UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

Total Maximum Daily Load
Nutrient and Sediment
for the Unnamed Tributary to Brush Run
and Upper Portions of Brush Run
Allegheny and Washington Counties, Pennsylvania

/s/
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Water Protection Division

Date: 12/09/03

Nutrient and Sediment TMDL Development for the Unnamed Tributary to Brush Run and Upper Portions of Brush Run Allegheny and Washington Counties, Pennsylvania

December 2003

U.S. Environmental Protection Agency
Region 3
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Summary of the Brush Run TMDLs

1. These TMDLs were developed for: (1) the unnamed tributary to Brush Run; and (2) a portion of Brush Run, from its headwaters down to 0.9 miles from the confluence with Chartiers Creek, above the discharge point of Peters Township wastewater treatment plant. Brush Run is a tributary to Chartiers Creek (State Water Plan Subbasin 20F - Ohio River). The watershed is located in Allegheny and Washington Counties in western Pennsylvania. Portions of the Peters, Upper Saint Clair and Bethel Park townships form the watershed. The towns of Thompsonville and McMurray are located in this watershed. The entire Brush Run watershed falls within the Pittsburgh urbanized area, as designated by the 2000 Census. The mainstem of Brush Run flows for approximately 4.5 miles in a northwesterly direction to its confluence with Chartiers Creek just north of Thompsonville. Approximately 24.1 miles of streams drain the 10.0 square mile watershed. Protected stream uses in the watershed include aquatic life, water supply, and recreation. Brush Run and all of its tributaries are designated as Warm Water Fishes (WWF) under §93.9w in Title 25 of the Pa. Code (Commonwealth of Pennsylvania, 2001).

2. Both the unnamed tributary and the portion of Brush Run identified above, along with the 0.9 mile portion of Brush Run just upstream of the confluence with Chartiers Creek, were listed on Pennsylvania's 1996 Section 303(d) list. TMDLs for the Brush Run watershed were developed to address use impairments caused by suspended solids and nutrients. Pennsylvania's 1996 Section 303(d) list identified 0.4 miles of an unnamed tributary and 0.9 miles of its main stem as being impaired due to nutrients and suspended solids. The impairments were attributed to urban runoff and storm sewers. Field visits conducted by the Department of Environmental Protection (PADEP) in November 2002 identified agricultural areas in the headwaters of the watershed as possible sources of nutrients and sediment. In addition, stream bank erosion due to increased impervious area was identified as a source of sediment during this assessment. Sediment and total phosphorus TMDLs were developed for these stream segments. The TMDLs address suspended solids and nutrient impairments. In order to ensure attainment and maintenance of water quality standards in this portion of the Brush Run watershed, mean annual loading of sediment and total phosphorus will need to be limited to 224,348 and 786.7 lbs/yr, respectively.

   The major components of these TMDLs are summarized below:

Component	Sediment (lbs/yr)	Total Phosphorus (lbs/yr)
TMDL (Total Maximum Daily Load)	224,348	786.7
MOS (Margin of Safety)	22,435	78.7
WLA (Wasteload Allocation)	201,913	252.8
LA (Load Allocation)	0	455.3

3. The current mean annual sediment loading to the upper portion of Brush Run is estimated to be 604,360 lbs/yr. A 67% reduction is needed for the stream to meet the TMDL. Mean annual total phosphorus loading is estimated to be 834.2 lbs/yr and will require a 15% reduction to meet the TMDL.

4. Waste Load Allocations (WLA) for sediment and total phosphorus were assigned to the Peters, Upper Saint Clair and Bethel Park township for storm sewers that serve each municipality. Surface runoff loads from the following sources were included in the waste load allocations for these storm sewers: hay

and pasture lands, croplands, coniferous forest, mixed forest, deciduous forest, transitional land, low intensity development and high intensity development. Loads from stream bank erosion were also included in the WLA portion of the TMDL due to its direct relationship to surface runoff. Of these sources, the ones receiving reductions are: hay and pasture, cropland, and streambank erosion. Load Allocations (LA) were assigned to groundwater and septic systems. These sources were not reduced.

5. Allocations to sediment sources receiving reductions (hay/pasture, cropland, and stream bank erosion) total 189,890 lbs/yr. Sediment loadings from the remaining sources (loads not reduced) were maintained at 12,020 lbs/yr. Allocations to phosphorus sources receiving reductions (hay/pasture and cropland) add up to 81.0 lbs/yr. Total phosphorus loadings from all other sources were maintained at 627.0 lbs/yr. Allocations of sediment and total phosphorus by source in the Brush Run watershed are summarized below:

Allocations for Sources of Sediment			
Source	**Current Loading (lbs/yr)**	**Allocation (lbs/yr)**	**% Reduction**
Hay and Pasture	15,260	7,335	52%
Cropland	194,320	91,277	53%
Stream Bank Erosion	382,760	91,277	76%
Loads Not Reduced	12,020	12,020	-
Total	**604,360**	**201,910**	**67%**

