Montour County
Act 167 County-Wide Stormwater Management Plan
Phase II

Part 1 of 2

Prepared for
Montour County Planning Commission
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Section I – Introduction

This Stormwater Management Plan is the product of a collaborative effort between the varied stakeholders within the Act 167 Designated Watersheds in Montour County, Pennsylvania. The Plan has been developed based upon the requirements contained within the *Pennsylvania Stormwater Management Act*, Act 167 of 1978, and guidelines established by the Pennsylvania Department of Environmental Protection (DEP). The intent of this document is to present the findings of a two-phased multi-year study of the watersheds within the county. Generally, the study was undertaken to develop recommendations for improved stormwater management practices, to mitigate potential negative impacts by future land uses, and to improve conditions within impaired waters. The specific goals of this Plan are discussed in detail in the following section. This section introduces some basic concepts relating the physical elements of stormwater management, the hydrologic concepts, and the planning approach used throughout this study.

RAINFALL AND STORMWATER RUNOFF

Precipitation that falls on a natural landscape flows through a complex system of vegetation, soil, groundwater, surface waterways, and other elements as it moves through the hydrologic cycle. Natural events have shaped these components over time to create a system that can efficiently handle stormwater through evaporation, infiltration, and runoff. The natural system often sustains a dynamic equilibrium, where this hydrologic system evolves due to various ranges of flow, sediment movement, temperature, and other variables. Alterations to the natural landscape change the way the system responds to precipitation events. These changes often involve increasing impervious area, which results in decreased evaporation and infiltration and increased runoff. The additional stormwater runoff increases both runoff quantity, or volume, and runoff rate. These two factors cause the natural system to change beyond its natural dynamic equilibrium, resulting in negative environmental responses such as accelerated erosion, greater or more frequent flooding, increased pollution, and degradation of surface waters. Decreased infiltration means less groundwater recharge which leads to altered dry weather stream flow.

Some level of stormwater runoff occurs as the ground surface becomes saturated. This occurs even in undisturbed watersheds. However, the volume and rate of runoff are substantially increased as land development occurs. Stormwater management is a general term for practices used to reduce the impacts of this accelerated stormwater runoff. Stormwater management practices such as detention ponds and infiltration areas are designed to mitigate the negative impacts of increased runoff. Volume of runoff and rate of runoff are often referred to by the term “water quantity”. Water quantity controls have been a mainstream part of stormwater management for years. Another aspect of runoff is water quality. This refers to the physical characteristics of the runoff water which include temperature, total suspended solids, salts, and dissolved nutrients. Water quality is an emerging topic in stormwater management and the general water resources field. Both water quantity and water quality can contribute to degradation of surface waters.

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As development has increased, so has the problem of managing the increased quantity of stormwater runoff. Individual land development projects are frequently viewed as separate incidents, and not necessarily as an interconnected hydrologic and hydraulic system. This school of thought is exacerbated when the individual land development projects are scattered throughout a watershed (and in many different municipalities). However, it is has been observed, and verified, that the cumulative nature of individual land surface changes dramatically influences flooding conditions. This cumulative effect of development in some areas has resulted in flooding of both small and large streams, with substantial financial property damage and risk to the public health and welfare. Therefore, given the distributed and cumulative nature of the land alteration process, a comprehensive (i.e., watershed-level) approach must be taken if a reasonable and practical management and implementation approach is to be successful.

Watersheds are an interconnected network in which changes to any portion of the watershed carry throughout the system. There are a variety of factors that influence how runoff from a particular site will affect the overall watershed. Many of the techniques for managing stormwater within a watershed are unique to each watershed. An effective stormwater management plan must be responsive to the existing characteristics of the watershed and recognize the changing conditions resulting from planned development. In Pennsylvania, stormwater management is generally regulated on the municipal level, with varying degrees of coordination on types and levels of stormwater management required between adjoining municipalities. A watershed-based stormwater management plan can minimize inconsistencies to more effectively address the issues which contribute to a watershed's degradation. While land use regulation remains at the municipal level, the framework established within a watershed plan enables municipalities to see the impact of their regulations on the overall system, and coordinate their efforts with other stakeholders within the watershed.

WATERSHED HYDROLOGY

Under natural conditions, watershed hydrology is in dynamic equilibrium. That is, the watershed, its ground and surface water supplies, and resulting stream morphology and water quality evolve and change with the existing rainfall and runoff patterns. This natural state is displayed by stable channels with minimal erosion, relatively infrequent flooding, adequate groundwater recharge, adequate base flows, and relatively high water quality. When all of these conditions are present the streams support healthy, diverse and stable in-stream biological communities. The following is a brief discussion of the impact of development on these steam characteristics:

1. Channel Stability – In an undisturbed watershed, the channels of the stream network have reached an equilibrium over time to convey the runoff from its contributing area within the channel banks. Typically, the channel will be large enough to accommodate the runoff from a storm, the magnitude of which will occur approximately every 18-24 months. Disturbances, such as development, in the watershed disrupt this equilibrium. As development occurs, additional runoff reaches the streams more frequently. This results in the channel becoming instable as it attempts to resize itself. The resizing occurs through bed and bank erosion, altered flow patterns, and shifting sediment deposits.

2. Flooding – When a watershed is disturbed, it results in increased localized flooding, and other associated problems. Overbank flows will occur more frequently until the channel reaches a new equilibrium. 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, a new equilibrium may not be reached. Additionally, floodplain encroachment and in-stream sediment deposits from channel erosion may exacerbate flooding.

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3. Groundwater Recharge – In an undisturbed watershed, runoff is minimal. Natural ground cover, undisturbed soils, and uneven terrain provide the most advantageous conditions for maximum infiltration to occur. When development occurs, these favorable conditions are diminished, or removed, causing more rainfall to become runoff that flows to receiving streams instead of being absorbed into the system. Less water is retained in the watershed to replenish groundwater supplies.
4. Base Flows – Loss of groundwater recharge, as described above, leads to insufficient groundwater available to replenish stream flow during dry weather. As a result, streams that may have an adequate base flow during dry weather under natural conditions may experience reduced flow, or become completely dry, during periods of low precipitation in developed watersheds. Thermal degradation of the waterbody often accompanies the reduction of base flow originating from groundwater. The base flow is generally much cooler than surface water sources. The increase in water temperature can be detrimental to many ecological communities.
5. Water Quality – Stormwater from developed surfaces carries a wide variety of contaminants. Pesticides, herbicides, fertilizers, automotive fluids, hydrocarbons, sediment, detergents, bacteria, increased water temperatures, and other contaminants that are picked up on land surfaces are carried into streams by runoff. These contaminants affect the receiving streams in different ways, but they all have an adverse impact on the quality of the water in the stream.
6. 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 is also diminished.

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 we manage our watersheds has a direct impact on the water resources of the watershed. Any decision that affects land use has implications on stormwater management and, in turn, impacts the quality of the available water resources. The quality of water resources has an economic consequence as well as an effect on the quality of life in the surrounding areas. This understanding is at the core of current stormwater management approaches.

The stormwater management philosophy of this plan is reflected in the required standards: peak flow management, volume control, water quality management, and channel protection requirements. The philosophy, and thus the standards, reflect an attempt to manage stormwater in such a way as to maintain the watershed hydrology as near to existing or historical conditions as possible.

STORMWATER MANAGEMENT PLANNING

Historically, the approach to stormwater management was to collect the runoff and convey it, via a system of inlets and pipes, as quickly as possible to the nearest receiving waters. The increased rate and volume of stormwater delivered quickly to receiving waters had a detrimental effect on channel morphology. Negative impacts, such as severe channel erosion and significant in-stream sediment deposits resulted. These impacts led to unstable, deepened and widened channels, nuisance flooding, infrastructure damage, increased culvert and bridge maintenance requirements, and have had a detrimental affect on the stream quality in terms of habitat for aquatic organisms. In addition, large amounts of rainfall were lost from the upper

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portions of the watershed and become unavailable for infiltration and groundwater recharge, and contaminants on the land surface entered the stream untreated. This pure conveyance approach cannot be considered stormwater management in any meaningful terms.

This approach was later replaced with the stormwater management standards that exist today in many municipalities. This latter rate-controlled approach requires that peak flow rates from development sites be managed, usually through detention ponds, such that the peak discharge from the site is no greater than the peak discharge rate from the site prior to development. While this may have helped reduce some stormwater problems, there were two significant failings with this approach: watersheds were not regulated as interconnected networks, and the hydrologic cycle was ignored

The first failing of the rate-controlled approach is that it does not consider the watershed as a single interrelated hydrologic unit. Because watersheds are interconnected networks, an integrated watershed management approach is needed. Two points are emphasized regarding the need for watersheds to be regulated as interconnected networks:

1. Stormwater regulatory responsibility, absent arrangements to the contrary, rests with each municipal government in Pennsylvania. Therefore, stormwater management regulations, if applied at all, are implemented by a municipality within the boundaries of its own jurisdiction. There is no guarantee that all municipalities within a given watershed have comparable standards. When standards are implemented by individual municipalities, the problems caused by unmanaged stormwater in areas with poor, or no, regulations are conveyed to municipalities downstream. Upstream municipalities can, and do, cause stormwater problems for downstream neighbors. In these situations, downstream municipalities are forced to deal with problems associated with increased water volume, increased sediment loads, and increased pollutants which originate in areas where they have no control.
2. Each area within a watershed is unique in terms of its contribution to the overall watershed hydrology. However, when the same standards are implemented throughout a broad area, and the overall watershed hydrology is not considered, these standards can result in over-management in some areas and under-management in other areas. In some cases, this type of management could actually exacerbate stormwater problems. Further, this "one-size-fits-all" approach does not take into account conditions such as soil infiltration rates, slopes, or channel conditions, which vary throughout a watershed and municipality.

The second key failing is that the rate-controlled approach does not consider the aspects of water quality, channel protection, or the importance of infiltration in the hydrologic cycle. Simply managing the rate at which stormwater leaves a development site does not maintain the overall watershed hydrology. When implementing a peak rate control strategy as the sole method of controlling stormwater runoff, pollutants are still delivered to surface waters, rainfall is still unavailable to the watershed for recharge, and channel erosion and sedimentation still occur.

LOW-IMPACT DEVELOPMENT AND STORMWATER MANAGEMENT

Low-Impact Development (LID) is an approach to land development that uses various land planning and design practices and technologies to simultaneously conserve and protect natural resource systems and reduce infrastructure costs (HUD, 2003). As the term applies to stormwater management, LID is an approach to managing stormwater in a manner similar to nature by managing rainfall at the source using uniformly distributed, decentralized, micro-scale controls (Low Impact Development Center, 2007). These concepts are the origin of many of the strategies identified to achieve the goals presented in this Plan.

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As a comprehensive technology-based approach to managing stormwater, LID has developed significantly since its inception, in terms of policy implementation and technical knowledge. The goals and principles of LID, as describe in *Low-Impact Development Design Strategies* (Prince Georges County, 1999) are defined as follows:

- Provide an improved technology for environmental protection of receiving waters;
- Provide economic incentives that encourage environmentally sensitive development;
- Develop the full potential of environmentally sensitive site planning and design;
- Encourage public education and participation in environmental protection;
- Help build communities based on environmental stewardship;
- Reduce construction and maintenance costs of the stormwater infrastructure;
- Introduce new concepts, technologies, and objectives for stormwater management such as micromanagement and multifunctional landscape features (bioretention areas, swales, and conservation areas); mimic or replicate hydrologic functions; and maintain the ecological/biological integrity of receiving streams;
- Encourage flexibility in regulations that allows innovative engineering and site planning to promote smart growth principles, and;
- Encourage debate on the economic, environmental, and technical viability and applicability of current stormwater practices and alternative approaches.

The overall design concepts and specific design measures for Best Management Practices (BMPs) are derived from the following conceptual framework (Prince Georges County, 1999):

1. The site design should be built around and integrate a site's pre-development hydrology;
2. The design focus should be on the smaller magnitude, higher frequency storm events and should employ a variety of relatively small, (BMPs);
3. The smaller BMPs should be distributed throughout a site so that stormwater is mitigated at its source;
4. An emphasis should be given to non-structural BMPs, and;
5. Landscape features and infrastructure should be multifunctional so that any feature (e.g., roof) incorporates detention, retention, filtration, or runoff use.

The LID process is meant to provide an alternative approach to traditional stormwater management; *Table 1.1* highlights the difference between the two approaches. These concepts, as they apply to stormwater, are the basis for the stormwater management approach presented in this Plan.

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LID Approach		Traditional Approach	
Approach	Examples	Approach	Examples
1. Integration of Pre-Development Hydrology	A development built around but outside of a drainage way and its functional floodplain	Elimination of all water features from project site	Redirection and conveyance of drainage; alteration of floodplain to meet site design
2. Emphasis on smaller magnitude, higher frequency storm events	Several small BMPs	Large stormwater ponds and facilities that focus on 10 and 100-year events	A single stormwater pond
3. Mitigation of stormwater at its source	BMPs located near buildings, within parking lot islands	Conveyance of Stormwater to low point on site	A single stormwater pond
4. Use of simple, non-structural BMPs	Narrower drive ways, conservation easements, impervious disconnection	Use of pipe and stormwater ponds	A single stormwater pond
5. Use of multifunctional landscape and infrastructure	Green roofs, rain gardens in parking lot islands	Separation of stormwater and site features	No consideration of impacts given

Table 10.1. Comparison of LID versus Traditional Stormwater Management Approach

When implemented at the site level, LID has been found to have a beneficial impact on water quality and in reducing peak flows for more frequent storm events (Bedan and Clausen, 2009; Hood et. al., 2007). There are numerous case studies and pilot projects that emphasize similar finding about the benefits of site-level development and of specific LID BMPs (EPA, 2000; DEP, 2006; Low Impact Development Center, 2009).

When implemented at the watershed level as proposed in this Plan, there are quantifiable benefits in terms of reduced peak discharges anticipated from future developments (as discussed in *Section VI*). The approach of considering water quality and existing condition hydrology will help address documented stream impairments (as discussed in *Section IX*). Additionally, adopting a LID approach will help alleviate the economic impact of the additional regulations proposed in the Model Ordinance (as discussed in *Section VIII*). Several other Act 167 Plans that have been recently prepared or are being prepared concurrently with this Plan further support these findings.

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Section II – Goals and Objectives of the Act 167 Stormwater Management Plan

This plan was developed to present the findings of a two-phased multi-year study of the watersheds within Montour County. Watershed-based 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. Although this Plan represents many things to many people, the principal purposes of the Plan are to protect human health and safety. It does so by addressing the impacts of future land use on the current levels of stormwater runoff 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 watershed stormwater management throughout Montour County. The Plan is intended to enable every municipality in the County to meet the intent of Act 167 through the following goals:

1. Manage stormwater runoff created by new development activities by accounting for the cumulative basin-wide stormwater impacts from peak runoff rates and runoff volume.

2. Meet the legal water quality requirements under Federal and State laws.

3. Provide uniform stormwater management standards throughout Montour County.

4. Encourage the management of stormwater to maintain groundwater recharge, to prevent degradation of surface and groundwater quality, and to protect water resources.

5. Preserve the existing natural drainage ways and water courses.

6. Ensure that existing stormwater problem areas are not exacerbated by future development and provide recommendations for improving existing problem areas.

These goals provided the focus for the entire planning process. A scope of work was developed in Phase 1 that focused efforts on gathering the necessary data and developing strategies that address the goals. With the general focus of the Plan determined, Phase II further researched County specific information, provided in-depth technical analysis, and developed a Model Ordinance to achieve these goals. On the following page, *Table 2.1* shows the preferred stategies to address the goals, and where these strategies are addressed in the Plan:

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1. Manage stormwater runoff created by new development activities by accounting for the cumulative basin-wide stormwater impacts from peak runoff rates and runoff volume	
Develop hydrologic models of selected watersheds to determine their response to rainfall	*Appendix C*
Determine appropriate stormwater management controls for these watersheds	
2. Meet the legal water quality requirements under Federal and State laws	
Provide recommendations for improving impaired waters within the County	*Section 9*
Encourage the use of particularly effective stormwater management BMPs	*Section 7*
3. Provide uniform standards throughout Montour County	
Develop a Model Stormwater Management Ordinance with regulations specific to the watersheds within the County	*Model Ordinance*
Adopt and implement the Model Ordinance in every municipality in Montour County	*Model Ordinance*
3. Encourage the management of stormwater to maintain groundwater recharge, to prevent degradation of surface and groundwater quality, and to protect water resources	
Provide education on the correlation between stormwater and other water resources	*Section 1, Section 10*
Require use of the Design Storm Method or the Simplified Method	*Model Ordinance*
4. Preserve the existing natural drainage ways and water courses	
Provide education on the function and importance of natural drainage ways	*Section 1, Section 10*
Protect these features through provisions in the Model Ordinance	*Model Ordinance*
5. Ensure that existing stormwater problem areas are not exacerbated by future development and provide recommendations for improving existing problem areas	
Develop an inventory of existing stormwater problem areas	*Section 5, Appendix B*
Analyze problem areas and provide conceptual solutions to the problems	*Section 5, Appendix B*

Table 2.1. Preferred Strategies to Address Plan Goals

STORMWATER PLANNING AND THE ACT 167 PROCESS

Recognizing the increasing need for improved stormwater management, the Pennsylvania legislature enacted the *Stormwater Management Act* (Act 167 of 1978). Act 167, as it is commonly referred to, enables the regulation of development and activities causing accelerated runoff. It encourages watershed based planning and management of stormwater runoff that is consistent with sound water and land use practices, and authorizes a comprehensive program of stormwater management intended to preserve and restore the Commonwealth's water resources.

The Act designates the Department of Environmental Resources as the public agency empowered to oversee implementation of the regulations and defines specific duties required of the Department. The Department of Environmental Resources was abolished by Act 18 of 1995. Its functions were transferred to the Pennsylvania Department of Conservation and Natural Resources (DCNR) and the Department of Environmental Protection (DEP). Duties related to stormwater management became the responsibility of DEP (Act 18 of 1995).

As described in Act 167, each county must prepare and adopt a watershed stormwater management plan for each watershed located in the county, as designated by the department, in consultation with the municipalities located within each watershed, and shall periodically review and revise such plan at least every five years. Within six months following adoption, and approval, of the watershed stormwater plan by DEP, each municipality must adopt or amend,

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and must implement such ordinances and regulations, including zoning, subdivision and development, building code, and erosion and sedimentation ordinances, as necessary to regulate development within the municipality in a manner consistent with the applicable watershed stormwater plan and the provisions of the Act.

PLAN ADVISORY COMMITTEES

Public participation by local stakeholders is an integral part of comprehensive stormwater management planning. Coordination amongst these various groups facilitates a more inclusive Plan, that is able to better address the variety of issues experienced throughout the County. Several Plan Advisory Committee (PAC) meetings were facilitated throughout the development of this Plan.

A PAC was formed at the beginning of the planning process, as required by the Stormwater Management Act. The purpose of the PAC is to serve as an access for municipal input, assistance, voicing of concerns and questions, and to serve as a mechanism to ensure that inter-municipal coordination and cooperation is secured. The PAC consists of at least one representative from each of the municipalities within the county, the County Conservation District, and other representatives as appropriate. A full list of the PAC members can be found in the Acknowledgements section at the beginning of this Plan.

As per Act 167, the Committee is responsible for advising the County throughout the planning process, evaluating policy and project alternatives, coordinating the watershed stormwater plans with other municipal plans and programs, and reviewing the Plan prior to adoption. *Table 2.2* is a summary of the PAC meetings that were held throughout the planning process.

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PAC Meeting	Purpose of Meeting	Meeting Dates
1	Phase 2 Start-up Meeting - Introduce the Phase 2 planning process. Emphasize the importance of full municipal involvement. Present summary of the data collection questionnaire from Phase 1.	2-26-2009
2	Review the project status, maps, institutional data (ordinances, etc), solicit input from municipalities, provide summary of stormwater problems. Identify areas that require detailed hydrologic modeling.	5-27-2009
3	Technical issues for detailed models: Review model selection and setup, initial modeling runs, calibration procedures, solicit input on technical standards, water quality issues.	9-9-2009
4	Technical issues for detailed models: Review modeling results, present standards and criteria; discuss water quality issues and preliminary technical content for ordinances.	8-12-2009
5	Technical review of draft Plan for areas that require detailed models: Review technical comments. (Draft Plan sent to municipalities prior to meeting).	4-27-2010
6	General review of draft Plan: Gather general comments and feedback prior to finalization of the Plan.	
7	Pre-hearing meeting: Review comments and responses to comments. Summarize implementation.	
Public Hearing	Conduct the hearing as required by Act 167 to present the Plan to the public.	5-XX-2010
8	Municipal Implementation Workshop: Provide assistance to municipalities on implementation of the Plan including adaptation, enactment, and implementation of the ordinances and other action items.	6-XX-2010
Public Workshop	Public Implementation Workshop: Provide introduction and overview of the PLAN to public.	

Table 2.2. Summary of PAC Meetings

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Section III – Montour County Description

Montour County is located in central Pennsylvania and was created in 1850, from part of Columbia County and named in honor of Madame Montour, a woman of American Indian and French descent, who was prominent in the Indian Affairs. Danville, the County Seat, was laid out in 1792 and incorporated into a Borough in 1849. Montour County is the smallest county in Pennsylvania in land area. Montour County has an area of approximately 132 square miles and is divided into 5 major watersheds (Montour County, 2010).

POLITICAL JURISDICTIONS

The County is comprised of 11 municipalities. The political jurisdictions include two boroughs, and nine townships. In 2008, Montour County had an estimated population of 17,705, decreasing 2.9% from the 2000 census total of 18,236. The 11 municipalities and their respective populations in Montour County are as follows:

Townships	Estimated 2008 Population	Area (mi²)	Boroughs	Estimated 2008 Population	Area (mi²)
Anthony	1,364	26.3	Danville	4,450	1.7
Cooper	922	7.2	Washingtonville	187	0.1
Derry	1,143	16.3			
Liberty	1,447	27.1			
Limestone	1,068	13.4			
Mahoning	4,241	9.1			
Mayberry	242	7.3			
Valley	2,120	16.3			
West Hemlock	521	7.6			

Table 3.1. Montour County Municipalities

In addition to these political boundaries, some municipalities use a County Zoning Ordinance to regulate their land use (Washingtonville Borough and the Townships of Anthony, Liberty, Cooper and Mayberry), some have their own regulations (Danville Borough, and the Townships of Mahoning and Valley) and a third group includes the Northern Montour Region with an additional set of regulations (Townships of Derry, Limestone and West Hemlock). Section 4 explores this existing regulatory framework and its relationship to stormwater management in detail.

LAND USE

GENERAL DEVELOPMENT PATTERNS

Montour County is primarily rural in nature with over 85% of the land use either Agricultural or Rural. Danville, the Route 11 and Route 54 corridors, and several "town centers" within the surrounding townships are primarily the commerce centers in the County. *Table 3.2* reflects the proportion of

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current land uses and the changes predicted in the *2009 Comprehensive Plan* (EADS, 2009). For the purpose of this Plan, the existing land use as defined in the *Comprehensive Plan* is the 2010 land use; all future land use is the assumed land use in the year 2020.

The major concepts that are incorporated into the development of the future land use include increase mixed-use village centers, clustering in areas where appropriate, and defined growth areas in Route 11 Corridor (Danville east through Cooper Township), Route 54/I-80 Corridor (Danville north into Valley Township), and the Route 54/254 Area in Derry Township. The increase in industrial use can be attributed a major regional industrial district in Derry Township.

Land Use	Percentage of Total Land Use	Projected Percentage Change in Land Use
Agricultural	44.6	-10
Commercial	1.0	+18
Forested	40.7	-5
Industrial	1.1	+229
Medical/Institutional	0.3	0
Public Semi Public	3.5	0
Residential	5.8	+36
Transportation	3.1	0

Table 3.2. Land Uses in Montour County
(Data adapted from *2009 Comprehensive Plan*)

TRANSPORTATION

The major traffic routes in Montour County include PA Routes 11, 44, 54, 254, 642 and Interstate 80. PA Route 11 runs for about 7 miles through the southern portion of the County along Sechler Run in Cooper Township and Danville Borough and continues to follow the Susquehanna River. Approximately 5.2 miles of PA Route 44 runs through the northern part of Montour County in the Chillisquaque Creek Watershed. PA Route 54 runs approximately 16 miles in a north-south direction through the center of Montour County, and runs through the Chillisquaque Creek Watershed, the Mahoning Creek Watershed and the Sechler Run Watershed. An estimated 7.7 miles of PA Route 254 runs through the western center of the County and splits the Chillisquaque Creek and Limestone Run watersheds in an east-west direction. PA Route 642 runs a length of about 12.9 miles through the southeastern portion of the County through the Mahoning Creek and Sechler Run Watersheds. The major traffic route of Interstate 80 travels through the southern center portion of Montour County for about 22 miles. Interstate 80 enters Montour County in the Chillisquaque Creek Watershed from the west and exist Montour County on the east in the Mahoning Creek Watershed.

FARMLANDS

About 21 percent of Montour County is considered prime farmland (NRCS, 1980). The major crops that occupy this land are corn and soy beans. The majority of prime farmlands are located in the northern portion of the County in the Chillisquaque Creek watershed in Limestone, Derry, and Anthony Townships.

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CLIMATE

Being located in central Pennsylvania, the climate in Montour County is relatively humid with approximately 42” of rainfall with the highest monthly precipitation occurring in May, June, and September. The average temperatures range from an average in the low 20s(°F) between December and February to the high 60s(°F) between June and September. The record low is -17°F in January of 1984 and the record high is 103°F in July of 1988 (Weather Channel, 2010). The region receives an average of 50” of snow annually (NCDC, 2010). Extreme storm events are driven by both slow moving rainstorms originating from the south to southwest that occur throughout the year and storms of tropical origin that occur on an average of once in three years (Delta Development Group, 2008)

RAINFALL

Figures 3.1 and 3.2 show the rainfall statistics for Montour County. The average rainfall, shown in Figure 3.1 portrays the amount of precipitation throughout each year since 1942, although there can be significant variation in the annual rainfall total (between 27 and 54 inches). While this variation can have a significant impact on water supply and vegetative growth, it is the quantity of rain in a relatively short time period (1-hour, 6-hour, 24-hour, 48-hour) that receives the focus of most stormwater regulations.

Figure 3.2 shows the annual maximum rainfall events recorded over the same time period graphed and the NOAA Atlas 14 values (Precipitation / Frequency Data) for the 2-year and 100-year storm events, derived using partial series data. The annual maximum rainfall for a station is constructed by extracting the highest precipitation amount for a particular duration in each successive year of record. A partial duration series is a listing of the period of record with the greatest observed precipitation depths for a given duration at a station, regardless of how many occurred in the same year. Thus, a partial data series accounts for various storms that may occur in a single year.

Historical focus on the annual maximum rainfall and the larger magnitude, low frequency storm events, as done in previous stormwater planning efforts throughout Pennsylvania, has lead to neglect of 1) the majority of storm events that are smaller than the annual maximum and their subsequent value to the landscape in terms of volume and water quality and 2) the fact that the inclusion of every storm may increase the 24-hour rainfall total typically used in design.

The majority of rainfall volume in Montour County comes from storms of low magnitudes. Only 10% of the daily rainfall between 1942 and 2010 exceeded 0.85 inches, which is below any design standards currently being used in the County. Thus, any stormwater policy should incorporate provisions such as water quality, infiltration, or retention BMPs that account for these small events. It is important to acknowledge that many of these smaller **rainfall** events lead to larger **runoff** events as they may saturate the soils prior to a larger storm or occur within a short time period after a larger storm so that they overwhelm existing conveyance facilities.

For the gage data shown in Figure 3.1 and 3.2, the NOAA Atlas 24-hour, 2-year storm event total of 2.82 inches was exceeded 15 times in more than 60 years of data. When analyzing only the annual maximum series, the NOAA Atlas 24-hour, 2-year storm was exceeded only 13 times. Thus, viewing only the annual maximum series may neglect significant historical rainfall events, particularly in years like 1972, 1975, or 2004 with several significant rainfall storms. The implication for stormwater policy in Montour County is that best management practices should incorporate the NOAA Atlas 14, partial duration data series to ensure the best available data is being used for design purposes.

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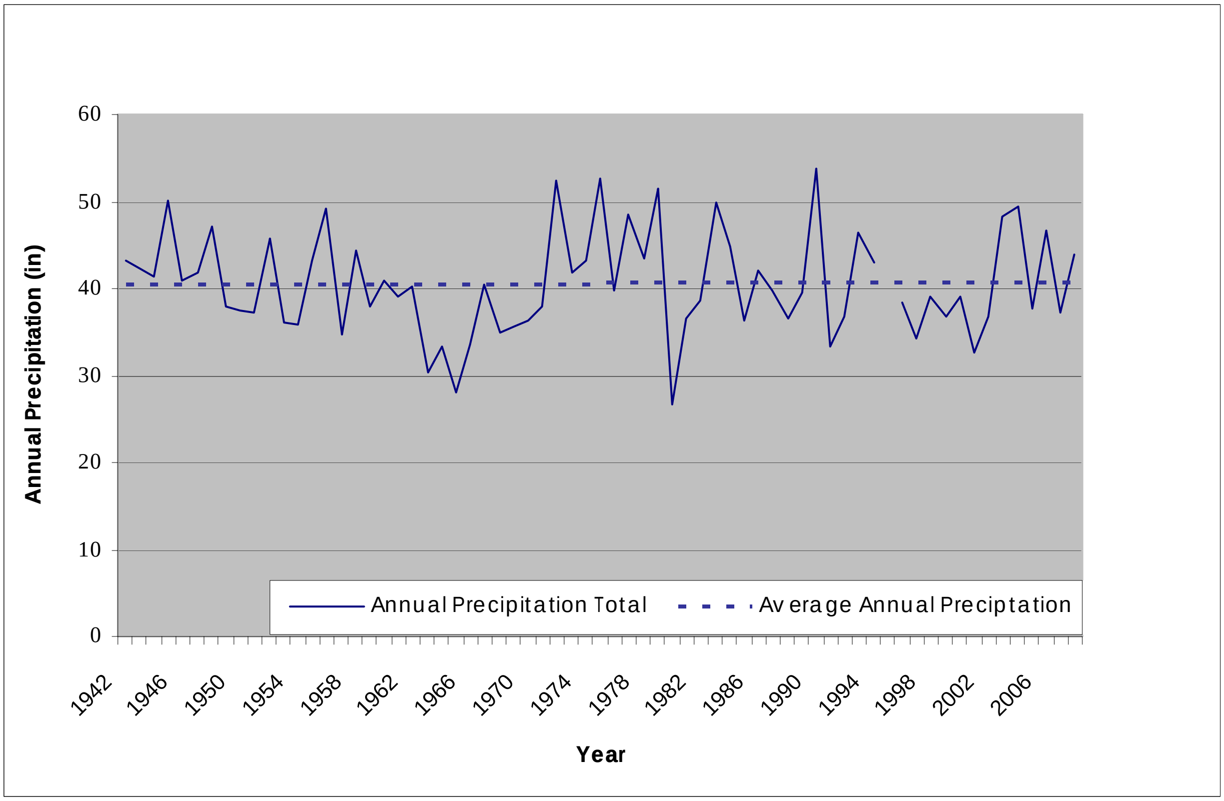

Figure 3.1. Annual Precipitation at Danville, Pennsylvania (Coop ID #362013)

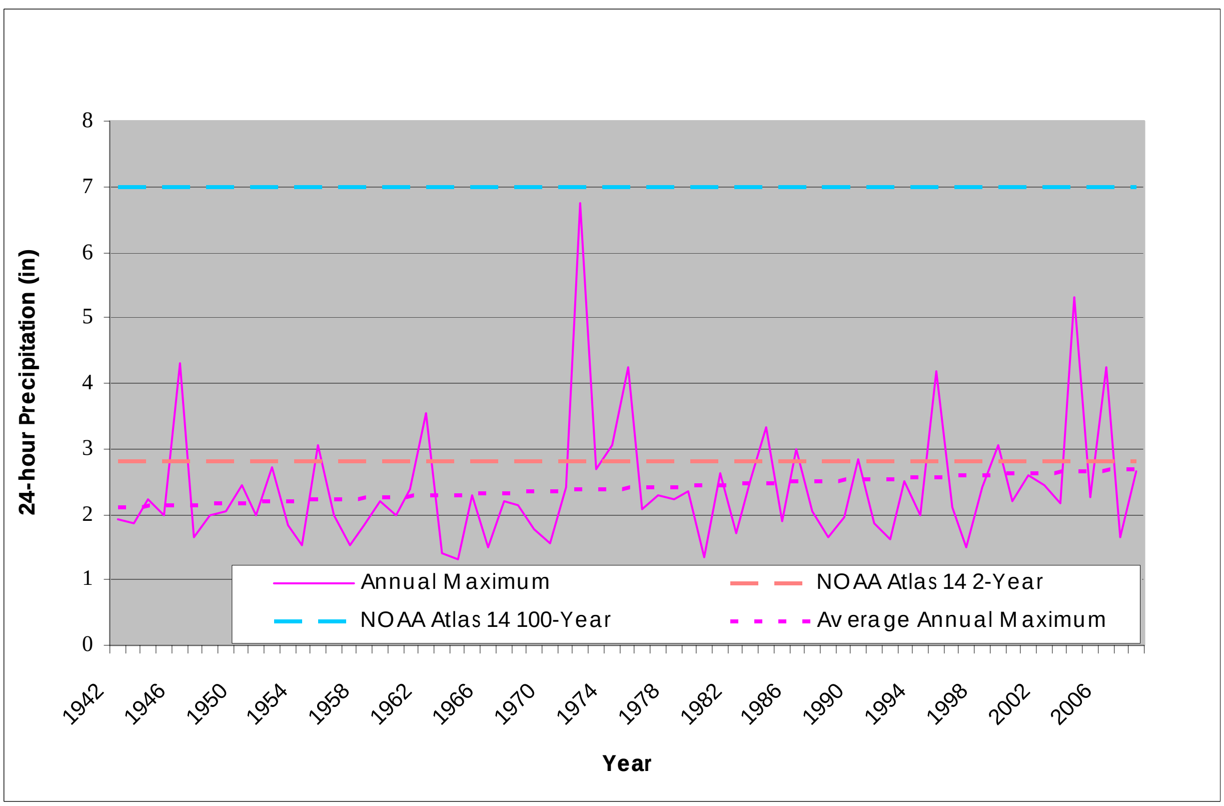

Figure 3.2. 24-Hour Rainfall Statistics at Danville, Pennsylvania (Coop ID #362013)

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GEOLOGY

Montour County is located in the Ridge and Valley Physiographic Province. The Ridge and Valley Province is characterized by alternating series of long, narrow, and even-crested ridges and valleys. The ridge and valleys are oriented in a southwestern and southern direction with moutains as high as 1380 feet down to 450 feet along the Susquehanna River. Some karst terrain exists in the valleys. The Muncy Hills create a natural border in the northern part of the County and the Montour Ridge is located in the southern part of the County. Refer to *Plate 6 – Geology* for more information.

