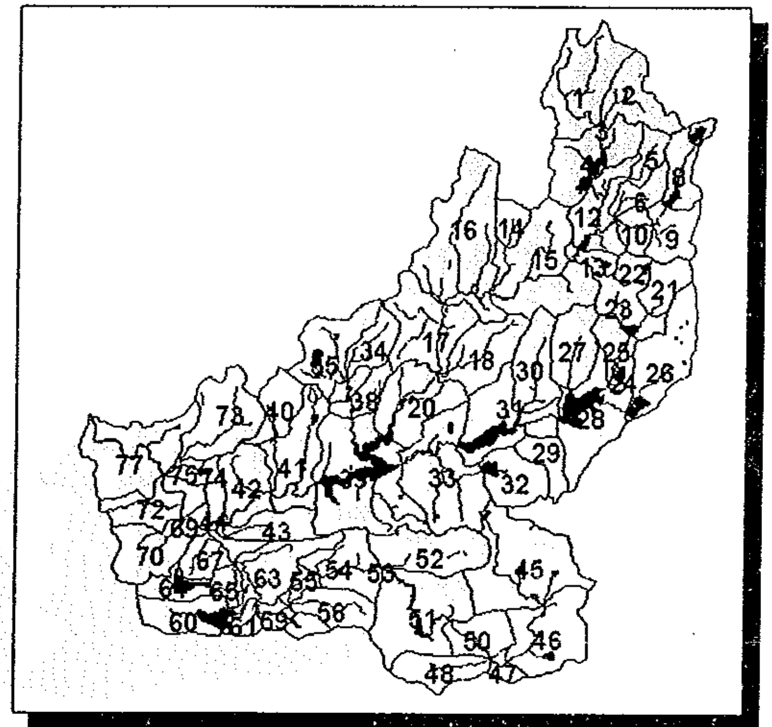
# ACT 167

## Watershed Stormwater Management Plan

### Volume I Executive Summary



# Tobyhanna Creek Watershed

## Monroe County, Pennsylvania

File No. SWMP 314:45
Project No. 95099.01-.12

**Prepared For:**
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# Act 167
# Watershed Storm Water Management Plan
# Phase II
# Tobyhanna Creek Watershed

Agreement No. SWMP 314:45
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# VOLUME I
# EXECUTIVE SUMMARY


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# VOLUME I - EXECUTIVE SUMMARY

## TABLE OF CONTENTS

# VOLUME I - EXECUTIVE SUMMARY

## I. BACKGROUND INFORMATION

### A. INTRODUCTION

The Tobyhanna Creek watershed is located in the north-west portion of Monroe County, with a portion in the eastern carbon County and southern Wayne County. the creek flows in a westward direction from its headwaters in coolbaugh township to its mouth at the Lehigh River near Blakeslee.

Large portions of this watershed are undeveloped with a potential for extensive growth. The effects of this proposed growth and development on drainage, flooding, and erosion problems is a major concern for county and township officials and affected property owners. Extensive commercial growth along Route 940 and Route 115 can result in accelerated storm water runoff which has the potential of causing flooding and erosion problems for property owners along the Tobyhanna Creek. Stream water quality can also become degraded as impervious areas grow throughout the watershed.

### B. STORM WATER RUNOFF - ITS PROBLEMS AND ITS SOLUTIONS

The water that runs off the land into surface waters during and immediately following a rainfall event is referred to as storm water. In any watershed in which development occurs, the volume of storm water resulting from a particular rainfall event increases because of an increase in impervious land area (i.e., pavement, concrete, or buildings). That is, the alteration of natural land cover and land contours to residential, commercial, industrial and even crop land uses results in decreased infiltration of rainfall and an increased rate and volume of runoff.

As development pressures increase, so will the problem of dealing with the increased quantity of storm water runoff. Failure to properly manage this runoff will result in greater flooding, stream channel erosion and siltation, as well as reduced groundwater recharge. This process occurs when the land development process causes changes in land surface conditions.

History has shown that individual land development projects are often viewed as separate incidents, and not necessarily a part of "a bigger picture". This has also been the case when the individual land development projects are scattered throughout a watershed ( and in many different municipalities). However, it is now being observed and verified that this cumulative nature of individual land surface changes dramatically effects flooding conditions. This cumulative effect of development in some areas has resulted in flooding of both small and large streams with property damages running into the millions of dollars and even causing loss of life. 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 and/or strategy is to be successful.

## C. STORM WATER MANAGEMENT

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

Storm water management involves cooperation between the state, county and local officials and involves proper planning, engineering, construction, operation and maintenance. This entails educating the public and local officials, and requires program development, financing, revising policy, development of workable criteria and adoption of ordinances. The Tobyhanna Creek Watershed Storm Water Management Plan, under the Storm Water Management Act, will enable the Tobyhanna Creek watershed to develop in a controlled, systematic fashion utilizing both structural and non-structural measures to properly manage storm water runoff in the watershed.