Allocations for Sources of Total Phosphorus			
Source	**Current Loading (lbs/yr)**	**Allocation (lbs/yr)**	**% Reduction**
Hay and Pasture	44.1	28.5	35%
Cropland	163.1	52.5	68%
Loads Not Reduced	627.0	627.0	-
Total	**834.2**	**708.0**	**15%**

6. The three townships were assigned WLAs for their relative contribution of surface runoff and streambank erosion loads. The loads were distributed by source based on land use areas. The remaining loads, namely from groundwater and septic systems, were assigned to the LA component of the TMDL. The following table shows the distribution of the WLAs by responsible party, and the LAs by source:

Component / Source	Sediment (lbs/yr)	Phosphorus (lbs/yr)
WLAs	**201,913**	**252.8**
Peters Township	175,384	200.2
Upper Saint Clair Township	23,419	47.1
Bethel Park Township	3,107	5.6
LAs	**0**	**455.3**
Groundwater	0	447.7
Septic Systems	0	7.5
WLA + LA	**201,913**	**708.0**

7. Ten percent of the Brush Run sediment and total phosphorus TMDLs were set aside as a margin of safety (MOS). The MOS is that portion of the pollutant loading that is reserved to account for any uncertainty in the data and computational methodology used for the analysis. The MOS for the sediment TMDL and the MOS for the total phosphorus TMDL were set at 22,435 lbs/yr and 78.7 lbs/yr, respectively.

8. The continuous simulation model used for developing the Brush Run TMDLs considers seasonal variation through a number of mechanisms. Daily time steps are used for weather data and water balance calculations. The model requires specification of the growing season and hours of daylight for each month. The model also considers the months of the year when manure is applied to the land. The combination of these actions accounts for seasonal variability.

I. Introduction

A. Watershed Description

The TMDL applies to the upper portions of the Brush Run watershed, from the headwaters of the unnamed tributary of Brush Run and Brush Run down to 0.9 miles from the confluence with Chartiers Creek, just above the discharge point of Peters Township wastewater treatment plant. This subwatershed will hereafter be referred to as the Brush Run watershed. The Brush Run watershed is located in Allegheny and Washington Counties in western Pennsylvania. Portions of the Peters, Upper Saint Clair and Bethel Park townships comprise the watershed (Figure 1). The towns of Thompsonville and McMurray are located in the watershed. The entire Brush Run watershed falls within the Pittsburgh urban area, as designated by the 2000 Census. Brush Run is a tributary of Chartiers Creek. It is considered part of the Lower Chartiers Watershed. Brush Run flows for approximately 4.5 miles in a northwesterly direction to its confluence with Chartiers Creek just north of Thompsonville. Approximately 24.1 miles of streams drain the 10.0 square mile watershed.

B. Topography & Geology

The watershed is in the Waynesburg Hills Section of the Appalachian Plateaus Physiographic Province. The dominant topographic form of this section is narrow valleys, high hills and steep slopes. Surface elevations range from 396 to 274 meters above sea level. The drainage pattern is dendritic. The primary soil associations are Gilpin-Dormont-Gulleoka (81%) and Dormont-Culleoka-Guernsey (19%). Table 1 presents a description of the soil series found in the Brush Run watershed. The dominant hydrologic soil group in the watershed is C, described by Natural Resource and Conservation Service as soils having slow infiltration rates when thoroughly wetted.

Table 1 - Soil Series Characteristics

SOIL SERIES	DRAINAGE CLASS	PARENT MATERIAL
Dormont	Moderately Well Drained	Shale, siltstone, and limestone residuum
Culleoka	Well Drained	Limestone, sandstone, siltstone, and shale medium
Guernsey	Moderately Well Drained	Clay shale, siltstone, and limestone residuum
Gilpin	Well Drained	Shale and fine grained sandstone residuum

Rock types in the Brush Run watershed are 100% interbedded sedimentary. The primary geologic unit in the Brush Run watershed is the Monongahela Group. This group is found along streambed and adjacent areas of Brush Run. The group consists of primarily of limestone, and also consists of shale, sandstone, and coal. Some of the tributaries of Brush Run, and the upper reaches of Brush Run, flow through the Waynesboro Formation, which primarily consists of sandstone, but also consist of shale, limestone, and coal. The highest elevations in the watershed are made up of the Washington Formation. This formation primarily consists of sandstone, but also consist of shale, limestone, and coal.

C. Land Use

Farms varying in size from 175 to 450 acres were the original land use in the Brush Run watershed. At the beginning of the 20^{th} century, these small farming communities began to turn into suburban communities. The most rapid growth occurred during the 1950's and 1960's. A large part of the Brush Run watershed is presently residential. There are cornfields on a few small tracts of land in the upper reaches of Brush Run. In addition, the headwaters of Brush Run originate and flow through a large horse farm, Empress Arabians. The current land use distribution is 46% Forests, 13% Cropland, 13% Hay/Pasture, 28% Low Intensity Development, and 1% High Intensity Development.

