition dictates important planning characteristics such as runoff generation, ability to support infiltration, suitability for on-lot sewage disposal, and the ability to support agricultural practices. An evaluation of the fertility of the region's soils helps to identify areas best suited to long-term agricultural use and most worthy to be preserved.

Soils affect the manner in which precipitation is transformed into stormwater runoff. Different soils absorb and infiltrate precipitation at varying rates. Soils should also play a hand in land use planning, including the selection of building sites, locations of stormwater BMPs, construction limitations, agricultural production, and forest management. A significant property of soil is its ability to absorb rainfall through infiltration. This property has been extensively studied by soil scientists and a rating system has been developed, referred to as the Hydrologic Soil Grouping. Table 7 identifies the four (4) Hydrologic Soil Groups and provides a description of their characteristics and infiltration potential:

TABLE 7: HYDROLOGIC SOIL GROUPS

SOIL GROUP DESIGNATION	SOIL CHARACTERISTICS AND INFILTRATION POTENTIAL	PERCENTAGE IN FULTON COUNTY
A	Low runoff potential; high infiltration rates even when thoroughly wetted. Generally, sand, loamy sand, or sandy loam.	0.3%
B	Moderate infiltration rates when thoroughly wetted; well drained. Consist of silt loams and loams.	18.0%
C	Low infiltration rates when thoroughly wetted with a layer that impedes downward movement of water. Consist of sandy clay loams.	75.7%
D	High runoff potential; very low infiltration rates; consist of clayey soils with a high swelling potential, soils with a permanent high water table, and soils with a claypan or clay layer at or near the surface.	5.6%
Unidentified	N/A	0.4%

The farmland soils which are defined in the County are the most productive soils for crop production because they are well drained, not highly erodible, and resist flooding during the growing season.

A detailed listing of the County's soils and their classifications are provided in the County Comprehensive Plan. The following list describes the major soil associations in the County. These principle soils are named in order of their importance in the association. After each soil name, there is a brief description explaining the extent of the soil in the association. It is important to note that minor soils occurring within the association are estimated and that one soil series can occur in more than one association, depending on its relative extent.

Berks-Weikert-Bedington Association
Shallow to deep, gently sloping to very steep, well drained soils that formed in material weathered from gray and brown shale, siltstone, and sandstone; on uplands.

Hagerstown-Duffield Association
Deep, nearly level to moderately steep, well drained soils that formed in material weathered from limestone; on uplands.

Hazleton-Laidig-Buchanan Association
Deep, nearly level to very steep, well drained to somewhat poorly drained soils that formed in material weathered from gray and brown quartzite, sandstone, siltstone, and shale; on uplands.

Murrill-Laidig-Buchanan Association
Deep, nearly level to moderately steep, well drained to somewhat poorly drained soils that formed in colluviums from gray sandstone, conglomerate, quartzite, and limestone; on uplands.

Weikert-Calvin-Berks Association
Shallow and moderately deep, gently sloping to very steep, well drained soils that formed in material weathered from red, gray, and brown shale, siltstone and sandstone; on uplands.

HYDRIC SOILS

A hydric soil is one that in its un-drained condition is flooded, ponded, or saturated long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation. Hydric soils generally have a seasonally high water table. The analysis of hydric soils has recently become an important consideration when performing almost any kind of development review. These soils are important to identify and locate because they provide an approximate location where wet areas may be found. Wetland areas are lands where water resources are the primary controlling environmental factor as reflected in hydrology, vegetation, and soils. Thus, the location of hydric soils is one indication of the potential existence of a wetland area. Wetland areas are protected by federal and state regulations and should be examined before deciding on any type of development activity. Refer to the Fulton County Soil Survey which graphically depicts the approximate location of hydric soils throughout Fulton County.

FLOODPLAIN DATA

Many scenic areas in the County are located within floodplains. The Pennsylvania Floodplain Management Act requires municipalities identified as being flood-prone to enact floodplain regulations which, at a minimum, meet the requirements of the National Flood Insurance Program (NFIP). All municipalities within the County are participating in the NFIP.

A review of the Federal Emergency Management Agency (FEMA) flood insurance maps and digitized data base revealed that 100-year floodplains exists within Fulton County for the main streams draining the County. Table 8 lists Fulton County streams, at least portions of which, have either approximate or detailed studies:

TABLE 8: STREAMS WITH FEMA DEFINED FLOODPLAINS

STREAM NAME	*DESCRIPTION*
North Big Cove Creek	Detailed Study
Sideling Hill Creek	Approximate Study
Brush Creek	Approximate Study
Little Brush Creek	Approximate Study
Aughwick Creek	Approximate Study
Little Aughwick Creek	Approximate Study
Tonoloway Creek	Approximate Study
Little Tonoloway Creek	Approximate Study
Roaring Run	Approximate Study
Oregon Creek	Approximate Study
Spring Run	Approximate Study
South Big Cove Creek	Approximate Study
Cove Creek	Approximate Study
Wooden Bridge Creek	Approximate Study
Licking Creek	Approximate Study

Floodplain management is a key issue in managing stormwater within the County. It is important to realize the function of a floodplain as a natural buffer for streams during significant storm events and to understand that unmanaged development typically increases flooding levels and, thereby, the floodplain boundary.

GENERAL LAND USE

Land use is also important to stormwater planning, because the way in which the land is used, directly impacts the way rainfall is transformed into stormwater runoff.

In 2007, 61.4% of Fulton County was considered as forests; 0.3% as open water; 0.4% as wetlands; 0.2% for extractive uses; 3.6% as developed land and 34.1% was considered as agriculture. In addition, approximately 95% of the land in the 13 municipalities is associated with natural or rural landscape. Plate #5 and Plate #6 depict the County-Wide Existing and Future Land Use conditions.

Some of the major land uses in Fulton County are described below:

INDUSTRY

The majority of industry sectors experienced increases in total employment with manufacturing employing the greatest percentage of the total labor force. Industrial uses occupy a very small portion of Fulton County. Nevertheless, this area can be a potential source of stormwater runoff and water pollution due to typically high percentages of impervious surfaces on lots.

FOREST AND PARK LAND

State and Federal forest and park lands and other municipal public lands represent over 26 percent of the land surface. The majority of forest ownership is private. Forest lands are important resources that, when properly managed, can preserve surface water quality and prevent stream bank erosion and sediment pollution. Recreation/tourism is an important industry to the County as is forestry. A focus of many within the County is the protection and preservation of the forest resource while managing the economic needs of forestry operations. A concern is the impact of the forestry operations on the environment, including runoff and pollution.

AGRICULTURE

Agriculture is an important land use with respect to stormwater management as it limits development and the impervious cover of the land. However, agriculture can also be a source of pollution through siltation and nutrient runoff. Approximately, 34.1 percent of the County's land is utilized for agricultural purposes.

Recently, Fulton County's agricultural industry, while still an important part of the local economy and landscape, has declined both in the number of farms and as a source of employment. Over the last decade, there has been an average of 550-farming operations per year in Fulton County, totaling approximately 100,000-acres. In 2006, the average farm size was around 180-acres. However, the average acreage under management for many of Fulton County's farms, particularly dairy operations, has increased, as has the average size of dairy herds. It is expected that one of the primary challenges facing Fulton County in the coming years is balancing the preservation of the rural landscape with the decreasing profitability of agriculture and the corresponding increase in development pressure.

RESIDENTIAL SUBDIVISIONS

Historically, residential development has been localized and well defined. Examples of these communities include McConnellsburg, Knobsville, Hustontown, Needmore, Warfordsburg, Crystal Spring, and Wells Tannery.

According to the County Joint Comprehensive Plan of 2007, recent development patterns within the region have been in the form of low density residential development located along the region's roadway network. This sprawling development pattern has begun to erode the once vibrant villages and boroughs and has placed a strain on financing and addressing infrastructure needs.

Should the current development patterns continue the trend of growth along major road corridors, the effects on the future of the County's stormwater management problems is clear and will only magnify.

UNPAVED ROADS

Dirt and gravel roads have the potential to contribute sediment pollution to local waterways. Fulton County has approximately 160-miles of dirt and gravel roads maintained by the municipalities (Fulton County Implementation Plan, 2006). This figure does not include private and state-owned dirt and gravel roads. Fulton County Conservation District administers an active Dirt and Gravel Road Program, which by 2007 has stabilized approximately 9-miles of unpaved township roads in Fulton County. However, the program does not provide funding to address the sediment problems associated with privately owned dirt and gravel roads in the County.

Existing Municipal Regulations/Related Plans

EXISTING MUNICIPAL REGULATIONS

An analysis of existing municipal regulations is required by Act 167, to assist in developing requirements and recommendations for municipal implementation. The two most common forms of land use planning and regulation in Pennsylvania are the Subdivision and Land Development Ordinance (SALDO) and the Zoning Ordinance. The SALDO is a regulating document, adopted by municipalities, that sets forth how parcels of land may be subdivided or developed. Some of the components covered by a SALDO may include: street specifications, lot layouts requirements, setbacks requirements, plan submission requirements, approval processes, and required easements. A Zoning Ordinance regulates how parcels of land may be used. A Zoning Ordinance is commonly broken down into districts, which may include agricultural, residential, commercial and industrial. The regulations then outline which uses are permitted in which district, which uses require special approvals, and other regulations.

SUBDIVISION AND LAND DEVELOPMENT ORDINANCES (SALDO)

Fulton County is made up of thirteen municipalities: eleven (11) townships and two (2) boroughs. Of those municipalities, all eleven (11) townships have a SALDO in place. The SALDOs vary in date of adoption from the early 1970s to as recently as 2007. They also vary in degree of regulation and breadth of coverage, based upon the needs of the municipality and community residents.

ZONING ORDINANCES

The only municipality in Fulton County with a Zoning Ordinance is McConnellsburg Borough. The existing ordinance was adopted in 1995. The Borough of McConnellsburg experiences the most mixed uses and therefore necessitates a need for a Zoning Ordinance. The remaining municipalities in Fulton County are very rural and zoning is not seen as a needed growth management tool at this time.

Table 9 provides a brief summary of existing municipal regulations. In addition, refer to Appendix B for a more detailed summary of existing regulations.

TABLE 9: MUNCIPAL ORDINANCE MATRIX

MUNICIPALITY	STORMWATER MANAGEMENT	SUBDIVISION AND LAND DEVELOPMENT	ZONING	FLOODPLAIN MANAGEMENT
Ayr Township	Cove Creek Watershed Plan (1993)	Adopted in 1995; E&S (Section 511); Drainage (Section 509)	No ordinance	FEMA FIRM Boundaries; Regulations in Building Permit Ordinance.
Belfast Township	No ordinance	Adopted in 1990; E&S (Section 807); Drainage (Section 804.S)	No ordinance	FEMA FIRM Boundaries
Bethel Township	No ordinance	Adopted in 1982; E&S (Section 1110); Drainage (Section 1109)	No ordinance	FEMA FIRM Boundaries
Brush Creek Township	No ordinance	Adopted in 1972; Stormwater (Section 804.S)	No ordinance	FEMA FIRM Boundaries
Dublin Township	No ordinance	Adopted in 1995; E&S (Section 511); Drainage (Section 509); Stormwater (Section 602.7)	No ordinance	FEMA FIRM Boundaries; Regulations in SALDO (Section 512)
Licking Creek Township	No ordinance	Adopted in 1972; E&S (Section 807); Stormwater (Section 804.S)	No ordinance	FEMA FIRM Boundaries
McConnellsburg Borough	Cove Creek Watershed Plan (1993)	No Ordinance	Adopted in 1995	FEMA FIRM Boundaries
Taylor Township	No ordinance	Adopted in 1972; E&S (Section 807)	No ordinance	FEMA FIRM boundaries
Thompson Township	Cove Creek Watershed Plan (1993)	Adopted in 2007; E&S (Section 610.6); Drainage (Section 610.4); Stormwater (Section 610.2)	No ordinance	FEMA FIRM Boundaries; Regulations in SALDO (Section 610.10)
Todd Township	Cove Creek Watershed Plan (1993)	Adopted in 2006; E&S (Section 512); Stormwater (Section 510)	No ordinance	FEMA FIRM Boundaries; Regulations in SALDO (Section 513)
Union Township	No ordinance	Adopted in 1982; E&S (Section 1111); Drainage (Section 1110)	No ordinance	FEMA FIRM Boundaries
Valley-Hi Borough	No ordinance	No ordinance	No ordinance	FEMA FIRM Boundaries
Wells Township	No ordinance	Adopted in 1979; E&S (Section 807); Stormwater (Section 804.S)	No ordinance	FEMA FIRM Boundaries; Regulations in Building Permit Ordinance (Section 4.01.B)

RELATED PLANS/PROGRAMS/ACTIVITIES

Prior to beginning a County-Wide Act 167 Stormwater Management Plan, Fulton County had created a variety of other plans to maintain its rural character, preserve natural resources, and guide the growth of the County. Analysis of existing related plans is required by Act 167. The following is a detailed summary of a few existing plans. Following the summary, Table 10 lists additional related plans, existing programs, and past activities.

Summary of Cove Creek Watershed Plan (1993)

The Cove Creek Watershed Stormwater Management Plan was developed in 1993 under the provisions of the Pennsylvania Stormwater Management Act, Act 167 of 1978 and was the only stormwater management planning implemented within Fulton County, prior to the County-Wide stormwater management efforts beginning in 2008. In 1993, within the Cove Creek watershed, the stormwater planning process involved a committee represented by the Fulton County Conservation District, McConnellsburg Borough, Ayr Township, Thompson Township and Todd Township. This watershed was chosen for stormwater planning due to the existence of stormwater related issues, the presence of the highest population density in Fulton County, and the greatest potential for future development.

The plan was not written to control or reduce development within the Cove Creek watershed. It was created to provide standards and criteria, to be incorporated into local ordinances, and manage peak runoff flows throughout the watershed as development occurs. While not developed to solve existing flooding or runoff problems, the plan worked to identify existing flooding or runoff problems for future correction and to assure that problems would not be exacerbated.

Preparation for the Cove Creek Watershed Plan involved:

- Collection of present and future land use information
- Identification of floodplains
- Analysis of obstructions and drainage problem areas
- Review of existing municipal ordinances
- Computer analysis of the watershed runoff conditions
- Development of technical standards and criteria for development activities
- Preparation of a model stormwater management ordinance
- Providing technical references and data

The plan included the development of a model stormwater management ordinance, adopted by the four (4) municipalities present on the committee, which included the following key items:

- All site developments creating 10,000 square feet or more of impervious cover shall submit a drainage plan to the municipality for review.
- Post-development rates of runoff from any development site shall not exceed the peak rates of runoff prior to development for the 2- and 10-year design storms.
- Stormwater management detention facilities shall be designed to provide an emergency spillway for flows greater than a 10-year storm through the 100-year storm.
- The following activities were eligible for exemptions to the requirements: Any regulated activity creating 10,000 square feet or less of impervious cover, disturbance associated with existing one and two family dwellings, and agricultural activities such as gardening, growing crops or grazing animals.

The effectiveness of the Cove Creek Watershed Stormwater Management Plan and its associated ordinance was to be evaluated at least every five years and updated as needed to address changes in stormwater runoff and additional drainage problems as a result of land development activities. As of the date of this Plan, no updates or revisions had been made.

Summary of Fulton County Act 167 County-Wide Stormwater Management Plan – Phase I (2008)

Stormwater planning requirements, as set forth by PADEP, require that two (2) phases of planning be complete. Phase I is designed to compile basic information for stormwater planning, provide a brief analysis of the study area, and create a scope for what will be completed during Phase II. Phase II contains all of the background information, watershed modeling, detailed studies and a Stormwater Management Model Ordinance. Phase I for Fulton County included: a summary of watershed characteristics; an inventory of relevant problems; and a proposed scope of study, schedule, and budget for completing Phase II.

Summary of Fulton County Joint Comprehensive Plan – "Moving Fulton Forward" (2007)

In February 2005, public officials and residents of Fulton County held a meeting and came to the conclusion that "change is inevitable." It could no longer be denied that development would arrive in Fulton County, sooner or later. Along with various county agencies, twelve (12) of the thirteen (13) Fulton County municipalities agreed that a new Joint Comprehensive Plan was needed to guide the County for the next 10 to 15 years. The brand "Moving Fulton Forward" was selected to represent the County's identity and image, and applies not only to the document, but the planning process as well.

Through research, tours, meetings, workshops, and a future land use design Charrette, it was established that a primary emphasis of the plan would be to conserve the small-town character and appearance, the agricultural prosperity, and the unique rural landscape of Fulton County's communities. During the eighteen (18) month planning process, a plan was created that provides the framework for growth and development, and also aims to preserve the quality of life within Fulton County for generations to come. The goals and objectives of the plan are as follows:

- Establish communication and coordination between public and private stakeholders regarding existing and future social, cultural, environmental and economic issues facing communities.
- Provide a wide range of housing types and level of affordability with respect to the surrounding environment and adequacy of infrastructure and services.
- Attract and maintain a healthy diversity of business.
- Capitalize on local assets such as existing employment opportunities, natural resources, a well-trained workforce and a strong work ethic.
- Preserve and enhance the diversified mix of rural and natural landscapes and uses.
- Provide for and accommodate a healthy mix of residential, institutional, industrial, and commercial land uses within and around the designated growth areas.
- Ensure a safe, adequate, diversified multi-modal transportation system and network to serve the present and future needs of residents and businesses.
- Ensure accessibility to and the provision of adequate community facilities, services and programs to meet the needs of existing and future residents and business owners.
- Provide for a coordinated and comprehensive network of parks, recreation, open space, and greenway areas that will meet the active and passive recreational needs of existing and future residents.
- Preserve, sustain, and enhance important natural, scenic, cultural, and historical assets while planning and accommodating more growth and guiding development away from these assets.

Summary of Fulton County Comprehensive Plan – "A Planning Guide for the 21st Century" (2000)

In May 2000, the Fulton County Board of Commissioners adopted the Comprehensive Plan as their official statement of public policy pertaining to growth and development in the County. The plan serves as a reference for needed policy changes and continues to serve as the basis for planning improvement and the rendering of services under the County's jurisdiction. The plan provides necessary information to other local, state, and county agencies to further the coordination of various planning and development programs. Additionally, the plan provides citizens and members of the business community with information to facilitate planning, protect existing development, preserve the environment, and identify opportunities for positive action. The goals and action strategies of the plan are as follows:

- Create jobs and induce private investments in Fulton County.
- Preserve the rural character of Fulton County while providing for the orderly growth and expansion of employment centers.
- Provide a broad range of housing opportunities for diverse income levels, while preserving the existing housing stock and creating a variety of new housing opportunities for current and future residents of Fulton County.
- Improve mobility (transportation) for all Fulton County residents.
- Maintain and improve the quality of life and environment for residents of Fulton County through the provision of parkland and recreational facilities.
- Provide accessible community facilities and services which meet residents' needs through the cooperation of the public and private sectors.
- Sustain and enhance environmentally sensitive areas for the benefit of current and future generations while accommodating planned growth.
- Preserve Fulton County's cultural heritage and historical resources.
- Achieve a higher level of inter-governmental coordination and public-private cooperation.

Summary of Southern Alleghenies Greenways and Open Space Network Plan – "Connections in Our Landscape" (2007)

The Southern Alleghenies region, situated in south-central Pennsylvania between Pittsburgh and Harrisburg, features 4,600-square miles of various man-made and natural resources such as the historic Town of Bedford, the Laurel Highlands and the Juniata River. These resources provide the region's 470,000 residents with opportunities for cultural and natural resource preservation, recreation and economic development. The region is made up of the following six (6) counties: Bedford, Blair, Cambria, Fulton, Huntingdon, and Somerset.

The Southern Alleghenies Greenways and Open Space Network Plan outlines a series of policies and projects for linking existing natural and man-made resources within the region's six counties. By connecting these assets into a comprehensive greenway network, the region's natural resources are leveraged to promote and strengthen their value to the region for a wide range of purposes.

In addition to delineating the elements that make up the greenway network, the plan identifies a strategic framework for implementation and management. This framework provides an overall strategy for prioritizing greenways or project corridors as well as a palette of potential implementation tools and a summary of support and funding sources. The purpose and goals of the plan are as follows:

- Conserve important natural resources.
    - Protect the region's most sensitive and unique natural areas and habitats by reserving sensitive and contiguous lands for greenways and open space areas.
    - Identify and manage watershed issues within the region to minimize negative impacts on natural resources.
    - Designate protected areas for wildlife habitat and migration patterns.
- Expand recreation opportunities.
    - Leverage the broad range of existing committed open space investments within the region's recreational network.
    - Delineate a formal system of land and water trails to link regionally significant recreation assets and heritage sites.
- Celebrate cultural heritage.
    - Establish formal linkages between cultural resources to increase tourism and awareness within the region.
    - Create educational opportunities and increase the visibility of cultural assets by integrating them into a publicly accessible trail network.
- Bolster economic development.
    - Capitalize on nationally and state-significant efforts, such as the Great Allegheny Passage, the Rock Run Recreation Area, Main Line Canal Greenway, and the Flight 93 Memorial, to strengthen regional economic development.
    - Expand local economic opportunities through the interconnection of various existing and future natural and cultural attractions, urban areas and historic sites.

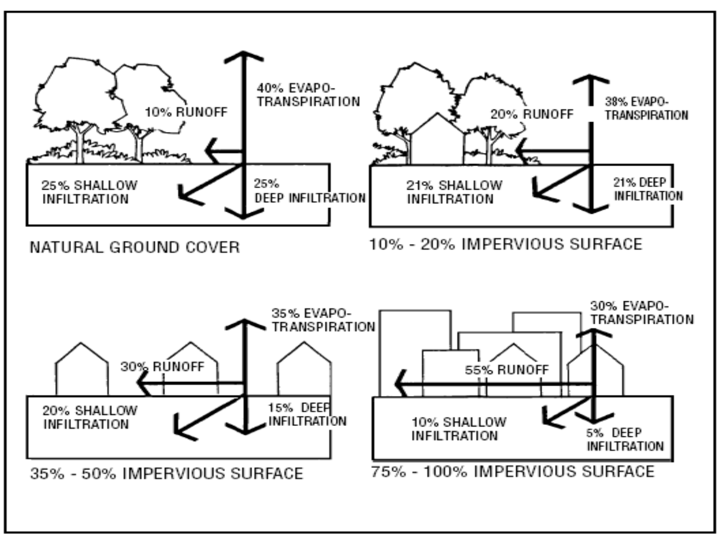
- Increase pedestrian and bicycle mobility.
  - Construct connections between county and regional trails to improve east-west travel.
  - Utilize existing railroad corridors, ridge tops and stream valleys to expand the region's trail network.
- Promote healthy lifestyles.
  - Expand trail opportunities to enhance the physical, mental and spiritual wellness among the region's residents.
  - Develop a natural resource-based network of greenways and open spaces that provide recreation uses such as hiking or cycling.

TABLE 10: SUMMARY OF RELATED PLANS/PROGRAMS

TITLE	*DATE*	*AUTHOR/SPONSOR*	*SUMMARY*
Licking/Tonoloway Creek Watershed Assessment and Management Plan	2001	Fulton County Conservation District	1. Macro-invertebrate and stream chemistry assessment; spring and groundwater sampling, agricultural conservation practices, and stream restoration projects.
Water Resources Forum	2001-2004	Fulton County Conservation District	1. Local citizens learn and discuss water resource issues.
Adopt – A – Stream	2003	Fulton County Conservation District	1. Working in conjunction with the PA F&B, a reach of Spring Run was included in the Adopt – A – Stream program.
Spring Run Watershed Technical Assessment	2002	Growing Greener Grant	1. Develop a comprehensive stream corridor evaluation of the Spring Run watershed.
Spring Run Agricultural BMP Nutrient Reduction Project	2004	Fulton County Conservation District	1. Implemented (3) BMP on agricultural operations to reduce nutrient and sediment loading.
Big Cove Creek Urban Stream Restoration Project	2003	Fulton County Conservation District	1. Stream bank restoration. 2. Demonstration project. 3. Restoring stream form and function.
Potomac and Juniata River Watersheds Agricultural BMP Project	2004	Fulton County Conservation District	1. Inventory existing agricultural conservation practices. 2. Looking at increased use of no-till planting and the use of cover crops.
Raystown Branch – Potomac – Aughwick Watersheds	2003	Fulton County Conservation District	1. Implement a cover crop program. 2. Reduce nutrient loading and soil erosion.

Fulton County Significant Problem Areas

Improper development causes a wide range of adverse impacts on water resources. Urbanization typically results in impervious areas being directly connected to stormwater conveyance systems (including roof drains and driveways connected to streets and curbs to inlets to pipes) which then are discharged to streams directly or through man-made channels. This results in stormwater being conveyed as fast as possible to receiving waters (and away from properties), which decreases the opportunity for infiltration, water quality treatment, and evapotranspiration. It is now recognized that because stormwater is discharged to streams in this manner, even small storm events can result in increased runoff flows that significantly increase the frequency and duration of stream flows.



Impact of Urbanization on Runoff
source: Center for Watershed Protection

The purpose of this section is to identify the location and nature of existing drainage problems throughout Fulton County, determine conceptual solutions for the most significant problems, and provide recommendations for implementation. The basin characterization and problem identification began with a review of existing information concerning the County's stormwater system, streams, and tributary drainage basins. Field visits were conducted on May 6th and May 7th, 2009.

Nine (9) of the thirteen (13) municipalities in Fulton County reported problem areas through a questionnaire distributed during Phase I and reviewed during Phase II of the Act 167 planning process. Field reconnaissance of the problem areas occurred during Phase II to document existing conditions, assess problem locations, identify the general contributory drainage patterns and determine watershed divides. Refer to Plate #4 – Problem Area Location and Existing Stormwater Systems for the location of the identified problem areas included in this Plan.

TABLE 11: SUMMARY OF FULTON COUNTY PROBLEM AREAS

MUNICIPALITY	PROBLEM AREA (CURRENT ID)	NUMBER OF PROBLEM AREAS	PROBLEM TYPE
Dublin Township	P1, P2, P3, P4, P5	5	Flooding, Erosion
Brush Creek Township	P6, P7	2	Debris, Flooding
Licking Creek Township	P8, P9, P10, P11, P12, P13, P14, P15, P16, P17, P18	11	Debris, Flooding, Sediment, Erosion
Todd Township	P19, P20, P21, P22, P23, P24	5	Debris, Flooding, Erosion
McConnellsburg Borough	P25, P26	2	Flooding, Erosion
Belfast Township	P27	1	Flooding
Ayr Township	P28	1	Flooding
Union Township	P29, P30	2	Flooding, Erosion
Thompson Township	P31	1	Flooding of Stream Ford

TABLE 12: FULTON COUNTY PROBLEM AREAS LOCATIONS

ID	MUNICIPALITY	LOCATION
P1	Dublin Township	Boy Scout Road
P2	Dublin Township	Boy Scout Road – Township Bridge
P3	Dublin Township	1/4 West of Plum Run Bridge on Plum Hollow Road Crossing Culvert
P4	Dublin Township	Turnpike Flooding to Properties (Burnt Cabins)
P5	Dublin Township	Decorum Road (Burnt Cabins)
P6	Brush Creek Township	Intersection of Spade Road and Old 126
P7	Brush Creek Township	Layton Road (Walt Schrierver Property)
P8	Licking Creek Township	Pump Station Road – Roadway Washout
P9	Licking Creek Township	Lear Road – Roadway Washout
P10	Licking Creek Township	Circle Drive – Roadway Washout
P11	Licking Creek Township	Possum Hollow Road
P12	Licking Creek Township	Back Hollow Road
P13	Licking Creek Township	Possum Hollow and Route 655
P14	Licking Creek Township	Diamond Road
P15	Licking Creek Township	Grade Road – Roadway Washout
P16	Licking Creek Township	Owl Creek Road
P17	Licking Creek Township	Creek Road at the new Bridge
P18	Licking Creek Township	Creek Road
P19	Todd Township	Johnston Drive
P20	Todd Township	Big Cove Creek as it flows along the west side of town
P21	Todd Township	Cooper Lane
P22	Todd Township	Fairgrounds to K.G. Richards flood area
P23	Todd Township	Between Wood and Patterson Streets
P24	Todd Township	Peach Orchard Road at Bill Cunningham
P25	McConnellsburg Borough	West of the intersection of Lincoln Way West and South First Street
P26	McConnellsburg Borough	East of the intersection of Crystal Drive and East Poplar Street
P27	Belfast Township	Gem Curve Bridge – US 522
P28	Ayr Township	Big Cove Tannery Road
P29	Union Township	Slide on Old 126 above Interstate 70
P30	Union Township	South Hixon Road – Fording Problem
P31	Thompson Township	Gordon Road

The reported problem areas occur due to several causes. Some problems occur in areas where the existing storm drain system has insufficient capacity. Other problems occur in areas where there is an incomplete system or a lack of a formal/comprehensive collection and conveyance system. Some problems occur when maintenance is required; for example, sometimes catch basin inlets become clogged and local flooding occurs. In addition, some problem areas are located in the floodplain area. A large number of these stormwater related problems have been traced back to uncontrolled runoff from local and upstream areas, inadequate culverts or bridges, and obstructions in the system that are blocking the natural flow of stormwater.

This Plan has identified some drainage problems that occur on a regular basis. Continued improper development within the Fulton County will amplify these problems. Remedial actions will be necessary to correct drainage problems. In the long term, a comprehensive approach should be considered to tackle these problems. This approach will have to incorporate regulations and development standards into local ordinances, consider both on-site and off-site drainage, provide a consistent stormwater management approach between communities, use natural existing features for the transport and storage of stormwater, and consider both quantity and quality of water.

SYSTEMATIC APPROACH FOR THE CORRECTION OF EXISTING PROBLEM AREAS

Based on the above description and summary, it is encouraged that each municipality take the following steps to implement solutions to the existing stormwater problem areas:

1. Review the list of known problem areas contained within their municipality and review the conceptual solutions as included in this Plan (Appendix C).

2. Prioritize the list of stormwater problems within their municipality based on frequency of occurrence, potential for injury to persons or property, damage history, public perception of the problems, estimated project costs, and other appropriate cost/benefit criteria.

3. For the top priority stormwater problems in the municipality, it is recommended that detailed engineering evaluations be conducted to determine the exact nature of the problems (if not known), alternative detailed solutions be designed, cost estimates for the alternative solutions be provided, and a course of municipal action is encouraged. The number of stormwater drainage problems to be evaluated by a municipality should be based on a schedule compatible with completing engineering studies on all problem areas within approximately five (5) years. The hydrologic model for used in this Act 167 study are available to provide peak flow data as input to the engineering studies for Cove Creek and Licking Creek subwatersheds.

4. On priority and cost basis, it is recommended to incorporate implementation of recommended solutions to the problems in the annual municipal capital budget or the municipal maintenance budget, as funds are available. Other options to assist in project implementation include applying for Federal and State financial assistance through either loans or grants programs.

It is important to emphasize that the above stated procedure for dealing with existing stormwater problem areas is not a mandatory action placed on municipalities with the adoption of the Plan by the Fulton County Commissioners. Rather, it presents a systematic method for municipalities to approach their existing problems. The key elements involved in the success of this strategy will be the dedication of the municipalities to secure funding and construct the corrective measures. The final design of any solution should be consistent with all stormwater runoff control criteria specified in the Plan. The latter element is essential to ensure that remedial measures do not become obsolete (under-designed) by increases in the volume of stormwater runoff with continued development.

Appendix C provides a summary of all the problem areas as well as conceptual solutions for the problem areas.

Stormwater master planning is one way to address all of the needs and potential threats to a watershed. However, implementation of the results of the planning can be difficult and may not be economically feasible for many communities. Looking ahead, it is expected that the status of the current stormwater infrastructure will keep deteriorating with time. Without increasing expenditures for maintenance and other improvements and imposing stricter regulations to control the possible negatives environmental effect of new development, the existing infrastructure will continue to deteriorate faster than the communities' ability to fix and maintain it.

While a certain amount of flooding during heavy rain is natural in streams, careful and proactive maintenance should prevent serious problems associated with flooding and erosion. During periods of flooding, water quantity is typically the greatest concern of municipal officials, however maintaining water quality is also important. Simple recommended maintenance activities to reduce flooding and maintain water quality include:

- ✓ Monitoring changes that might be occurring within the stream bed or banks
- ✓ Keeping waterways clear of obstructions
- ✓ Removing litter and rubbish and disposing of litter properly
- ✓ Monitoring sources of upstream pollution
- ✓ Keeping clear overland flow paths that stream flow takes during floods
- ✓ Preventing bank erosion by maintaining vegetation near stream banks
- ✓ Clearing away animal droppings
- ✓ Performing regular street sweeping
- ✓ Sweeping paths rather than hosing them
- ✓ Capturing and reusing rainwater for household uses such as watering the garden
- ✓ Emptying swimming pools into the sanitary sewer and not the storm sewer
- ✓ Discharging stormwater from impervious surfaces, such as roofs and driveways into gardens, lawns and rainwater planters

Technical Standards

The field of stormwater management has evolved rapidly in recent years as research has increased the comprehension of how stormwater runoff is interrelated with the rest of our natural environment. Stormwater management practices will continue to evolve as additional knowledge becomes available. Effective resource management involves balancing the positive and negative effects of all potential actions. These actions must be considered, and the individual management techniques which provide the best known balance must be chosen for implementation. The goal of this Plan is to manage stormwater as a valuable resource, and to manage all aspects of this resource as effectively as possible.

It is important to note that the criteria and standards developed for this Plan will be applied to all lands contained within Fulton County. The criteria and standards from the Cove Creek Act 167 Plan completed in 1993 will be superseded with this Plan.

TABLE 13: SUMMARY OF TECHNICAL CRITERIA

SIZING CRITERIA	*DESCRIPTION OF STORMWATER SIZING CRITERIA*
Volume Controls– Using Control Guideline 1 (CG-1)	- Applicable for any size of development - Management of the 2-year, 24-hour storm event - Existing non-forested pervious areas to be considered Meadow (Good) - 20% of existing impervious area, contained within the new proposed limit of disturbance, to be considered Meadow (Good) Use Worksheets 1-5*
Volume Controls – Using Control Guideline 2 (CG-2)	- Applicable for development sizes 0 to 1 acre - Capture the first 2" of runoff from new impervious areas - Permanently remove at least the first 1" of captured runoff - As appropriate, infiltrate at least the first 0.5" of captured runoff Use Worksheets 7-8*
Water Quality Controls	- 85% reduction in post-development particulate associated pollutant load (TSS) - 85% reduction in post-development total phosphorus loads (TP) - 50% reduction in post-development solute loads (NO3-N) Use Worksheets 10-13*
Peak Rate Controls	- 1-year, 2-year, 10-year, 25-year, 50-year, & 100-year storm events – See Release Rate Map for Cove Creek and Licking Creek watersheds - 1-year, 2-year, 10-year, 25-year, 50-year, & 100-year storm events – 100% Release Rate for all lands within Fulton County other than Cove Creek and Licking Creek watersheds
Riparian Buffers	- New development must maintain a 100-foot riparian buffer that prevents the placement of any new impervious area within the riparian buffer

* Worksheets can be found in the Pennsylvania Stormwater Best Management Practices Manual - December, 2006 – Chapter 8, pages 28 thru 44.

This Plan presents a unified approach for sizing stormwater BMPs throughout Fulton County to meet peak rates and volume control guidelines, meet pollutant removal goals, maintain groundwater recharge, and reduce channel erosion. The remainder of this section describes the sizing criteria, and presents guidance on how to properly compute and apply the required design volumes. These criteria were obtained from the BMP Manual and are to be adopted, for all lands contained within Fulton County.