Formation	Dominant Lithology	% of County
Bloomsburg and Mifflintown Formations	Shale	3.4
Buddys Run Member of Catskill Formation	Siltstone	2.0
Clinton Group	Shale	6.7
Hamilton Group	Shale	34.8
Irish Valley Member of Catskill Formation	Siltstone	6.4
Keyser and Tonoloway Formations	Limestone	6.2
Onondaga and Old Port Formations	Calcareous shale	8.5
Trimmers Rock Formation	Siltstone	24.8
Tuscarora Formation	Quartzite	2.1
Wills Creek Formation	Calcareous shale	5.1

Table 3.3. Geologic Formations in Montour County

BEDROCK FORMATIONS

Devonian-age rocks cover about two thirds of the County, including the Muncy Hills area and the valley and lowland areas to the south (Sevon, 2000). The Muncy Hills area consists of shales, sandstones, and graywackes. The low hill and valleys are made of shales and limestones. Silurian-age rocks cover the remaining one third of the County, including the Montour Ridge and the Washingtonville area. They consist of sandstone, limestones, shale and siltstone. Recent alluvial deposits are common along many of the streams, especially near the confluences (NRCS, 1980). *Table 3.3* describes the formations, their dominant lithology, and the portion of the County that they occupy.

KARST TOPOGRAPHY

A small portion of Montour County's landscape is underlain by limestone based geologic formations (6.2% as shown in *Table 3.3*). Limestone, which is a carbonate rich material, is highly soluble and susceptible to the formation of solution caverns and sinkholes (i.e. karst topography). Karst refers to any terrain where the topography has been formed chiefly by the dissolving of rock. Landforms associated with karst include sinkholes, caves, sinking streams, springs, and solution valleys.

Because of the unique geologic and hydrologic features associated with highly developed subterranean networks, the scope of problems related to the karst environment is large. A karst

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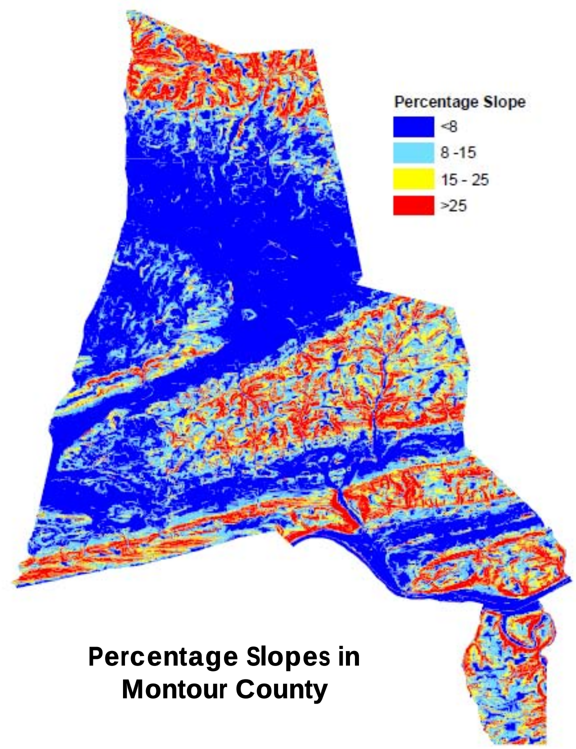
landscape is particularly sensitive to environmental degradation, with the depletion and contamination of groundwater supplies being among the most severe.

Stormwater runoff also contributes to sinkhole activity. According to Kochanov in his work Sinkholes in Pennsylvania, "The stormwater drainage problem is compounded in karst areas by the fact that development reduces the surface area available for rainwater to infiltrate naturally into the ground. A typical residential development having quarter-acre lots may reduce the natural ground surface by 25 percent, whereas a shopping center and parking lot may reduce it by 100 percent. If storm water, gathered over a specific area, is collected and directed into a karst area, the concentration of water may unplug one of the karst drains". Although karst landforms pose hazardous conditions, they are, in fact, valuable for various reasons. They serve as areas for endangered species of flora and fauna, may contain cultural resources (i.e., historic and prehistoric), contain rare minerals or unique landforms, and provide scenic and challenging recreational opportunities.

SLOPES

Montour County is located within a moderately folded and faulted geologic region. As a result, much of the County contains sizeable areas of steep slopes in the municipalities located near Muncy Hills and the Montour Ridge. Slopes with grades of 15% or greater are considered steep. If disturbed, these areas can yield heavy sediment loads on streams. Very steep slopes, with over 25% grade, produce heavy soil erosion and sediment loading. Slope values are broken into four categories and shown in *Table 3.4* below. Also shown is the total area in Montour County within each category, the total area as a percentage of all land in the county, and the general slope restrictions associated with each category.



Percentage Slopes in Montour County

SOILS

The behavior of a soil's response to rainfall and infiltration is a critical input to the hydrologic cycle and in the formation of a coherent stormwater policy. The soils within Montour County have variable drainage characteristics and have various restrictions on their ability to drain, promote vegetative growth, and allow infiltration. They range from well drained with a low runoff potential, to moderately to poor drained with a high runoff potential.

Impediments to subsurface drainage in Montour include lithic and paralithic bedrock (i.e., solid and weather or broken layers of bedrock). Higher runoff rates and reduced infiltration capacity may exist in these soils. *Table 3.5* displays the proportion of paralithic and lithic bedrock in Montour County.

An additional indicator of the ability of the soils in Montour County to absorb rainfall is the hydrologic soil group assigned to each soil. This classification varies between "A" which has very low runoff potential and high permeability and "D" which typically has very high runoff potential and low permeability. *Table 3.6* show a summary of the hydrologic soil groups for Montour

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County. *Table 3.7* provides a list of the specific soil series in Montour County. Some soils have variable runoff potential depending on whether or not they are drained or undrained. For example, agricultural field with tile drainage may decrease the runoff potential from hydrologic soil group D to hydrologic soil group A. 74% of the soils in Montour County are hydrologic soil group A, B, or C indicating a moderate runoff potential (Refer to *Plate 4 – Hydrologic Soils*).

Slope Classification	Slope Range	Land Area (mi²)	Portion of Total Area	Slope Restrictions
Flat to Moderate	0-8%	65.5	49.4%	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
Rolling Terrain and Moderate Slopes	8 - 15%	28.5	21.5%	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 perennial forage crops and pastures with occasional small grain plantings
Steep slopes	15 - 25%	20.2	15.3%	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 should be limited to pastures and tree farms
Severe and Precipitous Slopes	> 25%	18.4	13.8%	No development of an intensive nature should be attempted; land not to be cultivated; permanent tree cover should be established & maintained; adaptable to open space uses (recreation, game farms, & watershed protection)

Table 3.4. Summary of Slopes in Montour County

Restrictions	% of County
Bedrock (paralithic)	59.2
Bedrock (lithic)	2.2
None identified	38.6

Table 3.5. Soil Restrictions in Montour County

Hydrologic Soil Group	Runoff Potential	% of County
A	Low	2.9
B	Low to Moderate	18.8
B/D		4.6
C	Moderate to High	47.3
C/D		21.5
D	High	2.5
Unidentified		2.4

Table 3.6. Hydrologic Soil Groups in Montour County

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Series Name	Map Symbols	Hydrologic Soil Group	% of County	Restrictions
Albrights	AbB	C	0.2	
Allenwood	AnA, AoB, AoC	B	0.9	
Alvira	ArA, ArB, ArC, AsB	C	7.8	Bedrock (paralithic) (40in.)
Basher	Bc, Bd	B	1.9	
Bedington	BeB, BeC, BeD	B	1.7	Bedrock (paralithic) (40in.)
Berks	BkB, BkC, BkD	C	13.6	Bedrock (paralithic) (20-40in.)
Buchanan	BuB, BuC, BxB, BxD	C	1.3	
Calvin	CaB, CaC, CaD	C	1.4	Bedrock (paralithic) (20-40in.)
Dekalb	DeB, DeD, DeF	C	0.4	Bedrock (lithic) (20-40in.)
Edom	EdB, EdC, EdD	C	2.6	Bedrock (paralithic) (40-60in.)
Elliber	EsB, EsC, EsD, EtB, EtC, EtD, EtF	A	2.8	
Evendale	EvB	C	1.9	Bedrock (paralithic) (40in.)
Hagerstown	HaB, HaC, HaD	B	3.6	
Hartleton	HtB, HtC, HtD	B	8.4	Bedrock (paralithic) (40in.)
Hazleton	HuB, HuD	B	0.6	Bedrock (lithic) (40-40in.)
Holly	Hv, Hy, Hz	B/D	5	
Kreamer	KmB, KmC	C	1.3	
Laidig	LaB, LaC, LdD, LdF	C	0.9	
Leck Kill	LnB, LnC, LnD	B	0.4	Bedrock (paralithic) (40-60in.)
Linden	Lw	B	0.3	
Meckesville	MkB, MkC	C	0.2	
Monongahela	MoA, MoB	C	2.2	
Opequon	OpB, OpD, OpE	C	1.1	Bedrock (lithic) (12-20in.)
Shelmadine	ShA, ShB	D	2.1	
Udifluvents	Ug	C	0.5	

Table 3.7. Soil Characteristics of Montour County (NRCS, 2008)

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Series Name	Map Symbols	Hydrologic Soil Group	% of County	Restrictions
Unadilla	UnB, UnC, UnD	B	0.7	
Washington	WaB	C	1.7	
Watson	WbA, WbB, WbC, WeB	C	10.2	
Weikert	WeC, WeD, WkE	C/D	21.5	Bedrock (paralithic) (10-20in.)
Wheeling	WsA, WsB	B	0.3	
Wyoming	WyA, WyB	A	0.1	
Other	W, Ur, Qu, Pa, DAM	--	2.4	Water, urban land, quarries, pits, and dams

Table 3.7 (continued). Soil Characteristics of Montour County (NRCS, 2008)

HYDRIC SOILS

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 now protected by DEP and the USACE and should be examined before deciding on any type of development activity. Table 3.8, shown below, lists the hydric soils found in Montour County, according to NRCS:

Albrights silt loam	Evendale cherty silt loam	Shelmadine silt loam
Alvira silt loam	Holly silt loam	Udifluvents and Fluvaquents, gravelly
Basher soils	Kreamer cherty silt loam	Washington silt loam
Buchanan gravelly loam	Linden silt loam	Watson silt loam
Buchanan very stony loam	Monongahela silt loam	Weikert shaly silt loam

Table 3.8. Hydric Soils

WATERSHEDS

Surface waters include rivers, wetlands, streams and ponds, which provide aquatic habitat, carry or hold runoff from storms, and provide recreation and scenic opportunities. Surface water resources are a dynamic and important component of the natural environment. However, ever-present threats such as pollution, construction, clear-cutting, mining, and overuse have required the protection of these valuable resources.

Watersheds are delineated and subdivided for the sake of management and analysis. The physical boundaries of a watershed depend on the purpose of the delineation. Often a watershed is called a “basin” but is also a “subbasin” to an even larger watershed. This indistinct nature often leads to confusion when trying to categorize watersheds. As show in *Figure 3.4*, DEP has divided Pennsylvania into seven different major river basins, based upon the major waterbody to which they are tributary. These include: Lake Erie Basin, Ohio River Basin, Genesee River Basin, Susquehanna River Basin, Potomac River Basin, Elk & Northeast / Gunpowder Rivers Basin, and Delaware River Basin.

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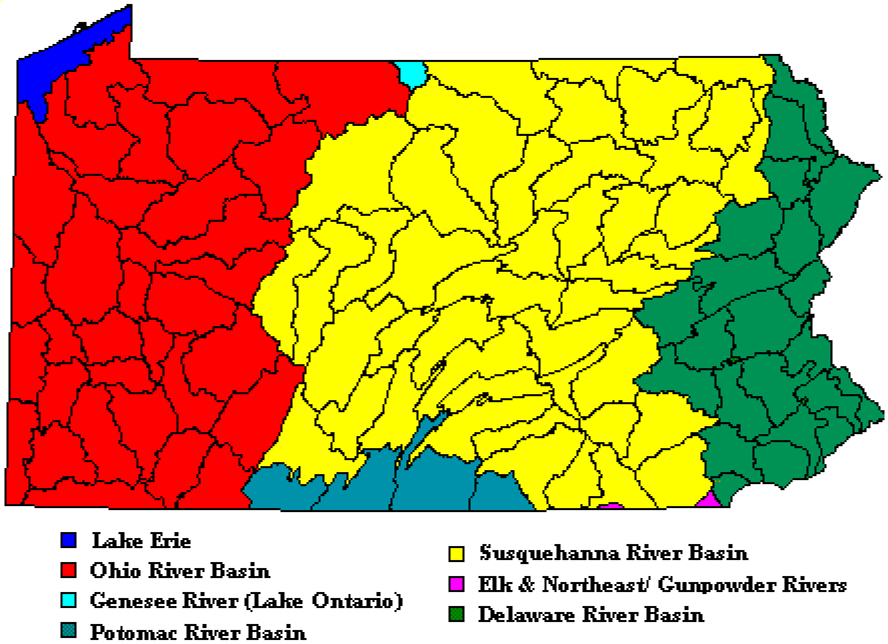

Figure 3.4. Pennsylvania's Major River Basins as Delineated by DEP (DEP, 2009)

For the purpose of this Plan, these are the largest basins within the Commonwealth. The major river basins are further divided into "subbasins" and "Act167 Designated Watersheds" for stormwater management purposes. Act 167 divided the Commonwealth into 29 subbasins and 357 designated watersheds. Montour County lies completely within the Susquehanna River Basin, but is tributary to two different subbasins: West Branch Susquehanna River and the Middle Susquehanna River. Montour County contains at least a portion of nine different Act 167 Designated Watersheds. This classification of the county's watersheds is summarized in the following *Table 3.9.*

MAJOR RIVER BASIN	SUBBASIN	ACT 167 Designated Watershed
Susquehanna	West Branch Susquehanna River	Limestone Run
		Mahoning Creek
		Sechler Run
		Roaring Creek
		Chillisquaque Creek
		Muddy Run
		Susquehanna River
	Middle Susquehanna River	Little Fishing Creek
		Susquehanna River

Table 3.9. Classification of Montour County Watersheds

ACT 167 DESIGNATED WATERSHEDS

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The vast majority of Mountour County is within the Chillisquaque, Mahoning Creek, and Sechler Run watersheds. Sechler Run drains to Mahoning Creek as is combined with Mahoning Creek for the purpose of this Plan. Small portions of Roaring Creek, Muddy Run, Little Fishing Creek, and the Susquehanna River account for the remaining area of the County, which were not part of the detailed analysis completed for this Plan.

Chillisquaque Creek

The Chillisquaque Creek watershed is located in the northern portion the County. It drains an area 112 square miles, of which 73.2 square miles are located within Montour County. *Table 3.10* details the municipalities within the watershed, and their contributing area.

From the headwaters in the Muncy Hills, the Chillisquaque Creek drains southwest towards the County border before joining the West Branch Susquehanna River. Its major tributaries include Beaver Run, County Line Branch, the East, West, and Middle Branches of Chillisquaque Creek, Mud Creek, and McKee Branch.

Major floods occurred on Chillisquaque Creek during June 1972, September 1975, and January 1996 (FEMA, 2008). Although flooding occurs throughout the watershed, the section from the confluence with the West Branch of Chillisquaque Creek down to the confluence with Mud Creek (near Washingtonville) has historically received the most intense flooding since this is the largest population center in the watershed and its located downstream of the valley's steepest slopes. As the Chillisquaque proceeds beyond the County boundary, it has already collected the majority of its drainage area.

Watershed	Municipality	Area (mi^2)
Chillisquaque Creek	Anthony Township	25.3
	Derry Township	14.5
	Liberty Township	23.5
	Limestone Township	8.0
	Valley Township	1.2
	Washingtonville Borough	0.1
	West Hemlock Township	0.6

Table 3.10. Chillisquaque Watershed

In addition to flooding, the critical issues for the Chillisquaque watershed include water quality impairments and developmental pressure (area of identified flooding is also where industrial growth is projected in the *2009 Comprehensive Plan*.

Mahoning Creek/Sechler Run Watershed

The Mahoning Creek/Sechler Run Watershed is located in the southcentral portion of Montour County. It drains an area of approximately 39 square miles, of which 36.6 square miles are located within Montour County. The following table details the municipalities within the watershed and their land area.

The major tributaries in this watershed include Blizzard Run, Kase Run, Mauses Creek and Indian Creek. Most of these steep-sloped tributaries meet near or within the Borough of Danville. When a substantial storm occurs, the flooding within this watershed is also affected by high water levels from the Susquehanna.

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Watershed	Municipality	Area (mi²)
Mahoning Creek	Danville Borough	0.5
	Derry Township	1.7
	Liberty Township	3.5
	Mahoning Township	1.6
	Valley Township	15.0
	West Hemlock Township	6.8
Sechler Run	Cooper Township	3.5
	Danville Borough	0.5
	Mahoning Township	3.4
	Valley Township	0.05
	West Hemlock Township	0.05

Table 3.11. Mahoning Creek/Sechler Run Watershed

There have been several years with major flooding within this watershed. Most of these correspond to noted floods along the Susquehanna River (FEMA, 2008). Mahoning Creek and Sechler Run begin in headwaters located in Liberty, Derry, West Hemlock, and Cooper Townships. They then proceed down relatively steep slopes to combine in the Borough of Danville, where there is an outlet to the Susquehanna River. The Borough of Danville is the most urbanized area within the County and is mostly built out; most of the the potential change in land use is considerable near the headwaters of Mahoning Creek and Sechler Run. Thus, sound land use and stormwater policy is critical in this watershed where future developments may exacerbate existing downstream flooding problems.

Additionally, the Borough of Danville is protected by the Danville Project, a system of levees that protects the Borough from flooding from the Susquehanna, Mahoning Creek, and Sechler Run. This system is designed to protect against existing projected flood conditions; future unregulated land use that substantially increases flooding elevations along Mahoning Creek may cause this project to fail.

Limestone Run Watershed

Limestone Run is located in the north central portion of the County. Its headwaters are almost entirely within Limestone Township before flowing through the Borough of Milton in Northumberland County and eventually joining the West Branch of the Susquehanna River.

Watershed	Municipality	Area (mi²)
Limestone Run	Limestone Township	5.3

Table 3.12. Limestone Run Watershed

Limestone Run drains 12 square miles of a relatively rural landscape and its hydrology is likely influenced by the high percentage of limestone that underlies its surface. Several noticeable Karst features are located within this watershed, although there is no clear relationship between development and these features.

IMPOUNDMENTS

There is only one major water impoundment located in Montour County, the Pennsylvania Power and Light's Lake Chillisquaque located on the Middle Branch Chillisquaque Creek.

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SURFACE WATER QUALITY

Water Quality Standards for the Commonwealth are addressed in *The Pennsylvania Code, Title 25, Chapter 93*. Within Chapter 93, all surface waters are classified according to their water quality criteria and protected water uses. According to the antidegradation requirements of §93.4a, "Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected."

Certain waterbodies which exhibit exceptional water quality and other environmental features, as established in §93.4b, are referred to as "Special Protection Waters." These waters are classified as High Quality or Exceptional Value waters and are among the most valuable surface waters within the Commonwealth. Activities that could adversely affect surface water are more stringently regulated in those watersheds than waters of lower protected use classifications. The existing water quality regulations are discussed in more detail in *Section IV – Existing Stormwater Regulations and Related Plans*.

Montour County streams are shown with their Chapter 93 protected use classification in *Figure 3.5*. (This figure is provided for reference only, the official classification may change and should be checked at: http://www.pacode.com/index.html) An explanation of the protected use classifications can be found in *Section IV*.

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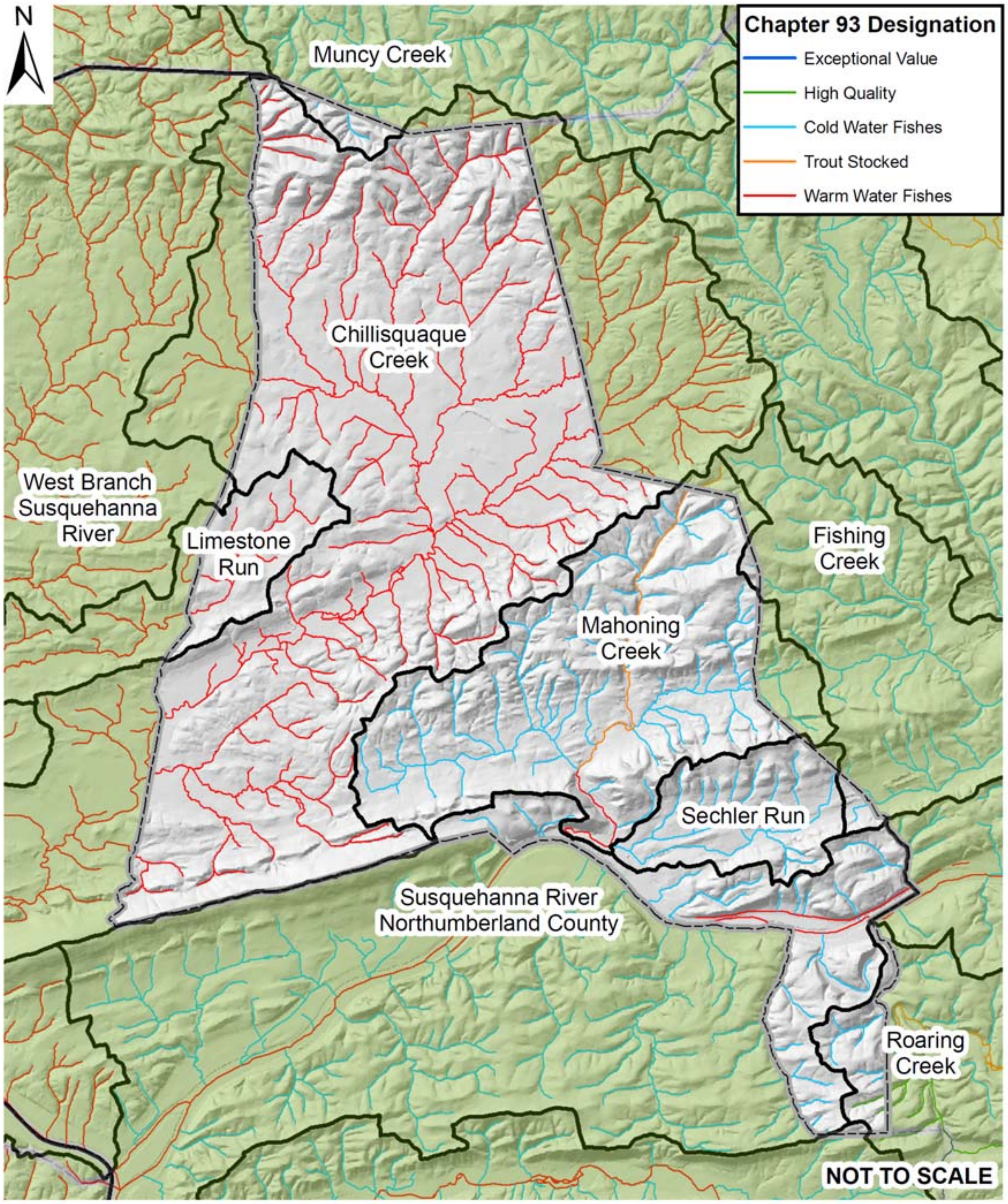

Figure 3.5. Chapter 93 Classification of Montour County Streams

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In Pennsylvania, bodies of water that are not attaining designated and existing uses are classified as “impaired”. Water quality impairments are addressed in *Section IX* of this Plan. A list of the impaired waters within Montour County is also included in that section.

FLOODPLAIN DATA

A flood occurs when the capacity of a stream channel to convey flow within its banks is exceeded and water flows out of the main channel onto and over adjacent land. This adjacent land is known as the floodplain. For convenience in communication and regulation, floods are characterized in terms of return periods, e.g., the 50-year flood event. In regulating floodplains, the standard is the 100-year floodplain, the flood that is defined as having a 1 percent chance of being equaled or exceeded during any given year. These floodplain maps, or Flood Insurance Rate Maps (FIRMs), are provided to the public (http://msc.fema.gov/) for floodplain management and insurance purposes. About 8.7% of the total land area within Montour County is delineated under the 100-year floodplain, or Special Flood Hazard Area (SFHA).

Storm Event	Number of Buildings at Least Moderately Damage	Total Economic Loss ($million)
10	12	6.98
50	20	10.30
100	23	14.08

Table 3.12. Potential Impact Due to Flooding (PEMA, 2009)

In 2007, the Pennsylvania Emergency Management Agency (PEMA) completed a statewide study to determine damage estimates for all major flood events. The study computed damages in dollars for total economic loss, building and content damage, and also estimated the number of damaged structures (PEMA, 2009). *Table 3.12* summarizes the findings from this study.

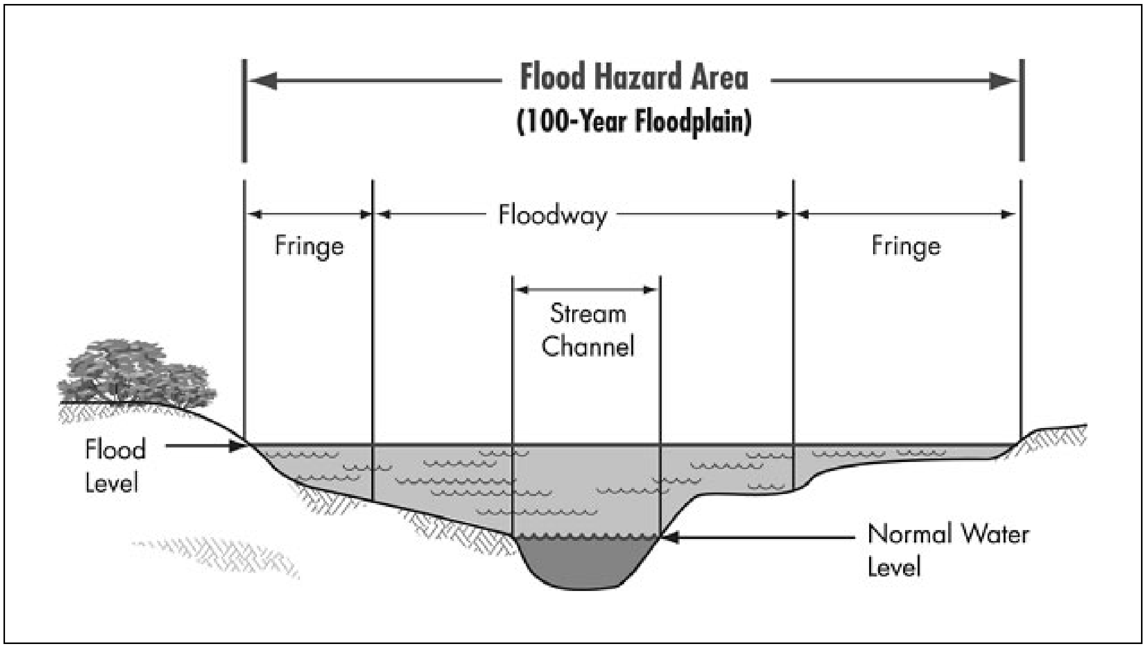

Figure 3.5. Floodplain Cross Section and Flood Fringe (NH Floodplain, 2007)

<u>Detailed Studies</u>

There are various levels of detail in floodplain mapping. Detailed studies (Zones AE and A1-A30 on the floodmaps) are conducted at locations where FEMA and communities have invested in engineering studies that define the base flood elevation and often distinguish sections of the floodplain between the floodway and flood fringe. See *Figure 3.5* below for a graphical representation of these terms. For a proposed development, most ordinances stat that there shall be no increase in flood elevation anywhere within the floodway; the flood fringe is defined so that any development will not cumulatively raise that water surface

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elevation by more than a designated height (set at a maximum of 1'). Development within the flood fringe is usually allowed but most new construction is required to be designed for flooding (floodproofing, adequate ventilation, etc).

A review of the FIRMs revealed that several 100-year floodplains exist within Montour County for the main streams draining the County. Detailed studies that clearly define the 100-year flood elevation and the floodway are provided in the locations indicated in the FIRM. Detailed studies have been peformed along a short section of Chillisquaque Creek, Mud Creek, Roaring Creek, Indian Creek, Mauses Creek, Mahoning Creek, Sechler Run, and the Susquehanna River. About 30% of the SFHA in Montour County is delineated using detailed methods.

Approximate Studies and Non-delineated Floodplains

Approximate studies (Zone A on the DFIRM) delineate the flood hazard area, but are prepared using approximate methods that result in the delineation of a floodplain without providing base flood elevations or a distinction between floodway and flood fringe. If no detailed study information is available, some ordinances allow the base flood elevation to be determined based on the location of the proposed development relative to the approximated floodplain; at times, a municipality find it necessary to have the developer pay for a detailed study at the location in question. There is no published engineering data or hydrology associated with approximate methods. About 70% of the SFHA in Montour County is delineated using approximate methods.

One limitation of FIRMs and older Flood Insurance Rate Maps is the false sense of security provided to home owners or developers who are technically not in the floodplain, but are still within an area that has a potential for flooding. Headwater streams, or smaller tributaries located in undeveloped areas, do not normally have FEMA delineated floodplains. This leaves these areas unregulated at the municipal level, and somewhat susceptible to uncontrolled development. Flood conditions, due to natural phenomenon as well as increased stormwater runoff generated by land development, are not restricted only to main channels and large tributaries. In fact, small streams and tributaries may be more susceptible to flooding from increased stormwater runoff due to their limited channel capacities.

Pennsylvania's Chapter 105 regulations partially address the problem of non-delineated floodplains. Chapter 105 regulations prohibit encroachments and obstructions, including structures, in the regulated floodway without first obtaining a state Water Obstruction and Encroachment permit. The floodway is the portion of the floodplain adjoining the stream required to carry the 100-year flood event with no more than a one (1) foot increase in the 100-year flood level due to encroachment in the floodplain outside of the floodway. Chapter 105 defines the floodway as the area identified as such by a detailed FEMA study or, where no FEMA study exists, as the area from the stream to 50-feet from the top of bank, absent evidence to the contrary. These regulations provide a measure of protection for areas not identified as floodplain by FEMA studies.

Levees and other flood control structures

As administrator of the National Flood Insurance Program (NFIP), FEMA has a series of policies and guidelines concerning the protection of life and property behind levees. Periodically, FEMA updates the effective FIRMs as new hydrologic and hydraulic data become available and to reflect changes within the community. In the ongoing map update process, FEMA issued *Procedure Memorandum 43 (PM 43) – Guidelines for Identifying Provisionally Accredited Levees* (PALs). For communities with levees, PM 43 has potential to substantially impact the communities protected by levees. A PAL is a levee that has previously been accredited with providing 1-percent-annual-chance flood protection on an effective FIRM.

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After being designated as a PAL, levee owners will have up to 24 months to obtain and submit documentation that the levee will provide adequate protection against a 1-percent-annual-chance flood. If the levee cannot be certified as providing protection from the 1-percent-annual-chance flood, the areas currently being protected by the levees will be mapped and managed as if they were within the floodplain (i.e., in most cases, the residents and businesses currently being protected by the levees would be forced to purchase flood insurance in accordance with the NFIP).

There are three major levee projects in Montour County, all of which comprise the Danville System.

Project	Owner	Waterbody	PAL Levee Status
Mahoning Creek Levee System	Borough of Danville	Mahoning Creek	Not Certified
State Hospital Levee	Borough of Danville	Hospital Run/ Susquehanna River	Not Certified
Susquehanna River Levee	Borough of Danville	Susquehanna River	Not Certified

Table 3.15. Levee Systems in Montour County

Community Rating System (CRS)

To reduce flood risk beyond what is accomplished through the minimum federal standards, the NFIP employs the Community Rating System to give a credit to communities that reduce their community's risk through prudent floodplain management measures. Several of these measures coincide with the goals and objectives of this plan: regulation of stormwater management, preservation of open space, and community outreach for the reduction of flood-related damages.

Flood insurance premiums can be reduced by as much as 45% for communities that obtain the highest rating. As of October, 2009, only 28 of the Commonwealth's 2500+ municipalities participate in the CRS. Currently, there is only the Borough of Danville participates in the CRS within Montour County participating in the CRS. The Borough currently maintains a CRS rating of 8 and receives a 10-percent discount on flood insurance premiums for properties within the Special Flood Hazard Area.

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Section IV – Existing Stormwater Regulations and Related Plans

An understanding of current and past regulations, what has worked in the past, and what has failed, is a key component of developing a sound plan for the future. Regulations affecting stormwater management exist at the federal, state, and local level. At the federal level the regulations are generally broad in scope, and aimed at protecting health and human welfare, protecting existing water resources and improving impaired waters. Regulations generally become more specific as their jurisdiction becomes smaller. This system enables specific regulations to be developed which are consist with national policy, yet meet the needs of the local community.

EXISTING FEDERAL REGULATIONS

Existing federal regulations affecting stormwater management are very broad in scope and provide a national framework within which all other stormwater management regulations are developed. An overview of these regulations is provided below in *Table 4.1*.