D. Surface Water Quality

Pennsylvania's 1996 Section 303(d) list identified Brush Run and one tributary as impaired from nutrients and suspended solids due to urban runoff and storm sewers (Table 2). A total of 0.7 miles were attributed to nutrients and 0.6 miles from suspended solids. This TMDL report addresses the unnamed tributary of Brush Run originally listed on the 1996 Section 303(d) list as well as that portion of Brush Run beginning 0.9 miles upstream of its confluence with Chartiers Creek and extending to Brush Run's headwaters. This is one portion of the Brush Run water quality limited segment originally identified on Pennsylvania's 1996 Section 303(d) list.

As part of PADEP's Unassessed Waters Program, now the Surface Waters Assessment Program, Brush Run was assessed in 1997. The surveys consisted of a habitat assessment, field identification of benthic macroinvertebrates to the family level, and field measurements of the following parameters: pH, temperature, dissolved oxygen, and conductivity. *Gammarus*, or scuds, dominated the macroinvertebrate population. Hydropsychid caddisflies and Chironomids (red midges and others) were the second and third most abundant organisms found. No stoneflies were collected in the entire watershed. Two out of twelve stations had one sensitive mayfly present, heptageniidae and leptophlebiidae. The habitat scores were consistently low for riparian zones, grazing, conditions of banks, and bank vegetation. Several stations also had low scores for riffle frequency, sediment deposition, embeddedness, and epifaunal substrate.

The information collected during these surveys identified aquatic life use impairments for the entire Brush Run watershed. The additional listings for the 1998 Section 303(d) list include 22.59 miles for turbidity, siltation, and nutrients from habitat modifications and 9.47 miles of siltation, turbidity, suspended solids, and flow alterations from construction activities (Table 3).

Table 2 - 1996 Section 303(d) Listings for Brush Run Watershed						
1996 Section 303(d) LIST						
STREAM NAME	**STREAM CODE**	**DATA SOURCE**	**SOURCE CODE**	**CAUSE CODE**	**MILES**	**SWP**
Brush Run	36873	305(b) Report	Urban Runoff / Storm Sewers	Nutrients	0.4	20-F
Brush Run	36873	305(b) Report	Urban Runoff / Storm Sewers	Suspended Solids	0.5	20-F
UNT Brush Run	36938	305(b) Report	Urban Runoff / Storm Sewers	Nutrients	0.3	20-F
UNT Brush Run	36938	305(b) Report	Urban Runoff / Storm Sewers	Suspended Solids	0.1	20-F

Table 3 - 1998 Section 303(d) Listings for Brush Run Watershed					
1998 Section 303(d) LIST					
STREAM NAME	**SEGMENT ID**	**DATA SOURCE**	**SOURCE CODE**	**CAUSE CODE**	**MILES**
Brush Run	971006-1315-ALF	SWWAP	Habitat Modification	Turbidity	2.47
			Habitat Modification	Siltation	
			Habitat Modification	Nutrients	
Brush Run	971006-1440-ALF	SWWAP	Habitat Modification	Turbidity	1.19
			Habitat Modification	Nutrients	
Brush Run	971007-1000-ALF	SWWAP	Habitat Modification	Nutrients	3.74
			Habitat Modification	Siltation	
Brush Run	971007-1120-ALF	SWWAP	Habitat Modification	Nutrients	2.01
			Habitat Modification	Siltation	
Brush Run	971007-1300-ALF	SWWAP	Habitat Modification	Nutrients	4.91
			Habitat Modification	Siltation	
			Construction	Siltation	
			Construction	Turbidity	
Brush Run	971007-1430-ALF	SWWAP	Habitat Modification	Siltation	1.56
			Habitat Modification	Nutrients	
			Habitat Modification	Turbidity	

Table 3 - 1998 Section 303(d) Listings for Brush Run Watershed					
1998 Section 303(d) LIST					
Brush Run	971009-0930-ALF	SWWAP	Construction	Turbidity	1.91
			Construction	Siltation	
			Habitat Modification	Habitat Alterations	
			Habitat Modification	Nutrients	
Brush Run	971009-1030-ALF	SWWAP	Habitat Modification	Habitat Alterations	1.09
			Habitat Modification	Nutrients	
			Habitat Modification	Turbidity	
Brush Run	971009-1200-ALF	SWWAP	Habitat Modification	Habitat Alterations	1.77
			Habitat Modification	Organic Enrichment	
Brush Run	971010-1145-ALF	SWWAP	Habitat Modification	Habitat Alterations	1.58
			Habitat Modification	Nutrients	
			Habitat Modification	Turbidity	
Brush Run	971010-1300-ALF	SWWAP	Habitat Modification	Turbidity	0.36
			Habitat Modification	Siltation	
			Habitat Modification	Nutrients	
Brush Run	971010-1430-ALF	SWWAP	Construction	Turbidity	2.65
			Construction	Siltation	
			Construction	Habitat Alterations	
			Construction	Flow Alterations	
			Construction	Suspended Solids	