## D. STORM WATER MANAGEMENT ACT

The Pennsylvania General Assembly, recognizing the adverse effects of inadequate management of excessive rates and volumes of storm water runoff resulting from development, approved the Storm Water Management Act, P.L. 864, No. 167, October 4, 1978. Act 167 provides for the regulation of land and water use for flood control and storm water management purposes. It imposes duties and confers powers to the Department of Environmental Resources, municipalities and counties, and provides for enforcement, and making appropriations. The Act requires the Department to designate watersheds and develop guidelines for storm water management and model storm water ordinances (the designated watersheds were approved by the Environmental Quality Board July 15, 1980, and the guidelines and model ordinances were approved by the Legislature May 14, 1985). The Act provides for grants to be appropriated by the General Assembly and administered by the Department for 75% of the allowable costs for preparation of official storm water management plans and administrative, enforcement and implementation costs incurred by any municipality or county in accordance with Chapter III - Storm Water Management Grants and Reimbursement Regulations (adopted by the Environmental Quality Board August 27, 1985). Each county will prepare and adopt a watershed storm water management plan for each of its designated watersheds in consultation with the municipalities and will periodically review and revise such plans at least every five years when funding is available. Within six months following adoption and approval of each watershed storm water plan, each municipality is required to adopt or amend, and implement ordinances and regulations as are necessary to regulate development within the municipality in a manner consistent with the applicable watershed storm water plan and the provisions of the Act. Developers are required to manage the quantity, velocity, timing and direction of resulting storm water runoff in a manner which adequately protects health and property from possible injury, and must implement such measures that are consistent with the provisions of the watershed plan and the Act. It also provides for civil remedies for those aggrieved by inadequate management of accelerated storm water runoff.

## E. PURPOSE OF THE STUDY

There is an increased state-wide, as well as local recognition, that a sound and effective storm water management plan should be a diversified multiple purpose plan. This plan should address the full range of hydrologic consequences resulting from development instead of simply focusing on controlling site-specific peak flow, without consideration of tributary timing, flow volume reduction, base flow augmentation, water quality control and ecological protection.

Managing storm water runoff on a site-specific basis does not meet the requirements of watershed-wide storm water management objectives. The timing of flood peaks for each subbasin within a watershed contributes greatly to the flooding potential of a particular storm. Each storm water control site within a subbasin should be managed by evaluating the comprehensive picture. The overall objective of the Plan is to maintain peak flows throughout the watershed to existing conditions as the watershed becomes developed.

By developing the Tobyhanna Creek Watershed Storm Water Management Plan, reasonable regulation of development activities can be administered to control accelerated runoff and thus protect the health, safety and welfare of the public. The plan shall include recognition of the various rules, regulations and laws at the federal, state, county and municipal level. Once implemented, the plan will aid in reducing costly flood damages by reducing the source and cause of local uncontrolled runoff. The plan will make municipalities and developers more aware of comprehensive planning in storm water control and will also help maintain the quality of the Tobyhanna Creek and its tributaries to sustain their reputation as high quality waters.

## F. PLAN FORMAT

The plan format of the Tobyhanna Creek Storm Water Management Plan consists of Volume I, Executive Summary, Volume II, Plan Content, and the Technical Appendices. Volume I provides an overview of Act 167 and Watershed Level Storm Water Management.

Volume II provides the purpose of the study, data collection, identification of existing problems, present conditions, projected and alternative land development patterns and the model ordinance. Volume II also assesses the impact of managing storm water by utilizing the criteria and standards set forth in this plan.

The technical appendices provide all of the supporting data, procedures, parameters and watershed modeling.

In order to provide for planning consistency in computational methods utilized for storm water calculations in the Tobyhanna Creek watershed, standards and criteria had to be established. Thus, standards were established for runoff curve numbers, rational 'C' values, rainfall depths and intensities, and time of concentrations.

## II. PLAN PREPARATION PROCESS

The detailed process involved in the preparation of the Tobyhanna Creek Watershed Act 167 Plan included the documentation of the physical watershed characteristics, development of a computer runoff simulation model based upon the documented watershed characteristics, "calibration" of the computer model to reflect recorded runoff conditions and analysis of computer results to devise the watershed runoff control strategy. A brief description of the basic steps involved is presented below.

### A. DOCUMENTATION OF THE PHYSICAL WATERSHED CHARACTERISTICS

Existing physical characteristics of the watershed were obtained from field surveys, published data, aerial photography and topographic map interpretation. Data acquired included existing land use, soils, land slopes, water impoundments and flow obstructions. A future condition land use was developed through interpretation of existing growth patterns.

### B. DEVELOPMENT AND CALIBRATION OF A COMPUTER RUNOFF SIMULATION MODEL FOR THE TOBYHANNA CREEK WATERSHED

The 127 square mile Tobyhanna Creek watershed was subdivided into 74 subareas for computer modeling purposes. With the assistance of a Geographic Information System (GIS), the physical watershed characteristics were aggregated by subarea for use as model input. The computer model used was the Penn State Runoff Model (PSRM) which generates runoff for each subarea and accumulates the runoff as flow proceeds downstream. "Calibration" of the model involves adjustment of certain model parameters within generally accepted limitations so that the model produces events consistent with historically recorded events. The calibrated model was run for design storm conditions to generate runoff events which could be analyzed to develop an appropriate runoff control strategy for the watershed. A "design storm" is an event that should produce the maximum reasonable runoff for a given rainfall depth due to an optimized rain pattern.

