Geo Decisions, Inc.

Gannett Fleming

Jacks Creek Watershed

-ACT 167-

Stormwater Management Plan

Located in Juniata, Mifflin, and Snyder Counties
Pennsylvania

Prepared for

The Mifflin County Commissioners

June 8, 1995

Table of Contents

Table of Contents, cont.

Table of Contents, cont.

LIST OF TABLES:

LIST OF FIGURES:

LIST OF PLATES (rear of document):

Letter of transmittal

LIST OF OFFICIALS

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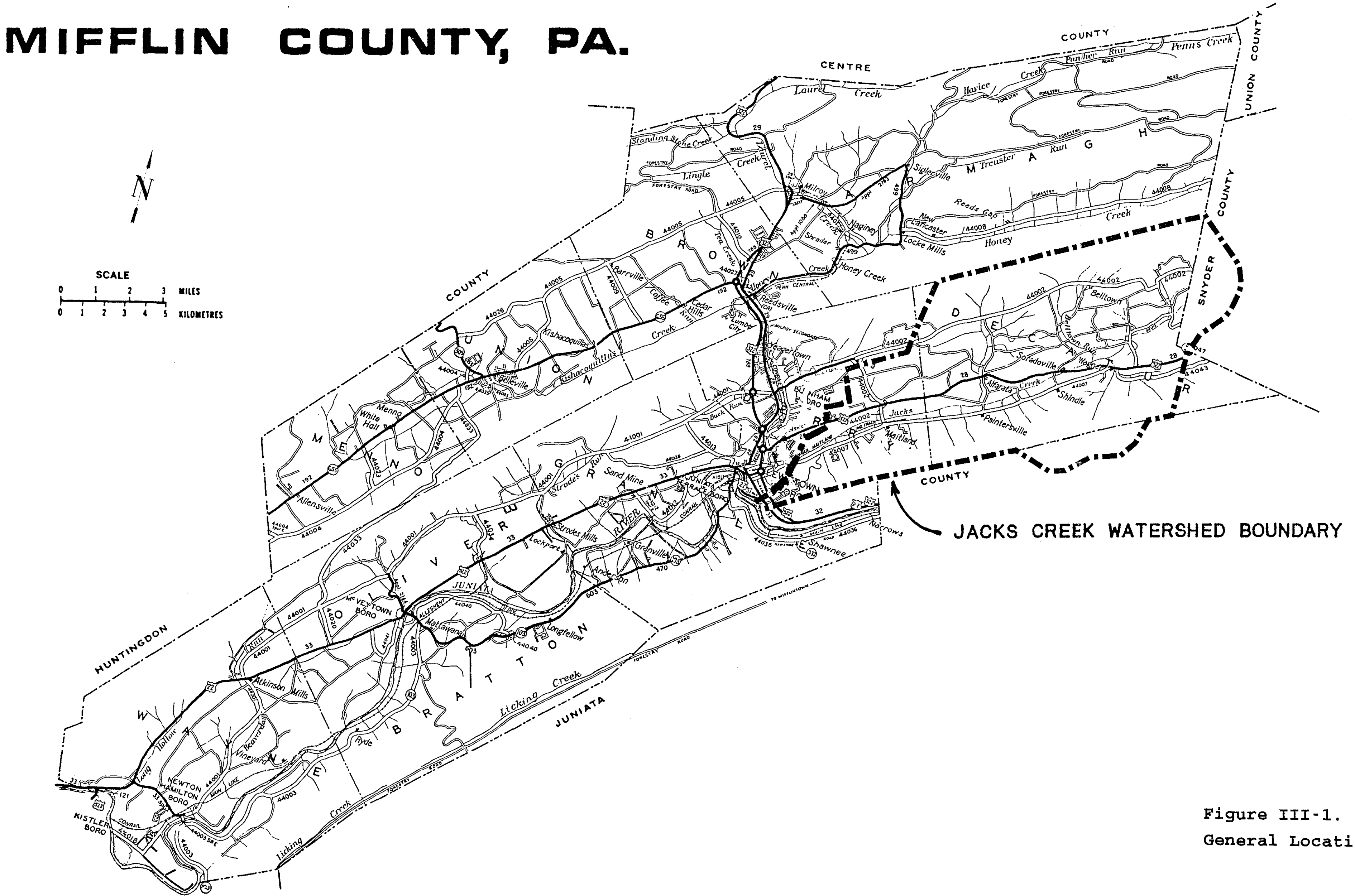
Chapter I. Introduction

Stormwater runoff problems in Pennsylvania are directly linked to new land developments that has occurred throughout the state. Increased urban expansion and land development decreases the infiltration of rainwater into the ground. This occurs due to covering of the land surface with buildings, paving, and other non-pervious materials. This increases the rate and volume of stormwater runoff and results in greater flooding, stream channel erosion and sedimentation, and reduced groundwater recharge.

Increased runoff has also resulted in the obsolescence of existing stormwater handling facilities. New larger capacity storm drainage works are required to handle the increased quantities of water involved. Most importantly, the cumulative effect of unregulated development results in increased flooding conditions. In severe instances, loss of life and property have occurred. If these negative effects are to be avoided, it is essential that a comprehensive approach be developed for the proper management of increased stormwater which is associated with new development.

The Jacks Creek Stormwater Management Plan is such a comprehensive approach, describing how stormwater can be managed to mitigate unwanted impacts from accelerated runoff due to development. The Plan is based on a detailed hydrologic study of the area and fulfills the requirements of the Pennsylvania Stormwater Management Act (Act 167).



BASE MAP SOURCE: PennDOT

Figure III-1.
General Location Map

Chapter II. Watershed Level Planning - Act 167

A. BASINWIDE STORMWATER MANAGEMENT

Basinwide stormwater management planning is a concept that is a central part of Pennsylvania's Act 167 program. Although there is no formal definition of the term "basinwide stormwater management", it is generally understood to mean the implementation of a comprehensive and/or coordinated program for managing storm runoff impacts at the watershed level. Though most areas that practice stormwater management recognize the fact that storm runoff (as well as its associated impacts) does not conform to political boundaries, downstream impacts have historically been ignored in land development planning and zoning. In the past, stormwater management designs have primarily been based solely upon the mitigation of "on-site" impacts from surface water runoff. This "on-site" design philosophy has prevailed mainly because engineers have lacked the necessary data (or database) to quantify downstream impacts, and also because most municipalities governing stormwater runoff have not required downstream runoff analyses of any kind. Due to a combination of increased storm drainage programs and new legislation, however, the trend in Pennsylvania has recently moved towards the implementation of stormwater plans which mitigated impacts throughout an entire watershed.

There are typically two components of a basinwide stormwater management plan - a technical and an institutional (or implementation) component. in successful basinwide programs, these two aspects have been more or less balanced with a somewhat greater emphasis usually being placed on the institutional portion.

The institutional component deals primarily with local government regulations and ordinances controlling stormwater runoff. This component has traditionally not been given sufficient attention; certainly not the same degree of attention as the technical component. In general, more time and effort has been devoted to simulation modeling than to the development of effective procedures for local governments to use in implementing the program. In addition, many basinwide programs also are deficient in municipal involvement and education during the preparation of the program. The Pennsylvania Stormwater Management Act (Act 167) program has now resolved this problem with a much greater emphasis on municipal participation in the watershed planning process for new Act 167 plans.

The other important component of a basinwide stormwater management program is the technical support base for the program, which is typically reflected in the individual watershed plans. This technical support base usually consists of a watershed model that has been developed to meet the specific technical and institutional requirements of a given watershed planning area.

B. ACT 167

The Pennsylvania Stormwater Management Act (Act 167) was enacted by the state to deal with the growing stormwater runoff problem. Act 167 requires counties and local municipalities to establish the relationship between land development and accelerated runoff in all watershed areas throughout the state and requires that a comprehensive program for managing stormwater be developed in each watershed area.

Prior to Act 167, municipalities attempted to address and regulate increases in peak runoff rates for specific projects in a piecemeal manner. The intent was to protect adjoining downstream properties. However, the cumulative effect of new development throughout the entire watershed was not taken into account. Potentially negative effects on properties further downstream or in adjoining municipalities was not addressed.

For stormwater management to be effective, the entire watershed must be considered to define the impact of cumulative runoff. Furthermore, consistent controls and regulatory measures among adjoining municipalities in the same watershed need to be implemented. Act 167 attempts to correct this situation by mandating an approach which requires comprehensive watershed planning and management. Act 167 requires that:

- Counties must prepare and adopt stormwater management plans for each watershed.
- Plans must be prepared in consultation with local municipalities, working through a watershed plan advisory committee (WPAC).
- Plans must provide unified technical standards and criteria for managing stormwater generated by new developments throughout the entire watershed.
- Plans must include considerations such as:
    - The expected future development pattern.
    - The hydrologic characteristics of each watershed.
    - A technical evaluation of the potential impact of stormwater runoff throughout the watershed.
    - The development of standards and criteria.
    - An implementation plan to address the overall problems and needs of each municipality in the watershed.

C. WATERSHED MODELING

The ability to quantify the downstream consequences of stormwater management decisions requires knowledge of the runoff interrelationships between various areas of the watershed. In most cases, this requires the development of a "model" of the watershed intended to reproduce the desired runoff response of the watershed for a given rainfall event. Many computer-based runoff models are available which can be used to develop runoff values from user-specified watershed parameters. The models available range from very complex, data-intensive, urban system models to simplified rural application models requiring much less data. Model selection largely depends upon inherent watershed characteristics and the level of hydrologic (and hydraulic) accuracy required.

The primary purposes of modeling are to identify the peak flow values at key points throughout the watershed in the existing, or pre-development, condition and to quantify the impact of flow from one watershed area on other downstream points. Runoff interrelationships between various watershed areas are used to determine an appropriate method of runoff control required to satisfy the overall watershed management goal (i.e., no increase in peak flow at key points in the watershed).

Over the years, watershed modeling technology has progressed to the point where it is no longer a limiting factor in the ability to practically complete a basinwide stormwater management plan. Early watershed modeling and planning projects were constrained by the lack of a practical "tool" to use for watershed analysis purposes. Most early simulation models were quite complex, and they seemed to spawn new and different versions of even more complex models. However, many watershed planners, and even many watershed modelers, foresaw the need to develop simplified models that could be practically used and applied by non-specialists in the field. A typical example of this type of model is the Penn State Runoff Model (PSRM) which has become the "standard tool" for completing Act 167 watershed plans in Pennsylvania. The PSRM model was used for the Jacks Creek Watershed Study. Other examples of models used in stormwater management include: SWRRB, SWMM, and the HEC models developed by the U.S. Corps of Engineers, and the TR-20 model developed by the USDA-Soil Conservation Service.

The utilization of computer-based hydrologic models in stormwater management studies has been increasing steadily over the past few years. Such models are used primarily to quantify surface runoff within certain segments or subareas of a given watershed. New hydrologic models are also being developed which incorporate sediment, erosion and chemical processes as well. While the theoretical basis of hydrologic models will continue to improve with increased understanding of fundamental rainfall-runoff processes, major advances are also possible through the use of improved data input procedures for parameters related to land surface conditions throughout a watershed. Typically, the information necessary to drive the model is compiled via manual, field-based methods. This can be an extremely time-consuming task in large watersheds having high spatial variability in land use/cover, topography, soil type, and other factors which affect the rainfall-runoff process. Automated geographic information systems (GIS) can provide more accurate, cost-effective tools for quantifying the spatial distribution of hydrologic model variables in stormwater studies. In this particular study, a GIS was used to derive model input data for the Jacks Creek Watershed.

Chapter III. Watershed Characteristics

A. LAND USE

The Jacks Creek Watershed area lies at the extreme southeasterly end of Mifflin County. It includes the area east of the Borough of Lewistown, situated between Jacks Mountain and Shade Mountain. Figure III-1 shows the general location of the watershed. Table III-1 summarizes the areal distribution of Jacks Creek Watershed among the several municipalities involved, including: Derry and Decatur Townships in Mifflin County, Fermanagh Township in Juniata County, and West Beaver Township in Snyder County.

The westerly one-third portion of the watershed is located in Derry Township, adjoining the Borough of Lewistown. This area contains numerous rural, agricultural, and rural non-farm residential developments. This section of the township has experienced some urban-type subdivision growth as an extension of Lewistown, particularly in the Glenwood section located on the northerly side of U.S. Route 522. Industrial development is limited.

The easterly two-thirds portion of the watershed comprises virtually all of Decatur Township. This Township is mostly rural and contains a number of small residential settlements in various locations along U.S. Route 522 and along other township roads. As in Derry Township, industrial development is limited. Some of the residential areas, such as Alfarata, Shindle, and Belltown have grown up close to Jacks Creek or its tributaries and have experienced flooding and drainage problems during heavy rains.

Overall, the watershed area is still largely undeveloped, with much of the valley land used for suitable agricultural uses. However, large portions of the watershed area are steeply sloping forested areas. These areas include State Game or Forest Lands located along the ridges and slopes of Jacks Mountain and Shade Mountain. *Chapter IV, Technical Analysis*, provides more detailed information on the present and projected future landuse distribution.

The area is served by one major highway (U.S. Route 522) which travels east-west through the lower one-third portions of Derry and Decatur Townships. This highway is located in the valley through which Jacks Creek traverses, parallel to both Jacks Mountain and Shade Mountain. Numerous other local township roads provide access in an east-west direction and also in a north-south direction, in a traditional pattern which provides local access to the various rural and rural non-farm properties, and to various developed parcels in the area.

Table III-1. Township Areas in Jacks Creek Watershed

Municipality	Area in Square Miles	
	Entire Township	Portion in Jacks Creek Watershed
Decatur Township	47.4	42.1
Derry Township	32.0	11.9
Total in Mifflin County	79.4	54.0
Additional portion of watershed in Snyder and Juniata Counties	---	5.9
Total Jacks Creek Watershed Area	---	59.9

B. POPULATION

Table III-2 presents the population trends of Decatur and Derry Townships, for the period between 1940 and 1980. This table also includes a preliminary projection of the population for these affected Mifflin County townships to the year 2000.

Derry Township has had a continuing steady growth in population since 1940. In 1980, Derry Township had a population of 8,108. However, almost two-thirds of the population was located outside of the Jacks Creek Watershed Area. The population located within the watershed area has also grown, but at a slower rate. Recently, sewer lines were extended into the watershed area by the township sewer authority and population growth within the watershed is expected to increase, as evidenced by the recent approval of a major new land subdivision in that area.

Decatur Township has also increased in population since 1940, with a population of 2,513 in 1980, virtually all of which is located in the Jacks Creek Watershed Area. The area is not served with public sewer or water facilities and growth in this area is expected to increase, but at a lesser degree than that expected for the Derry Township portion of the watershed. By the year 2000, it is expected that the overall increase in population in the watershed will increase from about 5,000 in 1980 to estimated 6,400.

Population in the watershed portions of Snyder and Juniata Counties is extremely limited. The area in Juniata County consists primarily of State Game Lands. The Snyder County portion of the watershed is very low density rural development which is also not expected to grow at a fast pace.

Table III-2. Population Trends in Decatur and Derry Townships, Mifflin County, PA

1940 to 1980 Actual and 1990 to 2000 Projected Population				
Year	Decatur Township	Derry Township	Remainder of County	Total Mifflin County
Actual				
1940	1,515	5,970	35,508	42,993
1950	1,599	6,675	35,417	43,691
1960	1,868	7,167	35,313	44,348
1970	2,216	7,877	35,176	45,269
1980	2,513	8,108	36,287	46,908
Projected				
1990	2,900	8,500	37,100	48,500
2000	3,500	9,000	38,000	50,500

Source: 1940 to 1980 - U.S. Bureau of the Census
1990 and 2000 - Mifflin County Planning Commission

Chapter III. Watershed Characteristics

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1990 and 2000 - Mifflin County Planning Commission

Chapter IV. Technical Analysis

Preparation for modeling required the collection and assembly of several different types of data. After collecting the necessary information, watershed runoff model selection and calibration ensued. Finally, the calibrated model was used to analyze the hydrologic characteristics of the watershed and results were interpreted to provide guidance in establishing specific stormwater management criteria for the Jacks Creek Watershed. This chapter describes the various factors used in modeling, their sources, and the results of the modeling effort.

A. DATA PREPARATION

1. Delineation of the Total and Component Subwatersheds

Watershed subarea delineation emphasized topographic subdivides, subarea outlet points of interest, and the refinement necessary to optimize model accuracy. Due the rural nature of the study area and limited projected future development, the number of subareas was limited to 24. Plate 1 (rear of document) shows the subarea delineation used for modeling in this study.

2. Present Landuse

Present landuses in the watershed were derived by interpretation of 1987 NAPP mid-altitude infrared areal photography (1:40,000). Table IV-1 presents a breakdown of present landuse into 18 categories. Data are shown for the entire watershed and each individual subarea. The areal extent occupied by each cover type was determined through the use of Geographic Information System (GIS) analysis of the digitized landuse coverage. Plate 2 (rear of document) graphically shows the distribution of landuse/cover in the study area. The PC ARC/INFO GIS software package was used for this analysis.

3. Future Landuse

Areas which may be subject to future development in the watershed over at least the next 10 years were identified by the Mifflin County Planning Office. Three general levels of development density were identified. These are: high density residential (½ acre/unit), low/medium density residential (2 acres/unit), and very low density residential (4 acres/unit). Areas which were identified for very low density residential growth were further broken down by township. In Derry Township 50% of the area in this landuse category is expected to see growth in the next 10 years. In Decatur township the growth rate is expected to be approximately 33%. Plate 2 (rear of document) shows where future landuse changes are projected. Table IV-1 provides a list of landuse changes by subwatershed and development category.

Table IV-1. Estimated Areal Extent of Present and Future Landuses for Jacks Creek Watershed

Landuse	Total Jacks Creek Watershed		Subarea 1		Subarea 2		Subarea 3		Subarea 4		Subarea 5		Subarea 6		Subarea 7		Subarea 8	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Mixed urban	245.2	0.64	15.4	0.59	0.0	0.00	0.00	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	8.6	0.32
[High density residential]	[182.8]	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
Low/med dens residential	2387.2	6.23	64.3	2.47	4.8	0.37	90.0	6.81	121.3	3.98	114.8	9.03	118.7	5.14	111.3	6.78	153.9	5.73
[Future low/med resident]	[513.7]	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	[22.5]	**
[Very low dens residential]	[221.3]	**	**	**	**	**	**	**	**	**	**	**	[3.4]	**	[14.2]	**	**	**
Commercial	42.1	0.11	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Industrial	42.1	0.11	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	3.9	0.17	0.0	0.00	0.0	0.00
Commercial/industrial	7.7	0.02	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Other build-up	26.8	0.07	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Farmstead	137.9	0.36	1.6	0.06	4.2	0.32	10.3	0.78	35.4	1.16	4.4	0.35	3.5	0.15	0.0	0.00	1.9	0.07
Cultivated	9518.2	24.84	790.9	30.37	95.8	7.34	752.2	56.94	1812.4	59.45	516.5	40.64	233.9	10.13	255.6	15.57	143.1	5.33
Orchard, nursery, etc.	103.5	0.27	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.5	0.04	89.3	3.87	3.0	0.18	5.1	0.19
Feedlot	19.2	0.05	1.3	0.05	0.0	0.00	0.9	0.07	7.0	0.23	1.4	0.11	0.0	0.00	0.0	0.00	0.0	0.00
Pasture/field	57.5	0.15	2.6	0.10	0.0	0.00	0.0	0.00	8.8	0.29	5.6	0.44	0.0	0.00	7.4	0.45	0.0	0.00
Meadow	528.8	1.38	47.9	1.84	27.2	2.08	66.8	5.06	54.9	1.80	1.5	0.12	10.4	0.45	60.9	3.71	5.4	0.20
Shrub/brush	160.9	0.42	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Mixed meadow/shrub/brush	751.0	1.96	35.9	1.38	0.0	0.00	12.3	0.93	64.6	2.12	24.9	1.96	30.0	1.30	60.6	3.69	62.6	2.33
Woodland	24059.	62.79	1643.8	63.12	1173.6	89.89	388.5	29.41	940.2	30.84	601.3	47.31	1819.3	78.80	1143.0	69.63	2305.4	85.84
Marsh	9	0.03	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Barren land	11.5	0.28	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Mines/quarries	107.3	0.31	0.0	0.00	0.0	0.00	0.0	0.00	3.7	0.12	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
	118.8																	
Present Landuse Totals	38318. 0	100.0	2604.3	100.0	1305.6	100	1321.1	100	3048.6	100	1270.9	100	2308.7	100	1641.5	100	2684.7	100
Future Landuse Change	[917.8]	2.0	**	**	**	**	**	**	**	**	**	**	[3.4]	**	[14.2]	**	[22.5]	**

NOTE: Future developed land changes are shown in "[ ]". Reduction in other landuses caused by development not shown.

Table IV-1. Estimated Areal Extent of Present and Future Landuses for Jacks Creek Watershed, cont.

Landuse	Subarea 9		Subarea 10		Subarea 11		Subarea 12		Subarea 13		Subarea 14		Subarea 15		Subarea 16		Subarea 17	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Mixed urban	4.0	0.95	0.0	0.00	0.4	0.01	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
[High density residential]	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**	**
Low/med dens residential	28.5	6.77	0.0	0.00	339.5	7.99	6.3	0.48	0.0	0.00	29.3	2.07	27.4	3.55	138.3	8.94	326.1	14.05
[Future low/med resident]	[62.9]	**	**	**	[85.6]	**	**	**	**	**	[41.2]	**	**	**	[20.4]	**	[107.5]	**
[Very low dens residential]	**	**	**	**	**	**	**	**	[0.8]	**	[3.2]	**	[1.4]	**	[6.6]	**	[47.1]	**
Commercial	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	2.8	0.12
Industrial	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	11.7	1.52	8.8	0.57	0.0	0.00
Commercial/industrial	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Other build-up	0.0	0.00	0.0	0.00	6.4	0.15	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Farmstead	1.3	0.32	0.0	0.00	9.3	0.22	0.0	0.00	3.2	0.40	2.3	0.21	2.5	0.33	1.7	0.11	8.1	0.35
Cultivated	156.5	37.18	0.7	3.45	343.8	8.09	3.9	0.30	113.2	14.09	207.1	19.09	152.9	19.83	570.8	36.89	831.0	35.81
Orchard, nursery, etc.	2.7	0.63	0.0	0.00	2.1	0.05	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Feedlot	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	1.1	0.07	3.5	0.15
Pasture/field	0.0	0.00	0.0	0.00	17.0	0.40	0.0	0.00	0.0	0.00	3.3	0.30	0.0	0.00	0.0	0.00	10.4	0.45
Meadow	7.1	1.69	0.0	0.00	44.2	1.04	0.0	0.00	0.0	0.00	0.0	0.00	110.3	14.31	45.5	2.94	0.2	0.01
Shrub/brush	0.0	0.00	0.0	0.00	16.6	0.39	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	75.4	3.25
Mixed meadow/shrub/brush	33.4	7.93	0.0	0.00	171.7	4.04	2.1	0.16	15.7	1.95	25.6	2.36	0.0	0.00	148.2	9.58	53.6	2.31
Woodland	187.4	44.53	18.7	96.55	3298.8	77.63	1292.9	99.00	671.4	83.56	817.2	75.35	461.1	59.80	615.6	39.79	1002.5	43.20
Marsh	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	11.1	0.72	0.0	0.00
Barren land	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Mines/quarries	0.0	0.00	0.0	0.00	0.0	0.00	0.7	0.05	0.0	0.00	0.0	0.00	5.1	0.66	5.7	0.37	6.7	0.29
Present Landuse Totals	420.8	100	19.4	100	4249.4	100	1306.0	100	803.5	100	1084.6	100	771.1	100	1547.2	100	2320.7	100
Future Landuse Change	[62.9]	**	**	**	[85.6]	**	**	**	[0.8]	**	[44.4]	**	[1.4]	**	[27.0]	**	[154.6]	**

Table IV-1. Estimated Areal Extent of Present and Future Landuses for Jacks Creek Watershed, cont.

Landuse	Subarea 18		Subarea 19		Subarea 20		Subarea 21		Subarea 22		Subarea 23		Subarea 24	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
Mixed urban	0.0	0.00	10.0	0.38	0.0	0.00	38.9	2.40	0.0	0.00	35.7	1.27	137.4	14.16
[High density residential]	**	**	**	**	**	**	[67.7]	**	**	**	[56.4]	**	[58.7]	**
Low/med density resident	6.3	46.67	140.9	5.33	20.0	1.30	335.1	20.72	8.2	52.94	136.8	4.87	44.6	4.60
[Future low/med residen]	**	**	[80.9]	**	**	**	[14.6]	**	**	**	[78.1]	**	**	**
[Very low dens residential]	**	**	**	**	[144.4]	**	**	**	**	**	**	**	**	**
Commercial	0.0	0.00	28.3	1.07	0.0	0.00	9.9	0.61	0.0	0.00	0.0	0.00	0.0	0.00
Industrial	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	16.0	0.57	0.0	0.00
Commercial/industrial	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	6.6	0.68
Other build-up	0.0	0.00	4.5	0.17	0.0	0.00	3.2	0.20	0.0	0.00	12.6	0.45	0.0	0.00
Farmstead	0.0	0.00	0.0	0.00	21.0	1.36	7.4	0.46	0.0	0.00	9.5	0.34	7.5	0.77
Cultivated	0.7	5.00	34.4	1.30	1258.4	81.65	417.8	25.83	0.0	0.00	651.2	23.19	123.0	12.68
Orchard, nursery, etc.	0.0	0.00	0.0	0.00	0.0	0.00	4.3	0.27	0.0	0.00	0.0	0.00	0.0	0.00
Feedlot	0.0	0.00	0.0	0.00	2.7	0.18	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Pasture/field	0.0	0.00	0.0	0.00	1.5	0.10	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Meadow	0.0	0.00	0.0	0.00	0.0	0.00	45.6	2.82	0.0	0.00	0.0	0.00	0.0	0.00
Shrub/brush	0.0	0.00	20.9	0.79	8.5	0.55	36.6	2.26	0.0	0.00	0.0	0.00	0.0	0.00
Mixed meadow/shrub/brush	1.4	10.00	0.8	0.3	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Woodland	5.2	38.33	2219.0	83.96	229.2	14.87	713.1	44.08	7.2	47.06	1936.3	68.95	642.0	66.19
Marsh	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00	0.0	0.00
Barren land	0.0	0.00	88.8	3.36	0.0	0.00	0.0	0.00	0.0	0.00	10.1	0.36	8.9	0.92
Mines/quarries	0.0	0.00	95.4	3.61	0.0	0.00	5.7	0.35	0.0	0.00	0.0	0.00	0.0	0.00
Present Landuse Totals	13.5	100.0	2642.9	100.0	1541.3	100	1617.6	100	15.4	100	2808.2	100	970.0	100
Future Landuse Change	**	**	[80.9]	**	[144.4]	**	[82.3]	**	**	**	[134.5]	**	[58.7]	**

4. Principal Channel Element Parameters

Field measurements of select stream channel cross-sections were secured with the assistance of County personnel. Based on field observations, the average stream channel roughness coefficient selected for use throughout the study was set at 0.043 (HUD&FHA, 1978; Chow, 1959; USGS, 1967). Average channel slopes were interpreted from 7½-minute USGS quadrangles. Where available, channel slopes were checked and corrected to match stream profiles provided by the Derry Township Flood Insurance Study (1978). Channel element lengths were determined from the digitized stream network using PC ARC/INFO. Data was analyzed to estimate full-flow channel capacity for each principal stream segment. Flow velocity and resulting stream element travel time were derived through this analysis. Plate 1 shows the location channel elements. Table IV-2 presents channel element parameters and travel times used in modeling.

5. Significant Obstructions

A field survey of Potentially Significant Obstructions (PSO's) was conducted. The PSO survey included all structures meeting the following criteria:

- The obstruction is a roadway overpass.
- The stream is perennial.
- The height between the top of the overpass opening and the crown of the road is greater than two feet.
- The cover material consists of a solid surface such as compacted earth, rock, brick or concrete.

The PSO survey team ultimately collected data on a number of bridges which did not meet the "two foot" criteria listed above (i.e., bridges where the "opening-to-crown" distance was less than two feet). However, upon review this information, it was judged to be valuable and therefore included in the obstruction capacity assessment.

Estimated obstruction capacity was determined using field measurements and observations in accordance with the methodology described in "Hydraulic Design of Highway Culverts" (USDOT, 1985). Inlet control with flow depth equal to the top of the opening was assumed in all cases. The location of PSO's surveyed in the field are shown on Plate 3. This plate also shows the flood plain delineation and wetlands locations in the study area as defined by the Mifflin County Planning Office, interpreted from existing sources. Table IV-3 shows the information that was collected during the field survey and the estimated hydraulic capacity for each PSO.

Table IV-2. Estimated Channel Element Parameters and Travel Times

Subarea	Channel Element	Channel Length (ft)	Average Slope (ft/ft)	Bank Full Average Velocity[1] (fps)	Bank Full Capacity (cfs)	Bank Full Travel Time (min)
1	1	6991	0.004	3.25	120	36
2	2	7435	0.007	3.25	60	38
3	3	11641	0.003	3.50	270	55
4	4	9354	0.002	3.00	290	52
5	5	1327	0.002	3.00	410	7
6	6	13464	0.005	2.75	50	82
7	7	1053	0.007	4.50	250	4
8	8	6408	0.007	3.50	60	31
9	9	427	0.007	4.25	170	2
10	10	20447	0.002	4.00	1100	85
11	11	738	0.003	4.50	1210	3
12	12	9555	0.008	2.50	10	64
13	13	5814	0.006	3.00	70	32
14	14	3901	0.008	2.25	10	29
15	15	4857	0.005	3.00	50	27
16	16	13569	0.003	3.50	270	65
17	17	573	0.005	4.50	340	2
18	18	16267	0.003	4.50	1210	60
19	19	749	0.003	5.75	1830	2
20	20	2969	0.008	5.00	210	10
21	21	729	0.008	5.00	210	2
22	22	16016	0.003	5.75	1830	46
23	23*	10376	0.003	4.50	1570	38
24	24	N/A	N/A	N/A	2000	N/A

[1] Assumes Manning's n = 0.043

*Juniata River backwater in channel element 23 not reflected in velocity, capacity, and travel time shown here.