The following established guidelines reflect ten (10) basic and fundamental principles of stormwater management. The principles are listed below to emphasize their importance as the foundation for the technical guidelines that follow:

1. Managing stormwater as a resource
2. Preserving and utilizing existing natural features and systems
3. Managing stormwater as close to the source as possible
4. Sustaining the hydrologic balance of surface and ground water
5. Disconnecting, decentralizing and distributing sources and discharges
6. Slowing runoff down, and not speeding it up
7. Preventing potential water quality and quantity problems
8. Minimizing problems that cannot be avoided
9. Integrating stormwater management into the initial site design process
10. Inspecting and maintaining all BMPs

The focuses of the following guidelines are to provide stream channel protection and water quality protection from the frequent rainfalls that comprise a major portion of runoff events throughout Fulton County. These guidelines are essential for:

Protecting Stream Channel Morphology: Increases in uncontrolled runoff volume results in an increase in the frequency of bank-full or near bank-full flow conditions in stream channels. The increased presence of high flow conditions has a detrimental effect on stream shaping, including stream channel and overall stream morphology. Consequently, stream bank erosion is greatly accelerated. As stream banks are eroded and undercut; meanders, pools, riffles, and other essential elements of stream habitat are lost or diminished. Strategies employed by the Control Guidelines include a combination of volume reduction and extended detention to reduce the bank-full flow occurrences.

Maintaining Groundwater Recharge: Under natural conditions, a significant percentage of the annual precipitation infiltrates into the soil mantle under natural conditions. A majority of the precipitation is absorbed and transpired by vegetation. Part of the infiltrated water moves in the soil mantle to emerge as springs and seeps, feeding local wetlands and surface streams. The rest of the infiltrated water enters deep groundwater aquifers that supply drinking water wells. Without groundwater recharge, surface stream flows and supplies of groundwater for wells may diminish or disappear during drought periods. Based on land use and soil characteristics, certain land areas recharges more groundwater than others; therefore, protecting critical recharge areas is very important in maintaining the hydrologic water cycle.

Preventing Downstream Increases in Runoff Volume and Flooding: Increased volume of runoff and prolonged duration of runoff from development sites can increase peak flow rates and duration of flooding from stormwater runoff caused by relatively small, higher frequency rain events. Replicating pre-development stormwater runoff volumes for small storms can substantially reduce the problem of frequent "nuisance" flooding. Although the control of runoff volumes from small storms significantly helps to reduce flooding, during large storms events, additional measures may be necessary to provide adequate relief from the serious flooding that occurs during such low frequency events.

Replicating Pre-Development Hydrology: The objective of stormwater management is to develop a design or system that replicates the natural hydrologic conditions of a site to the maximum extent practicable. However, the very process of clearing the existing vegetation from the site removes the evapotranspiration component of the natural hydrologic regime. Unless the evapotranspiration component is replaced in post-development, the stormwater runoff increase can be substantial.

VOLUME CONTROL

Developed sites experience an increased volume of runoff during all precipitation events. Reducing the total volume of runoff from a site is the key in minimizing the impacts of development. Volume reduction can be achieved through reuse, infiltration, transpiration, and evaporation. When infiltration is used as a stormwater management technique, multiple goals are achieved through implementation of a single practice. Infiltrating runoff reduces release rates, reduces release volumes, increases groundwater recharge, and provides a level of water quality improvement.

Control Guideline 1 (CG-1)

- CG-1 defines the storage volume required to ensure that the regulated activity does not increase the total runoff volume for the 2-year/24-hour event.
- A regulated activity is considered any earth disturbance activity or any activity that involves the alteration or development of land in a manner that may affect stormwater runoff.
- CG-1 is applicable for any sized regulated activity.
- CG-1 assumes that existing non-forested pervious areas must be considered meadow (good condition) for pre-development hydrologic calculations.
- CG-1 assumes that twenty (20) percent of existing impervious area, when present on a project site, and contained within the new proposed limit of disturbance, must be considered meadow (good condition) for pre-development hydrologic calculations for redevelopment.

Control Guideline 2 (CG-2)

- CG-2 is independent of site constraints, and should be considered if CG-1 is not followed.
- CG-2 is not applicable for regulated activities greater than one (1) acre.
- CG-2 sizes stormwater facilities to capture at least the first two (2) inches of runoff from all contributing new impervious surfaces.
- Of the two (2) inches captured, at least the first one (1) inch of stormwater runoff from the new impervious surfaces shall be permanently removed from the runoff flow, i.e. it shall not be released into the Surface Waters of the Commonwealth. Removal options include reuse, evaporation, transpiration, and infiltration.
- As applicable, infiltration facilities should be designed to accommodate infiltration of the entire permanently removed runoff volume, however, in all cases at least the first one-half (0.5) inch of the permanently removed runoff should be infiltrated.

WATER QUALITY CONTROL

The Volume Control achieved through applying CG-1 and CG-2 may also remove a major fraction of particulate-associated pollutants from impervious surfaces during most storms.

CG-1 will provide water quality control and stream channel protection and may provide flood control protection for most storms if the BMPs drain reasonably well and are adequately sized and distributed.

CG-2 will not fully mitigate the peak flow rate for larger storms, and will require the addition of secondary BMPs for peak rate control. These secondary BMPs may also provide water quality control. When these secondary BMPs are added to assure peak flow rate mitigation during severe storms, the incorporation of vegetation can provide effective water quality controls.

Control Guideline for Total Water Quality

- Achieve an 85% reduction in post-development particulate associated pollutant load (as represented by Total Suspended Solids (TSS)).
- Achieve an 85% reduction in post-development total phosphorus loads (TP).
- Achieve a 50% reduction in post-development solute loads (as represented by nitrates (NO3-N)).

The Total Water Quality Control Guideline is a set of performance-based goals. The guideline does not represent specific effluent limitations, but presents composite efficiency expectations that can be used to select appropriate BMPs.

These pollutant reductions may be estimated based on the pollutant load for each land use type and the pollutant removal effectiveness of the proposed BMPs, as shown in Chapters 5 and 6 and discussed in Chapter 8 of the BMP Manual.

When the proposed development plan for a site is measured by type of surface (roof, parking lot, driveway, lawn, etc.), an estimate of potential pollutant load can be made based on the volume of stormwater runoff from those surfaces, with a flow-weighted pollutant concentration applied. The total potential non-point source load can then be estimated for the parcel, and the various BMPs, both structural and non-structural, can be considered for their effectiveness in pollutant removal. This method is described in detail in Chapter 8 of the BMP Manual.

PEAK RATE CONTROL (RELEASE RATES)

Peak rate controls have been the primary method of implementing stormwater management controls for many years. However, peak rate controls are generally applied to individual sites with little to no consideration given to how the site discharge impacts overall stream flows. It is necessary to consider the cumulative effects of site level peak rate controls, and their contribution to the overall watershed hydrology, in order to control regional peak flows. This is accomplished through hydrologic modeling of the entire watershed. The intent of the modeling is to analyze the flow patterns of the watershed, the impact of development on those patterns, and, if necessary, develop release rates for various subwatersheds such that the rate of release of the increased volumes of runoff generated is not detrimental to downstream areas.

In some subwatersheds, it is necessary to implement reduced release rates that require sites to discharge at flows lower than those calculated for pre-development. This is due to the timing of the peak flows from all of the subwatersheds, and how flows from the subwatershed in question impacts the overall stream flows. Variable release rates for subwatersheds throughout a watershed are an important part of achieving regional peak flow controls. The proposed release rates for this Plan fall into two categories:

Control Guidelines for Peak Rate Control

- Areas covered by a Release Rate Map (Cove Creek and Licking Creek watersheds):
  - For the 1-, 2-, 10-, 25-, 50-, and 100-year storms, the post-development peak discharge rates will follow the applicable Release Rate Map.

- Areas not covered by a Release Rate Map:
  - Post-development peak discharge rates shall not exceed the pre-development peak discharge rates for the 1-, 2-, 10-, 25-, 50-, and 100-year storms. If it is shown that the peak rates of discharge indicated by the post-development analysis are less than or equal to the peak rates of discharge indicated by the pre-development analysis for 1-, 2-, 10-, 25-, 50-, and 100-year, 24-hour storms, then the requirement of this section has been met. Otherwise, the applicant shall provide additional controls to satisfy the peak rate of discharge requirement.

The general approach employed in Fulton County to establish release rates for each subwatershed within Cove Creek and Licking Creek was by determining the peak rate of runoff from the subwatersheds and their contribution to the peak discharges in downstream reaches. This procedure was accomplished using the HEC-HMS modeling program developed by the U.S. Army Corps of Engineers. The final modeling of this Plan provides release rates for the Cove Creek and Licking Creek watersheds that do not significantly increase (less then a 1%) the full-build out future peak flows above the existing condition peak flows at any point within the watersheds.

Refer to Appendix A – Technical Standards, for additional technical information regarding these release rates.

RIPARIAN BUFFERS

The riparian buffer is the transitional zone between the aquatic zone and adjacent uplands. It generally includes the stream banks, floodplain, and any adjacent wetlands. Natural riparian buffers are typically covered with trees, shrubs, and other types of native vegetation, all of which provide a natural buffer between waterways and human land use as well as providing vital and unique natural habitat.

Control Guidelines for Riparian Buffers

- New development that exceeds the threshold limits established in the Model Ordinance must maintain a 100-foot riparian buffer (100-foot on each side of an intermittent or perennial stream) that prevents the placement of any new impervious area within the riparian buffer.

- New development that exceeds the threshold limits established in the Model Ordinance must maintain a 100-foot riparian buffer around the perimeter edge of any lake or pond that prevents the placement of any new impervious area within the riparian buffer.

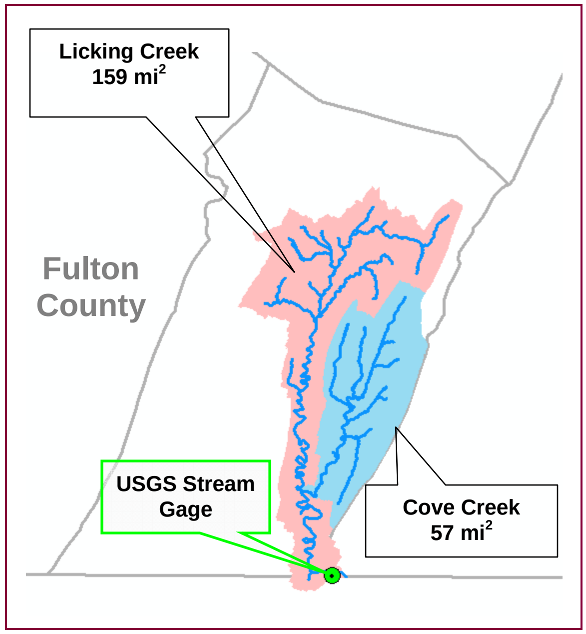
- New development that exceeds the threshold limits established in the Model Ordinance must maintain a 25-foot riparian buffer around the perimeter edge of any wetland that prevents the placement of any new impervious area within the riparian buffer.

IMPLEMENTATION OF STORMWATER MANAGEMENT CONTROLS

From a regulatory perspective, the standards and criteria developed in this Plan will be implemented through the municipal adoption process according to Act 167. The Model Ordinance contains provisions to realize the standards and criteria outlined in this section. Providing uniform stormwater management standards throughout the county is one of the stated goals of this Plan. This goal will be achieved through adoption of the Model Ordinance or the provision contained within the Model Ordinance by all of the municipalities in Fulton County.

Technical Modeling Analysis

TECHNICAL APPROACH



To provide technical guidance in the Act 167 planning process, a hydrologic model was prepared for two (2) specific watersheds identified by the municipalities, the County and PADEP. The result from this model increases the overall understanding of watershed response to rainfall and helps guide policy. Through the development and analysis of a hydrologic model, effective and fair regulations can be applied on a County-Wide basis, while addressing specific issues identified by the individual communities in Fulton County. The hydrologic methodology used in the technical approach is the Natural Resource Conservation Service (NRCS) Rainfall-Runoff Method. This method was chosen since it is the most common method used by designers in Pennsylvania and has widely available data. Additionally, this method is the basis for which many of the guidelines were developed in the BMP Manual. The calculations for this methodology were performed with HEC-HMS, the U.S. Army Corps of Engineers Hydrologic Modeling System.

The modeling approach in this study was to:

- Establish a reasonable estimate of rainfall-runoff response under existing conditions.
- Establish a reasonable estimate of rainfall-runoff response under an assumed full-build out future condition.
- Provide an examination of the impact with the implementation of guidelines from the BMP Manual (i.e., CG-1 and CG-2).
- Develop stormwater management release rate districts where it is determined necessary to do so.

Information from WPAC meetings has been incorporated to direct the focus of this modeling effort and to ensure the most current PADEP regulations are successfully incorporated throughout the entire County.

HYDROLOGIC MODEL PREPARATION

During the Phase I portion of the Fulton County's Act 167 planning process, the WPAC reached consensus that the Cove Creek watershed and the Licking Creek watershed hydrology would be modeled in detail due to those watersheds containing impaired streams, the entire watersheds being contained within the County boundary, the majority of the problem areas lie within these watersheds, and these watersheds have some of the greatest potential for development in the County. Since these watersheds are interconnected, they were analyzed as one hydrologic model (hereafter referred to as the Licking Creek Model). These watersheds were delineated into subwatersheds based on problem areas, significant obstructions, and natural subwatershed divides. The delineation of these subwatershed areas created points of interest at junctions where the subwatersheds were hydraulically connected in the HEC-HMS model.

LICKING CREEK MODEL: The Licking Creek HEC-HMS watershed model has a total drainage area of 216-square miles. The watershed was divided into 86 subwatersheds for the HEC-HMS model. Refer to Plate #11 to view the Licking Creek subwatersheds and cumulative discharge points.

This watershed contains one dam that was considered to have a significant enough impact on the hydrology of the watershed, Meadow Grounds Dam located in Ayr Township, to include in the model. Although the dam has a relatively large storage volume (4,670 acre-feet), the tributary drainage area to this dam is relatively small (3.2 square miles) compared to the total drainage area of Licking Creek. Outflow data for the dam was provided by PADEP in the form of HEC-1 output files. This information was used to model the flows from the dam within the HEC-HMS model.

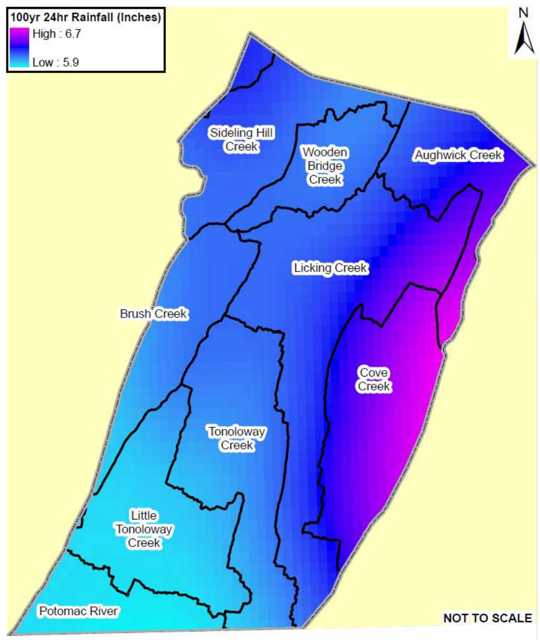
HYDROLOGIC MODEL PARAMETERS: The various parameters entered into the hydrologic model include subwatershed area, soil-type, land cover, lag time, reach lengths and slopes, reach cross sectional dimensions, and design rainfall depths. These parameters are discussed in further detail in Appendix A. A brief description of these components follows.

RAINFALL DATA: Rainfall data used in this modeling effort incorporates rainfall runoff data from NOAA Atlas 14. NOAA Atlas 14 provides the most up-to-date precipitation frequency estimates, with associated confidence limits, for the United States and is accompanied by additional information such as temporal distributions and seasonality. Rainfall depths were obtained from a single point at the approximate geographic center of the County. The following table provides the rainfall estimates used for various design storm frequencies in Fulton County:

TABLE 14: RAINFALL VALUES FOR FULTON COUNTY

DESIGN STORM (YEARS)	*24-HR RAINFALL DEPTH (INCHES)*
2	2.77
10	4.01
25	4.82
50	5.50
100	6.24

It was assumed in all of the following analyses that these single rainfall quantities could be applied uniformly over the entire watershed area. Additionally, the rainfall quantities were applied to the NRCS Type II storm distribution. Although this combination of Atlas 14 data with the NRCS Type II storm distribution results in a relatively conservative rainfall pattern, this approach is consistent with the guidelines in BMP Manual.



NOAA Atlas 14 100-year, 24-hour Rainfall

SUBWATERSHED AREA: Generally, the average subwatershed area for the modeled watersheds was between 3 to 5 square miles. The drainage areas may be slightly larger or smaller depending on hydrologic characteristics and location of problem areas. Subwatersheds with an area less than 1 square mile were included in the model if they formed a junction between two larger subwatersheds or were tributary to a defined problem area.

SOILS: Soil properties, specifically infiltration rate and subsurface permeability, are an important factor in runoff estimates. Runoff potential of different soils can vary considerably. Soils are classified into four Hydrologic Soil Groups (HSG) (A, B, C, & D) according to their minimum infiltration rate. HSG A refers to soils with relatively high permeability and favorable drainage characteristics; HSG D soils have relatively low permeability and poor drainage characteristics. The runoff potential increases dramatically in order of group A (lowest), B, C, and D (highest). Soil cover data was also used in conjunction with land use cover data within GIS to develop composite curve numbers for each subwatershed in the hydrologic model. Refer to Plate #2 for the locations of each Hydrologic Soil Group in Fulton County.

LAND USE: In order to perform hydrologic modeling to compare how land development affects stormwater runoff, existing land cover and projected future land cover must be obtained. This cover data was then converted to land uses that correspond to NRCS curve number tables. In order to create the future land use projections, a full build-out scenario was assumed. Current planning efforts within the County are encouraging redevelopment of urban areas and preservation of farmland and woodland. Future development is also being encouraged to stay in close proximity to existing developed areas, especially with regards to industrial and commercial development.

To compile an accurate assessment of the existing and future land uses in the Cove Creek and Licking Creek watersheds, a variety of sources were referenced. Those sources include:

- Fulton County Planning & Mapping GIS Data
- Fulton County Joint Comprehensive Plan (2007)
- Fulton County Act 167 Stormwater Management Plan – Phase I
- Fulton County Greenways and Open Space Network Plan (2007)
- PAMAP Aerial Imagery (2003)
- McConnellsburg Borough Zoning Ordinance

The break down of existing and future land uses within the Cove and Licking Creek watersheds can be seen in Table 15 and Table 16 and on Plates #7, #8, #9, and #10 respectively.

TABLE 15: COVE CREEK WATERSHED LAND USE DATA

COVE CREEK WATERSHED LAND USE	EXISTING LAND USES		FUTURE LAND USES		CHANGE FUTURE - EXISTING
	Acres	%	Acres	%	% Change
WATER	179	0.5 %	179	0.5 %	0 %
AGRICULTURE	17,106	47.0 %	16,570	45.4 %	- 1.6 %
WOODLANDS	18,514	50.7 %	18,503	50.7 %	0 %
LOW DENSITY RESIDENTIAL	104	0.3 %	445	1.2 %	+ 0.9 %
HIGH DENSITY RESIDENTIAL	334	0.9 %	320	0.9 %	- 0.0 %
COMMERCIAL	0	0.0 %	152	0.4 %	+ 0.4 %
INDUSTRIAL/OPPORTUNITY	252	0.6 %	320	0.9 %	+ 0.3 %
TOTAL:	***36,489***	***100 %***	***36,489***	***100 %***	***N/A***

TABLE 16: LICKING CREEK WATERSHED LAND USE DATA

LICKING CREEK WATERSHED LAND USE	EXISTING LAND USES		FUTURE LAND USES		CHANGE FUTURE - EXISTING
	Acres	%	Acres	%	% Change
WATER	0	0.0 %	0	0.0 %	0.0 %
AGRICULTURE	34,161	55.0 %	34,084	54.9 %	- 0.1 %
WOODLANDS	27,436	44.2 %	27,436	44.2 %	0.0 %
LOW DENSITY RESIDENTIAL	506	0.8 %	153	0.2 %	- 0.6 %
HIGH DENSITY RESIDENTIAL	0	0 %	430	0.7 %	+ 0.7 %
COMMERCIAL	0	0 %	0	0 %	0.0 %
INDUSTRIAL/OPPORTUNITY	0	0 %	0	0 %	0.0 %
TOTAL:	***62,103***	***100 %***	***62,103***	***100 %***	***N/A***

LAG TIME: Lag time is the transform routine when using the NRCS Curve Number Runoff Method. Lag time (T_{Lag}) can be related to time of concentration (T_c) using the empirical relation:

$$T_{Lag} = 0.6 * T_C$$

Lag time values for the subwatersheds were based on NRCS Lag Equation and altered as described in Appendix A:

$$T_{Lag} = L^{0.8} \frac{(S+1)^{0.7}}{1900\sqrt{Y}}$$

Where: T_{Lag} = Lag time (hours)

L = Hydraulic length of watershed (feet)

Y = Average overland slope of watershed (percent)

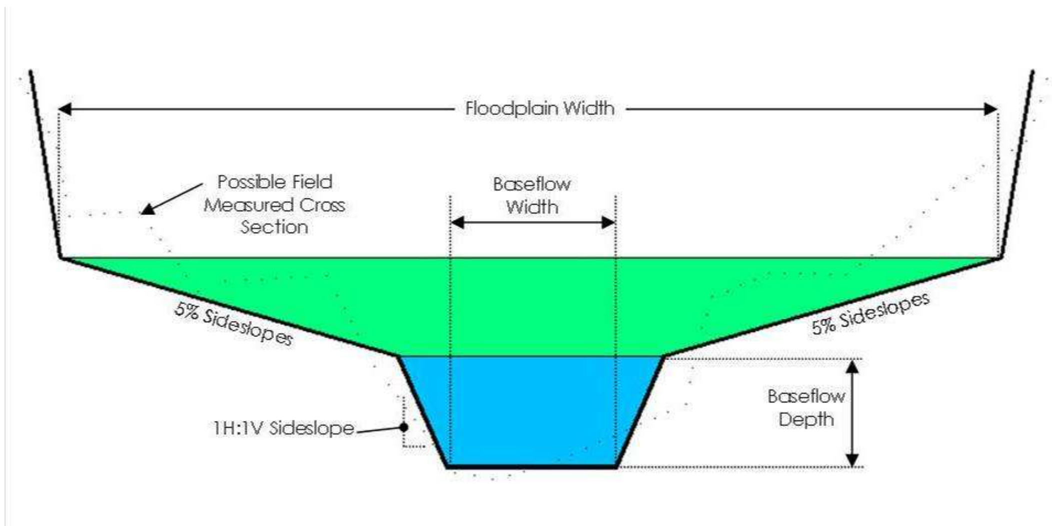
S = Maximum retention in watershed as defined by: S = [(1000/CN) – 10]

CN = Curve Number (as defined by the NRCS Rainfall-Runoff Method)

For comparison purposes, a lag time was also calculated for each subwatershed using the TR-55 Segmental Method. Given the rural landscape and karst topography of Fulton County, the best estimate for time of concentration calculation was provided by the NRCS Lag Equation.

INFILTRATION AND HYDROLOGIC LOSS ESTIMATES: Infiltration and all other hydrologic loss estimates (e.g., evapotranspiration, percolation, depression storage, etc.) were modeled using the standard initial abstraction (Ia) in the NRCS Rainfall-Runoff Method (i.e., Ia = 0.2S) for the existing conditions and future conditions models. For the future conditions with stormwater controls model, these losses were taken into account using a modified initial abstraction value. This modified value was developed to be consistent with, and account for, the volume removal criteria under the CG-1 and CG-2. A detailed explanation of this modeling effort is described in Appendix A.

REACH LENGTHS, SLOPES, AND CROSS SECTION DIMENSIONS: Reach lengths and slopes were determined within GIS. Channel baseflow widths and depths for each river reach were estimated based on drainage area and percent carbonate using the methodology outlined in *Development of Regional Curves Relating Bankfull-Channel Geometry and Discharge to Drainage Area for Streams in Pennsylvania and Selected Areas of Maryland*. Dimensions for the overbank areas were visually determined from FEMA floodplains or visual inspection of topographic data. The below figure depicts the cross section dimensions.

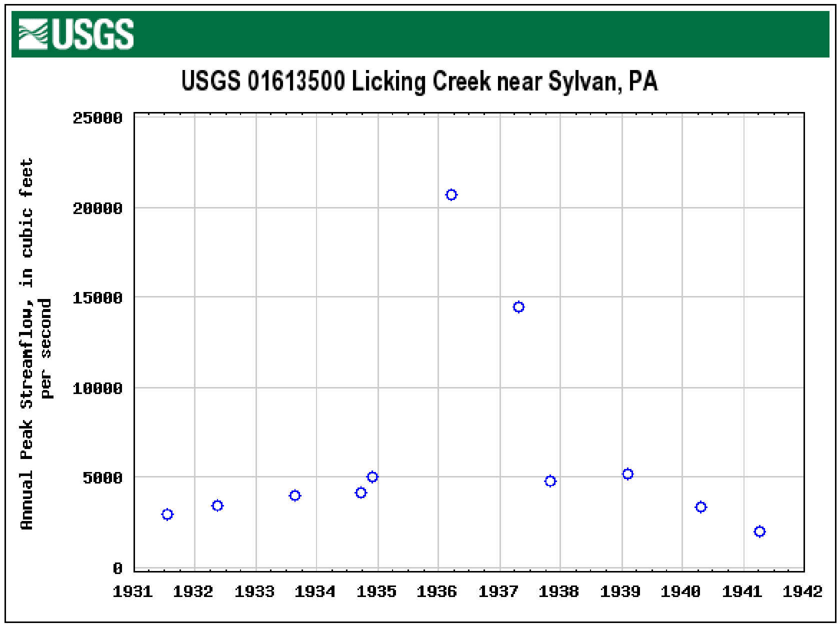


Cross Section Used for River Reaches in the HEC-HMS Model

The reaches were modeled using the Muskingum-Cunge routing procedure. This procedure is based on the continuity equation and the diffusion form of the momentum equation. Manning's Roughness Coefficient "n" values were assumed to be 0.055 in channel and overbank channel values were assumed to be 0.080. When necessary for calibration, Manning's "n" values and the overbank side slopes were altered so that realistic discharge values could be obtained. The data used for each specific reach is available within the HEC-HMS Model.

MODEL CALIBRATION

A previously discussed, the HEC-HMS Model incorporates a number of user-defined variables to generate runoff hydrographs. The accuracy of the model remains unknown unless it is calibrated to another source of runoff information. Possible sources of information include stream gage data, high water marks (where detailed survey is available to facilitate hydraulic analysis), and other hydrologic models. The most desirable source of calibration information is stream gage data, as this provides an actual measure of the runoff response of the watershed during rain events. There is only one USGS stream gage with adequate record located in Fulton County. Table 17 lists this gage and its respective statistics.

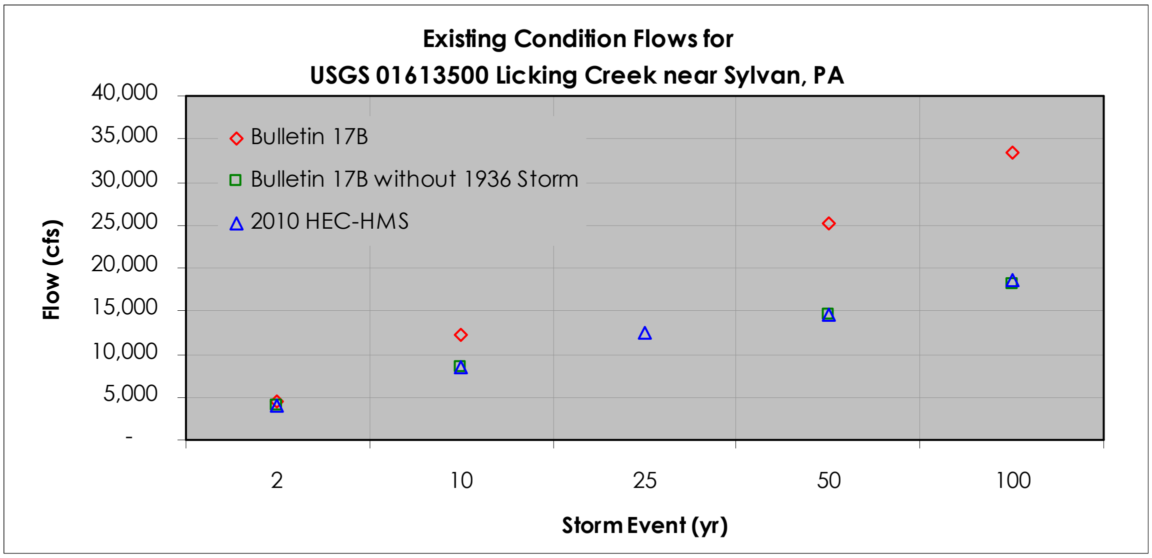


Historical Data from USGS Stream Gage 01613500

TABLE 17: USGS STREAM GAGE IN FULTON COUNTY

USGS STREAM GAGE NO.	SITE NAME	DRAINAGE AREA (SQUARE MILES)	AVAILABLE TIME PERIOD	USED IN HEC-HMS MODEL?
01613500	Licking Creek Near Sylvan, PA	158	1931-1941	Yes

The only gage within the watersheds being analyzed for this study is USGS Gage 01613500. Flow estimates were derived at this gage using the *Bulletin 17B* methodology as outlined in USGS. This method produces estimates for storms of all of the frequencies desired in this study (between the 1- and 100-year storm events) for any gage that has more than 10 years of data. However, usually more than 10 years of data is desirable so a truly representative historical sample can be observed at a gage. At USGS Gage 01613500, there were 11 years of data available, but one year (1936) was designated as an historical outlier. Given the extreme value of the 1936 storm, the presence of karst topography in a substantial part of the watershed, and the rural, undeveloped landscape throughout Fulton County, it was judged to be appropriate to perform the *Bulletin 17B* analysis without the 1936 storm. This analysis provides the best available estimate of the design storm discharges while considering other qualitative factors about the watershed. The figure below shows the results of this effort.



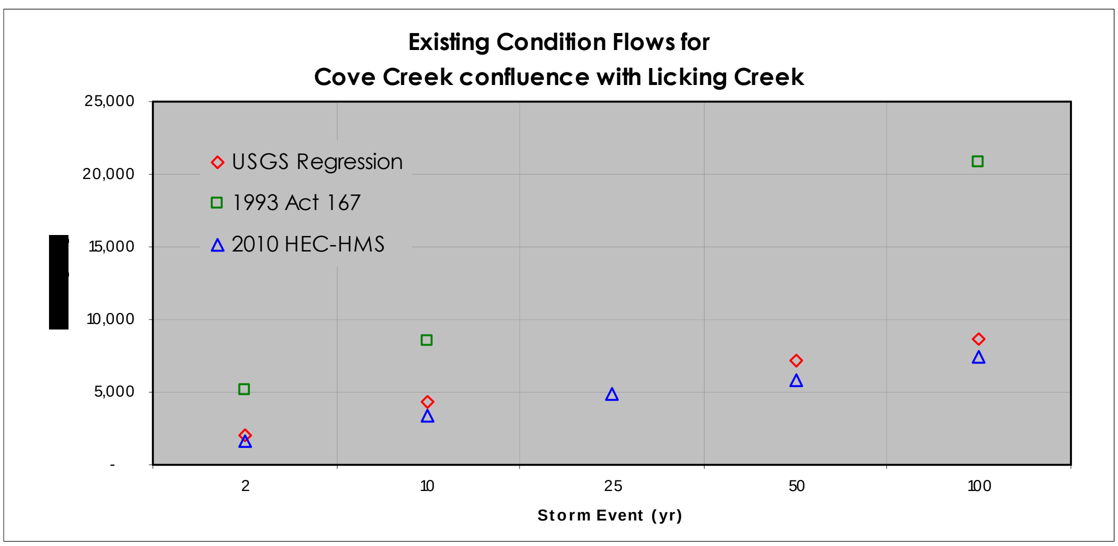
Comparing Stream Gage Data with the HEC-HMS Model

When no stream gage data is available, the next most desirable source of data for purposes of comparison is other hydrologic studies prepared by local, state, or federal agencies. FEMA Flood Insurance Studies (FIS) often provide discharge estimates at specific locations within FEMA floodplains. The estimates provided in FEMA FIS are valid sources for comparison, but should be carefully considered when used for calibration since they are sometimes dependent on outdated methodology, or focus exclusively on the 100-year event for flood insurance purposes.

The third available source of information that may be used for calibration is regression equation estimates. The regression equations were developed on the basis of peak flow data collected at numerous stream gages throughout Pennsylvania. This procedure is the most up-to-date method and takes into account watershed average elevation, carbonate (limestone) area, and minor surface water storage features such as small ponds and wetlands. The methodology for developing regression equation estimates within Pennsylvania is outlined in *USGS Scientific Investigations Report 2008-5102*. Mean Elevation, Percent Carbonate Rock, and Percent Storage, were calculated using GIS from layers supplied from USGS Digital Elevation Model (DEM) data, the Environmental Resources Research Institute and USGS.

The target flow rates were determined from one of these three sources. The HEC-HMS Model was then calibrated to the target flow rates at the overall watershed level, at points of interests where significant hydrologic features were identified (e.g., confluences, dams, USGS gages, etc.), and at each individual subwatershed. This approach was used so that a flow value anywhere in the model would compare favorably to the best available data source. The parameters of calibration for the entire overall watershed were the antecedent runoff condition, lag time, and reach routing coefficients. Detailed calibration results are provided in Appendix A.

As can be shown, the calibration results are in general agreement with the range of values for other hydrologic studies. The following figure shows a hydrologic comparison of Cove Creek above the confluence with Licking Creek. Included in the figure is the 1993 Act 167 Plan for the Cove Creek watershed. However, the USGS Regression equations were used to compute the target flow at this location because: 1) the 1993 Act 167 hydrologic model was not calibrated to any other studies; and 2) the 1993 Act 167 hydrologic model assumed artificially high curve numbers to mimic frozen ground conditions.



Cove Creek Existing Conditions Flow Comparison

MODELING RESULTS

Once the HEC-HMS Existing Conditions Model was calibrated and the existing conditions peak flows were established, additional models were developed to assist in determining appropriate stormwater management controls for the watersheds. Based on a comparison of existing and future land use, most subwatersheds will experience varying degrees of development through the future condition.

The following simulations were performed with HEC-HMS (2, 10, 25, 50 and 100-year) within the Licking Creek HEC-HMS Model:

Existing Conditions

An Existing Conditions Model was developed and analyzed using the calibration procedures previously described. Results from the existing conditions model reflect the estimated land uses from 2010. The existing condition flows are provided in Appendix A for both watersheds.

Future Conditions with No Stormwater Controls

A Future Conditions Model was developed and analyzed using the future land use coverage for the projected full-build out condition provided by Fulton County. The projected future land use resulted in an increased curve number and a decreased time of concentration for several subwatersheds. It was assumed that there was no required detention or any other stormwater controls in this simulation.

Future Conditions with CG-1 & Release Rates as Stormwater Controls

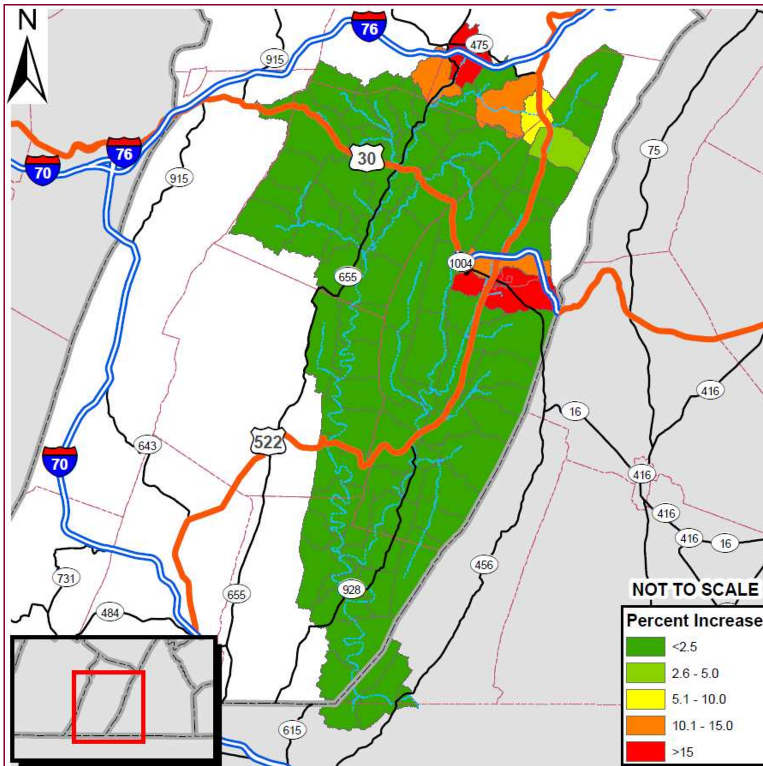
A Future Conditions Model With Stormwater Controls was developed by modifying the Future Conditions Model to include the effects of peak rate controls and the volume removal requirements of CG-1.