Figure 1 - Brush Run Watershed

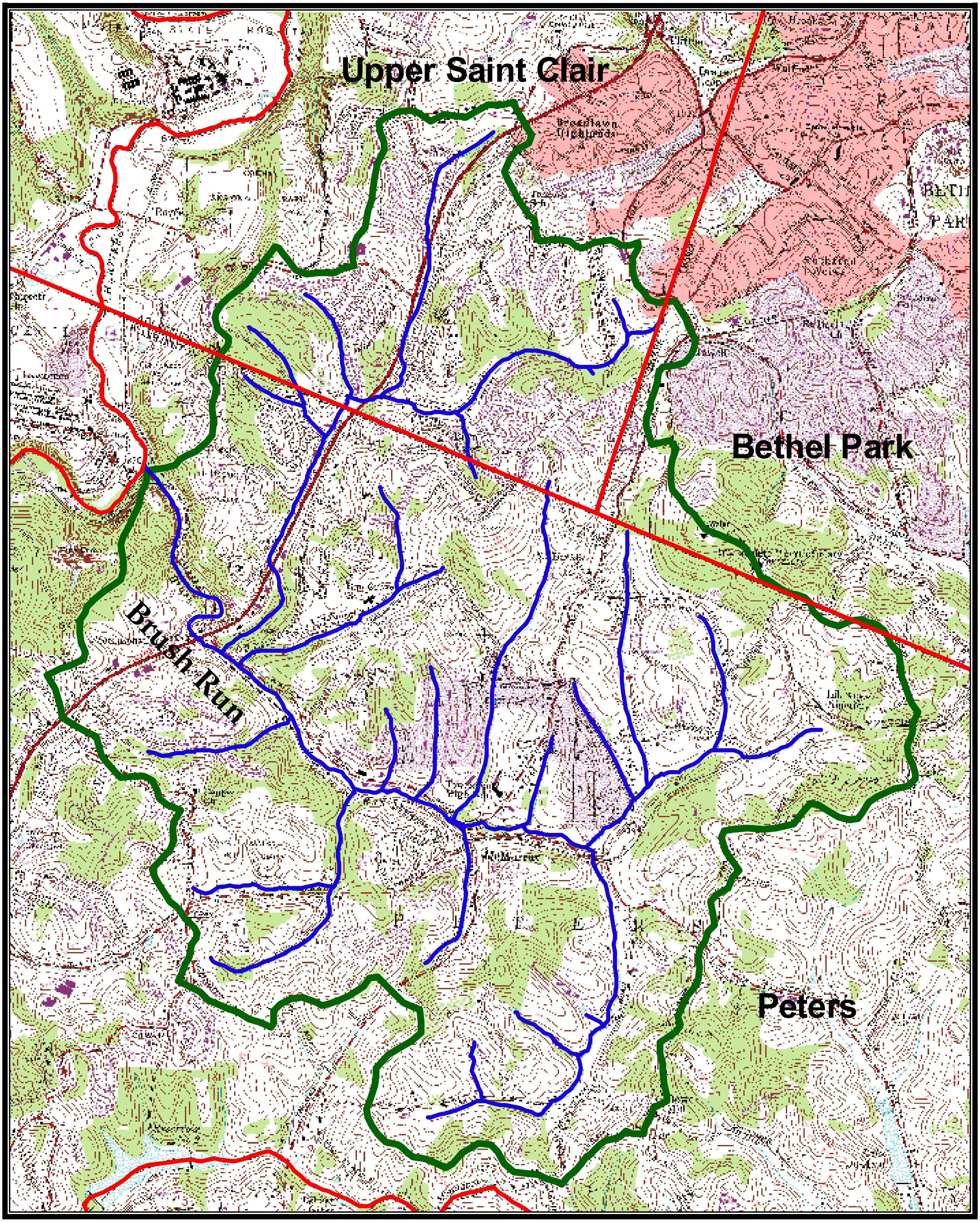