Clean Water Act	Section 303	Requires states to establish Total Maximum Daily Loads for point sources of pollution that are allowable to maintain water quality and protect stream flora and fauna. Other water quality standards (e.g., thermal) are also regulated.
Clean Water Act	Section 404	Regulates permitting of discharge of dredged or fill material into the waters of the United States. Includes regulation of discharge of material into lakes, navigable streams and rivers, and wetlands.
Clean Water Act	Section 401/402	Authorizes the Commonwealth to grant, deny, or condition Water Quality Certification for any licensed activity that may result in a discharge into navigable waters. Established the National Pollutant Discharge Elimination System (NPDES) that regulates any earth disturbance activity of 5 acres (or more) or 1 acre (or more) with a point source discharge.
Rivers and Harbors Act of 1899	Section 10	Regulates activities that obstruct or alter any navigable waters of the United States.
Federal Emergency Management Act		Requires that any proposed structure within the floodplain boundaries of a stream cannot cause a significant increase in the 100-year flood height of the stream.

Table 4.1. Existing Federal Regulations

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EXISTING STATE REGULATIONS

Pennsylvania has developed stormwater regulations that meet the federal standards and provide a statewide system for stormwater regulation. State regulations are much more specific than federal regulations. Statewide standards include design criteria and state issued permits. State regulations cover a variety of stormwater related topics. A brief review of the existing state regulations is provided below in *Table 4.2*.

Chapter 92	Discharge Elimination	Regulates permitting of point source discharges of pollution under the National Pollutant Discharge Elimination System (NPDES). Storm runoff discharges at a point source draining five (5) or more acres of land or one (1) or more acres with a point source discharge are regulated under this provision.
Chapter 93	Water Quality Standards	Establishes the Water Use Protection classification (i.e., water quality standards) for all streams in the state. Stipulates anti-degradation criteria for all streams.
Chapter 96	Water Quality Implementation Standards	Establishes the process for achieving and maintaining water quality standards applicable to point source discharges of pollutants. Authorizes DEP to establish Total Mass Daily Loads (TMDLs) and Water Quality Based Effluent Limitations (WQBELs) for all point source discharges to waters of the Commonwealth.
Chapter 102	Erosion and Sediment Control	Requires persons proposing or conducting earth disturbance activities to develop, implement and maintain Best Management Practices to minimize the potential for accelerated erosion and sedimentation. Current DEP policy requires preparation and implementation of a post-construction stormwater management (PCSM) plan for development areas of 5 acres or more or for areas of 1 acre or more with a point source discharge.
Chapter 105	Dam Safety and Waterway Management	Regulates the construction, operation, and maintenance of dams on streams in the Commonwealth. Also regulates water obstructions and encroachments (e.g., road crossings, walls, etc.) that are located in, along, across or projecting into a watercourse, floodway, wetland, or body of water.
Chapter 106	Floodplain Management	Manages the construction, operation, and maintenance of structures located within the floodplain of a stream if owned by the State, a political subdivision, or a public utility.

Table 4.2. Existing State Regulations

STATE WATER QUALITY STANDARDS

Water Quality Standards for the Commonwealth are addressed in *The Pennsylvania Code, Title 25, Chapter 93*. Within Chapter 93, all surface waters are classified according to their water quality criteria and protected water uses. The following is an abbreviated explanation of these standards and their respective implications to this Act 167 plan.

General Provisions (§93.1 - §93.4)

The general provisions of Chapter 93 provide definitions, citation of legislative authority (scope), and the definition of protected and statewide water uses. DEP's implementation of Chapter 93 is authorized by the Clean Streams Law, originally passed in 1937 to "preserve and improve the purity of the waters of the Commonwealth for the protection of public health,

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animal and aquatic life, and for industrial consumption, and recreation," and subsequently amended. *Table 4.3* is a summary of the protected water uses under Chapter 93 that are applicable to Montour County.

Protected Use	Relative Level of Protection	Description
Aquatic Life		
Warm Water Fishes (WWF)	Lowest	Maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat.
Trout Socking (TSF)	↓	Maintenance of stocked trout from February 15 to July 31 and maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat.
Cold Water Fishes (CWF)	↓	Maintenance or propagation, or both, of fish species including the family Salmonidae and additional flora and fauna which are indigenous to a cold water habitat.
Special Protection		
High Quality Waters (HQ)	↓	A surface water that meets at least one of chemical or biological criteria defined in §93.4b
Exceptional Value Waters (EV)	Highest	A surface water that meets at least one of chemical or biological criteria defined in §93.4b and additional criteria defined in §93.4b.(b)

Table 4.3. Chapter 93 Designations in Montour County

Antidegradation Requirements (§93.4a - §93.4d)

According to the antidegradation requirements of §93.4a, "Existing in-stream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected." Certain waterbodies which exhibit exceptional water quality and other environmental features, as established in §93.4b and summarized in *Table 4.3*, are referred to as "Special Protection Waters." Activities that could adversely affect surface water are more stringently regulated in those watersheds than waters of lower protected use classifications. For WWF, TSF, or CWF waterbodies, many of the antidegradation requirements can be addressed using guidance provided in this plan and the DEP BMP Manual; for HQ or EV watersheds, the current regulations follow DEP's antidegradation policy.

For a new, or additional, point discharge with a peak flow increase to an HQ or EV water, the developer is required to use a non-discharge alternative that is cost-effective and environmentally sound compared with the costs of the proposed discharge. If a non-discharge alternative is not cost-effective and environmentally sound, the developer must use the best available combination of treatment, pollution prevention, and wastewater reuse technologies and assure that any discharge is non-degrading. In the case where allowing lower water quality discharge is necessary to accommodate important economic or social development in an area, DEP may approve a degrading discharge after satisfying a

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multitude of intergovernmental coordination and public participation requirements (DEP, 2003).

Water Quality Criteria (§93.6 - §93.8c)

In general, the water discharged form either a point source or a nonpoint source discharge may contain substances in a concentration that would be inimical or harmful to a protected water use. The specific limits for toxic substances, metals, and other chemicals are listed in this section.

Designated Water Uses and Water Quality Criteria (§93.9)

The designated use and water quality criteria for each stream reach or watershed is specified. On the following page, *Table 4.4* shows the Chapter 93 designated uses for Montour County as defined by §93.9. The majority of streams in the county are either Cold Water Fishes or Warmwater Fishes. A small section of stream tributary the Roaring Creek watershed is designated as HQ-CWF. It should be noted, however, that all wetlands that are "located in or along the floodplain of the reach of a wild trout stream" qualify as Exceptional Value wetlands and receive the same level of protection as EV streams (*PA Code §105.17 (1)(iii)*). Since Mahoning Creek is designated as a wild trout stream by the Pennsylvania Fish and Boat Commission, any wetlands with the Mahoning Creek watershed are designated as EV.

Water Quality Impairments and Recommendations

Additional to the Chapter 93 regulations, DEP has an ongoing program to assess the qualities of water in Pennsylvania and identify stream and other bodies of water that are not attaining the required water quality standards. These "impaired" streams, their respective designations, and the subsequent recommendations are discussed in *Section IX*.

	Designated Act 167 Watersheds										
Category	**Chillisquaque Creek**	**Fishing Creek**	**Limestone Run**	**Mahoning Creek**	**Muncy Creek**	**Roaring Creek**	**Sechler Run**	**Shamokin Creek**	**Susquehanna River**	**Entire County**	**Percent of County**
EV	--	--	--	--	--	--	--	--	--	0.0	0.0
HQ-CWF	--	--	--	--	--	2.5	--	--	--	2.5	0.7
HQ-TSF	--	--	--	--	--	--	--	--	--	0.0	0.0
HQ-WWF	--	--	--	--	--	--	--	--	--	0.0	0.0
CWF	--	6.7	--	65.9	1.6	4.6	18.5	2.0	34.5	133.7	35.3
TSF	--	--	--	7.7	--	3.9	--	--	--	11.6	3.1
WWF	198.4	--	13.6	4.8	--	--	--	--	13.8	230.7	61.0
Total	198.4	6.7	13.6	78.3	1.6	11.0	18.5	2.0	28.4	378.4	100.0

Table 4.4. Montour County Chapter 93 Designations by Act 167 Watershed

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EXISTING MUNICIPAL REGULATIONS

In Pennsylvania, stormwater management regulations usually exist at the municipal level. A review of the existing municipal regulations helps us unravel the complex system of local regulation and develop watershed wide policy that both fits local needs and provides regional benefits. *Table 4.5* provides a summary of existing regulations for the 11 municipalities within Montour County. The land use regulations in Montour County originate from three basic sources: the County for, the Northern Montour Region Planning Commission (NMRPC), and the municipality.

MUNICIPALITY	STORMWATER MANAGEMENT	SUBDIVISION & LAND DEVELOPMENT (SALDO)	ZONING	FLOODPLAIN MANAGEMENT
Anthony Township	No separate Ordinance.	No SALDO. In this case, the County SALDO applies. The County SALDO, in Article 4, Section 4.10, addresses storm drainage.	No Ordinance. County Zoning Ordinance Applies	No Ordinance. Only limited language in Section 107 of County Ordinance applies.
Cooper Township	No separate Ordinance.	No SALDO. In this case, the County SALDO applies. The County SALDO, in Article 4, Section 4.10, addresses storm drainage.	No Ordinance. County Zoning Ordinance Applies	No Ordinance. Only limited language in Section 107 of County Ordinance applies.
Danville Borough	Stormwater Chapter Ordinance (Chapter 113); Drainage Permits are required. Plans to be submitted must be consistent with Mahoning/Sechler Watershed Plan (1995). 2, 25, and 50-year storms to be addressed in some regions	Subdivision and Land Development Ordinance (Chapter 118). No specific SWM requirements.	Zoning Ordinance (Chapter 139). Floodplain District Use Regulations.	Section 139-18 of Zoning Ordinance
Derry Township	No separate Ordinance.	Section 408 of NMRPC SALDO	NMRPC Zoning Ordinance Adopted in 2010. Floodplain district is designated but no SWM regulations are included.	Sections 204, 310, 311 and Article 6 of NMPRC Zoning Ordinance
Liberty Township	No separate Ordinance.	No SALDO. In this case, the County SALDO applies. The County SALDO, in Article 4, Section 4.10, addresses storm drainage.	No Ordinance. County Zoning Ordinance Applies	No Ordinance. Only limited language in Section 107 of County Ordinance applies.

Table 4.5 (continued). Montour County Municipal Ordinance Matrix

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Municipality	Stormwater Management	Subdivision and Land Development (SALDO)	Zoning	Floodplain Management
Limestone Township	No separate Ordinance.	Section 408 of NMRPC SALDO	NMRPC Zoning Ordinance Adopted in 2010. Floodplain district is designated but no SWM regulations are included.	Sections 204, 310, 311 and Article 6 of NMPRC Zoning Ordinance
Mahoning Township	Stormwater Management Ordinance (Chapter 202). Plans to be submitted must be consistent with Mahoning/Sechler Watershed Plan (1995). 2, 25, and 50-year storms to be addressed in some regions	Subdivision and Land Development Ordinance (Chapter 211). No specific SWM requirements.	Zoning Ordinance (Chapter 250); Floodplain Overlay District included	
Mayberry Township	No separate Ordinance.	No SALDO. In this case, the County SALDO applies. The County SALDO, in Article 4, Section 4.10, addresses storm drainage.	No Ordinance. County Zoning Ordinance Applies	No Ordinance. Only limited language in Section 107 of County Ordinance applies.
Valley Township	No separate Ordinance.	Subdivision and Land Development Ordinance (1991). Section 408 Addresses Stormwater Management; Proposed land use must conform with any Watershed Stormwater Management Plans. No specific Act 167 is referred to in the ordinance although some of valley	Zoning Ordinance (last updated 2000); Floodplain District provisions included;	
Washingtonville Borough	No separate Ordinance.	No SALDO. In this case, the County SALDO applies. The County SALDO, in Article 4, Section 4.10, addresses storm drainage.	No Ordinance. County Zoning Ordinance Applies	No Ordinance. Only limited language in Section 107 of County Ordinance applies.
West Hemlock Township	No separate Ordinance.	Section 408 of NMRPC SALDO	NMRPC Zoning Ordinance Adopted in 2010. Floodplain district is designated but no SWM regulations are included.	Sections 204, 310, 311 and Article 6 of NMPRC Zoning Ordinance

Table 4.5 (continued). Montour County Municipal Ordinance Matrix

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EXISTING RELATED PLANS

Review of previous planning efforts is another important component of regional planning. An analysis of previous plans, and the results achieved through implementation of recommendations within those plans, provides invaluable information for current and future planning efforts. The following table is a summary of related plans which includes a listing of pertinent plan goals:

Plan Title	Date	Author	Pertinent Plan Goals
Montour County Comprehensive Plan	2009	EADS, Inc.	1. To preserve and conserve critical natural and environmental features that define the County a. Preserve the existing concentrations of Prime Agricultural Soils and other land currently in productive agricultural use. b. Preserve 100-year floodplains and preserve wetland areas so that they can perform their natural functions. c. Preserve and enhance vegetated linear riparian buffers areas along surface waters providing stream bank and channel stabilization, reducing erosion and pollution, storing nutrients and managing runoff, while providing for passive recreational opportunities. d. Encourage best management practices in forestry, agriculture, 2. To provide an adequate level of public utility services appropriate for the rural-urban profile of the County a. Preserve and maintain groundwater recharge areas in the northern section of the County. 3. To assure the availability of an adequate supply and choice of housing a. Encourage higher density residential development around those areas with public sewer and water service as a means to help preserve the agricultural areas in the County. 4. To ensure orderly, appropriate and compatible development that produces economic growth and preserves the agricultural areas in the County a. Preserve environmentally sensitive land such as agricultural land, floodplains, wetlands and steeply sloping areas, while encouraging new development and expansion in level areas outside and/or above floodplains. b. Facilitate updating of Update Municipal/County Subdivision and Land Development Ordinances (SALDO) for consistency among the plans and also to establish smart growth development practices
Montour County Multi-Jurisdictional Hazard Mitigation Plan	2008	Delta Development Group	1. Make county less susceptible to disaster by increasing disaster resistance. 2. Prioritize the mitigation strategies to reduce potential loss to of life and property damage from those hazards.
Northern Montour Regional Comprehensive Plan	1997	Landplan, Inc.	1. Prime farmland should be preserved for agricultural use and agricultural production should be recognized as a viable, necessary economic activity (Goal#5 in plan). 2. Effective storm water management controls should be incorporated into the design of all new developments in the Planning Area (Goal #8 in plan).
Mahoning Creek/Sechler Run Act 167 Stormwater Management Plan	1995	RKR Hess Associates	All goals consistent with this plan.

4.6. Related Plans Review

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Section V – Significant Problem Areas and Obstructions

One of the stated goals of this Plan is to "ensure that existing stormwater problem areas are not exacerbated by future development and provide recommendations for improving existing problem areas." The strategy for achieving this goal required identification of the existing significant stormwater problem areas and obstructions, and then an evaluation of the identified problem areas and obstructions.

The first task was to identify the location and nature of existing drainage problems within the study area, and where appropriate, gather field data to be used for further analysis of the problems. The geographic location data was used to plot all of the problem areas and obstructions on a single map (Reference Plate 9 – Problem Areas & Obstructions). Mapping the location of the sites in this manner enables you to identify isolated problems and determine which problems are part of more systemic problems. Systemic problems are often an indication that larger stormwater management problems exist, which may warrant more restrictive stormwater regulations. This information was used when modeling the watersheds and determining appropriate stormwater management controls.

The second part of this task was to analyze individual problem areas and obstructions, determine potential solutions for the most significant problems, and provide recommendations. All of the problem areas and obstructions were evaluated and potential solutions were developed. Where possible, the individual problem areas and obstructions were modeled to determine approximate capacities to be used for planning purposes. Then a preliminary prioritization assessment was conducted to give a county-wide overview of the severity of the existing problems. The priority assessment also provides general guidance on the relative order in which the problems should be addressed when considered at a county-wide level.

IDENTIFICATION OF PROBLEM AREAS AND OBSTRUCTIONS

Identification and review of existing information concerning the County's stormwater systems, streams, and tributary drainage basins within the project limits was conducted during Phase I and Phase II of this Plan. During Phase I, questionnaires were distributed to all of the municipalities in Montour County. The questionaire enabled the municipalities to report all of the known problem areas and obstructions within their municipality. Of the 11 municipalities in Montour county, 10 participated in the assessment process by returning completed questionaires. The responses were summarzied and reported in the Phase I report of this Plan. The responses were reviewed and evalulated during Phase II of the Act 167 planning process. Field reconnaissance was subsequently conducted to confirm problem area locations, assess existing conditions, identify the general drainage patterns and gather data to complete a planning level analysis.

All of the reported problem areas, obstructions, and structures are listed in *Table 5.1* on the following pages. A more detailed explanation of each site can be found in *Appendix C –*

Significant Problem Area Modeling and Recommendations, which contains a summary of all of the data collected for each of the problem areas and obstructions reported throughout the county.

ID	Municipality	Location	Description
P01	Anthony Township	Betz Road (West End)	The existing culvert does not appear to provide sufficient conveyance capacity. No defined downstream channel.
P02	Anthony Township	Betz Road (West End)	The existing culvert does not appear to provide sufficient conveyance capacity.
P03	Anthony Township	SR0054	The existing bridge appears to have sufficient capacity to convey the 100yr storm event.
P04	Anthony Township	SR0044	The existing bridge does not appear to provide sufficient conveyance capacity.
P05	Anthony Township	SR1016	The existing bridge appears to have sufficient capacity to convey the 100yr storm event. The bridge is in poor condition.
P06	Anthony Township		The existing bridge appears to have sufficient capacity to convey the 100yr storm event. The bridge is in poor condition.
P07	Anthony Township	Sportsmans Rd./Lakeview Dr.	The existing culvert does not appear to provide sufficient conveyance capacity.
P08	Anthony Township	North Sneaky Hollow Road	The existing culvert appears to have sufficient capacity to convey the 100yr storm event. The culvert is in poor condition. A large area of the culvert contains rust.
P09	Anthony Township	Gearhart (Hollow) Rd. T441	The existing 15" culvert does not appear to provide sufficient conveyance capacity. Obstruction may cause downstream roadside erosion. The outlet of the cross pipe has been replaced with 4"x6" terracotta pipe 150' in length.
P10	Anthony Township	SR0044	The existing bridge has the capacity to convey between a 50-year and 100-year storm event.
P11	Anthony Township	Fox Hollow Road	The existing bridge appears to have sufficient capacity to convey the 100yr storm event.
P12	Anthony Township	Waltmyer Road	The existing culvert does not appear to provide sufficient conveyance capacity. The culvert headwall is in need of replacement.
P13	Anthony Township	Wolf Hollow Road	The existing culvert does not appear to provide sufficient conveyance capacity. The culvert bottom is rusted out.
P14	Anthony Township	SR0044	The existing bridge appears to have sufficient capacity to convey the 100yr storm event.
P15	Anthony Township	Mingle Road	The existing culvert does not appear to provide sufficient conveyance capacity. Additional flooding at roadside culverts next to site.
P16	Anthony Township	PP&L Road	The existing culvert does not appear to provide sufficient conveyance capacity.
P17	Cooper Township	Al Krum Motors along SR 11	Hartman Road drains to a depression along SR 11 at Al Krum Motors. There is no drainage system in place at this location. Infiltration is the only method of discharge.
P18	Danville Borough		Blizzard Run channel erosion.
P19	Danville Borough		Problem area was unidentified.
P20	Danville Borough		Debris enters the conveyance system and constricts the flow.
P21	Mahoning Township		Part of Danville flood control system. Most likely a capacity issue. If flooding occurred, the source would most likely be from the upstream culvert. MCCD had no complaints.

Table 5.1. Reported Problem Areas and Obstructions

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ID	Municipality	Location	Description
P22	Derry Township		The existing culverts do not appear to provide sufficient conveyance capacity.
P23	Derry Township		The existing culvert does not appear to provide sufficient conveyance capacity.
P24	Derry Township	PP&L Road	The existing bridge appears to have sufficient capacity to convey the 100yr storm event.
P25a	Derry Township	SR2014	The existing bridge appears to have sufficient capacity to convey the 100yr storm event.
P25b	Derry Township	SR2014	The existing bridge appears to have sufficient capacity to convey the 100yr storm event.
P26	Derry Township		The existing bridge appears to provide sufficient conveyance capacity. Unable to obtain bridge data.
P27	Derry Township	PP&L Road	The existing bridge appears to have sufficient capacity to convey the 100yr storm event.
P28	Derry Township		The W.Chillisquaque Creek backwater floods entire problem area. The whole area is mapped as wetlands.
P29	Liberty Township		The existing roadside channel does not appear to provide sufficient conveyance capacity.
P30	Liberty Township	George Farm Driveway	The existing culvert does not appear to provide sufficient conveyance capacity.
P31	Liberty Township		The existing culvert does not appear to provide sufficient conveyance capacity.
P32	Limestone Township		The problem area was unidentified.
P33	Limestone Township	Strick Road	The existing culverts do not appear to provide sufficient conveyance capacity.
P34	Limestone Township		The existing channel appears to provide sufficient conveyance capacity. Channel lining may be necessary to prevent erosion.
P35	Limestone Township		The existing conveyance system does not appear to provide sufficient conveyance capacity.
P36	Limestone Township		The existing culvert appears to provide sufficient conveyance capacity.
P37	Limestone Township	California Road	The existing culvert does not appear to provide sufficient conveyance capacity.
P38	Limestone Township		The existing culvert does not appear to provide sufficient conveyance capacity.
P39	Limestone Township		The existing roadside channel does not appear to provide sufficient conveyance capacity.
P40	Limestone Township		The existing culvert does not appear to provide sufficient conveyance capacity.
P41	Limestone Township		The existing culvert does not appear to provide sufficient conveyance capacity.
P42	Mahoning Township		The existing channel does not appear to provide sufficient erosion protection.
P43	Mahoning Township	Toby Run Road	The existing culvert does not appear to provide sufficient conveyance capacity.
P44	Mahoning Township		The existing culvert does not appear to provide sufficient conveyance capacity.
P45	Mahoning Township		The existing culvert does not appear to provide sufficient conveyance capacity.
P46	Mahoning Township		Channel erosion. Channel protection necessary.
P47	Mahoning Township	Red Lane	The existing culvert does not appear to provide sufficient conveyance capacity.
P48	Mahoning Township	Delwood Drive	Downstream properties are being impacted due to upslope runoff generated by the adjacent development.
P49	Mahoning Township		The existing channel does not appear to provide sufficient conveyance capacity and erosion protection.

Table 5.1 (continued). Reported Problem Areas and Obstructions

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ID	Municipality	Location	Description
P50	Mayberry Township	SR3012	Backwater from river causing flooding. MCCD had no complaints. SR3012.
P51	Mayberry Township	SR3012	PennDOT has been at this site numerous times because of complaints from the neighboring property owner. Backwater from the Susquehanna River is causing flooding to the property. The bridge appears to have capacity to convey the 100yr storm.
P52	Mayberry Township		Upslope slope runoff from the woodlands is causing erosion to the down-slope embankment.
P53	Valley Township		The existing bridge appears to provide sufficient conveyance capacity. The bridge is in the process of being replaced due to its condition. A PNDI impact has to be resolved before construction can begin.
P54	Valley Township		The existing culvert does not appear to provide sufficient conveyance capacity.
P55	Washingtonville Borough		Backwater from the Chillisquaque Creek is causing flooding issues. No signs of errosion at indicated problem area. Wetlands are present.
P56	Washingtonville Borough		Backwater from the Chillisquaque Creek is causing flooding issues. No signs of errosion at indicated problem area. Wetlands are present.
P57	West Hemlock Township	103 Shultz Road	Erosion of downstream channel. Outflow channel from culvert appears to clogged with debris and then floods adjacent property.
P58	Danville Borough		Ponding
P59	Danville Borough		Ponding
P60	Danville Borough		Stormwater runoff enters a brick lined channel that makes a 90-degree bend. Stormwater overtops the channel at the bend and enters Spring Street.
P61	Danville Borough		Existing gutter system/swale is insufficient.
P62	Danville Borough		The existing culvert does not appear to provide sufficient conveyance capacity.
P63	Danville Borough		Existing culvert flows to an inlet box which leads to SR0054. The culvert probably had sufficient capacity years ago before upslope development.
P64	Danville Borough		Ponding
P65	Danville Borough		Ponding
P66	Danville Borough		Existing channel requires improvements in order to sufficiently convey stormwater to the downstream system.
P67	Danville Borough		Existing channel is in need of maintenance.
P68	Danville Borough		Erosion of Blizzard Run and neighboring properties.
P69	Danville Borough		Existing discharge pipe was located. No problem could be identified.
P70	Danville Borough		Ponding
P71	Danville Borough		Existing conveyance system would provide sufficient conveyance capacity if maintenance would be performed.
P72	Liberty Township	Center Road between SR0045 and SR0642.	Flooding at the low point of Center Road along Beaver Run. As soon as Beaver Run over tops its banks, this area will flood.
P73	Liberty Township	Bridge Road between Pottsgrove Road and Center Road.	Flooding at the low point of Bridge Road along Beaver Run. As soon as Beaver Run over tops its banks, this area will flood.

Table 5.1 (continued). Reported Problem Areas and Obstructions

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ID	Municipality	Location	Description
P74	Liberty Township	Beaver Run Road between SR0642 and Pottsgrove Road.	Flooding at the low point of Beaver Run Road. As soon as Beaver Run over tops its banks, this area will flood.
P75	Liberty Township	Kelly Dam Road between Mexico Road and Narehood Road.	Chillisquaque Creek floods and affects the entire area. Wetlands are present in a large part of this area. Runoff in this area does not have an outlet due to the existing terrain.
P76	Anthony Township	Magargle Road	The existing culvert does not appear to provide sufficient conveyance capacity.
P77	Mahoning Township		The existing channel does not appear to provide sufficient conveyance capacity and erosion protection.
P78	Valley Township	Frosty Valley and Kaseville road.	The existing channel does not appear to provide sufficient erosion protection or capacity.
P79	Valley Township	SR0642	Culvert crosses SR0642. Discharge eventually flows to neighboring property which is located on a waterway.
P80	Valley Township	SR0642	Upsteam housing development discharges under SR 0642 and meanders through the downstream properties until it reaches Mahoning Creek. The existing culvert is also insufficient.
P81	Cooper Township	Mt.Zion drive	Two culverts discharge under Mt.Zion drive and discharge onto the downstream properties.
P82	Mahoning Township		Discharge from the Frosty Valley Country Club is discharged onto downstream properties.
P83	Mahoning Township	SR 11	The existing 24"culvert under SR 11 does not have an outlet since the opposite side of Rt.11 was filled. Infiltration is the only outlet for the stormwater.
P84	Derry Township	SR0254	The existing culvert appears to provide adequate conveyance capacity. The existing channel does not provide sufficient conveyance capacity due to the build-up of sediment.
P85	Cooper Township	SR2006	The culvert under SR2006 is crushed and blocked. The culvert under the railroad tracks is blocked and the downstream channel does not exist. The existing culverts appear to have adequate capacity if not blocked and if a downstream channel existed.
P86	West Hemlock	Woodside Road	Roadside channel is in need of maintenance. The channel overtops onto Woodside Road.
P87	Liberty Township	Rt. 642 and Cashner Road	The existing culvert does not appear to provide sufficient conveyance capacity.
P88	Liberty Township	Keefer Mill Road	Keefer Mill Road is located along the Chillisquaque Creek. The roadway elevation is a few feet about the Water Surface Elevation of the creek. Rip-rap is in place.
P89	Derry Township	Stamm Road	Chillisquaque Creek make a 90 degree turn near Stamm Road. The creek overtops the road. Rip-rap is in place.
P90	Derry Township	Mill Road	Mill Road lies between two branches of the Chillisquaque Creek. The elevation of the Roadway is only a few feet above the W.S.E. of the creek. Nearby SR0054 also floods and is at a higher elevation than Mill Road.

Table 5.1 (continued). Reported Problem Areas and Obstructions

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HYDRAULIC MODELING

Potential solutions were initally offered by the municipality, or the project engineer, for every identified problem based on a field view of the area. Some problems and obstructions are not related to conveyance capacity, or were not encouraging to basic hydraulic modeling. Public feedback and County staff reviews have also to be considered in whether or not to evaluate capacity of a particular problem. For these reasons the full list of problem areas and obstructions contains some sites that were not modeled. *Table 5.2* lists the reported problem areas, obstructions, and structures that were modeled to determine the existing conveyance capacities.

ID	Municipality	Location	Structure	Flow Capacity[1]
P01	Anthony Township	Betz Road (West End)	Culvert	<2YR
P02	Anthony Township	Betz Road (West End)	Culvert	2YR<Q<10YR
P05	Anthony Township	SR1016	Bridge	>100YR
P06	Anthony Township		Bridge	>100YR
P08	Anthony Township	North Sneaky Hollow Road	Culvert	>100YR
P10	Anthony Township	SR0044	Bridge	50YR<Q<100YR
P11	Anthony Township	Fox Hollow Road	Bridge	>100YR
P12	Anthony Township	Waltmyer Road	Culvert	<2YR
P13	Anthony Township	Wolf Hollow Road	Culvert	<2YR
P14	Anthony Township	SR0044	Bridge	>100YR
P15	Anthony Township	Mingle Road	Culvert	25YR<Q<50YR
P16	Anthony Township	PP&L Road	Culvert	2YR<Q<10YR
P18	Danville Borough		Channel	2YR<Q<10YR
P21	Mahoning Township		Culvert	50YR<Q<100YR
P23	Derry Township		Culvert	2YR<Q<10YR
P24	Derry Township	PP&L Road	Bridge	>100YR
P25a	Derry Township	SR2014	Bridge	>100YR
P25b	Derry Township	SR2014	Bridge	>100YR
P27	Derry Township	PP&L Road	Bridge	>100YR
P30	Liberty Township	George Farm Driveway	Culvert	2YR<Q<10YR
P31	Liberty Township		Culvert	<2YR
P33	Limestone Township	Strick Road	Culvert	<2YR
P34	Limestone Township		Channel	>100YR
P36	Limestone Township		Culvert	>100YR
P37	Limestone Township	California Road	Culvert	<2YR
P38	Limestone Township		Culvert	2YR<Q<10YR
P39	Limestone Township		Channel	50YR<Q<100YR
P40	Limestone Township		Culvert	<2YR
P41	Limestone Township		Culvert	<2YR
P42	Mahoning Township		Channel	<2YR
P44	Mahoning Township		Culvert	<2YR
P45	Mahoning Township		Culvert	10YR<Q<25YR
P46	Mahoning Township		Channel	>100YR
P49	Mahoning Township		Channel	<2YR
P57	West Hemlock Township	103 Shultz Road	Culvert	<2YR
P62	Danville Borough		Culvert	2YR<Q<10YR
P67	Danville Borough		Channel	>100YR
P76	Anthony Township	Magargle Road	Culvert	2YR<Q<10YR
P77	Mahoning Township		Channel	2YR<Q<10YR
P78	Valley Township	Frosty Valley and Kaseville road.	Channel	2YR<Q<10YR
P80	Valley Township	SR0642	Culvert	<2YR
P87	Liberty Township	Rt. 642 and Cashner Road	Culvert	2YR<Q<10YR

[1] Estimated flow capacities are for planning uses only and should not be used for design.

Table 5.2. Problem Areas and Obstructions with Hydraulic Modeling Completed

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The stated flow capacities are an estimate of the flow capacity, meant to give an indication of whether or not flow capacity is actually causing the stated problem. If the analysis indicates inadequate flow capacity, a detailed analysis should be conducted prior to making any plans to replace the system. These flow values also give insight to the general types of problem areas found throughout the county. The following figure depicts a summary of the calculated conveyance capacities for the problem areas that were modeled in Montour County.

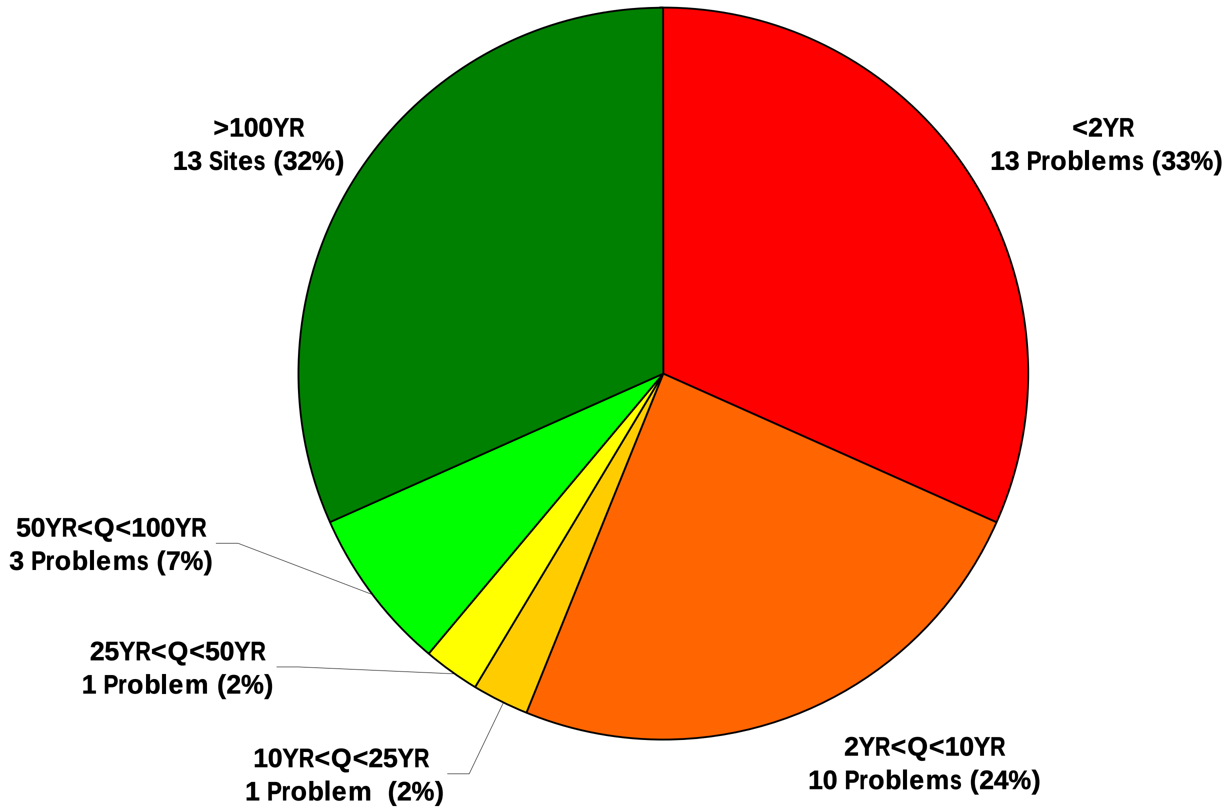

Figure 5.1. Overview of Modeled Problem Area Conveyance Capacity for All Municipalities in Montour County

If the modeling results show that the existing drainage system needs to be replaced because it provides inadequate conveyance resulting in frequent and chronic flooding, then solutions capable of preventing flooding could be developed. If a system is shown to have adequate capacity, the system needs to be further evaluated to determine other possible causes of flooding. The detailed data sheets in *Appendix C* list the proposed solutions for each problem area and obstruction.