In the modeling analysis of the Tobyhanna Creek watershed the 1, 2.33, 5, 10, 25, 50 and 100-year type II storms were analyzed for the 1, 6, 12, and 24-hour durations. The highest peak flows occurred during the 24-hour storm events not only for the total watershed but for the individual subareas also. This coupled with the general acceptance of the 24-hour type II storm for design purposes prompted a designated design duration of 24 hours for use in the obstruction capacity analysis. The determination of the storm frequency for standards and criteria development was not as simple. Act 167 does not address what storm frequency should be utilized. The intent, however, would be not to allow any increase in flows for any storm frequency. Since the Federal Flood Insurance Studies are based upon the 100-year flood elevations, and these elevations would increase if the peak flow increased (assuming the same channel dimensions), it would not make sense to ignore controlling runoff from the 100-year storm. Control or management measures for the 100-year storm can, however, become costly. On the other hand, controlling the first flush of storm events entraps sediment and improves water quality.

Thus, controlling a high frequency (i.e. one or two years) storm would promote infiltration and groundwater recharge and improve stream baseflow and water quality. Intermediate storms could also not be ignored since most structures in the watershed had been designed for these intermediate storms. Designing storm water control structures for every storm frequency would require an elaborate multi-stage outlet structure and a very large storage volume.

An analysis was therefore performed to find a combination of design storms which would provide protection over the entire range of design storm frequencies, yet not impose economic difficulties on the developer. The results of the analysis indicates that by limiting post-development outflow to pre-development conditions as specified in Section III-A the entire range of storm frequencies is essentially controlled. The design storm for which developers will have to manage runoff is therefore dependent on the Detention District in which the site is located.

## C. RUNOFF CONTROL STRATEGY DEVELOPMENT

An analysis was performed to find a combination of design storms which would provide protection over the entire range of design storm frequencies, yet not impose economic difficulties on the developer. In addition, capacities of obstructions, locations of problem areas and flood potential all had to be evaluated in determining which design storms should be managed.

The basic runoff control strategy employed for the Tobyhanna Creek watershed is to not increase peak runoff rates throughout the watershed even after development activities take place. Whereas conventional site design would only consider the runoff impact of development at the downstream end of the site itself, the comprehensive approach requires analysis of site runoff at points further downstream. Total volume of runoff increases with development of a site. With the increase in impervious area which accompanies site development, storm water volumes inevitably increase, unless of course the increase in runoff volume is recharged to the ground water. The timing of the watershed subareas must be thoroughly analyzed to determine storm water management criteria (or performance standard districts) to account for this increase on runoff volume and subarea timing. Thus, these districts will have varying degrees of storm water control criteria to achieve the goal of no net increase in flood flows within the watershed as shown on Plate I. The conclusion from the comprehensive approach is that in exchange for the increase in runoff volume with development, the rate of runoff leaving a site may have to be decreased. The magnitude of the required decrease in peak rate for a given site is determined from the computer model.

## III. WATERSHED LEVEL STORM WATER MANAGEMENT

### A. DESCRIPTION OF PERFORMANCE STANDARD DISTRICTS

In performing the tasks for the Tobyhanna Creek Watershed Plan under Act 167, a major goal was to determine where in the watershed storm water detention was appropriate for new development and, just as importantly, where detention was not appropriate. It was also important to determine to what extent storm water detention would be required in individual subareas. Individual subareas would fall into one of five districts:

The Tobyhanna Creek Watershed has been divided into five storm water management districts as follows:

Development sites located in each of the A, B, or C District must control post-development runoff to pre-development rates for the design storms as follows:

| District | Subareas | Post-Development | Pre-Development |
|---|---|---|---|
| A | 1-4, 7, 8 | 2.33-year | 2.33-year |
| | 21-40, 43 | 10-year | 10-year |
| | 45-67, 73 | 50-year | 50-year |
| B | 5,6, 9-20 | 10-year | 2.33 year |
| | | 50-year | 10-year |

C Development sites which can discharge directly to the Tobyhanna Creek main channel or major tributaries or indirectly to the main channel through an existing stormwater drainage system (i.e., storm sewer or tributary) may do so without control of post-development peak rate of runoff. If the pos-development runoff is intended to be conveyed by an existing stormwater drainage system to the main channel, assurance must be provided that such system has adequate capacity to convey the increased peak flows or will be provided with improvements to furnish the required capacity. When adequate capacity of downstream structure does not exist and will not be provided through improvements, the post-development peak rate of runoff must be controlled to the predevelopment peak rate as required in District A provisions for the specified design storms. The subwatershed areas which are included in this district are: 41, 42, 44, 68-72, 74-77.

Development in those subareas designated on Plate I, in District C must convey the generated storm water runoff to a stream or watercourse in a safe manner. The conveyance must manage the quantity, velocity and direction of resulting storm water runoff in a manner which otherwise adequately protects health and property from possible injury pursuant to Act 167, does not overtax existing drainage facilities and does not cause erosion or sedimentation. Anyone who proposes no detention must show that the downstream natural or man-made channel or watercourse has the capacity within its banks to convey the 2-year design storm at velocities which are not erosive. Acceptable velocities shall be based upon criteria contained in the DER "Erosion and Sediment Pollution Control Program Manual". The 50-year design storm must also be safely conveyed by the stream and its overbanks without causing erosion or sedimentation, or creating any damage, safety or property hazard. The post-development flow greater than pre-development flow can only be released if it does not aggravate a significant obstruction or existing problem area or would overload existing storm sewer networks. If it would, proper storm water management, obstruction replacement or standard detention would be required. Any flow from the 50-year storm not carried by downstream drainage facilities must be addressed and, where necessary, additional controls installed to assure upstream collection of this water by central facilities where required by the storm water design. Infiltration is promoted throughout the watershed where soils permit.