B. MODEL SELECTION AND SETUP

1. Model Selection

Two different runoff models were setup and assessed using preliminary watershed data. These models were; the Penn State Runoff Model (PSRM), and the SCS TR-20 Model. Following significant efforts to resolve differences between outputs from the models, a decision was made to concentrate all further efforts on calibrating the PSRM model. The reasons for this selection are as follows:

- The data input for PSRM is readily assembled and easily manipulated.
- The PSRM model appeared to be generating runoff peaks which were more consistent with computed channel capacities.
- The PSRM model appeared to better simulate runoff peaks predicted in the "Derry Township Flood Insurance Study" (HUD&FHA, 1978) and "Procedure PSU-IV for Estimating Design Flood Peaks on Ungaged Pennsylvania Watersheds" (PSU, 1981).
- The PSRM model offers output features for displaying subarea runoff contributions and release rates which are not available in TR-20.

Figure IV-1 is a schematic PSRM subwatershed connectivity diagram for Jacks Creek as it was modeled in this study. Boxes represent subareas and the arrows leaving each box represent discharge stream elements. This diagram graphically illustrates the stream flow paths and how individual subarea stormwater flows accumulate. Three of the subareas, numbers 10, 18, and 22 are "pseudo" subareas used in modeling for program optimization only.

The *Technical Analysis, Modeling, and Standards Document* contains documentation for the PSRM model as an Appendix. This has been provided for readers desiring more information about the model or details concerning some of the concepts discussed in the various plan reports.

Table IV-3. Potentially Significant Obstruction Survey

(O-C) - Distance from top of opening to crown of road (ft)
HT = Height(ft) W = Width(ft)

CODE (1)	DISCHARGE SOURCE ID	PSO ID	MUNICIPALITY	STREAM	ROAD #	ROAD TYPE	OPENING SHAPE (BRIDGE)		MEASUREMENTS			MATERIAL (2)	COMMENTS	ESTIMATED CAPACITY (CFS) (3)
							◠	⊓	(C)	HT	W			
	24	1A	Lewistown	Jacks Creek	22	Heavy Duty		X	3	31.5	117	STL & C	Large trapezoid opening. B=64' & Top=169'. In Juniata River backwater area.	>9300 (H)
	24	1	Lewistown	Jacks Creek	Park Foot Bridge	Light Duty	X		4	20	38	STN & C	At park. Steep right bank. Low grassy left bank. In Juniata River backwater.	>3750 (H)
	23	2	Derry Twp	Jacks Creek	T315	Medium Duty		X	4.5	14	101	C	Small dam on upstream side.	15200
	23	3	Derry Twp	Jacks Creek	44007	Medium Duty		X	4	12.5	72	STL & C	Steep left bank. Low brushy right bank.	9400
	22	3A	Derry Twp	Jacks Creek	Conrail	Railroad		X	3	12	74	STL	Two 8' piers subtracted from width.	7400
	22	4	Derry Twp	Jacks Creek	44002	Light Duty		X	3 3	11.5 13.5	68.5 57.5	STN & STL with W deck	Stone center pier. Island on down stream side of pier.	15600
	21	5A	Derry Twp	Unnamed Tributary to Jacks Creek	44002	Light Duty		X	1.75	6	17	C	Low grassy banks. Left bank 4' retaining wall. Basement flooding possible.	700
	21	5B	Derry Twp	Unnamed Tributary to Jacks Creek	522	Heavy Duty		X	2	6	17	C	Low grassy banks.	700
	21	6	Derry Twp	Unnamed Tributary to Jacks Creek	522	Heavy Duty	X		1.75	12	21.5	C		1800
	18	7A	Decatur Twp	Jacks Creek	T737	Medium Duty		X	1.5 1.5	6.5 6.5	18 18	STL, C & STN		1700
	18	7B	Decatur Twp	Jacks Creek	T737	Medium Duty		X	2	7.5	40	STL, C & STN	Dry stream bed.	2400

(1) Use unique ID code where applicable
(2) Material abbreviations: C=concrete; STL=steel; STN=stone; W=wood
(3) Estimate capacity based on "inlet control". Reference: USDOT. 1985. Hydraulic design of highway culverts, Hydaulic Series No. 5. Report No. FHWA-Ip-85-15.
ADDITIONAL NOTES:
(H) Estimated capacity from: HUD & FHA. 1978. Flood insurance study, Derry Township, Mifflin County, PA.

Table IV-3. Potentially Significant Obstruction Survey, Cont.

(O-C) - Distance from top of opening to crown of road (ft)
HT = Height(ft) W = Width(ft)

CODE (1)	DISCHARGE SOURCE ID	PSO ID	MUNICIPALITY	STREAM	ROAD #	ROAD TYPE	OPENING SHAPE (BRIDGE)		MEASUREMENTS			MATERIAL (2)	COMMENTS	ESTIMATED CAPACITY (CFS) (3)
							◠	⊓	(C)	HT	W			
	17	8	Decatur Twp	Meadow Creek	522	Heavy Duty		X	13	10 11	15 15	C	Low bushy sides.	3000
	17	10	Decatur Twp	Meadow Creek	T379	Medium Duty		X	1.5	4.75	20	STL & C	Low bushy banks.	600
	16	11	Decatur Twp	Meadow Creek	T737	Medium Duty		X	1.5	4	11	STL, STN & C	Low grassy banks.	250
	11	12	Decatur Twp	Jacks Creek	T323	Medium Duty	X		1.5	9	40	C	One lane bridge built 1910.	2000
	11	13	Decatur Twp	Jacks Creek	T707	Medium Duty		X	2	8.5	40	C	Built in 1923. Stream turns approx. 70 degrees at entry. Residents frequently flooded. 2 homes at risk.	2400
	10	14	Decatur Twp	Jacks Creek	522	Heavy Duty		X	3 3	9 7.5	41 41	C	Low grassy banks.	6500
	7	15	Decatur Twp	Belltown Run	T385	Medium Duty		X	1.75	4.7	24.5	C with STL guard rails	High sides. Minor flooding to residence and greenhouse possible.	700
	5	15A	Decatur Twp	Jacks Creek	T385	Medium Duty		X	2	10	66	STL & C	Overtopped in 1972. Residents never flooded.	6300
	7	16	Decatur Twp	Belltown Run	T383	Medium Duty		X	2 2	6.5 8.5	25 25	STN & C	Very low banks.	3000
	6	17	Decatur Twp	Belltown Run	T391	Medium Duty		X	1.5	6.3	21	STL & C	Low grassy banks.	900
	6	18	Belltown Decatur Twp	Belltown Run	44002	Light Duty		X	2	3	20	STL & C	Low grassy banks.	300

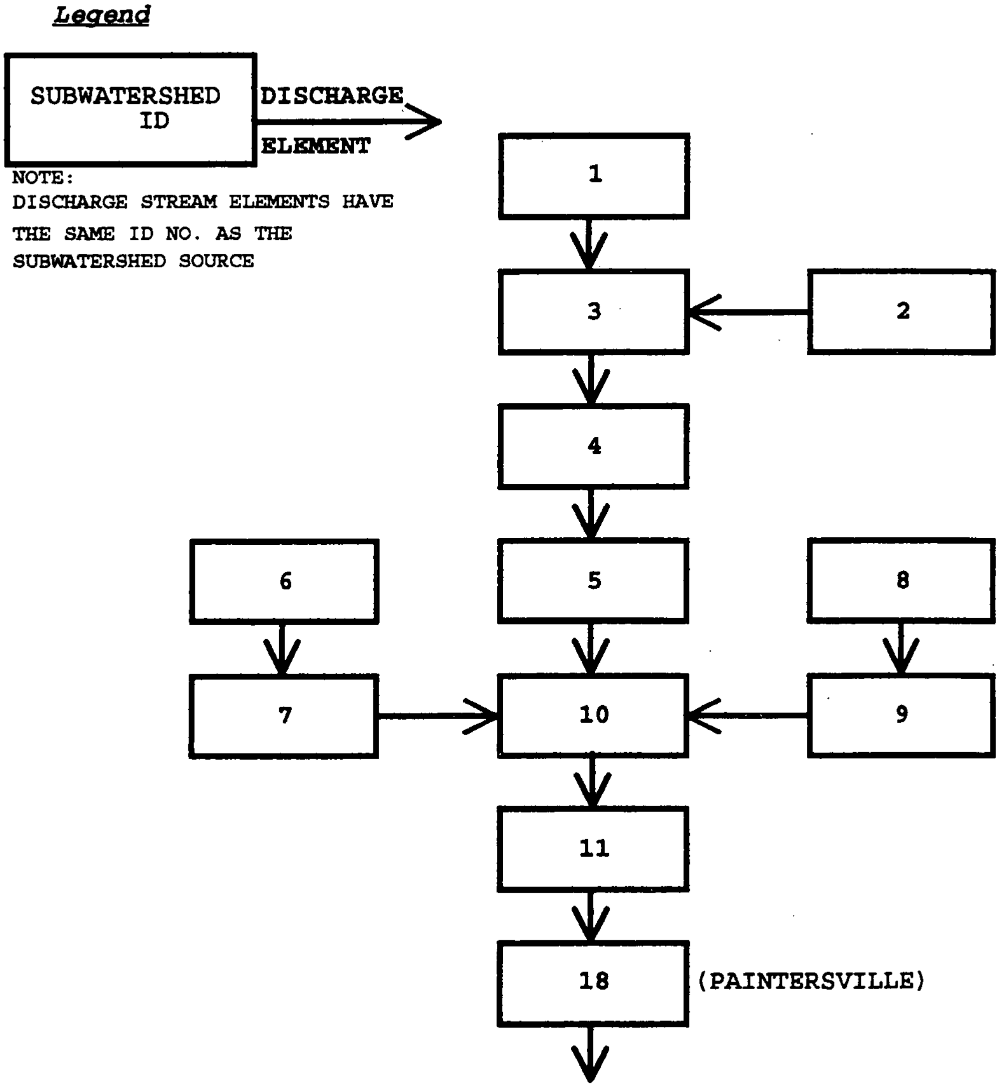
(1) Use unique ID code where applicable
(2) Material abbreviations: C=concrete; STL=steel; STN=stone; W=wood
(3) Estimate capacity based on "inlet control". Reference: USDOT. 1985. Hydraulic design of highway culverts, Hydaulic Series No. 5. Report No. FHWA-lp-85-15.
ADDITIONAL NOTES:
(H) Estimated capacity from: HUD & FHA. 1978. *Flood insurance study*, Derry Township, Mifflin County, PA.

Table IV-3. Potentially Significant Obstruction Survey, Cont.

(O-C) - Distance from top of opening to crown of road (ft)
HT - Height(ft)   W - Width(ft)

CODE (1)	DISCHARGE SOURCE ID	PSO ID	MUNICIPALITY	STREAM	ROAD #	ROAD TYPE	OPENING SHAPE (BRIDGE)		MEASUREMENTS			MATERIAL (2)	COMMENTS	ESTIMATED CAPACITY (CFS) (3)
							⌒	⊓	(C)	HT	W			
	4	19	Decatur Twp	Jacks Creek	T454	Light Duty		X	1.5	8	27	STL & C	18 ton limit.	1800
	4.	20	Decatur Twp	Jacks Creek	44015	Medium Duty		X	1.75	6.5	29.5	STL & STN	Open grate deck. Wooded area.	1400
	3	21	Decatur Twp	Jacks Creek	44015	Medium Duty		X	3	9.5	40	STL & C	Low grassy banks downstream side. Low banks w/saplings upstream. Minor flooding to house/barn possib	3300
	1	22	Bannerville Snyder Co.	Jacks Creek	44002	Light Duty		X	2	5	29.5	STL & C	Open grate deck. Low grassy sides/ brush. Minor flooding of 2 properties possible.	1000

(1) Use unique ID code where applicable
(2) Material abbreviations: C=concrete; STL=steel; STN=stone; W=wood
(3) Estimate capacity based on "inlet control". Reference: USDOT. 1985. Hydraulic design of highway culverts, Hydaulic Series No. 5. Report No. FHWA-Ip-85-15.
ADDITIONAL NOTES:
(H) Estimated capacity from: HUD & FHA. 1978. Flood insurance study, Derry Township, Mifflin County, PA.



SEE NEXT PAGE FOR CONTINUATION

Figure IV-1. PSRM Subwatershed Connectivity Diagram for Jacks Creek Watershed

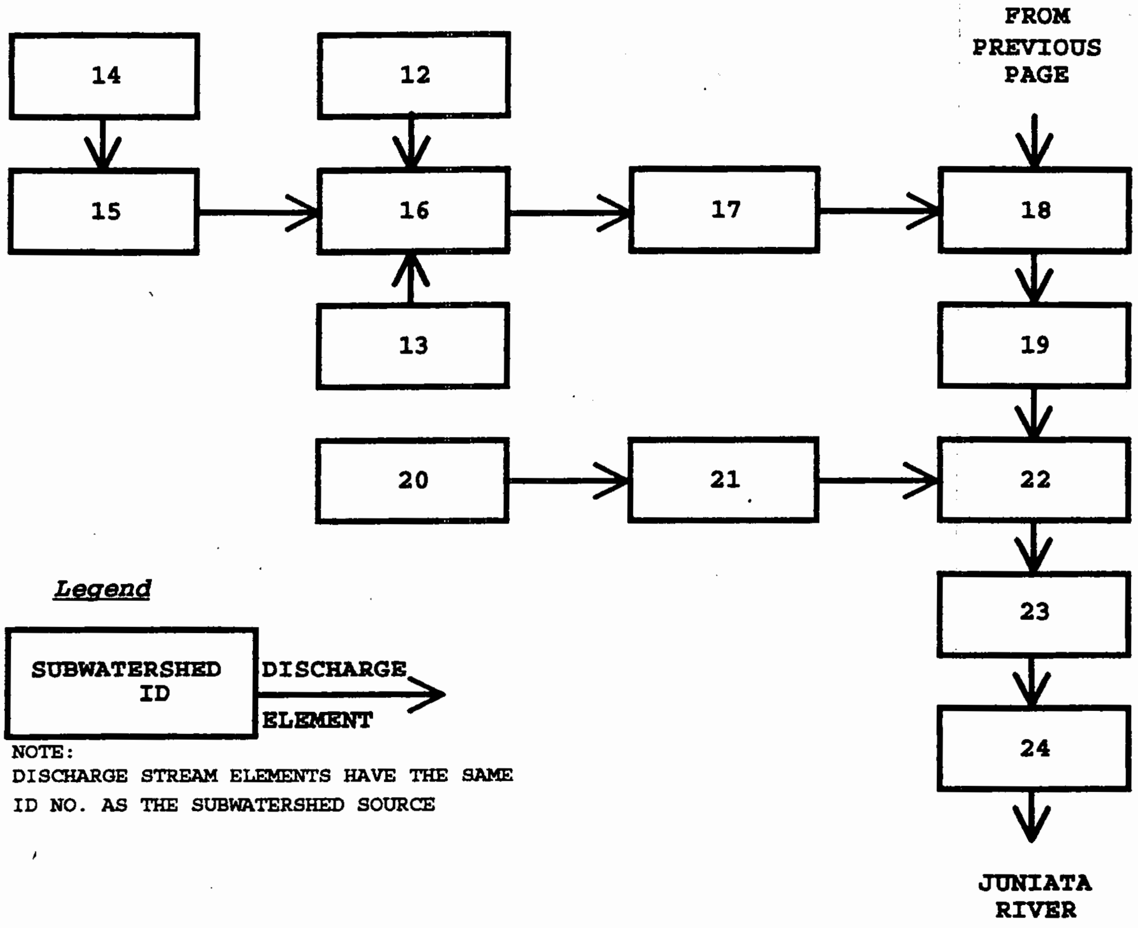


Figure IV-1. PSRM Subwatershed Connectivity Diagram for Jacks Creek Watershed

2. Runoff Curve Numbers

Curve numbers (CNs) for individual subareas were determined using cover type and hydrologic soil group (HSG) information in accordance with the methodology described in the SCS publication "TR-55, Urban Hydrology for Small Watersheds." Digital landuse and soil mapping (obtained from the SCS) of the watershed were used for this analysis. Plate 4 shows the distribution of HSG polygons in Jacks Creek Watershed. The raster based GIS package, ERDAS, and the GDI program, AVEPARM, were used to automate weighted CN parameterization for present and future landuses.

Once CN values were established for the study area, the strategy was to avoid further manipulation of this parameter during model calibration. This policy was observed with one exception. Runoff peaks from subarea 20 (Dry Valley) were considered excessive when compared to the estimated capacity of the small intermittent channel exiting in this area. The channel was dry at the time field work was conducted (May 1992). Since Dry valley is in a karst region it was decided that a reduction in CN was warranted to account for reduced runoff resulting from direct subsurface infiltration. The PSRM model does not have the capability to account for carbonate geology influences so an alternative approach was used to investigate runoff peaks from subarea 20. This analysis provided a basis for reducing the CN value used in PSRM modeling. The method used in this study is described in the following paragraph.

The estimated bank full channel capacity of the drainage way exiting subarea 20 was computed at 50 cfs. This discharge rate was assumed to generally represent the mean annual storm (2.33-yr) runoff peak. Analysis of anticipated runoff peaks using the PSU-IV program (Aron, et al., 1981) showed that the karst nature of subarea 20 could easily account for the apparently undersized channel leaving this area. The PSU-IV model was used for this analysis because it allows the user to estimate the amount of karst terrain in the drainage area and reduces the anticipated runoff peak accordingly. In this case 80% of subarea 20 was assumed to be impacted by karst conditions. The 2-yr storm runoff peak generated by PSU-IV closely matched the estimated channel capacity (51 cfs versus 50 cfs respectively). Through trial and error it was found that reducing the CN value from 78.7 to 75 in the PSRM model input file yielded peak runoff rates which reasonably approximated those predicted using PSU-IV for all storm events investigated. The CN was reduced by an equal amount during future landuse modeling to again account for carbonate geology influences in subarea 20.

The PSRM model requires two CN input values for each subwatershed; one for pervious area, and a second value for impervious area. Accordingly, pervious area CN values should refer only to pervious areas and so on. Weighted average CN values for developed areas which incorporate impervious fractions technically should not be used directly in the PSRM model. Rather, weighted average CNs, such as those listed in Table IV-4 or urban and residential landuses, should be partitioned into their pervious and impervious CN value components, which are then used in the model. However, as noted below, there is an exception to this guideline.

When the areal extent of developed areas is very small in comparison to the total subwatershed size, as is the case throughout the Jacks Creek watershed, direct use of published weighted average CNs makes little difference to the total subwatershed weighted average CN used in PSRM modeling. Hence, use of these values does not make a significant impact on modeling results. The CN values used in this investigation have been derived directly from published values without partitioning of pervious and impervious CN components. Table IV-4 lists the CN values used in the Jacks Creek study for subwatershed weighted averaging by landuse cover type and hydrologic soil group. It is important to reiterate that direct use of published weighted average CN values for developed landuse areas can make a large impact on runoff peaks in cases where a significant portion of a watershed (or subwatershed) is occupied by residential and urban land types. The Jacks Creek watershed is a unique case where use of published values does not alter modeling results to any great degree.

For modeling purposes very low density residential zones were assigned unique parameters by township. As explained earlier, areas expecting this type of development were only roughly identified for the study. Areas delineated in Derry Township are expected to experience a 50% development rate over the 10-year planning period. Similar areas in Decatur Township anticipate 33% development. The current landuse of these projected growth areas is primarily agriculture. The weighted average CN used in modeling assumes that agriculture and very low density residential uses share these areas.

Table IV-5 shows the weighted average CN values used in the model runs for each subarea. Both present and future landuse conditions are shown.

3. Overland Flow

Overland flow lengths and slopes (Table IV-5) for each subarea were estimated from the average of three measurements from 7½-minute USGS quadrangles. The overland roughness coefficient (Manning's n) values shown in the table were derived using the AVEPARM program in a manner similar to that employed for weighted CN value determination. The *Technical Analysis, Modeling, and Standards Document* provides additional reference material relating to overland flow parameters.

Table IV-4. Average Impervious Surface, Runoff Curve Numbers, and Pervious Surface Roughness Coefficients for Various Landuse Types in Jacks Creek Watershed

Landuse	Average Impervious Surface (%)	Hydrologic Soil Group and Curve Number				Roughness Coefficient
		A	B	C	D	
Mixed urban (1/4 acre lots)	38	61	75	83	87	0.02
Low/med dens residential (2 ac lots)	12	46	65	77	82	0.21
Commercial	85	89	92	94	95	0.02
Industrial	72	81	88	91	93	0.02
Mixed commercial/industrial	79	85	90	92	94	0.02
Other built-up	25	54	70	80	85	0.18
Farmstead	12	59	74	82	86	0.21
Cultivated	1	63	75	83	87	0.12
Orchard, nursery, etc.	1	43	65	76	82	0.50
Feedlot	1	77	86	91	94	0.02
Pasture/field	1	49	69	79	84	0.20
Meadow	1	30	58	71	78	0.24
Shrub/brush	1	30	48	65	73	0.60
Mixed meadow/shrub/brush	1	30	50	68	75	0.42
Woodland	1	30	55	70	77	0.60
Water	1	100	100	100	100	0.00
Marsh	1	85	85	85	85	0.00
Barren land	1	85	85	85	85	0.02
Mines/quarries	1	85	85	85	85	0.02
<u>Future Development</u>						
High dens residential (½ ac lots)	25	54	70	80	85	0.18
Low/med dens residential (2 ac lots)	12	46	65	77	82	0.21
*Very low dens residential (4 ac lots) (Derry Township)	3	53	69	79	84	0.18
*Very low dens residential (4 ac lots) *(Decatur Township)*	2	57	71	82	85	0.15

NOTE: For modeling purposes, very low density residential zones were assigned unique parameters by township. Areas expecting this type of development were only roughly identified for the study. Areas delineated in Derry Township are expected to experience a 50% development rate over the 10-year planning period. Similar areas in Decatur Township anticipate 33% development. Values shown are "weighted" by incorporating 4-acre residential lots with cultivated land (the primary present landuse).

REFERENCE: USDA-SCS, 1986, "Urban Hydrology for Small Watersheds" (TR 55).

Table IV-5. Jacks Creek Watershed Subarea Parameters

SUBAREA	AREA (ACRES)	CURVE NUMBER		IMPERVIOUS SURFACE (%)		MANNINGS N OVERLAND		OVERLAND FLOW LENGTH (FT)	SLOPE (%)	PREDOMINANT HYDROLOGIC SOIL GROUP (HSG)
		Present	Future	Present	Future	Present	Future			
1	2604.3	74.2	74.2	2	2	0.43	0.43	4800.0	0.241	C
2	1305.6	70.8	70.8	1	1	0.55	0.55	4434.0	0.233	C
3	1321.1	79.8	79.8	2	2	0.27	0.27	1576.0	0.123	C
4	3048.6	78.3	78.3	2	2	0.29	0.29	1438.0	0.124	C
5	1270.9	76.2	76.2	2	2	0.36	0.36	1380.0	0.123	C
6	2308.7	69.4	69.4	2	2	0.52	0.52	4400.0	0.220	C
7	1641.5	73.3	73.3	2	2	0.48	0.48	1000.0	0.235	C
8	2685.7	70.3	70.3	2	2	0.55	0.55	3776.0	0.271	C
9	420.8	73.8	73.0	2	4	0.38	0.38	900.0	0.147	C
10	19.4	76.3	76.3	1	1	0.59	0.59	600.0	0.233	D
11	4249.4	71.1	71.0	2	2	0.52	0.52	3850.0	0.258	C
12	1306.0	67.0	67.0	1	1	0.60	0.60	4066.0	0.244	C
13	803.5	70.4	70.4	1	1	0.52	0.52	5500.0	0.191	C
14	1084.6	68.3	68.1	1	2	0.49	0.49	6200.0	0.194	C
15	771.1	64.3	64.3	2	2	0.43	0.43	1926.0	0.173	B
16	1547.2	74.0	74.1	3	3	0.35	0.35	2800.0	0.072	C
17	2320.7	74.8	75.0	3	3	0.36	0.35	3066.0	0.104	C
18	13.5	73.5	73.5	4	4	0.42	0.42	600.0	0.120	C
19	2642.9	71.7	71.7	3	3	0.52	0.52	4000.0	0.247	C
20	1541.2	75.0	74.8	1	2	0.19	0.20	7875.0	0.037	C
21	1617.6	70.9	70.8	5	5	0.36	0.36	2900.0	0.103	C
22	15.4	76.4	76.4	8	8	0.36	0.36	600.0	0.250	C
23	2808.2	73.1	72.9	3	3	0.46	0.46	3012.0	0.258	C
24	970.0	73.6	73.4	8	9	0.43	0.43	2350.0	0.172	C

(1) Weighted curve numbers including both pervious and impervious areas.

4. Impervious Fraction

Impervious fraction (IF) for each subarea was determined by first assigning a fraction for each landuse type. All landuses were assumed to have at least 1% connected impervious area. Built-up areas were assigned values in accordance with the values presented in Table IV-4. A weighted average IF was determined for both present and future landuse conditions for each subarea using AVEPARM (see Table IV-5). The weighted average IF values were used in the PSRM model runs.

Since all of the IF has been considered as connected, the values used in modeling are probably conservative (i.e., on the high side), however this is not viewed as a significant source of error in the study. As will be discussed in the next section, the PSRM model appeared to calibrate quite well without modifying the IF factor.

5. Storm Parameters

Six different storm return periods were evaluated: 2.33-year (mean annual storm), 5-, 10-, 25-, 50-, and 100-year. The SCS 24-hour Type II storm distribution was selected for use in modeling. Rainfall depths for 24-hour storm durations were estimated as the average between Regions 1 and 2 according to the Pennsylvania Department of Transportation - IDF Field Manual (PENNDOT, 1986). Table IV-6 shows the rainfall depths used for modeling the Jacks Creek Watershed.

C. MODEL RUNS

1. Calibration

No stream gaging stations are maintained in the Jacks Creek Watershed. Accordingly, no measured data were available for model calibration. After model setup efforts were well underway it was discovered, however, that a Flood Insurance Study (FIS) of the Derry Township portion of Jacks Creek was conducted in 1978 (HUD&FHA, 1978). This study lists estimated stream flows at the mouth of Jacks Creek for several storm frequencies. Since no actual stream flow data were available for calibration, this information was used. A second estimation of stream flows was generated using the PSU-IV model. Peak flow estimates from PSU-IV runs appeared to compare favorably with those used in the Derry Township flood insurance study.

Table IV-6. Storm Frequency and Depth

Frequency	Depth (inches)
*2.33-year	2.7
5-year	3.1
10-year	3.6
25-year	4.5
50-year	5.0
100-year	5.6
*Mean annual storm	

SOURCE: PA DOT. 1986. Field Manual of PDT-IDF Charts.

NOTE: The average depth of regions 1 and 2 were used.

Calibration of the PSRM model involved detailed examination and selection of various input parameters. The most important calibration input parameters for Jacks Creek were discovered to be related to drainage element travel time (Tt). The ratio of in-bank to overbank flow velocities (CTS), which is directly related to channel travel time, was found to be a valuable "fine tuning" parameter. Estimates of travel times for the various stream elements involved the use of Manning's equation together with representative bank-full area cross-section estimates based on field measurements, and channel lengths derived from 7½-minute USGS map quadrangles. Use of Manning's equation required selection of stream channel roughness coefficients (Manning's n). This parameter plays a critical role in the computation of flow velocity. During this study Manning's n was varied in computations from a low of 0.03 to as high as 0.08 to assess resulting velocity predictions. Low n values showed excessive velocities which were deemed unreasonable for this stream. High values gave more realistic velocities, but after further consideration seemed to be pushing the limit for sound application of published n values with regard to observed streambed conditions. In the final analysis, a Manning's n value of 0.043 was selected for use throughout the stream network. This value predicted plausible velocities and can be reasonably supported by published n values for similar stream conditions. This value is also consistent with the upper end range of roughness coefficients reported for Jacks Creek in the 1978 FIS study.

Documentation accompanying the PSRM model reports that the normal range of CTS values is from 1.5 to 4.0. The typical value for an undeveloped stream is 2.5. During model calibration CTS values ranging form 1.0 to 3.0 were examined. Final fine tuning calibration of the model resulted in the selection of a CTS value of 2.3, well within the range of values normally found for similar stream networks.

Table IV-7 provides a comparison of calibrated PSRM model peak discharges with the 1978 FIS report and PSU-IV predictions. This Table shows that the PSRM calibration agrees very well with the other sources for the 5-, 10-, 25-, and 50-year storms. The 2.33-year (mean annual) storm peak is slightly overestimated and the 100-year storm peak is underestimated. Overall, the calibration effort was deemed to be very successful.