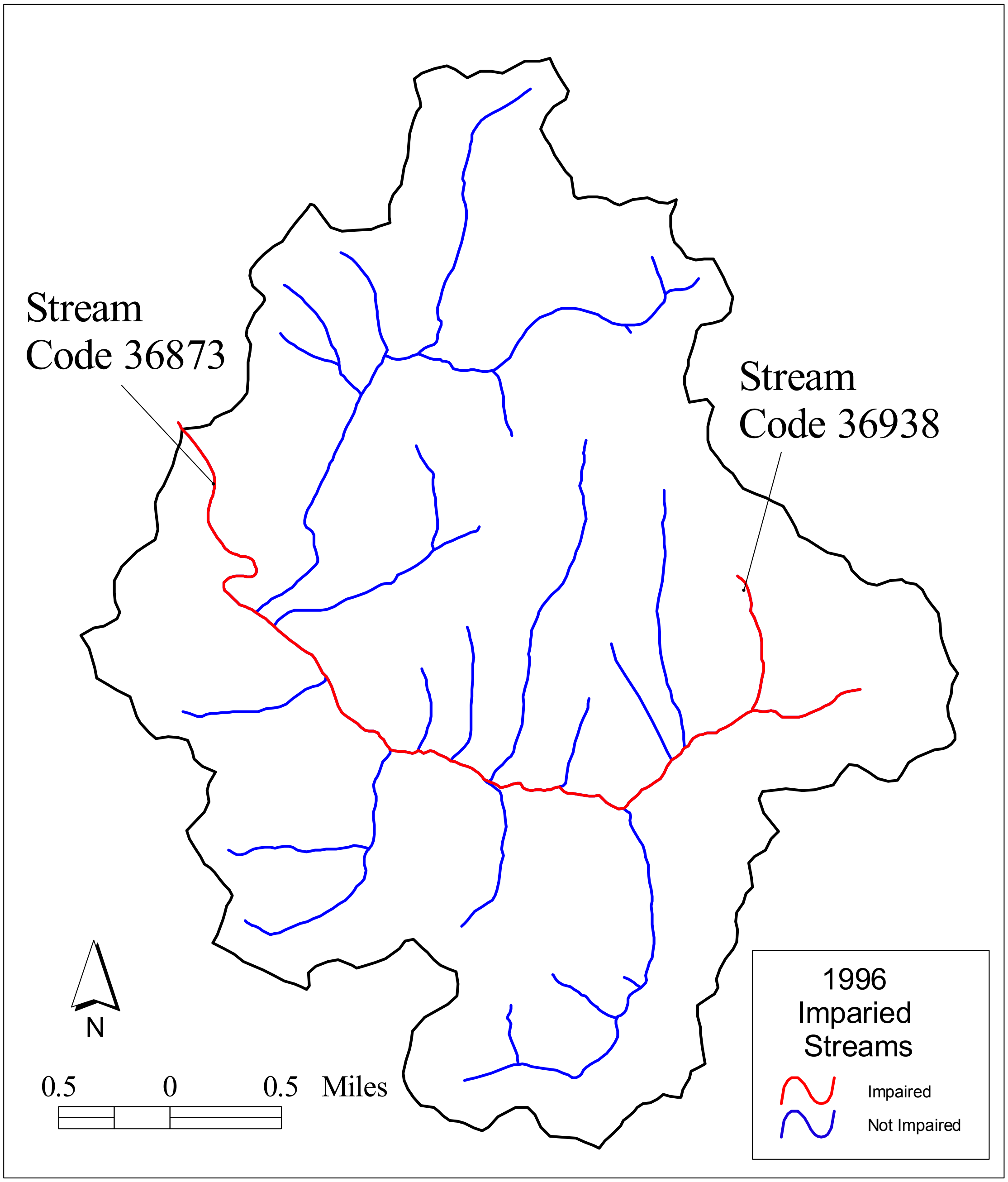