Proper analysis of channel capacity downstream of a development site for the purpose of discharging greater than predevelopment peak flow rates is essential for insuring that the goal of not creating any new problem areas or aggravating existing drainage problem areas is achieved. The analysis must include the assumption of complete build-out of the tributary areas to the channel being evaluated based upon the Future Land Use Map (Plate III, Volume II) or the latest zoning revision after plan adoption. Also, storm water control measures consistent with the Plan must be assumed in analyzing projected development tributary to the point of evaluation.

Culverts, bridges, stream enclosures or any other facilities proposed within the "Small Storm Detention Required" areas must pass flows for the 50-year design storm without causing a backwater which would act as a "detention basin" or meet more stringent DER criteria. Such facilities shall allow an unimpeded flow to be conveyed.

Stream channels, water courses or other conveyance facilities may be improved to meet the above requirements and alleviate existing capacity deficiencies as long as local, state, and federal requirements are met and permits obtained.

Any facilities that constitute stream enclosures or dams, as regulated by PA DER Chapter 105 regulations (as amended or replaced from time to time by PA DER), shall be designed in accordance with Chapter 105 and will require a permit from PA DER. The definition of dam is defined in Chapter 105 regulations. Any roadway crossing including pipes, bridges, storm sewers or any other drainage conveyance facilities or any work involving wetlands as described in PA DER Chapter 105 regulations shall be designed in accordance with Chapter 105 regulations and may require a permit from the Department. Any roadway crossing any facility located within a PA DOT right-of-way must meet PA DOT minimum design standards and permit submission requirements.

## B. SUB-REGIONAL (COMBINED SITE) STORAGE

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

The goal should be the development and use of the most cost-effective and environmentally-sensitive storm water runoff controls which significantly improves the capability and flexibility of land developers and communities to control runoff consistent with the Tobyhanna Creek Watershed Storm Water Management Plan.

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

To take this concept a step further, there is also the possibility that the storm water could be managed "off-site"; that is, in a location off the property(s) in question. There could be publicly owned detention, retention, lake, pond or other physical facilities to serve multiple developments. The design would need to be consistent with the Plan.

## C. "NO HARM OPTION"

For any proposed development site not located in a provisional no detention district, the developer has the option of using a less restrictive runoff control (including no detention) if the developer can prove that "no harm" would be caused by discharging at a higher runoff rate than that specified by the Plan. Proof of "no harm" would have to be shown from the development site through the remainder of the downstream drainage network until there is no additional flow increases. Proof of "no harm" must be shown using the capacity criteria specified in Section 303.C. of the Model Ordinance if downstream capacity analysis is a part of the "no harm" justification. Attempts to prove "no harm" based upon downstream peak flow versus capacity analysis shall be governed by the following provisions:

1. The peak flow values to be used for downstream areas for the design return period storms (2- and 50-year) shall be the values from the calibrated Penn State Runoff Model for the Tobyhanna Creek watershed. These flow values would be supplied to the developer by the municipality upon request.

2. Any available capacity in the downstream conveyance system as documented by a developer may be used by the developer only in proportion to his development site acreage relative to the total upstream undeveloped acreage from the identified capacity (i.e. if his site is 10% of the upstream undeveloped acreage, he may use up to 10% of the documented downstream available capacity).

3. Developer-proposed runoff controls which would generate increased peak flow rates at documented storm drainage problem areas would, by definition, be precluded from successful attempts to prove "no harm," except in conjunction with proposed capacity improvements for the problem areas consistent with Section 303.I.

   Any "no harm" justifications shall be submitted by the developer as part of the Drainage Plan submission per Article IV of the Model Ordinance.

D. "HARDSHIP OPTION"

The development of the plan and its standards and criteria was designed to maintain existing peak flows throughout the Tobyhanna Creek watershed as the watershed becomes developed. There may be certain instances, however, where the standards and criteria established are too restrictive for a particular landowner or developer. The existing drainage network in some areas may be capable of safely transporting slight increases in flows without causing a problem or increasing flows elsewhere. If a developer or homeowner cannot reasonably meet the storm water standards due to lot conditions or if conformance would become a hardship to an owner, and the developer/homeowner can demonstrate "no harm" if the hardship waiver is granted, the hardship option may be applied. The landowner would have to plead their case to the Municipal Officials with the final determination made by the municipality. Any landowners pleading the "hardship option" will assume all liabilities that may arise due to exercising this option. In cases where the hardship option is requested, it will be the applicant's responsibility to notify adjacent and/or affected property owners and municipalities and provide written proof of notification. Financial obligations are not considered a hardship.