2. Present Landuse Stormwater Runoff

The *Technical Analysis, Modeling, and Standards Document* provides a series of PSRM output summaries - one for each storm frequency studied. These outflow summary tables show a tabulation of peak runoff values for each subarea and the accumulated peak outflow. These values are useful for understanding how stream flows from the various subareas accumulate to create higher composite flow peaks. Readers desiring detailed information concerning composite peak flows are encouraged to obtain the *Technical Document.*

Table IV-7. Comparison of Calibrated PSRM Model Peak Discharges With Other Methods of Estimation*

1	2	3	4
Storm Frequency	PSRM Peak (cfs)	PSU-IV Peak (cfs)	FIS Study Peak (cfs)
2.33-year	2071	1533	-
5-year	2833	2770	-
10-year	3773	3888	3750
25-year	5690	5708	-
50-year	6906	7413	7100
100-year	8400	9456	9300

*Peak discharge from entire Jacks Creek Watershed drainage area (59.9 sq. mi.)

Column 1:	Storm return period frequency as per plan of study.
Column 2:	Penn State Runoff Model, May 1992 version.
Column 3:	As per "Field Manual of Procedure PSU-IV for Estimating Design Flood Peaks on Ungaged Pennsylvania Watershed," April 1981.
Column 4:	From "Flood Insurance Study, Township of Derry, Mifflin County, PA," March 1978.

3. Future Landuse Stormwater Runoff

Table IV-5 provides a comparison of present and future subarea CN, IF, and roughness coefficient values. Examination of the table shows that future landuse changes have very little or no impact on these critical values. Accordingly, it is not surprising that the runoff modeling shows very little change in peak runoff rates from the present landuse conditions.

The reason for stability in modeled runoff peaks (present vs future) is that the projected development activity in Jacks Creek watershed in most cases actually results in a net reduction in the CN and increased surface flow roughness coefficient values for areas expecting development. For example, the CN values for cultivated land are higher than those computed for future development in the study area. Reduced CN and higher roughness coefficients result in less runoff. However, developed areas have a higher IF. This leads to an increase in runoff. Overall, at the scale of this study, it appears that these offsetting factors tend to balance each other. On a more minute scale, localized flooding from uncontrolled stormwater originating from development areas could be a problem.

4. Runoff Peaks and Potentially Significant Obstructions

The stormwater carrying capacity of PSO's is compared to estimated peak discharges for both present and future conditions in Table IV-8. With few exceptions, the PSO's surveyed appear generally capable of handling up to the 10-year storm event. Many appear to have sufficient capacity to pass the 100-year storm. Most bridges are located such that backwater and/or overtopping will not create a significant risk to life or property. Several have the potential to contribute to minor flooding.

Only one PSO was singled out as a "SIGNIFICANT OBSTRUCTION" - PSO13. PSO13 is a concrete bridge located on T707 just outside the village of Shindle (see Plate 3). Jacks Creek takes a sharp bend immediately upstream of the bridge. The bridge carrying capacity and stream alignment, together, create a situation which promotes flooding of two residences. Detailed hydraulic analysis of this bridge is recommended.

5. Release Rate Considerations

The Department recommends that release rates be considered when formulating Act 167 stormwater management plans. For this study the individual outlet points from each subwatershed have been considered as "control points" for comparison of present and future stormwater flows. Release rate tables incorporating each of these points have been provided as a part of the PSRM model output results in the *Technical Document*.

Table IV-8. Potentially Significant Obstructions, Capacities, and Estimated Peak Runoff Flow Rates Predicted by PSRM

(1) PSO ID	(2) Subarea Discharge	(3) Estimated PSO Capacity (cfs)	(4) Present [Future] Estimated Peak Discharge						(5) Comments
			2.33-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1A	24	>9300 (H)	2072 [2073]	2833 [2834]	3773 [3774]	5690 [5687]	6906 [6903]	8400 [8397]	Juniata River backwater inundates bridge >100-yr. NOT a significant obs.
1	24	>3750 (H)	2072 [2073]	2833 [2834]	3773 [3774]	5690* [5687]	6906* [6903]	8400* [8397]	Juniata River backwater inundates bridge >10-yr. NOT a significant obs.
2	23	15200	2038 [2078]	2791 [2793]	3735 [3735]	5686 [5688]	6847 [6843]	8363 [8359]	Passes HEC II 500-yr. NOT a significant obs.
3	23	9400	2038 [2078]	2791 [2793]	3735 [3735]	5686 [5688]	6847 [6843]	8363 [8359]	Passes HEC II 50-yr. NOT a significant obs.
3A	22	7400	1946 [1947]	2664 [2667]	3587 [3587]	5624 [5623]	6860 [6859]	8372 [8371]	Passes HEC II 10-yr. NOT a significant obs.
4	22	15600	1946 [1947]	2664 [2667]	3587 [3587]	5624 [5623]	6860 [6859]	8372 [8371]	Passes HEC II 50-yr. NOT a significant obs.
5A	21	700	203 [214]	287 [300]	426 [438]	748* [759]	969* [979]	1274* [1282]	Minor flooding potential. One home basement. NOT a significant obs.
5B	21	700	203 [214]	287 [300]	426 [438]	748* [759]	969* [979]	1274* [1282]	Minor flooding potential. NOT a significant obs.
6	21	1800	203 [214]	287 [300]	426 [438]	748 [759]	969 [979]	1274 [1282]	NOT a significant obs.
7A/7B	18	4100	1739 [1742]	2366 [2372]	3246 [3248]	5118* [5119]	6273* [6274]	7745* [7746]	NOT a significant obs.
8	17	3000	362 [376]	524 [537]	744 [758]	1255 [1273]	1568 [1587]	1973 [1990]	NOT a significant obs.
10	.8 of 17	600	290 [301]	419 [430]	595 [606]	1004* [1018]	1254* [1270]	1578* [1592]	NOT a significant obs.

Table IV-8. Potentially Significant Obstructions, Capacities, and Estimated Peak Runoff Flow Rates Predicted by PSRM, cont.

(1) PSO ID	(2) Subarea Discharge	(3) Estimated PSO Capacity (cfs)	(4) Present [Future] Estimated Peak Discharge						(5) Comments
			2.33-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
11	.33 of 16	250	70 [73]	107 [112]	165 [170]	300* [304]	387* [394]	504* [512]	NOT a significant obs.
12	11	2000	1409 1407	1892 [1890]	2566* [2564]	3987* [3985]	4868* [4866]	5985* [5983]	NOT a significant obs.
13	.93 of 11	2400	1310 [1309]	1760 [1758]	2386 [2385]	3708* [3706]	4527* [4525]	5566* [5564]	SIGNIFICANT OBSTRUCTION Freq. flooding reported. Two homes at risk.
14	10	6500	1248 [1248]	1651 [1650]	2247 [2246]	3555 [3554]	4360 [4359]	5378 [5377]	NOT a significant obs.
15	7	700	275 [276]	433 [434]	667 [669]	1197* [1200]	1536* [1539]	1970* [1973]	Minor flooding potential. One home & greenhouse. NOT a significant obs.
15A	5	6300	896 [896]	1208 [1208]	1717 [1717]	2806 [2806]	3475 [3475]	4317 [4318]	NOT a significant obs.
16	7	3000	275 [276]	433 [434]	667 [669]	1197 [1200]	1536 [1539]	1970 [1973]	NOT a significant obs.
17	6	900	100 [100]	153 [153]	248 [248]	493 [493]	668 [668]	911 [911]	NOT a significant obs.
18	.33 of 6	300	33 [33]	51 [51]	82 [82]	163 [493]	220 [220]	300 [300]	NOT a significant obs.
19	4	1800	809 [809]	1120 [1120]	1577 [1577]	2655* [2655]	3317* [3317]	4150* [4150]	NOT a significant obs.
20	4	1400	809 [809]	1120 [1120]	1577* [1577]	2655* [2655]	3317* [3317]	4150* [4150]	NOT a significant obs.
21	3	3300	477 [477]	665 [665]	897 [897]	1385 [1385]	1694 [1694]	2104 [2104]	NOT a significant obs.
22	.80 of 1	1000	150 [150]	232 [232]	364 [364]	678 [678]	890 [890]	1174* [1174]	Minor flooding potential. Two properties. NOT a significant obs.

Table IV-8 Footnotes:

*PSRM peak flow greater than estimated PSO capacity.

(1) Potentially significant obstruction ID number

(2) Nearest applicable PSRM model subarea peak discharge.

(3) Estimated capacity based on inlet control with headwater depth equal to top of opening. (RE: US DOT. 1985. Hydraulic Design Series No. 5 Report No. FHWA-IP.85-15)

(H) Indicates that existing Flood Insurance Study (FIS) values were used because of backwater from Juniata River. (FIS Reference: HUD & FIA. 1978. Flood Insurance Study, Derry Twp., Mifflin Co)

(4) Peak discharge based on type II 24 hr. SCS storm using PSRM, 1992 version.

PSO = Potentially Significant Obstruction; defined as follows:
Paved or stabilized road (or railroad) crossing a perennial stream where the height between the water opening and road surface is greater than approximately two feet.

Significant Obstruction is defined as follows:
An obstruction which creates a flooding hazard resulting in significant risk to life or property (roadway or up/downstream properties).

At this point it is appropriate to define the meaning of the term "Release Rate". To do this, it is necessary to introduce several basic stormwater management concepts. The fundamental precept of stormwater management is that land development will result in a net increase in runoff due to land changes toward more impervious surfaces (e.g. pavement, roofs, etc.). Increases in impervious area also result in faster runoff and excessive stream flows which may exceed stream channel carrying capacity, giving rise to flash flooding.

Stormwater control practices attempt to reduce and/or delay runoff flows leaving the control area. Detention basins (or ponds) are commonly employed to capture and delay runoff so that stormwater is discharged at a flow rate equal to or less than that from pre-development conditions. This is accomplished by under-sizing the detention basin discharge pipe so that water leaves the pond at a slower rate than it enters. By design, water backs-up at the pond outlet and impounds in the basin. Very little water actually infiltrates through the pond floor. Over time the entire runoff volume is eventually discharged through the pond outlet and into the adjacent receiving stream in a controlled manner.

The greater the increase in runoff due to development, the greater the detention pond volume required, and the longer it takes for the pond to dewater. This prolonged site runoff period caused by pond dewatering can result in unintended downstream flooding. This occurs when stream flows originating higher in the watershed "catch-up" and add to delayed runoff flows from the control site. In such a case, a detention pond designed to control site runoff peak discharges at pre-development levels may actually tend to exacerbate downstream flooding problems.

To assess the potential for creating such problems in basin-wide (multi-watershed or drainage area) stormwater management studies, researchers at Penn State University developed a planning/design concept which permits engineers to estimate the runoff contribution from a single subwatershed on the cumulative runoff peak (cubic feet per second) at other points of interest in a basin-wide study area. This concept is called the "Release Rate" concept.

Release Rate is defined by the equation:

$$\textbf{Release Rate} = \frac{\text{Subarea Contribution to the Point of Interest Peak}}{\text{Subarea Peak Flow}}$$

The result of this computation is normally expressed as a percentage. In application, the "point of interest" is selected by the engineer at key locations in the basin-wide study area where increased cumulative stream flows could cause problems. For example, certain bridges which span a waterway may become significant obstructions to stream flow during heavy precipitation events. Such obstructions are good choices for release rate assessment and it is for this reason that the delineation of subwatersheds in a basin-wide study often involves selection of subarea outlet points at bridge locations. At a minimum, good stormwater management planning strives to prevent aggravation of existing problems.

The Release Rate represents the pre-construction percentage of peak stream flow contributed by a specific drainage area (subarea) at a particular location (point of interest). When the flows from sub-watersheds are controlled so that their individual contributions at a particular point of interest are not increased, the combined peak flow at the control point should not increase. When the minimum Release Rate for a subarea is used as the maximum design criterion for detention basin sizing in that subarea, theoretically, all downstream control points are adequately protected from increased stream flow peaking which would occur from uncontrolled or improperly controlled storm flows. However, application of Release Rate criterion from such an analysis must be tempered with knowledge of specific characteristics of the basin-wide study area.

Release rates for the various subareas in Jacks Creek Watershed were carefully examined in the context of subarea watershed position, PSO capacities (Table IV-8), predicted runoff peak changes (present vs future), necessity of stringent control requirements, and the reasonableness of those stringent requirements. It was determined that subarea release rates criterion may not apply because of the unique nature of this watershed. This conclusion was based on the following factors:

- Anticipated development is of limited intensity.
- Anticipated development is broadly distributed.
- Anticipated development acreage is minimal in comparison to the watershed size.
- PSRM analyses do not predict any significant increases in runoff peaks (i.e. greater than 2%) at the total watershed or subarea level.
- Only one significant obstruction is identified in the watershed (PSO13). Composite flows at this bridge actually show slight decreases in runoff peaks when present and future flows are compared.
- Increased costs associated with construction of detention facilities designed to control lower release rates do not appear justified.
- Adoption of release rate outputs from PSRM modeling to the exclusion of other factors would be an inappropriate use of the model. One of the developers of the PSRM model (Dr. Gert Aron) notes that the release rate

computation used in the model is extremely sensitive to stream element travel times. Travel time estimation is one of the "weaker" elements in this type of modeling, hence use of this data should be approached very cautiously. While the release rate concept may be a valuable tool for watersheds containing multiple limiting factors, rigorous application of release rate guidelines (less than 100%) does not appear appropriate for the Jacks Creek watershed.

The following chapter, *Chapter V, Control Techniques and Performance,* describes basic stormwater management tools available for drainage control. *Chapter VI, Technical Standards,* details standards recommended for implementation in the Jacks Creek Watershed based on the findings of the modeling work.

Chapter V. Control Techniques and Efficiency

A. GENERAL STORMWATER CONTROL STRATEGIES

Stormwater management control techniques are generally classified into different groupings depending on the runoff attribute to be controlled (control purpose) and/or the philosophical approach to controlling the runoff (control means). For the purposes of this stormwater management plan, control purposes and means are classified according to the categories listed in Tables V-1 and V-2, respectively.

Many control facilities are actually multipurpose, and therefore do not fall exclusively into a single "control purpose" classification. Multipurpose combinations include:

- A change in runoff volume will generally change the peak runoff rate in the same direction. For example, a decrease in volume typically results in a decreased peak rate. However, a change in peak rate can be made without affecting the volume.
- Runoff volume controls promoting infiltration of runoff into the soil profile also control erosion. Likewise, erosion controls usually reduce runoff, although to a lesser extent.
- Control measures that promote infiltration of runoff or inhibit erosion also provide control of source pollution. Soil infiltration provides pollutant control through the use of natural physical, chemical, and biological processes. Erosion control provides source pollution control by preventing pollutant-laden soils from being transported to downstream watercourses.

The following sections provide an overview of the approaches used to implement the various control strategies. These methods are not to be viewed as an all-inclusive listing. Rather, these approaches generally represent the current state of stormwater management technology. Developers are encouraged to explore innovative approaches which can achieve the desired goal.

The final section in this chapter summarizes the estimated performance of various control techniques.

Table V-1. Control Purpose Category

Runoff Volume Control - Control techniques designed to prevent a certain amount of the total rainfall from becoming surface runoff by providing an opportunity for the rainfall to infiltrate into the ground. Runoff infiltration into the ground can be encouraged by increasing the soils infiltration rates, increasing surface retention or detention storage (allows more time for infiltration), and increasing the interception of rainfall by growing plants.

Runoff Peak Rate Control - Control techniques designed to regulate the peak flow rate of runoff by increasing the hydraulic resistance of the surface, decreasing the land slope, increasing the length of flow path, or providing temporary storage and outlet control of runoff that would otherwise leave the site at an unacceptably high flow rate.

Erosion Control - Control techniques designed to minimize accelerated soil erosion and corresponding downstream sedimentation. Accelerated erosion is defined as that erosion caused by land disturbance, such as development and agricultural activities. This is erosion other than that resulting from natural geologic processes, such as wind, rain, temperature fluctuations, frost action, etc. Sedimentation of pollutant-laden soil particles caused by accelerated erosion is often the largest non-point source water pollutant. Sediment covers aquatic plants and fish spawning areas. It also carries pollutants such as nutrients, pesticides, and other oxygen demanding material that are attached to sediment particles.

Source Pollution Controls - Control techniques designed to minimize the accumulation of pollutants on the land surface, in the soils, and in the atmosphere prior to rainstorms, which controls pollution of downstream receiving waters during and following the rainstorm events. Source pollution controls are generally supplementary to the other control techniques because by themselves they usually do not provide sufficient control to meet regulatory requirements for control of flow volumes and peaks. Of particular concern is the control of the nutrient phosphorus. Phosphorus tends to be a less mobile, soluble nutrient than nitrogen. Therefore, phosphorus enrichment of downstream receiving waters is usually attributed to sediment transport following soil erosion. Being more soluble, nitrogen can be transported to receiving waters not only via soil erosion but also through interflow and surface waters.

Table V-2. Control Means Category

Structural - Control techniques consisting of physical facilities designed, constructed and installed for the exclusive function of storm runoff abatement including erosion and sediment runoff control.

Nonstructural - Control techniques consisting of land use management techniques geared towards minimizing storm runoff impacts through control of the type and extent of new development and of land disturbance activities in general.

On-site - Control techniques designed to control runoff at the source of origin which is the development or land disturbance site.

Off-site - Control techniques located downstream of the development or land disturbance site which are designed to control runoff by intercepting it or by purposely diverting it to another control facility.

It is noted that the control of runoff quality is not a stated goal of this stormwater management plan. However, stormwater quality is an area of concern that has received increased emphasis in recent years which will undoubtedly continue to grow. Recent enactment of nutrient management legislation in Pennsylvania illustrates the growing concern over non-point pollutant sources. Inclusion of "source pollution controls" in this chapter is intended to provide a limited coverage of this important topic.

B. RUNOFF VOLUME CONTROLS

1. Infiltration Pits and Trenches

Infiltration pits and trenches collect stormwater runoff from impervious areas for temporary storage and subsequent infiltration into the soil. Permeable soils are a prerequisite to ensure a reasonable rate of infiltration. Also there should be a low water table so that the pit or trench is above the groundwater. Application is usually limited to relatively small sources of runoff such as roof drains and small paved areas. The potential for groundwater pollution must be carefully evaluated, therefore highly polluted runoff should not be diverted to this type of facility. This is of special concern to the Jacks Creek Watershed because of the high usage of groundwater wells for potable water consumption. Infiltration pits and trenches are not recommended where runoff water contains high concentrations of suspended materials unless some sort of filtering mechanism is provided prior to infiltration, otherwise clogging could occur which would incapacitate the facility.

Pits or trenches are excavated and then backfilled with sand and/or graded aggregates. Pits vary in depth from about 6 to 20 feet, depending upon the depth of the permeable soil stratum and the depths to groundwater and bedrock. Trenches are long and narrow with a depth less than 6 feet. A "dry well" is a common type of infiltration pit, consisting of a perforated structural chamber buried in the ground. The interior of the chamber can be empty or filled with aggregate. The exterior is usually filled with gravel or crushed stone. Filter fabrics may be placed over the surface of a pit or trench to prevent sediment and debris from entering the facility.

Preventive maintenance is vital to the continued effectiveness of infiltration pits and trenches. Once void areas become clogged, maintenance entails nearly complete replacement of filter material. If filter fabrics are used, periodic cleaning or replacement will be necessary. The frequency of cleaning will depend upon the amount of sediment or debris that enters the facility. In areas where runoff is likely to carry considerable amounts of suspended materials, filtering, trapping or other measures should be considered.

2. Land Surface Controls and Zoning

Land surface controls and zoning can be used to naturally encourage infiltration, reduce runoff volumes, and inhibit local flooding and downstream sedimentation. Some control and zoning alternatives include grading slopes to less than 2 percent, restricting the amount of impervious surface coverage at industrial, commercial, institutional or high density residential development sites, and using special vegetative cover. Also, zoning can control the number of dwelling units or building square footage for a given site to discourage over-development. The major drawback to using this practice is the resistance of municipalities to discourage development particularly when development has potential to boost a sluggish local economy. If applied with foresight and ingenuity these controls and zoning practices can manage storm runoff and actually encourage aesthetic development.

3. Porous and Grid/Modular Pavement

This management practice includes the use of either porous asphalt pavement or concrete grid and modular pavement. Porous pavement includes a porous asphaltic paving material and a high-void aggregate base that allows for rapid infiltration and temporary storage of rain falling on paved surfaces. Grid and modular pavements have regularly interspersed void areas which are filled with pervious materials such as sod, gravel or sand.

Site limitations restricting the use of this technique include high groundwater tables and low subgrade permeabilities. Other considerations for using this technique include intended use of area, soil bearing capacity, land surface slope and drainage conditions and the direction of movement, natural quality and condition (confined/ unconfined) of the groundwater. The most suitable application for these pavement materials are low-volume traffic areas, such as:

- parking lots, especially fringe or overflow parking areas
- emergency stopping and parking lanes
- on-street parking aprons in residential neighborhoods
- recreational vehicle camping area parking pads
- private roads, easement service roads and fire lanes
- industrial storage yards and loading zones
- driveways for residential and light commercial use
- bike paths, walkways, patios and swimming pool aprons

One drawback to porous and grid/modular pavement is the potential for ground water pollution caused by motor oil drippings, gasoline spillage, and deicing chemical applications. Most dust and dirt and nutrient contaminants should be metabolized by the soil and therefore do not present a problem. Another drawback for this control technique, particularly for application in the Jacks Creek watershed, is the potential for water in voids to freeze causing a potentially hazardous icing condition on the road.

Maintenance for porous pavements involves removal of debris too coarse to be washed through the pavement system; vacuuming (at least four times per year) to remove particles that could clog the void space; and patching the surface as needed. Sections of pavement that do become clogged should be vacuumed followed by high pressure water washing of the pavement to remove any remaining fine particles. Maintenance for grid modular pavement involves normal turf maintenance (such as watering, fertilizing and mowing) where turf is incorporated in the pervious area. Both types of pavements should be inspected annually during wet weather conditions and, if broken or clogged in the stone reservoir or subsoil strata, replaced.

4. Seepage Areas

Grassed areas can be used for managing storm runoff by employing their natural capacity for reducing runoff velocities, infiltrating runoff flows, and filtering runoff contaminants. This practice is applicable to new development of low to moderate density, where the percentage of impervious cover is relatively small. Successful application requires consideration of natural drainage patterns, steepness of slopes, soil conditions, selection of proper grass cover, and proper maintenance. Water tolerant species of vegetative cover should be used to maintain high infiltration rates. Forage and fodder crops can be used successfully to handle significant amounts of runoff and are tolerant of variations in water quality.

Seepage areas are small dense turf grass-covered areas that infiltrate the water and allow particulate contaminants to settle out of the runoff water. The grass also tends to absorb some of the soluble pollutants. Seepage areas may be created by excavating shallow depressions in the land surface or by constructing a system of dikes or berms to pond water over permeable soils. Water depth of the "pond" should be controlled so that it does not exceed 18 inches and therefore does not become an impoundment facility. Seepage areas should not be used at sites receiving runoff with high concentrations of pollutants. The filtering mechanisms of the grasses and soils may be overwhelmed, thus allowing contamination of groundwaters. Maintenance considerations are similar to those required for filter strips.

C. RUNOFF PEAK RATE CONTROLS

1. Channel Modification

Channel modifications are physical realignments of the streams or streambeds, which serve to deter and reduce local flooding. Channelization may involve converting sinuous channels to linear ditches or enlarging and reshaping the streambeds to form trapezoidal cross-sectional areas. Channel modifications, including the removal of bank and streambed vegetation and/or natural obstructions, can deter flooding but also can create the following unfavorable stream characteristics: 1) unstable streambeds, 2) sparse streamside vegetation, 3) high erosion potential, and 4) unnatural appearance and low aesthetic value. Subsequently, channel modifications must be prudently designed and maintained to avoid accelerated erosion and decreased stream value. Maintenance should include annual inspections to ensure structural integrity of the modification, clear away any debris, and identify erosion or other deterioration.

2. Cistern Storage

This management practice involves the collection and storage of storm runoff in a cistern, in as a storage tank or chamber. Cisterns can serve solely as stormwater detention devices with continuous controlled flow release to storm sewers; as holding tanks that dispose of runoff via infiltration pits/trenches, seepage areas or subsurface drainage fields; or as holding tanks that collect water for later uses such as lawn watering, fire protection, and irrigation. In order for cisterns to have a water reuse capability, they must have sufficient capacity to accommodate storms that occur before water stored from a previous storm is completely used.

Since the function of cisterns is not dependent upon physiographic conditions and their sizes can vary as necessary, they are applicable practically anywhere. Cisterns can be installed beneath paved areas or other structural facilities, within a building, or above the ground. Routine maintenance, particularly following major storms, is important for the removal of sediment and debris to prevent clogging of inlets and outlets and to assure maximum operating efficiency. Inspections of cistern pumps, if they are used, should be included during routine maintenance visits to minimize failure.

3. Floodplain Management

This management practice incorporates land use planning to control flood corridor development and stream channel modification. Improper channel modification can increase erosion and decrease stream value. Development in flood corridors may cause clogging and increase both the likelihood of floods as well as damage when floods occur.

Prudent floodplain management can prevent these activities and preserve wetlands and wooded greenways that are ideally suited for flood damage control.

4. Impoundments

Surface water impoundments can be used to protect downstream areas from flooding, stream channel erosion, and water quality degradation from increased runoff due to upstream development. The basic objective is to detain stormwater and release it at a controlled rate. There are two types of impoundments. Detention basins are "dry" impoundments that temporarily store runoff and then release it to downstream surface water channels at a con- trolled rate. A variation of this type of impoundment is an extended detention basin which detains runoff for 12 to 48 hours before releasing it downstream. These basins provide a low cost means of removing particulate pollutants and controlling increases in downstream bank erosion. Retention basins are "wet" impoundments that provide "permanent" storage and release runoff waters through infiltration and evaporation.

Applicability of impoundments is dependent upon the availability of an adequate site, given geologic, topographic, and soil condition concerns. Impoundments may be designed to maximize runoff water quality improvements. Upgrading of water quality is primarily achieved through sedimentation but chemical transformation and biological uptake also occurs while runoff is detained in the basin. Impoundments can also be designed to control runoff from an individual site or from multiple development sites. Occasionally economies of scale can be achieved through utilization of centralized impoundments servicing large areas of development. However, the need for upstream channel protection above these impoundments can reduce impoundment effectiveness.

Maintenance of impoundments is essential to maintain the design efficiencies. A formal maintenance plan must be formulated and should include:

- Seasonal (wet-weather) inspections with as-built plans in hand and cleaning of pipe inlets and outlets for accumulated sediment and debris
- Insect control
- Mowing and reseeding of banks as necessary
- Biennial professional engineering inspection to ensure structural and hydraulic integrity
- Stabilization of banks and other critical areas

5. Parking Lot Storage

Parking lot storage involves impervious parking areas designed and equipped with modified storm-drain inlets that temporarily impound runoff. Parking lot storage systems can be designed to detain stormwater in designated areas, generally at the perimeter of parking areas, and release it at a controlled rate. This practice is most applicable to the large, paved parking areas of shopping centers and office complexes. Design should include grading and overflow arrangements which will not cause damage to downstream properties.

Ponding areas should be well marked with signs or pavement markings advising users to avoid these areas. Parking lot surfaces should be periodically cleaned (at least three times per year) to reduce accumulation of litter, debris, traffic-generated residues and other non-point source pollutants. Monthly inspection, sweeping or street vacuuming is recommended because "the first flush" effect of the polluted runoff from impervious areas can be very damaging to downstream aesthetics and water quality.

6. Rooftop Detention

Rooftop detention involves the temporary ponding and gradual release of stormwater on structurally reinforced flat roof surfaces. This is achieved by incorporating controlled-flow roof drains into building designs. Small perforated weirs or collars placed around the inlets of roof downdrain pipes are one example.

Because of the special structural needs, rooftop detention is most applicable to new structures. Building codes usually restrict the depth of rooftop ponding to a maximum of 3 inches. Even so, the structural capability of a roof must be considered when designing a rooftop detention system. To avoid the possibility of an overload, the roof should be designed with multiple outlets and free overflows. Roof surface waterproofing and routine inspections are also required. The inspections should determine if the controlled-flow drains are operational; check if any control devices were removed (such action may have been taken as a result of leaking roofs); and determine if cleaning or repairs are needed.

D. EROSION CONTROLS

1. Bank Stabilization

Bank stabilization techniques involve stabilizing banks and slopes around streams, creeks, and road swales which have no established vegetation and are highly erodible. Bank stabilization can be customized to match the needs of a specific site. They may involve installation of other control practices such as diversions, grassed waterways and impoundments as well as special grading, topsoil application, and seedings. When finished, earth structures should have side slopes and top width that provide a stable structure. The structures should then be covered using stone, asphalt paving, mulch, vegetation, or other available material (refer to the paragraphs on critical area planting of Section C.5 for more information on vegetative coverage).

Initially bank stabilization facilities will require regular maintenance to start reseeding, and repair erosion or other deterioration. When established, bank stabilization facilities may require the following forms of infrequent maintenance: mow grass, remove extraneous weeds (e.g. thistles, milkweed, etc.), clean-up debris or excess thatch, etc.

2. Conservation Tillage

Conservation tillage is the application of specialized cropping methods to control or reduce the amount of erosion from agricultural fields. It can also control storm runoff by retaining water, increasing infiltration, and slowing runoff velocity. This ability is dependent on the amount of soil compaction in the field and the amount of exposed crop residues. Additional benefits of conservation tillage include reduced farm labor requirements, lower equipment costs (in a start-up condition), and fuel savings. Disadvantages of conservation tillage include increase use of chemical herbicides, soil compaction, greater management requirements, and possible delayed planting leading to reduce yields.