The effects of peak rate controls, through detention of post-development flows, were estimated by routing the post-development flow for each subwatershed through a simulated reservoir. The reservoirs were designed so that they could release no more than the pre-development flow estimate. This approach was assumed to simulate the additive effect of all of the individual detention facilities within a subwatershed. The volume removal requirements of CG-1 were simulated using modified initial abstraction values as previously described and further detailed in Appendix A.

The modeling process in this Act 167 Plan was to: 1) estimate the effects of detention on future condition peak flows; and 2) apply release rates to subwatersheds wherever there is a significant increases in peak flow at the points of interest.

The results are presented below; detailed results of the modeling are provided in Appendix A.

LICKING CREEK MODELING RESULTS: The increases in the Licking Creek watershed are relatively insignificant except around McConnellsburg for Cove Creek and Fortune Tellers Run in the northern headwaters for Licking Creek, as shown in the figure to the right. Table 18 depicts the results of the Future Conditions Model with no stormwater controls for the 2, 10, 25, 50, and 100-year events. The maximum and average percentages indicate percentage increases at the points of interest when comparing existing peak rate flows with future peak rate flows.



Increases in Flow for the 2-year Storm Event with No Stormwater Management Controls

TABLE 18: FUTURE CONDITIONS WITH NO STORMWATER MANAGEMENT CONTROLS

STORM EVENT (YEAR)	MAXIMUM % INCREASE IN FUTURE CONDITIONS	AVERAGE % INCREASE IN FUTURE CONDITIONS[1]
2	76.4	2.3
10	57.6	1.8
25	49.6	1.5
50	47.3	1.5
100	43.2	1.4

Notes: [1] – Area Weighted Averages

Table 19 shows the reduction in peak flows that would occur if only CG-1 were implemented without any peak rate controls. The maximum and average percentages indicate increases at the points of interest when comparing existing peak rate flows with future peak rate flows. Generally, the flows for the lower magnitude events are substantially reduced compared to future conditions with no stormwater management controls with the implementation of CG-1. The flows for the higher magnitude events are moderately reduced with implementation of the CG-1, but significant increases still occur.

TABLE 19: FUTURE CONDITIONS FLOWS WITH CG-1 IMPLEMENTATION ONLY

STORM EVENT (YEAR)	MAXIMUM % INCREASE WITH CG-1	AVERAGE % INCREASE WITH CG-1[1]
2	1.0	0.2
10	15.6	0.6
25	18.9	0.7
50	21.8	0.7
100	22.3	0.7

Notes: [1] – Area Weighted Averages

After the implementation of CG-1, when there was still a significant increase at a point of interest, the release rate percentage was reduced until the increases in peak flows at the points of interest were reduced to acceptable values. Table 20 reflects the range of required release rate controls still needed after the uniform implementation of CG-1.

TABLE 20: RELEASE RATES

STORM EVENT (YEAR)	RELEASE RATES (%)
2	100
10	80-100
25	80-100
50	80-100
100	80-100

STORMWATER MANAGEMENT DISTRICTS

As previously described, when substantial increases were found in the HEC-HMS Model due to additive effects of future development, it was be necessary to restrict post development discharges to a fraction of pre-development flow. An 80% release rate district would indicate that any future development within the district would be required to restrict post-development flows to 80% of pre-development flows.

The release rate theory and the designation of stormwater management districts is not substantially supported in stormwater literature. The calculation of release rates is heavily dependent on timing and growth projections, both of which involve a high degree of uncertainty. Additionally, it has been observed that localized stormwater measures do not typically capture and detain entire tributary areas (Emerson, 2003). Given these limitations with release rates, the following criteria were examined before applying release rates to the modeled watersheds:

- Numerous problem areas exist in a pattern that indicates systemic stormwater problems.
- Historic, repeated flooding has been observed.
- Future planning projections indicate growth patterns that have historically contributed to documented problems.
- Generally, release rates are to be designated on subwatersheds with head-water streams; larger downstream areas with well established bed-and-bank streams are not as affected by relatively small scale development and therefore do not benefit from release rates.

When the above criteria indicated a need for additional stormwater management controls, release rates were considered. The results from the HEC-HMS Model are used as guidance to establish appropriate release rates. Ultimately, reasonable hydrologic judgment is used in the final designation of release rates.

LICKING CREEK WATERSHED: Evaluation of the Licking Creek watershed indicates a need for stormwater management districts. The watershed has had numerous problems areas in patterns indicative of systemic problems. The area also has a history of serious flooding as documented in previous studies. Additionally, future growth is projected throughout the watershed. Stormwater management districts have been developed for portions of the watershed with release rates ranging between 80% and 100%. The locations of the stormwater management districts are shown on Plate #12.

TECHNICAL RECOMMENDATIONS

The modeling results provide technical guidance on provisions that are included in the Model Ordinance. The following recommendations follow from the technical analysis and data collection efforts in preparing this Plan.

1. **Curve number and time of concentration methodologies should be restricted to reflect the observed runoff response in the hydrologic models.** For storm events greater than the 10-year storm event, the runoff response to NOAA Atlas 14 rainfall in Fulton County was lower than standard NRCS methods predict. This has the potential to allow designers to undersize their stormwater facilities and to increase peak discharges for the higher magnitude events. It is recommended for curve number calculations to assume 'good conditions' when using any curve number table, which is consistent with the proposed control guidance.

2. **Time of concentration computations should use the longest time of concentration for existing conditions provided by 1) the TR-55 segmental method and 2) the NRCS Lag Equation.**

3. **Implement a volume control policy in addition to a traditional peak rate control methodology**. The modeling results show a definite reduction in peak discharge in all storm events with the implementation of the volume control guidance criteria. The volume control guidance criteria will provide a direct benefit with volume reduction and also an indirect benefit of channel protection.

4. **Implement and enforce a flexible yet clearly documented release rate policy for the specified watershed.** The stormwater management districts are provided on Plate #12. These should be used to determine the allowable post-development peak flow rate. The use of strategically placed regional facilities and watershed-scale conservation, drainageway, and critical recharge area easements may also be considered as an alternative to release rate implementation.

Water Quality Impairments and Recommendations

SURFACE WATER QUALITY

Fulton County is located at the headwaters of streams that are tributary to the Potomac and Susquehanna River. Water quality in the Susquehanna River Watershed is excellent due to the forested and sparsely populated land uses found within the watershed boundaries.

Nearly three-fourths of the surface in Fulton County flows south into the Potomac River in Maryland. The principal streams of the Potomac River system within Fulton County are the Tonoloway Creek, Little Tonoloway Creek, and Licking Creek. The Potomac River Watershed in Fulton County has poorer surface water quality than the Susquehanna River Watershed. The by-products of agricultural activities have increased the level of nutrients in the watershed.

The Pennsylvania Chapter 93 Water Quality Standards classify all surface waters according to their water quality criteria and protected water uses. Selected waterbodies that exhibit exceptional water quality and other environmental features are referred to as "Special Protection Waters". Certain activities in those watersheds that could adversely affect surface water are more stringently regulated to prevent degradation.

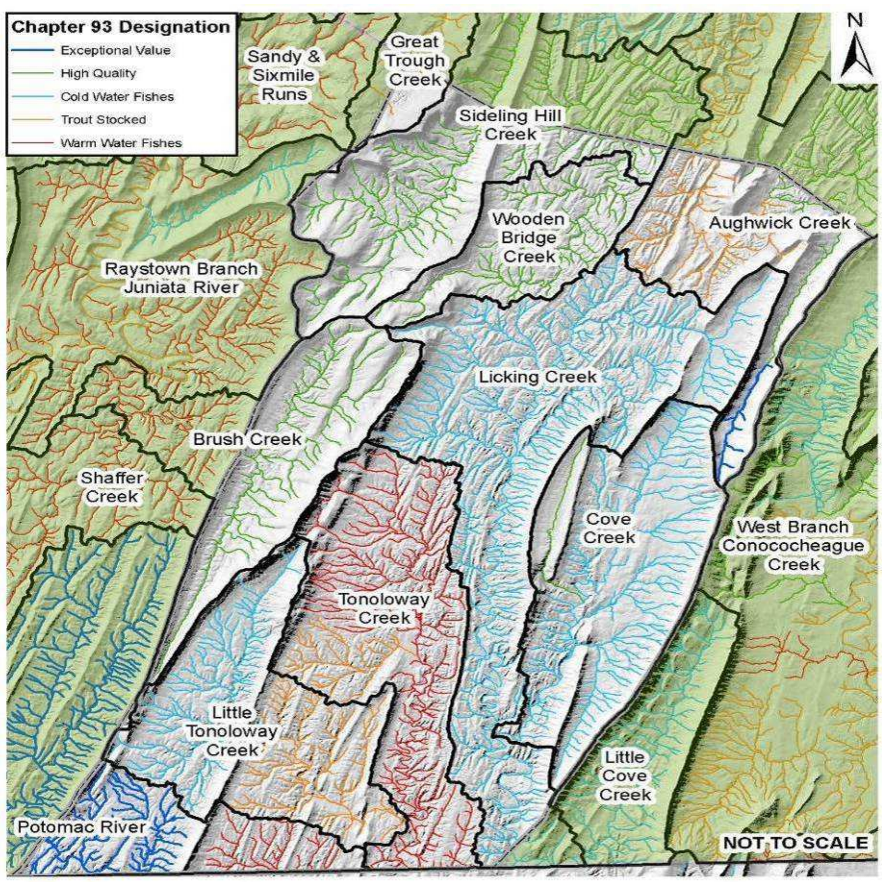


TABLE 21: CHAPTER 93 CLASSIFICATIONS

CLASSIFICATIONS	STREAM MILES	PERCENT OF COUNTY
Exceptional Value (EV)	62.4	4.9%
High Quality (HQ)	304.5	23.7%
Cold Water Fishes (CWF)	540.9	42.1%
Trout Stocked Fishes (TSF)	171.3	13.4%
Water Water Fishes (WWF)	204.5	15.9%
TOTAL:	***1,283.6***	***100%***

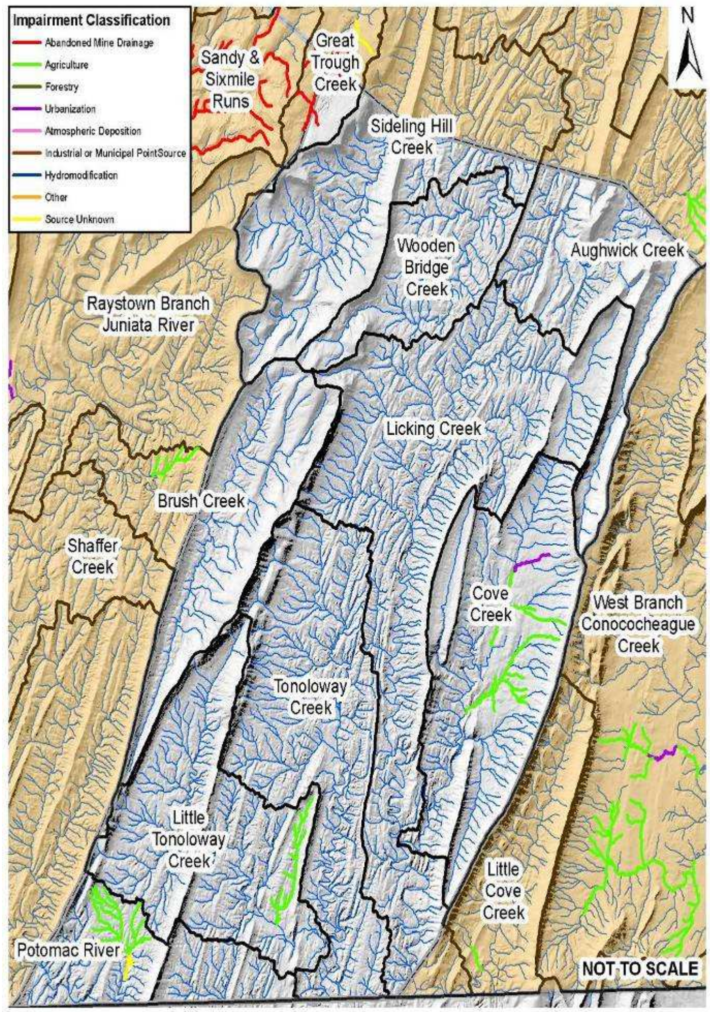
TABLE 22: PROTECTED USE DESIGNATION OF STREAMS IN FULTON COUNTY

STREAM	ZONE	PROTECTED USE DESIGNATION
SUSQUEHANNA RIVER WATERSHED (JUNIATA RIVER WATERSHED)		
Sideling Hill Creek	Basin	HQ-CWF
North Branch Little Aughwick Creek	Basin, Source to Confluence with South Branch	HQ-CWF
South Branch Little Aughwick Creek	Basin, Source to Inlet of Cowans Gap Lake	EV
South Branch Little Aughwick Creek	Basin, Inlet of Cowans Gap Lake to Confluence with North Branch	HQ-CWF
Brush Creek	Basin, Source to Fulton-Bedford County Border	HQ-CWF
POTOMAC RIVER WATERSHED		
Sideling Hill Creek	Basin, Confluence of West and East Branches to PA-MD State Border	EV
Unnamed Tributaries to Sideling Hill Creek	Basins (all sections in PA), PA-MD State Border to Mouth	EV
Crooked Run	Basin (all sections in PA)	EV
Bear Creek	Basin (all sections in PA)	EV
Unnamed Tributaries to Little Tonoloway Creek	Basins (all sections in PA)	WWF
Sawmill Hollow	Basin (all sections in PA)	WWF
Tonoloway Creek	Main Stem, Source to PA-MD State Border	WWF
Unnamed Tributaries to Tonoloway Creek	Basins, Source to PA-MD State Border	WWF
Crane Run	Basin	WWF
Sawmill Run	Basin	WWF
Foster Creek	Basin	WWF
Cummings Run	Basin	WWF
Palmer Run	Basin	WWF
Barnetts Run	Basin	TSF
Little Tonoloway Creek	Basin, Source to I-70	CWF
Little Tonoloway Creek	Basin, I-70 to Mouth	TSF
Plum Run	Basin (all sections in PA)	WWF
Ditch Run	Basin (all sections in PA)	WWF
Licking Creek	Main Stem, Source to PA-MD State Border	CWF
Unnamed Tributaries to Licking Creek	Basins, Source to PA-MD State Border	CWF
Fortune Teller Creek	Basin	CWF
Sindeldecker Branch	Basin	CWF
Baby Run	Basin	CWF
Patterson Run	Basin	CWF
Owl Creek	Basin	CWF
Joes Run	Basin	CWF
Cove Creek	Main Stem	CWF
Unnamed Tributaries to Cove Creek	Basins	CWF
Kendall Run	Basin	CWF
Back Run	Basin	CWF
Roaring Run	Basin	HQ-CWF
Spring Run	Basin	CWF
Esther Run	Basin	CWF

EV – Special Protection – Exceptional Value Waters	**CWF** – Aquatic Life – Cold Water Fishes
HQ – Special Protection – High Quality Waters	**TSF** – Trout Stocked Fishes
	WWF – Aquatic Life – Warm Water Fishes

IMPAIRED STREAMS

Section 303(d) of the Federal Clean Water Act requires states to list all impaired waters not supporting their designated and existing uses. PADEP has an ongoing program to assess the quality of waters in Pennsylvania and identify streams and other bodies of water as "impaired" when they do not attain their designated and existing uses. PADEP uses an integrated format for the Clean Water Act Section 305(b) reporting and Section 303(d) listing. The "2008 Pennsylvania Integrated Water Quality Monitoring and Assessment Report, List 5" includes waters not achieving their designated uses.



Water quality standards are comprised of the uses that waters can support, and goals established to protect those uses. The goals are numerical or narrative water quality criteria that express the in-stream levels of substances that must be achieved to support the uses. In Fulton County, all of the non-attaining streams segments were for the use designation "Aquatic Life", which generally pertains to maintaining flora and fauna indigenous to aquatic habitats.

PADEP protects four (4) stream water uses:

TABLE 23: PROTECTED WATER USES

WATER USE
Aquatic Life
Fish Consumption
Potable Water Supply
Recreation

The source-cause of impairment varies from stream to stream. Often, there are multiple source-causes attributed for impairment of a particular stream segment.

The 2007 Joint Comprehensive Plan found that the majority of the County's water quality impairments are located in the Potomac River Watershed and are found in association with population centers and agricultural areas. Fulton County contains nearly 44-miles of streams with reaches officially denoted as "impaired" by the PADEP Source Water Assessment Program. These streams are found in agricultural valleys and are "impaired" largely due to the impact of agriculture (e.g. grazing, loss of vegetation, excessive nutrients or sediments).

The following are the stream segments in Fulton County listed as non-attaining "impaired" streams and the source-cause of the pollution.

TABLE 24: IMPAIRED STREAM SEGMENTS

STREAM NAME	*SOURCE - CAUSE*	*LENGTH (MILES)*
Bear Creek	Grazing Related Agriculture - Siltation	4.44
UNT Bear Creek	Grazing Related Agriculture - Siltation	7.02
Big Cove Creek	Grazing Related Agriculture - Nutrients and Siltation	3.16
UNT Big Cove Creek	Recreation and Tourism - Cause Unknown	1.67
Cove Run	Grazing Related Agriculture - Nutrients and Siltation	4.87
UNT Cove Run	Agriculture - Siltation	4.18
UNT Great Trough Creek	Abandoned Mine Drainage - pH	2.27
Kendall Run	Grazing Related Agriculture - Siltation	2.74
UNT Kendall Run	Grazing Related Agriculture - Siltation	0.16
Spring Run	Grazing Related Agriculture and Habitat Modification - Nutrients and Siltation	5.37
UNT Spring Run	Agriculture - Siltation	4.61
Stahle Run	Grazing Related Agriculture and Removal of Vegetation - Nutrients and Siltation	1.87
UNT Stahle Run	Grazing Related Agriculture and Removal of Vegetation - Nutrients and Siltation	1.58
	TOTAL IMPAIRED LENGTH =	***43.94***

Of the 44-miles of "impaired" reaches, none have developed a Total Maximum Daily Load (TMDL). The state or EPA is required to develop a Total Maximum Daily Load (TMDL) for each waterbody on the impaired streams list. A TMDL identifies allowable pollutant loads to a waterbody from both point and non-point sources that will prevent a violation of water quality standards. A TMDL also includes a margin of safety to ensure protection of the water. At present, there are no impaired streams in Fulton County that are in the TMDL development process.

CRITICAL SOURCES OF IMPAIRMENT

Statewide, the primary causes of water quality impairment are siltation, metals, pH and nutrients. Non-point source pollution is a general term for water pollution generated by diffuse land use activities rather than from an identifiable or discrete facility. The leading non-point sources of impairment in Pennsylvania are:

- ✓ Abandoned Mine Drainage (AMD)
- ✓ Agriculture
- ✓ Urban Runoff/Storm Sewers
- ✓ Road Runoff
- ✓ Small Residential Runoff
- ✓ Atmospheric Deposition

Although some of these activities cannot be regulated by the provisions within the Model Ordinance of this Plan, they play a major role in the water quality of surface waters. The most critical of the above sources of impairment for Fulton County are agriculture activities.

AGRICULTURAL ACTIVITIES: Agricultural land use has many beneficial effects on a landscape's response to rainfall and properly managed agricultural activities provide many positive environmental benefits. However, agriculture has been shown to be a significant source of siltation and nutrient pollution for Fulton County streams. Agricultural activities that can cause non-point source pollution include confined animal facilities, grazing, plowing, pesticide spraying, irrigations, fertilizing, planting, and harvesting. The major pollutants that result from these activities are sediment and siltation and nutrients. Agricultural activities can also damage habitat and stream channels.

> *Sediment and Siltation:* The most common agricultural cause for surface water impairment is sediment and siltation. Of the 44-miles of impaired streams in Fulton County, agriculture-related sediment and siltation is attributed for 40-miles of impairment. This pollutant results from typical agricultural practices such as plowing and tilling, livestock grazing, and livestock access to waterbodies. When appropriate conservation practices are implemented, these activities can be continued while reducing erosion and enhancing and protecting water quality.
>
> Controlling sheet and gully erosion is a major step towards addressing sediment and siltation impairments. In Pennsylvania, a written Erosion and Sediment Control Plan is required for all agricultural plowing or tilling activities

that disturb 5,000 square feet or more of land. The implementation and maintenance of erosion and sediment control BMPs to minimize the potential for accelerated erosion and sedimentation is also a requirement for all agricultural activities regardless of disturbed area. In addition to reducing sediment pollution, controlling erosion also decreases the transport factors for other pollutants such as nutrients and pesticides.

Nutrients: The second most common agricultural cause for surface water impairment is nutrients. Agricultural activity related nutrients account for 17-miles of the 44-miles of impaired streams in Fulton County. Nutrients such as nitrogen, phosphorus, potassium and other micronutrients are essential for proper plant growth and development. However, when the available nutrients exceed those required for plant development, or when nutrients are improperly applied, they pose potential environmental hazards. Nutrient pollution results from agricultural activities such as fertilizer and manure application, livestock access to waterbodies, and animal concentration areas.

Nutrient management regulations have been developed in Pennsylvania in response to nutrient pollution problems. All livestock operations with animal densities higher than 2,000 pounds of live animal weight per acre of land available for nutrient application are required to have a Nutrient Management Plan (NMP). A NMP is a tool to help producers allocate nutrients from fertilizer and manure in a manner that maintains adequate nutrient levels for desired crop production and reduces the likelihood of nutrient pollution. Addressing agricultural nutrient impairments requires consideration of where the nutrients are coming from, also called nutrient source factors, and how they get to surface waters, or nutrient transport factors.

RECOMMENDATIONS FOR WATER QUALITY IMPROVEMENT

There is an ongoing need in Fulton County to encourage farmers to implement conservation practices such as addressing "brown" animal concentration areas, riparian buffers, stream bank fencing, cover crops and no-till. In addition, adequate, dedicated funding is necessary to implement these practices on local farms in order to significantly reduce the amount of nutrients discharged to local waterways. In order to encourage farmers to implement these types of conservation practices, the Fulton County Conservation District should continue to provide public education and outreach, whether in the form of public meetings, workshops, one-on-one interactions, field days, etc.

The Fulton County Conservation District has prepared and updated the County Implementation Plan to guide the efforts and resources of the Conservation District and its cooperating partners in reducing pollution to local waterways. Addressing water quality impairments is achieved most effectively through watershed-wide planning and implementation.

The water quality based approach is a common method of addressing impairments. The "2008 Pennsylvania Integrated Water Quality Monitoring and Assessment Report, List 5" identifies impaired streams and their source-causes of impairment. The next step toward improving the water quality in these streams has been to identify the critical areas within the impacted watershed. Critical areas are the geographic regions within a watershed that directly contribute pollutants to the stream. The primary purpose for identifying critical areas is to develop a strategy that effectively addresses the sources of water quality impairment. The inventory of each watershed that identifies the critical areas allows time, effort, and funds to be targeted towards those sites that most negatively impact water quality.

The Fulton County Conservation District, along with PADEP, has worked to develop a comprehensive watershed plan and an implementation strategy to address the sites within the critical areas. The goal is to address the most severe sources of pollutants in an efficient manner.

Developing an implementation strategy and determining specific BMPs to treat specific sites is the last step. Existing water quality programs have been considered as the implementation strategy was developed. These programs are being coordinated with the implementation strategy in order to achieve a common goal. Thought has also been given to potential funding sources and how they can be used to implement portions of the overall water quality improvement plans. As projects are implemented, the plan should continue to be reviewed and revised as necessary to ensure that the water quality goals are eventually obtained.

Non-point Source Pollution Reduction Programs: Addressing environmental resource concerns and implementing conservation practices is one of the primary focuses of the Fulton County Conservation District and the USDA Natural Resource Conservation Service (NRCS). The process of improving the county's water quality impairments has already been initiated by these two groups, among others.

Agricultural Conservation Practices: A variety of agricultural conservation practices are available to help achieve producer's goals while also protecting natural resources. These practices are used to reduce soil erosion and improve and protect water quality. These practices are intended to address specific resource concerns. Individual BMPs are most effective when used together to create a conservation system. A conservation system addresses all of the resource concerns on a particular farm through a combination of different management practices and BMPs that work together. Planning a conservation system ensures that the maximum benefits can be obtained from the individual components, and that the overall management goals are accomplished. The following BMPs have been identified as particularly well suited to address the impairments identified in Fulton County:

Streambank Protection

Streambank protection provides direct water quality results by reducing the amount of sediment, animal waste and nutrients entering the stream. Protection is implemented by excluding livestock from the stream and establishing buffer zones of vegetation around the stream. The practice can be implemented with or without fencing; however, it is much more effective when fencing is installed. This BMP usually requires installation of an alternate watering source for livestock and an animal crossing to allow animals access to pasture on both sides of the stream.

Riparian Buffers

Riparian areas, land situated along the banks of a watercourse, typically occur as natural buffers between uplands and adjacent water bodies. They act as natural filters of non-point source pollutants before they reach surface waters. In agricultural areas, many riparian buffers have been removed by agricultural activity to increase tillable acreage and provide animal access to water. Re-establishing riparian buffers by planting forest or grass buffers adjacent to water bodies provides significant water quality benefits. In addition to the filtering benefits that grass buffers provide, forested buffers provide shade to the stream, helping to reduce negative thermal impacts.

Riparian buffers are part of a larger group of practices referred to as Conservation Buffers. This general practice is any area or strip of land maintained in permanent vegetation to help reduce erosion and filter non-point source pollutants. This group also includes contour buffer strips, field borders, filter strips, vegetative barriers, and windbreaks.

Barnyard Runoff Control

Animal concentration areas are a principal source of sediment and nutrient pollution on agricultural operations. Barnyard runoff control is used to manage stormwater runoff from animal concentration areas to reduce the sediment and nutrients that reach surface waters. Runoff control can be achieved through a variety of methods, but the principals are the same for all of the methods. These principals are keeping "clean" water away from the barnyard and collecting runoff from the barnyard and filtering it with an appropriate BMP or storing it in a manure storage facility for field application. Clean water is diverted away from animal concentration areas with roof runoff structures, diversions, and drainage structures.

Nutrient Management

Nutrient management is planning for, and implementation of, the application of organic and inorganic materials to provide sufficient nutrients for crop production in a manner that limits negative environmental impact of their use. A nutrient management plan accounts for all nutrient sources and details the location, timing, rate, and method of nutrient application to crop fields. Implementing a nutrient management plan provides benefit to the farmer by allocating the available nutrients to where they are needed the most to maintain crop yields, while also limiting excess nutrients that would otherwise be susceptible to transport, eventually contributing to non-point source pollution.

Animal Waste Management Systems

Animal waste management systems are used for the proper handling, storage, and application of animal waste generated on livestock operations. Wastes are collected from animal confinement areas, and transferred to an appropriate waste storage facility. The waste storage facility enables the producer to store manure during adverse weather conditions when manure nutrients are most likely to reach surface waters. Manure is then field applied when conditions are most conducive to plant nutrient uptake.

Cover Crops

Cover crops are planted in the fall after the primary crop has been harvested. The cover crop grows through the fall and provides ground cover for the field throughout the winter months and early spring when the soil is extremely susceptible to erosion. The cover crop also provides nitrogen removal benefits as it utilizes excess nitrogen in the soil. The cover crop can either be harvested as a commodity crop in the spring or it can be left as ground cover prior to spring planting. Cover crops provide excellent soil erosion protection when the fields need it most.

Conservation Tillage

Conservation tillage is a crop production system that results in minimal disturbance of the surface soil. Maintaining soil cover with crop residue is an important part of conservation tillage. Maintaining ground cover throughout the year has many benefits to crop production, but the most significant water quality benefit is the reduction in soil erosion. No-till farming is one form of conservation tillage in which crops are planted directly into ground cover with no disturbance of the surface soil. Minimum tillage farming is another method that involves minor disturbance of the soil, but maintains much of the ground cover on the surface.

FULTON COUNTY PROGRAMS

Fulton County has a variety of existing programs that help improve water quality. Some of these programs are County-Wide and others are targeted specifically at impaired watersheds. Some of the existing programs include:

TABLE 25: FULTON COUNTY PROGRAMS

FULTON COUNTY PROGRAMS
Dirt and Gravel Road Maintenance (DGR) Program
Erosion and Sediment Pollution Control (E&S) Program / National Pollutant Discharge Elimination System Permitting (NPDES) Program
Farmland Preservation Program
Nutrient Management Program
Environmental Education Program
Agricultural Management Assistance (AMA)
Conservation Security Program (CSP)
Grassland Reserve Program (GRP)
Conservation Reserve Enhancement Program (CREP)
PADEP Stream Bank Fencing Program
Farm Stewardship Program (FSP)
Project Grass Program
Energy Harvest Grant Program
Raystown Branch – Potomac – Aughwick Watersheds Cover Crops Incentive Program
Potomac and Juniata River Watersheds Agricultural BMP Implementation and Technical Assistance Program

Economic Impact of Stormwater Requirements

A major cause for concern is the economic impact of urban stormwater runoff. For example, in 1997, the U.S. Environmental Protection Agency conservatively estimated the total cost to the American economy from illness and loss of economic output due to urban stormwater pollution to be millions of dollars each year. Therefore, measures to control stormwater runoff quality, rate, and volume are necessary to avoid costly mitigation of problems caused by stormwater mismanagement.

Site planning that integrates comprehensive stormwater management into the development process from the outset may result in efficiencies, from traditional detention basin size reduction or elimination, less redesign to retrofit water quality and infiltration measures, and/or decreased agency approval time. Early stormwater management planning may decrease the size and cost of structural solutions. Stormwater management efforts which incorporate BMP structural technologies into the site design at the final stages oftentimes result in the construction of unnecessarily large facilities.

The following two (2) examples illustrates the methods to design stormwater management facilities and both non-structural and structural BMPs in accordance with the volume and peak rate control strategies developed within this Plan. Examples of possible efficiencies gained by incorporating structural and non-structural BMPs are illustrated as well.

The design process encouraged by the BMP Manual is used to determine non-structural BMP credits and perform the calculations necessary to determine if the requirements of the Model Ordinance have been met. The 2-year design storm is utilized to illustrate the methods used to meet the volume requirements of the Model Ordinance. The SCS Runoff Curve Number Method is used for runoff volume calculations as suggested by the BMP Manual. Refer to the BMP Manual for additional guidance, rules and limitations applicable to these methods and the design of structural and non-structural BMPs.

EXAMPLE ONE

An 8-lot single family residential development, which is located in Cove Creek watershed, is analyzed below. All of the lots will be accessed via a single cul-de-sac road which will be constructed for the subdivision. The 2-year design storm (50% chance of occurrence annually) is examined to illustrate the method and cost to adhere to Control Guideline 1 (CG-1). Adherence to CG-1 is demonstrated in this example using a combination of non-structural BMP credits and structural BMPs that control volume through infiltration. Multiple design storms are examined to illustrate the method and cost of applying release rates to peak runoff volumes.

SIZING CRITERIA	DESCRIPTION OF STORMWATER SIZING CRITERIA
Volume Control – Using Control Guideline 1 (CG-1)	- Applicable for any size of development - Management of the 2-year, 24-hour storm event - Existing non-forested pervious areas to be considered Meadow (Good) - 20% of existing impervious area to be considered Meadow (Good)

Step 1

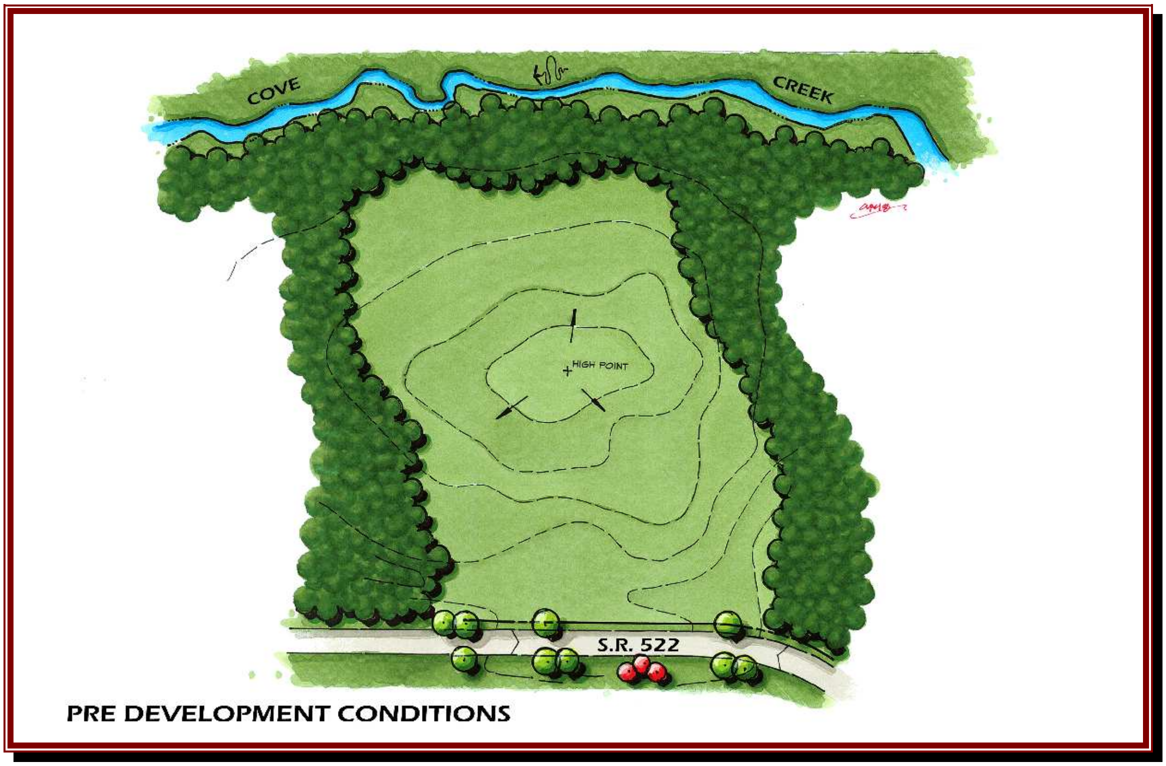
The first task of the design process is to gather the pertinent site information as it relates to stormwater management.