PROBLEM AREA ASSESSMENT

Upon completion of the hydraulic modeling and analysis of all of the problem areas and obstructions, an objective method was needed to assess the order in which the proposed solutions should be implemented. An analysis like this is necessary to prioritize where available funding is most needed. The chosen assessment system evaluates each problem area or obstuction independently of the others. This is more valuable than a ranking system which lists the problems in order because it helps determine the amount of resources that should be dedicated to addressing the existing problem areas and obstructions. However, as with any

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prioritization scheme, this assessment could not encompass all factors in the decision making process and should be considered as a guide for future planning efforts.

A set of criteria were developed to determine the priority of each problem area. Criteria from a stormwater prioritization assessment completed in Columbus, Ohio were used to establish a system for prioritization (Tickle, 2008). *Table 5.3* provides a list of criteria that were used to assess each problem area or obstruction. Each problem was assigned a rating between 1 and 10 for each of the six criteria. The six criteria were equally weighted in order to calculate a single relative rating between 1 and 10 for each problem.

Criteria	Description	Rating
Health & Safety	To what extent will the problem endanger human life?	1 to 10
Non-health & Safety Human Impact	How will the problem affect financial aspects of the surrounding areas?	1 to 10
Environmental Impact	To what extent will the problem contribute to erosion and sediment pollution?	1 to 10
Expected Life of Existing System	When will the system associated with the problem fail?	1 to 10
Frequency of Problem	How likely will the problem occur based on a 2-yr storm event?	1 to 10
Cost of Solution	Will the solution cost thousand's, hundred's of thousands, or millions of dollars to resolve?	1 to 10

Table 5.3. Problem Area/Obstruction Rating Criteria (Adapted from Tickle, 2008)

Each of the obstructions and problem areas have been categorized in one of three categories based on their composite score: 1) Highest Priority Problem, 2) Significant Problem, or 3) General Problem. A composite rating between of 7 and 10 would classify a problem area or obstruction as a Highest Priority Problem. A composite rating between 4 and 6.9 would classify a problem area or obstruction as a Significant Problem and a rating between 1 and 3.9 would be classified as a General Problem. Because each problem was evaluated independently, each municipality can use this assessment as the basis to develop their own problem area prioritization list.

Problem areas that were categorized as Highest Priority Problems, based upon the criteria provided in Table 5.3, have been analyzed in more detail. Table 5.4, shown below, is a list of the Highest Priority Problems. The data sheets in *Appendix C* for these problem areas include a more descriptive overview and a more detailed recommended solution. *Tables 5.5* and *5.6* provide a list of Significant Problems and General Problems respectively. All of the problem areas and obstructions are listed in the order of their relative ranking.

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ID	Problem
P78	The existing channel does not appear to provide sufficient erosion protection or capacity.
P68	Erosion of Blizzard Run and neighboring properties.
P84	The existing culvert appears to provide adequate conveyance capacity. The existing channel does not provide sufficient conveyance capacity due to the build-up of sediment.
P13	The existing culvert does not appear to provide sufficient conveyance capacity. The culvert bottom is rusted out.
P18	Blizzard Run channel erosion.
P31	The existing culvert does not appear to provide sufficient conveyance capacity.
P64	Ponding
P80	Upsteam housing development discharges under SR0642 and meanders through the downstream properties until it reaches Mahoning Creek. The existing culvert is also insufficient.
P85	The culvert under SR2006 is crushed and blocked. The culvert under the railroad tracks is blocked and the downstream channel does not exist. The existing culverts appear to have adequate capacity if not blocked and if a downstream channel existed.
P09	The existing 15" culvert does not appear to provide sufficient conveyance capacity. Obstruction may cause downstream roadside erosion. The outlet of the cross pipe has been replaced with 4"x6" terracotta pipe 150' in length.
P35	The existing conveyance system does not appear to provide sufficient conveyance capacity.
P42	The existing channel does not appear to provide sufficient erosion protection.
P44	The existing culvert does not appear to provide sufficient conveyance capacity.
P49	The existing channel does not appear to provide sufficient conveyance capacity and erosion protection.
P60	Stormwater runoff enters a brick lined channel that makes a 90-degree bend. Stormwater overtops the channel at the bend and enters Spring Street.
P77	The existing channel does not appear to provide sufficient conveyance capacity and erosion protection.
P04	The existing bridge does not appear to provide sufficient conveyance capacity.
P12	The existing culvert does not appear to provide sufficient conveyance capacity. The culvert headwall is in need of replacement.
P17	Hartman Road drains to a depression along SR 11 at Al Krum Motors. There is no drainage system in place at this location. Infiltration is the only method of discharge.
P52	Upslope slope runoff from the woodlands is causing erosion to the down-slope embankment.
P55	Backwater from the Chillisquaque Creek is causing flooding issues. No signs of errosion at indicated problem area. Wetlands are present.
P58	Ponding
P59	Ponding
P62	The existing culvert does not appear to provide sufficient conveyance capacity.
P82	Discharge from the Frosty Valley Country Club is discharged onto downstream properties.
P83	The existing 24"culvert under Rt.11 does not have an outlet since the opposite side of Rt.11 was filled. Infiltration is the only outlet for the stormwater.
P46	Channel erosion. Channel protection necessary.

Table 5.4. Highest Priority Problems (27 Total)

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ID	Problem
P30	The existing culvert does not appear to provide sufficient conveyance capacity.
P38	The existing culvert does not appear to provide sufficient conveyance capacity.
P45	The existing culvert does not appear to provide sufficient conveyance capacity.
P57	Erosion of downstream channel. Outflow channel from culvert appears to clogged with debris and then floods adjacent property.
P76	The existing culvert does not appear to provide sufficient conveyance capacity.
P16	The existing culvert does not appear to provide sufficient conveyance capacity.
P22	The existing culverts do not appear to provide sufficient conveyance capacity.
P23	The existing culvert does not appear to provide sufficient conveyance capacity.
P61	Existing gutter system/swale is insufficient.
P63	Existing culvert flows to an inlet box which leads to SR0054. The culvert probably had sufficient capacity years ago before upslope development.
P65	Ponding
P66	Existing channel requires improvements in order to sufficiently convey stormwater to the downstream system.
P67	Existing channel is in need of maintenance.
P71	Existing conveyance system would provide sufficient conveyance capacity if maintenance would be performed.
P79	Culvert crosses SR0642. Discharge eventually flows to neighboring property which is located on a waterway.
P81	Two culverts discharge under Mt.Zion drive and discharge onto the downstream properties.
P01	The existing culvert does not appear to provide sufficient conveyance capacity. No defined downstream channel.
P02	The existing culvert does not appear to provide sufficient conveyance capacity.
P33	The existing culverts do not appear to provide sufficient conveyance capacity.
P37	The existing culvert does not appear to provide sufficient conveyance capacity.
P41	The existing culvert does not appear to provide sufficient conveyance capacity.
P56	Backwater from the Chillisquaque Creek is causing flooding issues. No signs of erosion at indicated problem area. Wetlands are present.
P70	Ponding
P05	The existing bridge appears to have sufficient capacity to convey the 100yr storm event. The bridge is in poor condition.
P39	The existing roadside channel does not appear to provide sufficient conveyance capacity.
P08	The existing culvert appears to have sufficient capacity to convey the 100yr storm event. The culvert is in poor condition.. A large area of the culvert contains rust.
P40	The existing culvert does not appear to provide sufficient conveyance capacity.
P15	The existing culvert does not appear to provide sufficient conveyance capacity. Additional flooding at roadside culverts next to site.
P29	The existing roadside channel does not appear to provide sufficient conveyance capacity.
P50	Backwater from river causing flooding. MCCD had no complaints. SR3012.
P10	The existing bridge has the capacity to convey between a 50-year and 100-year storm event.
P34	The existing channel appears to provide sufficient conveyance capacity. Channel lining may be necessary to prevent erosion.

Table 5.5. Significant Problems (38 Total)

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ID	Problem
P06	The existing bridge appears to have sufficient capacity to convey the 100yr storm event. The bridge is in poor condition.
P28	The W.Chillisquaque Creek backwater floods entire problem area. The whole area is mapped as wetlands.
P36	The existing culvert appears to provide sufficient conveyance capacity.
P14	The existing bridge appears to have sufficient capacity to convey the 100yr storm event.
P53	The existing bridge appears to provide sufficient conveyance capacity. The bridge is in the process of being replaced due to its condition. A PNDI impact has to be resolved before construction can begin.
P72	Flooding at the low point of Center Road along Beaver Run. As soon as Beaver Run over tops its banks, this area will flood.

Table 5.5 (continued). Significant Problems (38 Total)

ID	Problem
P03	The existing bridge appears to have sufficient capacity to convey the 100yr storm event.
P25a	The existing bridge appears to have sufficient capacity to convey the 100yr storm event.
P25b	The existing bridge appears to have sufficient capacity to convey the 100yr storm event.
P51	PennDOT has been at this site numerous times because of complaints from the neighboring property owner. Backwater from the Susquehanna River is causing flooding to the property. The bridge appears to have capacity to convey the 100yr storm.
P11	The existing bridge appears to have sufficient capacity to convey the 100yr storm event.
P21	Part of Danville flood control system. Most likely a capacity issue. If flooding occurred, the source would most likely be from the upstream culvert. MCCD had no complaints.
P73	Flooding at the low point of Bridge Road along Beaver Run. As soon as Beaver Run over tops its banks, this area will flood.
P74	Flooding at the low point of Beaver Run Road. As soon as Beaver Run over tops its banks, this area will flood.
P75	Chillisquaque Creek floods and affects the entire area. Wetlands are present in a large part of this area. Runoff in this area does not have an outlet due to the existing terrain.
P24	The existing bridge appears to have sufficient capacity to convey the 100yr storm event.
P27	The existing bridge appears to have sufficient capacity to convey the 100yr storm event.
P26	The existing bridge appears to provide sufficient conveyance capacity. Unable to obtain bridge data.
P07	The existing culvert does not appear to provide sufficient conveyance capacity.
P19	Problem area was unidentified.
P20	Debris enters the conveyance system and constricts the flow.
P32	The problem area was unidentified.
P43	The existing culvert does not appear to provide sufficient conveyance capacity.
P47	The existing culvert does not appear to provide sufficient conveyance capacity.
P48	Downstream properties are being impacted due to upslope runoff generated by the adjacent development.
P54	The existing culvert does not appear to provide sufficient conveyance capacity.
P69	Existing discharge pipe was located. No problem could be identified.

Table 5.6. General Problems (21 Total)

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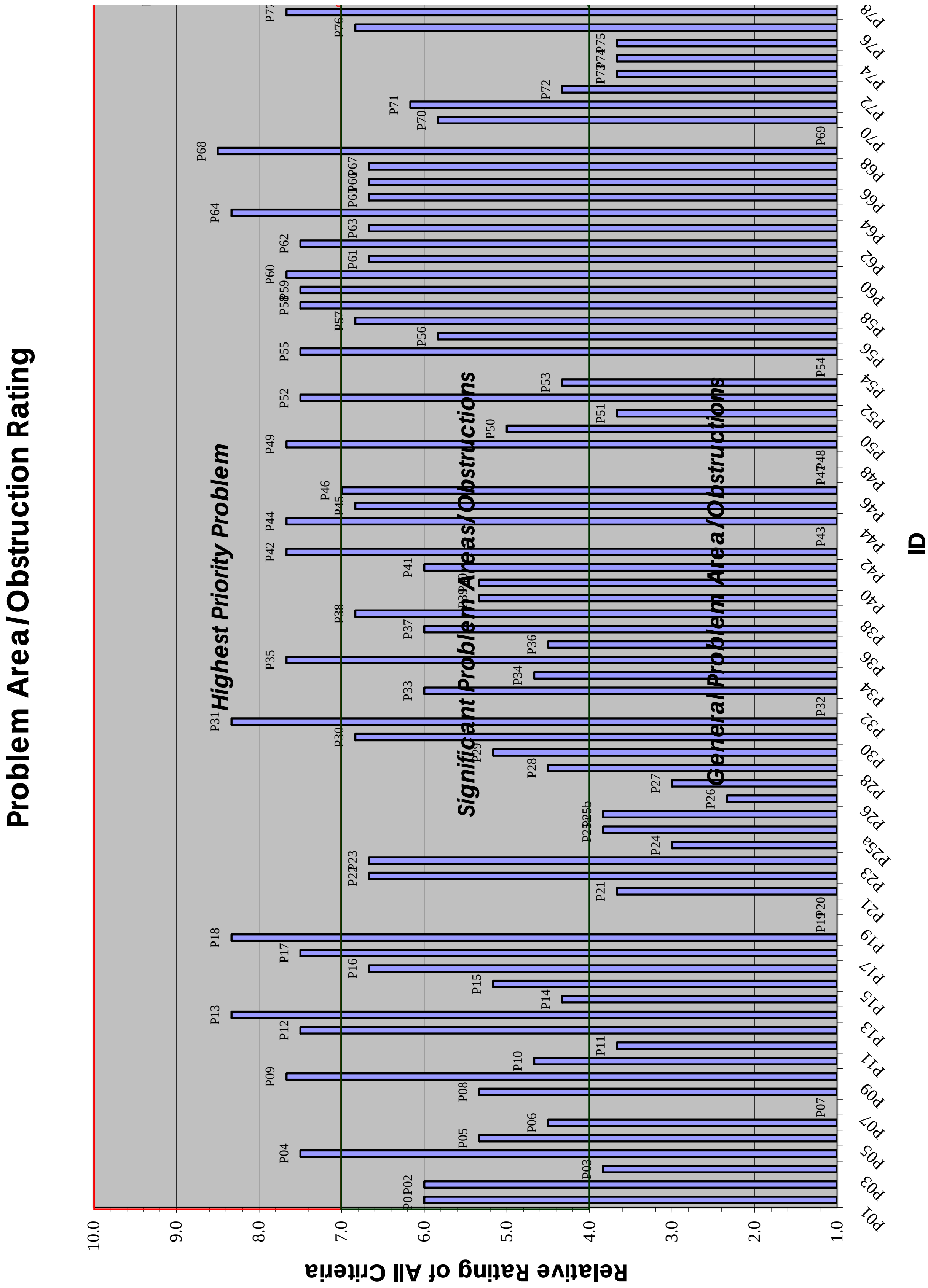

Figure 5.2. Problem Area/Obstruction Rating

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Figure 5.2 on the previous page shows the composite rating for all of the reported problem areas and obstructions throughout the entire county.

RECOMMENDATIONS

The problem areas within Montour County defined within this Act 167 planning process are varied spatially and in magnitude. The prioritization system presented in this section was initially developed outside of the planning process. The initial ordering was developed by the project consultant considering only technical analysis and engineering judgment. This initial list was then submitted to the PAC for review, comment, and clarification. Thus, it attempts to provide a technically sound prioritization system that carefully considers input from the public officials and interest groups who participated in this planning process. Thus, any County-wide or municipal capital improvement program may use these results to guide their scheduling and pursuit of funding.

It should be noted that attempting to solve each of these problem areas individually is only prudent where there is not an identified systemic, regional problem that may be the root cause of a specific problem. For the municipalities outside of the Mahoning Creek/Sechler Run watersheds (Anthony, Limestone, Washingtonville), it may be most prudent to fix each problem individually since there is not yet identified a dense pattern of problem areas that are directly related to watershed policy. *Appendix C* provides conceptual solutions to each of these problem areas.

As discussed in the following sections, Chillisquaque Creek (and to a lesser extent Limestone Run) have characteristics that indicate they are sensitive to development (e.g., numerous impairments, several problem areas related to stream erosion) and they will have future development pressure. Thus, for Anthony, Limestone and Washingtonville, solving individual problems now is a prudent approach; but adopting a watershed policy and following the recommendations in this plan will help prevent creating systemic, regional problems that are currently being encountered by other Municipalities.

Within the Mahoning Creek/Sechler Run and Susquehanna River watersheds, however, there are two distinct types of problem areas: 1) areas encountering increased flow from relatively recent development and 2) floodplain encroachment. The Mahoning Creek and Sechler Run watersheds are the most urbanized in the County and much of the potential growth is located in areas upstream of the current problem areas in Cooper, Valley, and Derry Township – thus increasing the potential to exacerbate existing problems located downstream in the Borough of Danville. Most notable is the Blizzard Run subwatershed within the Sechler Run watershed. Shallow depth to bedrock, a high level of development and steep slopes characterize this 2-square mile area. Blizzard Run has 11 of the County's defined problem areas and 8 of them are designated as high priority problem areas. *Appendix C* has a more detailed description of Blizzard Run its specific problem areas.

As discussed in Section 3, damage in the flood prone area of Montour County accounts for substantial economic losses. Employing floodplain management principles, discussed in Section 9, and improving the current stormwater management policy are the options for reducing the economic and social impacts of development in these high risk areas.

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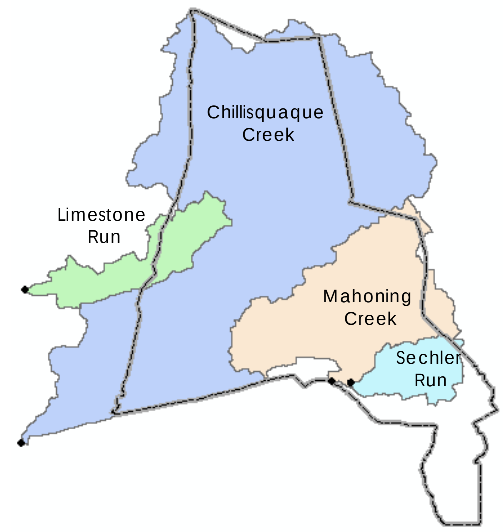
Section VI – Technical Analysis - Modeling



TECHNICAL APPROACH

To provide technical guidance in the Act 167 planning process, hydrologic models were prepared for specific watersheds identified by the municipalities, the County and Pennsylvania Department of Environmental Protection. The results from these models increase the overall understanding of watershed response to rainfall and help 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 Montour County. The hydrologic methodology used in the technical approach is the Natural Resource Conservation Service (NRCS) Rainfall-Runoff Method described in various NRCS publications (NRCS, 2008a). This method was chosen since it is the most common method used by designers in Pennsylvania and has widely available data (NRCS, 2008b). Additionally, this method is the basis for which many of the guidelines were developed in the PA Stormwater BMP Manual. The calculations for this methodology were performed with HEC-HMS, the US Army Corps of Engineers' Hydrologic Modeling System.

The modeling approach in this study was to:

1. Establish a reasonable estimate of rainfall-runoff response under existing conditions,

2. Establish a reasonable estimate or rainfall-runoff response under an assumed future condition land development,

3. Provide an examination of the impact with the implementation of guidelines from the PA Stormwater BMP Manual (i.e., Design Storm Method and Simplified Method), and finally

4. Develop stormwater management districts where it is determined necessary to do so.

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

HYDROLOGIC MODEL PREPARATION

Three watersheds within the county were selected for hydrologic modeling: Chillisquaque Creek, Mahoning Creek/Sechler Run, and Limestone Run. 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. Figures *6.1, 6.2, and 6.3* are maps of the Montour County watersheds considered in this study (Chillisquaque, Mahoning Creek, and Sechler Run watersheds, respectively). *Table 6.1* shows the essential data for each of these watersheds.

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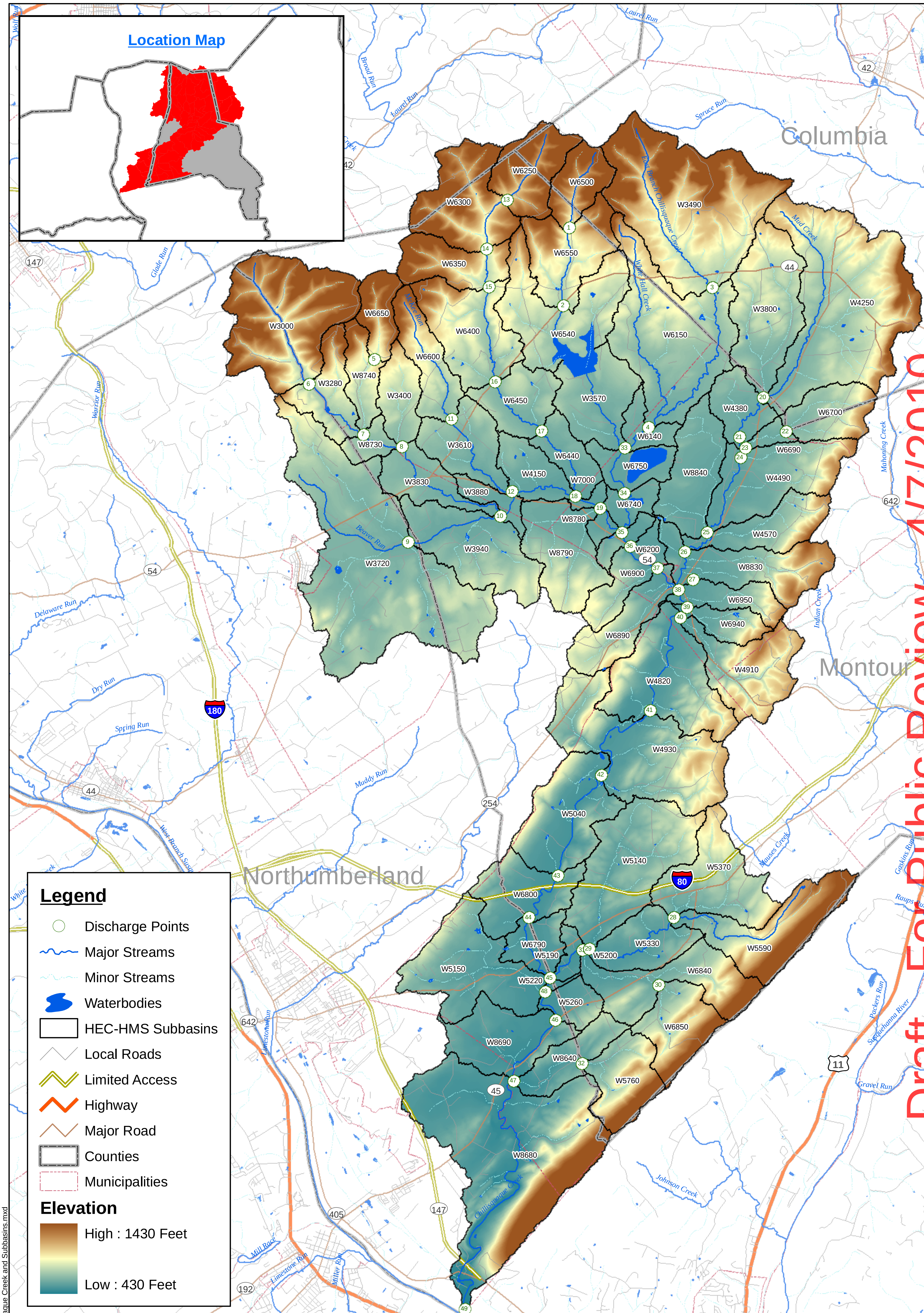

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NOTE:
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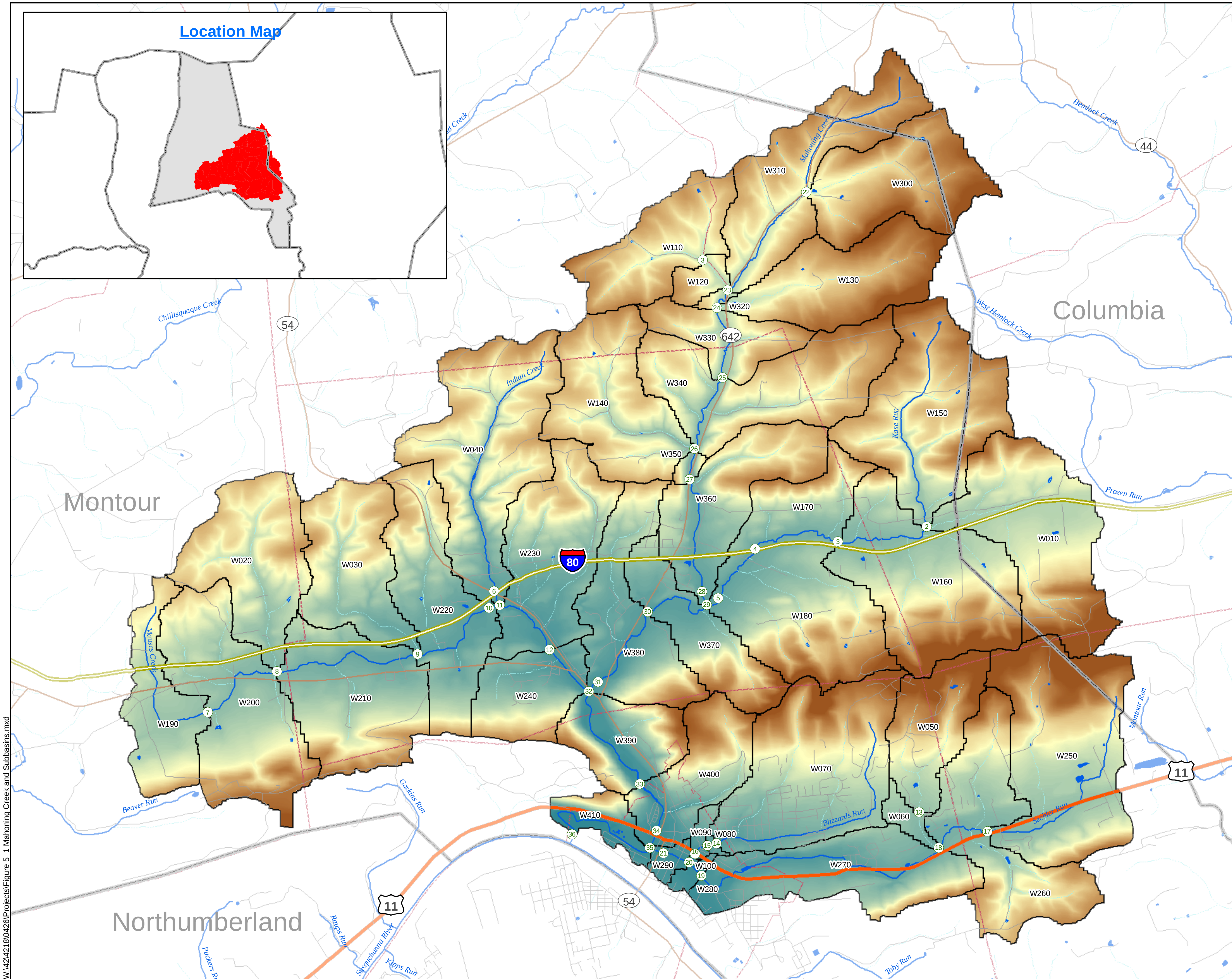
DATA SOURCES:
HEC-HMS Basins - HRG
Streams and Waterbodies - USGS NHD (2009)
Municipalities - PASDA (2004)
Major Highways - ESRI (2008)
Roads - PennDOT (2009)
Counties - PASDA (2004)

[BUILDING RELATIONSHIPS. DESIGNING SOLUTIONS.]

Figure 6.1
Chillisquaque Creek
HEC-HMS Subbasins
Montour County, Pennsylvania



[BUILDING RELATIONSHIPS. DESIGNING SOLUTIONS.]

Figure 6.2
Mahoning Creek HEC-HMS Subbasins
Montour County, Pennsylvania

Discharge Points
Local Roads
Limited Access
Highway
Major Road
Major Streams
Minor Streams
Waterbodies
HEC-HMS Subbasins
Counties
Municipalities

Elevation

High : 1290 Feet

Low : 420 Feet

NOTE:
Portions of this map that are provided for spatial reference only were generated from existing sources and may contain discrepancies that have not been corrected as part of this ACT 167 Plan.

DATA SOURCES:
HEC-HMS Basins - HRG
Streams and Waterbodies - USGS NHD (2009)
Municipalities - PASDA (2004)
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Counties - PASDA (2004)

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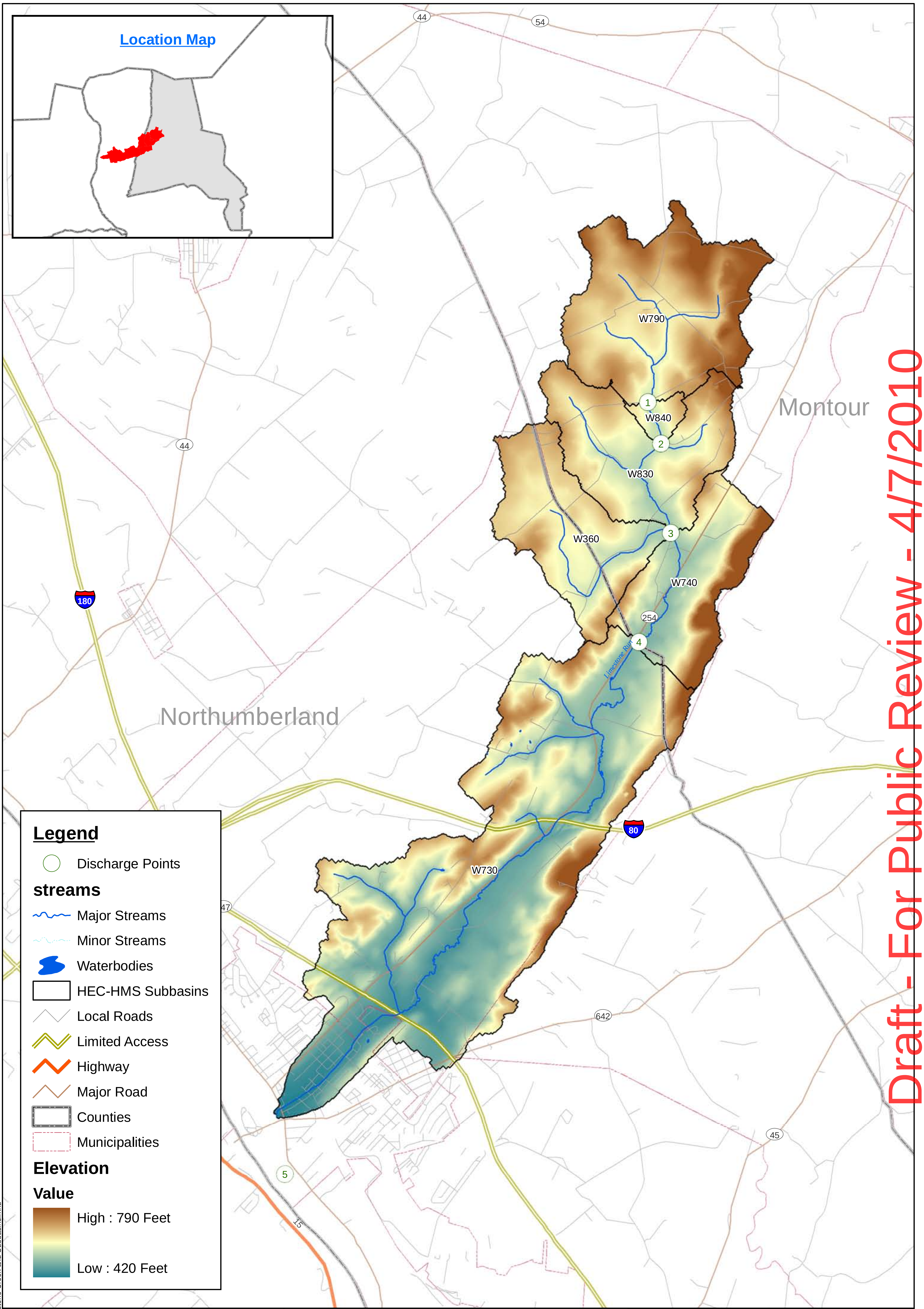

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Scale in Miles

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Streams and Waterbodies - USGS NHD (2009)
Municipalities - PASDA (2004)
Major Highways - ESRI (2008)
Roads - PennDOT (2009)
Counties - PASDA (2004)

[BUILDING RELATIONSHIPS. DESIGNING SOLUTIONS.]

Figure 6.3
Limestone Creek
HEC-HMS Subbasins
Montour County, Pennsylvania

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Watershed	Overall Drainage Area (mi²)	Number of Sub-watersheds	Scope of Study
Chillisquaqe Creek	112	66	Entire Watershed
Mahoning Creek	39	41	Entire Watershed + Sechler Run
Sechler Run	--	--	Included in Mahoning Creek
Limestone Run	12	6	Entire Watershed

Table 6.1 Watershed Data for Montour County

CHILLISQUAQUE CREEK MODEL

Chillisquaque Creek is a watershed with predominantly agriculture land use. The hydrology is somewhat altered by the presence of Lake Chillisquaqe located on the tributary of Middle Chillisquaque Creek. The general shape of the watershed is such that a relatively large portion of the runoff is generated in the headwater and the lower sections serve as a flood attenuating section where runoff may actually decrease as the river traverses downstream. Given this phenomena, control of upstream runoff is particularly important in the region upstream from Washingtonville. There are 43 problem areas within the Chillisquaque watershed, several involving undersized culverts or bridges.