The most common conservation tillage practice for the northeastern United States is termed no-tillage or zero-tillage. It involves soil preparation and planting that are done in one operation with specialized farm equipment. This results in limited soil disturbance and leaves most crop residues on the soil surface. Planting is normally done in narrow slots opened by a fluted coulter or double-disk opener. Soil infiltration rates of the area are increased by maintaining a plant canopy or a mulch of plant residues on the surface the entire year. However, soil compaction and reduction of evaporation from the surface due to the residues may lead to increases in runoff.

Other conservation tillage practices, e.g. ridge planting, strip tillage, plow planting, etc., are less common than no-tillage. Typically they required specialized soil and cropping conditions to be practical.

3. Contour Farming

Contour farming is the practice of plowing, preparing, planting, and cultivating farm land parallel to topographic contours. The primary purpose is erosion control, but because erosion control reduces sedimentation, a secondary purpose is source pollution control. To be effective, slopes exceeding 3 percent in gradient and 200 feet in length may need additional erosion control practices such as stripcropping, terraces, or diversions. Informal contour farming, cropping across rather than up and down a hill slope, can be easily applied and has been very useful to farmers throughout the northeastern United States. The installation of true contour farming requires special equipment which should be available through the U.S. Department of Agriculture Soil Conservation Service.

4. Cover Cropping

Two common forms of cover cropping involves cover and green manure crops which typically are close-growing grasses, legumes (clover), or small grains planted as an overwinter crop in fallow fields. They may be plowed under before planting the next year. Cover cropping controls erosion during periods when the major crops do not furnish ground cover. In addition, residual nitrogen from legume green manure crops can enhance soil fertility for the major commercial crops. Cover crops are most beneficial to farm practices that leave bare soil following harvesting, e.g. corn silage production. However, to be effective the crop must be planted before cold weather prevents germination.

5. Critical Area Planting

Critical area planting involves planting vegetation on critical areas to stabilize soil and promote stormwater infiltration. They can deter and reduce downstream damage due to sediment erosion and excessive runoff. Some examples of critical areas include sediment-producing, highly erodible, and severely eroded areas, where vegetation is difficult to establish with usual seeding or planting methods.

Due to these characteristics, experts such as extension personnel or landscaping companies should be consulted prior to critical area planting. One special concern is the selection of vegetation and the use of mulching materials immediately after seeding. Jute and excelsior matting and mulching can be used to protect soil from erosion during the period of vegetative establishment when plants are most sensitive to environmental conditions. Also if necessary, bank stabilization should be accomplished prior to critical area planting. Maintenance includes periodic inspection of seeded areas for failures. Repairs should be made as needed. If the stand is more than 60 percent damaged, the planting area should be re-established using the original planting criteria.

6. Diversion

Diversion are channels constructed across a sloping area and designed to intercept runoff from cropland, pastureland, farmsteads, and/or conservation practices. The intercepted flow is diverted at a safe velocity, to an infiltration pit, impoundment, wetland, etc. Diversions may be grassed or lined waterways. Grass waterways are generally shaped or graded by heavy equipment and are usually over 10 feet wide at the top of the channel. Lined waterways are used under conditions not suitable for grassed waterways.

Diversions differ from other erosion control techniques such as conservation tillage and cover crops in that diversions trap sediment after it has eroded from the field. The other techniques reduce erosion within the field, which keeps soil on site and preserves the land's agronomic value. However, diversions can be very useful at improving drainage and controlling runoff and erosion that naturally occur with modern agricultural practices. Runoff from higher lying areas can be intercepted by diversions to eliminate damage to lower lying cropland, pastureland, farmsteads, or conservative practices.

To be effective, diversions require careful design, accurate construction, and regular maintenance. Of particular concern is the design of the diversion's outlet. The design must prevent a high velocity discharge that would scour the outlet area. Also the slope of the diversion should be designed in accordance with the vegetation or other lining to prevent high velocity scour within the diversion itself. Using grass waterways for farm roads is a common practice that encourages channel erosion and thus should be avoided. Other maintenance requirements include:

- mowing grass
- controlling weeds
- reseeding
- removing sediment accumulations
- repairing eroded areas and lined waterways

7. Farmland Management

Farmland management involves practices which discourage accelerated erosion at farm sites. Some examples are pasture and hayland management and spring development.

Pasture and hayland management involves establishing long-term stands of adapted species of perennial and biennial forage plants. The pasture and hayland is properly managed through careful harvesting; the control of weeds, diseases, and insects; and the establishment of grazing plans. Adequate pasture facilities should be provided, including waters, shade and mineral feeders. These facilities should be periodically moved, if possible, so that a few areas of the pasture are not overused.

Another farmland management practice is the development and protection of springs used as water supply sources on farms. Spring development involves excavation, cleaning, and capping of waterways to convey and distribute water to livestock at several locations in the farmyard and pastures. This technique distributes grazing to several points rather than concentrating it in one area. Concentrated grazing can result in overgrazing which in turn leads to accelerated erosion. Developments should be confined to springs or seepage areas that are capable of providing a dependable supply of suitable water during the planned period(s) of use. Maintenance includes the periodic removal of sediment from spring boxes.

8. Fencing

Fencing involves enclosing and dividing an area of land with a permanent structure that serves as a barrier to animals and people. The primary purpose of fencing is to control erosion by protecting sensitive areas, particularly watercourses, from the disturbance of grazing or public access. Designated grazing areas can be subdivided for a planned grazing system, and new seedlings and plantings can be protected until they are well established. Fencing deters streambank erosion by preventing both the physical destruction of the bank and the denuding of streambank vegetation by grazing animals. Fencing can also prevent livestock from depositing their wastes in or near natural watercourses. Filter strips between fences and watercourse can increase erosion and source pollution control.

Depending on the type of animal to be restricted, permanent fences should be of woven, barbed, or high tension wire construction. Light gauge electric wire should never be used for this purpose. Annual maintenance may require checking for and replacing broken or disconnected wires, loose staples, and/or loose or deteriorated posts and braces.

9. Road Paving

Road paving is an erosion control practice for unimproved (dirt) roads. It involves grading, paving with a gravel sub-base and asphalt top-base, and compaction. All new development roads should be paved before they become well-traveled and poorly maintained.

10. Storm Sewers

Storm sewers deter flooding and prevent erosion by replacing overloaded and inadequate roadside swales. A storm sewer system may include curbs and gutters, conveyance facilities, storage facilities and flow regulators. All of these must be properly designed, constructed and maintained.

Conveyance facilities generally consist of underground pipes that collect stormwater and transport it to a storage facility or to a receiving stream. Storage in the conveyance facility may be provided by enlarged pipe diameters. Water quality inlets can be constructed for a storm sewer system to remove sediment, grit and oil from runoff before it is conveyed to the stormdrain network. These inlets are long, rectangular concrete chambers and typically serve parking lot areas of one acre or less including gas stations, lots, and loading areas. The inlets must be designed for easy access for regular cleaning.

Another means of protecting the water quality of the receiving waters is to install an alum (aluminum sulfate) injection system in the sewer system. This system can be automated to dose stormwater with alum which causes the pollutants to precipitate out of the stormwater and become entrained in the receiving waters sediment. Alum prevents recycling of metals and nutrients from sediment.

Minimum maintenance requirements for storm sewer systems include:

- Periodic above ground inspection of all pipelines and manholes
- Periodic cleaning and flushing of pipelines and pump wet wells and removal of any accumulation of foreign materials (includes silt, sand, grease, roots, garbage, etc.)
- Periodic measurement of flow in pipes
- Inspection of trouble areas, when needed, using a closed circuit television camera

- Excavation and repair or replacement of cracked, broken, or collapsed pipes
- Clearing of stoppage due to roots, debris, grease, etc.
- Daily inspection and, if needed, adjustment of all wet wells, pumps, and screening devices
- Periodic servicing and overhaul of pumps and pump station instruments and controls
- Repair of broken pumps and motors

Because maintenance of a storm sewer system is vital for the proper operation of the system and because maintenance includes so many tasks, a formal maintenance program is required. This program includes the development of maintenance schedules and the recording of maintenance tasks completed.

11. Strip Cropping

Strip cropping is a farming practice that involves alternate strips of various crops laid out so that all tillage and crop management practices are performed on the contour. It is most effective when a strip of grass (or other close-growing crop) is alternated with a strip of a row crop (e.g. corn, soybeans). The primary purpose of this technique is to control erosion caused by storm runoff flowing down the slope. The close-growing crop strip functions as a filter strip. Grassed waterways, diversions, or other outlets should be established where storm runoff accumulates to provide safe disposal of the excess water.

To be effective, strip cropping requires the operation and maintenance that are associated with good farming practices. As necessary, these may include: contour cultivation, proper tillage operations, crop residue mulching, cover covering, and crop rotation.

12. Terracing

A terrace is an earth embankment, ridge, or channel constructed across a slope at a suitable location to intercept runoff water and control erosion. Generally terraces are considered supporting practices to use in conjunction with contouring, strip cropping and reduced tillage methods (particularly on long slopes and slopes where these practices may not be effective enough alone). They can be divided into three types: graded terraces, level terraces, and tile terraces. Graded terraces carry runoff water across slope in a gradual descent to an impoundment, surface waterway, or subsurface pipe. Level terraces are constructed with no grade in the channel or ridge, and they hold runoff water until it infiltrates. Tile terraces are level terraces that use subsurface tile to remove runoff water. The subsurface tile collects runoff water from the terrace and diverts it to an impoundment, grass waterway, stream, or infiltration trench.

To be maintained terraces require careful tillage operations that preserve the graded form of the terrace. Tile terraces also require periodic inspection and clearing of the outlets to prevent clogging by sediment and debris. Any "blowouts" or "suck holes" in the tile system should be repaired and animals guards or flap gates should be maintained.

E. SOURCE POLLUTION CONTROLS

1. Agricultural Waste Storage Structure

Agricultural waste storage structures provide source pollution control by temporarily storing agricultural wastes away from surfaces where they can infiltrate and/or wash away to surface watercourses. They can be either an excavated pond or an aboveground fabricated structure such as a holding tank or manure stacking facility.

A typical manure stacking facility is a reinforced concrete pad with concrete block walls. Preferably it will be roofed although it may be open. Holding tanks often are cast-in place reinforced-concrete or fabricated-steel watertight tanks. Holding tank facilities' may be outside or inside enclosed housing beneath slotted floors. If holding tanks and stacking facilities are located outdoors and are not covered, a filter strip should be constructed to prevent surface runoff from reaching a stream or drainage channel.

The excavated pond for waste storage is an impoundment that can store wastes for up to a year, depending on size. Generally, extraneous surface runoff is prevented from entering the pond to the fullest extent possible and the pond is located near the waste source. Soils under the pond should be of low to moderate permeability or soils which will seal through sedimentation and physical pressure. High permeability soils, for which self-sealing is not probable, should be sealed with an impermeable membrane.

Proper maintenance of waste storage structures should include periodic inspection of the structure, its base, walls, roof and surroundings as well as clearing inlets and repairing any deteriorations.

2. Filter Strips

This practice uses vegetated areas for intercepting storm runoff, reducing runoff velocities, and filtering out the runoff contaminates. Although it is similar to grass waterways, it is used primarily for urban developments and logging areas.

Successful application of filter strips to urban developments requires consideration of natural drainage patterns, steepness of slopes, soil conditions, selection of proper grass cover, and proper maintenance. Grass buffer strips should consist of water tolerant species (reed canary grass, tall fescue, Kentucky bluegrass, white clover, etc.). However, other plants may be used depending upon land capability, uses of the strip, types of adjacent land use, kinds of wildlife desired, personal preferences of the landowner, and availability of planting stock or seed. The filter strips should be established at the perimeter of disturbed or impervious areas to intercept sheet flows of surface runoff, to settle particulate contaminants, and to encourage infiltration.

Filter strips consisting of sections of forest located along streams and steep slopes can be successfully used during logging operations. These strips are also termed "buffer" strips. They serve the same purposes as those discussed above.

The maintenance required for a filter strip depends on whether or not natural vegetative succession is allowed to proceed. The gradual transformation from grass to meadow to second growth forest will generally enhance the performance of longer filter strips and reduce the maintenance requirements. However, corrective maintenance is still required around the edge of the strip to prevent concentrated flows from forming. Shorter filter strips must be maintained as a lawn or short grass meadow and therefore mowed 2 to 3 times a year to control weeds and natural succession. These strips also require periodic spot repairs, watering, fertilization and removal of accumulated sediments. All filter strips should be inspected annually.

5. Sediment Basin

A sediment basin, sometimes referred to as a debris basin, is an earth embankment or ridge generally constructed across the slope or across minor watercourses and having subsurface outlets. The basin does not control erosion but rather traps sediment near the land disturbance and prevents it from entering downstream watercourses. Maintenance includes inspection of the basin after each storm and repairing when needed. When the storage provided for sediment has been exhausted, basins should be either cleaned out or the ridge raised to provide for more storage capacity.

Table V-3. Stormwater Management Alternatives Performance Estimates

Control Practice	Type of Control[1]		
	Runoff Peak Rate	Sediment	Phosphorus
Volume Controls			
Infiltration Pits and Trenches	90%	30-60%	40%
Land Surface Control and Zoning	UK	UK	UK
Porous Pavement (Asphalt)	100%	UK	40%
Porous Pavement (Concrete)	75%	UK	30-60%
Seepage Areas	30-60%	30-60%	30-60%
Peak Rate Controls			
Channel Modification	30-60%	N	N
Cistern Storage	>60%	25-70%	30-60%
Floodplain Management	UK	N	N
Impoundment (Dry Detention)	>60%	<30%	10%
Impoundment (Wet Detention)	>60%	60%	30%
Parking Lot Storage	>60%	30-60%	30-60%
Rooftop Detention	>60%	N	N
Erosion Controls			
Bank Stabilization	<30%	>60%	>60%
Conservation Tillage, General	30-60%	>60%	30-60%
Conservation Tillage, No-till	30-60%	>60%	>60%
Contour Plowing	30-60%	15-55%	30-60%
Cover Cropping, Alone	<30%	50-60%	30-60%
With Conservation Tillage	30-60%	95%	>60%
Critical Area Planting	30-60%	>60%	>60%
Diversion	<30%	30-60%	30-60%
Farmland Management	30-60%	>60%	>60%
Fencing	N	>60%	60-80%
Road Paving	N	UK	UK
Storm Sewers (Without Treatment)	60%	N	N
Stripcropping - Contour	30-60%	>60%	>60%
Terracing	30-60%	>60%	>60% Avg. 80%
Source Pollution Controls			
Agricultural Waste Storage Structure	>60%	>60%	>60%
Filter Strips	30-60%	85%	>60%
Sediment Basin	N	>60%	>60%
Street Cleaning-Mechanical Sweepers	N	50%	30-60%
Street Cleaning-Vacuum Sweepers	N	95%	30-60%
Wetland Preservation	30-60%	75%	50%

[1] N - not applicable or negligible preventive effect or reduction capacity.
V - variable preventive effect or reduction capability where performance is exclusively dependent on application.
UK - unknown preventive effect or reduction capability.

Table V-3 Sources:

Chesapeake Bay Foundation, Best Management Practices for Stormwater Control, Harrisburg, PA, (November 1988).

Metropolitan Washington Council of Governments, Department of Environmental Programs, A Framework for Evaluating Compliance with the 10% Rule in the Critical Area, (April 1987).

Metropolitan Washington Council of Governments, Department of Environmental Programs, Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs, (1987).

Metropolitan Washington Council of Governments, Department of Water Resources, Controlling Stormwater Runoff in Developing Areas, Selected Best Management Practices, (1979).

Virginia State Water Control Board, Best Management Practices Handbook - Urban Planning Bulletin 321, (1979).

Chapter VI. Technical Standards

This chapter describes the conditions where land development activities will be regulated for stormwater management planning and the requirements for drainage facilities. *Section A* defines these circumstances which trigger the need for detailed drainage plan preparation and municipal approval. Subsequent sections described acceptable methods for runoff computation and design specifications for stormwater management facilities in the Jacks Creek Watershed. While the technical standards contained in this chapter are quite specific, in many instances they have been fashioned to allow the designer a certain degree of freedom to encourage innovated approaches.

A. APPLICATION OF STANDARDS

Application of standards is broken down into two categories: those that apply to all land development activities, and; those that are specific according to the nature, size, and location of the land development activity.

1. General Requirements

All land development activities shall be conducted in compliance with applicable regulations relating to Erosion Control (Chapter 102), Dam Safety and Waterway Management (Chapter 105), and Flood Plain Management (Chapter 106) of Title 25 of PA DER's Rules and Regulations.

2. Specific Requirements

a. The technical standards described in this section shall apply to all land development activities which have greater than 10,000 square feet of impervious area. Determination of impervious area for residential subdivision, commercial, industrial, or institutional development shall include the sum total of all proposed units. Isolated single family residences, not a part of a subdivision, will normally be exempt from regulation due to the impervious area size limitation.

b. Development activities subject to regulation by these standards shall, at a minimum, be required to evaluate the mean annual, 5-, 10- and 100-year storm event peak discharges for both pre- and post-development conditions. Total runoff volume and runoff hydrographs may also be required, depending on the circumstances (refer to design and construction specifications contained later in this chapter).

c. Provisional No Detention (PND) stormwater management practices shall be employed for subareas 23, and 24. This includes all areas draining to Jacks Creek west of the junction of the unnamed stream joining Jacks Creek at Maitland. Stormwater detention facilities shall not be required in PND subwatershed areas unless a need for such facilities is necessitated by local conditions. However, stormwater conveyance facilities shall be sized to safely carry the 10-year storm event at a minimum.

d. All subareas in the Jacks Creek watershed, excluding subareas 23 and 24, shall be required to observe the following: Any development exceeding 10,000 square feet of impervious area shall at a minimum be required to provide conventional, "post-development" back to "pre-development," peak flow stormwater control for the mean annual, 5-year, and 10-year storm events. Detention facilities shall be designed to pass all flows above the 10-year event up through the 100-year event safely over an emergency spillway. Stormwater conveyance facilities shall be sized to safely carry the 10-year storm event at a minimum.

B. METHODS OF CALCULATION OF RUNOFF FLOW PARAMETERS

1. The methods of computation used to determine peak discharge and volume of runoff shall be one of the following methods or any other method approved by [the municipality] in advance:

a. The USDA SCS Soil-Cover-Complex Method as set forth in the latest edition of "Urban Hydrology for Small Watersheds", Technical Release No. 55.

b. The USDA SCS Soil-Cover-Complex Method as set forth in the "TR-20 Computer Program for Project Formulation Hydrology", Technical Release No. 20.

c. The Penn State Runoff Model (PSRM) as set forth in the latest edition of the Penn State Runoff User's Manual.

d. The "Rational Method" of Q=CIA, where Q is the peak discharge from the watershed in cubic feet per second (CFS), C is the coefficient of runoff, I is the intensity of rainfall in inches per hour and A is the area of the watershed in acres.

2. Where the drainage basin exceeds 200 acres or where a detention/retention facility is involved, a hydrographic method is to be used for design purposes. The method of computation shall be selected using the following guidelines:

Output Requirements	Drainage Area	Hydrologic Computation To Be Used
Peak Discharge Only	Up to 200 acres	Rational Method, TR-55, TR-20 or PSRM
	Up to 2000 acres	TR-55, TR-20 or PSRM
	Up to 20 sq. miles	TR-20 or PSRM
	Above 20 sq. miles	TR-20 or PSRM
Peak Discharge and Total Runoff Volume	Up to 2000 acres	TR-55, TR-20 or PSRM
	Up to 20 sq. miles	TR-20 or PSRM
	Above 20 sq. miles	TR-20 or PSRM
Runoff Hydrograph	Up to 2000 acres	TR-55, TR-20 or PSRM
	Up to 20 sq. miles	TR-20 or PSRM
	Above 20 sq. miles	TR-20 or PSRM

3. Rainfall frequency data to be used depends on the method of computation selected.

   a. When the SCS Soil-Cover-Complex Method is used for basin-wide modeling, storm runoff shall be based on the following storm events using the SCS Type II 24-hour rainfall distribution:

Storm Event	Inches of Rainfall
2.33-year	2.7
5-year	3.1
10-year	3.6
25-year	4.5
50-year	5.0
100-year	5.6

   b. Rainfall data shall be obtained from rainfall maps published by the PA DER, PA DOT, or available U.S. Department of Commerce, National Weather Service Information to obtain figures for specific sites.

   c. When the Rational method is used, Rainfall Intensity-Duration-Frequency charts shown in the PA DOT Field Manual, May 1986, shall be used to determine the rainfall intensity in inches per hour.

4. Runoff Curve Numbers (CN's) to be used in the Soil Cover Complex Methods shall be based upon the matrix presented in the latest edition of the SCS TR-55 Manual.

5. Time of Travel (Tt) estimates for overland flows shall be based on the average velocities determined using the charts presented in the in the latest edition of the SCS TR-55 Manual.

6. Runoff coefficients for use in the Rational Method shall be based upon Table VI-1.

7. The Manning equation shall be used to calculate the capacity and velocity of flow in open channels and in closed drains not under pressure. Manning "n" values used in the calculations shall be consistent with Table VI-2.

8. All runoff calculations shall include both a hydrologic and hydraulic analysis indicating:

- Rate and velocities of flow.
- Grades, dimensions, and capacities of water carrying structures and impoundment structures.
- Sufficient design information to construct such stormwater management facilities. Runoff calculations shall include both pre-development and post-development rates of peak discharge and volumes of storm runoff from the project development site. Runoff calculations for the site's condition during development shall be used to size temporary control measures.

C. WATER CARRYING FACILITIES

1. All water carrying facilities including storm sewer pipes, open channels, ditches, swales and any other water carrying facilities shall be designed for the 10-year post-development storm event unless [the municipality] requires a larger storm event because of special conditions or waivers.

Table VI-1. Runoff Coefficients for the Rational Method

Type of Surface	Normal Range	Recommended Value
Pavement:		
Concrete or Bituminous Concrete	0.75-0.95	0.90
Bituminous Macadam or Surface Treated Gravel	0.65-0.80	0.75
Gravel, Macadam, etc.	0.25-0.60	0.50
Brick	0.70-0.85	
Roofs	0.70-0.95	
Sandy Soil:		
Cultivated or Light Growth	0.15-0.30	0.20
Woods or Heavy Brush	0.14-0.30	0.20
Lawns		
Flat, less than 2%	0.05-0.10	
Average, 2-7%	0.10-0.15	
Steep, 7% or more	0.15-0.20	
Clay Soil:		
Bare or Light Growth	0.35-0.75	0.50
Woods or Heavy Growth	0.25-0.60	0.40
Lawns		
Flat, less than 2%	0.13-0.17	
Average, 2-7%	0.18-0.22	
Steep, 7% or more	0.25-0.35	
Type of Area:		
Business		
Downtown	0.70-0.95	0.90
Neighborhood	0.50-0.70	
Residential		
Single Family	0.30-0.50	
Multiunits, detached	0.40-0.60	
Multiunits, attached	0.60-0.75	
Residential, suburban	0.25-0.40	
Apartment	0.50-0.70	
Industrial		
Light	0.50-0.80	
Heavy	0.60-0.90	
Parks, Cemeteries, Golf Courses	0.10-0.25	
Railroad Yard	0.20-0.35	
Unimproved	0.10-0.30	

Table VI-2. Manning "n" Values

Surface	"n" Value
Uncoated cast-iron pipe	0.013
Coated cast-iron pipe	0.012
Commercial wrought-iron pipe, black	0.013
Commercial wrought-iron pipe, galvanized	0.014
Smooth brass and glass pipe	0.010
Smooth lockbar and welded "OD" pipe	0.011
Riveted and spiral steel pipe	0.015
Vitrified sewer pipe	0.013
Common clay drainage tile	0.012
Glazed brickwork	0.013
Brick in cement mortar; brick sewers	0.015
Neat cement surfaces	0.011
Cement mortar surfaces	0.013
Concrete pipe	0.012
Wood stave pipe	0.011
Plank flumes:	
Planed	0.012
Unplaned	0.013
With battens	0.015
Concrete-lined channels	0.014
Cement-rubble surface	0.020
Dry-rubble surface	0.030
Dressed-ashlar surface	0.014
Semicircular metal flumes, smooth	0.012
Semicircular metal flumes, corrugated	0.025
Canals and ditches:	
Earth, straight and uniform	0.025
Rock cuts, smooth and uniform	0.033
Rock cuts, jagged and irregular	0.040
Winding sluggish canals	0.025
Dredged earth channels	0.0275
Canals with rough stony beds, weeds on earth banks	0.035
Earth bottom, rubble sides	0.030
Natural stream channels:	
(1) Clean, straight bank, full stage, no rifts or deep pools	0.029
(2) Same as (1), but some weeds and stones	0.035
(3) Winding, some pools and shoals, clean	0.039
(4) Same as (3), lower stages, more ineffective slope and sections	0.047
(5) Same as (3), some weeds and stones	0.042
(6) Same as (4), stony sections	0.052
(7) Sluggish river reaches, rather weedy or with very deep pools	0.065
(8) Very weedy reaches	0.112

2. Level of Control and Design Parameter Calculations

   a. The time of concentration is defined as the interval of time required for water from the most remote portion of the drainage area to reach the point in question. Calculations of the time of concentration include calculations of travel times for sheet flow, shallow concentrated flow, open channel, or some combination of these. Chapter 3 of the SCS Technical Release No. 55, Second Edition (June 1986) shall be used to determine average velocities for estimating travel times for the various flow segments.

   b. The capacity and velocity of flow in open channels and in closed drains not under pressure shall be determined by the Manning equation. Maximum permissible open channel velocities and design standards shall be in accordance with good engineering practice as documented in the "Engineering Field Manual for Conservation Practices", USDA, SCS or in "Design Charts for Open-Channel Flow", Hydraulic Design Series No. 3, U.S. Department of Transportation.

   c. Storm sewer pipes shall be installed on sufficient slopes to provide a minimum flow velocity of 3 feet per second when flowing full.

3. Design and Construction Specifications

   a. Width requirements for public easements shall be as follows for storm drains: W = 2d+D+2 where W is the easement width in feet, d is the depth of pipe from the invert to finished grade and D is the inside pipe diameter. The calculated easement width shall be rounded up to the next 5 feet increment with the minimum required width being 10 feet.

   b. For ditches, at a minimum, the easement shall be 10 feet wider than the top width of the ditch, with at least 10 feet required on one side for future access. The easement width required shall be rounded up to the next 5 feet increment. Additional width may be required, as necessary, by [the municipality].

   c. Storm sewer pipes and culverts, other than those used as basin outlets, which are intended to be dedicated to [the municipality] shall have a minimum diameter of 15 inches. All pipes and culverts shall be made of reinforced concrete culvert pipe (RCP), corrugated metal pipe (CMP) or corrugated aluminum alloy pipe. Corrugated metal pipe shall be helical, 16-gage minimum, galvanized steel pipe. When conditions are such that the pipe requires coating (see Table 2.10.5.6, PA DOT Publication No. 13, Design Manual, Part 2, August 1981), galvanized steel pipes and fittings shall be fully-coated, inside and out, with either polymer or asphaltic cement in accordance with PA DOT Publication No. 408 Specifications. All storm sewer pipes shall be laid to a minimum depth of 1 foot from subgrade to the crown of the pipe.

d. Pressure flow is permitted in storm sewers. The elevation of the hydraulic gradient shall be at least 1 foot below ground level. Pressure heads up to 25 feet can be used with concrete pipe with rubber gasketed joints.

e. Manholes, inlets, headwalls and endwalls proposed for dedication to [the municipality] or located along streets shall conform to the PA DOT Bureau of Design, "Standards for Roadway Construction", Publication No. 72, in effect at the time the design is submitted. The design may be modified by adopted municipal construction standards. Headwalls and endwalls shall be used where storm runoff enters or leaves the storm sewer horizontally from either a natural or manmade channel.

f. Inlets shall be placed on both sides of the street at low points; at a maximum interval of 600 feet along any one continuous line; at points of abrupt changes in either the horizontal or vertical directions of storm sewers; and at points where the depth of flow in the street gutters exceeds 3 inches, or where the spread exceeds 10 feet on the typical street section calculated on a 2.33-year storm recurrence frequency. Inlets shall normally be along the curb line at or beyond the curb radius points. At intersections, the depth of flow across the through streets shall not exceed 1 inch. For inlets on continuous grades the maximum amount of water that should be bypassed onto the next downstream inlet is 10 percent. Inlets shall be of the Type C, M, or S type, as discussed in PA DOT Publication 13 and the "Standards for Roadway Construction", Publication No. 72. Inlet grates shall be cast iron or structural steel. A bicycle-safe grate shall be installed in areas where bicycle traffic is anticipated, such as curbed roadways or for roadways specifically established and signed as bikeways or having bike lanes.

g. Manholes may be substituted for inlets at locations where inlets are not required to handle surface runoff. Manholes shall be located on a continuous storm sewer system at all abrupt changes of grade, at all locations where a transition in storm sewer pipe sizing is required, at all angle points exceeding 15 degrees, and at all points of convergence of two or more influent storm sewer mains. Where storm sewer pipe is designed on a radius, the pipe shall be manufactured to the design radius.

4. Operation Specifications

a. Wherever possible, roof drains and pipes shall discharge water into a dispersion or infiltration control facility and not into street gutters or storm sewers.

b. All existing natural watercourses, channels, drainage systems and areas of surface water concentration shall be maintained in their existing condition unless an alteration is approved by [the municipality].

c. Flow velocities from any storm sewer outlet shall not result in a deflection of the receiving channel. Energy dissipators shall be placed at the outlets of all storm sewer pipes where flow velocities exceed maximum permitted water carrying velocities.