# APPENDIX A

# SUBAREA PEAK FLOW TABLES

# TOBYHANNA CREEK WATERSHED
# PEAK FLOWS (CFS)

| 2.33 YEAR | | | 5 YEAR | | | 10 YEAR | | |
|---|---|---|---|---|---|---|---|---|
| Subarea No. | Subarea Peak | Combined Peak | Subarea No. | Subarea Peak | Combined Peak | Subarea No. | Subarea Peak | Combined Peak |
| 1 | 264.0 | 264.0 | 1 | 438.5 | 438.5 | 1 | 799.5 | 799.5 |
| 2 | 204.9 | 204.9 | 2 | 328.7 | 328.7 | 2 | 587.2 | 587.2 |
| 3 | 1.6 | 436.4 | 3 | 2.1 | 715.4 | 3 | 2.9 | 1276.0 |
| 4 | 672.5 | 319.3 | 4 | 982.8 | 539.3 | 4 | 1567.5 | 938.5 |
| 5 | 234.6 | 234.6 | 5 | 347.0 | 347.0 | 5 | 553.8 | 553.8 |
| 6 | 255.5 | 406.3 | 6 | 374.7 | 580.7 | 6 | 592.8 | 896.5 |
| 7 | 280.2 | 86.9 | 7 | 364.9 | 105.0 | 7 | 501.4 | 105.0 |
| 8 | 498.1 | 244.1 | 8 | 688.7 | 331.3 | 8 | 1024.2 | 495.7 |
| 9 | 389.6 | 461.7 | 9 | 556.5 | 647.8 | 9 | 858.2 | 984.5 |
| 10 | 72.6 | 527.4 | 10 | 118.3 | 754.1 | 10 | 209.5 | 1172.8 |
| 11 | 1.6 | 907.5 | 11 | 2.1 | 1296.6 | 11 | 2.9 | 1998.1 |
| 12 | 357.5 | 958.7 | 12 | 536.3 | 1442.8 | 12 | 874.3 | 2347.0 |
| 13 | 237.6 | 992.7 | 13 | 329.4 | 1490.0 | 13 | 491.1 | 2416.8 |
| 14 | 106.9 | 106.9 | 14 | 164.6 | 164.6 | 14 | 276.8 | 276.8 |
| 15 | 838.8 | 1350.1 | 15 | 1255.8 | 2013.8 | 15 | 2048.3 | 3235.1 |
| 16 | 235.7 | 1575.6 | 16 | 386.4 | 2382.4 | 16 | 687.0 | 3841.0 |
| 17 | 354.5 | 1788.0 | 17 | 597.2 | 2714.8 | 17 | 1085.3 | 4338.4 |
| 18 | 211.9 | 211.9 | 18 | 322.2 | 322.2 | 18 | 537.0 | 537.0 |
| 19 | 1.6 | 1916.0 | 19 | 2.1 | 2917.7 | 19 | 2.9 | 4664.8 |
| 20 | 362.5 | 2146.9 | 20 | 570.2 | 3266.1 | 20 | 981.8 | 5339.3 |
| 21 | 373.7 | 373.7 | 21 | 525.0 | 525.0 | 21 | 792.4 | 792.4 |
| 22 | 202.5 | 202.5 | 22 | 283.6 | 283.6 | 22 | 427.1 | 427.1 |
| 23 | 365.4 | 530.3 | 23 | 545.2 | 855.7 | 23 | 880.7 | 1385.1 |
| 24 | 210.8 | 210.8 | 24 | 272.0 | 272.0 | 24 | 370.8 | 370.8 |
| 25 | 236.1 | 689.8 | 25 | 356.6 | 1061.6 | 25 | 581.9 | 1713.4 |
| 26 | 674.0 | 74.0 | 26 | 932.1 | 131.3 | 26 | 1388.1 | 304.4 |
| 27 | 241.0 | 241.0 | 27 | 397.7 | 397.7 | 27 | 710.2 | 710.2 |
| 28 | 544.6 | 118.9 | 28 | 744.2 | 191.1 | 28 | 1083.1 | 385.2 |
| 29 | 199.9 | 199.9 | 29 | 306.9 | 306.9 | 29 | 510.2 | 510.2 |
| 30 | 244.2 | 244.2 | 30 | 384.2 | 384.2 | 30 | 659.3 | 659.3 |
| 31 | 1030.0 | 432.7 | 31 | 1377.2 | 608.4 | 31 | 1962.9 | 1181.4 |
| 32 | 305.8 | 74.1 | 32 | 450.1 | 115.0 | 32 | 720.8 | 188.7 |
| 33 | 578.7 | 715.6 | 33 | 860.7 | 1045.3 | 33 | 1406.5 | 1941.3 |
| 34 | 136.7 | 136.7 | 34 | 228.9 | 228.9 | 34 | 412.5 | 412.5 |
| 35 | 707.8 | 707.8 | 35 | 1029.5 | 1029.5 | 35 | 1617.0 | 1617.0 |
| 36 | 1.6 | 831.9 | 36 | 2.1 | 1231.4 | 36 | 2.9 | 1980.9 |
| 37 | 62.1 | 837.2 | 37 | 96.6 | 1279.7 | 37 | 165.8 | 2044.0 |
| 38 | 106.3 | 791.8 | 38 | 174.2 | 1238.7 | 38 | 311.7 | 2057.9 |
| 39 | 982.4 | 1645.0 | 39 | 1358.4 | 2890.5 | 39 | 2024.5 | 6162.6 |
| 40 | 315.1 | 176.2 | 40 | 456.4 | 312.2 | 40 | 716.7 | 663.4 |
| 41 | 581.2 | 1734.6 | 41 | 864.5 | 3051.9 | 41 | 1395.8 | 6512.9 |
| 42 | 371.1 | 1776.2 | 42 | 537.0 | 3124.4 | 42 | 844.2 | 6654.1 |
| 43 | 295.2 | 295.2 | 43 | 466.8 | 466.8 | 43 | 791.7 | 791.7 |
| 44 | 200.9 | 1808.2 | 44 | 280.5 | 3184.3 | 44 | 422.3 | 6758.2 |
| 45 | 129.9 | 129.9 | 45 | 179.2 | 179.2 | 45 | 267.7 | 267.7 |
| 46 | 50.6 | 148.2 | 46 | 68.0 | 201.5 | 46 | 104.2 | 314.8 |
| 47 | 3.4 | 144.5 | 47 | 5.1 | 197.6 | 47 | 9.6 | 312.8 |
| 48 | 53.2 | 53.2 | 48 | 71.9 | 71.9 | 48 | 110.5 | 110.5 |