Impoundment	Stream	Location	Owner	Storage (acre-ft)
Lake Chillisquaque	Middle Chillisquaque Creek	Anthony Twp.	PPL	4,450

Table 6.2. Impoundments within the Chillisquaque Creek Watershed

MAHONING CREEK/SECHLER RUN MODEL

The watershed model was developed to replace the model created for the 1995 Act 167 for Mahoning/Creek Sechler Run (RKR Hess, 1995). The computer model used in the 1995 was PSRM (Penn State Runoff Model), which is no longer used in standard engineering practice. In this Plan, there are 34 problem areas within the Mahoning Creek/Sechler Run watershed.

LIMESTONE RUN MODEL

Limestone Run is included in the modeling effort since a large portion of its watershed lies within Montour County and its soil and geological characteristics (high infiltration capacity soils with karst geology) may be particularly sensitive to future land use changes.

HYDROLOGIC MODEL PARAMETERS

The various parameters entered into the hydrologic models 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 the technical appendix. A brief description of these components follows.

RAINFALL DATA

Rainfall data used in this modeling effort incorporates rainfall runoff data from the 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

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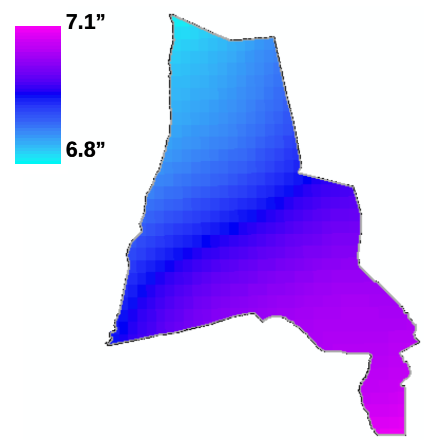
approximate geographic center of the county. The following table provides the rainfall estimates used for various design storm frequencies for Montour County (NOAA, 2008):

Design Storm (years)	24-hr Rainfall Depth (in)
2	2.82
10	4.09
25	5.05
50	5.94
100	6.99

Table 6.3. Rainfall Values for Montour County

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 *DEP BMP Design Manual*.



NOAA Atlas 14 100-year, 24-hour Rainfall

SUBWATERSHED AREA

Generally, the subwatershed area for the modeled watersheds was 1-5 mi^2. The drainage areas may be slightly larger or smaller depending on hydrologic characteristics and location of problem areas. Subwatersheds with an area less than one (1) square mile were included in the model if they formed a junction between two larger basins 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 (A, B, C, and D) according to their minimum infiltration rate (NRCS 1986). 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 used in conjunction with land use cover data within GIS to develop composite curve numbers for each subwatershed in the models.

In Section 3*, Table 3.6* show the relative percentage of hydrologic soil groups in Montour County. Generally, the runoff potential of soils in the northwestern portion of the county is very high; the location of these soil types corresponds to the location of many of the counties' identified problem areas.

LAND USE

Within Montour County, the existing and future land use was derived from the data used in the *2009 Comprehensive Plan*. For the small areas outside of the County, land use data was

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developed using data from the 2001 National Land Cover Data Set (USGS 2008a). This data was converted to land uses that correspond to NRCS curve number tables (NRCS, 1986). The land use categories that were used are listed in *Table 6.4, 6.5,* and *6.6* for each respective watershed. In general there is a loss is acreage (denoted by red) in either agriculture or forestry and a gain in acreage (shown in green) in commercial and residential development.

Land Use	Existing Land Cover		Proposed Land Cover		Change Future - Existing
	Acres	%	Acres	%	%
Commercial and Business	260.0	0.4	189.8	0.3	-0.1
Contoured Row Crops[1]	4,961.8	6.9	4,971.2	6.9	0.0
Industrial	816.2	1.1	2,891.4	4.0	2.9
Newly graded areas	1.3	0.0	1.3	0.0	0.0
Open space[1]	1,472.2	2.1	1,471.4	2.1	0.0
Pasture[1]	36,738.9	51.2	34,810.5	48.5	-2.7
Paved surfaces	1,207.8	1.7	1,210.1	1.7	0.0
Residential - 1 acre	1.3	0.0	1.3	0.0	0.0
Residential - 1/2 acre	36.2	0.1	36.2	0.1	0.0
Residential - Mixed	1,738.9	2.4	2,306.8	3.2	0.8
Residential <1/8 acre	0.0	-	86.2	0.1	0.1
Water	127.8	0.2	128.1	0.2	0.0
Woods[1]	24,396.4	34.0	23,654.7	33.0	-1.0
Total	**71,758.9**	**100.0**	**71,758.9**	**100.0**	**0.0**

Notes: [1] In Good Condition

Table 6.4. Existing and Future Land Use in the Chillisquaque Creek Watershed

Land Use	Existing Land Cover		Proposed Land Cover		Change Future - Existing
	Acres	%	Acres	%	%
Commercial and Business	519.4	2.0	710.3	2.8	0.8
Contoured Row Crops[1]	375.5	1.5	375.5	1.5	0.0
Industrial	261.8	1.0	271.8	1.1	0.0
Newly graded areas	0.2	0.0	0.2	0.0	0.0
Open space[1]	655.5	2.6	688.5	2.7	0.1
Pasture[1]	7,382.9	29.1	7,147.2	28.2	-0.9
Paved surfaces	979.5	3.9	979.5	3.9	0.0
Residential - 1 acre	0.0	-	0.0	-	0.0
Residential - 1/2 acre	15.6	0.1	15.6	0.1	0.0
Residential - Mixed	2,384.1	9.4	3,419.8	13.5	4.1
Residential <1/8 acre	0.0	-	52.6	0.2	0.2
Water	0.4	0.0	0.4	0.0	0.0
Woods[1]	12,765.8	50.4	11,679.1	46.1	-4.3
Total	**25,340.6**	**100.0**	**25,340.6**	**100.0**	**0.0**

Notes: [1] In Good Condition

Table 6.5. Existing and Future Land Use in the Mahoing Creek/Sechler Run Watershed

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Land Use	Existing Land Cover		Proposed Land Cover		Change Future - Existing
	Acres	%	Acres	%	%
Commercial and Business	1.3	0.0	5.9	0.1	0.1
Contoured Row Crops[1]	961.3	12.0	960.8	12.0	0.0
Industrial	15.5	0.2	14.0	0.2	0.0
Newly graded areas	0.1	0.0	0.1	0.0	0.0
Open space[1]	355.0	4.4	354.8	4.4	0.0
Pasture[1]	5,263.2	66.0	5,111.7	64.1	-1.9
Paved surfaces	82.1	1.0	82.1	1.0	0.0
Residential - 1 acre	98.9	1.2	98.8	1.2	0.0
Residential - 1/2 acre	182.3	2.3	182.2	2.3	0.0
Residential - Mixed	200.5	2.5	337.5	4.2	1.7
Residential <1/8 acre	0.0	-	19.7	0.2	0.2
Water	41.0	0.5	41.0	0.5	0.0
Woods[1]	778.9	9.8	771.7	9.7	-0.1
Total	**7,980.2**	**100.0**	**7,980.2**	**100.0**	**0.0**

Notes: [1] In Good Condition

Table 6.6. Existing and Future Land Use in the Limestone Run Watershed

LAG TIME

Lag time is the transform routine when using the NRCS Curve Number Runoff Method. Lag can be related to time of concentration 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 of Montour 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 in the NRCS

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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 Design Storm Method and the Simplified Method (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* (USGS, 2005). Dimensions for the overbank area were visually determined from FEMA floodplains or visual inspection of topographic data. *Figure 6.4* shows the dimensions as they are approximated.

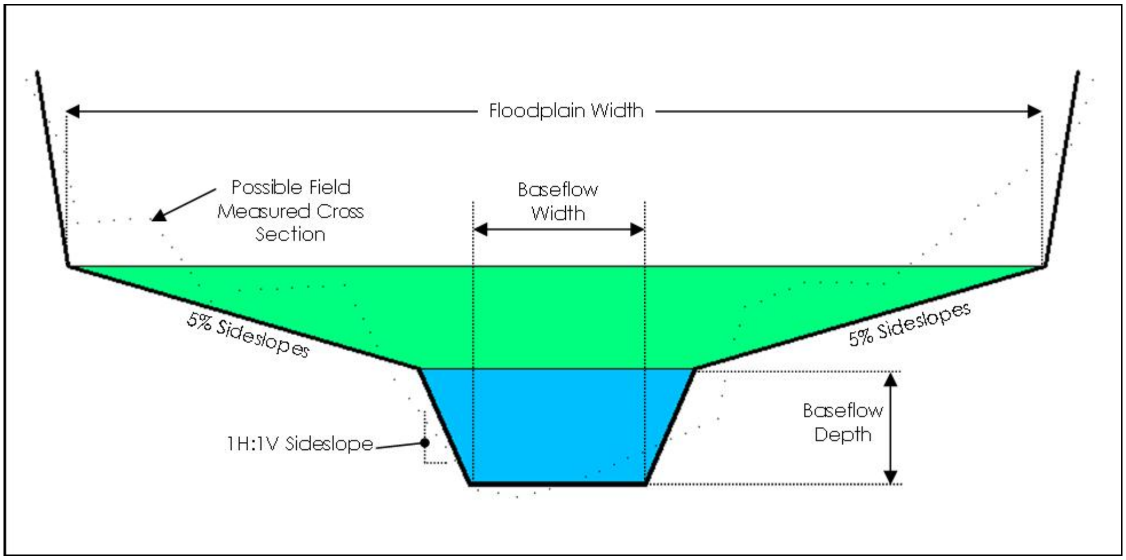

Figure 6.4. Cross Sections Used for Reaches in HEC-HMS Model

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; overbank channel values were assumed to be 0.08. When necessary for calibration, Manning's *n* values and the overbank sideslopes 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

The HEC-HMS models incorporate 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 real rain events.

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There are five USGS stream gages with adequate record located in Montour County. *Table 6.7* lists these gages and their respective statistics.

Flow estimates were derived at this gage using the *Bulletin 17B* methodology outlined in USGS (1982). 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.

USGS Stream Gage No.	Site Name	Drainage Area mi²	Period of Data	Used in HEC-HMS Model
01540500	Susquehanna River at Danville, PA	11,200	1899-Current	No
01553600	EB Chillisquaque Creek near Washingtonville, PA	9	1960-1978	Yes
01553700	Chillisquaque Creek at Washingtonville, PA	51	1979-Current	Yes

Table 6.7 USGS Stream Gages in Montour County

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 FISs 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.

USGS Gage 01540500 Susquehanna River at Danville, PA
Source: USGS, 2010

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, the applicable parameters within Montour County, were calculated using GIS from layers supplied from USGS Digital Elevation Model (DEM) data, Environmental Resources Research Institute (1996), and USGS (2008b).

The target flow rates were determined from one of these three sources. The HEC-HMS models were then calibrated to the target flow rates at the overall watershed level, at subwatersheds where significant hydrologic features were identified (e.g., confluences, dams, USGS Gages), and at each individual subbasin. 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*.

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The following figures (Figures 6.5-6.7) show the calibration results at critical locations for Chillisquaque Creek, Mahoning Creek, and Limestone Run. As can be shown, the calibration results are in general agreement with the range of values for other hydrologic studies.

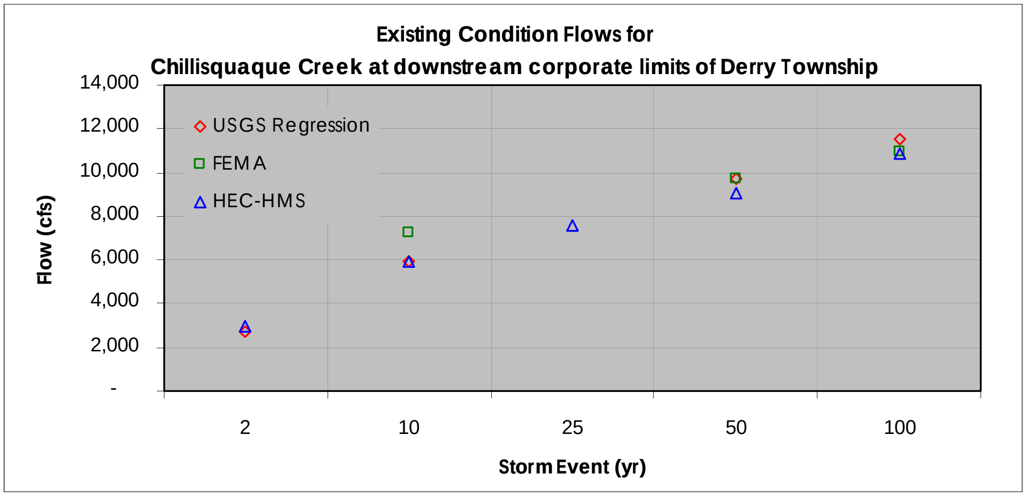

Figure 6.5.

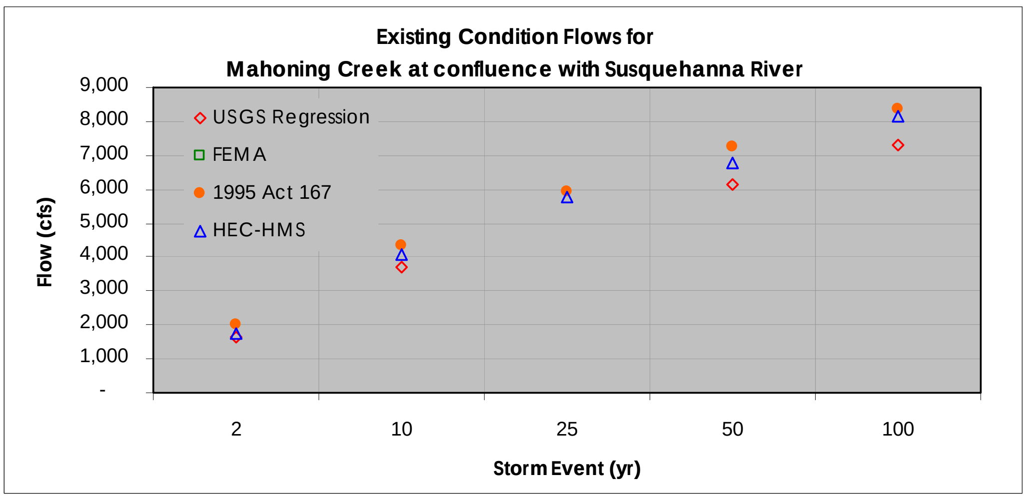

Figure 6.6.

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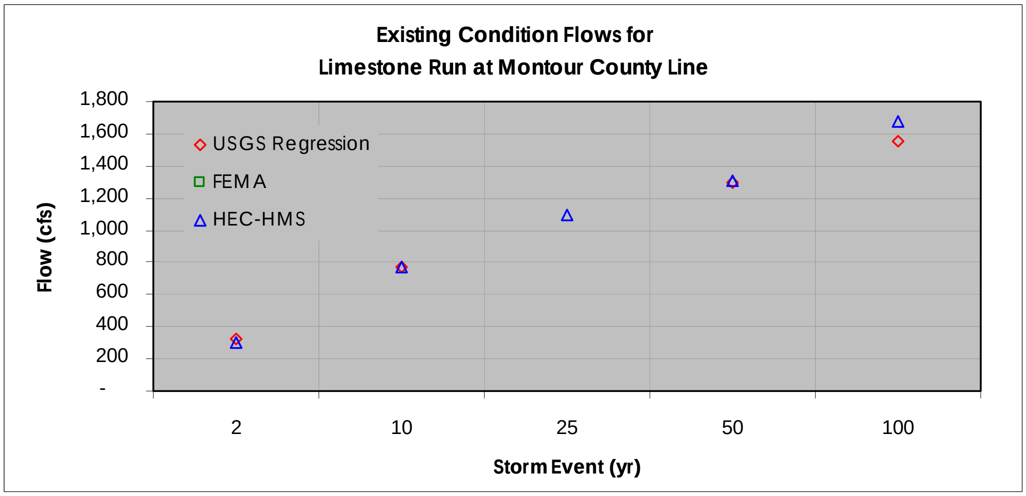

Figure 6.6.

MODELING RESULTS

Once the 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 subbasins will experience varying degrees of development through the full build-out future condition.

The following simulations were performed with HEC-HMS (2, 10, 25, 50 and 100-year) for Chillisquaque Creek, Mahoning Creek, and Limestone Run:

Existing Conditions (Ex)
An existing conditions model was developed and analyzed using the using the calibration procedures described above. 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 (F-1)
A future conditions model was developed and analyzed using the projected future land use coverage for the year 2020. The revised land use resulted in an increased curve number and a decreased time of concentration for several subbasins. It was assumed that there was no required detention or any other stormwater controls in this simulation.

Future Conditions with Design Storm Method and Release Rates as Stormwater Controls (CG-1R)
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 the Design Storm Method.

The effects of peak rate controls, through detention of post development flows, was estimated by routing the post development flow for each subbasin 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 sub-basin. The volume removal requirements of

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the Design Storm Method were simulated using modified initial abstraction values as described above and in *Appendix A.*

The approach in this Act 167 Plan was to 1) estimate the effects of detention of post development flows and 2) apply release rates to subwatershed wherever there is a significant increases in peak flow at the points of interest. The results for each watershed are presented below; detailed results of the modeling are provided in *Appendix A*.

CHILLISQUAQUE CREEK

The increases in the Chillisquaque Creek watershed are focused above Washingtonville Borough and Derry Township and the upper part of the watershed, as shown in *Figure 6.7*.

Storm Event (year)	Effects of Future Condition on Discharges	
	Maximum % Increase in Future Conditions	Average % Increase in Future Conditions[1]
2	537.1	12.6
10	212.0	8.1
25	195.6	7.8
50	186.8	7.8
100	177.1	7.5

Notes: [1] Area weighted averages

Table 6.8. Future Condition Increases with No Stormwater Management Controls for Chillisquaque Creek

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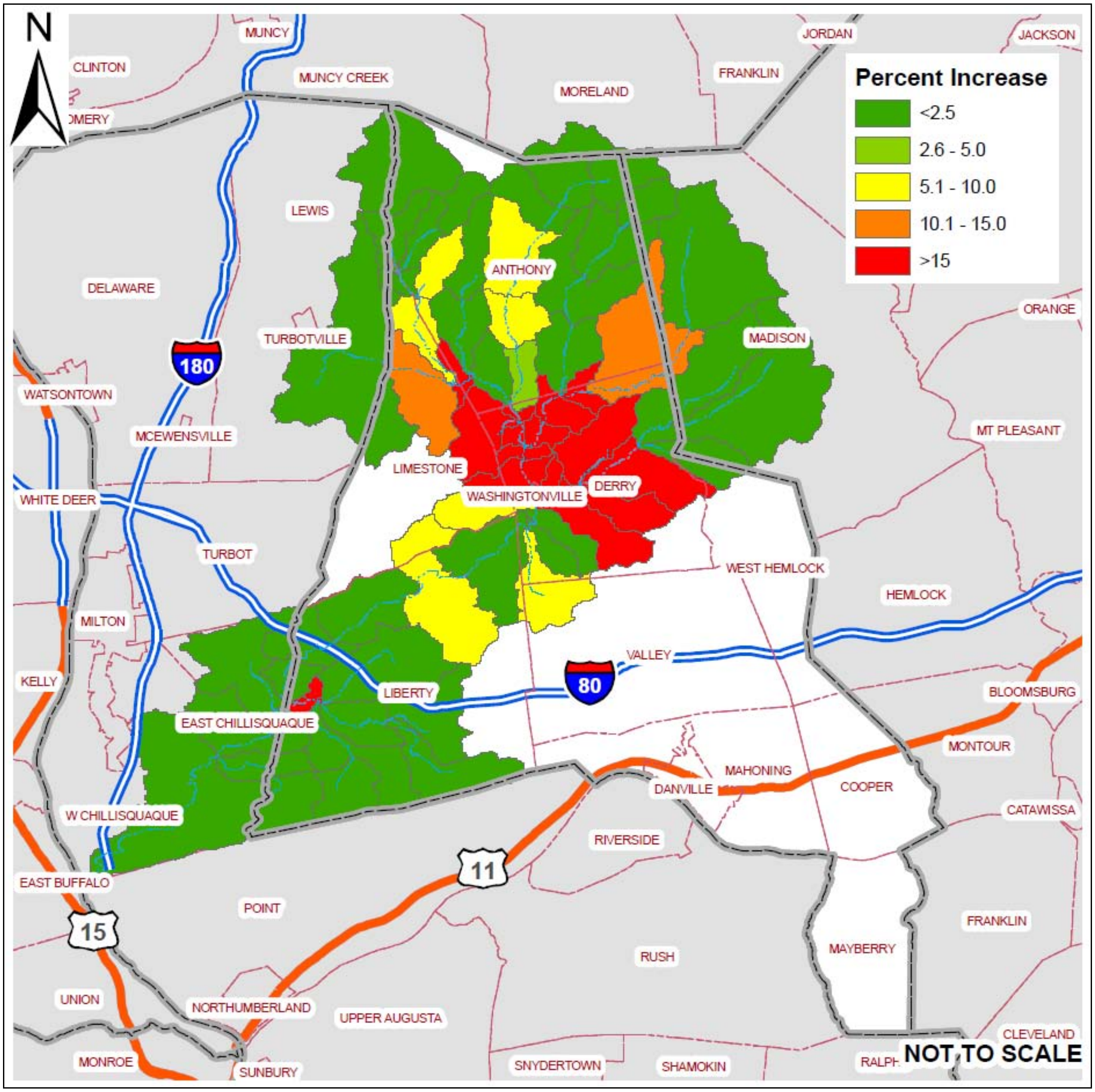

Figure 6.7. Increase in Flow for 2-year Storm Event with No SWM Controls for Chillisquaque Creek

Table 6.9 shows the reduction in peak flows that would occur if only the Design Storm Method were implemented without any peak rate controls. The flows for the lower magnitude events are substantially reduced compared to future conditions with no stormwater management controls with the implementation of the Design Storm Method. The flows for the higher magnitude events are moderately reduced with implementation of the Design Storm Method, but significant increases still occur.

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Storm Event (year)	Effects of CG-1 on Discharges	
	Maximum % Increase with CG1	Average % Increase with CG1[1]
2	15.3	0.7
10	47.6	2.7
25	75.8	3.6
50	101.2	4.3
100	107.1	4.7

Notes: [1]Area weighted averages

Table 6.9. Future Subbasin Increases with Design Storm Method Only – No peak control for Chillisquaque Creek

MAHONING CREEK/SECHLER RUN

The increases in the Mahoning Creek watershed are spread throughout the watershed with a high portion of the increases occurring in Valley, Cooper, and Mahoning Townships, as shown in *Figure 6.8.* A summary of these increases is shown in Table 6.11.

Storm Event (year)	Effects of Future Condition on Discharges	
	Maximum % Increase in Future Conditions	Average % Increase in Future Conditions[1]
2	85.2	16.6
10	59.4	12.4
25	53.8	11.5
50	53.6	11.6
100	52.9	11.4

Notes: [1] Area weighted averages

Table 6.11. Future Condition Increases with No Stormwater Management Controls for Mahoning Creek

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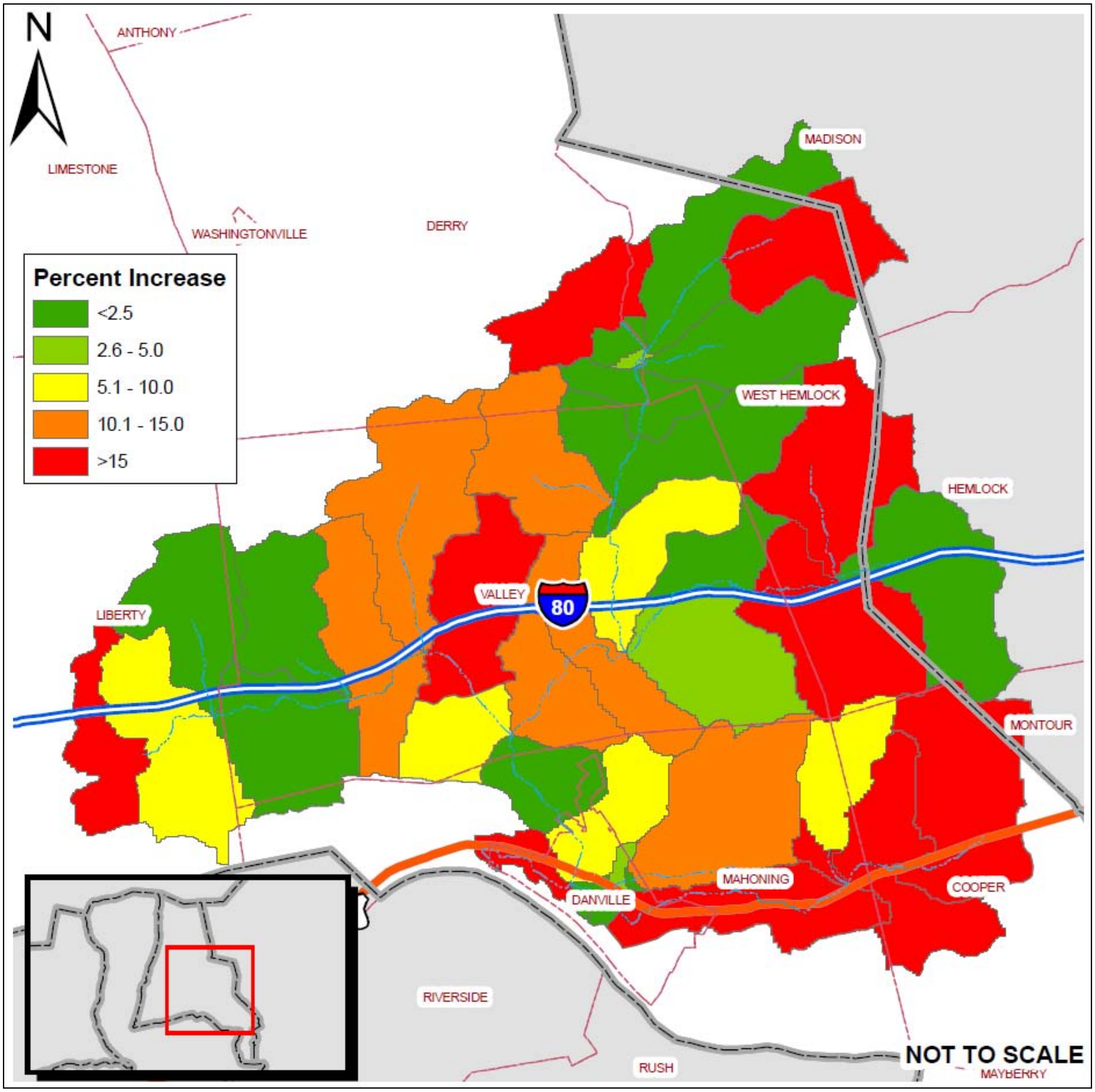

Figure 6.8. Increase in Flow for 2-year Storm Event with No SWM Controls for Mahoning Creek

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Table 6.12 shows the reduction in peak flows that would occur if only the Design Storm Method were implemented without any peak rate controls.

Storm Event (year)	Effects of CG-1 on Discharges	
	Maximum % Increase with CG1	Average % Increase with CG1[1]
2	0.7	0.2
10	12.1	3.0
25	19.4	4.4
50	24.3	5.6
100	28.0	6.3

Notes: [1]Area weighted averages

Table 6.12. Future Subbasin Increases with Design Storm Method Only – No peak control for Mahoning Creek

LIMESTONE RUN

The increases in peak discharges due to anticipated future development in the Limestone Run watershed are shown only in Montour County. First, it should be noted that these increases are relatively minor compared the increases observed on Chillisquaque Creek and Mahoning Creek. Second, it should be noted that this analysis is limited to Montour County only. While there may be actual increase in the portion of Limestone Run in Northumberland County, none are shown here because of the particular scope of this Act 167.

Storm Event (year)	Effects of Future Condition on Discharges	
	Maximum % Increase in Future Conditions	Average % Increase in Future Conditions[1]
2	8.8	3.1
10	6.3	2.2
25	6.4	2.2
50	6.5	2.2
100	5.9	2.0

Notes: [1] Area weighted averages

Table 6.14. Future Condition Increases with No Stormwater Management Controls for Limestone Run

Table 6.15 shows the reduction in peak flows that would occur if only the Design Storm Method were implemented without any peak rate controls.

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Storm Event (year)	Effects of CG-1 on Discharges	
	Maximum % Increase with CG1	Average % Increase with CG1[1]
2	0.2	0.0
10	1.8	0.6
25	2.6	1.0
50	3.2	1.2
100	3.5	1.2

Notes: [1]Area weighted averages

Table 6.15. Future Subbasin Increases with Design Storm Method Only – No peak control for Limestone Run

If there was a significant increase at a point of interest, the allowable release rate was reduced until the increase in peak flow at the points of interest was reduced to acceptable values. With this analysis, it was found there will be no reduced release rates for Limestone Run.

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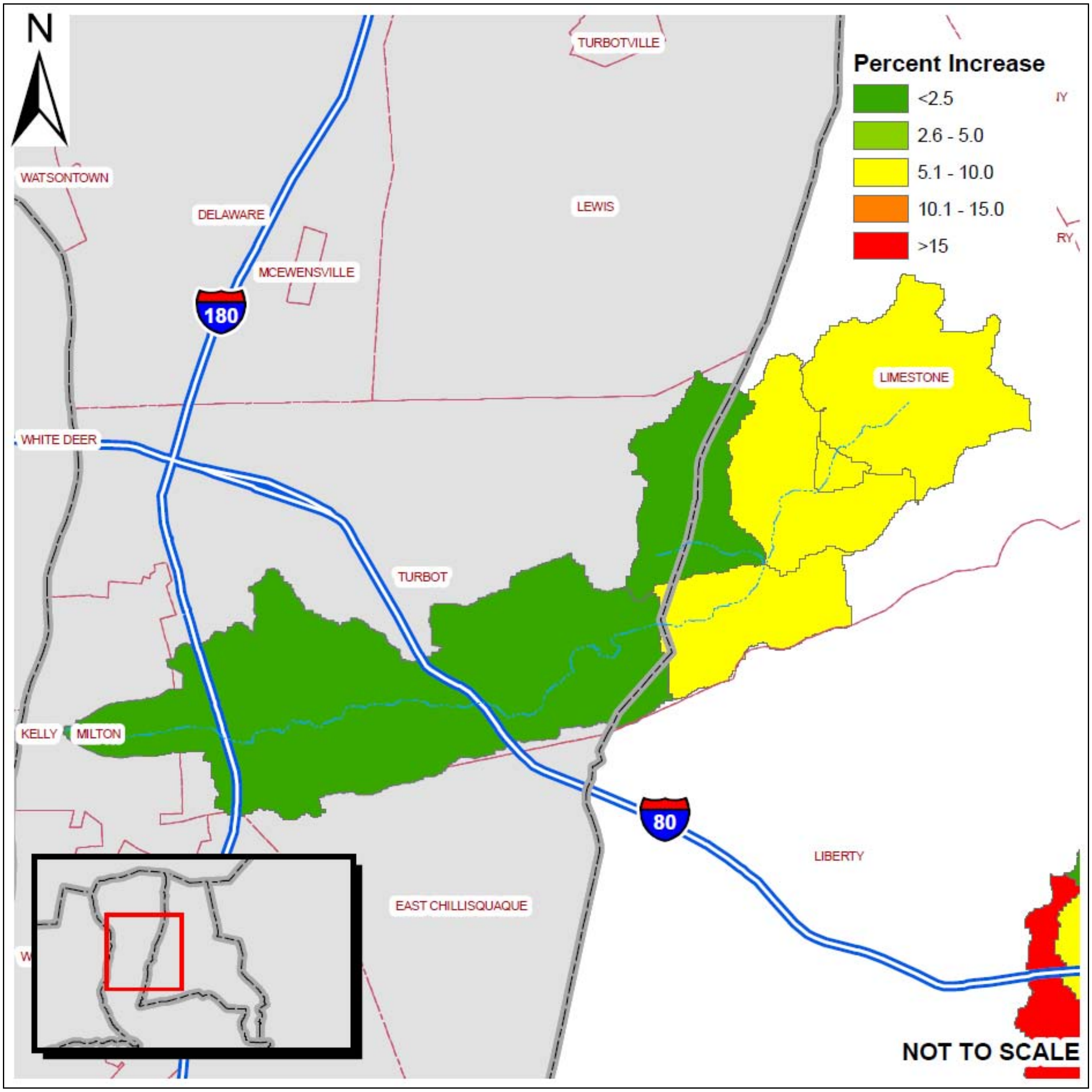

Figure 6.9. Increase in Peak Discharges for 2-year Storm Event with No SWM Controls for Limestone Run

STORMWATER MANAGEMENT DISTRICTS

When substantial increases are found in the HEC-HMS model due to additive effects of future development, it may be necessary to restrict post development flow rates to a fraction of pre-development flow. The fraction has historically ranged between 50 and 100 percent of the pre-development flow rate in previous Act 167 efforts. For example, a 75% release rate district would indicate that any future development within the district be required to restrict post-development flows to 75% of pre-development flows.

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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:

1. Numerous problem areas exist in a pattern that indicate systemic stormwater problems;

2. Historic, repeated flooding has been observed;

3. Future planning projections indicate growth patterns that have historically contributed to documented problems; and

4. Release rates are to be designated on higher order watersheds only; 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 indicate a need for additional stormwater management controls, release rates are considered. The results from hydrologic models are used as guidance to establish appropriate release rates. Ultimately, reasonable hydrologic judgment is used in the final designation of release rates.

CHILLISQUAQUE CREEK

Chillisquaque Creek was evaluated on the above criteria for implementation of 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 (FEMA, 2008). Additionally future growth is projected in upstream areas of the watershed that may have an impact on overall watershed hydrology. Stormwater management districts have been developed for portions of the watershed with release rates ranging between 70 and 100%.