D. IMPOUNDMENT FACILITIES

1. Permanent detention basins shall be designed with a primary outlet discharge that is less than or equal to the pre-development peak discharge for the mean annual (2.33-year), 5-year, and 10-year storm events. In addition, the facility must safely pass the 100-year post-development event at a minimum. A greater peak discharge may be permitted by the use of secondary outlets when the developer or his engineer show that (1) the increased peak discharge can be properly handled by the existing or proposed downstream stormwater management facilities; (2) the increased peak discharge will not be detrimental to the downstream areas; and (3) for any specified storm event the post-development peak discharge will not be greater than the pre-development peak discharge of an equivalent storm event.

2. General Design

a. All basins shall be structurally sound and shall be constructed of sound and durable materials. The completed structure and foundation of all basins shall be stable under all probable conditions of operation. Where dam permits are required, the design must meet the provisions of the Dam Safety and Encroachments Act as outlined in Chapter 105, Dam Safety and Waterways Management Rules and Regulations. For example, if a detention basin is considered to be a "dam" under Chapter 105 (by definition), the facility may require design for events ranging from the 50-year to the PMF storm. In such cases, the emergency spillway may be required to pass greater than the 100-year, 24-hour storm.

b. The effect of embankment failure on downstream areas shall be considered in the design of all basins. Where possible, the basin shall be designed to minimize the potential damage of embankment failure.

c. In some cases, separate detention facilities for a number of sites may be more expensive and difficult to maintain than a joint facility. In such cases [the municipality] may consider joint detention facilities that fulfill the detention requirements.

d. No basin shall be located within the 100-year flood hazard area of the floodplain. Construction of basins within the 100-year floodplain shall be avoided, where possible. If construction is unavoidable, the situation shall be examined for its functionality.

e. To facilitate drainage prior to stream flooding, impoundments may be waived by [the municipality] upon the recommendation of [the municipal engineer]. Such a decision depends on the proximity of the proposed impoundment to major streams, and the hydrology of the watershed.

f. An easement for maintenance crew access to the pond and outlet areas shall be established around all basins requiring maintenance. The limits of such easements shall be 15 feet from the outside toe of the dams and embankments and the top of all basin side slopes. The maintenance easement shall be connected to a public right-of-way.

g. A specific maintenance plan shall be formulated outlining the schedule and scope of maintenance operations. Items to be included in the maintenance plan are sediment removal, inspection of inlets and outlets, vegetation and insect control, ponding area prevention and safety inspections.

3. Basin Design

a. A basin shall, when site dimensions allow, have a length to width ratio of at least 2:1 to 3:1 and the distance between basin inflow and outflow points shall be placed to maximize the travel time through the pond.

b. A riprap apron of adequate length and flare shall be provided at all surface discharge points to disperse and slow down flow to minimize erosion, promote settling, and minimize resuspension of settled pollutants. The apron shall extend to the crown of the pipe and be sized according to the procedure set forth in Appendix F of the "Soil Erosion and Sedimentation Control Handbook, Cumberland, Dauphin and Perry County Conservation

Districts" or similar procedure. Riprap size shall be determined by the flow velocity at the discharge point as follows:

Flow Velocity (feet/second)	Average Stone Size (inches)
Up to 6	6-8
6 to 9	8-12
Greater than 9	(a)

(a) Shall use design procedure presented in Appendix F of the "Soil Erosion and Sedimentation Control Handbook, Cumberland, Dauphin & Perry County Conservation Districts" or similar procedure approved by [the municipality].

c. A cutoff trench of relatively impervious material shall be provided within all basin embankments whose side slope ratios are steeper than 3 horizontal to 1 vertical.

d. All culverts through basin embankments shall have properly spaced concrete cutoff collars or factory welded anti-seep collars according to the guidelines set forth in the USDA SCS (PA) "Standards and Specifications for Ponds" (#378).

e. [The municipality] shall make the decision to require fencing based on potential hazards at the site. Basins with water-edge side slopes steeper than 3 to 1, or depths greater than 3 feet may require 6-foot high fencing of a material acceptable to the municipality. A locked gate shall be supplied to allow restricted access to the basin for maintenance. For impoundments subject to freezing of detained runoff, some means of "thin ice" warning shall be incorporated in the overall operations plan established for the basin.

f. The basins shall have a minimum bottom slope of 1 percent towards the primary outlet to assure positive drainage and prevent saturated conditions and maintenance problems. Low flow channels may be required to convey small inflows to the basin outlet.

g. Safety ledges shall be constructed on the side slopes of all detention basins having a permanent pool of water. The ledges shall be 4 to 6 feet in width and located approximately 2½ to 3 feet below and 1 to 1½ feet above the permanent water surface.

h. The minimum top width of all dams and embankments shall be as follows:

Height (feet)	Top Width (feet)
0-5	8
5-15	10

i. The design top elevation of all dams and embankments shall be equal to or greater than the maximum water surface in the basin resulting from the routed 100-year storm, plus freeboard. The design height of the dam shall be increased by the amount needed to insure that the design top elevation will be maintained following settlement. This increase shall not be less than 5 percent.

4. Inlet and Outlet Design

a. Dry detention basins shall have an outlet structure designed to drain the basin within 24 hours. All outlet structures and emergency spillways shall include a satisfactory means of dissipating the energy of discharge at its outlet to assure conveyance of the discharge without endangering both the safety and integrity of either the basin or the downstream drainage channel and drainage area. If riprap is used to dissipate energy, the design criteria presented previously shall govern.

E. INFILTRATION FACILITIES

1. Infiltration pits and trenches shall be designed to provide control for the 10-year storm event. Seepage areas and filter strips shall be designed to provide control for the 5-year storm event. The infiltration facility control storm event may be reduced when the infiltration device is used in combination with other control facilities which together reduce the post-development peak discharges for the mean annual, 5-year, and 10-year events to pre-development levels.

2. Level of Control and Design Parameter Calculations

a. A seepage analysis must be made for infiltration pits and trenches to determine any adverse affects of seepage on nearby building foundations, roads, and parking lots. Pits and trenches must never be located next to foundation walls.

b. A soil analysis shall be submitted with the design plans of infiltration facilities. Surrounding soils shall have a percolation rate of at least 0.6 inch per hour. A groundwater quality analysis shall also be made and shall include depth of water table (with seasonal variations), probable runoff pollutants, and the uses of the local groundwater.

3. Design and Construction Specifications

a. Infiltration facilities shall not be considered in fill areas due to the lack of infiltration capacity in areas of controlled fill and the potential slope slippage problems in areas of uncontrolled fill.

b. Seepage areas shall not allow ponding to exceed 18 inches of depth. Soil percolation rates for these areas shall be at least 0.6 inches per hour. Areas shall be graded to allow positive drainage but slopes shall be as slight as possible to minimize velocities. Seepage areas should also include overflow systems such as flanking grass diversion swales graded to catch and transport excess water without subjecting nearby structures to flood waters.

c. Filter strips widths shall be at least 25 feet and should be designed with the following parameters:

- Land use and treatment above the strip
- Slope of land above and in the strip
- Length of slope above strip
- Erodibility of soil above strip
- Type of vegetation in strip
- Degree of maintenance the strip will receive

d. Infiltration trenches shall have a side area to bottom area ratio less than or equal to 4:1. Wheel stops or segmented curbs shall be used to keep vehicular traffic off the trenches when they are not protected by grating.

e. Volume storage calculations for pits and trenches depends on the intended purpose of the facility. A pit or trench designed to store all site runoff would be sized for the maximum runoff volume. A second option is to design the facility to store only the flow generated in excess of the pre-development condition. In this option some method of diverting flow into the facility is needed. This could be a weir device incorporated into base flow channels sized only to carry the pre-development runoff rates.

f. The aggregate filler of trenches and pits shall be stone with a size range greater than 1 inch. These stones shall be poorly graded to include a few stones smaller than the selected size. Rounded stone is preferable to crushed stone.

4. Operation Specifications

a. Maintenance tasks shall include maintenance of a dense grass buffer strip for surface facilities, removal of accumulated sediments within the pre-treatment devices of underground facilities, and partial or total reconstruction of facility in the event of clogging.

F. CISTERN FACILITIES

1. The design of the cistern storage volume and release rate is dependent upon the purpose of the structure. For reducing peak runoff rates, the facility shall be designed to detain the post-development 2.33-year storm event and release it at the pre-development peak rate and velocity. For controlling non-point source pollution, additional storage is needed to capture a predetermined initial volume of runoff which is to be released at a very slow rate.

2. For underground cisterns more than one access point for ventilation and cleaning shall be provided. Access manholes or drop boxes shall be sufficiently large to allow maintenance equipment to reach the facility. At least one access opening shall be a minimum of 60 inches in diameter.

3. To ensure complete drainage of the facility, the minimum slope of the tank floor shall be 1 percent. If a pumping system is included, provisions shall be made to prevent pump clogging and standby pumping capability shall be provided.

4. The outlet pipe shall not be less than 5 inches in diameter to lessen the possibility of it becoming clogged. When low release rates are designed for the outlet to enhance the water quality obtained through sedimentation, special maintenance considerations must be made for removing the accumulated sediments.

G. ROOFTOP DETENTION

1. The rooftop detention storage volume shall be designed to detain the post-development 2.33-year storm event and release it at the pre-development peak rate and velocity.

2. Roof design shall meet all Building and Occupational Code Act (B.O.C.A.) building code standards. Depth of rooftop ponding shall not exceed three (3) inches. Rooftops shall be capable of supporting a "live" load equal to 30 pounds per square foot. These requirements allow for a reasonable safety factor because 30 pounds allow for 5.8 inches of water. Roof drain requirements are as follows:

Minimum Number of Drains	Roof Area (square feet)
2	≤10,000
4	>10,000 and ≤40,000
1/10,000SF	>40,000

3. Maintenance shall consist of inspecting and cleaning inlets and of removing accumulated debris, ice, and fallen leaves.

H. PARKING LOT STORAGE

1. The parking lot storage volume shall be designed to detain the post-development 2.33-year storm event and release it at the pre-development peak rate and velocity.

2. The storage area shall have a minimum 1 percent slope to the control outlet to ensure positive drainage following a storm. The maximum depth of ponded water within the storage area shall not exceed 6 inches for pedestrian safety and to avoid wet brakes and other vehicle maintenance problems. The storage system shall be designed so that an overflow resulting from either clogging of the principle release structure or runoff in excess of the design storm does not result in flooding of nearby buildings or thoroughfares. The control orifice at the discharge control structure shall not be less than 4 inches in diameter.

I. POROUS PAVEMENT

1. Porous pavement designs shall be based on the pre-development 10-year storm event.

2. The following minimum standards shall apply to the porous asphalt and grid/modular pavement installations:

a. Test borings shall be taken to determine the character and permeability of the soil. The ability of the soil to transmit the water passing through the pavement shall determine the thickness of the base reservoir required.

b. Subgrade soil coefficient of permeability shall be greater than 0.01 foot per day.

c. Subgrade soil clay and silt contents shall total less than 40 percent by weight to resist frost heaving as defined by the Asphalt Institute Publication MS-15 (1966).

d. Slopes of pavement shall not exceed 5 percent to avoid excessive downslope surfacing of water.

e. The combined surface and base thickness shall exceed the anticipated frost penetration depth.

f. The aggregates selected for porous asphalt pavement construction shall meet requirements of the standard specification for "Crushed Stone, Crushed Slag, and Crushed Gravel for Bituminous Macadam Base and Surface Courses of Pavements," ASTM C-693-71, with one exception and one addition. The exception requires the gradation to be of the "open" graded type. The addition is a requirement for a soundness test as specified in ASTM D-694-62, "Crushed Stone, Crushed Slag, and Crushed Gravel for Dry-Bound or Water-Bound Macadam Base Courses." This is required to determine if the aggregate is susceptible to disintegration by water.

g. Asphalt mixing temperatures shall range from 230-260 degrees Fahrenheit, with the recommended temperatures at the lower end of that range (230-240°F).

h. Asphalt content shall be determined according to the testing procedure recommended in the FHWA Report No. FHWA-RD-74-2, "Design of Open-Graded Asphalt Friction Courses". The Marshall Design method for determining mix content is not recommended. Using a 5½ percent asphalt content and the Asphalt Institute's recommended 4-inch minimum surface course, a 0.6-inch rainfall reservoir capacity is obtained with a seepage rate of 176 inches per hour.

I. Design of porous asphalt pavement shall be based on the specifications of the Asphalt Institute. Asphalt pavement structures must be designed and built to support the heaviest traffic volumes and loads for a particular application. By increasing the depth of the base course, loads are spread conically over large areas, thus reducing the loading intensity until the subgrade will support the load without undue deformation. A porous asphalt pavement structure must not only carry the loads without damage but must also:

- Imbibe all or most of the rainfall as well as water from melted snow.
- Survive freeze-thaw and weathering.

The base course depth not only carries vehicular loads but also acts as a water reservoir. The ultimate storage capacity of this reservoir will depend on the material used, and the void area within it.

3. Maintenance shall include annual inspection of the porous pavement during wet weather; surface vacuuming at least 4 times per year followed by high pressure jet hosing; patching of potholes, cracks, and other pavement defects; and replacement of structure when clogging occurs in the stone reservoir or subsoil.

J. EROSION AND SEDIMENT CONTROL

1. PADER jointly regulates construction activities with county conservation districts. The program requires all earth movers to develop, implement and maintain erosion control measures and facilities that are detailed in an Erosion and Sediment Pollution Control Plan (E&S Control Plan).

2. A PADER general permit for Erosion and Sediment Pollution Control may be used for all construction activities except:

    a. Activities in special protection watersheds.
    b. Activities that discharge toxics.
    c. Activities that would violate water quality standards.
    d. Activities disturbing greater than 25 acres that are not parceled pursuant to 25 PA Code Section 102.31 (a)(4).

3. The permits for construction activities shall meet the existing Chapter 102 Erosion Control Rules and Regulations, emphasizing pollution prevention and best management practices. Specific effluent limits and discharge sampling are not required. The general permit will use a simplified permit application (Notice of Intent) and reduce the cost of the program to dischargers.

4. Preparation and filing of an E&S Control Plan that meets Chapter 102 requirements, along with a completed NOI and a $100 permit fee are required to obtain approval and use the general permit. A letter of E&S Control Plan adequacy from the conservation district will also be needed in those municipalities that require E&S plan approval. Dischargers must also consider pollution prevention measures for the storage and use of chemicals and fuels at construction sites.

5. All stormwater dischargers from construction activities to waters of the Commonwealth classified as Special Protection and discharges from construction sites generally disturbing more than 25 acres of land must obtain an individual NPDES permit. Applications must be submitted to the conservation district and include a complete E&S Control Plan. Districts will review and approve the plan and make recommendation to the PADER regional office on permit issuance or denial.

6. The E&S Control Plan must be available at the development site. All permits allowing earth moving activity shall be obtained by the developer before any construction on the development site may begin.

7. Approval of an E&S Control Plan by the municipality shall not be construed as an indication that the plan complies with the standards of any agency of the Commonwealth of Pennsylvania.

8. If the developer proposes to use a wetlands for stormwater treatment and control, [the municipality] in its review of the drainage plan shall evaluate:

a. If dredging or filling are proposed, the adverse effects of the dredging or filling on the treatment capability of the wetland.

b. If the normal range of water level fluctuation of the wetland as it existed prior to construction of the wetlands stormwater discharge facility, is adversely affected. Normal range of water level fluctuation is defined as the maintenance of the fluctuating water surface changes between the normal low water and the normal high water of the wetland system so as to prevent the desiccation or over impoundment of the wetland.

c. The discharge method of stormwater into the wetlands. The discharge shall be such that channelized flow of stormwater is minimized by employing methods including, but not limited to, sprinklers, overland flow, or spreader swales.

Chapter VII. Existing Ordinances

Under Act 167, the individual townships and boroughs are required to adopt or amend and implement ordinances or regulations as necessary to regulate development within their watershed in a manner that is consistent with the plan and provisions of the Act. The goal of the stormwater management act is to foster the development of local rules and regulations to protect and improve the capacity of natural stream channels throughout the state. The rules and regulations are developed under the requirements of Act 167 and other federal and state laws. The following is a partial list of other laws which may affect the final content of the local regulations:

- Pennsylvania Floodplain Management Act of 1978 (Act 166)
- Pennsylvania Dam Safety and Encroachments Act of 1978 (Act 325)
- Pennsylvania Clean Streams Law as amended (Act 394)
- Pennsylvania Scenic River Act as amended (Act 110)
- Pennsylvania Municipalities Planning Code as amended (Act 247)
- Federal Clean Water Act

To assist the individual townships and boroughs to implement the provisions of the stormwater management plan within the framework of their existing institutions, it is important to be familiar with and understand their existing related ordinances and regulations.

The Mifflin County Planning Office conducted a review of existing ordinances which relate to stormwater management. Of the several municipalities in the Jacks Creek watershed, only Derry Township has any existing ordinances which pertain to stormwater management. The Derry Township Zoning Ordinance contains provisions relating to drainage, erosion and sedimentation control, but these are not comprehensive in nature and do not adequately control the cumulative increase in stormwater runoff which can occur as the population increases and development occurs.

Chapter VIII. Model Ordinance

Enclosed herewith as APPENDIX A is a model ordinance fashioned specifically to address the needs of the Jacks Creek Watershed. This document is a single purpose ordinance that can be adopted by each municipality with minor customization. Principal articles contained in the ordinance are as follows:

- Article I. General Provisions
- Article II. Definitions
- Article III. Stormwater Management Requirements
- Article IV. Drainage Plan Requirements
- Article V. Inspections
- Article VI. Fees and Expenses
- Article VII. Financial Guarantees and Maintenance
- Article VIII. Enforcement and Penalties
- Article IX. Appeals
- Article X. Miscellaneous
- Article XI. Enactment

Chapter IX. Priorities for Implementation

A. IMPLEMENTATION OF THE PLAN BY THE MUNICIPALITIES

The regulatory approach for implementing the adopted plan utilizes the powers granted by Act 247, the Municipalities Planning Code (MPC). The MPC enables counties and municipalities to adopt zoning, subdivision and land development, and planned residential development ordinances and to address storm drainage concerns in these ordinances. In addition, the municipal codes enable the adoption of building codes. This section addresses several implementation scenarios that should be considered including adoption of a single purpose stormwater ordinance, incorporation of stormwater management provisions into existing ordinances, and adoption of stormwater ordinance provisions in either a single purpose ordinance or in existing ordinances for municipalities encompassing multiple subwatersheds.

Provided as part of this plan is the Model Stormwater Ordinance (Appendix A). This model ordinance is a single purpose stormwater ordinance that could be adopted by each municipality with minor customization to fulfill the needs of a particular municipality and to implement the plan. In addition to adopting the ordinance itself, the municipalities would also have to revise their existing subdivision and land development ordinances and zoning ordinances to incorporate the necessary linking provisions. These linking provisions would refer to any applicable regulated activities within the watershed to the single purpose ordinance. Of particular concern are the Financial Guarantees and Maintenance requirements addressed in Article VII of the model. References could be made to a municipality's subdivision and land development ordinance for such financial guarantees, rather than placing these requirements in the stormwater ordinance. If this is done, reference in the subdivision and land development ordinance should be made to the stormwater ordinance. This could make stormwater facilities part of the required improvements in the subdivision and land development ordinance with reference to the stormwater ordinance for specifics. Subsequently, the construction or financial guarantees for stormwater facilities could be regulated under the subdivision and land development ordinance. Similar cross-reference statements could be used for the waiver procedure addressed in Section 1001 of the model.

Adoption of a single purpose stormwater ordinance is not required if a municipality chooses to incorporate the necessary provisions, as provided in the model ordinance of this plan, into their existing ordinances. If this is desired, DER may review the revised ordinances to ensure that the amendments satisfactorily implement the plan. It should be noted that the stormwater provisions in the local ordinances will override other developmental standards. If a municipality decides to revise the existing ordinances rather than adopt a single purpose ordinance, it should consider the following guidelines.

1. The existing subdivision and land development ordinance should address most of the stormwater provisions including the drainage plan requirements and review procedures (Article IV of the model), the stormwater standards and criteria (Article III of the model), the design standards stormwater control facilities and techniques (Chapter VI of this plan), maintenance provisions for permanent facilities (Article VII of the model), inspections (Article V of the model), fees (Article VI of the model), penalties for violation (Article VIII of the model), and financial provisions (Article VII of the model).

2. The stormwater management provisions in the existing subdivision and land development ordinance should be compacted into one separate article to promote ease of use.

3. The zoning ordinance should be amended to link the ordinance to the stormwater provisions of the revised subdivision and land development ordinance, or if applicable, a single purpose stormwater ordinance. This is important because through its zoning ordinance, a municipality can assure the application of the watershed's plan to single lots (or single structure) developments, expansions or reuses of existing uses and structures, and special land use activities. This amendment can be made to the general provisions or supplementary regulations section if there is one.

4. The building code should be amended to reference sections of the subdivisions and land development ordinance and/or the zoning ordinance. This provides assurance that stormwater controls will be applied to all building construction. This covers the situation where the builder and the developer who prepared the approved drainage plan are not the same entity such as may occur in "strip development". Also, building code provisions generally cover such stormwater management techniques as rooftop storage, porous pavement, parking lot storage, and storm drains.

Some municipalities in the Jacks Creek Watershed encompass multiple subwatersheds. These subwatersheds may require different control standards and criteria as described in Chapter VI. Therefore, specific articles/sections of the model ordinance may need to be modified to allow for multiple provisions so that stormwater control requirements are satisfied. Two Pennsylvania municipalities, the Town of McCandless and Indiana Township, have adopted ordinances addressing two and three watersheds, respectively. These ordinances can be referenced by those municipalities of the Jacks Creek Watershed which have similar situations. The Town of McCandless has implemented their stormwater management provisions by amending their existing planning and zoning code, whereas Indiana Township adopted a separate stormwater management ordinance.

In addition to adopting the ordinance provisions, the municipalities must require developers to contact PADER concerning permits for regulated activities involving streams, dams, floodplains, and wetlands. Where permits are required, the design of any facility must meet the provisions outlined in the rules and regulations of Chapter 102

(Erosion Control), Chapter 105 (Dam Safety and Waterway Management), and Chapter 106 (Flood Plain Management) of Title 25, Rules and Regulations of the PADER. To ensure that the PADER permitting process is consistent with the adopted and approved watershed plan, a local review program could be established. The program should coordinate with the PADER review process by monitoring permit applications as published in the Pennsylvania Bulletin. It is recommended that if this local program is established that it be performed by one of the local county conservation districts. The conservation district should be responsible for providing comments consistent with the plan within the stated PADER review period. In addition, the conservation district should keep records of the applications reviewed and the PADER action.

B. WATERSHED-LEVEL COORDINATION OF PLAN IMPLEMENTATION

Although individual municipalities traditionally have been the focus for stormwater management activities, effective stormwater management requires a watershed-wide perspective. This watershed-wide perspective is consistent with Act 167, which requires municipalities to prevent stormwater damage and problems throughout the watershed.

One alternative is to select Mifflin County Planning Commission or Conservation District to preside as a watershed level coordination agency. The model ordinance provided in this plan recommends that the local municipal planning commission and the conservation district review the drainage plans prepared by developers. Comments from these agencies are then reviewed by the appropriate municipality. The coordination agency's responsibilities could be expanded to include not only drainage plan review but also on-site inspection, monitoring and ordinance code enforcement. Traditionally, and currently as presented in the model ordinance, these functions are performed by the individual municipality. To expand the coordination agency's responsibilities to take over these functions and to ensure the involvement of various agencies requires the preparation of a joint municipal-agency agreement, such as a Memorandum of Understanding, between all participating parties. This agreement should detail the responsibilities and liabilities of all concerned parties, the rewriting of the ordinance to state as much, the consideration of the fee schedule to cover the agency's incurred costs proportionally by the municipalities, and a personnel commitment by the agency. Having a coordinating agency more involved in the implementation process of stormwater controls would help assure that the potential impacts of a proposed development on downstream locations are considered not only during plan review but also during the actual development activity.

Also recommended as part of this plan is the development of a procedure for testing the effectiveness of the stormwater control techniques presented in Chapter VI. This procedure should be established by the watershed-level coordination agency and should include long-term observation to determine the effectiveness of a technique for given site and development activity characteristics.

C. DEVELOPMENT OF A SYSTEMATIC APPROACH FOR CORRECTION OF EXISTING STORM DRAINAGE PROBLEMS

Correction of the existing storm drainage problem areas in the watershed is not specifically part of the Act 167 planning process. However, the development of the watershed plan has provided a framework for their correction for the following reasons: 1) existing storm drainage problems have been identified; 2) implementation of the runoff control criteria specified in the Plan will prevent the existing drainage problems from becoming worse (and prevent the creation of new drainage problem areas); and 3) the hydrologic model developed to formulate the runoff control criteria could be used as an analytical tool for identifying engineering solutions to existing drainage problems.

With the above in mind, municipalities within the Jacks Creek Watershed should include the following steps in their efforts to implement solutions to existing storm drainage problem areas:

1. Prioritize storm drainage problems within the municipality based on frequency of occurrence, potential for injury to persons or property, damage history, public perception of the problems and other appropriate criteria.

2. For the top priority drainage problems in the municipality, conduct detailed engineering evaluations to determine the exact nature of the problems, determine alternative solutions, provide cost estimates for the alternative solutions, and recommend a course of municipal action. The number of drainage problems to be evaluated by a municipality as a first cut from the priority list should be based on a schedule commensurate with completing engineering studies on all problem areas. The Jacks Creek hydrologic model will be available through the County to provide input to the engineering studies. The engineering studies should include consideration of the downstream effects of eliminating specific drainage problems so as to avoid transfer of problems progressively downstream.

3. On the priority and cost basis, incorporate implementation of recommended solutions to the drainage problems in the annual municipal capital or maintenance budgets as funds are available. Also, evaluate the potential for receiving low interest loans from the Pennsylvania Infrastructure Investment Authority (PENNVEST) to address stormwater drainage problems.

The above stated procedure for dealing with existing storm drainage problems is not a mandatory action placed on municipalities with the adoption of the watershed plan. Rather, it represents a systematic method to approach the problems uniformly throughout the watershed and attempt to improve the current runoff situation in the basin. The key elements involved in the success of the remedial strategy will be the dedication of the municipalities to construct the corrective measures and the consistent and proper application of the runoff control criteria specified in the Plan. The latter element is essential to ensure that remedial measures do not become obsolete (under-designed) by increases in peak flows with development.

Chapter X. Adoption and Updating Procedures

A. PLAN REVIEW AND ADOPTION

This plan must undergo a local review process prior to adoption by the County. This local review is to include 3 groups of reviewers including the WPAC, the County, and the governing body of each involved municipality. The reviews and resulting comments are to include an evaluation of the plan's consistency with other plans and programs affecting the Jacks Creek Watershed at the appropriate governmental level. All reviews and comments must be documented by submitting to the Mifflin County Planning Commission an official correspondence for the records. Below is a summary of the review requirements.

1. The County Review

The 3 counties (Juniata, Snyder, and Mifflin) of the watershed, including their planning commissions, are to document their own review of the plan and receive copies of all official review comments from the other agencies.

2. WPAC Review

The committee has been formed, as required by Section 6 of the Act, to assist in the development of the Jacks Creek Watershed Plan. The committee has assisted by providing the plan preparers with pertinent information, soliciting responses from the public, and promoting the dissemination of materials. The committee has met on 2 occasions to review the progress of the plan and are to meet again to initiate the review process. The meeting will consist of a presentation of the plan contents by the Consultant. An official letter documenting the WPAC review should be received by the Counties.

3. Municipal Review

Act 167 specifies that prior to adoption of the draft plan by the County, the planning agency and the governing body of each municipality in the watershed must review the plan. For the preparation of this plan, the WPAC was formed to represent the municipalities' interests, therefore the WPAC Review described in Section 2 satisfies this requirement of the Act. However, Derry and Decatur Townships are encouraged to provide independent reviews since it is these municipalities which will be most affected.

Of primary concern during the municipal review is the draft Stormwater Management Model Ordinance of Appendix A which has been designed to implement the plan through municipal adoption.

4. Public Hearing

After the WPAC meeting has been held to initiate the review process and after all review agencies have received a copy of the draft plan, the Mifflin County Planning Commission is to provide a 2-week public notice for holding a public hearing. The public hearing is to provide a forum for presenting the draft plan and the review agency comments to the public for open discussion. The Mifflin Planning Office will prepare the meeting notice which will contain a brief summary of the principal provisions of the plan and a reference to the places within each affected municipality where copies of the plan may be examined or purchased at cost.

The Consultant, with support from the Mifflin Planning Office and the counties, is to respond to all comments received from the counties, municipalities, WPAC, and public hearing participants. Also, the draft plan will be revised as appropriate. After all revisions have been made, the final plan will be presented to the counties for adoption. Since Mifflin County has been selected as the lead county for monitoring the preparation of the plan, it has the responsibility for formulating the resolution for adopting the plan. The resolution must be carried by an affirmative vote of at least a majority of the Mifflin County Board of Commissioners, and shall refer expressly to the maps, charts, textual matter, and other materials comprising the plan. This action will then be recorded on the adopted plan. Mifflin County is then to transmit the plan to the Juniata and Snyder County Commissioners and Planning Commissions for consideration for the adoption and approval in accordance with the Act. As is the case for Mifflin County, the resolution for adopting the plan must be carried by an affirmative vote of at least a majority of the individual County Boards of Commissioners.