# TOBYHANNA CREEK WATERSHED
# PEAK FLOWS (CFS)

| 2.33 YEAR | | | 5 YEAR | | | 10 YEAR | | |
|---|---|---|---|---|---|---|---|---|
| Subarea No. | Subarea Peak | Combined Peak | Subarea No. | Subarea Peak | Combined Peak | Subarea No. | Subarea Peak | Combined Peak |
| 49 | 1.0 | 156.0 | 49 | 1.6 | 221.3 | 49 | 2.5 | 364.3 |
| 50 | 16.3 | 160.8 | 50 | 23.2 | 230.4 | 50 | 37.0 | 379.3 |
| 51 | 208.0 | 126.6 | 51 | 282.4 | 193.7 | 51 | 414.9 | 343.3 |
| 52 | 95.6 | 95.6 | 52 | 131.2 | 131.2 | 52 | 204.5 | 204.5 |
| 53 | 1.1 | 134.8 | 53 | 1.7 | 216.2 | 53 | 2.5 | 380.3 |
| 54 | 58.1 | 171.6 | 54 | 82.4 | 241.3 | 54 | 132.2 | 418.2 |
| 55 | 23.0 | 165.8 | 55 | 32.6 | 246.0 | 55 | 54.2 | 422.5 |
| 56 | 85.9 | 85.9 | 56 | 116.7 | 116.7 | 56 | 175.7 | 175.7 |
| 57 | 1.2 | 222.3 | 57 | 1.8 | 299.1 | 57 | 2.6 | 469.5 |
| 58 | 141.8 | 4.7 | 58 | 182.2 | 6.6 | 58 | 248.7 | 10.0 |
| 59 | 24.5 | 231.6 | 59 | 32.9 | 311.6 | 59 | 53.1 | 492.5 |
| 60 | 516.1 | 74.9 | 60 | 659.2 | 95.3 | 60 | 895.2 | 132.9 |
| 61 | 23.2 | 78.1 | 61 | 29.1 | 99.9 | 61 | 40.5 | 146.0 |
| 62 | 0.1 | 297.8 | 62 | 0.4 | 394.6 | 62 | 1.2 | 617.2 |
| 63 | 74.1 | 340.9 | 63 | 100.8 | 456.4 | 63 | 150.9 | 701.9 |
| 64 | 472.1 | 15.4 | 64 | 596.6 | 21.3 | 64 | 794.4 | 35.0 |
| 65 | 44.2 | 51.2 | 65 | 56.7 | 65.1 | 65 | 76.0 | 86.8 |
| 66 | 0.1 | 372.5 | 66 | 0.5 | 488.8 | 66 | 1.4 | 743.1 |
| 67 | 70.7 | 391.3 | 67 | 89.9 | 512.1 | 67 | 119.4 | 760.3 |
| 68 | 2.3 | 2041.5 | 68 | 3.1 | 3575.7 | 68 | 4.6 | 7469.1 |
| 69 | 129.5 | 2043.0 | 69 | 196.3 | 3576.5 | 69 | 322.3 | 7480.5 |
| 70 | 240.0 | 240.0 | 70 | 372.4 | 372.4 | 70 | 652.7 | 652.7 |
| 71 | 2.7 | 2051.5 | 71 | 4.8 | 3586.1 | 71 | 5.2 | 7519.2 |
| 72 | 275.1 | 2065.4 | 72 | 443.6 | 3625.0 | 72 | 780.4 | 7618.5 |
| 73 | 494.5 | 494.5 | 73 | 801.3 | 801.3 | 73 | 1392.6 | 1392.6 |
| 74 | 161.0 | 45.1 | 74 | 219.2 | 61.1 | 74 | 319.1 | 87.8 |
| 75 | 92.9 | 544.9 | 75 | 140.8 | 850.0 | 75 | 228.9 | 1407.4 |
| 76 | 2.5 | 2531.5 | 76 | 3.5 | 3749.9 | 76 | 5.3 | 7868.6 |
| 77 | 436.5 | 2870.4 | 77 | 738.4 | 4261.1 | 77 | 1353.2 | 8050.8 |