Figure 2 - Stream Segments on the 1996 Section 303(d) List - Brush Run Watershed



II. Approach to TMDL Development

A. Pollutants & Sources

Nutrients and siltation have been identified as the pollutants causing designated aquatic life use impairments in the Brush Run watershed. Assessments conducted by PADEP in 1997 documented designated aquatic life use impairments for the entire watershed, including the main stem and its numerous unnamed tributaries. Urban runoff/storm sewers, habitat modification, and construction were identified as sources of the nutrients and siltation impairments during these assessments.

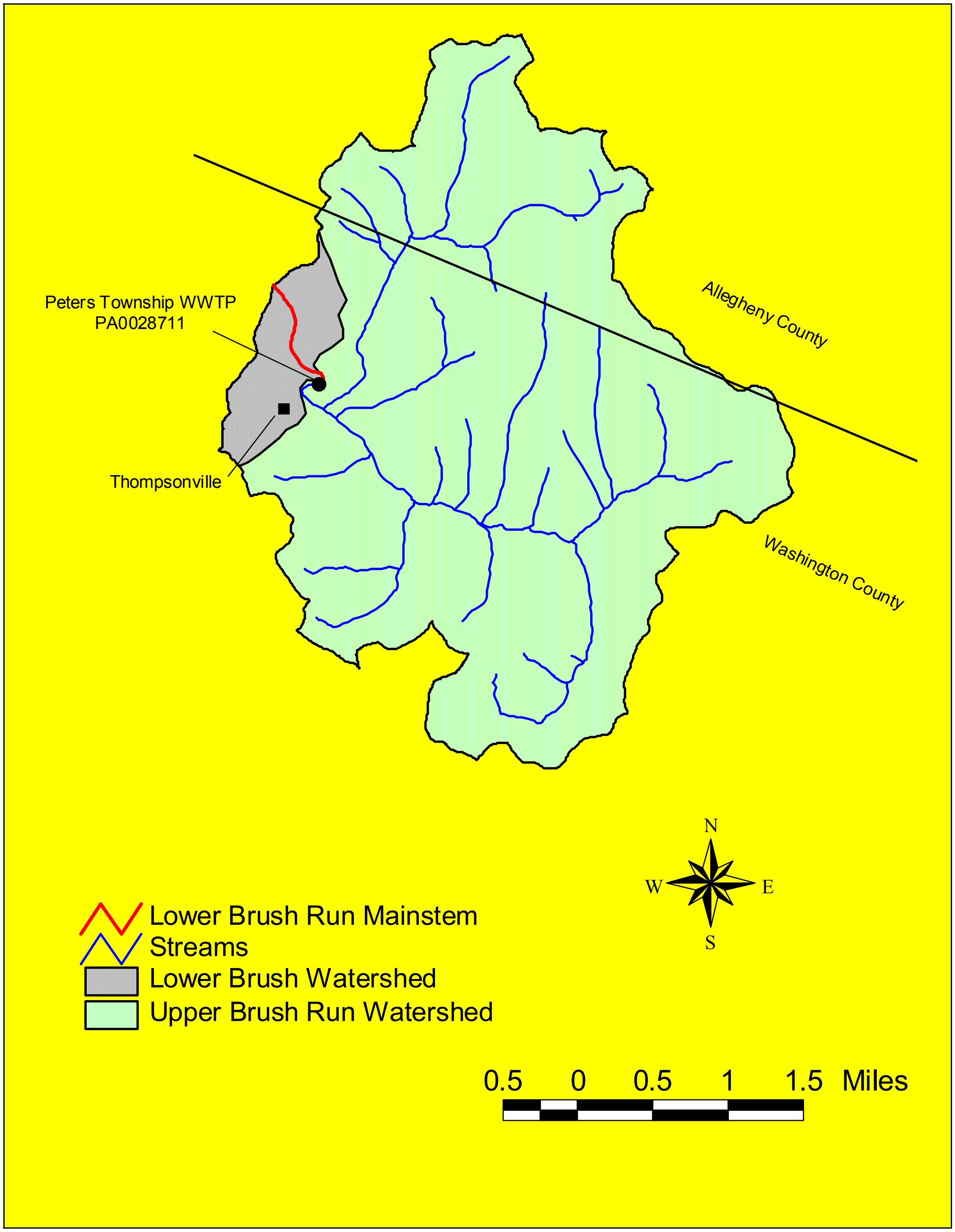
Additional assessments conducted by PADEP in November 2002 identified agricultural areas in the headwaters of the watershed as possible sources nutrients and sediment. Improperly managed agricultural activities may impact surface water by contributing nutrients and sediment. Improper fertilizer management can contribute nutrients from excessive use of either commercial fertilizer or manure, improper application methods or timing, or inadequate BMPs to minimize leaching or runoff. Row-crop production can also increase the sediment load because exposed soil is more susceptible to wind and water erosion.

There are livestock present in the watershed. The area of the watershed listed as pasture is assumed as being utilized for pasturing livestock. When animals are allowed continuous, unrestricted access to streams and lakes, manure ends up in the water and riparian vegetation may be severely damaged. Exposed, compacted soil is more susceptible to erosion and is more difficult to re-vegetate. Manure from livestock operations away from the water's edge may also cause problems if it is not properly contained and managed. When animals are confined in feeding areas, vegetation is usually limited and manure is concentrated. During storm events this material might find its way to the streams by means of surface runoff.

Stream bank erosion due to increased impervious area was also identified as a source of sediment in the Brush Run watershed. An increase in impervious surface in a watershed results in greater frequency of higher velocity runoff events. The increased frequency of higher flows results in the modification of the stream channel in an effort of that stream channel to become stable. The most evident repercussion of this stream channel adjustment is the increased erosion on the outside of bends and the subsequent deposition of sediment on the downstream inside of bends.

Water quality impairments from nutrients and sediment are mainly attributed to sources including urban runoff/storm sewers, habitat modification, and construction, though wastewater may also be a potential source. Population within the watershed is estimated to be 10,000 to 15,000. The watershed is largely on public sewer, but there are approximately 50 on-lot septic systems located within the watershed. This TMDL will address the impairments in the Unnamed Tributary of Brush Run and the Brush Run mainstem upstream of the Peters Township wastewater treatment facility. A TMDL addressing the lower main stem of Brush Run shown in Figure 3 will be developed by EPA in the near future.

Figure 3 - Brush Run lower mainstem



B. TMDL Endpoints

In an effort to address nutrient and siltation impairments found in the Brush Run watershed, Total Maximum Daily Loads (TMDLs) were developed for sediment and total phosphorus. The sediment TMDL was developed to address siltation impairments. The total phosphorus TMDL is intended to address nutrient impairments. The decision to use phosphorus load reductions to address nutrient impairments was based on an understanding of the relationship between nitrogen, phosphorus, and organic enrichment in stream systems. Elevated nutrient loads (nitrogen and phosphorus, in particular) can lead to increased productivity of plants and other organisms (Novotny and Olem, 1994). In aquatic ecosystems, the quantities of trace elements are typically plentiful; however, nitrogen and phosphorus may be in short supply. The nutrient that is in the shortest supply is called the limiting nutrient because its relative quantity affects the rate of production (growth) of aquatic biomass. If the limiting nutrient load to a water body can be reduced, the available pool of nutrients that can be utilized by plants and other organisms will be reduced and, in general, the total biomass can subsequently be decreased as well (Novotny and Olem, 1994). In most efforts to control the eutrophication processes in water bodies, emphasis is placed on the limiting nutrient. This is not always the case, if nitrogen is the limiting nutrient, it still may be more efficient to control phosphorus loads if the nitrogen originates from sources that are difficult to control like nitrates in ground water.