The final requirement for approval of the plan is the submission of the plan (3 copies with a letter of transmittal) to the PADER. In addition to the plan, DER should also receive copies of all agency review comments, the public hearing notice and minutes of the public meeting, and the resolution for the adoption of the plan by Mifflin County. Using all material presented, DER is to review the plan for approval.

B. PROCEDURE FOR UPDATING THE PLAN

The Act requires that the plan be reviewed and any necessary revisions to be made at least every 5 years after adoption by the Counties and approval by the PADER. If the counties determine that there is a need for significant changes to the plan before the 5-year period has elapsed, the counties may undertake the plan revision and submit it to the

PADER for review and approval. Any proposed revisions to the plan would require municipal and public review prior to county adoption. The Act also requires that a procedure be developed to monitor the implementation of the plan to initiate review and revisions in a timely manner. Mifflin County, the assigned lead county for the plan, shall assign the responsibility to the appropriate county official or agency. To ensure watershed-wide stormwater management, it is recommended that the plan updating responsibilities be given to the Mifflin County Planning Commission.

The responsible agency could use the following items for assessing the need for plan updates:

- Records of all subdivision and land development drainage plans subject to review.
- Records of all DER permits issued under Chapter 102 (Erosion Control), Chapter 105 (Dams and Waterway Management), and Chapter 106 (Floodplain Management), including location and design capacity of facilities.
- Zoning revisions or curative amendments resulting in significant landuse changes.
- Complaints from developers and/or municipalities concerning the impact or requirements of the plan.
- Information regarding additional storm drainage problem areas from the developers and/or municipalities, including changes in stream conditions that indicate that the plan's stormwater management standards and criteria are ineffective.
- Updates of the flood insurance studies and maps.

The responsible agency is to review the above information and make recommendations to Mifflin County as to the need for revisions to the plan. The county is to review the recommendation and determine if revisions are warranted. A revised plan is subject to the same rules of adoption as the original plan preparation. Should the responsible agency and Mifflin County determine that no revisions to the plan are required for a period of 5 consecutive years, the counties will adopt a resolution stating that the plan has been reviewed and has been found satisfactory to meet the requirements of Act 167. This resolution shall then be forwarded to PADER.

The funding for monitoring the plan implementation and for preparing plan updates when needed will come from the PADER stormwater program. Among these possible sources are state and federal grants, county and municipal funds, and drainage plan review fees. The counties and municipalities can establish a stormwater reserve fund using annual contributions from revenues from taxes (or general funds) and the drainage plan review fees. This fund could be allowed to accumulate to be used by the responsible agency and the counties for updating the plan, and if the monies are available, for constructing major capital projects to improve or correct stormwater problems on a watershed-wide basis. PENNVEST's low interest loans provide another potential source of funding for correction of stormwater problems.

Geo Decisions, Inc.

Gannett Fleming

APPENDIX A

Jacks Creek Watershed

- ACT 167 -

Stormwater Management Plan

Draft Model Ordinance

June 8, 1995

All text found inside square brackets, [ ], in the model ordinance fall into one of the following categories:

1. Text to be replaced by proper names.

   Example:

   [the municipality] is to be replaced with the name of the municipality.

2. Optional text that can be deleted if not applicable for a given municipality. Note, this sometimes includes entire sections.

3. Recommended values that can be replaced with other values if the supervisors of a given municipality feel the new values better reflect their needs. Examples include dollar values for fees and penalties, square footage/acreage values for defining regulated activities, and time values for the drainage plan review/approval process.

STORMWATER MANAGEMENT PLAN MODEL ORDINANCE

Table of Contents

Table of Contents, cont.

Table of Contents, cont.

STORMWATER MANAGEMENT PLAN MODEL ORDINANCE

ARTICLE I
GENERAL PROVISIONS

SECTION 101. STATEMENT OF FINDINGS

The [governing body] of [the municipality] finds that:

A. Inadequate management of accelerated runoff of stormwater resulting from development throughout a watershed increases flood flow volumes and velocities, contributes to erosion and sedimentation, overtaxes the carrying capacity of streams and storm sewers, greatly increases the cost of public facilities to carry and control storm water, undermines floodplain management and flood control efforts in down-stream communities, reduces groundwater recharge, deteriorates the water quality of receiving waters, and threatens public health and safety.

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

SECTION 102. PURPOSE

The purpose of this Ordinance is to promote the public health, safety, and welfare within the Jacks Creek Watershed by minimizing the damages described in Section 101.A of this Ordinance. To accomplish this, the Ordinance establishes a comprehensive stormwater management program designed to:

A. Control accelerated runoff and erosion and sedimentation problems at their source by regulating activities which cause such problems.

B. Utilize and preserve the desirable existing natural drainage systems.

C. Encourage recharge of groundwaters.

D. Maintain the existing flows and quality of streams and water courses in [the municipality] and the Commonwealth.

E. Preserve and restore the flood carrying capacity of streams.

F. Provide for proper design, installation, and maintenance of all permanent storm water management structures which are constructed in [the municipality].

SECTION 103. STATUTORY AUTHORITY

[The municipality] is empowered to regulate these activities by the authority of the Act of October 4, 1978, P.L. 864 (Act 167), the "Stormwater Management Act" and the Municipal Planning Code (Act 247).

SECTION 104. APPLICABILITY

A. This Ordinance shall apply to those areas of [the municipality] as delineated on an official map available for examination at the Mifflin County Planning Office.

B. This Ordinance contains only those stormwater runoff control criteria and standards which are necessary or desirable from a total watershed perspective. Additional design standards for stormwater management facilities (i.e. inlet spacing, inlet type, collection system details, etc.) may be listed in [the municipality's] subdivision/land development ordinance, or may be instituted by [the municipality's] Engineer.

C. The following land disturbance activities are defined as Regulated Activities and shall be regulated by this Ordinance, except those individual land disturbance activities which meet the criteria to qualify for exemption, as described in Section 402 [or Section 1001]:

1. General land disturbance activities, including clearing and excavation.
2. Land development.
3. Subdivision.
4. Construction of new or additional impervious or semi-pervious surfaces (driveways, parking lots, etc.).
5. Construction of new buildings or additions to existing buildings.

[6. Nursery operations.]

7. Diversion or piping of any natural or manmade drainage channel.
8. Installation of stormwater systems or appurtenances thereto.

ARTICLE II
DEFINITIONS

Unless otherwise stated, the following words shall, for the purpose of this Ordinance, have the meaning herein indicated. Words in the present tense include the future tense. Words in the singular include the plural and words in the plural include the singular. The word "shall" is mandatory and not discretionary. The word "may" is permissive. Technical definitions not included in this article can be found in Appendix B. Words not defined herein or in Appendix B shall be construed to have the meaning given by common and ordinary use.

Act - The Pennsylvania Storm Water Management Act of October 4, 1978 (P.L. 864, No. 167).

Agricultural Operations - All activities connected with farming including dairying, pasturage, agriculture, apiaries, horticulture, floriculture, forest management, viticulture, and animal and poultry husbandry, except for construction of new buildings and impervious areas.

Best Management Practice (BMP) - A non-point source pollution control practice that is developed by a process that considers water quality impacts, as well as political, social, economic, and technical feasibility.

Conservation District - A public organization created under State enabling law as a special - purpose district to develop and carry out a program of soil, water, and related resource conservation, use, and development within its boundaries, usually a subdivision of State government with a local governing body and always with limited authorities. Often called a soil conservation district or a soil and water conservation district. For this Ordinance Conservation District applies to the [County] Conservation District.

Critical Area - An area defined by this ordinance to require more stringent control of post-development runoff flow rates and/or pollutant loads than those specified for the general watershed area.

Developer - A person or persons, partnership, association, corporation or other entity, or any responsible person therein or agent thereof, that undertakes any Regulated Activities covered by this Ordinance.

Development Site - The specific tract of land for which a Regulated Activity is proposed.

Drainage - The flow of water or wastewater and the methods of directing such flow, whether natural or artificial.

Drainage Plan - The documentation of the proposed stormwater management controls, if any, to be used for a given development site, the contents of which are established in Section 403.

Enforcement Officer - An individual designated by [the municipality] to execute the regulations set forth in this Ordinance. The enforcement officer must either 1) be a registered professional engineer in the Commonwealth of Pennsylvania, or 2) work under the supervision of a registered professional engineer.

Engineer - A professional engineer licensed as such in the Commonwealth of Pennsylvania, duly appointed as the Engineer for the [municipality].

Erosion - The removal of soil particles or rock fragments of the land surface by the action of running water, wind, ice, or other geological agents.

FHWA - Federal Highway Administration, United States Department of Transportation (USDOT).

Forest Management Operations - All activities connected with growing and harvesting of forest products including the site preparation, cultivation and logging of trees, and the construction and maintenance of roads. Refer to "Agricultural Operations".

Impervious Area - A surface which prevents the infiltration and percolation of water into the ground. Any areas which may be designed to initially be semi-pervious (e.g., gravel, crushed stone, porous pavement, compacted earth, etc.) shall be considered impervious areas for the purpose of waiver evaluations.

Land Development - Any of the following activities: (1) The improvement of one lot or two or more contiguous lots, tracts or parcels of land for any purpose involving: (i) a group of two or more residential or nonresidential buildings, whether proposed initially or cumulatively, or a single non-residential building on a lot or lots regardless of the number of occupants or tenure; or (ii) the division or allocation of land or space, whether initially or cumulatively, between or among two or more existing or prospective occupants by means of, or for the purpose of streets, common areas, leaseholds, condominiums, building groups or other features. (2) A subdivision of land.

Land Disturbance Activity - Any activity that changes existing cover or contours of the land. This includes grading; tilling; excavating; filling of ground; removal or destruction of the topsoil, trees or other vegetative cover; or any other activity which causes land to be exposed to the danger of erosion.

Memorandum of Understanding (MOU) - An agreement initiated by the municipality and outside agency(s) to document the responsibilities and liabilities of concerned parties for specified task(s). The document may also include provisions for enacting a fee schedule for work performed.

[Municipality - [City, Borough, Township], [County], Pennsylvania. (Note, if the municipality is a township, borough, etc. then this definition should be substituted with the appropriate term).]

Nonpoint Source Pollution - Pollution that enters a water body from diffuse origins in the watershed and does not result from discernible, confined, or discrete conveyances.

Nursery - A tract of land on which trees and plants are raised or stored for transplanting and sale.

Obstruction - Any structure or assembly of materials which might impede, retard, or change channel flows, including fill above or below land or water surfaces.

Owner - Any person, partnership, corporation, company, or other legal entity holding a current legal title.

PA DER - Pennsylvania Department of Environmental Resources.

PA DOT - Pennsylvania Department of Transportation.

Regulated Activity - Action or proposed action which impacts upon proper management of stormwater runoff and which is governed by this Ordinance as specified in Section 104.

Runoff - That part of precipitation which does not enter the soil but flows over the surface of the land.

SCS - Soil Conservation Service, U.S. Department of Agriculture (USDA).

Semi-Pervious Surface - A surface such as stone, rock, concrete or other materials which permits some vertical transmission of water into the ground.

Stormwater - Runoff and drainage from land surfaces resulting from precipitation including snow or ice melt.

Stormwater Management - A program of controls and measures designed to regulate the quantity and quality of stormwater from a development and/or land disturbance while promoting the protection and conservation of ground waters and groundwater recharge.

Stormwater Management Plan - The plan for managing stormwater runoff adopted by the applicable municipalities as required by the Act.

Stormwater Structures - The basins, pipes, swales, terraces, etc. designed and installed to collect, transport, detain and/or retain stormwater.

Subdivision - The division or redivision of a lot, tract or parcel of land by any means into two or more lots, tracts, parcels or other divisions of land including changes in existing lot lines for the purpose, whether immediate or future, of lease, partition by the court for distribution to heirs or devisees, transfer of ownership or building or lot development; provided, however, that the subdivision by lease of land for agricultural purposes into parcels of more than ten (10) acres, not involving any new street or easement of access or any residential dwelling, shall be exempted.

Subwatershed - The smallest breakdown unit of watershed for hydrologic modeling purposes for which the runoff control criteria have been established in the Stormwater Management Plan. These areas are identified in Section 302.

USDA - United States Department of Agriculture.

USDI - United States Department of Interior.

USDOT - United States Department of Transportation.

USEPA - United States Environmental Protection Agency.

USFWS - United States Fish and Wildlife Service.

Watershed - The entire region or area drained by a river or other body of water, whether natural or manmade.

ARTICLE III
STORMWATER MANAGEMENT REQUIREMENTS

SECTION 301. GENERAL REQUIREMENTS

A. Where applicable, stormwater management facilities or programs shall comply with the requirements of the Pennsylvania Clean Water Act (NPDES permitting for construction activities), Chapter 102 (Erosion Control), Chapter 105 (Dam Safety and Waterway Management) and Chapter 106 (Flood Plain Management) of Title 25, Rules and Regulations of the PA DER.

B. Stormwater management facilities which involve a state highway shall be subject to the approval of PA DOT.

C. Stormwater management facilities located within or affecting the floodplain of any watercourse shall also be subject to the requirements of any [municipal] or County ordinance which regulates construction and development within areas which are subject to flooding.

D. Stormwater management facilities must be designed so that the post-development runoff rates equal the pre-development runoff rates for the mean annual, 5-year, and 10-year, [redacted] storm return frequencies. Exceptions to this rule are defined in Section 302. The pre-development and post-development runoff rates and volumes shall be calculated for the appropriate design storm events presented in Section 303.C.

[E. Additional studies and a higher level of control than the minimum provided in the design criteria may be required by the [reviewing municipality] to assure adequate drainage to protect life and property.]

F. It is the responsibility of the developer to provide adequate drainage. Adequate drainage must have the hydraulic characteristics to accommodate the maximum expected flow of stormwaters for the watershed or portion thereof, for the required design year storm. Adequate drainage is to be designed to:

1. Account for on-site stormwaters at ultimate development with proposed controls and any runoff entering site from adjacent property based on the current comprehensive development plan prepared by the [municipal, county, and regional] planning department.

2. Honor natural drainage divides;

3. Convey stormwater to a natural outfall;

4. Not adversely affect the adjacent or neighboring properties including the concentration of runoff at property boundaries.

5. Not adversely affect the water quality of receiving waters.

It is the responsibility of the developer to provide adequate drainage for the proposed development and upstream watershed along or through his property to a natural outfall. Staged construction will be considered for perimeter and off-site improvements where the developer's engineer can show that it is feasible. Off-site drainage improvements will be required to prevent the proposed development from having any significant detrimental effect on the downstream facilities to the point of a natural outfall.

If a developer concentrates dispersed (sheet) flow or redirects flow to exit at another location on the property, the developer is responsible for constructing an adequate channel on the adjacent property and on all downstream properties until a natural outfall is reached.

G. A natural outfall shall have sufficient capacity to receive the design storm peak runoff from the watershed without deterioration of the facility and without adversely affecting property in the watershed. This natural outfall may be a river, creek, or other drainage facility so designated by the [reviewing municipality] for the proposed system.

H. Detention is the provision of acceptable storage area for stormwater with the use of a control structure providing a significant reduction in the peak discharge of stormwater. Detention of stormwater is desirable in many cases to alleviate existing downstream drainage problems and to preclude the development of new ones. Detention or retention is mandatory where the existing downstream drainage system is clearly inadequate and its expansion or improvement is either financially prohibitive or aesthetically unacceptable. [The municipality] reserves the right to waive the requirement for detention of stormwater where [the municipality] determines that its use is not in the public interest and where alternatives may apply.

I. Innovative stormwater management systems may be used when approved by [the municipality]. Various combinations of stormwater management systems should be developed to suit the particular, unique requirements of the development and topographic features of the development site.

Approval of a proposed stormwater management control facility using these innovative methods shall depend on the effectiveness of the facility in controlling the impacts of post-development runoff rates and volumes. The following is a partial listing of control methods which can be used in stormwater management facilities where appropriate:

1. Impervious area runoff diffused over pervious area
2. Infiltration pits, trenches, and dry wells
3. Concrete grid and modular pavement
4. Porous asphalt
5. Grass waterways
6. Detention basins
7. Oversized conveyance system storage
8. Parking lot storage
9. Rooftop detention
10. Cistern storage
11. Gravel parking lots and driveways
12. Rooftop gardens

General descriptions, including applicability, advantages, disadvantages, and maintenance of these stormwater management facilities, are provided in the "Technical Analysis, Modeling, and Standards" document for Jacks Creek Watershed Stormwater Management Plan (Technical Document). Chapters V and VI of the plan (herein) also provide coverage of this topic.

J. Access to facilities shall be provided for maintenance and operation. This access shall be a cleared access that is, when possible, approximately [twenty (20)] feet wide. Proximity of facilities to public right-of-ways shall be encouraged in order to minimize the length of access-ways. Multiple accesses shall be encouraged for major facilities.

K. All control facility designs shall conform to the applicable standards and specifications of the following governmental and institutional agencies:

1. American Society of Testing and Materials (ASTM).
2. Asphalt Institute (AI).
3. Conservation District.
4. Federal Highway Administration (FHWA).
5. National Crushed Stone Association (NCSA).
6. National Sand and Gravel Association (NSGA).
7. Pennsylvania Department of Environmental Resources (PA DER).
8. Pennsylvania Department of Transportation (PA DOT).
9. U.S. Department of Agriculture, Soil Conservation Service, Pennsylvania (USDA, SCS, PA).

[L. Control facilities which receive stormwater from areas which are a potential source of oil and grease contamination shall include a baffle, skimmer, grease trap or other mechanism suitable for preventing oil and grease from leaving the facility in concentrations that would cause or contribute to violations of applicable water quality standards in the receiving waters.]

M. "No Harm" Option.

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 criteria of this Ordinance. Proof of "no harm" would have to be shown from the development site through the remainder of the downstream drainage network to the headwaters of Jacks Creek. Proof of "no harm" must be shown using the capacity criteria specified by references of Section K above and Jacks Creek Watershed Technical Document 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 various return period storms shall be the values from the PSRM Runoff Model for the Jacks Creek Watershed. These flow values, which are contained in the Jacks Creek Watershed Technical Document, would be supplied to the developer by [the municipal] engineer 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.

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

SECTION 302. STORMWATER MANAGEMENT SUBWATERSHEDS

A. Mapping of Stormwater Management Subwatersheds - In order to implement the provisions of the Jacks Creek Watershed Stormwater Management Plan, [the municipality] is hereby divided into stormwater management subwatersheds which shall be as designated in the official map available for examination at the Mifflin County Planning Office.

[B. Identification of Provisional No Detention Areas - Subwatershed Areas 23 and 24, which includes all areas draining to Jacks Creek west of the junction of the unnamed stream joining Jacks Creek at Maitland, shall observe "Provisional No Detention" stormwater management practices. Unless local conditions dictate, no stormwater detention facilities will be required for these subareas. However, principal stormwater conveyance facilities shall be sized to safely carry the 10-year storm event at a minimum.]

SECTION 303. METHODS OF CALCULATION OF RUNOFF FLOW PARAMETERS

A. The methods of computation used to determine peak discharge and volume of runoff shall be one of the following methods or any other method approved by [the municipality] in advance:

1. The USDA SCS Soil-Cover-Complex Method as set forth in the latest edition of "Urban Hydrology For Small Watersheds", Technical Release No. 55.

2. The USDA SCS Soil-Cover-Complex Method as set forth in the "TR-20 Computer Program for Project Formulation Hydrology", Technical Release No. 20.

3. The Penn State Runoff Model (PSRM) as set forth in the Penn State Runoff User's Manual, January 1987 Version.

4. The "Rational Method" of Q=CIA, where Q is the peak discharge from the watershed in cubic feet per second (cfs), C is the coefficient of runoff, I is the intensity of rainfall in inches per hour and A is the area of the watershed in acres.

B. Where the drainage basin exceeds 200 acres or where a detention/ retention facility is involved, a hydrographic method is to be used for design purposes. The method of computation shall be selected using the following guidelines:

Output Requirements	Drainage Area	Hydrology Computation to be Used
Peak Discharge Only	Up to 200 acres Up to 2000 acres Up to 20 sq. mi. Above 20 sq. mi.	Rational Method, TR-55, TR-20, or PSRM TR-55, TR-20, or PSRM TR-20 or PSRM TR-20 or PSRM
Peak Discharge and Total Runoff Volume	Up to 2000 acres Up to 20 sq. mi. Above 20 sq. mi.	TR-55, TR-20, or PSRM TR-20 or PSRM TR-20 or PSRM
Runoff Hydrograph	Up to 2000 acres Up to 20 sq. mi. Above 20 sq. mi.	TR-55, TR-20, or PSRM TR-20 or PSRM TR-20 or PSRM

C. Rainfall frequency data to be used depends on the method of computation selected.

1. When the SCS Soil-Cover-Complex Method is used for basin-wide modeling, storm runoff shall be based on the following storm events using the SCS Type II 24-hour rainfall distribution:

Storm Event	Inches of Rainfall
2.33-Year*	2.7
5-Year*	3.1
10-Year*	3.6
25-Year	4.5
50-Year	5.0
100-Year*	5.6

*Indicated storm events must be evaluated in drainage plans, at a minimum.

2. Rainfall data shall be obtained from rainfall maps published by the PA DER, PA DOT, or available U.S. Department of Commerce, National Weather Service Information to obtain figures for specific sites.

3. When the Rational Method is used, Rainfall Intensity-Duration-Frequency chart shown in the PA DOT Field Manual, May 1986 shall be used to determine the rainfall intensity in inches per hour.

D. Runoff Curve Numbers (CN's) to be used in the Soil Cover Complex Methods shall be based upon the matrix presented in the most recent edition of SCS TR-55 manual.

E. Time of Travel (Tt) estimates for overland flows shall be based on the average velocities determined using the chart presented in the most recent edition of the SCS TR-55 manual.

F. Runoff coefficients for use in the Rational Method shall be based upon Table 10 in the Jacks Creek Watershed Technical Document (Table VI-1, herein).

G. The Manning equation shall be used to calculate the capacity and velocity of flow in open channels and in closed drains not under pressure. Manning "n" values used in the calculations shall be consistent with Table 11 in the Jacks Creek Watershed Technical Document (Table VI-2, herein).

H. All runoff calculations shall include both a hydrologic and hydraulic analysis indicating: 1) rate and velocities of flow; 2) grades, dimensions, and capacities of water carrying structures and impoundment structures; and 3) sufficient design information to construct such stormwater management facilities. Runoff calculations shall include both pre-development and post-development rates of peak discharge and volumes of storm runoff from the project development site. Runoff calculations for the site's condition during development shall be used to size temporary control measures.

ARTICLE IV
DRAINAGE PLAN REQUIREMENTS

SECTION 401. GENERAL REQUIREMENTS

Prior to the final approval of subdivision and/or land development plans, the issuance of any permit, or the commencement of any land disturbance activity involving any of the Regulated Activities of this Ordinance, the owner, subdivider, developer or his agent shall submit a Drainage Plan to [the municipality] for approval. The plan shall meet the requirements set forth herein, and shall also meet all requirements of Title 25 Rules and Regulations of the PA DER - Chapter 102 (Erosion Control), Chapter 105 (Dam Safety and Waterway Management), and Chapter 106 (Flood Plain Management).

SECTION 402. EXEMPTIONS

This section includes activities which may be requested for exemption from the plan preparation provisions of this Ordinance. Exemptions will be considered and granted by [the municipality] on a case-by-case basis. However, activities granted exemption from plan preparation provisions must still manage stormwater in the manner specified in the other provisions of this Ordinance.

A. Residential Land Disturbance Exclusions

Any land disturbance associated with an existing or proposed single residential family dwelling to be used as the developer's residence or with land used for gardening for home consumption is exempt from the Drainage Plan preparation provisions of this Ordinance.

B. Agricultural Operations Exclusion

Any land disturbance associated with agricultural activities operated in accordance with a conservation plan or erosion and sedimentation control plan prepared by the Conservation District, Soil Conservation Service, or under the supervision of a Pennsylvania registered professional engineer is exempt from the Drainage Plan preparation provisions of this Ordinance, as long as the plan meets the requirement of applicable rules and regulations noted in Section 401 above.

C. Forest Management Operations Exclusion

Any land disturbance associated with forest management operations which is following the PADER's management (practices contained in its publication "Soil Erosion and Sedimentation Control Guidelines for Forestry") and is operating under an adequate Erosion and Sediment Pollution Control Plan and Forest Management Plan is exempt from the Drainage Plan preparation provisions of this Ordinance.

[D. Nursery Operations Exclusion

Any land disturbance associated with nursery operations conducted in accordance with a conservation plan or erosion and sedimentation control plan prepared by the Conservation District, Soil Conservation Service, or under the supervision of a Pennsylvania registered professional engineer is exempt from the Drainage Plan preparation provisions of this Ordinance as long as the plan meets the requirements of applicable rules and regulations noted in Section 401 above.]

E. Limited Land Development Disturbance Exclusion

Any land disturbance associated with an existing or proposed land development having a total impervious area of less than 10,000 square feet is exempt from the Drainage Plan preparation provisions of this Ordinance.

SECTION 403. PLAN CONTENTS

The following items, where appropriate, shall be included in the Drainage Plan:

A. Written report, including the following information:

1. General description of project.

2. General description of proposed stormwater controls (temporary and permanent) both during and after development including the stormwater runoff calculations, assumptions and factors considered, and criteria used for both pre-development and post-development conditions.

3. General description of the erosion and sediment pollution control plan that conforms to the requirements of Chapter 102 (Erosion Control) of Title 25 Rules and Regulations of the PA DER.

4. General description of an ownership and maintenance program that clearly sets forth the ownership and maintenance responsibility of all temporary and permanent stormwater management facilities and erosion and sediment pollution control facilities, including:

    a. Description of temporary and permanent maintenance requirements.

    b. Identification of a responsible individual, corporation, association or other entity for ownership and maintenance of both temporary and permanent stormwater management and erosion and sediment pollution control facilities.

    c. Establishment of suitable easements for access to all facilities.

    d. The intent of these regulations is to provide private ownership and maintenance of stormwater management and erosion and sedimentation control facilities. Where the Drainage Plan proposes that [the municipality] own or maintain the facilities, a description of the methods, procedures, and the extent to which any facilities shall be turned over to [the municipality] shall be incorporated as an integral part of the Drainage Plan.
    e. Where private development is involved, deed covenants and restrictions must be submitted to provide for maintenance of stormwater facilities by property owner or owner's association.
5. Expected project time schedule, including anticipated start and completion date.

6. Training and experience of person(s) preparing the plan.

B. Plans, showing the following information:

1. General

    a. All plans shall be on sheet sizes consistent with [the municipal subdivision and land development ordinance].

    b. Proposed name or identifying title of project.

    c. Name and address of the landowner and developer of the project site.

d. Plan date and date of the latest revision to the plan, north point, graphic scale and written scale. All plans shall be at a scale of [ten (10), twenty (20), forty (40), fifty (50), or one hundred (100) feet] to the inch.

e. Total acreage and boundary lines of the project site and the tract of land on which the project site is located.

f. A location map, for the purpose of locating the project site to be developed, at a minimum scale of [two thousand (2,000)] feet to the inch, showing the relation of the tract to adjoining property and to all highways, streets [municipal] boundaries, and other identifiable landmarks existing within [one thousand (1,000)] feet of any part of the tract of land on which the project site is proposed to be developed.

g. Certificate for approval by [the municipality's] Board of Supervisors.

h. Certificate for review by the [Municipal Planning Commission].

i. Certificate for review by [the municipality's] engineer, if required by [the municipality's] Board of Supervisors.

2. Existing Features

a. Tract boundaries showing distances, bearings and curve data, as located by field survey or by deed plotting.

b. Existing contours at vertical intervals of [two (2)] feet for land with an average natural slope of [(15%) percent or less] and at vertical intervals of [five (5)] feet for more steeply sloping land; except that for residential and agricultural uses where a preliminary subdivision or land development plan is not required by [the municipal sub- division and land development ordinance], no contours shall be required; however, the plan should indicate the natural drainage patterns of the site along with the approximate grades of all slopes. Where contours are shown, the location of the benchmark and the name of the datum shall also be indicated.

c. The names of all owners of all immediately adjacent unplatted land, the names of all proposed or existing developments immediately adjacent, and the locations and dimensions of any streets or easements shown thereon.

d. The names, locations and dimensions of all existing highways, streets, railroads, watercourses and bodies of water, drainage facilities, floodplains, and other significant features within [two hundred (200)] feet of any part of the tract proposed to be developed and the location of all buildings and approximate location of all tree masses within the tract.

e. Locations and dimensions of overhead and underground utilities, sewers, and water lines.

f. Soil types as designated by the USDA SCS Soil Survey of [County].

3. Proposed Features

a. The proposed land use, the number of lots and dwelling units and the extent of commercial, industrial or other nonresidential uses.

b. The locations and dimensions of all proposed streets, parks, playgrounds, and other public areas; overhead and underground utilities and sewer and water facilities; lot lines and building locations, and parking compounds and other impervious and semi-pervious surfaces.

c. The proposed changes to land surface and vegetative cover.

d. Areas of cuts or fills.

e. Final contours at vertical intervals of [two (2)] feet for land with an average natural slope of [(15%) percent or less] and at vertical intervals of [five (5)] feet for more steeply sloping land. Where existing contours are not shown or where proposed contour lines cannot be accurately located (i.e., as in a single family detached residential development when the building has not been determined), arrows indicating general surface runoff flow patterns shall be shown.

SECTION 405. PLAN REVIEW AND APPROVAL

Plan review and approval by agencies outside of the municipal government are contingent upon a Memorandum of Understanding with [the municipality].

f. A [twenty-five (25)] foot right-of-way around all stormwater management structures and from such structures to a public right-of-way.