Given Values:

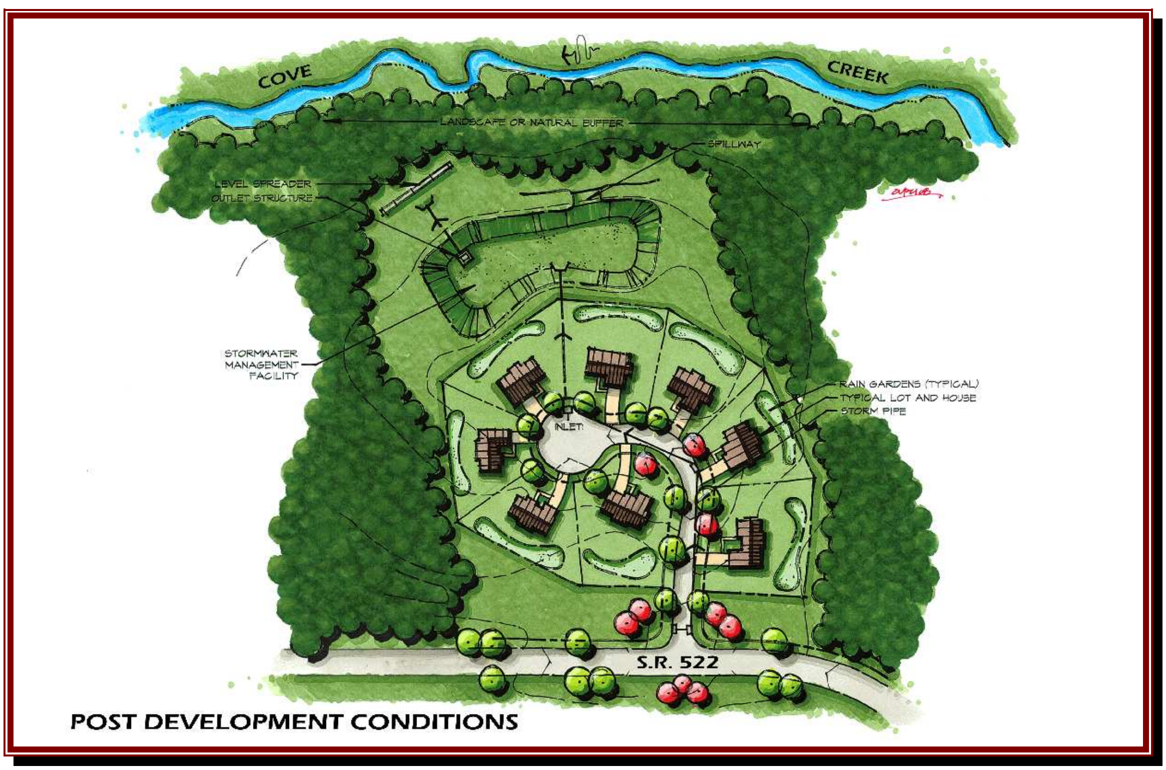
PARCEL SIZE:	15 acres
EXISTING NUMBER OF LOTS:	1 lot
PROPOSED NUMBER OF LOTS:	8 lots + residual land
LOCATION:	Subwatershed W0300 of Cove Creek
HYDROLOGIC SOIL GROUP	'B' – Entire Site

PRE-DEVELOPMENT COVER TYPE/CONDITION:	Meadow (13-Acres) Woods (2-Acres)
PRE-DEVELOPMENT SENSITIVE NATURAL RESOURCES:	Woods (2-Acres)

POST-DEVELOPMENT COVER TYPE/CONDITION:	Meadow (6-Acres) Woods (1-Acre) Impervious (4-Acres) Open Space (4-Acres)
POST-DEVELOPMENT SENSITIVE NATURAL RESOURCES:	Woods (1-Acre)



Example One - Pre-Development Conditions



Example One - Post-Development Conditions

Step 2

The next step is to determine the sensitive natural resources that are present on the site (BMP Manual Worksheet 2). Understanding the sensitive natural resources characterizing the site is important in any stormwater management design. The developer is encouraged to protect these site features during land development to the maximum extent practicable. The BMP Manual lists "Wooded" areas as a Sensitive Natural Resource. In this example, one (1) acre of woods will remain undisturbed on the site and be protected during construction.

Step 3

As the site layout is being contemplated, consideration should be given to which non-structural BMPs are appropriate for the site in order to reduce the need for stormwater management through the use of structural BMPs. Once the site layout has been considered and non-structural BMPs have been determined, the designer can begin the stormwater management calculations. The first calculation is to determine the "Stormwater Management Area" (BMP Manual Worksheet 3). This is the land area which must be evaluated for volume of runoff in both pre and post-development conditions. Sensitive natural resources that have been protected are not used in the ensuing pre or post-development volume calculations. Similarly, one would not incorporate offsite areas into volume calculations. In this example, the one (1) acre of protected woodland is removed from the "Stormwater Management Area". This will reduce cost by reducing the total volume needed in the peak-rate management facility.

Protect Sensitive Natural Resources

Stormwater Management Area	=	Site Area – Protected Area
	=	15 – 1 (Acre of Woods)
	=	**14-Acres** (for pre and post development)

Step 4

The next step is to calculate the "volume credits" for the non-structural BMPs that have been incorporated into the design (BMP Manual Worksheet 3). This reduces the total volume that is required to be controlled by structural BMPs. There are two credits used in the example, a meadow area and a lawn area have been protected from soil compaction and roof drains have been disconnected from the storm sewer system. The areas protected from compaction facilitate higher infiltration rates and disconnecting the roof leaders from the storm sewer system allows infiltration of some stormwater as it flows across the pervious surface.

Minimum Soil Compaction

Meadow Area (post-development) protected from compaction = 6 Acres
(6-Ac x (43,560-ft^2 / Ac)) x 1/3" x 1/12 = **7,260-ft^3** *

Lawn Area (post-development) protected from compaction = 2 Acres
(2-Ac x (43,560-ft^2 / Ac)) x 1/4" x 1/12 = **1,815-ft^3** *

*Formulas are from BMP Manual Worksheet 3. Areas used for this credit must be protected from compaction during construction. Credits for lawn area (Open Space), as shown on the BMP Manual Worksheets are taken for only 2 acres, because specific measures are planned to protect only 2 acres of lawn area (Open Space) surrounding the dwellings in this example.

Disconnect Roof Leaders to Vegetated Areas

Roof Area = 8 (Units) x 1,000 (square feet/Unit) = 8,000-ft^2.
8,000-ft^2 x 1/3" x 1/12 = **222-ft^3** **

**Formula is from BMP Manual Worksheet 3. The 1/3" credit is used because in this example, the runoff from the 8 roofs discharge across the lawn area and is received by rain gardens, which are structures specifically placed to receive and infiltrate runoff. A 1/4" credit would be used for roof runoff not discharged to a specific infiltration BMP.

Step 5

The next step is to calculate the difference in the 2-year design storm runoff volume from pre-development conditions to post-development conditions (BMP Manual Worksheet 4). The 2-year volume increase, minus the volume credits for non-structural BMPs, represents the volume that must be managed through structural BMPs.

2-year, 24-hour Rainfall Depth = **2.77"**

Existing Conditions: [Protected Area = 1-Ac Woods]

COVER	SOIL TYPE	AREA (SF)	ACRES	CN	S	IA	Q RUNOFF (IN)	Q RUNOFF (FT)	RUNOFF VOLUME (FT^3)
Woods	B	43,560	1	55	8.18	1.64	0.14	0.012	523
Meadow	B	566,280	13	58	7.24	1.45	0.20	0.017	9,627
			14					**Total:**	**10,150**

Proposed Conditions: [Protected Area = 1-Ac Woods]

COVER	SOIL TYPE	AREA (SF)	ACRES	CN	S	IA	Q RUNOFF (IN)	Q RUNOFF (FT)	RUNOFF VOLUME (FT^3)
Open Space	B	174,240	4	61	6.39	1.28	0.28	0.023	4,008
Impervious	B	174,240	4	98	0.20	0.04	2.54	0.212	36,939
Woods	n/a	n/a	n/a	Runoff Volume from Protected Area not included					
Meadow	B	261,360	6	58	7.24	1.45	0.20	0.017	4,443
			14					**Total:**	**45,390**

Change in Runoff Volume for the 2-year, 24-hour storm event:
= 45,390-ft^3 – 10,150-ft^3 = **35,240-ft^3**

Summation of Non-Structural BMP Credits:
= 222-ft^3 + 1,815-ft^3 + 7,260-ft^3 = **9,297-ft^3**

The total non-structural credits are limited to 25% of the total required structural volume. This does not limit the amount of practices that can be implemented, only the amount of credit that can be used to reduce the total required structural volume. The total credits calculated must be checked to ensure the 25% threshold has not been exceeded.

Check 25% Non-Structural Credit Limit:

= 9,297-ft^3 / 35,240-ft^3 = **26.38%**

Credits are over the allowable 25% non-structural credit by 1.38% of 35,240-ft^3. Therefore, this percentage (1.38% = 486-ft^3) cannot count toward meeting CG-1.

Reduced Non-Structural Credit to meet 25% Criteria:

= 9,297-ft^3 – 486-ft^3 = **8,811-ft^3**

= Non-Structural BMP Credits as limited by 25% cap from BMP Manual.

Required Structural BMP infiltration volume:

= 35,240-ft^3 – 8,811-ft^3 = **26,429-ft^3**

= Volume to be infiltrated using Structural BMPs.

Step 6

The next step is to determine the type of structural BMPs that may be appropriate for the site and decide which practices will be used in post-development conditions (BMP Manual Worksheet 5). If the total structural volume is greater than (or equal to) the required volume, the volume requirements of the Model Ordinance have been met.

Rain gardens and an infiltration forebay to the detention basin are the structural BMPs used in this example to fulfill the volume control requirements not fully met by Non-Structural BMP Credits. Both of the chosen structural BMPs are infiltration facilities.

Rain Gardens

One (1) rain garden is proposed for each lot. It is assumed for this example that the entire roof area and lot area of each lot drains to its respective rain garden and all dwellings are equal in size. These rain gardens are sized based on two criteria:

A. To stay within loading ratio limits in Appendix C of the BMP Manual.

B. To be of sufficient size to accommodate the expected runoff volume.

Check A1. Maximum loading ratio of impervious area to infiltration area = 5:1

Total roof area (impervious area) = 8,000-ft^2

= 8,000-ft^2 / 5 = **1,600-ft^2**

= minimum bottom surface area of all rain gardens per impervious loading ratio

Check A2. Maximum loading ratio of total drainage area to infiltration area = 8:1
Total drainage area = lawn (open space) 174,240-ft^2 + impervious (roofs) 8,000-ft^2 = 182,240-ft^2
= 182,240-ft^2 / 8 = **22,780-ft^2**
= minimum bottom surface area of all rain gardens per total drainage area loading ratio

The loading ratio of the total drainage area to infiltration area governs, therefore, each rain garden bottom surface area shall be:
= 22,780-ft^2 / 8 lots = **2,848-ft^2**

Check B1. Total roof area = 8,000-ft^2 = 4.6% of 4-Ac of proposed impervious.
4.6% of 36,939-ft^3 (runoff from Proposed Conditions Chart) = **1,700-ft^3**
Total 2-year stormwater runoff volume from roofs = **1,700-ft^3**

Check B2. Total lawn (open space) area = 4-Ac = 100% of proposed open space.
100% of 4,008-ft^3 (runoff from Proposed Conditions Chart) = **4,008-ft^3**
Total 2-year stormwater runoff volume from lawns = **4,008-ft^3**

Total 2-year stormwater runoff volume load tributary to each rain garden:
= (1,700-ft^3 + 4,008-ft^3) / 8 lots = **714-ft^3**

The rain garden depth equals:
= The volume tributary to each, divided by the required area of each
= 714-ft^3 / 2,848-ft^2 = **0.25-ft or approximately 3.0"**

A rain garden on each lot 3.0" deep with a bottom surface area of 2,848-ft^2, properly planted/seeded with select vegetation, will be sufficient to contain the 2-year stormwater runoff volume from each roof and lot and will be in compliance with the BMP Manual loading ratio guidelines.

The volume reduction of rain gardens employed among all 8 lots:
= 714-ft^3 x 8 lots = **5,712-ft^3**

An overflow spillway or drain must be provided to convey storms greater than the 2-year, 24-hour storm event.

Infiltration Forebay

The remaining volume control will occur in a forebay that accepts runoff from all areas of the site. This forebay will be immediately upstream of a traditional stormwater management detention basin.

Stormwater runoff that has been infiltrated or credited to infiltration without employing additional measures thus far:

= 5,712-ft^3 Rain Garden infiltration + 8,811-ft^3 Non-Structural Credit =**14,523-ft^3**

Stormwater runoff volume remaining to be controlled by infiltration forebay to meet CG-1:

= 35,240-ft^3 – 14,523-ft^3 = **20,717-ft^3**

Of the original 4-Acres of total impervious area, 100,000-ft^2 (57.4%) is tributary to the infiltration forebay due to the storm sewer that captures and conveys runoff into the forebay from the proposed street. This impervious area produces 21,200-ft^3 of runoff (which is 57.4% of the 36,939-ft^3 of total impervious runoff) during the 2-year, 24-hour storm. Because the runoff volume contributory to the infiltration forebay from the impervious area is greater than the runoff volume remaining to be controlled, there is adequate volume tributary to supply the infiltration forebay.

The forebay must infiltrate 20,717-ft^3 of this volume for the stormwater management design to meet CG-1. The infiltration forebay will receive runoff from various ground cover conditions, and from an area that is larger than necessary to provide the required infiltration volume of 20,717-ft^3. To calculate a minimum forebay-bottom infiltration area that complies with the BMP Manual Appendix C loading ratios, check the area that drains to the infiltration facility, to determine that it will produce the necessary runoff volume to be infiltrated, and base the minimum forebay infiltration area on it.

In this example, it is assumed that an impervious area of 100,000-ft^2, will produce the 21,200-ft^3 of runoff yet to be infiltrated during the 2-year, 24-hour storm. Runoff from this impervious area was calculated by using the SCS runoff equation from TR-55. The 5:1 impervious loading ratio guideline will yield a minimum infiltration forebay bottom area of:

= 100,000-ft^2 / 5 = **20,000-ft^2**

The infiltration forebay depth equals:

= 20,717-ft^3 / 20,000-ft^2 = **1.04-ft or approximately 12.5"**

For this example, an orifice with an invert 12.5" above the forebay bottom will be placed on the outlet structure to ensure the correct volume is infiltrated.

Available volume on top of the infiltration depth can be used to control peak runoff rates; however the BMP Manual recommends in Appendix C that no greater than two (2) feet of head be allowed to avoid sealing the soil structure of an infiltration BMP. An infiltration forebay, limited to a depth of two (2) feet is used in this example upstream of a larger traditional stormwater management detention basin to comply with this guideline.

Drawdown time is another parameter to be checked in this example. A drawdown time must be between 24 and 72-hours as recommended in Chapter 3 of the BMP Manual. Infiltration tests at the forebay location resulted in a **½" per hour** infiltration rate.

Drawdown Time:
= 12.5-in / (0.5-in/hr) = **25.0-hours**

Drawdown time for water above the infiltration volume in the forebay is ignored in this example because it will exit the basin quickly, relative to the drawdown time of the infiltration volume. If extended detention or other circumstances that cause gradual draining are required, the designer must account for total drawdown time of the entire volume.

Step 7

The next step is to complete an analysis of the post-development peak rate of runoff to the pre-development peak rate of runoff to determine if the rate requirements of the Model Ordinance have been satisfied. Additional stormwater facilities, such as a stormwater management detention basin, may be necessary to reduce post-development peak flow rates to the required peak flow rates.

Pre-Development Curve Number (weighted) = 58	**Post-Development Curve Number (weighted) =** 70
Pre-Development Time of Concentration = 15 Minutes	**Post-Development Time of Concentration =** 10 Minutes

The site is located in the Cove Creek watershed, subwatershed W0300, which requires an 80% release rate for the 1-year through 100-year storm events.

Storm	Pre-Development Runoff Rate (cfs)	Post-Development Unmanaged Runoff Rate (cfs)	Release Rate Applied to Pre-Development Rate	Post Development Allowable Runoff Rate (cfs)
1-year	0.63	4.60	80%	0.50
2-year	1.49	9.11	80%	1.19
10-year	6.98	21.56	80%	5.58
25-year	12.76	31.39	80%	10.21
50-year	18.42	40.73	80%	14.74
100-year	24.76	50.61	80%	19.81

It is estimated for this example, that a **65,340-ft^3** or 1.5-ac-ft sized detention basin, with an appropriately configured outlet structure, would be required to meet the peak rate control requirements. It is assumed for this example that the entire site is tributary to the basin, and there is no bypass flow.

Recall that the infiltration forebay will be placed directly upstream of the traditional stormwater basin, and will flow into the stormwater basin in this example. The infiltration depth within the forebay was 12.5". The forebay is limited by BMP Manual guidelines to two (2) feet of depth to avoid compacting and sealing the infiltration surface with head pressure.

It is acceptable to route post-development inflow hydrographs through the infiltration forebay before the traditional stormwater management detention basin to take advantage of the forebay volume above and below the outlet placed at 12.5" above the forebay bottom. This method takes advantage of the required infiltration volume in the forebay, and volume above the infiltration volume up to the two (2) foot depth limit in the forebay to help mitigate peak flow rates leaving the site. The effect is that the total volume in the infiltration forebay becomes a part of the 65,340-ft^3 of basin volume required to control peak flow rates leaving the site. An explanation follows:

Recall the infiltration forebay bottom minimum surface area = **20,000-ft^2**

Recall the depth within the infiltration forebay required to capture the remainder of the CG-1 volume = **1.04-ft**

Total depth within forebay = **2.0-ft**

Remaining depth available for peak rate attenuation within forebay:
= 2.0-ft – 1.04-ft = **0.96-ft**

Available volume within infiltration forebay:
= 20,000-ft^2 x 0.96-ft depth (assuming vertical sides) = **19,200-ft^3**

Total required volume of traditional stormwater basin downstream of infiltration forebay:
= 65,340-ft^3 – 19,200-ft^3 = **46,140-ft^3**

Values are approximate and will vary depending on outlet structure configuration and basin depth.

Economic Implications of Employing Structural and Non-Structural BMPs: The primary economic benefit of using non-structural credits and rain gardens is found in the reduction of the primary downstream infiltration structure size. In this example, the minimum size of the infiltration forebay bottom, based on the 5:1 impervious loading ratio was 20,000-ft^2. If the infiltration forebay was tasked with the total volume reduction load to meet CG-1, the minimum bottom size assuming a 5:1 loading ratio would have been 34,848-ft^2, based on the assumption that the total impervious area of 4 acres produces the total CG-1-required volume of 35,240-ft^3. The smaller, distributed BMPs used throughout the site resulted in an infiltration BMP that covers 57% of what would be required without those smaller BMPs. A larger primary downstream infiltration BMP brings with it an opportunity cost by reducing the amount of marketable land, and a direct cost in the form of increased earthwork.

Opportunity Cost Savings: Assume one (1) acre of subdivided residential land costs $70,000 on average. Implementing a stormwater design that reduces the total BMP area of the infiltration forebay from 34,848-ft^2 to 20,000-ft^2, or by 0.34-acres, leaves open ground with a value of approximately $23,800. Depending on factors such as minimum lot size, allowable density, etc., this ground could potentially be used to site additional dwelling units which would have been otherwise unavailable.

Direct Cost Savings: It is conservatively assumed that the forebay in this example is three (3) feet in depth (two (2) feet of water depth plus one (1) foot of freeboard around the berm). As identified in the Opportunity Cost Savings calculation, reducing the infiltration forebay area by 14,848-ft^2 could eliminate approximately 1,650-yd^3 of earth moving. At $25/cubic yard for bulk excavation, the direct savings realized by reducing the infiltration forebay size would be $41,250, or $5,156 per lot in this example.

Cost of Rain Gardens: The cost of constructing rain gardens will detract from the savings of implementing a stormwater design plan as presented. However, the cost of constructing each rain garden is less than the per lot cost savings realized by constructing a smaller infiltration forebay. Each rain garden has a bottom surface area of 2,848-ft^2 and an assumed 6" depth. Total volume of the eight (8) rain gardens with these specifications is 422-yd^3. At $25/cubic yard for bulk excavation, the total cost of all rain garden excavation is $10,550. Assume an additional 20% expense for special soil and seed mixes and landscaping for a total cost of approximately $12,660, or $1,583 per lot. Even considering the cost of rain gardens in this example, a per lot savings of $3,573 is realized.

EXAMPLE TWO

Example Two explains the computations associated with the implementation of Control Guideline 2 (CG-2). The site is a one (1) acre parcel with some existing impervious cover, on which a car dealer expansion lot will be built to contain additional inventory. CG-2 compliance depends mainly on containing runoff volume from pre-development and post-development impervious areas, and staying less than or equal to one (1) acre of regulated activity.

Implementation of CG-2 is independent of existing and proposed ground cover conditions (other than impervious cover) and hydraulic soil groups.

Given Values:

PARCEL SIZE:	1 acre
NUMBER OF LOTS:	1 lot located in Cove Creek watershed

EXISTING COVER CONDITION:	**PROPOSED COVER CONDITION:**
0.2 Acres Impervious 0.8 Acres Open Space	0.5 Acres Impervious 0.5 Acres Open Space

Volume Control to Meet CG-2

The total area is equal to one (1) acre, thus CG-2 criteria will be implemented.

Based on the CG-2 criteria, the first two (2) inches of runoff from the new proposed impervious area is required to be captured by proposed stormwater management facilities.

One (1) inch of runoff from new impervious area is required to be removed from the runoff flow permanently. This example uses infiltration to remove the runoff permanently. Other removal options include reuse, evaporation, transpiration, etc. This volume is considered to be a component of the two (2) inches of runoff discussed above, and not in addition to it.

The BMP Manual describes the removal volume as the "first" one (1) inch of runoff, indicating that it should be diverted from the stormwater system and held separately. The first inch of runoff typically contains the greatest amount and concentration of pollutants. Thus, it is of greatest benefit to segregate and infiltrate (or otherwise remove) it from the system.

An option for segregating the first inch of runoff is to use a drainage box in which a lower outlet would be diverted to an infiltration bed. A higher outlet would then become active when the infiltration bed was filled and convey stormwater runoff to the remaining stormwater management system. Some mixing may occur between the first inch of runoff and subsequent runoff, but would be minimal relative to the total first inch of runoff collected and conveyed to the infiltration facility.

Stormwater Facility Sizing

In this example, we will capture the first two (2) inches from both existing and proposed impervious surfaces:

Existing impervious contribution to runoff volume:
(0.2-Ac x 43,560-ft^2/Ac) x (2" x 1/12) = 1,452-ft^3

New additional proposed impervious contribution to runoff volume:
(0.3-Ac x 43,560-ft^2/Ac) x (2" x 1/12) = 2,178-ft^3

Total runoff volume to be captured by proposed facilities:
1,452-ft^2 + 2,178-ft^2 = **3,630-ft^3**

IMPERVIOUS COVER	AREA (AC)	RUNOFF CAPTURE VOLUME (FT^3)
Existing Impervious	0.2	**1,452**
New Additional Proposed Impervious	0.3	**2,178**
TOTAL:	**0.5**	**3,630**

Infiltration or Permanent Removal Volume

Remove one (1) inch from proposed impervious:

Proposed impervious runoff volume of first inch:
(0.3-Ac x 43,560-ft^2/Ac) x (1" x 1/12) = **1,089-ft^3**

IMPERVIOUS COVER	AREA (AC)	INFILTRATION VOLUME (FT^3)
Existing Impervious	0.2 (n/a)	**n/a**
New Proposed Impervious	0.3	**1,089**
TOTAL	**0.3**	**1,089**

An infiltration bed (designed with the appropriate void spaces) with total storage volume of **1,089-ft^3** is proposed to provide the infiltration volume.

Loading Ratios

The loading ratio limit of 5:1 results in the following minimum infiltration bed surface area:

(0.3-Ac x 43,560-ft^2/Ac) / 5 = **2,613-ft^2**

Depth of infiltration volume is as follows:

1,089-ft^3 / 2,613-ft^2 = **0.42-ft** or **5"** (depth is well under the 2-ft limit)

Drawdown Time

Five (5) inches of runoff will infiltrate in ten (10) hours, given the 0.5-in/hr rate used in this example. This is within the 72-hour maximum.

Upon filling the infiltration bed to capacity, runoff is diverted downstream to a detention basin with volume of at least **2,541-ft^3** = 3,630-ft^3 – 1,089-ft^3. It is proposed to accept the remainder of the required runoff volume and treat it by extended detention.

Stormwater management facilities must be designed to control peak rates of runoff to the required release rates for the watershed district. The proposed 2,541-ft^3 detention basin represents a minimum volume to meet CG-2. A larger facility may be required to perform the required peak rate reductions.

Peak Rate Control

The site is located in the Cove Creek watershed, subwatershed W0300, which requires an 80% release rate for the 1-year through 100-year storm event.

Recall that a detention basin with minimum volume 2,541-ft^3, is required to fulfill the remainder of the CG-2 two (2) inch capture requirement. This volume must be released over at least a period of 24-hours to be considered extended detention under the CG-2 Guideline. This volume can coexist within a basin that serves the dual purpose of providing peak runoff rate control.

In this example, a detention basin is proposed with a small outlet orifice at the basin bottom that will release 2,541-ft^3 of water over a period of at least 24-hours. Additional volume above the extended detention volume is proposed for peak rate runoff control.

It is estimated for this example, that 779-ft^3 of additional volume is required within the detention basin, above the extended detention volume, to control peak runoff rates.

Total volume of basin, downstream of infiltration bed, for peak rate control:
2,541-ft^3 + 779-ft^3 = **3,320-ft^3**

Thus, a **3,320-ft^3** detention basin, with an appropriately configured outlet structure would be required to meet the peak rate control requirements for the entire one (1) acre site. It is assumed for this example that the entire site is tributary to the detention basin, and there is no bypass flow.

Economic Implications of Employing CG-2 over CG-1 on Small Sites: Control Guideline 2 (CG-2) is provided as an option in the BMP Manual to alleviate some of the challenges of complying with CG-1 on small sites. The primary economic benefit of the CG-2 option is that smaller required infiltration volumes are typically required.

The one (1) acre site in Example Two would produce the following pre-development runoff volume under CG-1 criteria:

2-year, 24-hour Rainfall Depth = **2.77"**

Existing Conditions:

COVER	SOIL TYPE	AREA (SF)	ACREAGE	CN	S	IA	Q RUNOFF (IN)	RUNOFF VOLUME (FT^3)
Meadow	B	36,590	0.84	58	7.24	1.45	0.20	610
Impervious	B	6,970	0.16	98	0.20	0.04	2.54	1,475
			1.0				**Total**	**2,085**

Note that only 80% of existing impervious can be considered in pre-development runoff calculations. All other site area must be considered Meadow (or woods if present).

Proposed Conditions:

COVER	SOIL TYPE	AREA (SF)	ACREAGE	CN	S	IA	Q RUNOFF (IN)	RUNOFF VOLUME (FT^3)
Open Space	B	21,780	0.5	61	6.39	1.28	0.28	508
Impervious	B	21,780	0.5	98	0.20	0.04	2.54	4,610
			1.0				**Total**	**5,118**

Note that actual conditions are used in post-development runoff calculations.

Change in Runoff Volume for the 2-year, 24-hour storm event:
5,118-ft^3 – 2,085-ft^3 = **3,033-ft^3**
= required infiltration volume under CG-1 Guideline

Required infiltration volume under CG-2 from Example Two = **1,089-ft^3**
CG-2 relieves the designer of infiltrating **1,944-ft^3** of runoff.

For this cost comparison example, assume an infiltration BMP uses a stone bed with 40% void space to contain the infiltration volume.

1,944-ft^3 of infiltration volume would require additional stone bed volume of 4,860-ft^3.
(1,944-ft^3 / 40% = 4,860-ft^3 or 180-yd^3)

Savings realized by eliminating 1,944-ft^3 of infiltration and 4,860-ft^3 of stone:

180-yd^3 of Bulk Excavation @ \$25/yd^3 = \$4,500

180-yd^3 of #57 Stone @ \$30/yd^3 = \$5,400

Total savings on construction cost of infiltration BMP = **\$9,900.**

Additional Activities To Be Regulated

Through interaction with citizens and local community leaders, Fulton County has been able to identify additional non-development related earth-moving activities that need to be further regulated to ensure the protection of health, safety, and property. The top two operations that were identified were timber harvesting and oil and gas drilling. The County feels that these activities need to be more strictly regulated to not only protect the natural environment of Fulton County, but also to protect the residents of the County.

TIMBER HARVESTING OPERATIONS

Timber harvesting operations represent a reasonable size of the local economy of Fulton County. Because 61.4% of the County is classified as forest land, timber harvesting represents a large potential economic benefit in the County. A majority of the wooded lands are owned by the Pennsylvania Bureau of Forestry, with the remainder being privately owned. Many private landowners sell timber as a way of generating supplemental income. As evident by the number of residential complaints, stormwater runoff generated from this activity has always been an issue in Fulton County. Fulton County would like to institute stricter regulations and monitoring on timber harvesting operations to help prevent future stormwater problems.

1. **Recommend that all municipalities require a land use permit for all timber harvesting activities.**

2. **Develop guidelines specifically designed for timber harvesting operations to minimize the effect of stormwater runoff.**

3. **Encourage additional cooperation between loggers, landowners and the Fulton County Conservation District.**

OIL & GAS WELL DRILLING OPERATIONS

Within the past two years, there has been a surge of interest in Marcellus Shale throughout Pennsylvania. According to the most up-to-date information, Fulton County sits on the eastern fringe of the Marcellus Shale formation. Consequently, Fulton County does not expect to see the same level of drilling activity as is being experienced in other Pennsylvania counties, such as Bradford or Greene Counties. However, Fulton County feels it would be best to prepare for any future oil and gas drilling activities by implementing regulations to protect water resources and landowners.

1. **Recommend that all municipalities require a land use permit for all oil and gas drilling operations.**

2. **Educate local officials and landowners on the benefits and cautions of oil and gas drilling.**

3. **Design stormwater management criteria specifically for oil and gas drilling operations.**

OTHER EARTH-MOVING ACTIVITIES

While timber harvesting and oil and gas well drilling constitute some of the large earth-moving operations in the County, there may be instances where other activities are occurring that need to be regulated with regards to stormwater management. Not included in these restrictions will be any activities mentioned above or related to agriculture.

1. **Recommend that all municipalities require a land use permit for any activity that will have an earth disturbance of over 5,000 square feet.**

Additional Recommendations

The stormwater management standards developed for this Plan are an excellent beginning for managing stormwater throughout Fulton County. Under Act 167 and within the defined scope of this Plan, additional stormwater management practices can not be considered requirements. Further, some important and beneficial practices may not be implemented through a stormwater ordinance, but are more appropriately implemented through zoning, subdivision and land development, or floodplain ordinances.

Following are several recommendations to all municipalities of Fulton County that go beyond the minimum requirements of this Plan. Because sound stormwater management requires a comprehensive approach, municipalities are encouraged to consider implementing these recommendations. These recommendations are put forth as suggestions to municipalities that wish to manage stormwater at a higher level than required under this Plan or Act 167. These suggestions offer increased water quality, groundwater recharge, and peak flow benefits. Not all suggested practices could be implemented by each municipality due to variations in the type of ordinances that are in place.

ADDITIONAL RIPARIAN BUFFER ESTABLISHMENT IN EXISTING DEVELOPED AREAS

Riparian buffers provide two principal benefits in regards to stormwater management. They offer flood protection by providing temporary storage area, slowing the velocity of flood waters, and provide a small amount of volume reduction through infiltration and permanent retention of water by disconnected low lying areas. The second primary benefit of riparian buffer is the water quality functions they offer. The vegetation in the riparian buffer provides shade that reduces water temperature, traps and removes pollutants from stormwater, and provides protection from streambank erosion.

Encourage voluntary establishment of riparian buffers in existing developed areas. The regulatory approach listed in the Model Ordinance will limit future development within the riparian buffer, but will have little effect on existing land uses in critical riparian areas. There are numerous existing incentive programs that offer technical and/or financial assistance to encourage land owners to alter existing land uses and establish riparian buffers. These include agricultural land retirement programs such as USDA's Conservation Reserve Enhancement Program (CREP) program, cost-share programs such as USDA's Environmental Quality Incentives Program (EQIP), as well as grant and loan programs.

STRENGTHEN FLOODPLAIN MANAGEMENT REGULATIONS

Municipalities should consider revising floodplain management ordinances to prohibit structures, fill, and most forms of development or obstructions in 100-year floodplains. Major streams and tributaries that have no designated floodplains should have a 100-year floodplain delineated. By keeping the floodplain free of potential obstructions, several goals will be achieved: the flood carrying capacity of the floodplain will be maintained; homes, businesses, and other structures will be kept clear of the floodplain, thereby avoiding flooding problems, and; with preservation of the floodplain in a more natural state, a greater opportunity will exist for water quality benefits from riparian buffers.

LIMIT DISTURBANCE/COMPACTION OF TOPSOIL

Municipalities should consider ordinance language that discourages or controls stripping and removal of topsoil from development sites. Topsoil serves as an absorbent layer, providing storage for rainfall and promoting groundwater replenishment. Removal of the topsoil layer reduces, or eliminates this benefit.

Avoiding unnecessary compaction of soils, particularly in areas that are not to be disturbed, should be encouraged. Possible means of discouraging this practice include requiring that the stormwater runoff calculations from post-development disturbed (but not impervious) areas be calculated with a lower hydrologic soil group (e.g., D vs. C) or, with an increase in curve number (e.g., 80 vs. 78). Additionally, temporary fencing could be required around the perimeter of areas not intended to be disturbed.

LIMIT THE AMOUNT OF IMPERVIOUS COVER/ALTERNATIVE SITE DESIGN

Many studies have shown that the biological indicators of stream quality begin to show degradation when the contributing watershed impervious cover reaches approximately 10% of the overall watershed area. As the total percent of impervious cover rises above 10%, stream quality continues to decline. Prudent application of non-structural and structural stormwater BMPs can reduce the amount of impervious cover potentially created by development. Examples of non-structural methods include low impact, cluster or open space site design. These well documented design approaches act to minimize impervious cover and can be facilitated by flexible zoning and subdivision and land development ordinances. Structural BMPs require the installation of various facilities specifically designed to beneficially manage stormwater. Numerous structural BMPs have been designed and are included in BMP Manual.

It is recommended that municipalities modify and enhance ordinances in order to provide enough flexibility to allow these innovative design methods to be employed by developers to effectively reduce the amount of stormwater generated from a development site.

MUNICIPAL ORDINANCE REVISIONS

Each municipality should review its existing ordinances and update them to achieve the most effective stormwater management possible. There are abundant resources currently available that discuss the types of revisions to ordinances that can be implemented to allow for better management of stormwater runoff.

Potential Funding Sources

ACT 167 REIMBURSEMENT COSTS

When there is local interest and a local commitment to deal with problems that are caused by stormwater, there is always a need for resources to make projects a reality. There are a variety of public and private resources that may be helpful in completing stormwater projects.

According to Chapter 111, Section 111.21 of Pennsylvania Code, "*Municipalities located in designated watersheds for which watershed stormwater plans have been prepared and adopted by counties and approved by the Department shall be eligible annually for reimbursement for expenses incurred in the adoption or revision of ordinances or regulations and other actual administrative, enforcement and implementation costs incurred in complying with the act and this subchapter*." Chapter 111 lists the activities that are eligible for reimbursement.

TABLE 26: ALLOWABLE/INELIGIBLE COSTS

<table>
<tr><th>ALLOWABLE COSTS</th><th>INELIGIBLE COSTS</th></tr>
<tr><td rowspan="2">Costs for the preparation and enactment of ordinances and regulations as are necessary to regulate development within the municipality consistent with the applicable watershed stormwater management plans and the act, including: (i) Costs of technical and legal services necessary to prepare and enact regulations, ordinances, administrative forms, maps and similar materials required by the act and (ii) Costs of technical and legal services for required public hearings.</td><td>Legal fees resulting from appeals or suits against the Commonwealth.</td></tr>
<tr><td>Allowances for the purchase of clothing.</td></tr>
<tr><td rowspan="2">Costs for administrative, enforcement and implementation activities, including: (i) Cost for review of the stormwater management component of development plans, (ii) Fees for special technical consultation concerning complex or unusual stormwater management issues, (iii) Costs of monitoring and inspection activities, and (iv) Mileage expenses incurred.</td><td>The printing or reproduction of regulations, forms or maps.</td></tr>
<tr><td>Costs which are offset by permit or review fees imposed by a municipality.</td></tr>
<tr><td rowspan="2">Costs incurred by municipalities for participation in a watershed plan advisory committee and other costs incurred when a municipality is acting under contract to the county for preparation, revision and adoption of watershed stormwater plans which shall be reimbursed by counties from grants awarded to counties under this chapter.</td><td>Costs incidental to routine municipal operations.</td></tr>
<tr><td>Costs for activities or expenses which are not solely required by the act and the watershed stormwater management plan.</td></tr>
</table>

STORMWATER MANAGEMENT FUNDING RESOURCES

The following is a list of possible funding resources which local municipalities may find helpful to begin searching for eligible funding to address stormwater management financing challenges and begin solving stormwater management problems in their jurisdictions. In addition to the list, municipalities may find the following two websites helpful in locating funding sources:

http://www.grants.gov

http://www.newPA.com

H2O PA Act (Act 63 of 2008)

H2O PA Act provides grant funding up to a maximum of $20 million. Grants can cover all project-related costs. The Act requires a 50% match with local funding. The matching funds can be from any source (e.g., other grants, tax revenue, etc.). Some in-kind services are also eligible to count toward the matching fund requirement. Apply to the PA Department of Community and Economic Development. Projects must be "shovel ready" (i.e., design complete, permits and rights-of-way obtained) when funds are made available.