MAHONING CREEK AND SECHLER RUN

Evaluation of the Mahoning Creek and Sechler Run 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 (RKR Hess, 1995 and FEMA, 2008). Additionally, future growth is projected in areas of the watershed that may exacerbate existing problem areas.

Additionally, Danville's flood protection system is sensitive to the ability of the watershed to limit the effects of future growth. The actual flood protection system has various factors of safety incorporated into its design so that it may only be marginally affected by uncontrolled stormwater runoff increases. However, the existing free board (the parameter that defines the distance between the water surface and the top of the levee) is sensitive to any potential runoff increase. Currently, the freeboard that is required for the system to maintain its certification is three feet. If this freeboard is reduced because of increased runoff in the Mahoning Creek watershed, the certification status of the flood protection system of Danville may be jeopardized.

Because of these reasons, stormwater management districts have been developed for portions of the watershed with release rates ranging between 75 and 100%.

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LIMESTONE RUN

Because of the minimal projected stormwater runoff increases on Limestone Run, no release rates area designated for this watershed.

The location of the stormwater management districts is shown on *Plate 10 - Stormwater Management Districts*, which also identifies the location for potential regional stormwater facilities.

RECOMMENDATIONS

The modeling results discussed in this and previous sections provide technical guidance on provisions that should be included in the model ordinance. The following recommendations follow from the technical analysis and data collection efforts in preparing this Plan.

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 events, the runoff response to NOAA Atlas 14 rainfall in Montour County was often 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 proposed control guidance. It is recommended for time of concentration computations to use the maximum value provided by 1) the TR-55 segmental method and 2) the NRCS Lag Equation.

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

Implement and enforce a flexible yet clearly documented release rate policy for the specified watershed. The stormwater management districts are provided on *Plate 10*. These should be used to determine the allowable post-development peak flow rate. The use of strategically placed regional facilities and watershed-scale conservation, drainage way, and critical recharge area easements should also be considered as an alternative to release rate implementation.

Additionally, a clear alternative volume-control and peak-rate control strategy for areas with poorly drained soils or areas with geologic restrictions should be provided. Montour County has some potential limitations to infiltration facilities: shallow bedrock, Hydrologic Soil Group D soils, floodplains, and documented problem areas. Section 7 provides a recommended procedure for sites with these limitations.

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Section VII – Technical Standards and Criteria for Control of Stormwater Runoff

The field of stormwater management has evolved rapidly in recent years as research has increased our comprehension of how stormwater runoff is interrelated with the rest of our natural environment. 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. This Plan contains technical standards that seek to achieve this goal through four different methods. These standards are summarized as follows:

1. Peak Discharge Rate Standards – Peak discharge rate standards are implemented primarily to protect areas directly downstream of a given discharge by attenuating the peak discharge rate from large storm events. These standards are also intended to attenuate peak flow rate throughout the watershed during large storm events. Peak discharge rate controls are applied at individual development sites. Controlling peak discharge rates from the sites entails collection, detention, and discharge of the runoff at a prescribed rate. This is an important standard for achieving stable watersheds.

2. Volume Control Standards – The standards in this Plan that address increased stormwater volume are intended to benefit the overall hydrology of the watershed. The increased volume of runoff generated by development is the primary cause of stormwater related problems. Increased on-site runoff volume commonly results in a sustained discharge at the design peak discharge rate, as well as an increased volume and duration of flows experienced after the peak discharge rate. Permanently removing a portion of the increased volume from a developed site is key in mitigating these problems and maintaining groundwater recharge levels.

3. Channel Protection Standards – Channel protection standards are designed to reduce the erosion potential from stormwater discharges to the channels immediately downstream. Even though peak discharge rate controls are implemented for larger design storms, they do not provide controls for the smaller storms. These storms account for the vast majority of the annual precipitation volume. Past research has shown that channel formation in developed watersheds is largely controlled by these small storm events. The increased volume and rate of stormwater runoff during small storms forces stream channels to change to accommodate the increased flows. Channel protection standards will be achieved through the implementation of permanent removal of increased volume from discharges during low flow storm events.

4. Water Quality Standards – The water quality standards contained in this Plan are meant to provide a level of pollutant removal from runoff prior to discharge to receiving streams. Stormwater runoff can deliver a wide range of contaminants to the receiving stream, which leads to a variety of negetive impacts. Water quality standards can be achieved through reducing the source of pollutants and utilizing natural and engineered systems that are capable of removing the pollutants.

Beyond the standards discussed above, other measures may be taken to ensure that stormwater is properly managed. Some of these measures are discussed later in *Section X, Additional*

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Recommendations. These measures are included as recommendations because they are beyond the regulatory scope of this Plan. Municipalities should consider these recommendations seriously.

Stormwater management is an issue that 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 a consideration in any ordinance decisions that affect how land is used.

CRITERIA FOR CONTROL OF STORMWATER RUNOFF

The principal purpose of this Plan was to develop criteria for control of stormwater runoff that are specific to the watersheds within Montour County. Mathematical modeling techniques, as discussed in the previous section, were used to simulate the existing conditions throughout the county and to determine the effects anticipated future development will have on stormwater runoff within these watersheds. The models were used to determine the outcome of a variety of different stormwater control scenarios. These results were then used to determine a group of control criteria that provides the best results on a watershed wide basis. The outcome of each analysis is stormwater control criteria that are appropriate and applicable to that watershed.

The process of developing unique controls for individual watersheds is complicated by the reality that regulations must be implemented and enforced across varying jurisdictions. The more site specific and complicated a regulatory structure is, the more difficult it becomes to implement the regulations. For this reason it is most advantageous to develop a system of controls that are similar in structure but can also be adjusted as necessary to meet the specific needs of each watershed. The need for balance between these two important concepts has led to the system of stormwater control criteria contained within this Plan.

A broad and uniform approach has been developed for implementation of water quality, volume control, and channel protection controls. These criteria have been developed with adequate flexibility in implementation to be applicable to most watersheds statewide. Peak discharge rate control standards, which are unique to each watershed, have been developed to achieve watershed specific controls.

PEAK DISCHARGE RATE CONTROLS

Peak discharge 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 mathematical modeling of the 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 a release rate for various subwatersheds such that the rate of release of the increased volumes of runoff generated is not detrimental to downstream areas.

In some subbasins, it is necessary to implement strict release rates that require sites to discharge at flows much lower than those calculated for pre-development flows. This is due to the timing of the peak flows from all of the subbasins, and how flows from the subbasin in question impact the overall stream flows. Variable release rates for subbasins throughout a watershed are an important part of achieving regional peak flow controls. The proposed release rates calculate no peak flow increase above the existing condition peak flows at any study point throughout the watersheds being modeled. Strict release rates for the more frequent design storms are

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necessary to meet this criterion in some subwatersheds. The proposed release rates for this Plan fall into two categories:

1. Areas not covered by a Release Rate Map:

   Post-development discharge rates shall not exceed the predevelopment discharge rates for the 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 2-, 10-, 25-, 50-, and 100-year, 24-hour storms, then the requirements of this section have been met. Otherwise, the applicant shall provide additional controls as necessary to satisfy the peak rate of discharge requirement.

2. Areas covered by a Release Rate Map:

   For the 2-, 10-, 25-, 50-, and 100-year storms, the post-development peak discharge rates will follow the applicable approved release rate maps. For any areas not shown on the release rate maps, the post-development discharge rates shall not exceed the predevelopment discharge rates.

VOLUME CONTROLS

Developed sites experience an increased volume of runoff during all precipitation events. The increased volume of stormwater is the cause of several related problems such as increased chanel erosion, increased main channel flows, and reduced water available for groundwater recharge. Reducing the total volume of runoff is 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. These opportunities will be provided by use of Best Management Practices such as infiltration structures, replacement of pipes with swales, and disconnecting roof drains. Other methods that may be used are reducing impervious cover, maximization of open space, and preservation of soils with high infiltration rates.

The proposed volume controls for this Plan include two pieces:

1. Reduction of runoff generated through use of low impact development practices to the maximum extent practicable.

2. Permanent removal of a portion of the runoff volume generated from the total runoff flow.

The permanent removal of runoff volume is to be achieved through one of three available methods:

1. *The Design Storm Method* (CG-1 in the SWM BMP Manual[1]) is applicable to any size of Regulated Activity. This method requires detailed modeling based on site conditions.

   A. Do not increase the post-development total runoff volume for all storms equal to or less than the 2-year 24-hour duration precipitation.

   B. For modeling purposes:

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i) Existing (pre-development) non-forested pervious areas must be considered meadow or its equivalent.

ii) Twenty (20) percent of existing impervious area, when present, shall be considered meadow in the model for existing conditions.

2. *The Simplified Method* (CG-2 in the SWM Manual[1]) provided below is independent of site conditions and should be used if the Design Storm Method is not followed. This method is not applicable to Regulated Activities greater than one (1) acre or for projects that require design of stormwater storage facilities. For new impervious surfaces:

   A. Stormwater facilities shall capture at least the first two inches (2") of runoff from all new impervious surfaces.

   B. At least the first one inch (1.0") of runoff from new impervious surfaces shall be permanently removed from the runoff flow -- i.e. it shall not be released into the surface waters of this Commonwealth. Removal options include reuse, evaporation, transpiration, and infiltration.

   C. Wherever possible, infiltration facilities should be designed to accommodate infiltration of the entire permanently removed runoff; however, in all cases at least the first one-half inch (0.5") of the permanently removed runoff should be infiltrated.

   D. This method is exempt from the requirements of Section 304 of the model ordinance, Rate Controls.

3. Alternatively, in cases where it is not possible, or desirable, to use infiltration-based best management practices to partially fulfill the volume control requirements the following procedure shall be used:

   A. The following water quality pollutant load reductions will be required for all disturbed areas within the proposed development:

Pollutant Load	Units	Required Reduction (%)
Total Suspended Solids (TSS)	Pounds	85
Total Phosphorous (TP)	Pounds	85
Total Nitrate (NO_3)	Pounds	50

   B. The performance criteria for water quality best management practices shall be determined from the *Pennsylvania Stormwater Best Management Practices Manual*, most current version.

WATER QUALITY CONTROLS

Urban runoff is one of the primary contributors to water pollution in developed areas. The most effective method for controlling non-point source pollution is through reduction, or elimination, of the sources. However, it is not reasonable to assume that all sources of pollution can be reduced or eliminated. For this reason, implementation of natural and engineered systems must be used to achieve the desired results. The water quality control standards will be achieved

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through the use of various Best Management Practices to reduce the sources of water pollution and treat those that cannot be eliminated.

A combination of source reduction measures through non-structural BMPs and water quality treatment through use of structural BMPs is the proposed water quality control strategy of this Plan. Reducing the amount of runoff to be treated is the preferred strategy to meet this goal:

- Minimize disturbance to floodplains, wetlands, natural slopes over 8%, and existing native vegetation.
- Preserve and maintain trees and woodlands. Maintain or extend riparian buffers and protect existing forested buffer. Provide trees and woodlands adjacent to impervious areas whenever feasible.
- Establish and maintain non-erosive flow conditions in natural flow pathways.
- Minimize soil disturbance and soil compaction. Over disturbed areas, replace topsoil to a minimum depth equal to the original depth or 4 inches, whichever is greater. Use tracked equipment for grading when feasible.
- Disconnect impervious surfaces by directing runoff to pervious areas, wherever possible.

Treating the runoff that cannot be eliminated is the secondary strategy for attaining the water quality standards. By directing runoff through one or more BMPs, runoff will receive some treatment for water quality, thereby reducing the adverse impact of contaminants on the receiving body of water.

RECOMMENDED BEST MANAGEMENT PRACTICES

As previously stated, the preferred strategy for achieving the goals of this plan is to reduce, or eliminate, the sources of non-point source pollution. "The treatment of runoff is not as effective as the removal of runoff needing treatment" (Reese, 2009). This is an important concept, in that the most effective way to reduce the number of stormwater runoff problems is to reduce the amount of runoff generated. There are a wide variety of non-structural practices that are used to reduce the amount of runoff generated and to minimize the potential negative impacts of runoff that is generated. All of these BMPs are intended to minimize the interruption of the natural hydrologic cycle caused by development. The relative effectiveness of each non-structural BMP listed in the *Pennsylvania Stormwater Best Management Practices Manual* in *Table 7.1* below. These practices should be used where applicable to decrease the need for less cost effective structural BMPs.

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Non-Structural Best Management Practice	Stormwater Functions[1]			
	Peak Rate Control	Volume Reduction	Recharge	Water Quality
Protect Sensitive / Special Value Features	Very High	Very High	Very High	Very High
Protect / Conserve / Enhance Riparian Areas	Low/Med.	Medium	Medium	Very High
Protect / Utilize Natural Flow Pathways in Overall Stormwater Planning and Design	Med./High	Low/Med.	Low	Medium
Cluster Uses at Each Site; Build on the Smallest Area Possible	Very High	Very High	Very High	Very High
Concentrate Uses Areawide through Smart Growth Practices	Very High	Very High	Very High	Very High
Minimize Total Disturbed Area - Grading	High	High	High	High
Minimize Soil Compaction in Disturbed Areas	High	Very High	Very High	Very High
Re-Vegetate and Re-Forest Disturbed Areas using Native Species	Low/Med.	Low/Med.	Low/Med.	Very High
Reduce Street Imperviousness	Very High	Very High	Very High	Medium
Reduce Parking Imperviousness	Very High	Very High	Very High	High
Rooftop Disconnection	High	High	High	Low
Disconnection from Storm Sewers	High	High	High	Low
Streetsweeping	Low/None	Low/None	Low/None	High

NOTES:
[1] All Stormwater function values from *PA Stormwater BMP Manual*

Table 7.1. Stormwater Functions of Structural Best Management Practices

When non-structural practices are unable to achieve the stormwater standards, it may be necessary to employ structural practices. Generally, structural BMPs are chosen to address specific stormwater functions. Some BMPs are better suited for particular stormwater functions than others. The relative effectiveness of structural BMPs at addressing individual stormwater functions varies, as shown in *Table 7.2*. This table contains all of the structural BMPs listed in the *Pennsylvania Stormwater Best Management Practices Manual* and their stated effectiveness for each stormwater function. Additional information on each practice can be found in the *Pennsylvania Stormwater Best Management Practices Manual*.

Table 7.2 shows the qualitative effect of individual BMPs when used as stand alone treatment practices. The overall effectiveness of a stormwater system can be improved when several, smaller BMPs are dispersed throughout a given site. The combination of different BMPs enables each BMP to complement each other by providing a particular stormwater function then allowing the runoff to pass downstream to another BMP that is used to address different criteria. This allows designers to better mimic the site's existing hydrologic features, which are not typically isolated to one area of the site. The "treatment train" system of utilizing multiple BMPs on a single site is an effective technique that, in some cases, may be used to meet all of the stormwater criteria.

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Structural Best Management Practice	Stormwater Functions[1]			
	Peak Rate Control	Volume Reduction	Recharge	Water Quality
Porous Pavement with Infiltration Bed	Medium	Medium	Medium	Medium
Infiltration Basin	Med./High	High	High	High
Subsurface Infiltration Bed	Med./High	High	High	High
Infiltration Trench	Medium	Medium	High	High
Rain Garden / Bioretention	Low/Med.	Medium	Med./High	Med./High
Dry Well / Seepage Pit	Medium	Medium	High	Medium
Constructed Filter	Low-High*	Low-High*	Low-High*	High
Vegetated Swale	Med./High	Low/Med.	Low/Med.	Med./High
Vegetated Filter Strip	Low	Low/Med.	Low/Med.	High
Infiltration Berm and Retentive Grading	Medium	Low/Med.	Low	Med./High
Vegetated Roof	Low	Med./High	None	Medium
Rooftop Runoff - Capture and Reuse	Low	Med./High	Low	Medium
Constructed Wetland	High	Low	Low	High
Wet Pond / Retention Basin	High	Low	Low	Medium
Dry Extended Detention Basin	High	Low	None	Low
Water Quality Filter	None	None	None	Medium
Riparian Buffer Restoration	Low/Med.	Medium	Medium	Med./High
Landscape Restoration	Low/Med.	Low/Med.	Low/Med.	Very High
Soils Amendment and Restoration	Medium	Low/Med.	Low/Med.	Medium

NOTES:
[1] All Stormwater function values from *PA Stormwater BMP Manual*
[2] Depends on if infiltration is used

Table 7.2. Stormwater Functions of Structural Best Management Practices

Several of the structural BMPs are particularly effective at achieving the criteria for control of stormwater presented in this Plan. The following practices should be considered where appropriate:

RAIN GARDENS

A rain garden, also referred to bioretention, is an excavated shallow surface depression planted with native, water-resistant, drought and salt tolerant plants with high pollutant removal potential that is used to capture and treat stormwater runoff. Rain gardens treat stormwater by collecting and pooling water on the surface and allowing filtering and settling of suspended solids and sediment prior to infiltrating the water. Rain gardens are generally constructed to provide 12 inches or less of pending depth with shallow side slopes (3:1 max). They are designed to reduce runoff volume, filter pollutants and sediments through the plant material and soil particles, promote groundwater recharge through infiltration, reduce stormwater temperature impacts, and enhance evapotranspiration. Their versatility has proved extremely successful in most applications including urban and suburban areas (Pennsylvania Stormwater Best Management Practices Manual, 2006).

Construction of rain gardens varies depending on site specific conditions. However, they all contain the same general components: appropriate native vegetation, a layer of high organic content mulch, a layer of planting soil, and an overflow structure. Often times, an infiltration bed is added under the planting soil to provide additional storage and infiltration volume. Also,

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perforated pipe can be installed under the rain garden to collect water that has filtered through the soil matrix and convey it to other stormwater facilities. Rain gardens can be integrated into a site with a high degree of flexibility and can be used in coordination with a variety of other structural best management practices. They can also enhance the aesthetic value of a site through the selection of appropriate native vegetation.

DRY WELL / ROOF SUMP

A dry well, sometime referred to as a roof sump, is a subsurface storage facility that temporarily stores and infiltrates stormwater runoff from the roofs of structures. Roof runoff is generally considered “clean” runoff, meaning that it contains few or no pollutants. However, roofs are one of the primary sources of increased runoff volume from developed areas. This runoff is ideal for infiltration and replenishment of groundwater sources due to the relatively low concentration of pollutants. By decreasing the volume of stormwater runoff, dry wells can also reduce runoff rate thereby improving water quality.

Roof drains are connected directly into the dry well, which can be an excavated pit filled with uniformly graded aggregate wrapped in geotextile or a prefabricated storage chamber. Runoff is collected during rain events and slowly infiltrated into the surrounding soils. An overflow mechanism such as an overflow outlet pipe, or connection to an additional infiltration area, is provided as a safety measure in the event that the facility is overwhelmed by extreme storm events or other surcharges (Pennsylvania Stormwater Best Management Practices Manual, 2006). Dry wells are not recommended within a specified distance to structures or subsurface sewage disposal systems.

VEGETATED SWALES

Vegetated swales are broad, shallow channels, densely planted with a diverse selection of native, close-growing, water-resistant, drought and salt tolerant plants with high pollutant removal potential. Plant selection can include grasses, shrubs, or even trees. These swales are designed to slow runoff, promote infiltration, and filter pollutants and sediments while conveying runoff to additional stormwater management facilities. Swales can be trapezoidal or parabolic, but should have broad bottoms, shallow side slopes (3:1 to 5:1 ratio), and relatively flat longitudinal slopes (1-6%). Check-dams can be utilized on steeper slopes to reduce flow velocities. Check-dams can also provide limited detention storage and increase infiltration volume. Vegetated swales provide many benefits over conventional curb and gutter conveyance systems. They reduce flow velocities, provide some flow attenuation, provide increased opportunity for infiltration, and providing some level of pretreatment by removing sediment, nutrients and other pollutants from runoff. A key feature of vegetated swales is that they can be integrated into the landscape character of the surrounding area. They can often enhance the aesthetic value of a site through the selection of appropriate native vegetation.

A vegetated swale typically consists of a band of dense vegetation, underlain by at least 24 inches of permeable soil. Swales constructed with an underlying 12 to 24 inch aggregate layer provide significant volume reduction and reduce the stormwater conveyance rate. The permeable soil media should have a minimum infiltration rate of 0.5 inches per hour and contain a high level of organic material to enhance pollutant removal. A nonwoven geotextile should completely wrap the aggregate trench (Pennsylvania Stormwater Best Management Practices Manual, 2006). There are several variations of the vegetated swale that include installing perforated pipe under the swale to collect water that has filtered through the soil matrix and convey it to other stormwater facilities or combining the swale with an infiltration bed to provide additional infiltration volume.

SUBSURFACE INFILTRATION FACILITIES

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Subsurface infiltration beds are created by placing storage facilities below the proposed surface grade that collects stormwater and provides temporary storage and allows water to slowly infiltrate. Infiltration facilities are designed to provide significant volume reduction through temporary storage and infiltration, which also benefits peak rate control and water quality. Subsurface beds are ideally suited for expansive, generally flat open spaces, such as lawns, playfields, and other recreational areas (PA DEP, 2006). These systems are also well suited for cold climates as they can function year-round if constructed below the frost line.

An infiltration bed usually consists of a layer of highly pervious planting soil and vegetation, underlain by a storage facility. Storage can be provided by an excavated pit filled with uniformly graded aggregate wrapped in geotextile or a prefabricated storage chamber. An overflow structure should be included to provide protection in case of extreme storm events or system failure. Additionally, inspection ports are often added to ease monitoring and maintenance. The bottom of the infiltration bed must be level and distribution systems must be added to larger facilities to ensure that water is infiltrated evenly over the entire surface area. The soil layer and vegetation provide water quality through filtration and increase evapotranspiration. A popular variation of this facility is an infiltration trench, which is the same concept applied as a linear facility. Infiltration trenches are often more shallow than infiltration beds and are designed for smaller flows than infiltration beds. These facilities provide groundwater recharge while also preserving or creating valuable open space and recreation areas.

IMPLEMENTATION OF STORMWATER MANAGEMENT CONTROLS

From a regulatory perspective, the standards and criteria developed in this Plan will be implemented through municipal adoption of the Model Stormwater Management developed as part of the Plan. 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 by all of the municipalities in Montour County.

From the pragmatic development viewpoint, the stormwater management controls will be put into practice through use of comprehensive stormwater management site planning and various stormwater BMPs. Site designs that integrate a combination of source reducing non-structural BMPs and runoff control structural BMPs will be able to achieve the proposed standards. A design example has been included in *Section VIII* and *Appendix B* to demonstrate how to incorporate the various aspects of the Model Ordinance into the stormwater management design process.

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Section VIII – Economic Impact of Stormwater Management Planning

Traditional Land Development Layout in Montour County

IMPLEMENTATION OF STORMWATER STANDARDS

The economic impact of managing urban stormwater runoff is a major concern. For example, the U.S. EPA has estimated the costs of controlling combined sewer overflows (CSO) throughout the U.S. at approximately $56 billion (MacMullan and Reich, 2007). Developing and implementing stormwater management programs and urban-runoff controls will cost an additional $11 to $22 billion (Kloss and Calarusse, 2006). There are direct economic impacts associated with implementation of stormwater management regulations, regardless of the type of stormwater control standards that are proposed. The design example provided in this section has been developed to highlight a site design approach that can reduce the costs of employing the proposed stormwater management control measures and, at the same time, maximize the benefits which they are intended to provide. The design example is then compared to a similar site design that uses traditional peak rate stormwater controls in order to provide an illustration of the direct economic impact of the proposed regulations using initial construction costs.

Site planning that integrates comprehensive stormwater management into the development process from the initial stages often results in efficiencies and cost savings. Examples of efficiencies include reduction in area necessary for traditional detention basins, less redesign to retrofit water quality and infiltration measures into a plan, and reduced costs for site grading and preparation. Planning for stormwater management early in the development process may decrease the size and cost of structural solutions since non-structural alternatives are more feasible early in the process. In the vast majority of cases, the U.S. EPA has found that implementing well-chosen LID practices, like the proposed stormwater management methods, saves money for developers, property owners, and communities while protecting and restoring water quality (EPA, 2007).

DESIGN EXAMPLE 1

The following design example illustrates the methods used to design stormwater management facilities and structural BMPs in accordance with the volume and peak rate control strategies developed within this Plan. The design process encouraged by the *Pennsylvania Stormwater 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 Ordinance. The SCS Runoff Curve Number Method is used for runoff volume calculations as suggested by the *Pennsylvania Stormwater BMP Manual* (2006). Refer to this document for additional guidance, rules and limitations applicable to these methods, and the design of structural and non-structural BMPs.

For the following example, Low Impact Design techniques are utilized to address the volume control and rate control requirements of the *Model Ordinance*. The example addresses these

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requirements for the entire development, not any single lot, thereby superseding the requirements of the *Small Project Stormwater Management Application*.

PRE-DEVELOPMENT CONDITIONS

The design example is a 10-lot single family residential subdivision on an 8.1 acre parcel with a total drainage area of 9.78 acres. The existing land use is partially wooded (2.29 acres) with a fallow agricultural field covering the remaining acreage. The entire site is tributary to Mill Run, which flows near the back of the property. All on-site soils are classified in hydrologic soil group B.

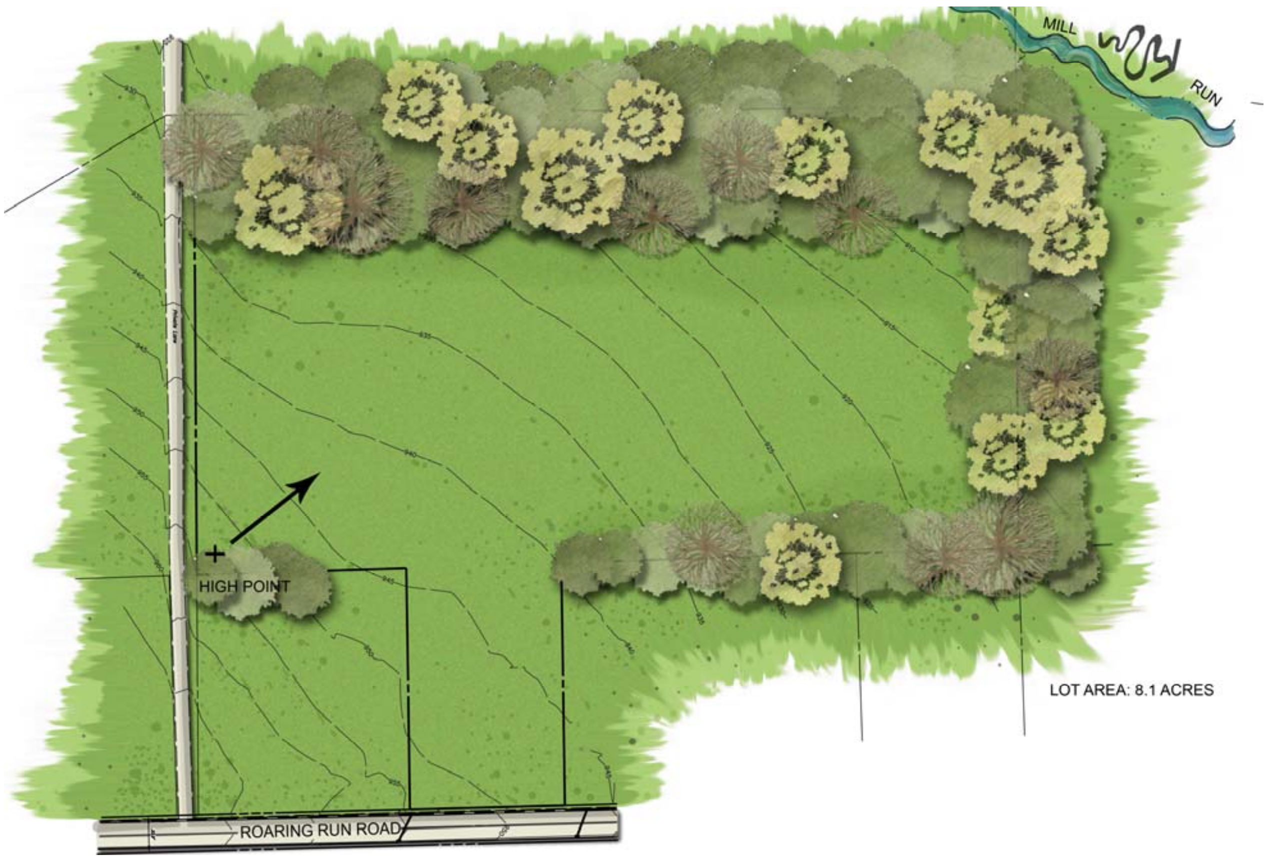

Figure 8.1. Design Example 1 – Pre-Development Conditions

Watershed:	Mill Run
Total Drainage Area:	9.78 acres
Existing Land Use:	Meadow = 7.49 acres
	Woods = 2.29 acres
Hydrologic Soil Group:	'B' – Entire Site
Parcel Size:	8.1 acres
On-Site Sensitive Natural Resources:	Woods (2.18 acres)
Pre-Development Drainage Area:	Meadow = 7.12 acres
	Woods = 0.98 acres
	Total = 8.10 acres

Table 8.1. Pre-Development Data

POST-DEVELOPMENT CONDITIONS

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All of the lots will be accessed by a single cul-de-sac road to be constructed for the subdivision. Each house has an assumed 2,150-sf impervious footprint. Various low impact design techniques were used in the site design. A large portion of the existing woodlands (1.31 acres) was preserved during construction and will remain wooded through a permanent easement on lots 6-9, the back portion of lots 9-10 were protected from compaction during construction and will remain protected through an easement, roof drains are disconnected from the storm sewer system and directed to dry wells, and rain gardens will be installed on each lot. Runoff from the roadway is collected by swales and conveyed to a bioretention area.

Figure 8.2. Design Example 1 – Post-Development Conditions

Proposed Land Use:	Meadow = 1.61 acres
	Woods = 1.32 acre
	Open Space = 5.43 acres
	Impervious = 1.13 acres
	Ponds as Impervious = 0.31 acres
Protected Sensitive Natural Resources:	Woods (1.31 acre)
Other Protected Areas:	Minimum Disturbance (0.37 acre)
Post-Development Drainage Area:	SWM Area = 7.74 acres
	Undetained = 0.36 acres
	Total = 8.10 acres
Proposed Lot Impervious Areas:	2,150 ft² / house
	1,000 ft² / lot

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Table 8.2. Post-Development Data

DESIGN PROCESS FOR VOLUME CONTROLS

The following is a summary of the design process used for implementation of the volume control and rate control requirements of the *Model Ordinance*. This is an outline of the sequence of steps that are used to implement the *Design Storm Method* through a combination of Non-Structural BMP Credits and Structural BMPs that remove volume through infiltration. Detailed calculations and example Worksheets are provided in *Appendix B* for additional clarification of the design process.

Step 1

The first task of the design process is to gather the pertinent site information as it relates to stormwater management. This general information determines which Ordinance provisions are applicable to the stormwater management design for the project. *Worksheet 1* is used for this task.

Step 2

The next step is to determine the sensitive natural resources that are present on the site. *Worksheet 2* is used to inventory these resources. These areas should be considered as the site layout is determined, and should be protected to the maximum extent practicable.

Step 3

As the site layout is being completed, thought should be given to which non-structural BMPs are appropriate for the site in order to reduce the need for stormwater management through structural BMPs. Once the site layout has been finalized 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". This is the land area which must be evaluated for volume of runoff in both pre-development and post-development conditions. Sensitive natural resources that have been protected are not used in the ensuing pre or post-development volume calculations, just as one would not incorporate offsite areas into volume calculations. The top of *Worksheet 3* shows this information. In the example, the 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.

Step 4

The next step is to calculate the volume "credits" for the non-structural BMPs that have been incorporated into the design. This reduces the total volume that is required to be infiltrated by structural BMPs. There are three practices 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 for the storm sewer system allows infiltration of some stormwater as it flows across the pervious surface. These calculations are completed on *Worksheet 3*.

The total non-structural credits are limited to 25% of the total required infiltration 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 infiltration volume. The total credits calculated must be checked to ensure the 25% threshold has not been exceeded.

Step 5

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

Step 6

Determine the type of structural BMPs that may be appropriate for the site and decide which practices will be used. Use *Worksheet 5.A* to calculate the volume of water that will be infiltrated by each BMP. Then, *Worksheet 5* is used to summarize the volume that will be infiltrated through structural practices. If the total structural volume is greater than (or equal to) the required volume, the volume control requirements of the *Model Ordinance* have been met.

Summary of Results

The design process outlined above was followed to design the facilities necessary to meet the volume control and peak rate control requirements of the *Model Ordinance*. The total required permanently removed volume is 12,599 ft^3. A summary of the results for Design Example 1 is provided in the table below:

Description of Stormwater Best Management Practice	Size (ft^3)	Volume Credit (ft^3)
Minimum Soil Compaction	16,200	337
Disconnect Non-Roof Impervious to Vegetated Areas	10,000	278
Total Non-Structural Volume:		615
On-Lot Rain Gardens (10)	6,740	5,049
On-Lot Dry Wells (10)	4,400	5,787
Bioretention	5,175	3,778
Total Structural Volume:		14,613
Total Volume Removed:		**15,228**

Table 8.3. Summary of BMP Credits

DESIGN OF PEAK RATE CONTROLS

In this example, additional stormwater control facilities are necessary to manage the increase in peak rate flows that would otherwise result from the development activities. Peak rate control facilities are designed to reduce post-development peak flows to, or below, pre-development peak flows. In release rate districts, post-development flows are further reduced to a given percentage of the pre-development peak flows. Design of peak rate controls necessitates flood routing, for which a flood hydrograph is required (PennDOT, 2008). A suitable hydrologic method is needed to generate runoff hydrographs for flood routing.