[If the Stormwater Ordinance is adopted as an Ordinance separate from a Subdivision and Land Development Ordinance, then reference should be made in this section to have the respective agencies coincide their reviews of drainage plans and subdivision plans for related projects.]

A. [Municipal] Engineer Review

The [municipal] engineer shall review the Drainage Plan for consistency with the adopted Jacks Creek Watershed Stormwater Management Plan, as embodied by this Ordinance and with any additional storm drainage provisions contained in [the municipality's] applicable codes, regulations, and ordinances. The [municipal] engineer shall provide written comment of his review to [the municipality].

B. [Municipal Planning Commission/Conservation District] Review

The [municipal planning commission/Conservation District] shall review the Drainage Plan for consistency with the Jacks Creek Watershed Storm Water Management Plan. The [Commission/District] shall provide written comment of their review to [the municipality].

For applicable Regulated Activities specified in Section 104 the [Commission/District] shall review the Drainage Plan for coordination with the PA DER permit application process the Pennsylvania Clean Water Act (NPDES permitting for construction activities), under Chapter 102 (Erosion Control), Chapter 105 (Dam Safety and Waterway Management), or Chapter 106 (Flood Plain Management) of Title 25 of PA DER's Rules and Regulations. The [Commission/District] shall notify a regional office of the PA DER whether the Drainage Plan is consistent with the Stormwater Management Plan and forward a copy of the review letter to [the municipality] and the developer.

[This section can be expanded to include two separate reviews, one by a municipal planning commission and one by the Conservation District. Also, a Section for additional reviewers, such as a county planning commission, can be added.]

C. Public Hearing

[The municipality] may require a public hearing if the [municipal] engineer or the [municipal/county planning commission] request one and the municipality deems it appropriate. Provisions for a public hearing shall be consistent with requirements of the Municipal Planning Code (Act 147), and shall include at a minimum:

1. A minimum of a two-week public notice in a local newspaper or in a mailed newsletter.

2. The notice shall contain a brief summary of the Drainage Plan and a reference to the places where copies may be examined or purchased at cost.

E. Notification of Decision

The decision of [the municipality] shall be in writing and shall be communicated to the developer personally or mailed to him at his last known address no later than [ninety (90)] days from receipt of a complete Drainage Plan submission.

F. Disapproval Stipulations

When the Drainage Plan is not approved in terms as submitted, the decision shall specify the defects found in the Drainage Plan and describe the requirements which have not been met and shall, in each case, cite to the provisions of the Ordinance relied upon.

G. Approval Time Limitation

Failure of [the municipality] to render a decision and communicate it to the developer within the time and in the manner required herein shall be deemed an approval of the Drainage Plan in terms as presented unless the developer has agreed in writing to an extension of time or change in the prescribed manner of presentation of communication of the decision, in which case, failure to meet the extended time or change in manner of presentation of communication shall have like effect.

H. Approval Agency

The agency who prepares the plan should not be the agency who approves the plan.

I. Records

[The municipality] shall record the approved plan and all accompanying documentation at [the municipality's] office.

SECTION 406. MODIFICATION OF PLANS

A modification to an approved Drainage Plan which involves a change in control methods or techniques, or which involves the relocation or redesign of control measures, or which is necessary because soil or other conditions are not as stated on the approved plan application (as determined by the [municipal] engineer or a qualified designee), shall require a resubmission of the modified Drainage Plan consistent with Section 404 and subject to review per Section 405 of this Ordinance.

ARTICLE V
INSPECTIONS

SECTION 501. GENERAL REQUIREMENTS

A. Prior to approval of the constructed stormwater management facilities of the approved Drainage Plan, the developer must provide a schedule of inspections along with a final inspection and submission of "as-built" drawings to the [municipal] engineer. These inspection provisions pertain only to construction activities regulated by the plan preparation provisions of Article IV. However, any activities granted exemption from plan preparation provisions as described in Section 402 and Section 1001 and therefore exemption from the inspection provisions must manage stormwater in the manner specified in the other provisions of this Ordinance.

SECTION 502. SCHEDULE OF INSPECTIONS

A. The developer must submit a certification by a Pennsylvania Registered Professional Engineer; which certifies that all elements of the approved Drainage Plan have been constructed as designed and approved.

B. The [municipal] engineer or a designee shall inspect all phases of development of the site including, but not limited to:

1. Completion of preliminary site preparation including stripping of vegetation, stockpiling of topsoil, and construction of temporary stormwater management and erosion control facilities.
2. Completion of rough grading, prior to placing top soil, permanent drainage or other site development improvements and ground covers.
3. During construction and installation of the permanent storm water facilities at such times to be specified by the [municipal] engineer.
4. Upon completion of permanent stormwater management facilities, including established ground covers and plantings.

5. Upon completion of any final grading, vegetative control measures or other site restoration work done in accordance with the approved Drainage Plan.

C. No work shall begin on a subsequent stage until the proceeding stage has been inspected and approved by the [municipal] engineer or the designee.

D. It is the responsibility of the developer to notify the [municipal] engineer or the designee [forty-eight (48)] hours in advance of the completion of each identified phase of development.

E. In the event the [municipal] engineer or designee discovers that the work does not comply with the approved Drainage Plan or any applicable laws and ordinances, [the municipality] shall stop work until corrections are made. Any portion of the work that does not comply with the approved plan must be corrected by a developer within [ten (10)] days. No work may proceed on any subsequent phase of the Drainage Plan, the subdivision or land development or building construction until the required corrections have been made.

F. If at any stage of the work, the [municipal] engineer or the designee determines that the soil or other conditions are not as stated or shown in the approved Drainage Plan, he may refuse to approve further work and [the municipality] may revoke approvals until a revised Drainage Plan is submitted and approved, as required by Section 406 of this Ordinance. If the revised Drainage Plan cannot remedy the situation then [the municipality] reserves the right to cancel the [municipal] approval and halt all work except for that work required to "close-out" the activity and return the site to pre-activity conditions as much as is reasonably possible.

G. If the [municipal] engineer or designee discovers that the facilities or measures installed may be in violation of Chapter 102 (Erosion Control) of the Clean Streams Law provision, the engineer or designee will refer these violations to the appropriate conservation district.

SECTION 503. FINAL INSPECTION

When the developer has completed all the required facilities, he shall notify [the municipality] in writing by certified or registered mail, and shall send a copy of such notice to [the municipal] engineer. [The municipality] shall, within [ten (10)] days after receipt of such notice, authorize [the municipal] engineer to inspect the required facilities. Following this final inspection, the [municipal] engineer shall promptly file a report, in writing, with [the municipality] and shall mail a copy of the report to the developer by certified or registered mail. The report shall be made and mailed within [thirty (30)] days after receipt by [the municipal] engineer of the aforesaid authorization by [the municipality].

SECTION 504. AS-BUILTS

Following final inspection, the developer shall submit drawings bearing the seal of a Pennsylvania Registered Professional Engineer indicating the "As-Built" improvements called for in the approved plan.

ARTICLE VI
FEES AND EXPENSES

SECTION 601. GENERAL (This section may be revised if the municipality has established a more appropriate fee basis to meet its needs)

A fee covering costs to [the municipality] for Drainage Plan review and inspections shall be established by resolution of [the municipality's governing body]. No approval of the Drainage Plan shall be issued until the requisite fee has been paid. The fee shall be established in accordance with the following schedule:

A. Regulated Activities involving the construction of buildings - [The municipality] shall be entitled to receive a fee at the rate of [?? dollars ($??) per one thousand dollars ($1,000)] of the costs of construction on the basis of the applicant's contract price for the construction or bids, including but not limited to the contracts or bids for the general, electrical, plumbing and mechanical contracts. Where the applicant at the time of application certifies that there is no fixed bid or contract establishing the cost of the construction, the applicant shall estimate the total cost of the construction which shall initially be used for calculation of Drainage Plan fee. In such cases, prior to the final approval of the stormwater management control facilities by [the municipality], the applicant shall submit final bills for construction to reflect the actual costs incurred. In the event that the estimated costs exceeds the actual costs, [the municipality] shall refund to the applicant any excess fee, likewise if the actual costs exceed the estimated cost, the applicant shall remit the additional monies to [the municipality].

B. Regulated Activities involving the installation of diversions, piping, or stormwater systems including all ditches, trenches, swales, etc. - [The municipality] shall be entitled to receive the following fees:

		Fee
1.	First [1,000] lineal feet or fraction thereof	[$??]
2.	Each additional [200] lineal feet or fraction thereof	[$??]

C. Regulated Activities involving non-construction activities - [The municipality] shall be entitled to receive the following fees:

		Fee
1.	First acre or fraction thereof	[$??]
2.	Each additional acre or fraction thereof	[$??]

SECTION 602. MODIFICATION OF PLANS

If it is determined that a modification to the existing Drainage Plan is required under Section 406 of this Ordinance, a revised plan shall not be approved until the additional fee has been paid by the applicant.

SECTION 603. EXPENSES COVERED BY FEES

The fees payable by an applicant shall at a minimum cover:

A. The review of the Drainage Plan by the [municipal] engineer as presented in Section 405 of this Ordinance.

B. The site inspection.

C. The inspection of required controls and improvements during construction as presented in Section 502 of this Ordinance.

D. The final inspection upon completion of the controls and improvements required in the plan as presented in Section 503 of this Ordinance.

E. Any additional work required to enforce any provisions regulated by this Ordinance, correct violations, and assure the completion of stipulated remedial actions.

[Other expenses to be covered may be added to this list].

ARTICLE VII
FINANCIAL GUARANTEES AND MAINTENANCE

SECTION 701. PERFORMANCE GUARANTEES

A. When requested by the developer, in order to facilitate financing, [the municipality] if designated, shall furnish the developer with a signed copy of a resolution indicating approval of the Drainage Plan contingent upon the developer obtaining a satisfactory financial security. The Drainage Plan shall not be approved until the financial improvements agreement is executed. The resolution or letter of contingent approval shall expire and be deemed to be revoked if the financial security agreement is not executed within [ninety (90)] days unless a written extension is granted by [the municipality]; such extension shall not be unreasonably withheld and shall be placed in writing at the request of the developer.

B. The developer shall provide [the municipality] financial security as a performance guarantee in a form to be approved by [the municipality's] solicitor. Documentation of the financial security is to be provided in the Drainage Plan submission as per Paragraph 403.C of this Ordinance.

C. Without limitation as to other types of financial security which [the municipality] may approve, which approval shall not be unreasonably withheld, Federal or Commonwealth chartered lending institution irrevocable letters of credit and restrictive or escrow accounts in such lending institutions shall be deemed acceptable financial security for the purposes of this section.

D. Such financial security shall be posted with a bonding company or Federal or Commonwealth chartered lending institution chosen by the party posting the financial security, provided said bonding company or lending institution is authorized to conduct such business within the Commonwealth.

E. Such bond, or other security shall provide for, and secure to the public, completion of the installation of all stormwater management facilities on or before the date fixed on the approved Drainage Plan for the completion of such facilities.

F. The amount of financial security to be posted shall be equal to [one hundred ten percent (110%)] of the cost to install the required facilities estimated as of [ninety (90)] days following the date scheduled for completion by the developer. Annually, [the municipality] may adjust the amount of the financial security by comparing the actual cost of the facilities which have been installed and the estimated cost for the completion of the remaining facilities as of the expiration of the [90th] day after either the original date scheduled for completion or the rescheduled date of completion. Subsequent to said adjustment, [the municipality] may require the developer to post additional security in order to assure that the financial security equals said [110%]. Any additional security shall be posted by the developer in accordance with this subsection.

G. The amount of financial security required shall be based upon an estimate of the cost of completion of the required facilities, submitted by an applicant or developer and prepared by a professional engineer licensed as such in this Commonwealth and certified by such engineer to be a fair and reasonable estimate of such cost. [The municipality], upon the recommendation of the [municipal] engineer, may refuse to accept such estimate for good cause shown. If the applicant or developer and [the municipality] are unable to agree upon an estimate, then the estimate shall be recalculated and recertified by another professional engineer licensed as such in this Commonwealth and chosen mutually by [the municipality] and the applicant or developer. The estimate certified by the third engineer shall be presumed fair and reasonable and shall be the final estimate. In the event that a third engineer is so chosen, fees for the services of said engineer shall be paid equally by [the municipality] and the applicant or developer.

H. If the developer requires more than one (1) year from the date of posting of the financial security to complete the required facilities, the amount of financial security may be increased by an additional [ten percent (10%)] for each one (1) year period beyond the first anniversary date from posting of financial security or to an amount not exceeding [one hundred ten percent (110%)] of the cost of completing the required facilities as re-established on or about the expiration of the preceding one (1) year period by using the above bidding procedure.

I. Financial Security for Staged Development - In the case where development is projected over a period of years, [the municipality] may authorize submission of Drainage Plan applications by sections or stages of development so as to require or guarantee that stormwater management facilities in both current and future stages of development will provide the protection of the finally approved stage of the development.

J. Release of Financial Security - As the work of installing the required stormwater management facilities proceeds, the developer posting the financial security may request [the municipality] to release or authorize the release, from time to time, such portions of the financial security necessary for payment to the contractor or contractors performing the work. Any such requests shall be in writing addressed to [the municipality] who shall have [forty-five (45)] days from receipt of such request within which to allow [the municipal] engineer to certify, in writing, to [the municipality] that such portion of the work upon the facilities has been completed in accordance with the approved plan. Upon such certification, [the municipality] shall authorize release by the bonding company or lending institution of an amount as estimated by [the municipal] engineer fairly representing the value of the facilities completed or, if [the municipality] fails to act within said [forty-five (45)] day period, [the municipality] shall be deemed to have approved the release of funds as requested. [The municipality] may, prior to final release, require retention of [ten percent (10%)] of the estimated cost of the aforesaid facilities. The final release of the financial security provisions shall be permitted only after receipt by [the municipality] of certification and "As-Builts" as required in Sections 502 and 503.

K. Where [the municipality] accepts dedication of all or some of the required facilities following completion, [the municipality] may require the posting of financial security to secure structural integrity of said facilities as well as the functioning of said facilities in accordance with the design and specifications as depicted on the Drainage Plan for a term not to exceed [eighteen (18)] months from the date of acceptance of dedication. Said financial security shall be of the same type as otherwise required in this section with regard to installation of such facilities, and the amount of the financial security shall not exceed [fifteen percent (15%)] of the actual cost of installation of said facilities.

L. Based on the report of the [municipal] engineer, [the municipality] shall indicate approval or rejection of the stormwater management facilities, either in whole or in part; and if not approved, state reasons for the rejection. [The municipality] shall notify the developer, within [fifteen (15)] days of receipt of the engineer's report, in writing by certified or registered mail, of its actions.

M. If [the municipality] or the [municipal] engineer fails to comply with the time limitation provisions contained herein, all stormwater management facilities will be deemed to have been approved, and the developer shall be released from all liability, pursuant to its performance guaranty bond, or other security agreement.

N. If any portion of said improvements are not approved or are rejected by [the municipality], the developer shall proceed to complete the same and, upon completion, the same procedure of notification, as outlined herein, shall be followed.

O. Nothing herein, however, shall be construed in limitation of the developer's right to contest or question by legal proceedings or otherwise, any determination of [the municipality] or the [municipal] engineer.

P. Where herein reference is made to the [municipal] engineer, he shall be as a consultant thereto.

Q. Remedies to Effect Completion of Facilities - In the event that any stormwater management facilities which may be required have not been installed as provided in this Ordinance or in accordance with the approved final plan, [the municipality] has the power to enforce any corporate bond or other security by appropriate legal and equitable remedies. If proceeds of such bond or other security are insufficient to pay the cost of installing or making repairs or corrections to all the facilities covered by said security, [the municipality] may, at its option, install part of such facilities in all or part of the development and may institute appropriate legal or equitable action to recover the monies necessary to complete the remainder of the facilities. All of the proceeds, whether resulting from the security or from any legal or equitable action brought against the developer, or both, shall be used solely for the installation of the stormwater management facilities covered by such security, and not for any other purpose.

SECTION 702. MAINTENANCE RESPONSIBILITIES

A. The maintenance responsibilities for permanent stormwater management facilities shall be determined based upon the type of ownership of the property and/or facilities. The following priority process was established for facility ownership and maintenance responsibility:

   1. As first priority, the property and facilities are owned by a private entity which shall be responsible for maintenance. A private entity shall be defined as an association, public or private corporation, partnership firm, trust, estate or any other legal entity empowered to own real estate exclusive of an individual lot owner.

2. As second priority, the facilities shall be dedicated to [the municipality] which shall be responsible for maintenance which requires the establishment of maintenance guarantees as described in Section 703. For certain types of facilities [the municipality] may benefit by transferring the maintenance responsibility to an individual or group of individuals residing within the controlled area. These individuals may have the permanent stormwater control facilities adjacent to their lots or otherwise have an interest in the proper maintenance of the facilities. In these instances, [the municipality] and the individual(s) may enter into a formal agreement for the maintenance of the facilities. [The municipality] shall maintain ownership of the facilities and be responsible for periodic inspections.

3. As third priority, the property and facilities are owned by an individual lot owner who shall be responsible for maintenance.

B. The failure of any person, individual lot owner or private entity to properly maintain any stormwater management facility shall be construed to be a violation of this Ordinance and is declared to be a public nuisance, subject to Article VIII, Enforcement and Penalties.

SECTION 703. MAINTENANCE GUARANTEES

Upon approval of any stormwater management facilities by [the municipality], the developer shall provide a financial security, in a form approved by [the municipal] solicitor for maintenance guarantees, as follows:

A. Construction Maintenance Bond

[The municipality] may require the posting of a maintenance bond to secure the structural integrity of said facilities as well as the functioning of said facilities in accordance with the design and specifications as depicted on the approved Drainage Plan for a term not to exceed [eighteen (18)] months from the date of acceptance of dedication. Said financial security shall be the same type as required in Section 701 with regard to installation of such facilities, and the amount of the financial security shall not exceed [fifteen percent (15%)] of the actual cost of installation of said facilities.

B. Long-term Maintenance Bond

The long-term maintenance bond shall be in an amount equal to the present worth of maintenance of the facilities for a [ten- (10-)]year period. The estimated annual maintenance cost for the facilities shall be based on a fee schedule provided by [the municipal] engineer and adopted by [the municipality]. The fee schedule must be reasonable.

C. Documentation

The terms of the maintenance guarantees shall be documented as part of the Drainage Plan as per Section 403.D of this Ordinance.

SECTION 704. MAINTENANCE BY PRIVATE ENTITY

When a private entity (such as a homeowner's association) retains ownership of any stormwater management facility, such entity shall be responsible for maintenance of the facility. The stated responsibilities of the entity in terms of owning and maintaining the facilities shall be submitted with the Drainage Plan for determination of their adequacy. Approval of the Drainage Plan shall be conditioned upon the approval of these terms. These terms shall be in writing, shall be in recordable form, and shall, in addition to any other terms deemed necessary by [the municipality], contain a provision permitting inspection at any reasonable time by [the municipality] or its designee of all such facilities deemed critical in the public welfare.

SECTION 705. MAINTENANCE BY INDIVIDUAL LOT OWNERS

When any stormwater management facility is located on an individual lot, and when maintenance thereof is the responsibility of that landowner, a description of the facility or systems and the terms of the required maintenance shall be incorporated as a part of the deed to the property. The deed shall be recorded with the [County] Recorder of Deeds within [ninety (90)] days following [municipality] approval. In addition, [the municipality] may require as a condition of approval that a deed conveying any interest in such lot contain language indicating that the conveyance is subject to an express covenant by the grantee that the grantee will maintain the stormwater management facility.

ARTICLE VIII
ENFORCEMENT AND PENALTIES

SECTION 801. ENFORCEMENT

The [municipality] shall designate by resolution a qualified individual, agency, or combination thereof to act as the Enforcement Officer. Said Enforcement Officer will execute the regulations set forth in this Ordinance.

In the event that the Enforcement Officer is unable to perform his duties, or in the event of a conflict of interest, the [municipality] may appoint an alternate to fulfill his responsibilities.

SECTION 802. RIGHT-OF-ENTRY

Upon presentation of proper credentials, duly authorized representatives of [the municipality] may enter at reasonable times upon any property within [the municipality] to investigate or ascertain the condition of the subject property in regard to any aspect regulated by this Ordinance. This includes property housing stormwater management facilities for which [the municipality] is not directly responsible for maintenance as provided in Sections 703 and 704.

SECTION 803. VIOLATIONS

Any activity conducted in violation of this Ordinance is declared to be a public nuisance.

A. Notice

In the event that an owner, applicant, developer, property manager or his agent fails to comply with the Ordinance, the [Enforcement Officer] shall provide a written notice of the violation to be served upon the person. Such notice shall set forth the nature of the violation(s) and direct the person to whom it is served to comply with all the terms of this Ordinance within [seven (7)] days, or such additional period, not to exceed [thirty (30)] days, as the [Enforcement Officer] shall deem reasonable, and further the [Enforcement Officer] shall give notice to the owner, applicant, developer, property manager or his agent that if the violation is not corrected, [the municipality] may correct the same and charge the landowner or other person responsible the cost thereof plus penalties as specified herein for failure to comply.

B. Service of Notice

Such notice may be delivered by the United States mail, first class, postage prepaid, or by certified or registered mail; or by personal service; or, if the property is occupied, by posting the notice at a conspicuous place upon the subject property.

SECTION 804. PENALTIES

A. Any owner, applicant, developer, property manager or his agent violating the provisions of this Ordinance shall, upon being found liable therefore in a civil enforcement proceeding commenced by [the municipality], pay a judgement of not more than [five hundred dollars ($500.00)] plus all court costs, including reasonable attorney fees incurred by [the municipality] as a result thereof. No judgment shall commence or be imposed, levied or payable until the date of the determination of a violation by the district justice. If the defendant neither pays nor timely appeals the judgment, [the municipality] may enforce the judgment pursuant to the applicable rules of civil procedure. Each day that a violation continues shall constitute a separate violation, unless the district justice determining that there has been a violation further determines that there was a good faith basis for the owner, applicant, developer, property manager or his agent violating the ordinance to have believed that there was no such violation, in which event there shall be deemed to have been only one such violation until the fifth day following the date of the determination of a violation by the district justice and thereafter each day that a violation continues shall constitute a separate violation.

B. The court of common pleas, upon petition, may grant an order of stay, upon cause shown, tolling the per diem judgment pending a final adjudication of the violation and judgment.

C. Nothing contained in this section shall be construed or interpreted to grant to any person or entity other than [the municipality] the right to commence any action for enforcement pursuant to this section.

ARTICLE IX
APPEALS

SECTION 901. APPEAL TO [MUNICIPALITY'S GOVERNING BODY]

Any person, partnership, corporation or organization aggrieved by any action of [the municipality] or its designee may appeal to [the municipality's governing body] within [thirty (30)] days of that action.

SECTION 902. APPEAL TO COURT

Any person, partnership, corporation or organization aggrieved by any decision of [the municipality's governing body] may appeal to the [County Court] within [thirty (30)] days of that decision.

ARTICLE X
MISCELLANEOUS

[SECTION 1001. HARDSHIP WAIVER PROCEDURE] (If Ordinance is an amendment to a zoning ordinance, then this waiver procedure should be in the form of a variance.)

A. [The municipality governing body] may hear requests for waivers where it is alleged that the provisions of this ordinance inflict unnecessary hardship upon the applicant. The waiver request shall be in writing using [an application form promulgated by [the municipality]] and accompanied by the requisite fee [based upon a fee schedule adopted by [the municipality]]. A copy of the completed application form shall be provided to each of the following: [municipality, municipal engineer, municipal solicitor, municipal planning commission, and County planning commission]. The application shall state in full the grounds and facts of unreasonableness or hardship on which the request is based, the provision or provisions of the Ordinance involved and the minimum waiver necessary.

B. [The municipality] may grant a waiver of one or more provisions of this Ordinance provided that such waiver will not be contrary to the public interest and that all of the following findings are made in a given case:

   1. That there are unique physical circumstances or conditions, including irregularity of lot size or shape, or exceptional topographical or other physical conditions peculiar to the particular property, and that the unnecessary hardship is due to such conditions, and not the circumstances or conditions generally created by the provisions of this Ordinance;

   2. That because of such physical circumstances or conditions, there is no possibility that the property can be developed in strict conformity with the provisions of this Ordinance, including the "no harm" provision documented in Section 304, and that the authorization of a waiver is therefore necessary to enable the reasonable use of the property;

   3. That such unnecessary hardship has not been created by the applicant; and

4. That the waiver, if authorized, will represent the minimum waiver that will afford relief and will represent the least modification possible of the regulation in issue.

C. In granting any waiver, [the municipality] may attach such reasonable conditions and safeguards as it may deem necessary to implement the purposes of this Ordinance. [The municipality] shall keep a record of all action on all requests for waivers.]

SECTION 1002. REPEALER

Any ordinance of [the municipality] inconsistent with any of the provisions of this Ordinance is hereby repealed to the extent of the inconsistency only.

SECTION 1003. COMPATIBILITY WITH OTHER PERMIT AND ORDINANCE REQUIREMENTS

Approvals issued pursuant to this Ordinance do not relieve the applicant of the responsibility to secure required permits or approvals for activities regulated by any other applicable code, rule, act or ordinance. If more stringent requirements concerning regulation of stormwater or erosion and sedimentation control are contained in the other code, rule, act or ordinance, the more stringent regulation shall apply. Refer to Appendix A for a list of related regulations, codes and ordinances. Appendix A is not a part of this Ordinance.

SECTION 1004. MUNICIPAL LIABILITY

The making of an administrative decision shall not constitute a representation, guarantee or warranty of any kind by [the municipality] or by any official or employee thereof, of the practicability or safety of any proposed structure or use with respect to damage from erosion, sediment pollution, storm water runoff, or floods, and shall create no liability upon, or cause of action against, [the municipality], its officials or employees.

ARTICLE XI
ENACTMENT

SECTION 1101. SEVERABILITY

If any section, subsection, or requirement of this Ordinance shall be held to be unconstitutional or invalid by any court of competent jurisdiction, such decision shall not affect the legality of the remaining provisions of this Ordinance or of this Ordinance as a whole.

SECTION 1102. AMENDMENTS

Amendments to this Ordinance may be initiated by the [municipal planning commission] or the [municipal governing body]. If the amendments are initiated by the [governing body], the proposed amendment or amendments shall be submitted to the [planning commission] for review and comment at least thirty (30) days prior to a public hearing. Before enactment of a proposed amendment or amendments the [governing body] shall hold a public hearing thereon pursuant to public notice.

SECTION 1103. EFFECTIVE DATE

This Ordinance shall become effective on [____________________________, 1990].

Ordained and enacted this [____] day of [____________________________].

____
Chairman

[Board of Supervisors/Borough Council]

ATTEST:

____
Secretary

JACKS CREEK WATERSHED MANAGEMENT DISTRICT MODEL STORMWATER MANAGEMENT ORDINANCE

APPENDICES

MODEL ORDINANCE APPENDIX A

LIST OF RELATED [MUNICIPAL] REGULATIONS, CODES, AND ORDINANCES

(Note: This "list" is only an outline of the types of related regulations, codes, and ordinances that are to be included in an actual ordinance.)

A.1 Subdivision/Land Development Ordinance
[Name] [Date Enacted] [Summary of Relationship]

A.2 Zoning Ordinance
[Name] [Date Enacted] [Summary of Relationship]

A.3 Erosion, Sediment Control Ordinance
[Name] [Date Enacted] [Summary of Relationship]

A.4 Stormwater/Runoff Control Ordinance
[Name] [Date Enacted] [Summary of Relationship]

A.5 Floodplain Management Regulations
[Name] [Date Enacted] [Summary of Relationship]

A.6 Road Ordinance
[Name] [Date Enacted] [Summary of Relationship]

A.7 Building Code
[Name] [Date Enacted] [Summary of Relationship]

A.8 Building Permits
[Name] [Date Enacted] [Summary of Relationship]

A.9 Grading Code
[Name] [Date Enacted] [Summary of Relationship]

A.10 Comprehensive Plan
[Name] [Date Enacted] [Summary of Relationship]

Geo Decisions, Inc.

Gannett Fleming

APPENDIX B

Jacks Creek Watershed

- ACT 167 -

Stormwater Management Plan

Technical Definitions

June 8, 1995

APPENDIX B

Technical Definitions

Accelerated Erosion - The removal of the surface of the land through the combined action of man's activities and natural processes at a rate greater than would occur because of the natural processes alone.

Aggregate - Term for the stone or rock gravel needed to fill in an infiltra- tion stormwater control facility such as a trench or porous pavement.

Agricultural Waste - Wastes that have their origin from agriculture. Most such wastes are associated with the production of food and fiber on farms, ranges, and forests. These wastes normally include animal manure, crop residues, dead animals, and agricultural chemicals.

Bank Stabilization - Includes grade stabilization structures to stabilize soils and, in some cases, provide some stormwater infiltration.

Bedrock - The more or less solid rock in place either on or beneath the surface of the earth. It may be soft, medium or hard and have a smooth or irregular surface.

Borings - Cylindrical samples of a soil profile used to determine infiltration capacity.

Channel - A natural or artificial watercourse with a definite bed and banks which confine and conduct continuously or intermittently flowing water. See "Watercourse".

Channel Erosion - The widening, deepening, and headward cutting of small channels and waterways, due to erosion caused by moderate to large floods.

Channelization - Any artificial reconstruction of a stream channel such as straightening, lining, or deepening.

Cistern - An underground or above ground reservoir or tank for storing rain- water.

Commercial Land Use - Any use involving in part or in whole the sale of merchandise, materials or services, but not including home occupations.

Conduit - Any channel intended for the conveyance of water, whether open or closed.