Pennsylvania Infrastructure Investment Authority

Governmental agencies are eligible to obtain low interest loans from the Pennsylvania Infrastructure Investment Authority (PENNVEST) to resolve drainage problems. Loans are available for the construction, improvement or rehabilitation of stormwater systems and installation of best management practices to address point or non-point source pollution associated with stormwater. Examples of stormwater projects eligible for funding include: new or updated storm sewer systems to eliminate stormwater flooding or to separate stormwater from sanitary sewer systems; detention basins to control stormwater runoff; and/or stormwater facilities to implement best management practices to reduce non-point source pollution.

Department of Community and Economic Development (DCED)

Infrastructure Development Program (IDP)

The program makes grants and loans to eligible applicants such as municipalities for specific infrastructure improvements necessary to complement eligible capital investment by private companies and private developers. Some examples of projects that could be funded under this program are the construction or rehabilitation of drainage system infrastructure, the cleanup of hazardous waste materials, and the engineering design, construction, and inspection of drainage systems.

Floodplain Land Use Assistance Program

The program provides grants and technical assistance to encourage the proper use of land and the management of floodplain lands within Pennsylvania. Local municipalities in Fulton County that participate in the National Flood Insurance Program (NFIP), and comply with Act 166 and submit an Annual Report are eligible to receive grants under this program.

Pennsylvania Department of Environmental Protection (PADEP)

PADEP has many types of grants and loans to assist individuals, groups, local governments, and businesses with a host of environmental issues. The following is a list of the available funds/loans that are applicable to stormwater problems in Fulton County:

Enactment & Implementation of Stormwater Ordinances

PADEP may reimburse municipalities for allowable costs incurred to enact and implement ordinances consistent with approved stormwater management plans pursuant to the Pennsylvania Stormwater Management Act (1978 Act 167). Municipalities are eligible for this reimbursement after they enact ordinances to implement the stormwater management plan. As active participants in the ongoing Act 167 study of Fulton County, local municipalities are eligible to receive reimbursement.

Environmental Education Grants Program

The conservation of Commonwealth resources depends on the effectiveness of the environmental literacy of its citizens. The focus of this Environmental Education Grants Program is to support environmental education through counties, municipalities, schools, county conservation districts and other non-profit conservation or educational organizations, including colleges and universities. The average grant amount is $10,000.

Flood Protection Grant Program

The program gives funds to government entities responsible for the operation and maintenance of flood protection projects for non-routine maintenance, project improvements and specialized equipment. Local municipalities in Fulton County are eligible to receive this grant. PADEP has been providing funds for stormwater control projects in the main three River Basins in Pennsylvania: Ohio River Basin, Delaware River Basin, and the Susquehanna River Basin.

Types of projects that are covered under the above referenced grant include: stormwater detention facilities, concrete channels, concrete floodwalls, compacted earth levees, channel improvements, or a combination of a number of these types of alternatives. The average grant amount is $25,000.

Growing Greener II

$230 million has been allocated to PADEP as a result of the Growing Greener Bond Initiative for existing programs for watershed protection, mine and acid mine drainage remediation, plugging of abandoned oil and gas wells, advanced energy projects, flood protection, and brown fields. Projects must be for capital improvement to land and there must be a reasonable expectation that the project will last for the term of the bond, which is 20 years.

Non-point Source Pollution Prevention Education Mini-grant Program (319)

PADEP provides funding to the PA Association of Conservation Districts to administer this grant program. This program provides mini-grants for the purpose of providing education on non-point source water pollution.

Non-point Source Implementation Program (Section 319)

The program provides funding to implement PA's Non-point Source Management Program. This includes funding for agricultural and urban runoff control, and natural channel design/stream bank stabilization projects, and for development of watershed-based restoration plans. The average grant amount is $110,000.

League of Women Voters of Pennsylvania

The League of Women Voters of Pennsylvania Citizen Education Fund accepts proposals for water resources education projects through its Water Resources Education Network Project. In order to be eligible to receive funding, projects should be designed to encourage individual or collective action that will protect and improve local water resources.

Funding is allocated to watershed protection projects which educate about how to protect, improve, or remediate the watershed from the impacts of non-point source pollution. Funding for the watershed protection projects is provided by the PADEP Non-point Source Management Program.

Environmental Protection Agency (EPA)

Water Quality Cooperative Agreements (Clean Water Act)

Grants are provided to support the creation of unique and new approaches to address stormwater issues, sanitary sewer issues, and combined sewer overflows.

Targeted Watersheds Grants Program

The Targeted Watersheds Grant Program is a competitive grant program that provides funding to community-driven, environmental-results-oriented watershed projects. To date, more than $37 million has been awarded to 46 watershed organizations. The program also provides capacity building grants to service provider organizations that can deliver training and tools for all watershed organizations across the country.

Chesapeake Bay Program Grants

The Chesapeake Bay Program awards grants to reduce and prevent pollution and to improve the living resources in the Chesapeake Bay. Grants are awarded for implementation projects, as well as for research, monitoring, and other related activities. In addition, the Chesapeake Bay Small Watershed Grants Program provides grants to organizations and local governments working on a local level to protect and improve watersheds in the Chesapeake Bay basin, while building citizen-based resource stewardship. The purpose of the grants program is to support protection and restoration actions that contribute to restoring healthy waters, habitat and living resources of the Chesapeake Bay ecosystem. The Small Watershed Grants Program has been designed to encourage the development and sharing of innovative ideas among the many organizations wishing to be involved in watershed protection activities. The Small Watershed Grants Program is administered by the National Fish and Wildlife Foundation, in cooperation with the U.S. Environmental Protection Agency, Chesapeake Bay Program. The Chesapeake Bay Program is a partnership among Virginia, Maryland, Pennsylvania, the District of Columbia, the Chesapeake Bay Commission, and the federal government.

Five-Star Restoration Program

EPA supports the Five-Star Restoration Program by providing funds to the National Fish and Wildlife Foundation and its partners, the National Association of Counties, NOAA's Community-based Restoration Program and the Wildlife Habitat Council. These groups then make sub grants to support community-based wetland and riparian restoration projects. 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. Preference will be given to projects that are part of a larger watershed or community stewardship effort and include a description of long-term management activities. Projects must involve contributions from multiple and diverse partners, including citizen volunteer organizations, corporations, private landowners, local conservation organizations, youth groups, charitable foundations, and other federal, state, and tribal agencies and local governments. Each project would ideally involve at least five partners who are expected to contribute funding, land, technical assistance, workforce support, or other in-kind services that are equivalent to the federal contribution.

Federal Emergency Management Agency (FEMA)

Flood Mitigation Assistance (FMA)

The Flood Mitigation Assistance program helps states and communities identify and implement measures to reduce or eliminate the long-term risk of flood damage to homes and other structures insurable under the National Flood Insurance Program (NFIP). There are three types of grants: planning, project and technical assistance. Technical assistance grants are given to state agencies that provide assistance to communities, so communities apply for planning and project grants. Projects may include (1) elevation, relocation, or demolition of insured structures; (2) acquisition of insured structures and property; (3) minor, localized structural projects that are not fundable by state or other federal programs (erosion-control and drainage improvements); and (4) beach nourishment activities such as planting of dune grass.

Project Impact Grant Program

This program helps communities that have a history of losses from natural disasters or have significant disaster risk, such as those located in watershed floodplain. Funds are provided to help assess risks, build public-private partnerships, and communicate and mentor success.

United States Army Corps of Engineers (ACOE)

Continuing Authorities Program (CAP)

If the ACOE determines a project falls within the CAP, they initiate a short reconnaissance effort to determine Federal interest in proceeding. If there is interest, a feasibility study is performed, and the project continues through a plans and specifications phase, and a construction phase. The cost share is 65% ACOE and 35% local. The federal project limit is $7,000,000.

Floodplain Management Services Program

The program aims to support comprehensive floodplain management planning to encourage and guide sponsors to prudent use of the Nations' floodplains for the benefit of the national economy and welfare. Some examples of the types of projects that would be funded include: flood warning and flood emergency preparedness, flood proofing measures, studies to improve methods and procedures for mitigating flood damages, and preparation of guides and brochures on flood related topics. ACOE may provide up to 100% of funding at the request of the sponsor.

Flood Hazard Mitigation and Riverine Ecosystem Restoration Program

The program is informally known as Challenge 21. It is a watershed-based program that focuses on identifying sustainable solutions to flooding problems by examining non-structural solutions in flood-prone areas, while retaining traditional measures where appropriate. Projects might include the relocation of threatened structures, conservation or restoration of wetlands and natural floodwater storage areas.

Aquatic Ecosystem Restoration (CAP Section 206)

Applicants receiving grants under this authority may carry out aquatic ecosystem restoration projects that will improve the quality of the environment, are in the public interest, and are cost-effective. There is no requirement that an existing ACOE project be involved.

Natural Resources Conservation Service (NRCS)

Small Watershed Program and Flood Prevention Program

The program helps participants solve natural resource and related economic problems on a watershed basis. Some examples of projects that could be funded under this program are watershed protection, flood prevention, erosion and sediment control, water quality, fish and wildlife habitat enhancement, wetlands creation and restoration, and public recreation in watersheds of 250,000 or fewer acres.

Emergency Watershed Protection (EWP)

The program helps protect lives and property threatened by natural disasters such as floods. The program includes watershed plans, river basin surveys and studies, flood hazard analyses, and floodplain management assistance. The focus of these plans is to identify solutions that use land treatment and non-structural measures to solve resource problems. NRCS requires that the measures that are taken must be environmentally and economically sound and generally benefit more than one property owner. Examples of these measures are clearing debris from clogged waterways, restoring vegetation, and stabilizing river banks.

EWP also provides funds to purchase floodplain easements as an emergency measure. Floodplain easements restore, protect, maintain, and enhance the functions of the floodplain; conserve natural values including fish and wildlife habitat, water quality, flood water retention, ground water recharge, and open space; reduce long-term federal disaster assistance; and safeguard lives and property from floods, and the products of erosion. It is important to note that it is not necessary for a national emergency to be declared for an area to be eligible for assistance. EWP can provide up to 90% cost share in limited resource areas as determined by the US Census.

Each EWP project, with the exception of floodplain easements, requires a sponsor who applies for the assistance. A sponsor can be any legal subdivision of State or local government. They determine priorities for emergency assistance while coordinating work with other Federal and local agencies. The role of sponsors is to provide legal authority to do repair work, obtain necessary permits, contribute funds or in-kind services, and maintain the completed emergency measures.

Environmental Quality Incentives Program(EQIP)

The USDA Natural Resources Conservation Service's Environmental Quality Incentives Program (EQIP) was established to provide a voluntary conservation program for farmers and ranchers to address significant natural resource needs and objectives. EQIP offers contracts with a minimum term that ends one year after the implementation of the last scheduled practices and a maximum term of ten years. These contracts provide incentive payments and cost-shares to implement conservation practices. Persons who are engaged in livestock or agricultural production on eligible land may participate in the EQIP program. EQIP activities are carried out according to an environmental quality incentives program plan of operations developed in conjunction with the producer that identifies the appropriate conservation practice or practices to address the resource concerns. The practices are subject to NRCS technical standards adapted for local conditions. The local conservation district approves the plan.

Farm and Ranch Lands Protection Program (FRPP)

The USDA Natural Resources Conservation Service's Farm and Ranch Lands Protection Program (FRPP) is a voluntary program that helps farmers and ranchers keep their land in agriculture and prevent conversion of agricultural land to non-agricultural uses. The program provides matching funds to organizations with existing farmland protection programs that enable them to purchase conservation easements. These entities purchase easements from landowners in exchange for a lump sum payment, not to exceed the appraised fair market value of the land's development rights. The easements are for perpetuity unless prohibited by state law. Eligible land is land on a farm or ranch that has prime, unique, statewide, or locally important soil or contains historical or archaeological resources; is subject to a pending offer by an eligible entity; and includes cropland, rangeland, grassland, pasture land, and incidental forest land and wetlands that are part of an agricultural operation.

Plan Review, Implementation & Update Procedures

PLAN REVIEW AND IMPLEMENTATION

As required by Act 167, this Stormwater Management Plan must be reviewed by municipal, county, and regional planning agencies. A public hearing must be held and the Fulton County Commissioners must formally adopt the Plan following the public hearing. Once adopted, the Plan, along with the review comments and official county adoption resolution must be submitted to PADEP for approval. Subsequent to PADEP's approval of this Stormwater Management Plan, implementation of the Plan will be the responsibility of all municipalities within Fulton County.

The following outlines the sequence of events that must take place to implement this Plan:

Bold text below the events indicates the date at which the event took place.

1. Review of the Plan by all municipalities, Fulton County Planning Commission and PADEP.
   May 10, 2010 – Final WPAC Meeting

2. A public hearing.
   June 1, 2010 – Fulton County Commissioners Office

3. Incorporate in the Plan, applicable modifications to address comments received at the public hearing and from reviewing agencies.
   June 9, 2010 – Comment Response Document Completed

4. Formal adoption, by resolution, of the Plan by the Fulton County Commissioners.
   June 29, 2010 – by Fulton County Board of Commissioners

5. Submission of the Plan, as adopted by Fulton County Commissioners, and all review comments to PADEP for Plan approval.
   July 2010 – Submission to PADEP

6. Municipal adoption of the Model Ordinance or integration of the Plan's provisions into existing regulations. It is important that the standards and criteria contained in the Plan are implemented correctly, especially if the

municipality chooses to integrate the standards and criteria into existing regulations. In either case, it is recommended that the resulting regulatory framework be reviewed by the local planning commission, the municipal solicitor, and/or the Fulton County Planning Commission for compliance with the provisions of the Plan and consistency among the various regulations. Additionally, the adopted regulations may be reviewed by PADEP for compliance with this Plan.

7. Municipal review of Stormwater Management Site Plans and Stormwater Management Site Reports for all activities regulated by the Plan and the resulting ordinances. The municipalities and/or the Fulton County Planning Commission will review the Stormwater Management Site Plans and Stormwater Management Site Reports for compliance with the standards and criteria of the Plan and shall approve or disapprove the Stormwater Management Site Plans and Stormwater Management Site Reports accordingly.

PLAN UPDATE PROCEDURES

According to Section 5(a) of Act 167, this Stormwater Management Plan is to be reviewed and updated "at least every five years". The review and update procedure would follow a similar process to the original adoption process including municipal review, public comment, County adoption, and PADEP approval.

The framework for determining if and when the Plan will require review and update would consist of information pertaining to zoning changes, continued development of Fulton County watersheds, new stormwater-related problems, an increase in severity of existing problems, or construction of significant stormwater facilities or flood control projects. Additionally, because of funding constraints during the planning process, only two (2) of the ten (10) PADEP's Designated Watersheds were modeled in detail for this Plan. A future Plan update should consider modeling the remaining Designated Watersheds. Also, certain Plan elements that were deemed "optional" were omitted from this Plan so that funding could be concentrated on what were deemed more significant issues.

The Fulton County Planning Commission will evaluate zoning changes, new or intensified stormwater problems, significant stormwater facilities, and flood control projects. This information may be obtained through supplemental municipal questionnaires or personal contact with municipal officials and planning commission members. If it is believed that the existing Plan may need to be updated, the Watershed Plan Advisory Committee will be reactivated. The purpose of the activation will be to investigate the Plan's status and to determine if a Plan Update is required. The committee will formulate a Plan Review describing the need for an update and would develop recommendations for the Plan Update.

If the Watershed Plan Advisory Committee requires activation to determine if the Plan is to be updated, the Fulton County Planning Commission will notify PADEP. Subsequently, PADEP will be notified of the committee's decision.

It is possible, perhaps even probable; that the need for Plan revisions will be on an individual watershed basis. If this situation should arise, the watershed of concern will be dealt with individually and necessary revisions to the Plan may be incorporated as an addendum rather than revising the entire Plan.

References

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2. Fulton County Conservation District, 1993: Cove Creek Watershed - Act 167 Storm Water Management Plan.

3. Fulton County Conservation District, February 2005, last revised March 2009: County Implementation Plan.

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6. Commonwealth of Pennsylvania, August 2006: Title 25, Part I, Subpart C, Article II, Chapter 93. Water Quality Standards.

7. NRCS, NRCS Planning and Design Manual.

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

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10. Prince George's County, Maryland, 1999: Low-Impact Development: An Integrated Design Approach.

11. U.S. Army Corps of Engineers, Hydrologic Engineering Center, January 2001: Hydrologic Modeling System HEC-HMS User's Manual.

12. U.S. Army Corps of Engineers, Hydrologic Engineering Center, March 2000: Hydrologic Modeling System HEC-HMS Technical Reference Manual.

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14. U.S. Department of Transportation, Federal Highway Administration, September 1985: Hydraulic Design Series 5. Hydraulic Design of Highway Culverts.

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16. U.S. EPA. 1999: Preliminary Data Summary of Urban Stormwater Best Management Practices, EPA 821-R-99-012. Washington, D.C.

17. U.S. Geological Survey, Stuckey, Marla H, Reed, Lloyd A., 2000: Water-Resources Investigations Report 00-4189 Techniques for Estimating Magnitude and Frequency of Peak Flows for Pennsylvania Streams.

18. Southern Alleghenies Planning and Development Commission, May 2007: 'Connections in Our Landscape' – The Southern Alleghenies Greenways and Open Space Network Plan.