The Rational Equation (i.e., Q = C x I x A) was originally developed to estimate peak runoff flows. The Modified Rational Method is an adaptation of the Rational Method which is used to estimate runoff hydrographs and volumes. While, this method is useful for estimating peak flows from relatively small, highly developed drainage areas, various sources document the shortcomings of this method in developing hydrographs and estimating volume (PennDOT, 2008, DEP 2006). For this reason, use of the Rational Method is strongly discouraged for the volume-sensitive routing calculations necessary tor design detention facilities and outlet controls.

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The SCS Unit Hydrograph Method was developed to be used in conjunction with the Curve Number Runoff Method of generating runoff depths to estimate peak runoff rates and runoff hydrographs. While these methods have numerous limitations, the principal application of this method is in estimating runoff volume in flood hydrographs, or in relation to flood peak rates (NRCS, 2008). Therefore, the NRCS Rainfall-Runoff Method (i.e. using the Curve Number Runoff Method and SCS Unit Hydrograph Method together to produce rainfall-runoff response estimates) is the preferred method to calculate runoff peak rates and for rate control facility design calculations.

Various computer software programs are available for modeling rainfall-runoff simulations to perform peak rate control analyses for development projects. Most of the available computer modeling software is based on the NRCS Rainfall-Runoff Method. These models include the U.S. Army Corps of Engineers' Hydrologic Modeling System (HEC-HMS), SCS/NRCS Technical Release No. 20: Computer Program for Project Formulation Hydrology (TR-20) and Technical Release 55 (TR-55), NRCS National Engineering Handbook 650, Engineering Field Handbook, Chapter 2 (EFH2), and U.S. Environmental Protection Agency's Storm Water Management Model (SWMM). These modeling packages are further described in the *Pennsylvania Stormwater BMP Manual* (2006). There are also a variety of other commercially available software packages that complete many of the same functions. Designers should be careful when determining which software should be used to model a particular project to ensure that appropriate methods are being used (i.e., review the modeling method restrictions contained in the *Model Ordinance*).

DESIGN PROCESS FOR PEAK RATE CONTROLS

The peak rate analysis is carried out by completing a comparison of the post-development runoff peak rate to the pre-development runoff peak rate to determine if the rate controls of the *Model Ordinance* have been satisfied. Additional stormwater facilities, such as a detention basin and outlet structure, may be necessary to reduce post-development peak flow rates to the required peak flow rates. The volume of runoff removed by BMPs should be removed from the total runoff volume when completing peak rate calculations. This is necessary in order to size peak rate control facilities appropriately.

Step 1

The first step is to delineate the pre-development drainage area. This area should include all areas that will be tributary to any proposed stormwater facilities, including any off-site area. Any areas on site that have no proposed land-use changes, and are not tributary to the proposed stormwater facilities, can be removed from the drainage areas. Once the drainage area has been delineated, determine the soil-cover complex and the corresponding curve number for each subarea. If the drainage area contains multiple soil-cover complexes, the designer must determine the appropriate runoff estimation method. (A comparison of the two most prevalent methods is covered in *Appendix B*).

Step 2

The next step is to determine a time of concentration for the pre-development drainage area(s). The *Model Ordinance* requires use of the NRCS Lag Equation for all pre-development time of concentration calculations unless another method is pre-approved by the Municipal Engineer. The average watershed land slope of the pre-development drainage area(s) must be calculated for use in the Lag Equation.

Step 3

Use the information from the previous two steps to calculate the pre-development peak runoff rates for each design storm. Use design storm rainfall depths from NOAA Atlas 14

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specific to the area of interest, or the values provided in the *Model Ordinance*. Any appropriate method of estimating peak runoff rates and runoff hydrographs can be used, however use of hydrologic modeling software is the most common method.

Step 4

Delineate the post-development drainage area(s) and any sub-areas. Post-development sites generally have several drainage sub-areas with multiple soil-cover complex groups in each subarea. The designer must determine a suitable level of detail to be included in the post-development model based on the site design and site conditions. The runoff estimation method chosen for multiple soil-cover complexes should be appropriate for the level of detail that is modeled.

Step 5

Determine time of concentration values for the post-development drainage area(s). The NRCS Segmental Method is the preferred method for all post-development time of concentration calculations. The Segmental Method is used to calculate travel times for individual segments of sheet flow, shallow concentrated flow, and open channel flow which are summed to calculate the time of concentration. The *Model Ordinance* allows the NRCS Lag Equation to be used for residential, cluster, or other low impact designs less than or equal to 20% impervious area.

Step 6

Use the information from the previous two steps and relevant stormwater facility information (e.g. BMP size and outlet configuration, detention facility stage-discharge data, etc.) to calculate the post-development peak runoff rates for each design storm. This is most often done by using hydrologic modeling software to develop a model of the post-development site which is used to estimate peak runoff rates and runoff hydrographs.

The hydrologic model is used to finalize the design of the peak rate control facilities such as the detention basin and the outlet control structure. Steps 4-6 must be revisited whenever additional BMPs are added, or moved, or any change to the site design alters drainage areas.

Summary of Results

For this example, the peak rate control analysis was completed with hydrologic modeling software that is based on TR-20 modeling procedures. Every component of the stormwater design (including each structural BMP) was included in the model. This helped account for peak flow attenuation and permanent volume removal that was provided by the BMPs. The runoff volume removed by the BMPs was removed from the total runoff volume by using an option within the software. A detention basin providing 8,600 ft^3 of storage (plus the required freeboard depth) and associated outlet controls were necessary to reduce the 100-year post-development peak rate flows to the pre-development flow rate. If the effects of the individual BMPs had been ignored in the post-development model, the design would have needed a basin that provided 23,850 ft^3 of storage (plus the required freeboard depth) to achieve the required flow reduction for the 100-year storm. As shown in *Table 8.4* the peak rate control requirements of the *Model Ordinance* have been achieved.

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	Design Storm					
	1-year	2-year	10-year	25-year	50-year	100-year
Pre-Development	0.1	0.6	4.1	7.6	11.1	15.3
Post-Development with No SWM	2.5	5.2	14.5	21.9	28.8	36.6
Post-Development	0.1	0.4	4.1	7.4	10.6	15.3

Table 8.4. Summary of Peak Rate Flows

ECONOMIC IMPACT OF STORMWATER MANAGEMENT STANDARDS

Stormwater management standards are necessary to mitigate the adverse affects of increased stormwater runoff from developing areas. Implementation of these standards comes at a cost to regulators and developers alike. However, these costs are only a fraction of the costs associated with mitigating mis-managed or un-managed runoff. Since activities within a watershed do not always exhibit a direct and measurable cause and effect relationship, identifying some of the costs associated with stormwater management can be difficult and somewhat subjective. It can be similarly difficult to quantify certain costs and altogether impossible to assign an economic value to outcomes such as environmental benefits.

There are three principal methods available to assess the economics of implementing the proposed stormwater management regulations:

1. <u>Cost Comparison</u> – This is the most basic type of analysis. It is completed by comparing initial construction costs and other direct costs such as land value. This type of analysis is incomplete in scope in that it does to capture the benefits of improved stormwater management or variances in life-cycle costs such as operation and maintenance and life expectancy.

2. <u>Life-Cycle Cost Analysis</u> – A life-cycle cost analysis includes all costs throughout the projects period of service. This includes planning, design, installation, operation and maintenance and life expectancy. A life-cycle analysis gives a more complete financial comparison than a cost comparison, but again excludes the environmental and other benefits of improved stormwater management.

3. <u>Cost-Benefit Analysis</u> – This is the most thorough method of analysis and considers the full range of costs and benefits for each alternative. A cost-benefit analysis considers the same project costs as a life-cycle analysis, but includes the environmental and other benefits of improved stormwater management practices in the assessment. This method of analysis is very difficult because it requires valuation of costs and benefits which are not easily measured in monetary terms (i.e. environmental goods and services such as clean air, reduced erosion, or improved aquatic habitat). It is difficult to quantify the value of these non-market goods and services.

The amount of information required to perform a life-cycle cost or cost-benefit analysis makes use of these two methods impractical for this discussion. These methods are also complicated by the fact that costs and benefits are often realized by different parties. As an example, a developer/owner pays for initial construction costs, the owner can benefit from potential life-cycle cost savings, and the general public benefits from potential environmental benefits such as improved water quality. The flexibility, availability of data, and simplicity of cost comparisons make this the most commonly used method of comparison. A cost comparison will give a

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relatively accurate representation of the economic impact of the initial cost of implementing the proposed stormwater management controls.

A cost comparison has been completed for two conceptual stormwater management designs to provide an example of the direct costs associated with implementation of the standards contained within this Plan. The stormwater designs are based on the site used in the Design Example. The site layout is similar for both designs to reduce the number of variables. The first plan was designed to meet traditional peak-rate stormwater management standards of reducing the post-development peak flow rates to those present in pre-development conditions for all design storms. The second plan follows the design procedures found in this Plan and meets the volume control requirements of the *Model Ordinance*.

TRADITIONAL SUBDIVISION LAYOUT WITH PEAK RATE CONTROL DESIGN

The layout for this example is typical of conventional subdivision designs. All of the existing woodlands were converted to lawns and no measures were taken to reduce impervious area (e.g. front yard setbacks were not reduced to decrease driveway lengths). The roadway has a 24' cartway with concrete curbs, and there is a sidewalk on one side of the street. The traditional cul-de-sac is entirely paved. The stormwater design utilizes a conventional stormwater collection and conveyance system that uses the concrete curb to direct runoff towards inlets, and an HDPE pipe network carries runoff to a detention basin which is located at the low point on the property. A swale is placed near the downstream edge of the property to collect runoff that is not tributary to the storm sewer network and convey it to the detention basin. In the detention basin, a concrete outlet structure is designed to reduce peak flow rates before discharging to an outlet pipe. A rock rip-rap apron energy dissipater is installed at the pipe outfall.

Figure 8.3. Traditional Subdivision Layout (Designed for Peak Rate Control)

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LID SUBDIVISION LAYOUT WITH VOLUME CONTROL DESIGN

This design is the post-construction layout that was presented in the Design Example (see *Figure 8.2*). Several LID techniques were used to reduce runoff. This includes reducing impervious area, preserving existing woodlands where possible, and protecting areas from soil compaction. The roadway is reduced to an 18' cartway with 3' gravel shoulders and swales are employed to collect and convey roadway runoff. Roof runoff is directed to dry wells on each lot, rain gardens are installed on each lot to collect the runoff from on-lot impervious areas as well as part of the lawn runoff. A larger bioretention facility is used to treat runoff from common areas such as the roadway and remove additional runoff volume. A detention basin and concrete outlet structure is used to control the peak discharge rates. A level spreader installed at the end of the outfall serves as an energy dissipater and distributes flow.

COST COMPARISON

A cost comparison was completed for the two designs described above. This comparison consists of two components: 1) initial construction costs for the developer, and 2) land value in the form of sale price. Construction costs were calculated for only the design elements which differ between the two examples (i.e. earthwork, paving, and stormwater management facilities). Other construction costs were considered to be similar for both layouts and were omitted from the analysis. An itemized estimate of the initial construction cost is included in *Appendix* B. The results are summarized in *Table 8.5*.

Description	Traditional Layout	LID Layout
Earthwork	$ 23,950	$ 14,925
Storm Drainage	$ 102,769	$ 114,172
Paving & Curbing	$ 138,657	$ 53,790
Initial Construction Cost:	$ 265,376	$ 182,887
Cost / Sellable Acre:	$ 42,734	$ 28,355

Table 8.5. Results of Cost Comparison for Initial Construction Costs

The cost analysis performed for this example shows a cost savings of $14,379 per sellable acre in initial construction cost for the developer. These results must be combined with a land value comparison to provide a more accurate comparison.

The value of land is highly variable depending on various influencing factors. A value of $50,000/acre was assumed for this example as the cost per acre of developed land. This assumed value was used in the cost comparison to provide a more complete cost comparison. For this example, we have also assumed that some of the cost of constructing the stormwater BMPs will result in a dollar for dollar reduction in the market value of the sellable land. *Table 8.6* shows the total land sale value for each layout after subtracting the cost of BMP construction from market value.

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Description	Traditional Layout	LID Layout
Total Acres For Sale	6.21	6.45
2009 Market Value / Acre	$ 50,000	$ 50,000
BMP Cost / Acre	$ 0	$ 12,682
Calculated Market Value / Acre	$ 50,000	$ 37,318
Total Land Sale Value:	$ 310,500	$ 240,701

Table 8.6. Land Sale Value

A final cost comparison is completed by subtracting the initial construction cost from the land sale value to determine the cost difference between the two layouts. For this example, the developer realizes an increase in total profit of $12,690 by using the LID layout with no additional cost to individual homeowners.

Description	Traditional Layout	LID Layout
Land Sale Value	$ 310,500	$ 240,701
Initial Construction Cost	$ 265,376	$ 182,887
Total Profit for Project:	$ 45,124	$ 57,814

Table 8.7. Project Profit

Discussion of Costs

The cost comparison completed for the design example resulted in similar initial construction costs for each design, with a small final cost advantage for the volume control design. The proposed methods for implementing the proposed stormwater standards can cost less to install, have lower operations and maintenance (O&M) costs, and provide more cost-effective stormwater management and water quality services than conventional stormwater management controls (MacMullan and Reich, 2007; EPA, 2007). However, the costs and benefits of implementing the proposed stormwater management standards can be very site specific and will vary based on the BMPs used to meet the standards and site characteristics such as topography, soils, and intensity of the proposed development.

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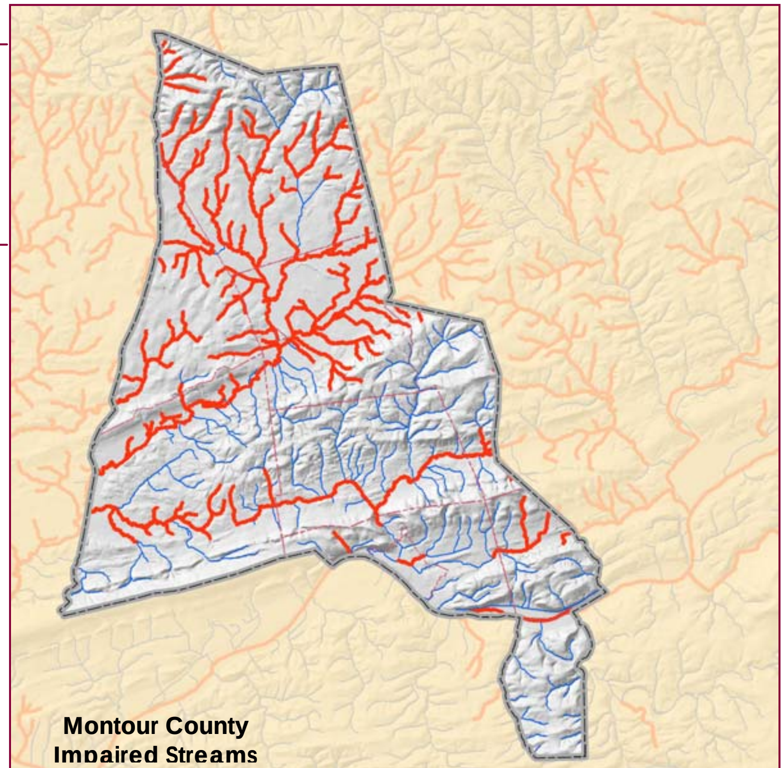
Section IX – Water Quality Impairments and Recommendations



The Clean Water Act is a series of federal legislative acts that form the foundation for protection of U.S. water resources. These include the Water Quality Act of 1965, Federal Water Pollution Control Act of 1972, Clean Water Act of 1977, and Water Quality Act of 1987. The goal of the Clean Water Act is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters". Section 305(b) of the Federal Clean Water Act requires each state to prepare a Watershed Assessment Report for submission to the United States Environmental Protection Agency (EPA). The reports include a description of the water quality of all waterbodies in the state and an analysis of the extent to which they are meeting their water quality standards. The report must also recommend any additional action necessary to achieve the water quality standards, and for which waters that action is necessary.

Section 303(d) of the Act requires states to list all impaired waters not meeting water quality standards set by the state, even after appropriate and required water pollution control technologies have been applied (USEPA, 2010). The law also requires that states establish priority rankings for waters on the list and develop Total Maximum Daily Loads (TMDLs) for these waters. A TMDL is the maximum amount of pollutant that a water body can receive and still safely meet the state's water quality standards for that pollutant. TMDLs are a regulatory tool used by states to meet water quality standards in impaired waterbodies where other water quality restoration strategies have not achieved the necessary corrective results.

IMPAIRED STREAMS

Pursuant to the provisions of the Clean Water Act, DEP has an ongoing program to assess the quality of waters in Pennsylvania and identify streams, and other bodies of water, that are not attaining designated and existing uses as "impaired". Water quality standards are comprised of the uses that waters can support, and goals established to protect those uses. Each waterbody must be assessed for four different uses, as defined in DEP's rules and regulations:

1. Aquatic life,
2. Fish consumption,
3. Potable water supply, and
4. Recreation

The established goals are numerical, or narrative, water quality criteria that express the in-stream levels of substances that must be achieved to support the uses. This assessment effort is used to support water quality reporting required by the Clean Water Act. DEP uses an integrated format for the Clean Water Act Section 305(b) reporting and Section 303(d) listing in a biennial report called the "Pennsylvania Integrated Water Quality Monitoring and Assessment Report". The

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narrative report contains summaries of various water quality management programs including water quality standards, point source control and nonpoint source control. In addition to the narrative, the water quality status of Pennsylvania's waters is presented using a five-part characterization of use attainment status (DEP, 2008). The listing categories are:

Category 1: Waters attaining all designated uses.

Category 2: Waters where some, but not all, designated uses are met. Attainment status of the remaining designated uses is unknown because data are insufficient to categorize the water.

Category 3: Waters for which there are insufficient or no data and information to determine if designated uses are met.

Category 4: Waters impaired for one or more designated use but not needing a total maximum daily load (TMDL). These waters are placed in one of the following three subcategories:

- Category 4A: TMDL has been completed.
- Category 4B: Expected to meet all designated uses within a reasonable timeframe.
- Category 4C: Not impaired by a pollutant and not requiring a TMDL.

Category 5: Waters impaired for one or more designated uses by any pollutant. Category 5 includes waters shown to be impaired as the result of biological assessments used to evaluate aquatic life use. Category 5 constitutes the Section 303(d) list submitted to EPA for final approval

MONTOUR COUNTY IMPAIRMENTS

If a stream segment is not attaining any one of its designated uses, it is then considered to be "impaired". In Montour County, all of the non-attaining streams were for Aquatic Life use attainment, which is reflective of any component of the biological community (i.e. fish or fish food organisms). The source-cause of impairment varies from stream to stream. Oftentimes, there are multiple source-causes attributed for impairment of a particular stream segment.

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Category	Act 167 Watershed					
	Chillisquaque Creek	Limestone Run	Mahoning Creek	Sechler Run	Entire County	Percent of County
Abandoned Mine Drainage	0.8	--	--	--	0.8	0.2
Agriculture	121.0	9.2	15.8	4.2	152.9	40.4
Atmospheric Deposition	--	--	--	--	--	--
Forestry	--	--	--	--	--	--
Hydromodification	--	--	--	--	--	--
Industrial or Municipal Point Source	5.4	--	--	--	5.4	1.4
Urbanization	7.0	--	--	--	7.0	1.8
Source Unknown	--	--	--	--	9.8	2.6
Other	--	--	0.8	0.5	1.3	0.3
Total Impaired	134.1	9.2	16.5	4.7	177.2	46.8
Percent of Total	67.6	67.5	21.1	25.2	46.8	46.8

Notes: Based on DEP Impairment List: *IntegratedListNonAttaining2009_10.zip*

Table 9.1. Summary of Detailed Study Streams in Montour County

Table 9.1 lists the non-attaining streams in Montour County and the source-cause of the pollution. 40.4 percent of all streams in Montour County have agricultural impairments, and 46.8 of all streams have some kind of impairments.

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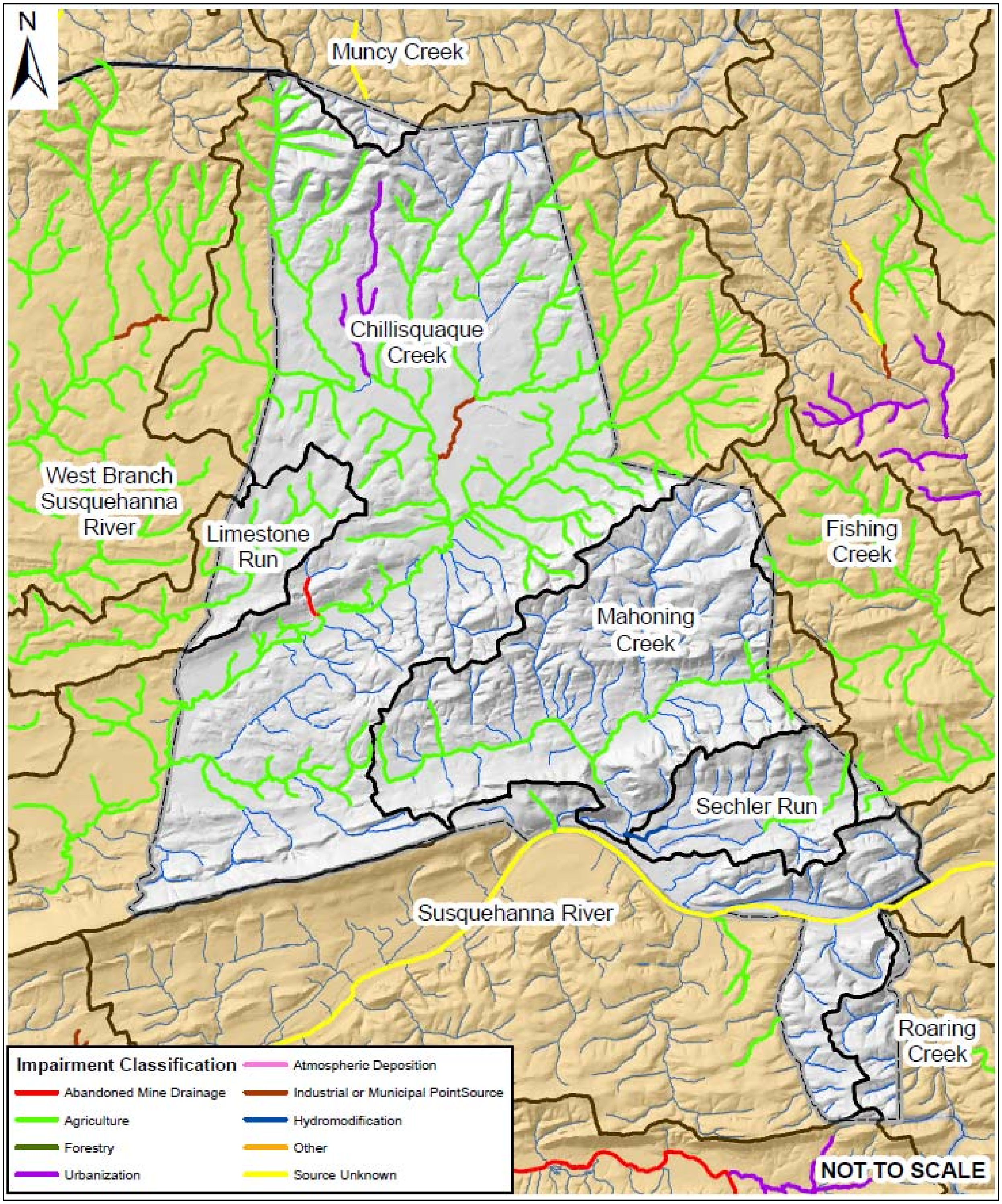

Figure 9.1. Non-Attaining Streams in Montour County

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TMDL DISCUSSION

Once a waterbody is listed on the EPA approved 303(d) list, it is required to be scheduled for development of a TMDL. TMDLs are expressed in terms of mass per time, toxicity, or other appropriate measures that relate to a water quality standard. They can be developed to address individual pollutants or groups of pollutants, if it is appropriate for the source of impairment.

A TMDL must identify the link between the use impairment, the cause of the impairment, and the load reductions needed to achieve the applicable water quality standards. However, a precise implementation plan is not part of the approved TMDL. A TMDL is developed by determining how much of the pollutant causing the impairment can enter the waterbody without exceeding the water quality standard for that particular pollutant. The calculated pollutant load is then distributed among all the pollutant sources as follows:

$$TMDL = WLA + LA + MOS$$

Where: TMDL = Total Maximum Daily Load

WLA = Waste Load Allocation; from point sources such as industrial discharges and wastewater treatment plants

LA = Load Allocation; from nonpoint sources such as stormwater, agricultural runoff and natural background levels

MOS = Margin of Safety

TMDL's are developed by the State and submitted to EPA for review and approval. Once a TMDL has been approved, it becomes a tool to implement pollution controls. It does not provide for any new implementation authority. The point source component of the TMDL must be implemented through existing federal programs with enforcement capabilities (e.g. National Pollution Discharge Elimination System, NPDES). Implementation of the Load Allocations for nonpoint sources can happen through a voluntary approach, or by means of existing state or local regulations.

There is one approved TMDL in Montour County for the Susquehanna River. This applies to the main stem of the Susquehanna River (Stream Code 06685) from the PA Route 92 bridge at Falls (River Mile 208.8) to the confluence with the West Branch Susquehanna River (River Mile 125.5). The TMDL is for PCBs located in the sediments of the Susquehanna that are believed to be a legacy of historical activities. The goal of this TMDL is to lower the current level of PCBs (0.02433 μg/L) to the criterion designated by the EPA of (0.00004 μg/L). The *Final Total Maximum Daily Load for the Susquehanna River, PCBs* suggests that natural attenuation may be the best implementation alternative since it involves the less habitat disturbance than other available methods (DEP, 1999).

CRITICAL SOURCES OF IMPAIRMENT

The primary causes of water quality impairment are sediment/siltation, nutrients, metals, and pathogens. Nonpoint source (NPS) pollution is a general term for water pollution generated by diffuse land use activities rather than from an identifiable or discrete facility. In Pennsylvania the leading nonpoint sources of impairment are:

- Abandoned Mine Drainage (AMD)
- Agriculture
- Urban Runoff/Storm Sewers

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- Road Runoff
- Forestry
- Small Residential Runoff
- Atmospheric Deposition

Some of these sources are regulated by stormwater ordinances and have been covered in previous section. However, several of these categories are more appropriately addressed by other regulations. Although these activities cannot be regulated by the provisions within the stormwater management ordinance of this Plan, they play a major role in the water quality of surface waters. The following is a summary of the nonpoint sources and causes for impairment that affect Montour County waters:

AGRICULTURAL ACTIVITIES

Agricultural land use has many beneficial effects on a landscapes response to rainfall and properly managed agricultural activities provide many positive environmental benefits. However, when improperly managed, these activities can cause significant degradation of water quality. Agricultural activities that can cause NPS pollution include confined animal facilities, grazing, plowing, pesticide spraying, irrigation, fertilizing, planting, and harvesting. The major pollutants that result from these activities are sediment and siltation, nutrients, pathogens, and pesticides. Agricultural activities can also damage habitat and stream channels.

SEDIMENT/SILTATION

The most common agricultural cause for surface water impairment is sediment and siltation. Of the 177 miles of impaired streams in Montour County, agriculture related siltation is attributed for 153 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 the first step in addressing siltation impairments. The majority of erosion problems are a result of plowing and tilling activities and concentrated livestock areas. 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. Nutrients such as nitrogen, phosphorus, potassium and other micronutrients are essential to 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

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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.

URBANIZATION

This is a broad category that includes the following three critical sources of impairment listed earlier in this section: 1) Urban Runoff/Storm Sewers, 2) Road Runoff, and 3) Small Residential Runoff. These sources have been grouped together because they are all types of urbanization, or human development activities. When development activities replace forests, fields, and meadows with impervious surfaces the landscape's capacity for initial abstraction is greatly reduced and surface runoff increases. This topic has been the focus of this Plan. The quantity of runoff from urbanized areas, and the water quality characteristics of the runoff, are the two base causes of surface water impairments. These two primary pollutants translate into surface water impairments in several different forms.

SEDIMENT/SILTATION

As stormwater flows over land it collects silt and sediment and carries them to surface waters. Urbanization decreases the opportunity for natural filtration of runoff through vegetation and often concentrates flow in discharges that cause increased overland erosion. The increased rate of stormwater flow and increased sediment load delivered to the stream combine to raise the in-stream energy. This in turn changes the physical structure of the receiving streams by causing increased bank erosion as well as scour of the streambed and sedimentation when the water finally slows down. Increased sediment loading in a stream contributes to increased total suspended solids and turbidity, which can in turn lead to increased stream temperatures as darker particles absorb heat (USEPA, 1997). As water temperature rises and dissolved oxygen levels decrease. These changes caused by sediment and siltation are all substantial contributors to aquatic life impairments.

HABITAT ALTERATIONS

Natural channels are composed of alternating sequences of pools, riffles, and runs. The diverse characteristics of each of these features provide unique habitats that allow various aquatic species to live, feed, and reproduce (USEPA, 2007). The elevated stream power that occurs when additional runoff and sediment loading are experienced causes physical alterations to the stream channel. The increased energy carries large debris downstream, erodes streambeds and banks, creates scour holes at existing structures, and deposits new sediment in the channel as flows subside. These changes can drastically alter the structure of pools, riffles, and runs and eventually diminish the quality of the habitat to a point where the stream can long longer support aquatic life.

NUTRIENTS AND METALS

As runoff flows over impervious surfaces it picks up various pollutants and transports them to waterbodies. This includes oil and grease from automobiles; fertilizers, herbicides and pesticides from lawns; fecal matter from pet waste and malfunctioning septic tanks; chlorides from winter road maintenance; and heavy metals from tires, shingles, paints, and metal surfaces. These pollutants degrade water quality and limit the beneficial uses of the surface waters. Beneficial uses that may be impacted include drinking water supply, swimming, fishing, other recreation, and aquatic life support.

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RECOMMENDATIONS

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 "Integrated Waters List" identifies impaired streams and identifies source-causes of impairment. The next step towards improving the water quality in these streams is 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.

An 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. This stage should be completed by a watershed planner with the technical knowledge necessary to accurately identify critical areas and the ability to provide a technical assessment of the severity of each source. The planner will need to prioritize the inventoried sites within the critical area based on the degree to which the sites contribute to the impairment and the overall objectives of the community.

It is important to involve the stakeholders within the watershed at this point in the form of a steering committee. A group such as a local watershed group or the County Conservation District would be able to assist in identifying the stakeholders and coordinating everyone's efforts. The planner and steering committee will work together 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. The next step in developing a comprehensive watershed plan is to set definable water quality goals based on the detailed inventory.

Developing an implementation strategy and determining specific BMPs to treat specific sites is the last step. Existing water quality programs should be considered as the implementation strategy is developed. These programs can be coordinated with the implementation strategy in order to achieve a common goal. Thought must also be 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 be reviewed and revised as necessary to ensure that the water quality goals are eventually obtained.

NONPOINT SOURCE POLLUTION REDUCTION PROGRAMS

Addressing environmental resource concerns and implementing conservation practices is one of the primary focuses of the Montour 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.

RECOMMENDED 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. Conservation planning services are offered by a variety of private consultants as well as state

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and federal agencies including the local county conservation district and USDA Natural Resource Conservation Service staff. The following BMPs have been identified as particularly well suited to address the impairments identified in Montour 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 (see *Riparian Buffers*). 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. According to the *Chesapeake Bay Program Best Management Practices, Agricultural BMPS – Approved for CBP Watershed Model* (PA DEP, 2007) the pollutant removal efficiency of this practice, with fencing and off-stream watering applied, is 60% (Nitrogen), 60% (Phosphorus), and 75% (Sediment). Without fencing, the efficiency is reduced to 30%, 30%, and 38% for nitrogen, phosphorus, and sediment respectively. This practice is eligible for several funding programs.

Riparian Buffers

Riparian areas, land situated along the bank of a water source, typically occur as natural buffers between uplands and adjacent water bodies. They act as natural filters of nonpoint 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 (see *Streambank Protection*). Re-establishing riparian buffers by planting forest buffer 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.

Additionally, wetlands and riparian areas also help decrease the need for costly stormwater and flood protection facilities. The efficiency of riparian buffers varies by hydrologic setting. This practice can be implemented with several funding programs such as CREP.

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 nonpoint source pollutants. This group also includes contour buffer strips, field borders, filter strips, vegetative barriers, and windbreaks (NRCS, 1999).

Barnyard Runoff Control

Animal concentration areas (ACA) 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 with 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 ACAs with roof runoff structures, diversions, and drainage structures. When barnyard runoff control is implemented without storage the pollutant removal efficiency is 20% (Nitrogen), 20% (Phosphorus), and 40% (Sediment) (PA DEP, 2007). When

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the practice is implemented in conjunction with a manure storage the nitrogen and phosphorus efficiencies are both reduced to 10% and the sediment efficiency remains the same.

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 (NRCS, 1999). 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 NPS pollution. Pollutant delivery reductions achieved by implemented nutrient management plans are greatly varied by individual agricultural operations and there is no efficiency directly associated with this practice. Several cost-share programs are available to assist costs associated with plan development and implementation.

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. Waste storage facilities have a nitrogen and phosphorus efficiency of 75%. This practice is eligible for funding through a few of the cost-share programs.

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 killed and left as ground cover prior to spring planting. Cover crops provide excellent soil erosion protection when the fields need it most. The County Conservation District has several cost incentive programs to encourage use of cover crops. The efficiency of cover crops varies based on when the crop is planted and whether or not the crop is harvested. The pollutant removal efficiencies and cost incentive programs are identified in the Appendix.

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 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. There is no efficiency associated with this practice. The effects of each tillage

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system can be calculated by the Revised Universal Soil Loss Equation (RUSLE), which will give an estimation of the annual soil loss for each field.

POTENTIAL FUNDING SOURCES

Montour County has a variety of potential sources for funding projects and individual practices that will help improve water quality. Some of these programs are county-wide and others are targeted specifically at impaired watersheds. This is a review of the major funding programs available for projects addressing water quality impairments, and not an all-inclusive listing. Funding sources available throughout the county include:

Conservation Reserve Enhancement Program (CREP) – This funding program offered by USDA's Farm Service Agency provides financial incentives to protect environmentally sensitive land by removing it from agricultural production and placing it in a conservation easement planted with permanent vegetation. CREP supports installation of conservation buffers, wetlands, and retirement of highly erodible land.