Contour - An imaginery line on the surface of the earth connecting points of the same elevation. A line drawn on a map connecting points of the same elevation.

Cover Crop - A close-growing crop grown primarily for the purpose of protecting and improving soil between periods of permanent vegetation.

Culvert - A pipe, conduit or similar structure, including appurtenant works, which carries surface water.

Design Storm - The magnitude of precipitation from a storm event measured in probability of occurrence (e.g., 50-yr. storm) and duration (e.g., 24-hour), and used in the planning and design of stormwater management control systems.

Detention Basin - A basin designed to retard stormwater runoff by temporarily storing the runoff and releasing it at a predetermined rate. Detention basins are designed to drain completely after a storm event.

Detention Time - The amount of time a parcel of water actually is present in a stormwater control facility. Theoretical detention time for a runoff event is the average time parcels of water residue in the basin over the period of release from the facility.

Diversion - A channel with a supporting ridge on the lower side instructed to a predetermined grade across or at the bottom slope, and designed to collect and divert surface runoff from slopes which are subject to erosion.

Easement - A right granted by a land owner to a grantee, allowing the use of private land for certain public, quasi-public or private purposes such as stormwater management.

Emergent Plants - Aquatic plants that are rooted in the sediment but whose leaves are at or above the water surface. These wetland plants often have high habitat value for wildlife and waterfowl, and can aid in pollutant uptake.

Eutrophication - The process of over-enrichment of water bodies by nutrients often typified by the presence of algal blooms.

Evaporation - The process by which a liquid is changed to a vapor or gas.

Evapotranspiration - The combined loss of water from a given area and during a specific period of time, by evaporation from the soil surface and by trans- piration from plants.

Event Mean Concentration (EMC) - The average concentration of an urban pollutant measured during a storm runoff event. The EMC is calculated by flow-weighting each pollutant sample measured during a storm event.

Filter Fabric - Textile of relatively small mesh or pore size that is used to (a) allow water to pass through while keeping sediment out (permeable), or (b) prevent both runoff and sediment from passing through (impermeable).

Filter Strips - Long, narrow strips of close-growing vegetation at the perimeter of disturbed or impervious areas which serve to intercept or retard sheet flows of surface runoff and/or collect sediment. Used often to protect other stormwater control facilities such as diversions, impoundments, etc.

First Flush - The delivery of a disproportionately large load of pollutants during the early part of storms due to the rapid runoff of accumulated pollutants. The first flush of runoff has been defined several ways (e.g., one-half inch per impervious acre).

Floodplain - The nearby level land area situated on either side of a channel which would be inundated temporarily by overflow waters caused by stormwater runoff equivalent to that which would occur from a rainfall of one hundred (100) year frequency.

Flow-Weighting - A statistical technique used to adjust a series of pollutant concentration measurements for the effect of flow.

Flume - A device constructed to convey water on steep grades lined with erosion-resistant materials.

Forebay - An extra storage area provided near an inlet of a stormwater control facility to trap incoming sediments before they accumulate in a pond facility.

Freeboard - A vertical distance between the elevation of the design highwater and the top of a dam, levee, tank, basin, or diversion ridge. The space is required as a safety margin in a pond or basin.

Frost-Heave - The upward movement of soil surface due to the expansion of ice stored between particles in the first few feet of the soil profile. May cause surface fracturing of asphalt or concrete.

Gabion - A large rectangular box of heavy gage wire mesh which holds large cobbles and boulders. Used in streams and ponds to change flow patterns, stabilize banks, or prevent erosion.

Grade - A slope, usually of a road, channel, or natural ground, specified in percent (%) and shown on plans as specified herein. (To) Grade - To finish the surface of a roadbed, top of embankment or bottom of excavation.

Grassed Waterway - A natural or constructed waterway, usually broad and shallow, covered with erosion-resistant grasses, used to conduct surface water from cropland.

Grid/Modular Pavement - Involves using a strong concrete structural material, having regularly interspersed void areas that are filled with pervious materials such as sod, gravel, or sand which allows infiltration of rain.

Groundwater Recharge - Replenishment of existing natural underground water supplies.
Hydraulic Gradient - The slope of the hydraulic grade line, i.e. the line joining points whose vertical distance from the center of the cross section of the fluid flowing in a pipe are proportional to the pressure in the pipe at that point.

Hydrograph - A graph showing for a given point on a stream or for a given point in any drainage system the discharge, stage (water depth), velocity, or other property of water with respect to time.

Impoundment - A retention or detention basin designed to retain stormwater runoff and release it at a controlled rate.

Infiltration - The flow of a liquid into a substance through pores or other openings, connoting flow into a soil in contradistinction to the word, percolation, which connotes flow through a porous substance. The infiltration capacity is expressed in terms of inches per hour.

Infiltration Pits/Trenches - An excavated area filled with sand and/or graded aggregates into which stormwater surface runoff is directed for infiltration into the ground.

Infiltration Structures - A structure designed to direct runoff into the ground, e.g. french drains, pits, trenches.

Inlet - A surface connection to a closed drain. A structure at the diversion end of a conduit. The upstream end of any structure through which water may flow.

Invert Elevation - The vertical elevation of a pipe or orifice in a pond which defines the water level.

Low Flow Channel - An incised or paved channel from inlet to outlet in a dry basin which is designed to carry low runoff flows and/or baseflow, directly to the outlet without detention.

Manning's Equation - An equation used to predict velocity of water flow in an open channel or pipelines:

$$V = \frac{1.486r^{2/3} S^{1/2}}{n}$$

where:
V = mean velocity of flow in feet per second (fps);
r = hydraulic radius in fee (ft.);
S = slope of the energy gradient or, for assumed uniform flow, the slope of the channel in feet per foot (ft./ft.); and
n = roughness coefficient or retardance factor of the channel lining

Nitrogen - Chemical element usually available as ammonium, nitrite, and nitrate ions, and certain simple amines for plant growth. A small fraction of organic or total nitrogen in the soil is available at any time.

Nutrients - Substances necessary for growth of algae or bacteria in water, such as nitrates and phosphates.

Outfall - Point where water flows from a conduit, stream, or drain.

Outlet - Point of water disposal from a stream, river, lake, tidewater, or artificial drain.

Overflow Rate - Detention basin release rate divided by the surface area of the basin. It can be thought of as an average flow rate through the basin.

Parking Lot Storage - Involves the use of impervious parking areas as temporary impoundments with controlled release rates during rainstorms.

Peak Discharge - The maximum instantaneous rate of flow (at a given point and time) resulting from a specified storm event.

Phosphorus - Inorganic element that is readily available for plant growth.

Porous Asphalt Pavement - Involves using a porous asphaltic paving material and a high-void aggregate base that allows infiltration of rain falling on paved surfaces.

Rational Formula - A rainfall - runoff relation used to estimate peak flow, expressed by the following formula:

$$Q = CIA$$

where: Q = peak runoff rate in cubic feet per second (cfs);
C = runoff coefficient;
I = design rainfall intensity in inches per hour (in/hr), lasting for a critical time, Tc;
Tc = time of concentration in hour (hrs.); and
A = drainage area in acres.

This methodology is applicable for computing small runoff volumes such as roof and driveway runoff flows required in the design of infiltration structures.

Release Rate - The rate of discharge in volume per unit time from a detention facility.
Residential Land Use - The use of land for dwelling units or rooming units, including single-family or two-family houses, multiple dwellings, boarding or rooming houses or apartments.

Retention Basin - A basin designed to retain stormwater runoff by having a controlled subsurface discharge system. Generally, its primary release of water is through ground infiltration. "Release" can also be via evaporation or, when warranted, via an emergency bypass.

Return Period - The average interval in years over which an event of a given magnitude can be expected to recur. For example, the twenty-five (25) year return period rainfall or runoff event would be expected to recur on the average once every twenty-five years. See "Storm Frequency".

Riparian - A relatively narrow strip of land that borders a stream or river, often coincides with the maximum water surface elevation of the 100 year storm.

Riprap - Broken rock, cobbles, or boulders placed on earth surfaces, such as the face of a dam or the bank of a stream, for protection against the action of water (waves); also applied to brush or pole mattresses, or brush and stone, or other similar materials used for soil erosion control and filtering of sediment.

Riser - A vertical pipe extending from the bottom of a pond that is used to control the discharge rate from the pond for a specified design storm.

Rooftop Detention - Temporary ponding and gradual release of stormwater falling directly onto flat roof surfaces by incorporating controlled-flow roof drains into building designs.

Sedimentation - The process by which solid material, both mineral and organic, is accumulated; transported, or deposited by moving wind, water, or gravity. Once this matter is deposited (or remains suspended in water), it is usually referred to as "sediment".

Sediment Basin - A barrier, dam, retention or detention basin designed to retain sediment.

Seepage Areas - Grass-covered areas that infiltrate stormwater runoff and allow particulate contaminants to settle.

Senescence - The annual die-back of aquatic plants at the end of the growing season.
Sheetflow - Runoff which flows over the ground surface as a thin, even layer, not concentrated in a channel.

Short Circuiting - The passage of runoff through a stormwater control facility in less than the theoretical or design treatment time.

Slope - The face of an embankment or cut section; any ground whose surface makes an angle with the plane of the horizon. Slopes are usually expressed in a percentage based upon vertical difference in feet per 100 feet of horizontal distance.

Soil-Cover Complex Method - A metal of runoff computation developed by SCS, and found in its publication "Urban Hydrology for Small Watersheds", Technical Release No. 55, SCS, January 1975, revised 1986. It is based upon relating soil type and land use/cover to a runoff parameter called a Curve Number and abbreviated as RCN.

Soil Group, Hydrologic - A classification of soils by the Soil Conservation Service into four runoff potential groups. The groups range from A soils, which are very permeable and produce little runoff, to D soils, which are not very permeable and produce much more runoff.

Soil Strata - The various horizontal layers of sedimentary rock (soil).

Sorption - The physical or chemical binding of pollutants to sediment or organic particles.

Spillway - A depression in the embankment of a pond or basin which is used to pass peak discharge greater than the maximum design storm controlled by the pond.

Storm Frequency - The number of times that a given storm "event" occurs or is exceeded on the average in a stated period of years. See "Return Period".

Storm Sewers - A system of pipes, conduits, swales, or other similar structures including appurtenant works which carries intercepted surface runoff, street water and other wash waters, or drainage, but excludes domestic sewage and industrial wastes.

Subgrade - A layer of stone or soil used as the underlying base for a stormwater control facility.

Substrate - The natural soil base underlying a stormwater control facility.

Suspended Solids - Solids either floating or suspended in water, sewage, or other liquid wastes and that are removable by filtering.

Swale - A wide shallow ditch or low-lying stretch of land characterized as a depression which gathers then temporarily stores, routes or filters surface water runoff.

Terrace - An embankment or combination of an embankment and channel across a slope to control erosion by diverting or storing surface runoff instead of permitting it to flow uninterrupted down the slope.

Time of Concentration (Tc) - The time for surface runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed. This time is the combined total of overland flow time and flow time in pipes or channels, if any.

TR-20 - A SCS methodology developed for evaluating the hydrologic response of a watershed to various rainfall conditions and land use development patterns using the soil-cover complex method. This methodology has been computerized for more efficient use.

TR-55 - A simplified procedure to calculate storm runoff volume, peak rate of discharge, hydrographs, and storage volumes required for floodwater reservoirs. The procedure is most applicable to small watersheds especially urban watersheds. The storage-routing curves and the graphical peak discharge and tabular hydrograph methods used by TR-55 are generalizations derived from TR-20 routings. The TR-55 procedure has been computerized for more efficient use.

Transpiration - The process by which vapor escapes from living plants and enters the atmosphere.

Travel Time - (Tt) - The time it takes water to travel from one location to another in a watershed. It is a component of time of concentration and includes overland flow travel time, reach (a pipe or channel) flow travel time, etc.

Watercourse - A stream of water; river; brook; creek; or a channel or ditch for water, whether natural or manmade. See "Channel".

Water Table - The upper surface of the free groundwater in a zone of saturation (indicates the uppermost extent of groundwater); locus of points in soil water at which hydraulic pressure is equal to atmospheric pressure.

PLATE 1

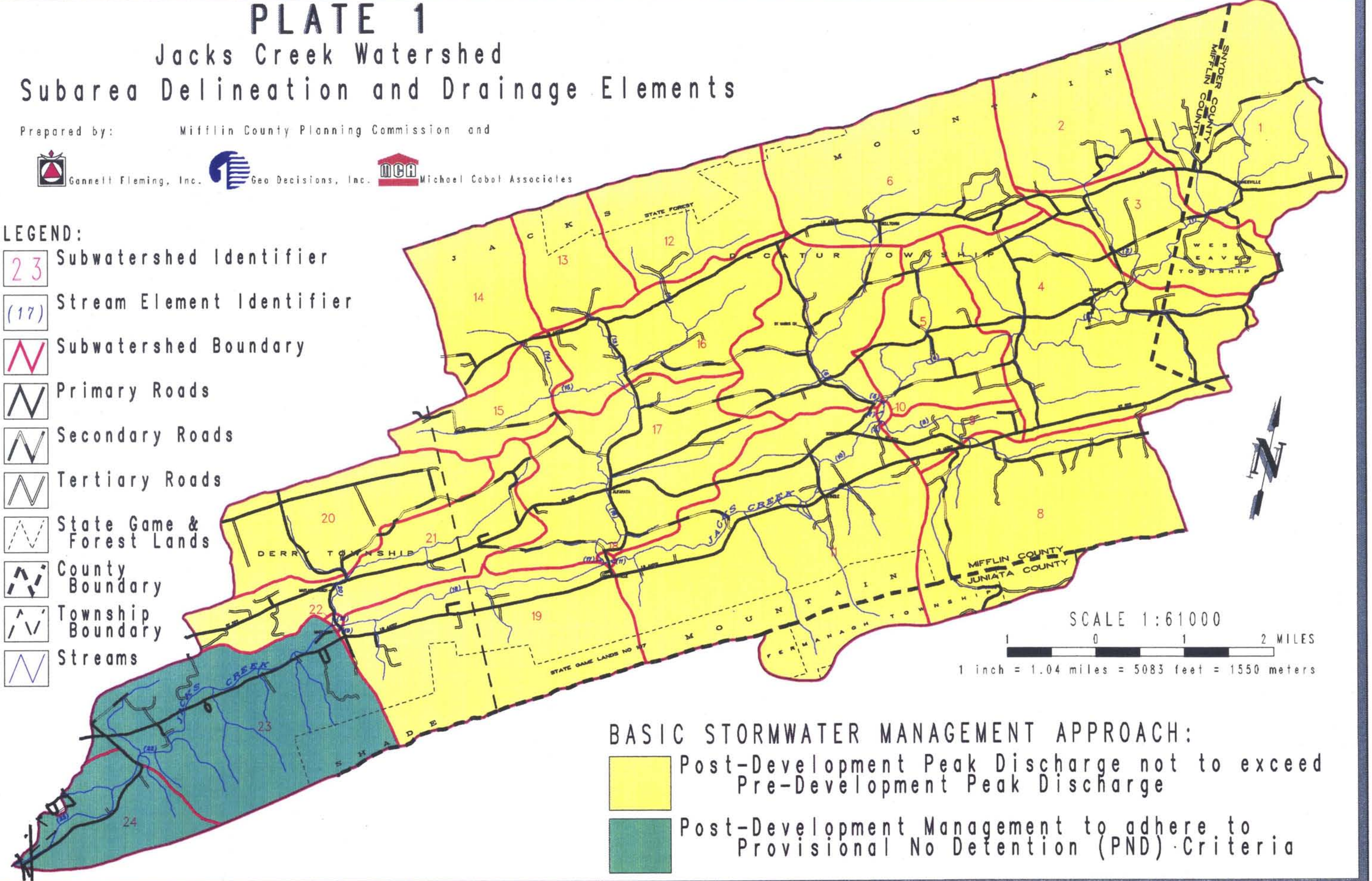
PLATE 1

Jacks Creek Watershed

Subarea Delineation and Drainage Elements

Prepared by: Mifflin County Planning Commission and

Gannett Fleming, Inc. Geo Decisions, Inc. Michael Cabot Associates



LEGEND:

23	Subwatershed Identifier
(17)	Stream Element Identifier
/\/	Subwatershed Boundary
/\/	Primary Roads
/\/	Secondary Roads
/\/	Tertiary Roads
/\/	State Game & Forest Lands
/\/	County Boundary
/\/	Township Boundary
/\/	Streams

SCALE 1:61000

1 0 1 2 MILES

1 inch = 1.04 miles = 5083 feet = 1550 meters

BASIC STORMWATER MANAGEMENT APPROACH:

🟨	Post-Development Peak Discharge not to exceed Pre-Development Peak Discharge
🟩	Post-Development Management to adhere to Provisional No Detention (PND) Criteria

Plotted with SMALLPL1.SML by GM 3/01/95

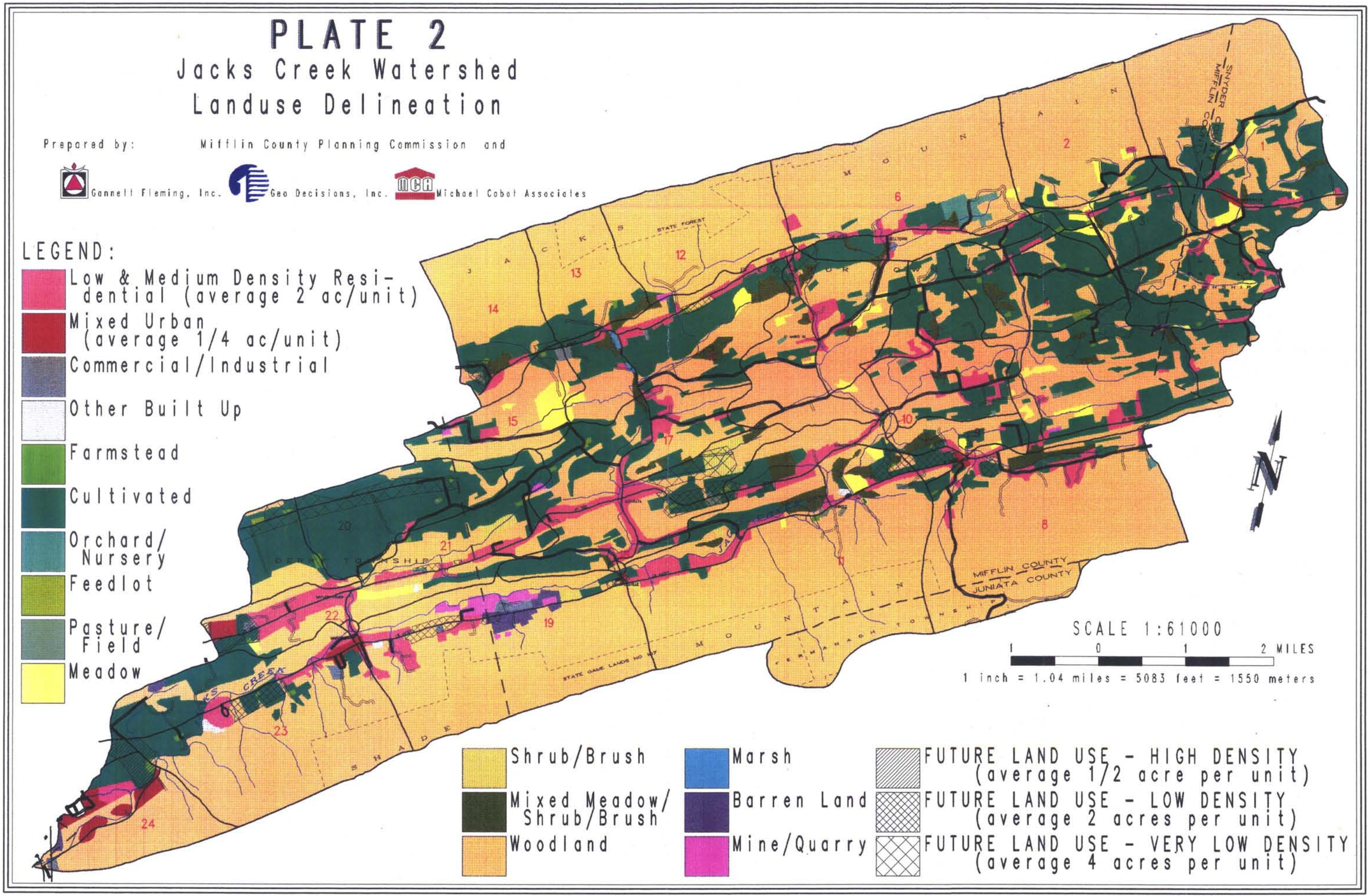
PLATE 2

PLATE 2

Jacks Creek Watershed
Landuse Delineation

Prepared by: Mifflin County Planning Commission and

Gannett Fleming, Inc. Geo Decisions, Inc. Michael Cabot Associates



Plotted with SMALLPL2.SML by GW 3/01/95

PLATE 3

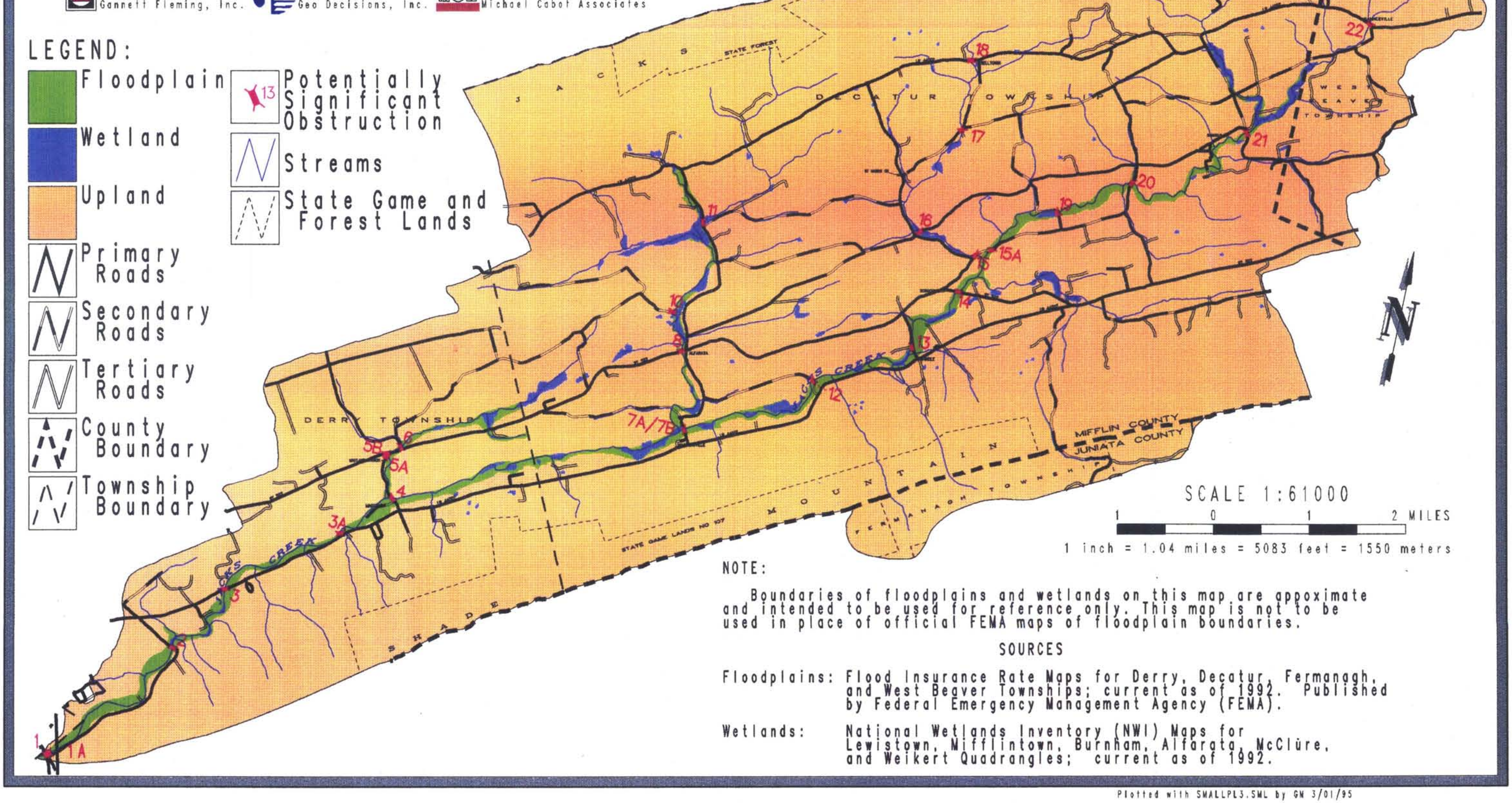
PLATE 3

Jacks Creek Watershed

Floodplain Delineation and Potentially Significant Obstruction Location

Prepared by: Mifflin County Planning Commission and

Gannett Fleming, Inc. Geo Decisions, Inc. Michael Cabot Associates



NOTE:

Boundaries of floodplains and wetlands on this map are appoximate and intended to be used for reference only. This map is not to be used in place of official FEMA maps of floodplain boundaries.

SOURCES

Floodplains: Flood Insurance Rate Maps for Derry, Decatur, Fermanagh, and West Beaver Townships; current as of 1992. Published by Federal Emergency Management Agency (FEMA).

Wetlands: National Wetlands Inventory (NWI) Maps for Lewistown, Mifflintown, Burnham, Alfarata, McClüre, and Weikert Quadrangles; current as of 1992.

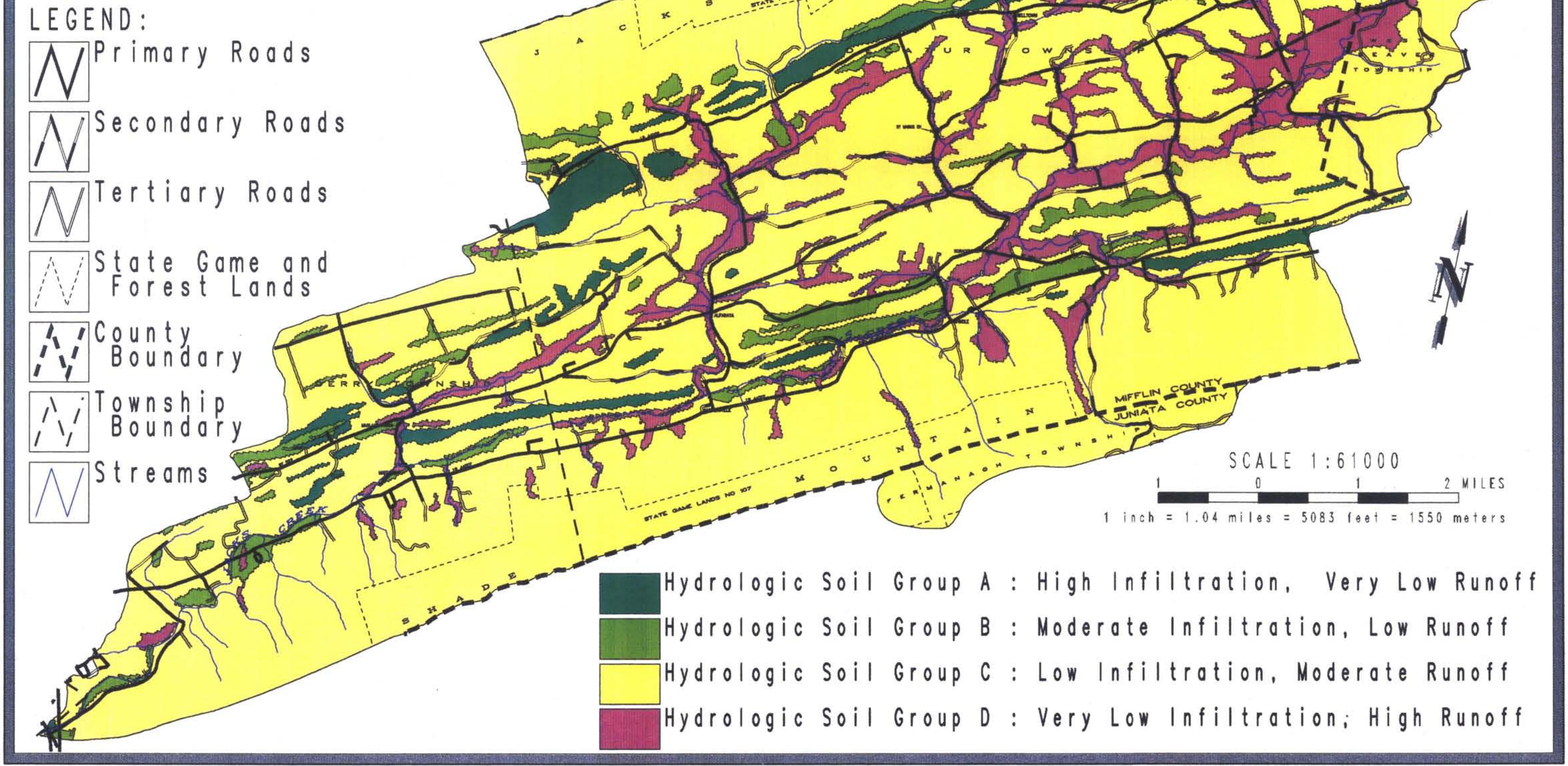
Plotted with SMALLPL3.SML by GM 3/01/95

PLATE 4

PLATE 4

Jacks Creek Watershed
Hydrologic Soil Group Distribution

Prepared by: Mifflin County Planning Commission and
Gannett Fleming, Inc. Geo Decisions, Inc. Michael Cobot Associates



Plotted with SMALLPL4.SML by GN 3/01/95