19. Chesapeake Bay Program Best Management Practices, Agricultural BMPs – Approved for CBP Watershed Model.

20. Growing Greener, www.growinggreener2.com.

21. Pennsylvania State University, SoilMap, www.soilmap.psu.edu.

22. MSN Maps, www.msn.com.

Plate #1 – County Base Map

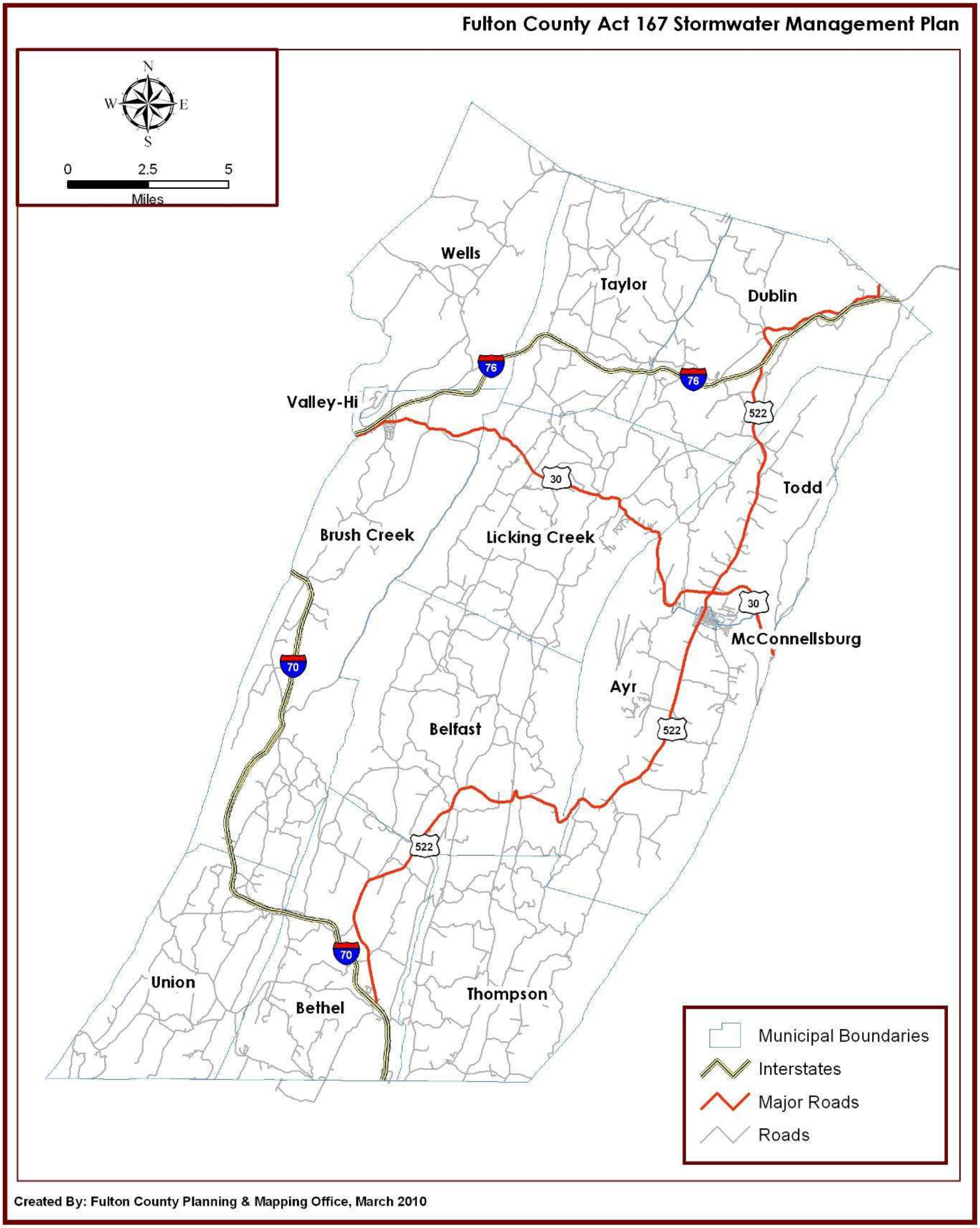


Plate #2 – Hydrologic Soils Map

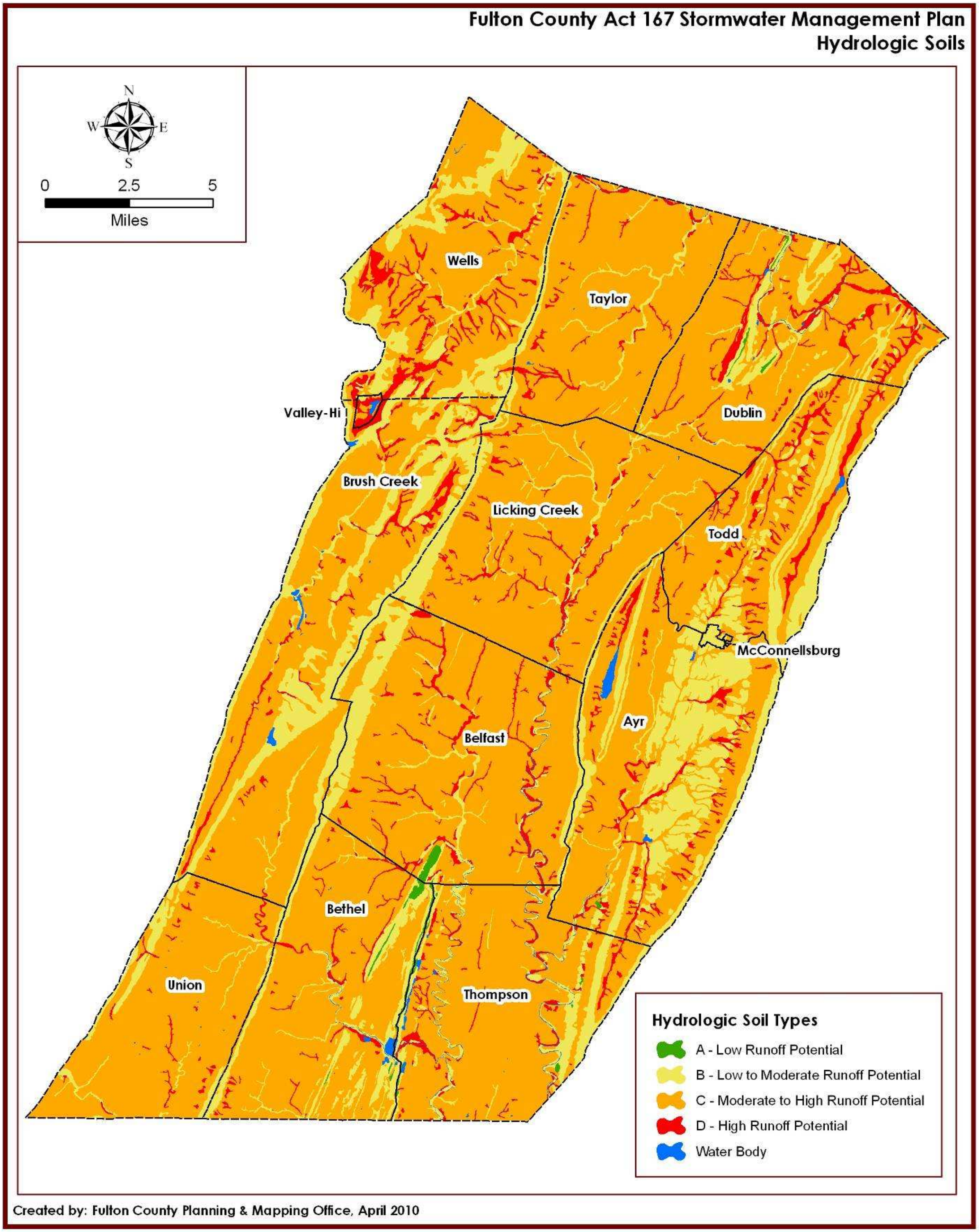


Plate #3 – FEMA Delineated 100-year Floodplains

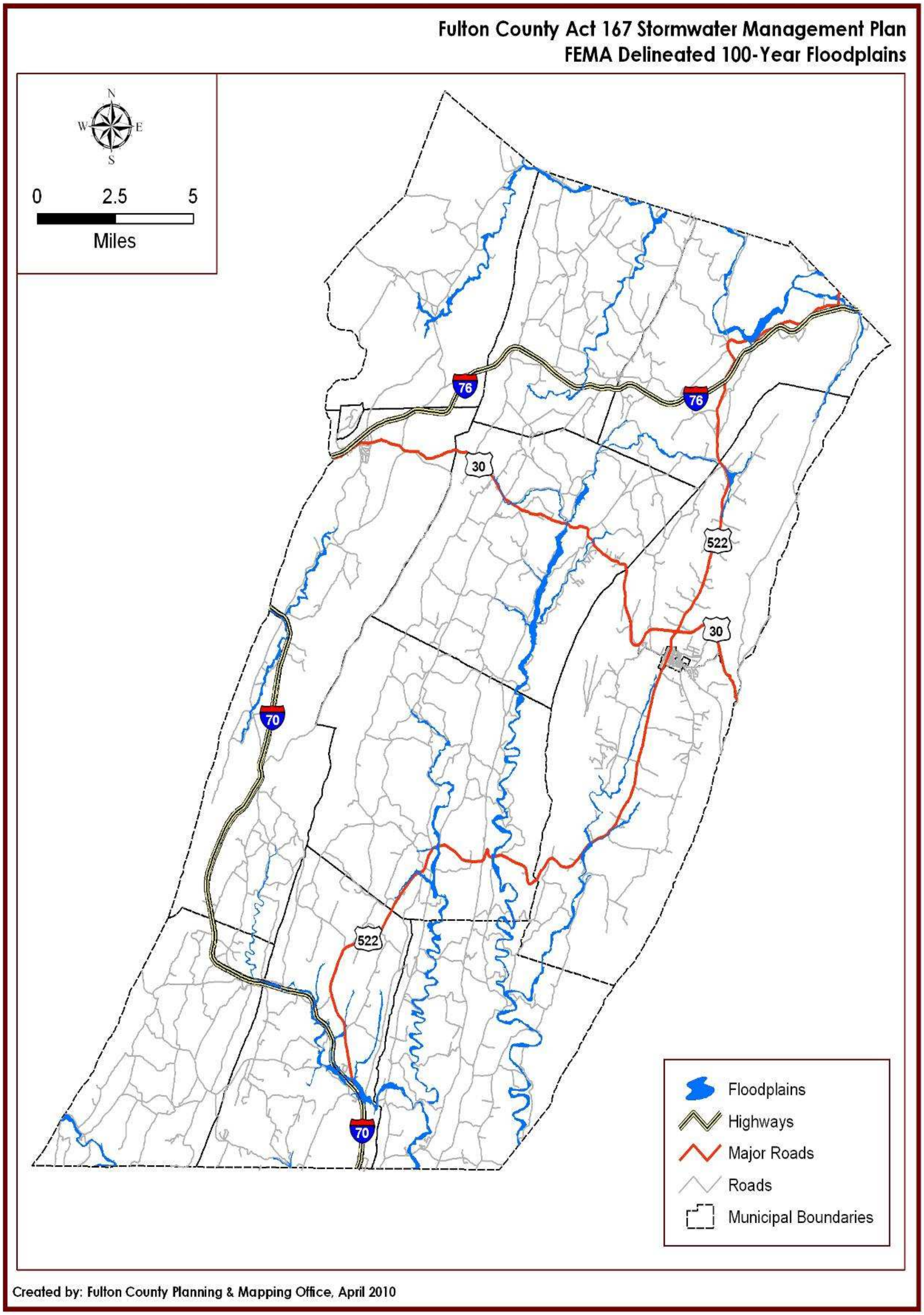


Plate #4 – Problem Area Location and Existing Stormwater Systems

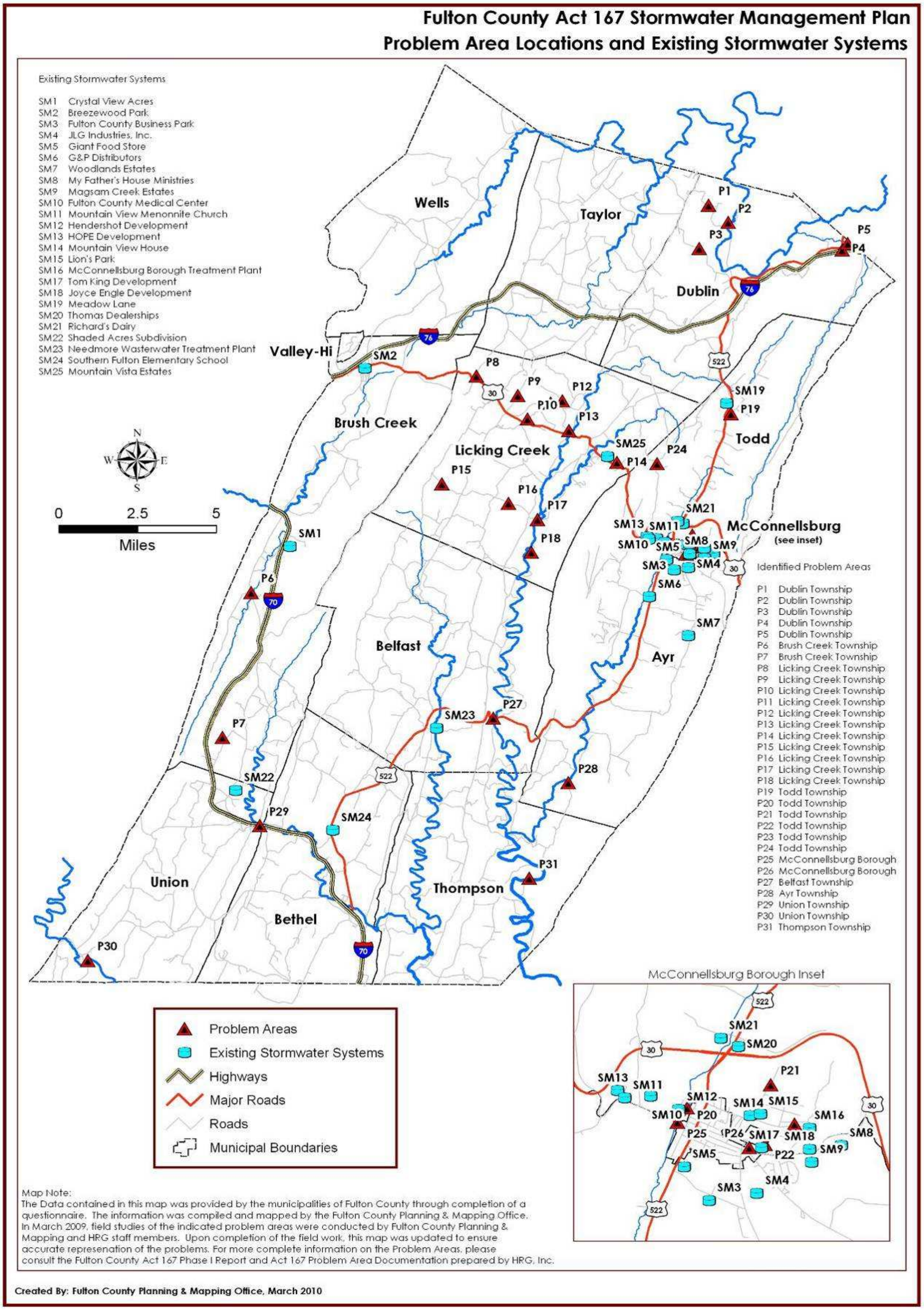


Plate #5 – Existing Land Uses Coverage – County-Wide

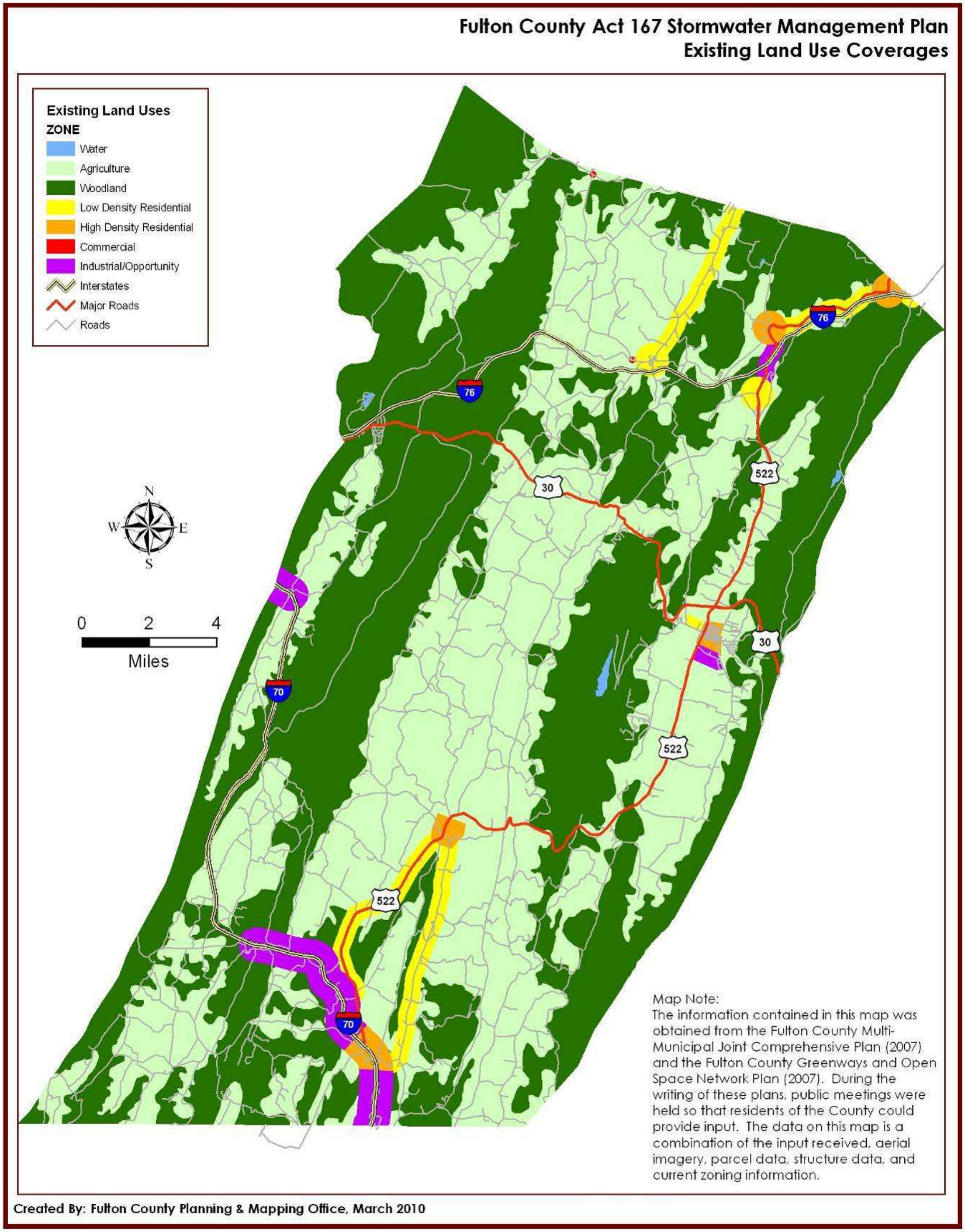


Plate #6 – Future Land Uses Coverage – County-Wide

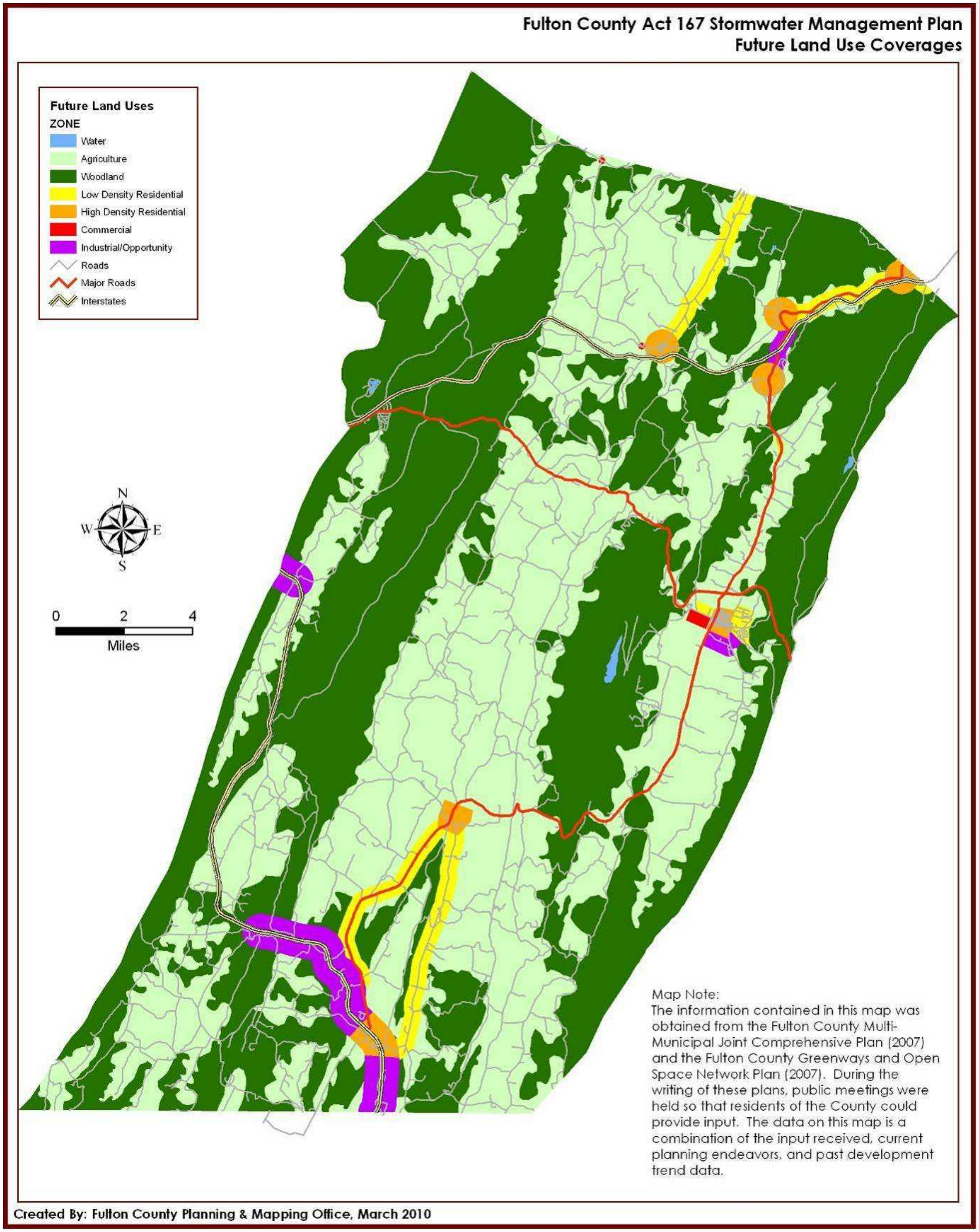


Plate #7 – Existing Land Uses Coverage – Cove Creek Watershed

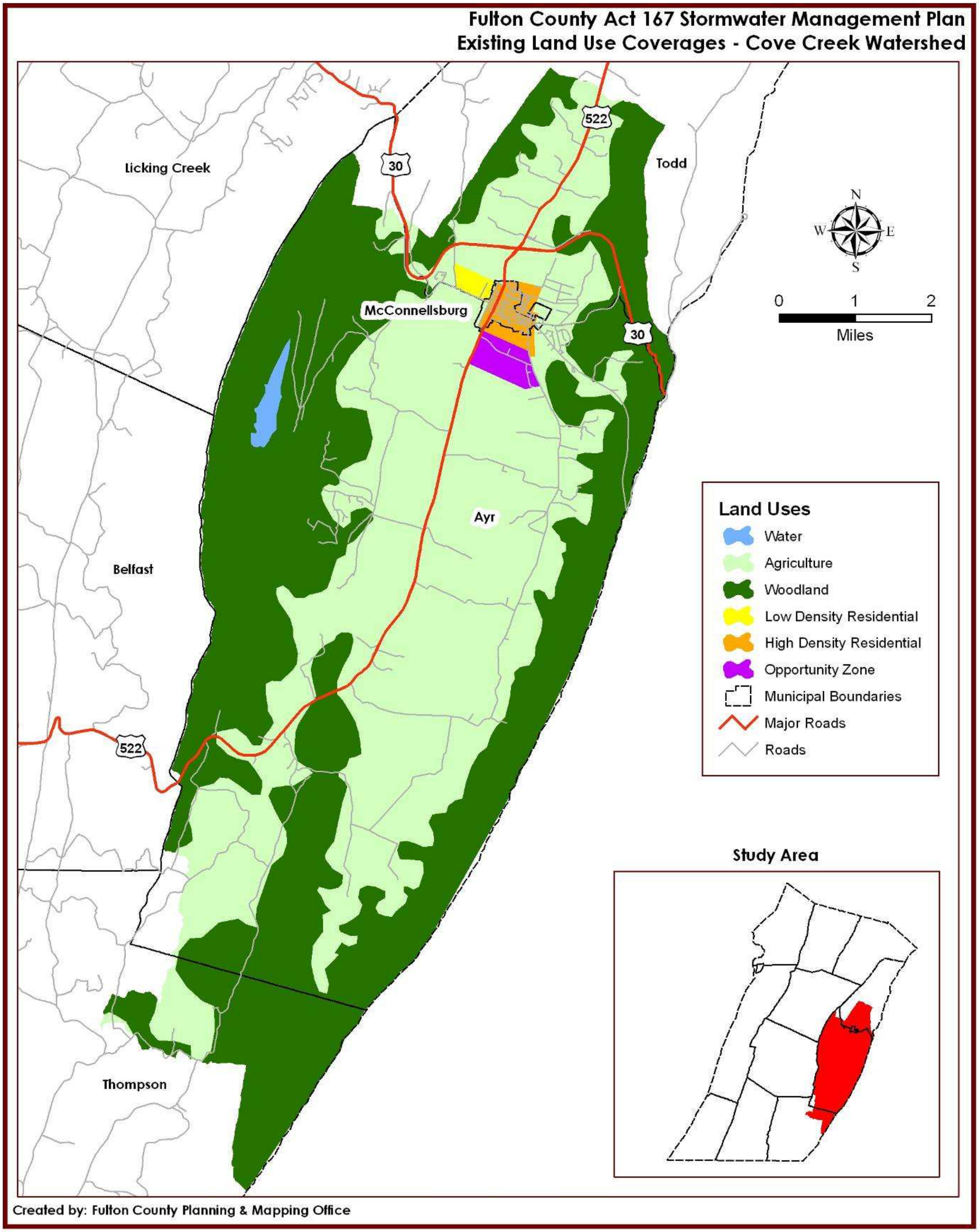


Plate #8 – Future Land Uses Coverage – Cove Creek Watershed

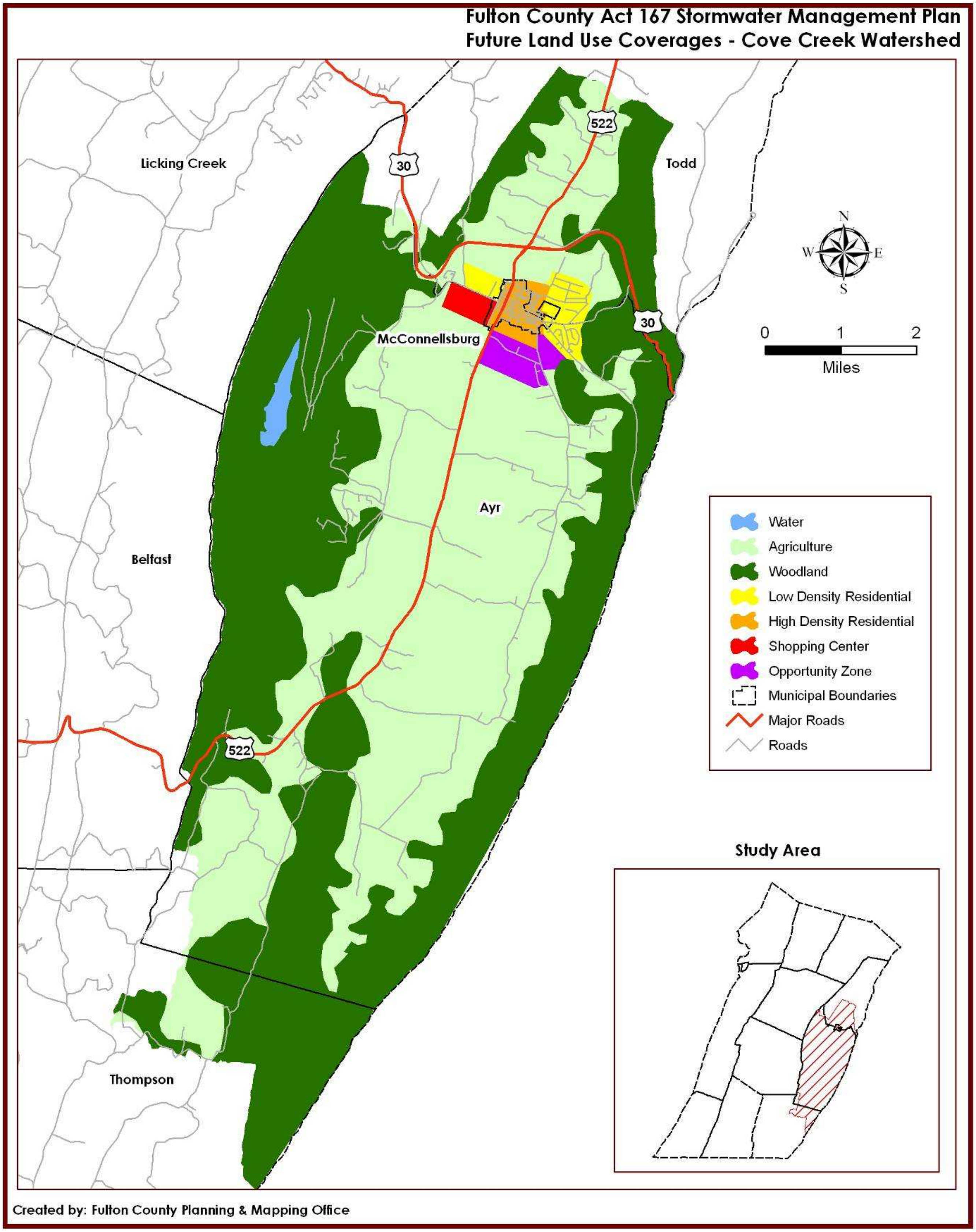


Plate #9 – Existing Land Uses Coverage – Licking Creek Watershed

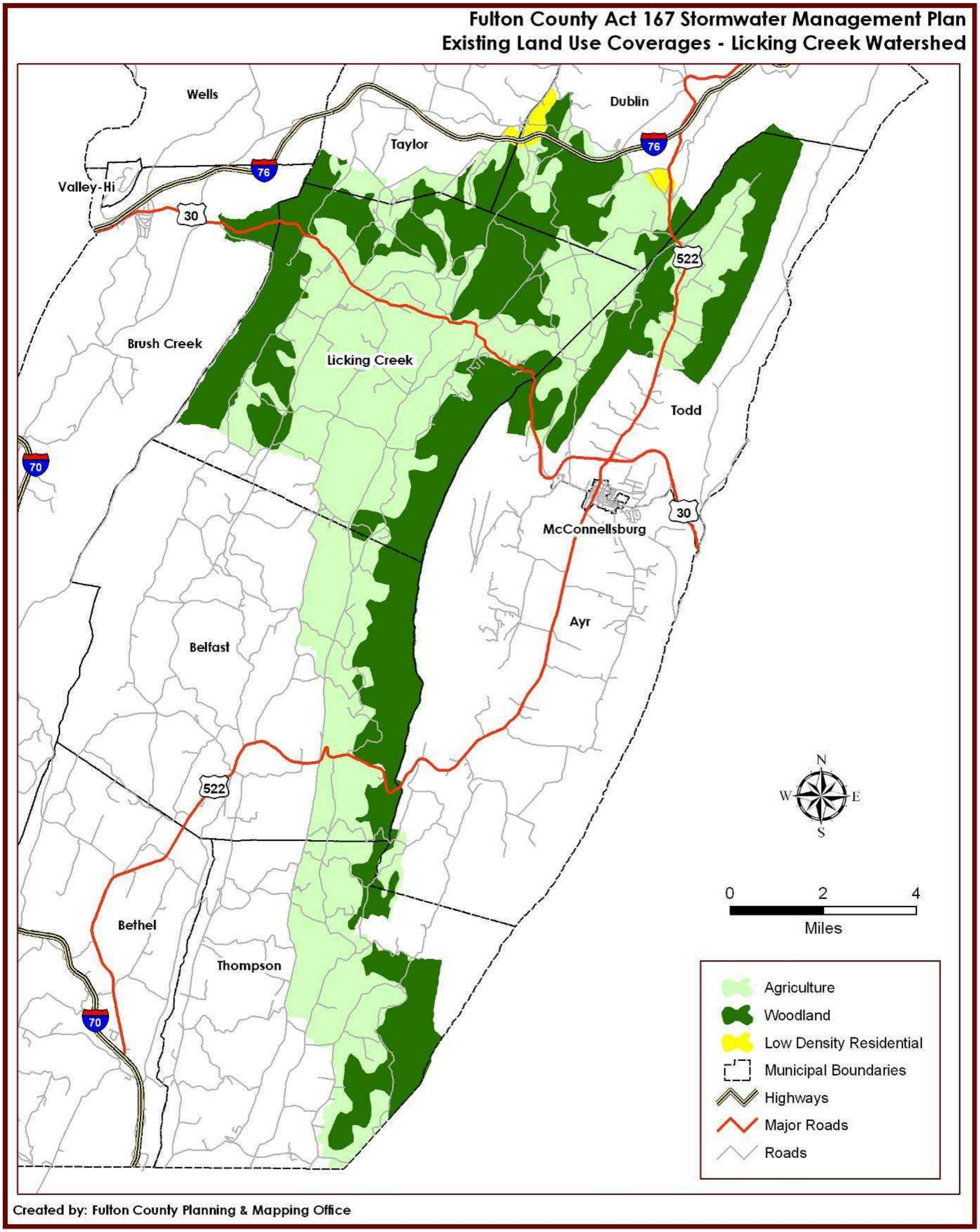


Plate #10 – Future Land Uses Coverage – Licking Creek Watershed

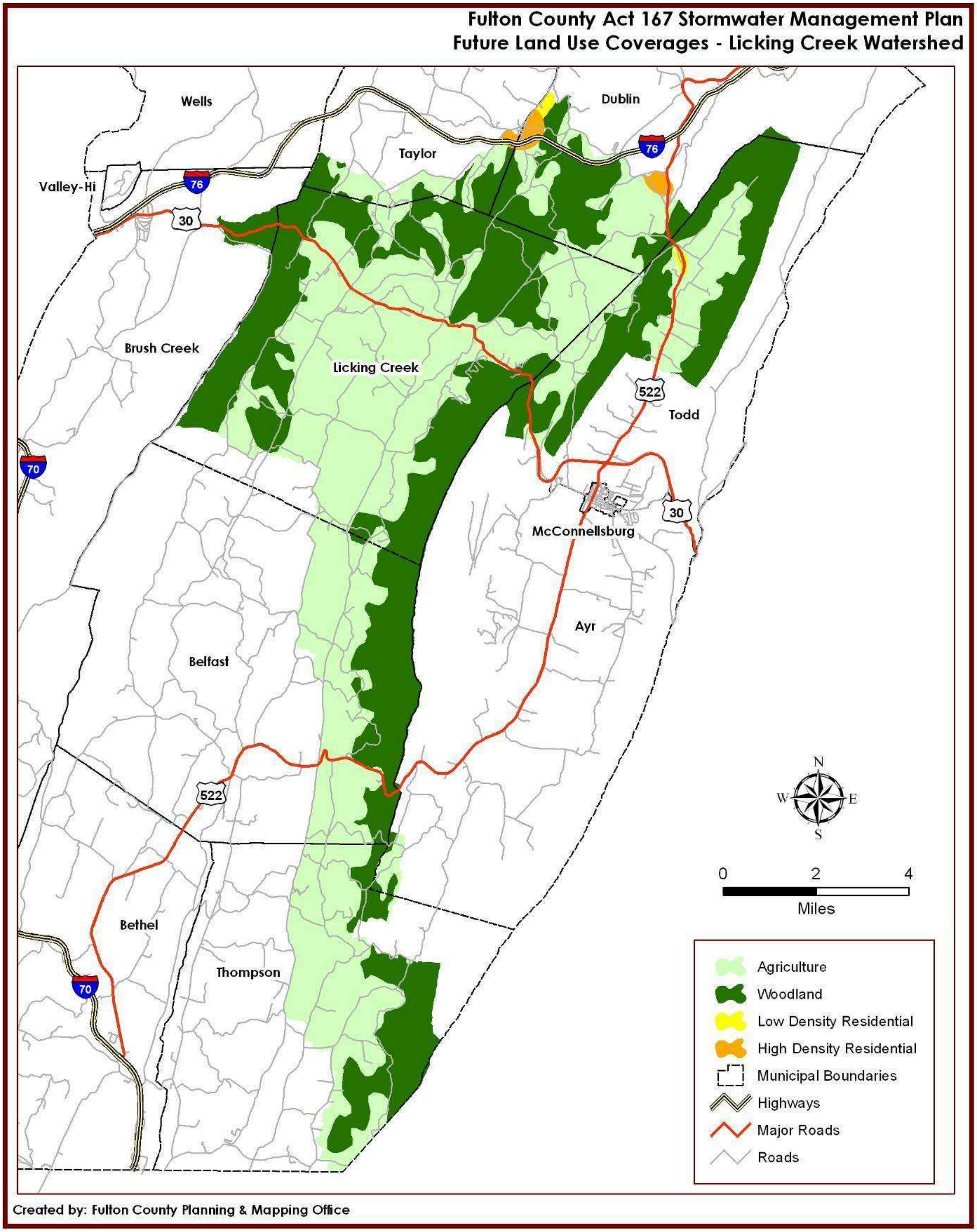


Plate #11 – Cove Creek and Licking Creek Subwatersheds

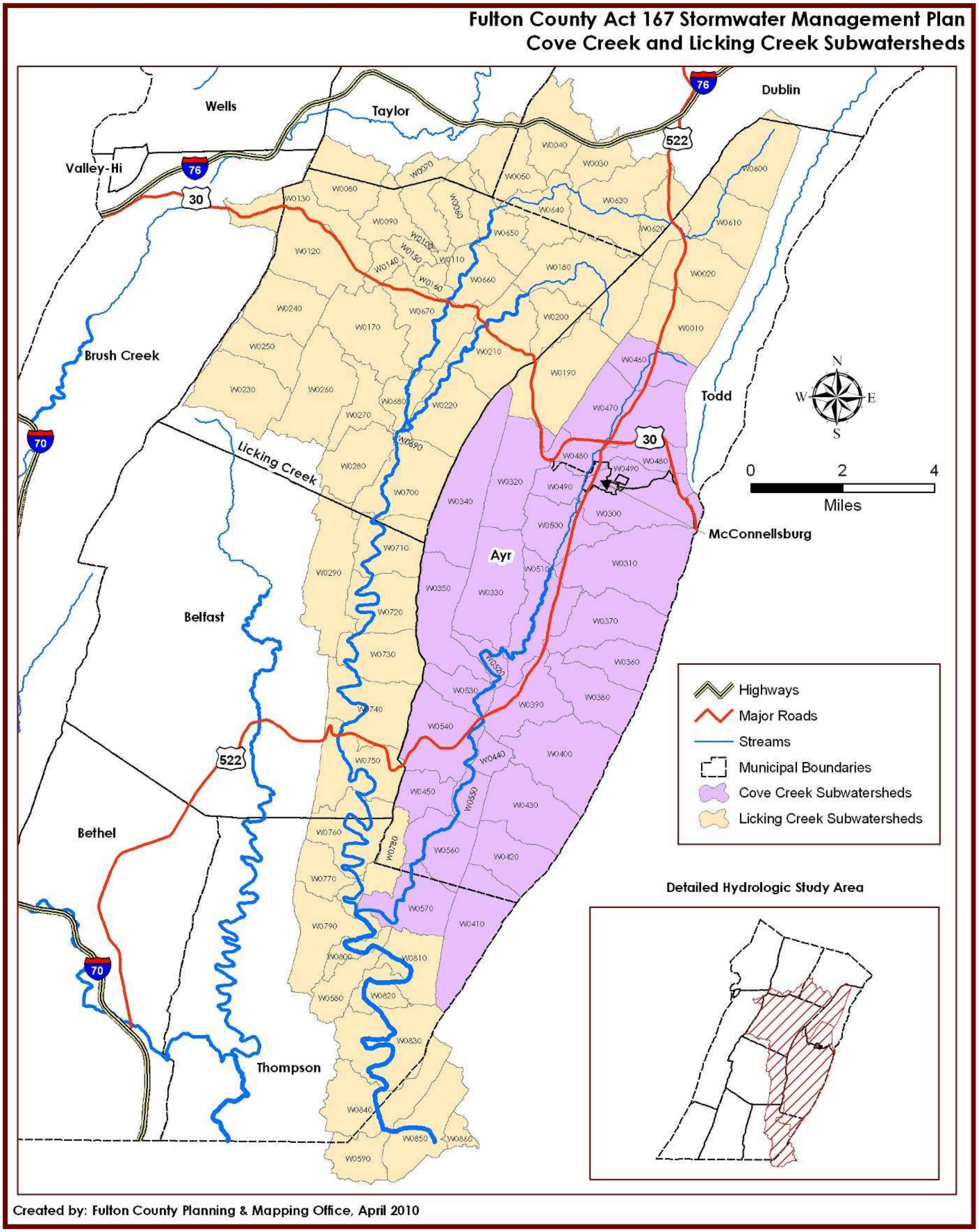
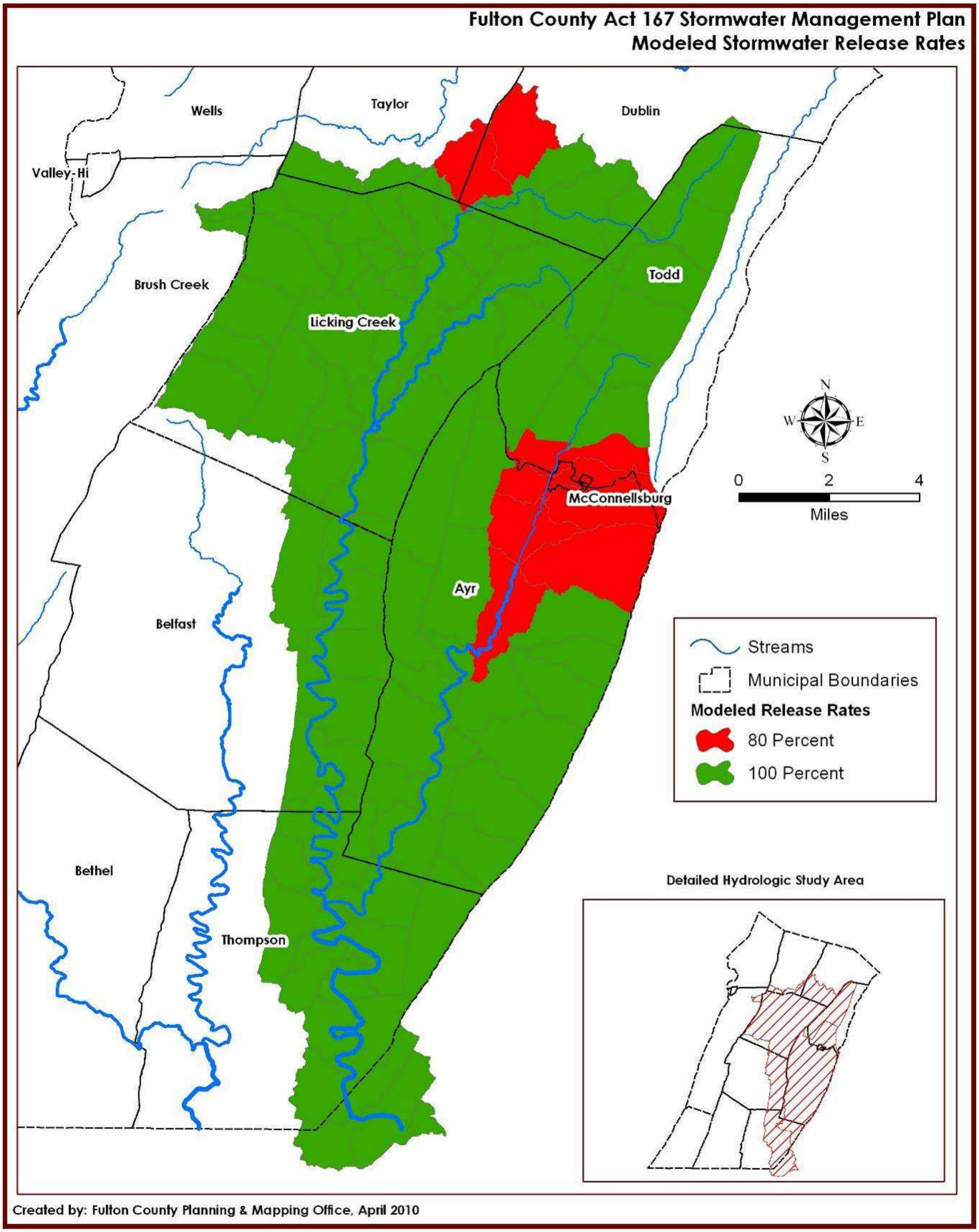


Plate #12 – Release Rates for Cove Creek and Licking Creek



- APPENDIX A -
TECHNICAL STANDARDS

Appendix A – Technical Standards

An overview of the process that was used to complete the hydrologic modeling in preparation of this Plan is presented in the Technical Modeling Analysis section of the Plan. The following technical data is included here to supplement the general information provided in that section.

DATA COLLECTION

The GIS data for the hydrologic model was compiled from a variety of sources by county, state, and federal agencies. The data was collected in and processed using GIS software. A description of GIS data collected, the source, and its use is provided in the following table.

DATA	*SOURCE*	*USE*
3.2 Foot Digital Elevation Model (DEMs)	PA MAP (2009)	Watershed delineation, length, basin slope, stream slope, average elevation
High Resolution Streamlines	USGS (2008)	Watershed delineation, cartography, spatial orientation
2010 – County Wide Land Use	Fulton County	Curve number generation for subwatersheds
Full Build-Out – County Wide Land Use	Fulton County	Curve number generation for subwatersheds
SURRGO Soils Data	NRCS (2008)	Curve number generation; Analysis of infiltration limitations
Carbonate Bedrock	ERRI (1996)	Calculation of percentage of limestone geology within subwatersheds; Analysis of infiltration limitations
Storage (percent of lakes, ponds, and wetlands)	USGS (2008)	Calculation of parameters for USGS Regression Equations
Roadway Data	Fulton County	Cartography, spatial orientation

HYDROLOGIC MODEL PARAMETER DATA

SOILS, LAND USE, AND CURVE NUMBERS

The determination of curve numbers is a function of soil type and land use. The hydrologic soil groups were defined by National Resources Conservation Service (NRCS). The 2001 National Land Cover Database (NLCD) was simplified to provide an estimate of curve numbers according to the following table:

GIS VALUE	NLCD (2001) DESCRIPTION	NRCS (1986) DESCRIPTION	A	B	C	D
LAND USE OUTSIDE OF FULTON COUNTY						
11	Open Water	Water	98	98	98	98
21	Developed, Open Space	Open space - Good Condition	39	61	74	80
22	Developed, Low Intensity	Residential - 1 acre	51	68	79	84
23	Developed, Medium Intensity	Residential - 1/2 acre	54	70	80	85
24	Developed, High Intensity	Commercial and Business	89	92	94	95
31	Barren Land (Rock/Sand/Clay)	Newly graded areas	77	86	91	94
41	Deciduous Forest	Woods - Good Condition	30	55	70	77
42	Evergreen Forest	Woods - Good Condition	30	55	70	77
43	Mixed Forest	Woods - Good Condition	30	55	70	77
52	Shrub/Scrub	Brush - Good Condition	30	48	65	73
71	Grassland/Herbaceous	Meadow - Good Condition	30	58	71	78
81	Pasture/Hay	Pasture - Good Condition	39	61	74	80
82	Cultivated Crops	Contoured Row Crops - Good Condition	65	75	82	86
90	Woody Wetlands	Woods - Good Condition	30	55	70	77
95	Emergent Herbaceous Wetlands	Water	98	98	98	98
LAND USE WITHIN FULTON COUNTY						
301	AG – Agriculture	Pasture - Good Condition	39	61	74	80
302	WL – Woodland	Woods - Good Condition	30	55	70	77
303	HDR – High Density Residential	Residential - 1/8 acre	77	85	90	92
304	LDR – Low Density Residential	Residential - 1/2 acre	54	70	80	85
305	SC – Shopping Center	Commercial and Business	89	92	94	95
306	OZ – Opportunity Zone	Industrial	81	88	91	93

The curve numbers presented in the previous table represent "average" antecedent runoff condition (i.e. ARC = 2). In a significant hydrologic event, runoff is often influenced by external factors such as extremely dry antecedent runoff conditions (ARC = 1) or wet antecedent runoff conditions (ARC = 3). The antecedent runoff conditions of the above curve numbers were altered during the calibration process so that model results are within a reasonable range of other hydrologic estimates.

INFILTRATION AND HYDROLOGIC LOSS ESTIMATES

Infiltration and all other hydrologic loss estimates (e.g., evapotranspiration, percolation, depression storage, etc.) taken into account within the HEC-HMS model was consistent with the recharge volume criteria contained in Control Guidance 1 and 2 (CG-1 and CG-2). These losses were modeled in existing conditions as the standard initial abstraction in the NRCS Curve Number Runoff method (i.e., $I_a = 0.2*S$). CG-1 was simulated by modifying the standard initial abstraction using the following procedure:

The runoff volume is computed by HEC-HMS using the following equation:

$$Q_{volume} = \frac{(P - I_a)^2}{(P - I_a) + S}$$

Where: P = rainfall for a specific storm event (in)
I_a = initial abstraction (in)
S = maximum retention (in)

S is defined by the following equation which relates runoff volume to curve number:

$$S = \frac{1000}{CN} - 10$$

The standard initial abstraction (I_a) used in Pennsylvania is typically 0.2*S. HEC-HMS calculates this automatically if no value is entered by the user. This was the approach used for the existing and future conditions modeling scenarios.

In future conditions with implementation of CG-1, the following equation is applicable. The goal of CG-1 is to ensure there is no discharge volume increase for the 2-year storm event, so:

$$Q_{CG1} = Q_{Existing} = \frac{(P - I_a)^2}{(P - I_a) + S_{Proposed}}$$

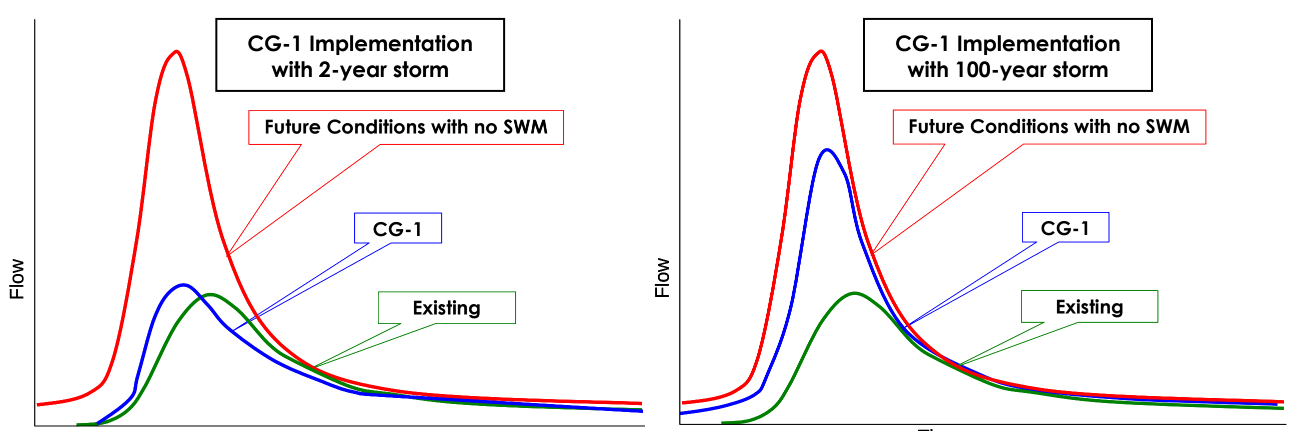
Where P = rainfall for a specific storm event (in)
I_a = initial abstraction (in)
$S_{Proposed}$ = maximum retention in proposed conditions
as a function of the proposed conditions curve number (in)

Assume I_a = 0.2*S as the Initial abstraction is no longer applicable with CG-1 since BMPs are to be installed to control or remove the increase in runoff volume for the 2-year storm. Using the HEC-HMS modeling output for $Q_{Existing}$, the initial abstraction for CG-1 may be calculated using the following equation:

$$I_a = P_{2-year} - \frac{1}{2}(Q_{Existing} \pm \sqrt{Q_{Existing}^2 + 4Q_{Existing}S_{Proposed}}) \text{ for the 2-year event}$$

Thus, the volume control required by CG-1 is implicitly modeled by overriding the HEC-HMS default for initial abstraction with the above value. The qualitative effect of this will be to eliminate the increase in runoff volume for the 2-year storm and to reduce the increase in runoff volume of the more extreme events. Increases in the peak flow values are reduced for all storms, but not eliminated, since the time of concentrations for proposed condition are decreased.

The Figure A.1 shows the effects of implementing a CG-1 policy on an example watershed. In the first figure representing a 2-year storm event, the hydrograph volumes (the area under the hydrographs) are exactly the same and the peaks are similar. In the second graph representing a 100-year storm event, the hydrograph volumes are not the same since only the 2-year volume is abstracted; consequently there is still a substantial increase in peak flows, although the CG-1 implementation does reduce the peak flow some. **Figure A.1. Typical On-Site Runoff Control Strategy**



In the case of this particular example, release rates might be necessary to prevent increases in peak flow. However, in situations where there is only a small increase in impervious coverage, CG-1 may reduce the proposed conditions peak flow to existing conditions levels without the use of release rates.

For the 2-year event, modeling CG-1 with the previous equations results in an increased approximation in initial abstraction represented by D:

$$D = I_a^{CG-1} - 0.2S$$

For every event of greater magnitude (e.g., 10, 25, 50, and 100-year events), the initial abstraction is calculated using the sum of the traditional method and the increase in initial abstraction for the 2-year event.