# TOBYHANNA CREEK WATERSHED
# PEAK FLOWS (CFS)

| 25 YEAR | | | 50 YEAR | | | 100 YEAR | | |
|---|---|---|---|---|---|---|---|---|
| Subarea No. | Subarea Peak | Combined Peak | Subarea No. | Subarea Peak | Combined Peak | Subarea No. | Subarea Peak | Combined Peak |
| 1 | 1099.0 | 1099.0 | 1 | 1691.2 | 1691.2 | 1 | 2387.0 | 2387.0 |
| 2 | 806.3 | 806.3 | 2 | 1249.5 | 1249.5 | 2 | 1778.4 | 1778.4 |
| 3 | 3.4 | 1754.0 | 3 | 4.3 | 2717.3 | 3 | 5.2 | 3869.1 |
| 4 | 2026.5 | 1258.0 | 4 | 2895.3 | 1879.0 | 4 | 3867.7 | 2581.3 |
| 5 | 712.8 | 712.8 | 5 | 1006.7 | 1006.7 | 5 | 1335.6 | 1335.6 |
| 6 | 759.9 | 1135.5 | 6 | 1069.3 | 1571.5 | 6 | 1409.3 | 2042.0 |
| 7 | 596.9 | 105.0 | 7 | 761.7 | 105.0 | 7 | 931.3 | 105.0 |
| 8 | 1276.4 | 635.6 | 8 | 1738.9 | 886.5 | 8 | 2244.6 | 1142.8 |
| 9 | 1088.5 | 1242.4 | 9 | 1515.5 | 1723.9 | 9 | 1987.2 | 2279.7 |
| 10 | 284.4 | 1498.6 | 10 | 431.1 | 2114.6 | 10 | 602.4 | 2828.8 |
| 11 | 3.4 | 2554.2 | 11 | 4.3 | 3573.8 | 11 | 5.2 | 4691.5 |
| 12 | 1141.6 | 3039.2 | 12 | 1650.4 | 4406.7 | 12 | 2226.7 | 5930.7 |
| 13 | 612.3 | 3134.6 | 13 | 833.3 | 4510.7 | 13 | 1073.5 | 6084.4 |
| 14 | 367.8 | 367.8 | 14 | 544.0 | 544.0 | 14 | 746.6 | 746.6 |
| 15 | 2677.3 | 4146.2 | 15 | 3879.1 | 5870.2 | 15 | 5243.3 | 7738.9 |
| 16 | 939.1 | 4936.7 | 16 | 1438.1 | 7024.6 | 16 | 2030.3 | 9308.2 |
| 17 | 1485.1 | 5556.3 | 17 | 2263.4 | 7815.6 | 17 | 3159.9 | 10340.0 |
| 18 | 712.5 | 712.5 | 18 | 1058.4 | 1058.4 | 18 | 1464.8 | 1464.8 |
| 19 | 3.4 | 5972.1 | 19 | 4.3 | 8572.9 | 19 | 5.2 | 11612.4 |
| 20 | 1317.8 | 6995.9 | 20 | 1974.4 | 10164.9 | 20 | 2733.7 | 13758.5 |
| 21 | 993.6 | 993.6 | 21 | 1362.4 | 1362.4 | 21 | 1769.8 | 1769.8 |
| 22 | 535.3 | 535.3 | 22 | 734.1 | 734.1 | 22 | 951.9 | 951.9 |
| 23 | 1142.0 | 1756.7 | 23 | 1631.4 | 2515.4 | 23 | 2174.7 | 3690.0 |
| 24 | 440.3 | 440.3 | 24 | 561.1 | 561.1 | 24 | 686.5 | 686.5 |
| 25 | 757.3 | 2188.2 | 25 | 1085.5 | 3073.2 | 25 | 1449.7 | 4431.0 |
| 26 | 1734.0 | 478.4 | 26 | 2376.6 | 808.5 | 26 | 3092.4 | 1096.7 |
| 27 | 964.2 | 964.2 | 27 | 1456.0 | 1456.0 | 27 | 2019.4 | 2019.4 |
| 28 | 1333.1 | 593.1 | 28 | 1788.6 | 1082.4 | 28 | 2288.5 | 1719.9 |
| 29 | 670.7 | 670.7 | 29 | 974.7 | 974.7 | 29 | 1316.3 | 1316.3 |
| 30 | 882.9 | 882.9 | 30 | 1318.2 | 1318.2 | 30 | 1821.5 | 1821.5 |
| 31 | 2392.0 | 1588.4 | 31 | 3167.5 | 2336.3 | 31 | 4008.8 | 3177.4 |
| 32 | 934.8 | 239.9 | 32 | 1343.0 | 338.6 | 32 | 1807.7 | 443.7 |
| 33 | 1850.4 | 2605.6 | 33 | 2719.6 | 3780.0 | 33 | 3732.4 | 5136.1 |
| 34 | 562.3 | 562.3 | 34 | 852.9 | 852.9 | 34 | 1186.9 | 1186.9 |
| 35 | 2067.8 | 2067.8 | 35 | 2902.0 | 2902.0 | 35 | 3832.5 | 3832.5 |
| 36 | 3.4 | 2569.3 | 36 | 4.3 | 3681.4 | 36 | 5.2 | 4931.0 |
| 37 | 222.6 | 2633.5 | 37 | 334.6 | 3584.8 | 37 | 464.4 | 4631.4 |
| 38 | 425.6 | 2701.9 | 38 | 649.1 | 3850.9 | 38 | 908.4 | 5116.1 |
| 39 | 2535.4 | 8341.2 | 39 | 3495.5 | 11674.5 | 39 | 4579.8 | 15042.5 |
| 40 | 918.8 | 947.6 | 40 | 1298.1 | 1321.2 | 40 | 1722.2 | 1656.5 |
| 41 | 1812.9 | 8814.9 | 41 | 2601.7 | 12268.8 | 41 | 3488.4 | 15752.3 |
| 42 | 1084.8 | 9011.3 | 42 | 1540.7 | 12537.9 | 42 | 2056.4 | 16084.0 |
| 43 | 1045.6 | 1045.6 | 43 | 1521.1 | 1521.1 | 43 | 2048.2 | 2048.2 |
| 44 | 529.6 | 9186.9 | 44 | 727.0 | 12748.9 | 44 | 942.9 | 16356.2 |
| 45 | 337.2 | 337.2 | 45 | 472.0 | 472.0 | 45 | 630.3 | 630.3 |
| 46 | 136.0 | 399.2 | 46 | 204.9 | 574.1 | 46 | 295.0 | 817.0 |
| 47 | 15.0 | 412.0 | 47 | 26.6 | 581.5 | 47 | 41.3 | 812.7 |
| 48 | 144.0 | 144.0 | 48 | 215.2 | 215.2 | 48 | 306.3 | 306.3 |