Conservation Security Program (CSP) – The CSP is a program administered by USDA-NRCS that rewards farmers who have already adopted good conservation systems by providing substantial incentives to expand or enhance current conservation efforts.

Environmental Quality Incentive Payment (EQIP) – This is a USDA - NRCS voluntary conservation program that promotes agricultural production and environmental quality as compatible goals. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land. Most agricultural BMPs are eligible for cost-share payments under this program

Growing Greener II – This grant program is available in Pennsylvania to "address some of the state's most pressing environmental problems, spark new growth in core communities, and create new opportunities for citizens". (PA DEP, 2005). Some of this funding was delegated to Pennsylvania DEP to clean up rivers and streams and address other serious environmental concerns.

Section 319 Funds – This funding source is administered by USEPA. Under Section 319 of the Clean Water Act, State, Territories, and Indian Tribes receive grant money which support a wide variety of activities including technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific nonpoint source implementation projects.

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Section X – Additional Recommendations and Considerations

The stormwater management standards developed in this Plan are the basis for sound stormwater management throughout the county. However, there are many activities that fall outside the scope of stormwater management regulations that have a significant impact on stormwater runoff and the goals of sound stormwater management planning. Generally, standards for many of these activities are contained withn Zoning Regulations and Subdivision and Land Development Ordinances. Some of these activities and their impact on stormwater management are discussed below.

These measures are included here because they are beyond the regulatory scope of this Plan but may provide valuable tools in obtaining the goals discussed in *Section II*. It is suggested that all municipalities consider these additional recommendations, and determine whether adoption of some of these policies could be beneficial to their respective communities. Municipalities with substantial stormwater problem areas could especially benefit from regulation of some, or all, of these activities. A holistic approach that considers all land use policies, and how they impact stormwater runoff, is necessary to maximize the effectiveness of a stormwater management program.

MUNICIPAL ZONING

Municipal zoning is perhaps the single most influential factor on a stormwater management program. This is because the rainfall-runoff response of a given geographical area is directly linked to land use. In this manner, zoning regulations can help achieve the goals of a stormwater program or they can be a hinderance to successful implentation of the program. Only 34% of rural municpalites have enacted zoning ordinances and the majority of these are located in the southeast portion of the Commonwealth (Center for Rural Pennsylvania, 2001). Instituting new zoning regulations, or even changes to existing regulations, can be very difficult. Potential obstacles may include political backlash from a perceived overreach in municipal regulation, increased enforcement costs, and a lack of professional staffing (often related to a lack of financial resources) in the development of regulations.

Despite the difficulties associated with implementing zoning regulation changes, this is a vital element of a successful stormwater management program. This being said, the impacts of zoning regulation reach far beyond stormwater management. Zoning changes should be developed with careful consideration of all of the potential effects of the ordinance changes.

Recommendations for Improved Municipal Zoning

The following zoning tools are recommended by the Center for Watershed Protection that, if possible to implement, may aid in achieving the stated goals of this Plan (Center for Watershed Protection, 1999):

- **Watershed Based Zoning** –Master planning efforts and zoning incorporate recommendations for individual watershed, with watershed specific regulations. Long-term monitoring and evaluation of the effectiveness of the regulations should be part of the program.

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- **Overlay Zoning** – With this option, specific criteria can be applied to isolated areas without the limitations of underlying base zoning. Overlay zoning superimposes additional regulatory standards, specifies permitted uses, or applies specific development criteria onto existing zoning provisions. Overlay zones may take up only part of an underlying zone or may encompass several underlying zones. An example of watershed-releated overlay zoning may be "Impervious Overlay Zoning" in areas with documented stormwater problems, which sets a maximum impervious area cap.
- **Performance Zoning** – This technique requires a proposed development to ensure a desired level of performance within a given area. This method has been used to control traffic or noise limits, light requirements, and architectual styles. Watershed-related performance zoning might provide precise limits on storwater quality and quantity. This may be one option to address impaired waters.
- **Large Lot Zoning** – This type of zoning district requires development to occur at very low densities to disperse impervious cover. This helps disperse the stormwater impacts of future development, but may contribute to urban sprawl.
- **Urban Growth Boundaries** – Growth boundaries set dividing lines for areas designated for urban and suburban development and areas appropriate for traditionally rural land uses, such as agriculture and forest preservation. Growth boundaries are typically set for up a specific time period (e.g. 10 to 20 years) and re-evaluated at appropriate intervals.
- **Infill Community Redevelopment** – This strategy encourages use of vacant or under-used land within existing growth centers for urban redevelopment. This practice is one method used to reduce the negative impacts of urban sprawl and minimize additional impervious area by miximizing utilization of existing infrastructure.
- **Transfer of Development Rights** – This allows transfer of development rights from sensitive subwatersheds (where the potential for adverse impacts is relatively high) to other watersheds designated for growth (where the potential for adverse impacts are relatively low).

RIVER CORRIDOR PROTECTION

River corridor protection is a very broad term that encompasses several closely related river (the term river is used loosely here to include all rivers, streams, creeks, etc.) management approaches. River corridors provide an important spatial context for maintaining and restoring the river processes and dynamic equilibrium associated with high quality aquatic habitats (Kline, 2008). The river corridor includes the existing channel, the floodplain, and the adjacent riparian zone. The basic concept behind river corridor protection is recognizing the natural functions of rivers and streams and managing them to resolve conflicts between the natural systems and human land use.

Rivers and streams adjust over time through dynamic fluvial processes in response to the varying inputs of water, sediment, and debris. Natural adjustments to these inputs are occuring continually in rivers and streams. These adjustments are generally minor and occur over long time periods. The result of these processes is evidenced in streambank erosion, channel incision, meadering stream channels, and the inevitable conflict between the stream and nearby human infrastructure. The more significant changes, such as channel relocation, usually occur during large flood events. River corridor protection includes the following management strategies to complement a stormwater management program:

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FLOODPLAIN MANAGEMENT

There is a direct relationship between stormwater management and floodplain management. Stormwater management policy focuses on future development and reducing the likelihood of increased flooding while floodplain management focuses on preventive and corrective measures to reduce flood damage. Implementation of the Model Stormwater Management Ordinance will reduce the probability of new flooding problems, but will have only minor impacts on existing problems. Examples of these problems are documented in *Section V – Significant Problem Areas and Obstructions*. Many of these problems are due to historic development that has occurred in the floodplain and inadequately sized infrastructure. Floodplains are necessary to convey and attenuate the natural peak flows that occur during major hydrologic events.

As discussed in *Section III*, Montour County incurs a substantial economic loss in major hydrologic events (as much as $6.98 million in a 10-year storm event). Floodplain management policy serves to minimize the impact of such events by reducing the conflicts between human infrastructure and floodplains. While improved stormwater management will greatly reduce the occurrence of nuisance flooding, floodplains are necessary to attenuate flood waters from events that exceed the intended scope of stormwater policy. The most effective floodplain management policy provides preventive provisions that restrict future development within floodplains and corrective measures that reduce flood damage in existing problem areas.

Recommendations for Floodplain Management

- **Adopt and enforce the Pennsylvania Department of Community and Economic Development (DCED) Model Floodplain Ordinance.** When the FIRMs in Montour County were updated, it was strongly recommended by DCED that each municipality adopt the DCED model ordinance. This will ensure that the local ordinance addresses the minimum state and federal requirements of the NFIP and provide a consistent basis of floodplain management between all of municipalities in the county.
- **Participate in the Community Rating System.** The CRS gives communities credit for reducing the risk of flood hazards. By implementing many of the same principles that are discussed in this Plan, municipalities can reduce flood insurance rates for residents inside of floodplains by up to 45%.
- **Provide open space preservation in floodplain areas.** Open space preservation may also provide credits to future developments by reducing impervious area and thereby reducing stormwater requirements.
- **Acquire and relocate flood-prone buildings so they are no longer within the floodplain.** Repetitive loss properties (properties for which two or more claims of at least $1000 have been paid by the NFIP within any 10-year period since 1978) constitute a large portion of the NFIP flood insurance claims. Nationally, less than 2% of all properties have accounted for 33% of flood insurance claims since 1978 (FEMA, 2002). Removing these and any other structure that incurs flood risk on an annual basis reduces the overall risk of the NFIP and reduces the community's exposure to flood damage. It is usually more economical to remove properties than to install structural alternatives such as levies, diversion projects, or dams.
- **Implement a drainage system maintenance program.** As noted in *Section V*, there are numerous locations where clogged or poorly maintained facilities result in flooding of areas not normally prone to flooding. Most engineering design calculations for stormwater detention and conveyance facilities, assume full function of a bridge or culvert. Implement a systematic inspection and maintenance program where periodic

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inspections are conducted on all channels, conveyance and storage facilities and remove debris and perform maintenance as necessary.

RIVER CORRIDOR PLANNING

River corridor planning is a process for selecting and implementing river corridor management alternatives in which all aspects of the river are considered. The process is accomplished through river specific assessments and planning that is able to characterize the river and identify important features as well as the areas that are susceptible to potential threats to those features. This is a form of land use planning that focuses on the impacts of land use on the river system.

One particularly useful aspect of river corridor planning is to use the assessment information to designate corridors along the rivers where natural river changes are most likely to occur resulting in accelerated erosion or bank failures. These areas are sometimes referred to as “fluvial erosion hazard zones” and are responsible for a large portion of the damage to human infrastructure during flood events (Dolan, 2008). Once these areas are identified and mapped, land use planning mechanisms are used to protect identified sensitive areas and limit future development within this zone. Keeping infrastructure, such as roads and utilities, out of the high risk areas greatly reduces the cost of protecting and maintaining this infrastructure.

Recommendations for River Corridor Planning

- **Identify areas that could benefit river corridor planning and initiate the planning process.** Identifying areas that could benefit from improved river corridor management can protect river resources and greatly reduce the economic impact caused by major hydrologic events. River corridor planning can be especially beneficial in areas with special value, areas that are likely to receive considerable future development near the river, or areas that currently experience persistent flood damage.
- **Identify and protect fluvial erosion hazard zones.** Flood damage may also occur as a stream channel changes course and meanders. The channel changes may result from either naturally occurring geologic processes or human-induced changes to watershed hydrology or hydraulics. A geomorphic assessment can identify the areas that are most likely to experience channel changes through erosion. These areas can then form the basis for an overlay zoning district or area with specified stream buffers for additional protection. Another option that has been implemented in the state of Vermont, is to integrate Fluvial Erosion Zones into the floodplain mapping process, so that all of the tools of floodplain management are available for the specified areas (Vermont Agency of Natural Resources, 2009).

RIPARIAN ZONE PROTECTION

The riparian zone is the transitional zone between the aquatic zone and adjacent uplands. It generally includes the streambanks, flood plain, and any adjacent wetlands. The riparian zone is often overlapping with the river corridor, but has a slightly different connotation. The term riparian zone does not refer to an explicit width, rather a width that varies along the length of a given stream depending on the geography of the area. Natural riparian zones are typically covered with trees, shrubs, and other types of local vegetation, all of which provide a natural buffer between waterways and human land use as well as providing vital and unique natural habitat.

Riparian zones 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

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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 zones is the water quality functions they offer. The vegetation in the riparian zone provides shade that reduces water temperature, traps and removes pollutants from stormwater, and provides protection from streambank erosion.

Recommendations for Riparian Zone Protection

- **Adopt and enforce the riparian buffer provisions of the Model Stormwater Management Ordinance.** The Model Ordinance includes provisions to require establishment of riparian buffers on all new development that occurs near watercourses. These requirements are in accord with the recently proposed changes to the statewide erosion and sediment pollution control regulations (Pennsylvania Code, Chapter 102). This will provide riparian zone protection by creating buffers between stream segments and all future development.
- **Establish a riparian zoning overlay district.** Identify critical riparian areas in which existing land uses may not be achieving water quality, floodplain management, and stormwater management objectives. Use this inventory of critical riparian zones to create a riparian zoning overlay district that establishes regulations on activities inside the zoning district.
- **Adopt stream specific guidelines where appropriate.** Where numerous problems areas have been identified and a riparian buffer is identified as a potential solution, a municipality may wish to adopt a stream specific set of guidelines that consider the specific fluvial geomorphological processes of that stream. A stream corridor study may be prepared that designates varying widths along a reach of stream. An ordinance that uses a stream corridor study as it basis will establish buffer widths using the best available scientific data. Some buffer ordinances have zones that vary between 75’ and 1000’ depending on the scientific and economic justification (Wenger and Fowler, 2000).
- **Encourage voluntary establishment of riparian buffers.** A regulatory approch will limit future development within the riparian zone, but will have little affect 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.

WETLAND PROTECTION

Wetlands play an essential role in stormwater management and water quality protection, as well as providing other valuable ecological and cultural functions. Some of the functions wetlands provide relevant to stormwater include: storm flow modification, erosion reduction, flood control, water quality protection, sediment and nutrient retention, and groundwater replenishment. Wetlands associated with lakes and streams provide temporary storage of floodwater by spreading the water over large flat areas, essentially acting as natural detention basins. This decreases peak flows, reduces flow velocity, and increases the time period for the water to reach the watersheds outlet. Novitzki (1979, 1989) found that basins with 30 percent or more areal coverage by lakes and wetlands have flood peaks that are 60 to 80 percent lower than the peaks in basins with no lake or wetland area.

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Wetlands can also maintain good quality water and improve degraded water. Wetland vegetation also decreases water velocities causing suspended solids to drop out of suspension, thus decreasing the erosive power of the water. Wetlands also trap, precipitate, transform, recycle, and export sediment, as well as nutrients, trace metals, and organic material. Water leaving a wetland can differ noticeably from that entering (Mitsch and Gosselink, 1993; Elder, 1987).

Recommendations for Wetland Protection

- **Identify and protect special value wetlands.** Due to the diversity of the benefits provided by wetlands, they are protected through various levels of federal and state regulations. These regulations protect wetlands from development, however, they permit minor wetland encroachments for certain activities. Some wetlands provide specific ecological or stormwater related benefits to an area. These wetlands should be identified and further protected through municipal regulations.

LOW-IMPACT DEVELOPMENT SITE DESIGN

The basic principles and concepts of LID were covered in *Section I* along with some of the benefits of implementing LID stormwater management practices. These concepts have been further developed throughout this Plan. This information has primarily discussed LID concepts as they relate to stormwater management. However, there are many non-stormwater LID practices that can have a very positive impact on a stormwater management program.

Development alters the natural landscape with human infrastructure like buildings, roads, sidewalks, parking lots, and other impervious surfaces. As previously discussed, all of these “improvements” alter the natural hydrology of a site and generate increased runoff. LID site design concepts include reducing impervious surface area, minimizing the amount of natural area disturbed during development, decentralizing stormwater management facilities, and generally attempting to minimize the effects of development on natural resources. Stormwater management can be improved by encouraging use of additional LID practices.

LIMIT IMPERVIOUS COVER

Increased impervious area within a watershed is a direct contributor to increased storm flows and decreased water quality. Research in recent years has consistently shown a strong relationship between the percentage of impervious cover in a watershed and the health of the receiving stream (USEPA, 2009). Various studies have indicated that as overall watershed imperviousness approaches 10% biological indicators of stream quality begin to show degradation. Limiting impervious cover is one method of reducing the impact of development on the hydrologic cycle.

Recommendations to Limit Impervious Cover

Some alternative development approaches within the LID approach include cluster development, reduction in street widths, reduction in parking space requirements (number and/or sizes), and creating a maximum impervious percentage on individual lots. Some specific elements within the LID framework include the following:

- **Road Widths** – These are usually specified based on the anticipated road use category (e.g., major, minor, collector). Most ordinances assume a standard 12-foot wide travel lane and then add width for shoulders, parking lanes, bicycle lanes, and other considerations. Reducing the travel lane width to 11 feet for minor roads (e.g., roads

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within a subdivision development) could reduce the impervious cover of those roadways by up to 8 percent.

- **On-Street Parking** – Parking lanes are often specified to be 8 or 10 feet wide. Standardizing the maximum width of these lanes to 8 feet would reduce runoff. Also, limiting parking to one side of a street, particularly in subdivisions, could result in a significant reduction in total runoff. Another option would be to require that the parking lanes be constructed of pervious pavement, grid blocks or another pervious surface.
- **Sidewalks** – In instances where ordinances require sidewalks, consideration should be given to only requiring them on one side of the street in order to reduce impervious cover. Also, sidewalks should be separated from the roadway surface by a "green strip" (e.g., grass or shrubs) to allow runoff from the impervious surface an opportunity to infiltrate before entering the roadway drainage system. In fact, the sidewalks could, in some instances, be laid out so that they do not parallel the roadway, providing even greater opportunity for infiltration.
- **Curb and Gutter Systems With Storm Sewers** – In heavy residential areas, many ordinances require the developer to install curb and gutters along roadways and to use inlets and storm sewers to remove and transport the runoff from the roads. Ordinances should be modified to allow roadside swales that would provide additional infiltration opportunity and some water quality benefit through filtration. This option would have the added benefits of significantly reducing development costs and minimizing future maintenance requirements.
- **Parking Requirements and Parking Stall Dimensions** – Consideration should be given to reducing the number of parking spaces that must be provided on-street or in parking lots for residential, commercial, educational, and industrial developments. Furthermore, stall sizes in parking lots should be set to 8-feet wide by 18-feet long. In addition, consideration could be given to requiring that larger parking lots establish special areas for compact cars with stall sizes reduced to 7-feet wide by 15-feet long. Finally, the ordinances should include requirements for a minimum amount of "green space" in parking lots which should allow runoff from the impervious surfaces to flow over them so that infiltration and water quality filtration would be enhanced.
- **Lot Sizes and Total Impervious Cover** – Most ordinances establish minimum lot sizes for various types of development and the number of "units" permitted on each lot. However, the ordinances do not always limit the amount of impervious cover that can be built on a specific lot, particularly in residential developments. Limits should be established and those limits should be used in determining the "post-development" runoff condition when designing the proposed storm water management systems. In addition, requirements should be established for the minimum amount of "green space" that should be provided in commercial, educational, and industrial developments and these "green spaces" should be designed so that runoff from the impervious surfaces can flow over them to the maximum extent practical.
- **Lot Setbacks** – There are at least two schools of thought regarding lot setbacks as they relate to stormwater management: 1) Minimizing lot setbacks will reduce driveway lengths and, thereby, reduce total impervious cover and 2) Maximizing lot setbacks will allow runoff from impervious surfaces (e.g., roof tops) greater opportunity to infiltrate prior to reaching roadway drainage systems. Either method could be beneficial as long as the method works in coordination with the other Ordinance requirements.

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LIMIT DISTURBANCE OR COMPACTION OF TOPSOIL

Topsoil is an absorbant top layer that provides significant stormwater management functions through initial abstraction. During rainfall events, no runoff occurs until the topsoil becomes saturated and the initial holding capacity of the soil is exceeded. The void spaces in undisturbed topsoil can provide significant water storage. The ability for initial abstraction can alter drastically from one soil type to another or because of varied site conditions. However, soil compaction plays a significant role in the ability of a given soil type to hold water. As topsoil is disturbed, or compacted, the holding capacity of the soil is drastically reduced, thus limiting its effectiveness in reducing runoff. Previous studies (Gregory, 2006) have shown that compacted pervious area effectively approaches the infiltration behavior of an impervious surface.

Recommendations for Topsoil Management

- **Adopt ordinance language that discourages the common practice of removing all topsoil from development sites during construction.** The area of disturbance during a project should be limited to the minimum area necessary to complete the project. This provides the dual benefit of limiting erosion during construction and improving post construction stormwater management.
- **Adopt ordinance provisions that limit soil compaction where possible.** Areas that are not disturbed should be protected from compaction by construction activities to the maximum extent practicable. These areas should be designated on site plans and demarcated and protected by in-field measures. This is especially important for areas intended for infiltration based stormwater management facilities.

IMPEDIMENTS TO LID IMPLEMENTATION

The LID concept has been around for a long time, but has been slow to catch on in mainstream implementation. In an effort to assess the impediments to LID in Chesapeake Bay portion of Virginia, Lassiter (2007) identified and ranked several impediments to LID implementation. The two most important impediment identified were 1) lack of education about the LID concept and 2) existing development rules that conflict with LID principles.

Other recent studies have found that existing municipal regulations are often a significant impediment to LID implementation (*Chesapeake Bay Program, 2002*). Many existing municipal regulations were developed to provide adequate infrastructure to meet the needs of growing communities. Often times these standards encourage use of unnecessary impervious surfaces such as extra wide streets in small residential areas, parking spaces for "worst-case scenarios" that get used only a few times a year, and dead-end sidewalks. Municipalities are encourage to review their ordinances for regulations that conflict with low-impact development and revise them to encourage the use of LID site design. There are many direct economic, environmental, aesthetic, and social benefits for a municipality adopting LID-friendly Ordinances.

Recommendations to Remove LID Impediments

- **Provide education activities and training workshops to various stakeholder groups.** As decision makers, and the group responsible for setting policy, municipal and county officials should be encouraged to obtain additional education on LID practices. Other stakeholders such as developers, builders, and homeowners should also have educational resources available to increase awareness and encourage implementation of LID practices. Education is the key to successful implementation of LID practices.

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- **Promote guidance documents such as this Plan and included references.** There are a variety of publications and internet sites that discuss LID and offer design solutions: Low Impact Development Center (2009), DEP (2006), and Prince George's County (2000). These resources should be made available through municipal offices, websites, or trainings.
- **Alter existing Subdivision and Land Development Ordinances and Zoning Ordinances to allow for successful LID implementation.** Adoption of the Model Stormwater Management Ordinance in this Plan is an important tool in accomplishing the goals of LID. However, 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 in order to advance the goals of this Plan. Potential alterations that may help create flexibility include: 1) creation of overlay zoning, 2) providing amendments to Ordinances to support LID efforts (i.e. reducing impervious cover and limiting topsoil compaction), or 3) creating an expedited waiver process for LID-specific requests.
- **Provide incentives for LID implementation.** Lassiter (2007) identifies tax credits, allowing for higher density developments, mitigation credits, and reduced land development fees for sites with LID developments as potential incentives to encourage developers to use LID.
- **Keep an inventory of LID efforts to help provide County-specific recommendations and successful BMP installation.** While considerable documentation exists on specific BMPs (e.g. National Research Council, 2008; DEP, 2006), very little scientific data exists within this region, and particularly this County. A valuable part of LID, one that is too often neglected, is the component of encouraging debate and expanding the LID knowledge base. Having an agency with a central role in land development permitting such as the Conservation District would be invaluable to developers and design professional in determining what works in Montour County – and what may not.

SUMMARY

Implementation of the standards developed in this Plan are a necessary step towards developing a holistic stormwater management plan, but much more can be done to improve how we manage water resources. There are many opportunities for local governments to improve the way this resource is managed, and protected, and the benefits are vast for those who undertake the challenge. There is a substantial number of technical resources available to guide development of regulations for proactive thinking municipalities.

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Section XI – Plan Adoption, Implementation and Update Procedures

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PLAN REVIEW AND ADOPTION

The opportunity for local review of the draft Stormwater Management Plan is a prerequisite to county adoption of the Plan. Local review of the Plan is composed of several parts, namely the Plan Advisory Committee review (with focused assistance from others including Legal Advisors and Municipal Engineer's review, Municipal review), and County review. Local review of the draft Plan is initiated with the completion of the Plan by the County and distribution to the aforementioned parties. Presented below is a chronological listing and brief narrative of the required local review steps through County adoptions.

1. Plan Advisory Committee Review - This body has been formed to assist in the development of the Montour County Act 167 Stormwater Management Plan. Municipal members of the Committee have provided input data to the process in the form of storm drainage problem area documentation, storm sewer documentation, proposed solutions to drainage problems, etc. The Committee met on four occasions to review the progress of the Plan. Municipal representatives on the Committee have the responsibility to report on the progress of the Plan to their respective municipalities. Review of the draft Plan by the Plan Advisory Committee will be expedited by the fact that the members are already familiar with the objectives of the Plan, the runoff control strategy employed, and the basic contents of the Plan. The output of the Plan Advisory Committee review will be a revised draft Plan for Municipal and County consideration.

   a. Municipal Engineers Review - This body has been formed to focus on the technical aspects of the Plan and to educate the Municipal Engineers on the ordinance adoption and implementation requirements of the Plan. The group met twice to solicit input as well as to receive comments and direction in the development of the model ordinance. The result of this is a revised draft model ordinance for Municipal and County consideration.

   b. Legal Advisory Review - This body has been formed to focus on the legal aspects of the Plan and to educate the Municipal solicitors on the ordinance adoption and implementation requirements of the Plan. The group met to provide input as well as to receive comments and direction in the development of the model ordinance. The result of this effort is a revised draft model ordinance for Municipal and County consideration.

2. Municipal Review - Act 167 specifies that prior to adoption of the draft Plan by the County, the planning commission and governing body of each municipality in the study area must review the Plan for consistency with other plans and programs affecting the study area. Of primary concern during the municipal review would be the draft Montour County - Act 167 - Stormwater Management Ordinance that would implement the Plan through municipal adoption. The output of the municipal review will be a letter directed

to the County outlining the municipal suggestions, if any, for revising the draft Plan (or Ordinance) prior to adoption by the County.

3. County Review and Adoption - Upon completion of the review by the Plan Advisory Committee, with assistance from the Municipal Engineer and Legal Advisory focus groups, and each municipality, the draft Plan will be submitted to the County Board of Commissioners for their consideration.

The Montour County review of the draft Plan will include a detailed review by the County Board of Commissioners and an opportunity for public input through the holding of public hearings. Public hearings on the draft Plan must be held with a minimum two-week notice period with copies of the draft Plan available for inspection by the general public. Any modifications to the draft Plan would be made by the County based upon input from the public hearings, comments received from the municipalities in the study area, or their own review. Adoption of the draft Plan by Montour County would be by resolution and require an affirmative vote of the majority of the members of the County Board of Commissioners.

The County will then submit the adopted Plan to DEP for their consideration for approval. The review comments of the municipalities will accompany the submission of the adopted Plan to DEP.

IMPLEMENTATION OF THE PLAN

Upon final approval by DEP, each municipality within the county will become responsible for implementation of the Plan. Plan implementation, as used here, is a general term that encompasses the following activities:

- Adoption of municipal ordinances that enable application of the Plans provisions.
- Review of Drainage Plans for all activities regulated by the Plan and the resulting ordinances.
- Enforcement of the municipal regulations.

Each municipality will need to determine how to best implement the provisions of this Plan within their jurisdiction. Three basic models for Plan implementation are presented in *Table 11.1* below. In some cases it may be advantageous for multiple municipalities to implement the Plan cooperatively, or even on a county-wide basis.

Individual Municipal Model	Each municipality passes, implements, and enforces the SWM ordinance individually.
Multi-Municipal Model	Several municipalities cooperate through a new, or existing, service-sharing agreement (COG, Sewage Association, etc.)
County Service Provider Model	County department, or office, (e.g. County Planning Entity or County Conservation District) provides SWM ordinance implementation and enforcement services to municipalities.

Table 11.1. Models for Municipal Plan Implementation

Regardless of what model is used for implementation, each municipality will need to adopt regulations that enable the chosen implementation strategy. For municipalities that choose the Individual Municipal Model, this means municipal adoption of the Model Ordinance or integration of the Plan's provisions into existing municipal regulations. For the other two models, this will require ordinance provisions that designate the regulatory authority and adoption of an inter-municipal agreement or service-sharing agreement.

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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, the Montour County Planning Commission and the Montour County Conservation District for compliance with the provisions of the Plan and consistency among the various related regulations. Additionally, the adopted regulations may be reviewed by PADEP for compliance with this Plan.

PROCEDURE FOR UPDATING THE PLAN

Act 167 specifies that the County must review and, if necessary, revise the adopted and approved study area plan every five years, at a minimum. Any proposed revisions to the Plan would require municipal and public review prior to County adoption consistent with the procedures outlined above. An important aspect of the Plan is a procedure to monitor the implementation of the Plan and initiate review and revisions in a timely manner. The process to be used for the Montour County Act 167 Stormwater Management Plan will be as outlined below.

1. Monitoring of the Plan Implementation - The Montour County Planning Commission will be responsible for monitoring the implementation of the Plan by maintaining a record of all development activities within the study area. Development activities are defined and included in the recommended Municipal Ordinance. Specifically, the MCPC will monitor the following data records:

    a. All subdivision and land developments subject to review per the Plan which have been approved within the study area.
    b. All building permits subject to review per the Plan which have been approved within the study area.
    c. All DEP permits issued under Chapter 105 (Dams and Waterway Management) and Chapter 106 (Floodplain Management) including location and design capacity (if applicable).

2. Review of Adequacy of Plan - The Plan Advisory Committee will be convened periodically to review the Stormwater Management Plan and determine if the Plan is adequate for minimizing the runoff impacts of new development. At a minimum, the information to be reviewed by the Committee will be as follows:

    a. Development activity data as monitored by the MCPC.
    b. Information regarding additional storm drainage problem areas as provided by the municipal representatives to the Watershed Plan Advisory Committee.
    c. Zoning amendments within the study area.
    d. Information associated with any regional detention alternatives implemented within the study area.
    e. Adequacy of the administrative aspects of regulated activity review.

The Committee will review the above data and make recommendations to the County as to the need for revision to the Montour County Act 167 Stormwater Management Plan. Montour County will review the recommendations of the Plan Advisory Committee and determine if revisions are to be made. A revised Plan would be subject to the same rules of adoption as the original Plan preparation. Should the County determine that no revisions to the Plan are required for a period of five consecutive years, the County will adopt resolutions stating that the Plan has been reviewed and been found satisfactory to meet the requirements of Act 167 and forward the resolution to DEP.

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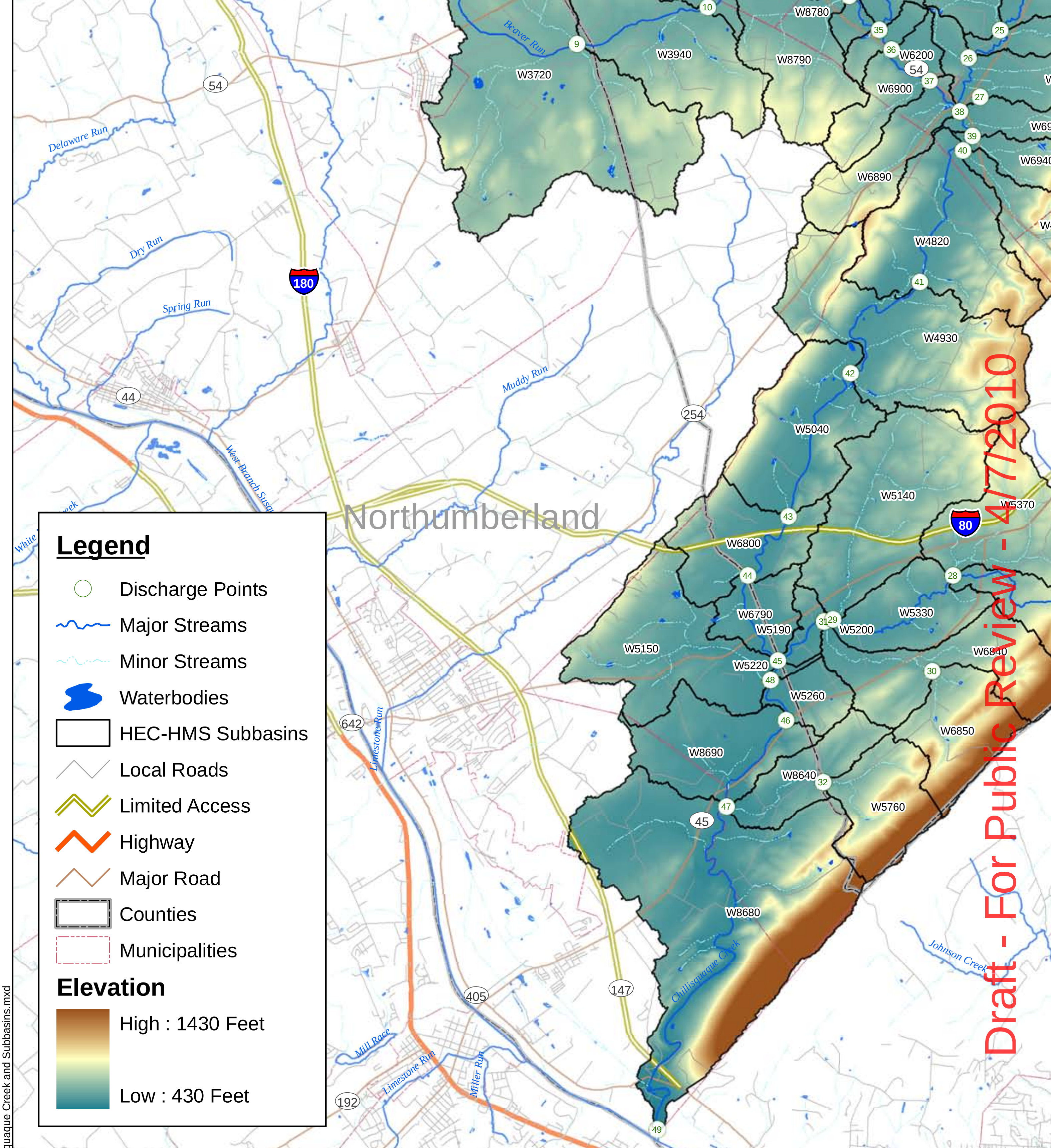

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Scale in Miles

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NOTE:
Portions of this map that are provided for spatial reference only were generated from existing sources and may contain discrepancies that have not been corrected as part of this ACT 167 Plan.

DATA SOURCES:
HEC-HMS Basins - HRG
Streams and Waterbodies - USGS NHD (2009)
Municipalities - PASDA (2004)
Major Highways - ESRI (2008)
Roads - PennDOT (2009)
Counties - PASDA (2004)

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