$I_a = 0.2S + D$ for all events greater than the 2-year event.

MODEL CALIBRATION

Three parameters were modified to develop a calibrated hydrologic model: the curve number, the time of concentration, and the Manning's "n" coefficient used in the Muskingum-Cunge routing method.

The antecedent runoff condition was altered for each storm event so that each subwatershed and calibration point was within an acceptable range of a target flow. The equation used to modify antecedent runoff condition (ARC):

For ARC ≤ 2:

$$CN_x = \frac{[10 + 5.8(x - 2)]CN_2}{10 + 0.058(x - 2)CN_2}$$

For ARC > 2:

$$CN_x = \frac{[10 + 13(x - 2)]CN_2}{10 + 0.013(x - 2)CN_2}$$

Thus a unique ARC and resulting curve number was calculated for each subwatershed for each storm event. The same ARC was applied in both existing and proposed conditions.

Additionally, lag times were calculated using both TR-55 and the NRCS lag equation. The initial model runs used the results from the NRCS lag equation. A factor between 0 and 2 was applied to the initial value to obtain a calibrated time of concentration value. The same time of concentration was applied to all existing condition storms. The future land use time of concentration was calculated using the NRCS lag equation with future land curve numbers and it was subsequently adjusted by the same factor used in existing conditions.

Finally the Manning's "n" value for channels and overbank areas was modified to obtain realistic flow values. Manning's Roughness Coefficient "n" values were initially assumed to be 0.055 in-channel and overbank values were initially assumed to be 0.080. The values were changed for calibration purposes at various locations and the resulting ranges for the channel and overbank areas were 0.02-0.07 and 0.03-0.20, respectively.

STORMWATER MANAGEMENT DISTRICTS

The regional philosophy used in Act 167 planning introduces a different stormwater management approach than is found in the traditional on-site approach. The difference between the on-site stormwater control philosophy and the Act 167 watershed-level philosophy is the consideration of downstream impacts throughout an entire watershed. The objective of typical on-site design is to control post-development peak flow rates from the site itself; however, a watershed-level design is focused on maintaining existing peak flow rates in the entire drainage basin. The watershed approach requires knowledge of how the site relates to the entire watershed in terms of the timing of peak flows, contribution to peak flows at various downstream locations, and the impact of the additional runoff volume generated by the development of the site. The proposed watershed-level stormwater runoff control philosophy is based on the assumption that runoff volumes will increase with development and the philosophy seeks to manage the increase in volumes such that peak rates of flow throughout the watershed are not increased. The controls implemented in this Plan are aimed at minimizing the increase in runoff volumes and their impacts, especially for the 2-year storm event.

The basic goal of both on-site and watershed-level philosophies is the same, i.e. no increase in the peak rate of stream flow. The end products, however, can be very different as illustrated in the following simplified example.

Presented in Figure A.2 is a typical on-site runoff control strategy for dealing with the increase in the peak rate of runoff with development. The Existing Condition curve represents the pre-development runoff hydrograph. The Developed Condition hydrograph illustrates three important changes in the site's runoff response with development:

- A higher peak rate,
- A faster occurring peak (shorter time for the peak rate to occur), and
- An increase in total runoff volume

The "Controlled" Developed Condition hydrograph is based on limiting the post-development runoff peak rate to the pre-development level through use of detention facilities; but the volume is still increased. The impact of "squashing" the post-development runoff to the pre-development peak without reducing the volume is that the peak rate occurs over a much longer period of time. The instantaneous pre-development peak has become an extended peak (approximately two (2) hours long in this example) under the "Controlled" Developed Condition.

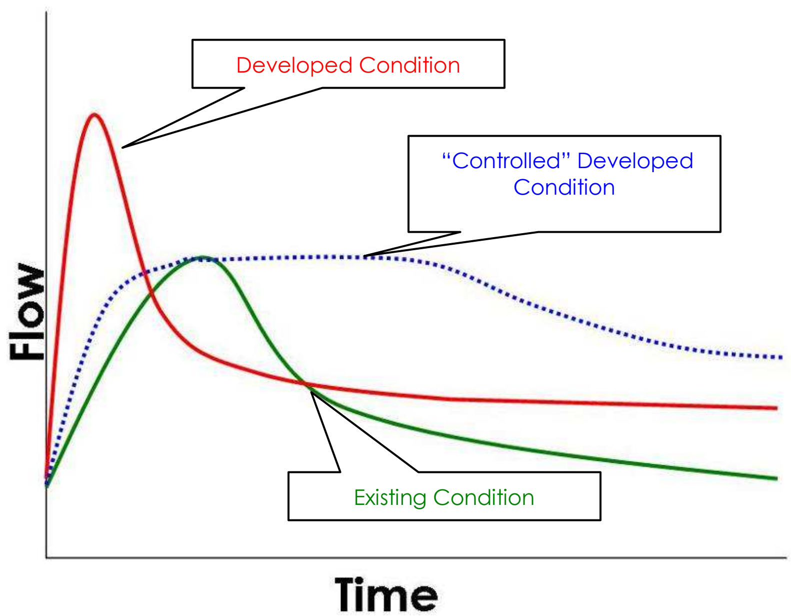


Figure A.2. Typical On-Site Runoff Control Strategy

Considering the outflow from the site only, the maintenance of the pre-development peak rate of runoff is an effective management approach. However, Figures A.3 and A.4 illustrate the potential detrimental impact of this approach. Figure A.3 represents the existing hydrograph at the point of confluence of Watershed A and Watershed B. The timing relationship of the watersheds is that Watershed A peaks more quickly (at time tp_A) than the Total Hydrograph, while Watershed B peaks later (at time tp_B), than the Total Hydrograph, resulting in a combined time to peak approximately in the middle (at time Tp). Watershed A is an area of significant development pressure, and all new development proposals are met with the on-site runoff control philosophy as depicted in Figure A.2. The eventual end product of the Watershed A development under the "Controlled" Watershed A Condition is an extended peak rate of runoff as shown in Figure A.4. The extended Watershed A peak occurs long enough so that it coincides with the peak of Watershed B. Since the Total Hydrograph at the confluence is the summation of Watershed A and Watershed B, the Total Hydrograph peak is increased under these conditions to the "Controlled" Total Hydrograph. The conclusion from the example is that simply controlling peak rates of runoff on-site does not guarantee an effective watershed level of control because of the increase in total runoff volume. The net result is that downstream peaks can increase and extend for longer durations.

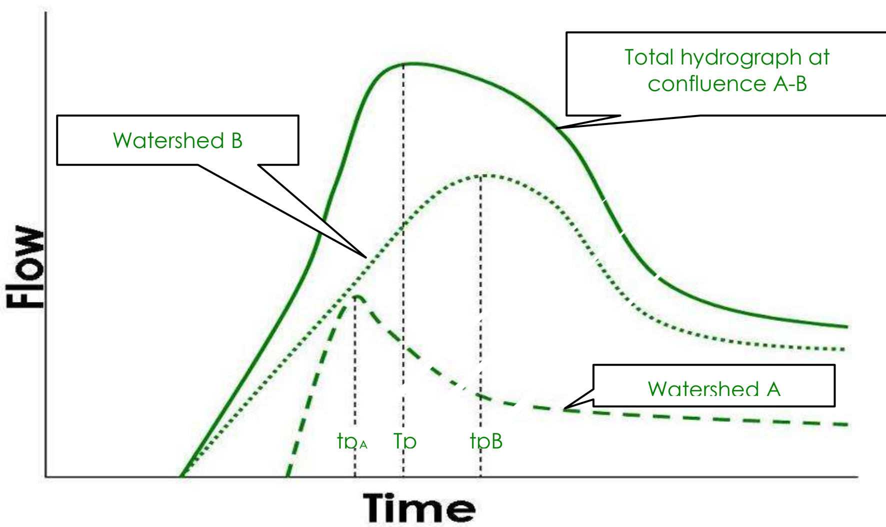


Figure A.3.
Existing Hydrograph (Pre-Development)

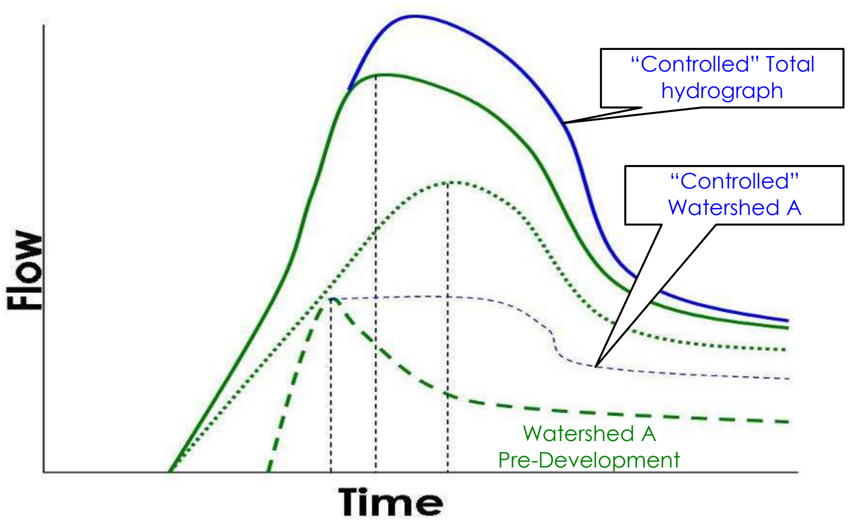


Figure A.4.
Controlled Runoff Condition (Post-Development)

RELEASE RATE CONCEPT

The previous example indicated that, in certain circumstances, it is not enough to control post-development runoff peaks to pre-development levels if the overall goal is no increase in peak runoff at any point in the watershed. The reasons for this potential increase are how the various parts of the watershed interact, in time, with one another with increased rate and volume of runoff associated with development and increases in impervious surfaces. The critical runoff criteria for a given site or watershed area is not necessarily its own pre-development peak rate of runoff but rather the pre-development contribution of the site or watershed area to the peak flow at a given point of interest.

To account for increases of volume and peak flow resulting from the combination of these post-development hydrographs, stormwater management districts have been assigned to various areas within the county boundary that have more restrictive release rates than the conventional 100% release rate. As shown in Plate #12, some areas within specific watersheds have reduced release rates.

The specification of a 100% release rate as a performance standard would represent the conventional approach to runoff control philosophy, namely controlling the post-development peak runoff to pre-development levels. This is a well-established and technically feasible control that is effective at-site and, where appropriate, would be an effective watershed-level control.

It is important to acknowledge that there are several problems with the release rate concept. One of the problems is that some areas can reach unreasonably low release rates. This can be seen in the release rate equation, which dictates that subwatersheds that peak farther away from the entire watershed will have a lower release rate. Indeed, subwatersheds whose runoff drains almost completely before or after the watershed peak will approach a release rate of zero (because the numerator approaches zero).

Another problem is that release rates are highly dependent on, and sensitive to, the timing of hydrographs. Since natural storms follow a different timing than design storms, it is still possible that watershed-wide controls designed with release rates only, will encounter increased runoff problems. This is because the runoff rates are still much higher in the developed condition, and increased volumes over an extended time can combine to increase peak flow rates. Similar to the traditional on-site detention pond, release rates are purely a peak "rate" type of control.

Patterns of development may also determine how effective designs are that uses only release rates, or any control based on timing. This is because rates based on timing assume a certain development and rainfall patterns, and the model uses uniform parameters across a subwatershed. In reality, the actual development and rainfall patterns can be highly variable across a subwatershed and can be quite different than the "Future Full-Build Out" land use scenario used in this planning study. This uncertainty can affect any type of control, but controls based on timing alone are especially sensitive to this parameter. Some controls, such as volume controls, are less sensitive since they remove a certain amount of runoff from the storm event wherever development occurs. In a sense, volume controls tend to more closely simulate what occurs in a natural system.

Combining volume controls with peak rate controls, as proposed in this Plan, will be more effective than having only peak rate controls. Volume controls have several advantages such as:

- Increased runoff volume may infiltrate and provide recharge to existing groundwater supplies. This may not happen with rate controls since all of the runoff excess is discharged in a relatively short time frame.
- Volume controls tend to mimic natural systems (i.e., excess runoff volume is infiltrated) and thus are more effective in controlling natural storms since they are not highly sensitive to timing issues.
- Volume controls often have enhanced water quality benefits.

CG-1 and CG-2 as implemented in this Plan provide the benefits described above.

SUMMARY MODEL OUTPUT (SUMMARY TABLES)

The following Hydrologic Parameters table for the Licking Creek HEC-HMS Model provides some of the input data needed for the model. The information includes the subwatershed name; drainage area; existing and future conditions curve numbers, and lag time.

The following Hydrologic Results tables for the Licking Creek HEC-HMS Model (Existing) and (Future) provides the calibrated peak flow rates at each subwatershed for the 2-year through 100-year storm event.

The following Hydrologic Results table for the Licking Creek HEC-HMS Model provides the discharge point identification number (Refer to Plate #11 for location); the cumulative drainage area; and a comparison of the existing and future peak flow rates for the 2-year through 100-year storm event.

The following Calibration Results graphs for the HEC-HMS Model provides the results of the calibration for six (6) different locations in the overall Licking Creek Watershed.

Hydrologic Parameters for the Licking Creek HEC-HMS Model

SUBWATERSHED NAME	SUBWATERSHED ID	DRAINAGE AREA (mi^2)	EXISTING CONDITIONS (2010)		FUTURE CONDITIONS (FULL BUILD-OUT)	
			CN	LAG (min)	CN	LAG (min)
Baby Run	W0170	2.59	74.0	66.6	74.0	53.8
Back Run	W0320	2.35	70.4	71.4	70.4	59.8
	W0330	2.96	68.9	83.9	68.9	70.0
Big Cove Creek	W0300	2.17	70.2	98.6	72.0	67.9
	W0450	1.04	72.5	43.4	72.5	34.7
	W0460	1.38	70.4	57.0	70.4	46.6
	W0470	3.22	68.6	73.3	68.6	60.5
	W0480	1.80	69.4	84.9	70.4	68.7
	W0490	1.75	69.9	99.1	74.4	72.0
	W0500	1.83	66.1	88.8	66.1	72.0
	W0510	2.34	64.2	142.7	64.2	117.0
	W0520	0.61	72.8	44.7	72.8	36.7
	W0530	1.03	69.4	51.8	69.4	43.5
	W0540	2.54	69.1	63.3	69.1	52.8
	W0550	0.75	67.7	37.4	67.7	30.9
	W0560	1.87	69.1	47.8	69.1	39.0
	W0570	2.02	68.8	68.6	68.8	56.7
Ditch Run	W0230	2.53	68.3	73.5	68.3	60.9
Esther Run	W0400	3.20	65.8	81.6	65.8	67.7
	W0410	2.85	66.9	71.0	66.9	59.6
	W0420	1.71	67.3	51.9	67.3	43.1
	W0430	2.47	67.9	74.7	67.9	61.9
	W0440	0.54	69.6	33.9	69.6	28.4
Fortune Teller Creek	W0040	2.11	73.7	56.1	75.2	43.2
	W0050	1.90	71.6	64.5	72.3	52.1
Joes Run	W0290	2.94	74.4	84.1	74.4	66.8
Kendall Run	W0310	3.71	66.1	109.1	66.1	90.4
Licking Creek	W0010	2.28	70.0	59.8	70.0	49.1
	W0020	2.12	70.4	74.5	70.6	60.8
	W0030	1.09	70.6	51.7	70.6	43.5
	W0060	1.20	71.1	61.3	71.1	51.3
	W0580	1.10	73.9	64.2	73.9	51.8
	W0590	1.18	71.8	54.5	71.8	45.1
	W0600	2.50	68.9	63.5	68.9	53.3
	W0610	2.10	69.0	64.2	69.0	53.0
	W0620	1.45	71.3	42.8	71.7	35.3
	W0630	2.76	73.1	76.8	73.9	60.4
	W0640	1.57	69.8	64.6	69.8	54.2
	W0650	1.51	69.2	52.6	69.2	45.0
	W0660	1.45	70.4	54.6	70.4	45.7
	W0670	2.54	73.5	82.5	73.5	65.4
	W0680	0.86	72.9	50.4	72.9	40.2
	W0690	0.11	73.9	31.5	73.9	26.3
	W0700	2.52	70.8	71.6	70.8	59.0

Hydrologic Parameters for the Licking Creek HEC-HMS Model

SUBWATERSHED NAME	SUBWATERSHED ID	DRAINAGE AREA (mi²)	EXISTING CONDITIONS (2010)		FUTURE CONDITIONS (FULL BUILD-OUT)	
			CN	LAG (min)	CN	LAG (min)
Licking Creek	W0710	1.94	70.9	63.5	70.9	52.5
	W0720	1.86	69.8	72.0	69.8	60.0
	W0730	1.84	69.8	54.3	69.8	44.8
	W0740	2.53	70.6	60.3	70.6	49.7
	W0750	2.44	72.1	60.2	72.1	49.0
	W0760	2.23	72.0	91.1	72.0	74.0
	W0770	1.02	74.0	50.7	74.0	40.2
	W0780	1.31	71.8	76.0	71.8	62.8
	W0790	2.26	73.7	53.4	73.7	42.8
	W0800	0.59	71.5	43.2	71.5	35.0
	W0810	1.61	64.6	48.1	64.6	40.3
	W0820	0.90	72.1	51.8	72.1	42.3
	W0830	3.07	65.4	103.0	65.4	86.0
	W0840	2.74	69.2	84.5	69.2	70.2
	W0850	2.21	67.5	58.2	67.5	48.5
	W0860	0.37	70.1	39.9	70.1	33.2
Owl Creek	W0240	1.88	70.5	60.6	70.5	50.1
	W0250	1.37	67.9	66.4	67.9	55.6
	W0260	2.73	73.9	65.2	73.9	52.5
	W0270	1.19	74.1	56.2	74.1	44.3
	W0280	1.80	73.9	65.2	73.9	50.8
Patterson Run	W0180	3.84	72.6	92.5	72.6	75.9
	W0190	3.14	71.2	63.4	71.2	53.0
	W0200	1.09	71.8	55.4	71.8	45.5
	W0210	2.80	70.9	77.5	70.9	64.1
	W0220	2.18	70.6	65.0	70.6	53.9
Roaring Run	W0340	3.21	70.0	118.9	70.0	99.9
	W0350	2.35	67.0	93.7	67.0	79.1
Sindeldecker Branch	W0120	2.74	68.0	88.6	68.0	73.2
	W0130	1.61	68.6	94.3	68.6	78.3
	W0140	0.56	72.4	39.2	72.4	31.6
	W0150	0.47	72.8	38.0	72.8	31.2
	W0160	0.45	72.4	35.6	72.4	28.8
Sipes Branch	W0070	1.47	71.4	71.7	71.4	59.5
	W0080	2.06	69.3	61.5	69.3	51.2
	W0090	1.18	70.8	61.9	70.8	51.4
	W0100	0.02	68.1	12.5	68.1	10.0
	W0110	0.12	71.8	20.0	71.8	16.7
Spring Run	W0360	1.33	66.7	67.8	66.7	56.0
	W0370	2.31	66.2	99.7	66.2	81.6
	W0380	1.90	66.1	78.9	66.1	65.4
	W0390	1.94	65.3	97.2	65.3	80.3

Hydrologic Results for the Licking Creek HEC-HMS Model (Existing)

CALIBRATED EXISTING CONDITIONS (YEAR 2010) – PEAK FLOWS							
SUBWATERSHED NAME	SUBWATERSHED ID	EXISTING CN (ARC=2)	2-YR	10-YR	25-YR	50-YR	100-YR
Baby Run	W0170	74.0	63.7	58.8	57.4	54.7	53.4
Back Run	W0320	70.4	63.9	59.2	57.8	55.1	54.0
	W0330	68.9	64.2	59.8	58.3	55.6	54.6
Big Cove Creek	W0300	70.2	65.4	61.8	60.5	58.2	57.0
	W0450	72.5	62.9	58.0	56.5	53.9	52.9
	W0460	70.4	63.5	58.7	57.3	54.9	53.8
	W0470	68.6	63.5	58.6	57.1	54.1	53.0
	W0480	69.4	64.9	61.0	59.8	57.5	56.6
	W0490	69.9	65.7	62.5	61.4	59.3	58.4
	W0500	66.1	65.0	61.3	60.0	57.6	56.4
	W0510	64.2	67.4	64.5	63.4	62.5	61.5
	W0520	72.8	67.1	62.9	61.5	59.1	58.0
	W0530	69.4	63.4	58.8	57.4	54.9	53.8
	W0540	69.1	63.2	58.3	56.7	53.8	52.6
	W0550	67.7	61.8	57.3	55.9	53.4	52.2
	W0560	69.1	62.3	57.1	55.5	52.5	51.3
	W0570	68.8	63.8	59.1	57.7	55.1	53.8
Ditch Run	W0230	68.3	63.8	59.0	57.6	54.9	53.6
Esther Run	W0400	65.8	63.8	59.3	57.8	55.0	53.6
	W0410	66.9	63.5	58.6	57.0	54.1	52.8
	W0420	67.3	62.8	57.5	56.0	53.3	52.0
	W0430	67.9	63.9	59.3	57.8	55.3	54.0
	W0440	69.6	64.3	60.0	58.6	56.1	55.0
Fortune Teller Creek	W0040	73.7	63.1	58.2	56.6	53.8	52.8
	W0050	71.6	63.6	58.9	57.5	55.0	54.1
Joes Run	W0290	74.4	64.5	60.1	58.7	56.3	55.1
Kendall Run	W0310	66.1	65.2	61.3	59.9	57.4	56.2
Licking Creek	W0010	70.0	63.1	58.2	56.6	53.8	52.7
	W0020	70.4	64.1	59.8	58.4	55.7	54.6
	W0030	70.6	63.5	58.8	57.4	54.8	53.9
	W0060	71.1	63.9	59.7	58.4	55.9	55.1
	W0580	73.9	64.3	60.4	59.2	57.0	56.1
	W0590	71.8	63.5	59.0	57.6	55.2	54.3
	W0600	68.9	63.3	58.3	56.7	53.8	52.7
	W0610	69.0	63.4	58.6	57.2	54.6	53.2
	W0620	71.3	62.4	57.3	55.8	53.0	51.7
	W0630	73.1	64.0	59.5	58.1	55.5	54.3
	W0640	69.8	63.9	59.3	58.0	55.6	54.5
	W0650	69.2	63.1	58.2	56.8	54.1	52.9
	W0660	70.4	63.2	58.5	57.1	54.6	53.4
	W0670	73.5	64.5	60.1	58.8	56.3	55.4
	W0680	72.9	66.2	61.9	60.5	58.1	56.9
	W0690	73.9	68.9	64.8	63.5	61.1	60.0
	W0700	70.8	63.7	59.0	57.6	54.9	53.8

Hydrologic Results for the Licking Creek HEC-HMS Model (Existing)

CALIBRATED EXISTING CONDITIONS (YEAR 2010) – PEAK FLOWS							
SUBWATERSHED NAME	SUBWATERSHED ID	EXISTING CN (ARC=2)	2-YR	10-YR	25-YR	50-YR	100-YR
Licking Creek	W0710	70.9	63.6	58.8	57.4	54.7	53.8
	W0720	69.8	64.1	59.7	58.3	55.8	54.8
	W0730	69.8	63.0	57.9	56.4	53.8	52.3
	W0740	70.6	63.0	58.0	56.5	53.7	52.5
	W0750	72.1	63.3	58.2	56.6	53.7	52.8
	W0760	72.0	65.2	61.1	59.9	57.6	56.8
	W0770	74.0	63.4	58.9	57.6	55.0	54.1
	W0780	71.8	64.9	61.1	60.0	57.8	56.7
	W0790	73.7	62.9	57.7	56.2	53.3	52.2
	W0800	71.5	65.1	60.8	59.4	56.9	55.8
	W0810	64.6	62.3	57.2	55.6	52.6	51.2
	W0820	72.1	66.2	61.9	60.6	58.1	57.0
	W0830	65.4	65.0	61.3	60.0	57.5	56.3
	W0840	69.2	64.3	60.1	58.7	56.0	55.0
	W0850	67.5	63.0	57.9	56.3	53.4	52.1
	W0860	70.1	64.8	60.4	59.1	56.5	55.4
Owl Creek	W0240	70.5	63.3	58.5	57.1	54.4	53.2
	W0250	67.9	64.0	59.7	58.3	55.9	54.9
	W0260	73.9	63.4	58.5	57.0	54.4	53.0
	W0270	74.1	63.7	59.2	57.8	55.4	54.4
	W0280	73.9	63.8	59.3	57.9	55.4	54.2
Patterson Run	W0180	72.6	64.6	60.2	58.7	56.0	55.1
	W0190	71.2	63.2	57.8	56.4	53.6	52.4
	W0200	71.8	63.6	59.3	58.0	55.4	54.6
	W0210	70.9	64.0	59.3	57.9	55.3	54.1
	W0220	70.6	63.6	58.8	57.4	54.7	53.5
Roaring Run	W0340	70.0	66.1	62.6	61.5	59.3	58.2
	W0350	67.0	65.0	61.2	59.9	57.5	56.4
Sindeldecker Branch	W0120	68.0	64.5	60.4	59.0	56.4	55.2
	W0130	68.6	65.6	62.3	61.1	59.0	57.9
	W0140	72.4	65.9	61.6	60.2	57.7	56.6
	W0150	72.8	67.2	63.0	61.6	59.1	58.0
	W0160	72.4	66.0	61.7	60.3	57.8	56.7
Sipes Branch	W0070	71.4	64.4	60.3	59.1	56.8	55.7
	W0080	69.3	63.3	58.4	56.9	54.1	53.0
	W0090	70.8	64.1	59.8	58.5	56.1	55.0
	W0100	68.1	60.9	56.4	55.0	52.5	51.3
	W0110	71.8	66.8	62.5	61.2	58.7	57.6
Spring Run	W0360	66.7	64.0	59.9	58.5	56.1	54.9
	W0370	66.2	65.2	61.7	60.4	58.0	57.0
	W0380	66.1	64.3	60.2	58.8	56.3	55.0
	W0390	65.3	65.2	61.9	60.7	58.4	57.2

Hydrologic Results for the Licking Creek HEC-HMS Model (Future)

CALIBRATED FUTURE CONDITIONS (YEAR FULL BUILD-OUT) – PEAK FLOWS							
SUBWATERSHED NAME	SUBWATERSHED ID	FUTURE CN (ARC=2)	2-YR	10-YR	25-YR	50-YR	100-YR
Baby Run	W0170	74.0	63.7	58.8	57.4	54.7	53.4
Back Run	W0320	70.4	63.9	59.2	57.8	55.1	54.0
	W0330	68.9	64.2	59.8	58.3	55.6	54.6
Big Cove Creek	W0300	72.0	67.3	63.8	62.6	60.3	59.1
	W0450	72.5	62.9	58.0	56.5	53.9	52.9
	W0460	70.4	63.5	58.7	57.3	54.9	53.8
	W0470	68.6	63.5	58.6	57.1	54.1	53.0
	W0480	70.4	66.0	62.1	60.9	58.7	57.7
	W0490	74.4	70.6	67.6	66.5	64.6	63.7
	W0500	66.1	65.0	61.3	60.0	57.6	56.4
	W0510	64.2	67.4	64.5	63.4	62.5	61.5
	W0520	72.8	67.1	62.9	61.5	59.1	58.0
	W0530	69.4	63.4	58.8	57.4	54.9	53.8
	W0540	69.1	63.2	58.3	56.7	53.8	52.6
	W0550	67.7	61.8	57.3	55.9	53.4	52.2
	W0560	69.1	62.3	57.1	55.5	52.5	51.3
	W0570	68.8	63.8	59.1	57.7	55.1	53.8
Ditch Run	W0230	68.3	63.8	59.0	57.6	54.9	53.6
Esther Run	W0400	65.8	63.8	59.3	57.8	55.0	53.6
	W0410	66.9	63.5	58.6	57.0	54.1	52.8
	W0420	67.3	62.8	57.5	56.0	53.3	52.0
	W0430	67.9	63.9	59.3	57.8	55.3	54.0
	W0440	69.6	64.3	60.0	58.6	56.1	55.0
Fortune Teller Creek	W0040	75.2	64.9	60.1	58.5	55.7	54.7
	W0050	72.3	64.4	59.8	58.4	55.8	54.9
Joes Run	W0290	74.4	64.5	60.1	58.7	56.3	55.1
Kendall Run	W0310	66.1	65.2	61.3	59.9	57.4	56.2
Licking Creek	W0010	70.0	63.1	58.2	56.6	53.8	52.7
	W0020	70.6	64.3	60.1	58.6	56.0	54.9
	W0030	70.6	63.5	58.8	57.4	54.8	53.9
	W0060	71.1	63.9	59.7	58.4	55.9	55.1
	W0580	73.9	64.3	60.4	59.2	57.0	56.1
	W0590	71.8	63.5	59.0	57.6	55.2	54.3
	W0600	68.9	63.3	58.3	56.7	53.8	52.7
	W0610	69.0	63.4	58.6	57.2	54.6	53.2
	W0620	71.7	62.8	57.8	56.3	53.5	52.2
	W0630	73.9	64.9	60.4	59.0	56.5	55.3
	W0640	69.8	63.9	59.3	58.0	55.6	54.5
	W0650	69.2	63.1	58.2	56.8	54.1	52.9
	W0660	70.4	63.2	58.5	57.1	54.6	53.4
	W0670	73.5	64.5	60.1	58.8	56.3	55.4
	W0680	72.9	66.2	61.9	60.5	58.1	56.9
	W0690	73.9	68.9	64.8	63.5	61.1	60.0
	W0700	70.8	63.7	59.0	57.6	54.9	53.8

Hydrologic Results for the Licking Creek HEC-HMS Model (Future)

CALIBRATED FUTURE CONDITIONS (YEAR FULL BUILD-OUT) – PEAK FLOWS							
SUBWATERSHED NAME	SUBWATERSHED ID	FUTURE CN (ARC=2)	2-YR	10-YR	25-YR	50-YR	100-YR
Licking Creek	W0710	70.9	63.6	58.8	57.4	54.7	53.8
	W0720	69.8	64.1	59.7	58.3	55.8	54.8
	W0730	69.8	63.0	57.9	56.4	53.8	52.3
	W0740	70.6	63.0	58.0	56.5	53.7	52.5
	W0750	72.1	63.3	58.2	56.6	53.7	52.8
	W0760	72.0	65.2	61.1	59.9	57.6	56.8
	W0770	74.0	63.4	58.9	57.6	55.0	54.1
	W0780	71.8	64.9	61.1	60.0	57.8	56.7
	W0790	73.7	62.9	57.7	56.2	53.3	52.2
	W0800	71.5	65.1	60.8	59.4	56.9	55.8
	W0810	64.6	62.3	57.2	55.6	52.6	51.2
	W0820	72.1	66.2	61.9	60.6	58.1	57.0
	W0830	65.4	65.0	61.3	60.0	57.5	56.3
	W0840	69.2	64.3	60.1	58.7	56.0	55.0
	W0850	67.5	63.0	57.9	56.3	53.4	52.1
	W0860	70.1	64.8	60.4	59.1	56.5	55.4
Owl Creek	W0240	70.5	63.3	58.5	57.1	54.4	53.2
	W0250	67.9	64.0	59.7	58.3	55.9	54.9
	W0260	73.9	63.4	58.5	57.0	54.4	53.0
	W0270	74.1	63.7	59.2	57.8	55.4	54.4
	W0280	73.9	63.8	59.3	57.9	55.4	54.2
Patterson Run	W0180	72.6	64.6	60.2	58.7	56.0	55.1
	W0190	71.2	63.2	57.8	56.4	53.6	52.4
	W0200	71.8	63.6	59.3	58.0	55.4	54.6
	W0210	70.9	64.0	59.3	57.9	55.3	54.1
	W0220	70.6	63.6	58.8	57.4	54.7	53.5
Roaring Run	W0340	70.0	66.1	62.6	61.5	59.3	58.2
	W0350	67.0	65.0	61.2	59.9	57.5	56.4
Sindeldecker Branch	W0120	68.0	64.5	60.4	59.0	56.4	55.2
	W0130	68.6	65.6	62.3	61.1	59.0	57.9
	W0140	72.4	65.9	61.6	60.2	57.7	56.6
	W0150	72.8	67.2	63.0	61.6	59.1	58.0
	W0160	72.4	66.0	61.7	60.3	57.8	56.7
Sipes Branch	W0070	71.4	64.4	60.3	59.1	56.8	55.7
	W0080	69.3	63.3	58.4	56.9	54.1	53.0
	W0090	70.8	64.1	59.8	58.5	56.1	55.0
	W0100	68.1	60.9	56.4	55.0	52.5	51.3
	W0110	71.8	66.8	62.5	61.2	58.7	57.6
Spring Run	W0360	66.7	64.0	59.9	58.5	56.1	54.9
	W0370	66.2	65.2	61.7	60.4	58.0	57.0
	W0380	66.1	64.3	60.2	58.8	56.3	55.0
	W0390	65.3	65.2	61.9	60.7	58.4	57.2

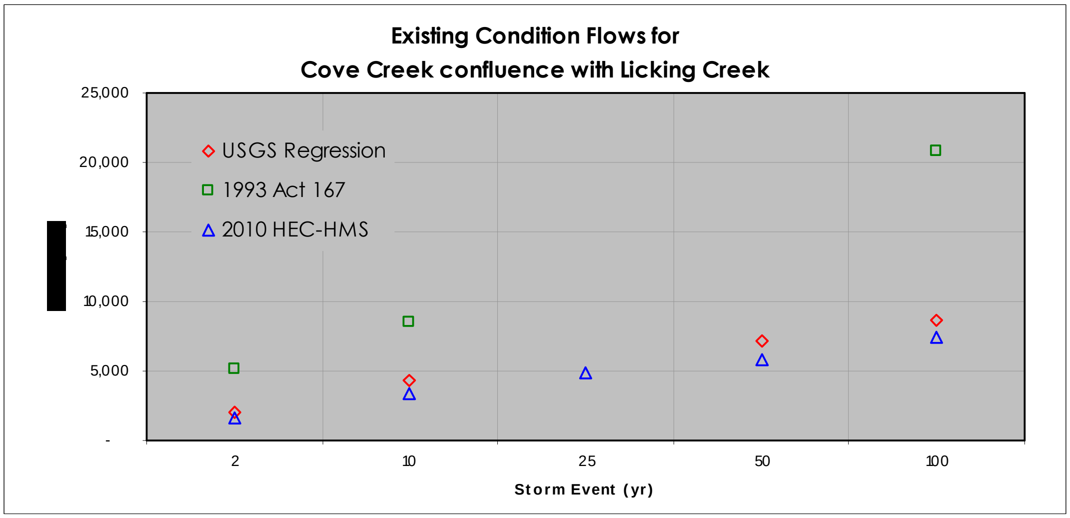
Hydrologic Results for the Licking Creek HEC-HMS Model