In most freshwater systems, phosphorus is the limiting nutrient for aquatic growth. In some cases, however, the determination of which nutrient is the most limiting is difficult. For this reason, the ratio of the amount of nitrogen to the amount of phosphous (N/P) is often used to make this determination (Thomann and Mueller, 1987). If the N/P ratio is less than 10, nitrogen is limiting. If the N/P ratio is greater than 10, phosphorus is the limiting nutrient. For the Brush Run watershed, the N/P ratio is estimated to be near 32, which points to phosphorus as the limiting nutrient. Controlling the phosphorus loading to these waters will limit plant growth, thereby helping to eliminate use impairments currently being caused by excess nutrients.

C. Reference Watershed Approach

The TMDLs for the Brush Run watershed were developed to address excessive sediment and phosphorus loadings to the stream. Neither EPA nor Pennsylvania has developed instream numeric water quality criteria for sediment or phosphorus. Therefore a method was developed to implement the narrative standard. The method employed for these TMDLs is termed the "Reference Watershed Approach." Meeting the water quality objectives specified by these TMDLs will result in the impaired stream segments attaining their designated uses.

The Reference Watershed Approach compares two watersheds, one attaining its uses and one that is impaired based on biological assessments. Both watersheds must have similar land use/cover distributions. Other features such as base geologic formation should be matched to the extent possible; however, most variations can be adjusted in the modeling process. The objective of this approach is to reduce the loading rate of pollutants in the impaired stream segment to a level equivalent to, or slightly lower than, the loading rate in the non-impaired, reference segment. This load reduction will result in conditions favorable to the return of a healthy biological community to the impaired stream segments.

D. Selection of the Reference Watershed

In general, three factors are considered when selecting a suitable reference watershed. The first factor is to use a watershed that PADEP has assessed and determined to be attaining water quality standards. The second factor is to find a watershed that closely resembles the impaired watershed in physical properties such as land cover/land use, physiographic province, and geology. Finally, the difference in the size between the reference watershed and the impaired watershed should not be greater than 20-30%. The search for a reference watershed for Brush Run that would satisfy the above characteristics was done by means of a desktop screening using several geographic information system (GIS) coverages, including the Multi-Resolution Land Characteristics (MRLC), Landsat-derived land use/cover grid, geologic rock types, and the Pennsylvania's 305(b) assessed streams database.

The Deer Creek watershed, in Allegheny County, was selected as the reference watershed for developing the TMDLs for the unnamed tributary and the upper portion of Brush Run (Figure 3). Deer Creek watershed's protected uses include aquatic life, water supply, and recreation. Deer Creek is currently designated as Warm Water Fishes (WWF) under §93.9f in Title 25 of the Pa. Code (Commonwealth of Pennsylvania, 2001). Based on PADEP's 305(b) report database, the upper portion of Deer Creek is currently attaining its designated uses. The attainment of designated uses is based on sampling completed by PADEP using the Unassessed Waters program protocol.

The Deer Creek Watershed was assessed in 1997. The surveys consisted of a habitat assessment, field identification of benthic macroinvertebrates to the family level, and field measurements of the following parameters: pH, temperature, dissolved oxygen, and conductivity. The information collected during these surveys identified the upper reaches of the Deer Run Watershed as attaining its uses. The habitat assessments conducted at two stations in the watershed were excellent. The main stem of Deer Creek contained a variety of aquatic insects, particularly mayflies and stoneflies. The other station, located on an unnamed tributary, also supports a variety of aquatic macroinvertebrates including dragonflies, fishflies, and snipe flies.

Drainage area, location, and other physical characteristics of the Brush Run watershed were compared to the Deer Creek watershed and are shown in Table 4. The Deer Creek watershed closely resembles the Brush Run watershed upstream of the sewage treatment plant in terms of drainage area, geology, soils associations and hydrologic soil groups. There appears to be different hydrologic conditions downstream of that point, as the bottom 0.9 miles of Brush Run (which is not within the scope of this TMDL) experiences much higher flows and is influenced significantly by the Peters Township sewage treatment plant.

The geology of the streambed and valley of the Deer Creek watershed primarily consists of the Glenshaw Formation. This formation consists of shale, in addition to sandstone, limestone, and coal. The upper regions of the watershed consist of the Casselman Formation, which is made up of shale, siltstone, sandstone, coal, and limestone. The Allegheny Formation is found in the tip of the watershed. This formation is made up of sandstone along with shale, and some limestone, clay, and coal. The geology of Brush Run watershed is described in Section I. C.

The dominant soil group of both watersheds is C, which is defined as soils having slow infiltration rates when thoroughly wetted. The ratio of average runoff to average rainfall is 17% higher in the Brush Run watershed upstream of the discharge than the Deer Creek watershed. Figure 4 shows the land use distribution of both watersheds, and Appendix I presents the definitions of the land use categories. The major difference between the watersheds is their percentage of developed area. The Deer Creek watershed has a significantly smaller amount of developed area than the Brush Run watershed. The impervious areas of the Brush Run watershed were considered a cause of the increased surface flows, and thus, increased stream bank erosion in Brush Run.