# TOBYHANNA CREEK WATERSHED
# PEAK FLOWS (CFS)

| 25 YEAR | | | 50 YEAR | | | 100 YEAR | | |
|---|---|---|---|---|---|---|---|---|
| Subarea No. | Subarea Peak | Combined Peak | Subarea No. | Subarea Peak | Combined Peak | Subarea No. | Subarea Peak | Combined Peak |
| 49 | 3.1 | 483.7 | 49 | 4.0 | 687.0 | 49 | 4.9 | 948.5 |
| 50 | 48.8 | 509.2 | 50 | 73.6 | 726.3 | 50 | 104.8 | 979.8 |
| 51 | 517.9 | 448.2 | 51 | 715.9 | 504.3 | 51 | 946.4 | 668.7 |
| 52 | 268.5 | 268.5 | 52 | 404.0 | 404.0 | 52 | 576.6 | 576.6 |
| 53 | 3.1 | 481.9 | 53 | 4.0 | 556.4 | 53 | 4.9 | 736.0 |
| 54 | 175.2 | 517.2 | 54 | 265.4 | 698.5 | 54 | 378.6 | 1006.4 |
| 55 | 74.9 | 519.4 | 55 | 119.7 | 749.1 | 55 | 177.3 | 1087.1 |
| 56 | 224.8 | 224.8 | 56 | 324.5 | 324.5 | 56 | 446.6 | 446.6 |
| 57 | 3.2 | 598.4 | 57 | 4.1 | 927.8 | 57 | 5.0 | 1358.1 |
| 58 | 297.0 | 12.5 | 58 | 384.6 | 16.8 | 58 | 480.8 | 21.4 |
| 59 | 73.0 | 651.5 | 59 | 120.7 | 1018.7 | 59 | 184.9 | 1488.7 |
| 60 | 1068.1 | 164.9 | 60 | 1385.0 | 228.2 | 60 | 1737.6 | 300.2 |
| 61 | 51.3 | 186.7 | 61 | 75.6 | 266.8 | 61 | 110.2 | 357.6 |
| 62 | 1.8 | 819.7 | 62 | 2.7 | 1261.3 | 62 | 3.7 | 1811.9 |
| 63 | 191.8 | 917.9 | 63 | 274.3 | 1419.7 | 63 | 375.1 | 2054.6 |
| 64 | 933.6 | 44.9 | 64 | 1179.5 | 64.9 | 64 | 1442.4 | 87.3 |
| 65 | 89.2 | 101.7 | 65 | 113.3 | 128.5 | 65 | 141.2 | 160.3 |
| 66 | 1.9 | 967.5 | 66 | 2.9 | 1486.3 | 66 | 3.7 | 2147.3 |
| 67 | 140.3 | 994.3 | 67 | 183.3 | 1536.7 | 67 | 240.4 | 2244.6 |
| 68 | 5.6 | 10158.8 | 68 | 7.3 | 14266.4 | 68 | 9.1 | 18531.4 |
| 69 | 420.1 | 10172.9 | 69 | 602.1 | 14270.6 | 69 | 801.5 | 18560.7 |
| 70 | 895.9 | 895.9 | 70 | 1393.8 | 1393.8 | 70 | 2001.1 | 2001.1 |
| 71 | 6.3 | 10259.7 | 71 | 8.2 | 14423.1 | 71 | 12.4 | 18761.3 |
| 72 | 1056.9 | 10404.5 | 72 | 1596.7 | 14614.7 | 72 | 2218.7 | 19020.0 |
| 73 | 1861.0 | 1861.0 | 73 | 2747.3 | 2747.3 | 73 | 3739.8 | 3739.8 |
| 74 | 392.6 | 96.4 | 74 | 525.1 | 97.8 | 74 | 667.3 | 99.6 |
| 75 | 296.5 | 1828.4 | 75 | 421.1 | 2579.1 | 75 | 557.3 | 3512.0 |
| 76 | 6.7 | 10761.7 | 76 | 8.7 | 15092.6 | 76 | 10.8 | 19588.4 |
| 77 | 1863.5 | 11024.6 | 77 | 2866.6 | 15441.7 | 77 | 4029.1 | 20054.0 |