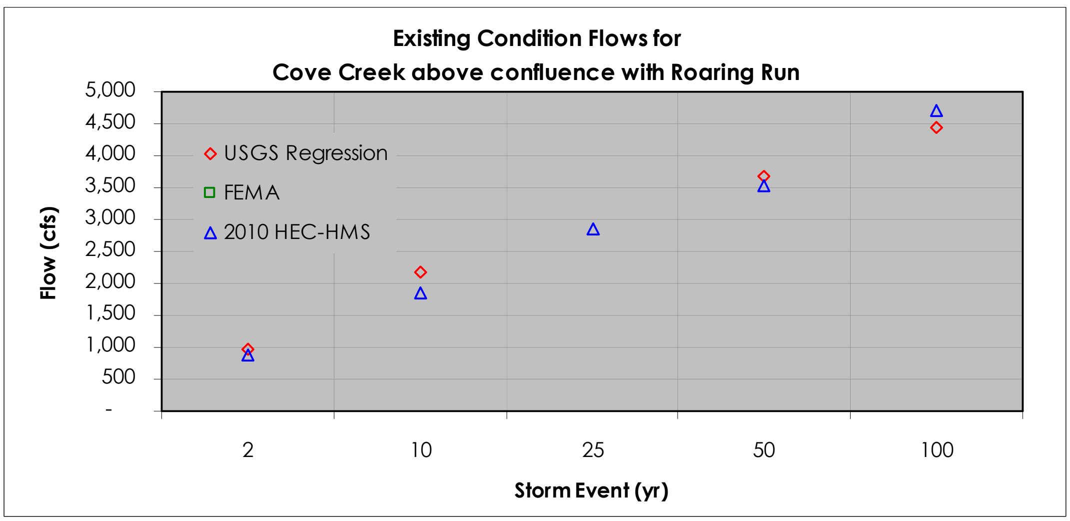
DISCHARGE POINT	HEC-HMS NODE	COORDINATES		CUMULATIVE DRAINAGE AREA (mi^2)	2010 PEAK FLOW RATES WITH EXISTING SWM					FULL BUILD-OUT PEAK FLOW RATES WITH NO FUTURE SWM				
		X	Y		2-YR	10-YR	25-YR	50-YR	100-YR	2-YR	10-YR	25-YR	50-YR	100-YR
1	J109	1889668.8	212180.8	2.35	126	283	442	529	691	123	277	433	518	678
2	J1670	1894801.6	197854.4	3.64	181	425	648	781	1,010	197	454	688	826	1,065
3	J1656	1893204.8	195700.8	5.54	276	644	990	1,192	1,540	295	681	1,039	1,251	1,610
4	J102	1886699.2	173252.8	2.85	146	328	509	597	779	141	319	497	583	762
5	J103	1888584.0	178753.6	4.56	209	455	704	840	1,107	205	446	691	825	1,089
6	J1643	1888753.6	185758.4	10.23	461	975	1,514	1,813	2,421	465	982	1,517	1,817	2,410
7	J110	1903246.4	228302.4	1.38	82	186	297	363	478	91	203	321	391	511
8	J1712	1899412.8	221432.0	4.61	223	480	748	897	1,246	240	510	790	967	1,320
9	P25-P20	1897608.0	218286.4	6.41	307	665	1,034	1,245	1,695	334	712	1,100	1,330	1,807
10	J1686	1896782.4	215441.6	10.33	496	1,109	1,712	2,067	2,738	651	1,393	2,109	2,530	3,251
11	J1675	1893694.4	207828.8	15.87	655	1,438	2,283	2,784	3,683	844	1,813	2,773	3,359	4,358
12	J1678	1887956.8	198273.6	23.52	859	1,826	2,835	3,516	4,680	1,061	2,231	3,420	4,218	5,487
13	J_Big_Cove_Upstream	1887064.4	194278.6	24.13	869	1,842	2,852	3,532	4,697	1,072	2,245	3,432	4,227	5,499
14	J1667	1886747.2	194091.2	29.68	934	1,980	3,053	3,779	5,017	1,136	2,383	3,640	4,483	5,833
15	J1653	1885627.2	189976.0	38.19	1,188	2,487	3,732	4,619	6,162	1,391	2,901	4,426	5,474	7,173
16	J1646	1884699.2	184222.4	51.50	1,499	3,177	4,625	5,468	7,231	1,681	3,421	5,163	6,376	8,353
17	J1638	1882478.4	178984.0	53.29	1,525	3,233	4,706	5,558	7,306	1,709	3,469	5,222	6,439	8,426
18	J108	1877508.8	173803.2	55.15	1,550	3,286	4,779	5,644	7,354	1,736	3,515	5,266	6,473	8,444
19	J_Big_Cove_Outlet	1871916.2	168830.0	57.17	1,579	3,349	4,867	5,749	7,414	1,768	3,569	5,317	6,512	8,467
20	J107	1873297.6	249371.2	2.06	113	255	403	479	633	116	260	409	487	643
21	P12	1880214.4	244612.8	3.23	168	367	570	681	918	171	374	579	692	932
22	J1757	1880619.2	244113.6	4.72	246	540	835	1,005	1,350	252	549	848	1,021	1,372
23	J1769	1891627.2	253883.2	2.11	119	273	431	509	681	191	401	604	709	923
24	J1733	1872251.2	241681.6	4.36	226	524	799	962	1,236	234	541	820	988	1,266
25	J1740	1880529.6	242836.8	10.23	475	1,049	1,590	1,906	2,469	491	1,077	1,627	1,950	2,523
26	P11	1881908.8	238785.6	4.92	243	558	845	1,016	1,305	254	576	868	1,044	1,338
27	J1717	1894916.8	234283.2	3.14	166	361	575	685	900	164	357	568	679	891
28	J1728	1890910.4	239358.4	8.07	389	837	1,324	1,586	2,103	405	862	1,359	1,628	2,155
29	J105	1882027.2	231092.8	10.87	440	920	1,441	1,733	2,306	456	950	1,480	1,780	2,364
30	J1723	1864712.0	233518.4	1.88	104	239	378	452	595	110	251	393	470	617
31	J1704	1863838.4	227985.6	5.79	303	672	1,045	1,251	1,669	312	689	1,068	1,280	1,707
32	P16	1870710.4	226779.3	8.51	396	860	1,345	1,617	2,141	416	896	1,393	1,674	2,216

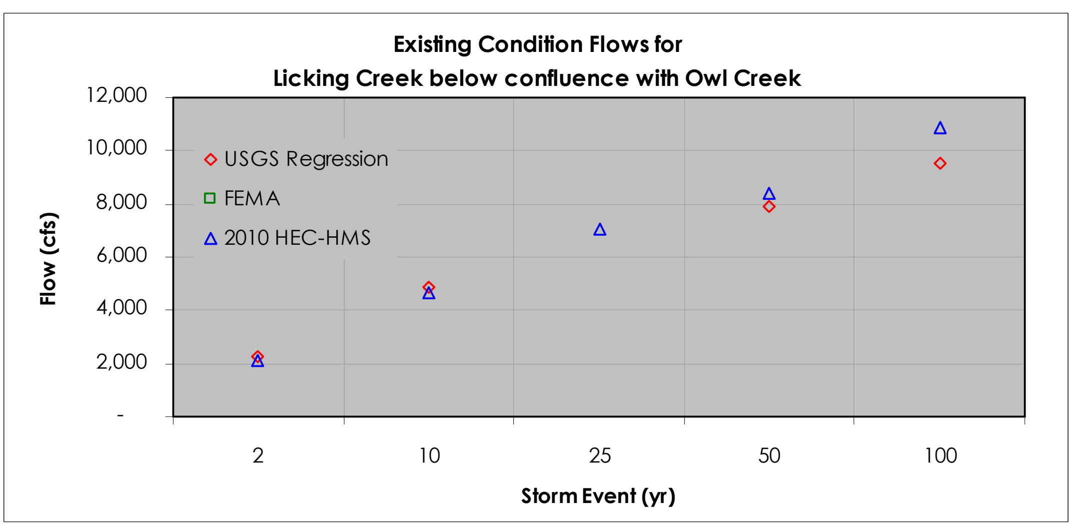
Hydrologic Results for the Licking Creek HEC-HMS Model

DISCHARGE POINT	HEC-HMS NODE	COORDINATES		CUMULATIVE DRAINAGE AREA (mi²)	2010 PEAK FLOW RATES WITH EXISTING SWM					FULL BUILD-OUT PEAK FLOW RATES WITH NO FUTURE SWM				
		X	Y		2-YR	10-YR	25-YR	50-YR	100-YR	2-YR	10-YR	25-YR	50-YR	100-YR
33	J1707	1874836.8	223540.8	9.71	422	904	1,407	1,698	2,251	448	945	1,461	1,765	2,333
34	J113	1908068.8	240177.6	2.28	123	282	446	528	699	136	305	478	565	744
35	J106	1913723.2	251051.2	2.50	134	301	472	553	732	128	291	457	537	712
36	J1594	1908987.2	245988.8	9.00	394	852	1,316	1,558	2,057	406	873	1,344	1,591	2,093
37	J114	1903956.8	248468.8	10.44	426	915	1,407	1,665	2,192	439	937	1,436	1,699	2,228
38	J1754	1895851.2	251486.4	14.29	543	1,149	1,742	2,061	2,692	573	1,199	1,837	2,179	2,795
39	J1762	1887524.8	249284.8	19.87	717	1,649	2,559	3,040	3,968	860	1,924	2,938	3,481	4,458
40	J1747	1884417.6	244900.8	22.59	801	1,851	2,855	3,387	4,407	948	2,122	3,229	3,829	4,919
41	P13	1881908.8	238785.6	34.73	1,317	2,933	4,516	5,392	7,006	1,474	3,212	4,897	5,836	7,529
42	J1720	1877425.6	229473.6	39.86	1,460	3,215	4,893	5,819	7,499	1,640	3,512	5,283	6,270	8,024
43	P17	1876123.2	223534.4	53.76	1,782	3,782	5,702	6,900	9,163	1,904	4,053	6,077	7,296	9,634
44	J_Owl_Creek	1875918.4	221435.2	65.38	2,150	4,683	7,044	8,383	10,889	2,342	5,019	7,498	8,909	11,475
45	J700	1872955.2	213377.6	67.91	2,184	4,761	7,149	8,508	11,022	2,389	5,098	7,597	9,026	11,609
46	J104	1872926.4	206587.2	69.84	2,207	4,808	7,206	8,576	11,089	2,413	5,143	7,646	9,083	11,666
47	J1683	1870670.4	199960.0	74.64	2,287	4,969	7,421	8,824	11,377	2,506	5,311	7,864	9,333	11,963
48	J1664	1871265.6	195688.0	76.48	2,310	5,012	7,478	8,888	11,449	2,531	5,354	7,919	9,395	12,032
49	J111	1869166.4	188648.0	79.01	2,341	5,065	7,543	8,961	11,524	2,560	5,406	7,980	9,462	12,100
50	J112	1871227.2	181950.4	81.45	2,371	5,112	7,600	9,023	11,586	2,589	5,452	8,034	9,520	12,156
51	J1659	1871300.8	172056.0	83.68	2,401	5,160	7,654	9,081	11,637	2,618	5,498	8,082	9,570	12,201
52	J1633	1871790.4	170955.2	84.70	2,413	5,182	7,684	9,116	11,679	2,632	5,523	8,115	9,608	12,246
53	J1630	1871268.8	167748.8	143.18	3,828	8,165	12,073	14,340	18,161	4,279	8,919	12,985	15,318	19,211
54	J1627	1870417.6	165083.2	145.44	3,849	8,205	12,117	14,386	18,212	4,298	8,959	13,030	15,368	19,271
55	J1619	1874158.4	163969.6	147.14	3,868	8,242	12,163	14,437	18,274	4,316	8,996	13,076	15,422	19,340
56	P31	1875124.8	160225.6	148.74	3,878	8,266	12,192	14,470	18,314	4,323	9,017	13,104	15,455	19,382
57	J101	1874206.4	156276.8	149.65	3,883	8,280	12,201	14,476	18,314	4,325	9,027	13,109	15,460	19,386
58	J1622	1874024.0	147944.0	152.71	3,912	8,349	12,279	14,561	18,406	4,349	9,090	13,182	15,543	19,480
59	J1597	1875201.6	143112.0	156.64	3,947	8,426	12,371	14,663	18,523	4,383	9,163	13,271	15,645	19,599
60	USGS 01613500	1881256.0	142136.0	158.85	3,961	8,460	12,410	14,705	18,568	4,396	9,195	13,307	15,684	19,643
61	Outlet-Licking Creek	1885342.4	141150.4	159.22	3,951	8,456	12,392	14,677	18,523	4,383	9,184	13,281	15,650	19,594

CALIBRATION RESULTS FOR THE HEC-HMS MODEL







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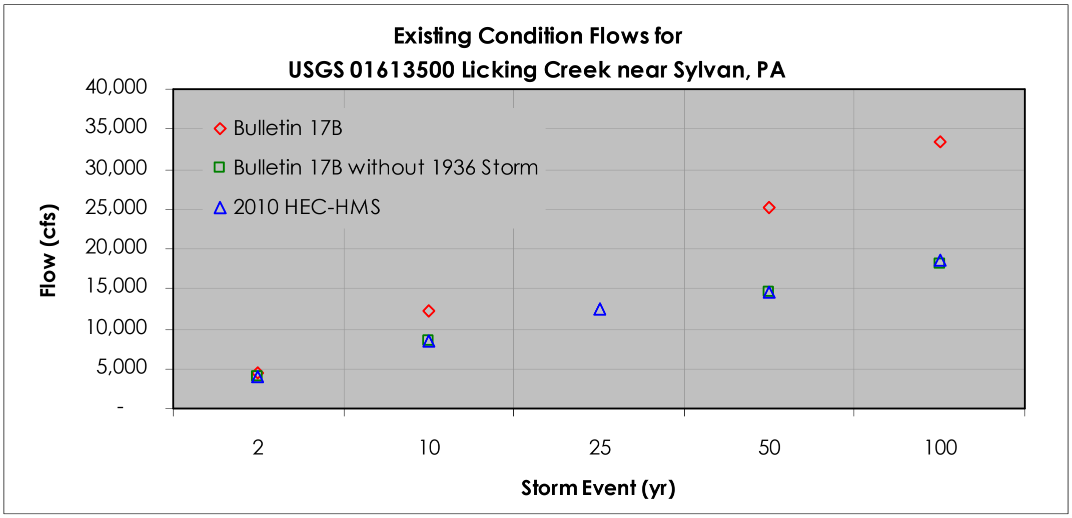
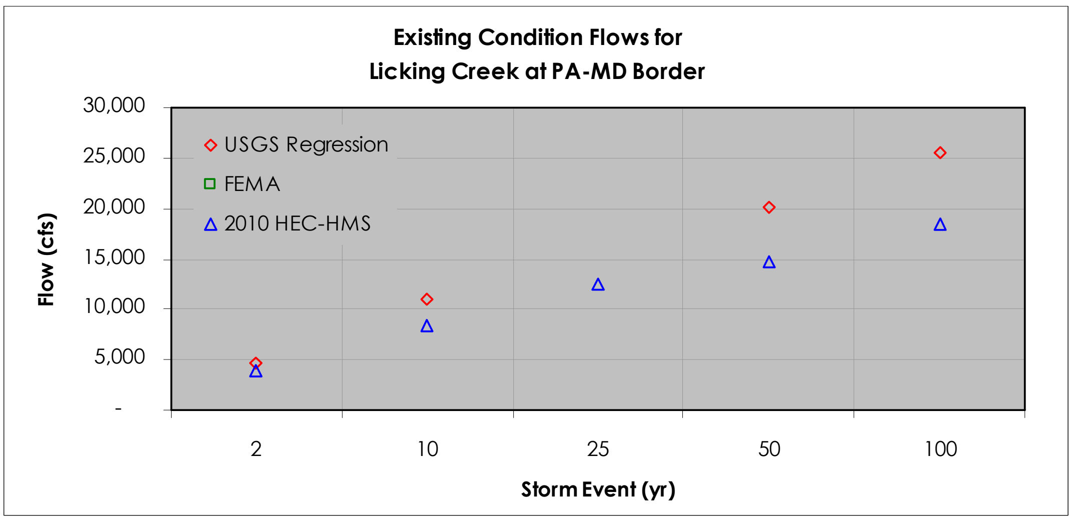
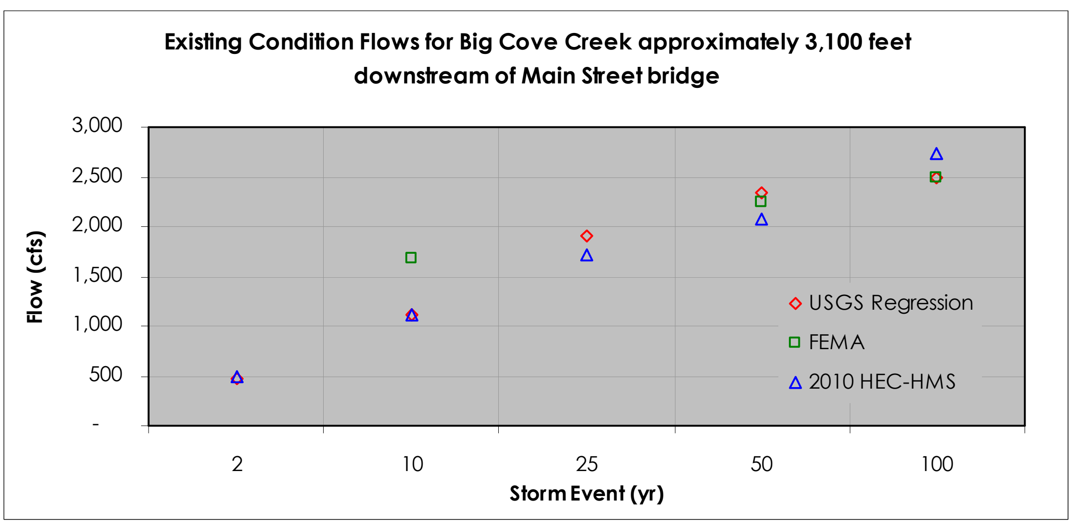






- APPENDIX B -
EXISTING MUNICIPAL REGULATIONS

VALLEY-HI BOROUGH SUMMARY

Valley-Hi Borough is the smallest municipality in Fulton County, both in area and population. Located around Valley-Hi Lake, off of Route 30 between Brush Creek and Wells Township, Valley-Hi Borough has a population of twenty (20) people (US Census 2000). Valley-Hi Borough covers approximately 350 acres of ground, divided up as: 42 acres – lake; 294 acres – private association (family owned); and 14 acres – private owners. Because of the small population, large tracts of private ownership, and almost negligible development, Valley-Hi Borough does not have a Subdivision and Land Development Ordinance or Zoning Ordinance in place. Valley-Hi also does not have any stormwater or flood control regulations. Additionally, they opted to not participate in the Joint Comprehensive Plan the other Fulton County municipalities adopted in 2007.

EXISTING REGULATIONS SUMMARY

The existing regulations of the remaining 12 municipalities in Fulton County, other then Valley-Hi Borough, are summarized on the following pages.

DESIGN CRITERIA	AYR TOWNSHIP	BELFAST TOWNSHIP	BETHEL TOWNSHIP	BRUSH CREEK TOWNSHIP	DUBLIN TOWNSHIP	LICKING CREEK TOWNSHIP
ROAD STANDARDS						
Road Width	Based on road category	Based on road category	Based on road category	Based on road category	Based on road category	Based on road category
Curb & Gutter	May be required	May be required	May be required	May be required	May be required	May be required
On-street Parking	X	Allowed based on category	X	Allowed based on category	X	Allowed based on category
Sidewalks	May be required	May be required	May be required	May be required	May be required	May be required
Right-of-Way	Specified base on road category	Specified based on road category	Specified based on road category	Specified based on road category	Specified based on road category	Specified based on road category
Cul-De-Sacs	1500 ft minimum; 50 ft bulb length	Max 1000 ft length; max 100 ft diameter paving	Max 800 ft length; min 35 ft diameter paving	Max 1000 ft length; min 80 ft diameter paving	Max 1000 ft length; min 40 ft diameter paving	Max 1000 ft length; min 100 ft diameter paving
PARKING STANDARDS						
Residential ratio requirements	2 spaces/unit	1 space/unit	2 spaces/unit	1 space/unit	2 spaces/unit	1 space/unit
Commercial ratio requirements	Varies on land use	May be required	1 space/3 occupants	X	Varies on land use and gross floor area	X
Industrial ratio requirements	1 space per employee (at peak work shift)	May be required	2 spaces/3 workers at any one shift	X	Varies based on land use and sq ft (gross floor area)	X
Stall widths	9 ft	X	X	X	9 ft	X
Stall lengths	18 ft	X	X	X	18 ft	X
Green space requirements	10% of parking area	X	X	X	10% of parking area	X
Pervious material allowed		X	X	X	X	X
DEVELOPMENT LAYOUT						
Categories (e.g., R1)	No categories specified	X	X	X	X	X
Densities	X	X	X	X	X	X
Lot sizes	Varies depending on sewer/water	Varies depending on sewer/water	Varies depending on sewer/water & land use	Varies depending on sewer/water	Varies depending on sewer/water	Varies depending on sewer/water
Setbacks	Varies depending on sewer/water	35ft front; 10ft sides; 25ft rear	35ft from r-o-w front; 25ft rear; 10ft side	X	Varies depending on sewer/water	35ft front; 10ft sides; 25ft rear
Frontages	Varies depending on sewer/water	35 ft minimum	35 ft minimum	Varies depending on sewer/water	Varies depending on sewer/water	Varies depending on sewer/water
Driveway widths	X	X	X	X	Max 50 feet	X
Open/green space requirements	X	Subdivisions over 50 units	X	Subdivisions over 50 units	X	Subdivisions over 50 units
Vegetation requirements	X	X	X	X	Buffers along non-residential development	X
Development layout (e.g., LID)	X	X	X	X	X	X

DESIGN CRITERIA	MCCONNELLSBURG BOROUGH	TAYLOR TOWNSHIP	THOMPSON TOWNSHIP	TODD TOWNSHIP	UNION TOWNSHIP	WELLS TOWNSHIP
ROAD STANDARDS						
Road Width	X	Based on road category	Based on road category	Based on road category	Based on road category	Based on road category
Curb & Gutter	X	May be required	Required on all streets	Required when lot widths <100ft	May be required	May be required
On-street parking	X	Based on road category	X	X	X	Based on road category
Sidewalks	X	May be required	Required	Required	May be required	May be required
Right-of-Way	X	Based on road category	Based on road category	Based on road category	Based on road category	Based on road category
Cul-De-Sacs	X	Max 1000 ft length; min 100 ft diameter paving	Max length = 600 ft, 80 ft diameter	Max 800 ft length; Min 100 ft diameter paving	Max 800 ft length; Min 35 ft diameter paving	Max 1000 ft length; Min 100 ft diameter paving
PARKING STANDARDS						
Residential ratio requirements	2 spaces/unit	1 space/unit	X	2 spaces/unit	2 spaces/unit	1 space/unit
Commercial ratio requirements	Varies based on gross floor area	X	X	Varies based on land use	1 space/3 occupants	As needed
Industrial ratio requirements	Varies based on gross floor area	X	X	1 space/employee	2 spaces/3 workers on any one shift	X
Stall widths	9ft - perpendicular; 8ft - parallel	X	Varies based on parking lot layout	9ft minimum	X	X
Stall lengths	18ft - perpendicular; 23ft - parallel	X	Varies based on parking lot layout	18ft minimum	X	X
Green space requirements	X	X	X	10% of parking area	X	X
Pervious material allowed	X	X	Pavement required	Pavement required	Pavement required	X
DEVELOPMENT LAYOUT						
Categories (e.g., R1)	R1, R2, C1, C2, LI, P/S	X	X	X	X	X
Densities	X	X	X	High Density: 3 units/acre Low Density: 1-2 units/acre	X	X
Lot sizes	Varies depending on land use type	Varies depending on sewer/water	Minimum 1 acre	Varies depending on sewer/water	Varies depending on sewer/water and land use type	Varies depending on sewer/water
Setbacks	Varies depending on land use type	35ft front; 10ft sides; 25ft rear	75ft from road centerline; 25 ft side; 25ft rear	Varies depending on sewer/water	35ft front; 10 ft sides; 25ft rear	35ft front; 10ft sides; 25ft rear
Frontages	Varies depending on land use type	Varies depending on sewer/water	Minimum 150 feet	Varies depending on sewer/water	Minimum 35 ft	Varies depending on sewer/water
Driveway widths	X	X	Min. 10 ft wide	12ft min; 20ft max	X	X
Open/green space requirements	X	Subdivisions over 50 units	X	5% of area in High Density subdivisions	X	Subdivisions over 50 units
Vegetation requirements	Buffers may be required	X	May be required	Buffer required	X	X
Development layout (e.g., LID)	X	X	X	X	X	X

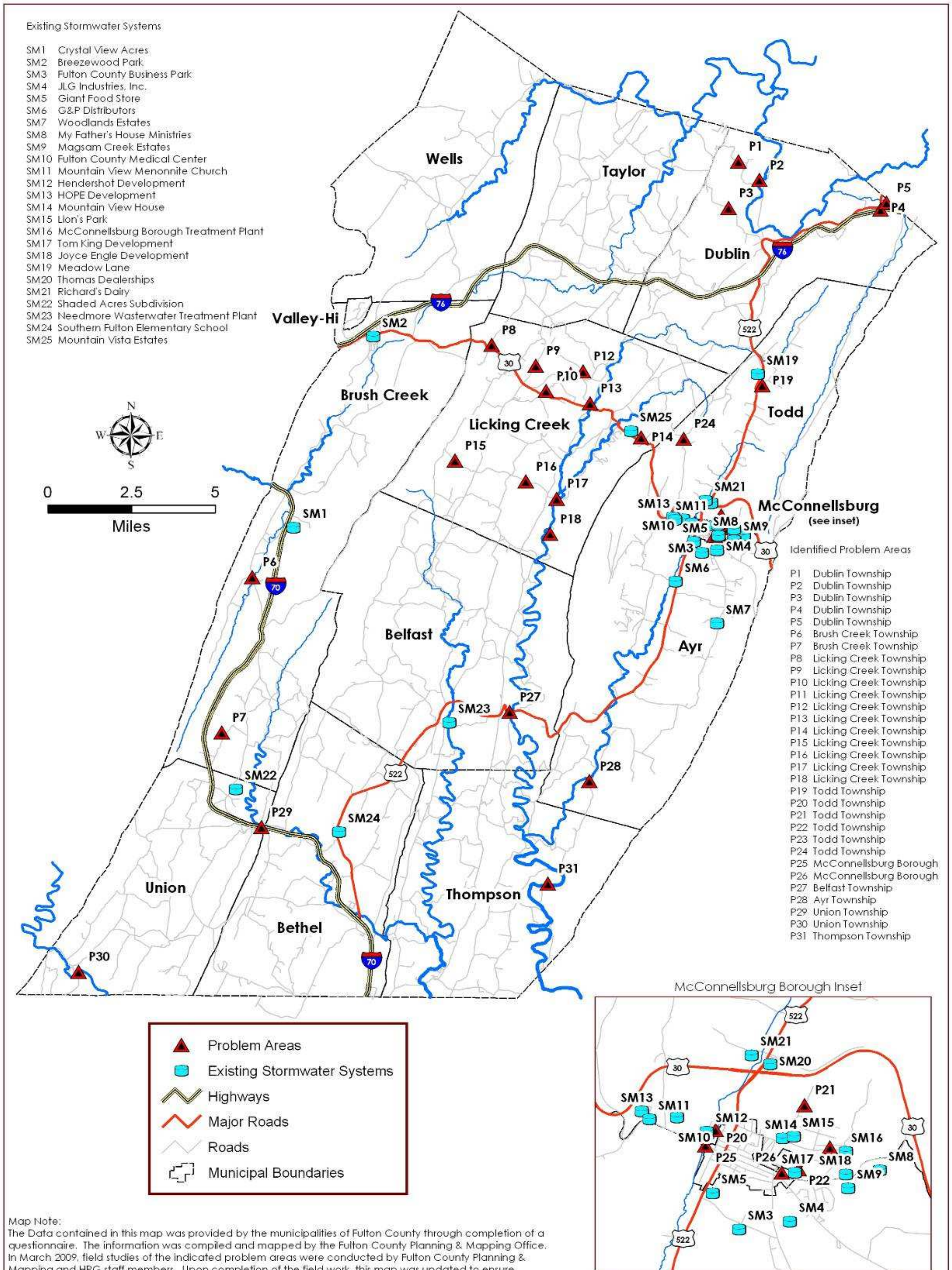
DESIGN CRITERIA	AYR TOWNSHIP	BELFAST TOWNSHIP	BETHEL TOWNSHIP	BRUSH CREEK TOWNSHIP	DUBLIN TOWNSHIP	LICKING CREEK TOWNSHIP
STORMWATER MANAGEMENT						
Computational methodology for runoff	TR-55 or Rational	X	X	X	TR-55 or Rational	X
Land cover assessment (e.g, RCN)	X	X	X	X	X	X
Time of concentration methodology	Ch. 3 of TR-55	X	X	X	X	X
Runoff rate control criteria	2 & 10 yr storms; post ≤ pre	X	X	X	X	X
Runoff volume control criteria	X	X	X	X	X	X
Water quality control criteria	X	X	X	X	X	X
Infiltration requirements	X	X	X	X	X	X
Detention pond design methodology	TR-55, Rational method, PSRM, HEC-1	X	X	X	post ≤ pre for 2, 10, 25, and 100 yr storms	X
Detention control criteria	2 & 10 yr storms; post ≤ pre; Emerg. spillway for 100-yr storm	X	X	X	2, 10, 25, 100 year storms	X
Pipe sizing / inlet locations	25 yr; min. pipe = 15"	X	Minimum 15 inches	X	Minimum 15 inches; Rational 10-yr storm	X
Inlet design criteria	PennDOT standards	X	X	Township Standards	PennDOT Standards	Township Standards
Grass swale design criteria	25 yr	X	X	X	Rational method - 10-year storm	X
Pervious pavement design criteria	X	X	X	X	X	X
Infiltration system design criteria	X	X	X	X	X	X
Water quality design criteria	X	X	X	X	X	X
FLOODPLAIN MANAGEMENT						
Floodplain/floodway definition	Areas subject to the 100-yr flood; Zone A on the FHBM Map.	X	X	X	Area subject to inundation; area subject to accumulation of surface waters	X
Flood insurance studies (approx./detailed)	FEMA	FEMA	FEMA	FEMA	FEMA	FEMA
Development restrictions	yes - not within 50 feet of streambank and use restrictions	X	X	X	Yes	X
Floodplain boundary methodology	FEMA FIRM	FEMA FIRM	FEMA FIRM	FEMA FIRM	FEMA FIRM	FEMA FIRM
Modeling coefficient criteria	X	X	X	X	X	X
Flood proofing requirements	yes	X	X	X	Yes - structural and non-structural	X
Encroachment requirements	No development within 50 feet from top of bank of any watercourse	X	X	X	X	X
Other	Refer to Ordinance No. 2 of 1981 - Issuance of Building Permits	X	X	X	Refer to Floodplain Ordinance	X
MISCELLANEOUS						
Stream/wetland buffers	X	X	X	X	Yes - no distance given (ROW provided by developer)	X
Wetland protection	X	X	X	X	X	X
Aquatic habitat protection	X	X	X	X	X	X
Steep slope restrictions	X	X	X	X	X	X
Forest conservation	X	X	X	X	X	X
Rooftop storage	X	X	X	X	X	X
Inspection/maintenance of BMPs	Yes - by agreement	X	X	X	Yes	X
Land conservation incentives	X	X	X	X	X	X
Grading restrictions	X	X	X	X	X	X

DESIGN CRITERIA	MCCONNELLSBURG BOROUGH	TAYLOR TOWNSHIP	THOMPSON TOWNSHIP	TODD TOWNSHIP	UNION TOWNSHIP	WELLS TOWNSHIP
STORMWATER MANAGEMENT						
Computational methodology for runoff	Rational Method or SCS	X	Rational Method (less than 60 ac); SCS (over 60 ac)	TR-55; HEC-1/HEC-HMS, PSRM, Rational Method	X	X
Land cover assessment (e.g, RCN)	X	X	X	X	X	X
Time of concentration methodology	TR-55 Methodology	X	TR-55 Methodology	TR-55 and Township Standard in Ordinance	X	X
Runoff rate control criteria	25-yr storm	X	Post ≤ Pre	2, 10, 25, and 100 yr storm	X	X
Runoff volume control criteria	25-yr storm	X	X	X	X	X
Water quality control criteria	X	X	X	Yes	X	X
Infiltration requirements	X	X	X	Yes - suitability of soils	X	X
Detention pond design methodology	Post 2yr and 10yr design standards; handle 100-yr storm	X	Rational or TR-55	2yr, 10yr, 25yr, & 100 yr design standards; post ≤ pre for all storms	X	X
Detention control criteria	Post 2yr and 10yr design standards; handle 100-yr storm	X	2, 5, 10, 25, 50, & 100-yr storm events	Post ≤ pre for all storms	X	X
Pipe sizing / inlet locations	X	X	Min 18 inches	Min 15 inches	Min 15 inches	X
Inlet design criteria	X	Township standards	25-yr storm event	PennDOT Standards	X	Township standards
Grass swale design criteria	Manning's equation	X	25-yr storm event	min.10-yr storm event, with additional criteria	X	X
Pervious pavement design criteria	X	X	X	X	X	X
Infiltration system design criteria	X	X	X	Yes - BMPs	X	X
Water quality design criteria	X	X	X	Yes - BMPs	X	X
FLOODPLAIN MANAGEMENT						
Floodplain/floodway definition	X	X	Areas subject to 100-yr flood, areas delineated by FEMA	Lands that may be expected to be inundated by a 100-yr frequency flood	X	Areas subject to the 100-yr flood; Zone A on the FHBM Map.
Flood insurance studies (approx./detailed)	FEMA	FEMA	FEMA	FEMA	FEMA	FEMA
Development restrictions	X	X	Yes - Section 610.10 E.F.& G.	Yes - meet Ordinance regulations	X	yes - not within 50 ft of streambank and use restrictions
Floodplain boundary methodology	FEMA FIRM	FEMA FIRM	FEMA FIRM	FEMA FIRM	FEMA FIRM	FEMA FIRM
Modeling coefficient criteria	X	X	X	X	X	X
Flood proofing requirements	X	X	Section 610.10.H	Yes - up to Regulatory Flood Elevation	X	yes
Encroachment requirements	X	X	X	Yes	X	
MISCELLANEOUS						
Stream/wetland buffers	Yes	X	Buffer to preserve unimpeded flow of 100-yr rainfall	Yes - no width specified	X	X
Wetland protection	Yes	X	X	Yes	X	X
Aquatic habitat protection	X	X	X	X	X	X
Steep slope restrictions	X	X	X	No development on slopes >25%	X	X
Forest conservation	X	X	Yes	X	X	X
Rooftop storage	X	X	X	X	X	X
Inspection/maintenance of BMPs	Yes	X	Yes	Yes	X	X
Land conservation incentives	X	X	X	X	X	X
Grading restrictions	X	X	X	X	X	X

- APPENDIX C -

PROBLEM AREA DOCUMENTATION

Fulton County Act 167 Stormwater Management Plan
Problem Area Locations and Existing Stormwater Systems



Map Note:
The Data contained in this map was provided by the municipalities of Fulton County through completion of a questionnaire. The information was compiled and mapped by the Fulton County Planning & Mapping Office. In March 2009, field studies of the indicated problem areas were conducted by Fulton County Planning & Mapping and HRG staff members. Upon completion of the field work, this map was updated to ensure accurate represenation of the problems. For more complete information on the Problem Areas, please consult the Fulton County Act 167 Phase I Report and Act 167 Problem Area Documentation prepared by HRG, Inc.

Created By: Fulton County Planning & Mapping Office, March 2010

Fulton County Act 167 Stormwater Management Plan
County Adoption Resolution

Resolution No. 15 of 2010
Fulton County, Pennsylvania

Whereas, an Act 167 Stormwater Management Plan, hereafter referred to as the Fulton County Act 167 Stormwater Management Plan, has been prepared for Fulton County, and

Whereas, the Fulton County Act 167 Stormwater Management Plan has been prepared in compliance with the requirements set forth in the Storm Water Management Act (Act 167) of 1978, and

Whereas, the plan includes text, maps, plates, charts, tables, figures, and other materials intended to form the official Act 167 Stormwater Management Plan for Fulton County, and

Whereas, there is an existing Act 167 Plan for the Cove Creek Watershed, and

Whereas, the Fulton County Act 167 Stormwater Management Plan will incorporate and update the existing plan, and

Whereas, in accordance with Act 167, a properly advertised public hearing was conducted on June 1, 2010,

Now therefore be it resolved by the Board of Commissioners of the County of Fulton, that the Fulton County Act 167 Stormwater Management Plan is hereby adopted as the official Stormwater Management Plan of the County.

Adopted, this 29th day of June, 2010.

ATTEST:

Daniel H. Swain

FULTON COUNTY COMMISSIONERS

Bonnie Mellott Keefer
Bonnie Mellott Keefer, Chair

David R. Hoover II
David R. Hoover, II

Craig C. Cutchall
Craig C. Cutchall