Table 4 - Comparison Between Brush Run and Deer Creek Reference Watershed

ATTRIBUTE	WATERSHED	
	Brush Run	**Deer Creek**
Physiographic Province	Appalachian Plateaus Province (Waynesburg Hills Section)	Appalachian Plateaus Province (Pittsburgh Low Plateau Section)
Area (mi^2)	10.0	7.1
Land Use	Agriculture (26%) Forested (46%) Developed (28%)	Agriculture (28%) Forested (68%) Developed (4%)
Geology	Interbedded Sedimentary (100%)	Interbedded Sedimentary (100%)
Soils	Gilpin-Dormont-Culleoka (81%) Dormont-Culleoka-Guernsey (19%)	Gilpin-Wharton-Weikert (82%) Gilpin-Dormont-Culleoka (19%)
Dominant HSG	C	C
23-Year Average Rainfall (in)	37.4	39.8
23-Year Average Runoff (in)	1.79	1.63

Figure 4 - Locations of Brush Run Watershed and Deer Creek Reference Watershed

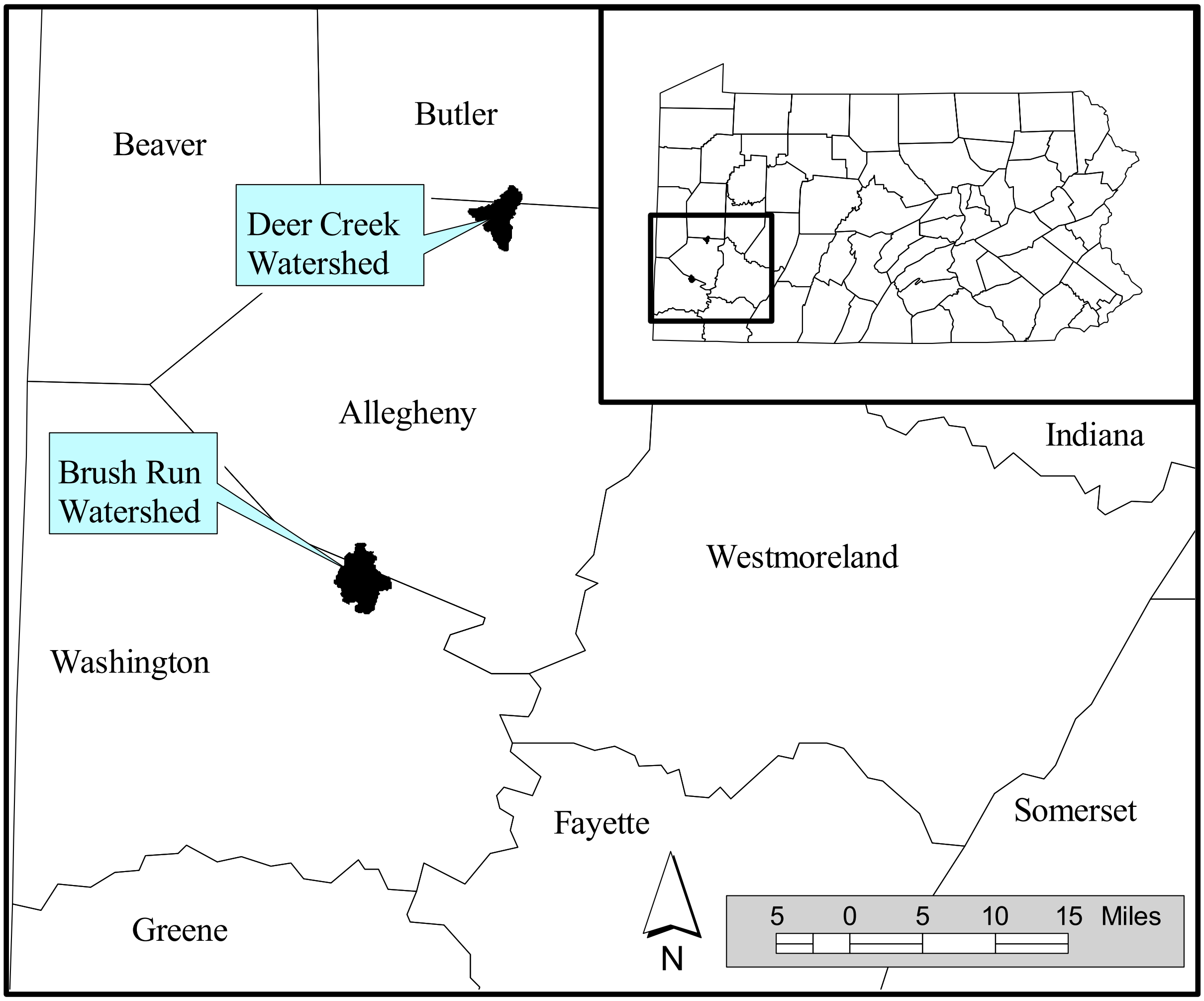
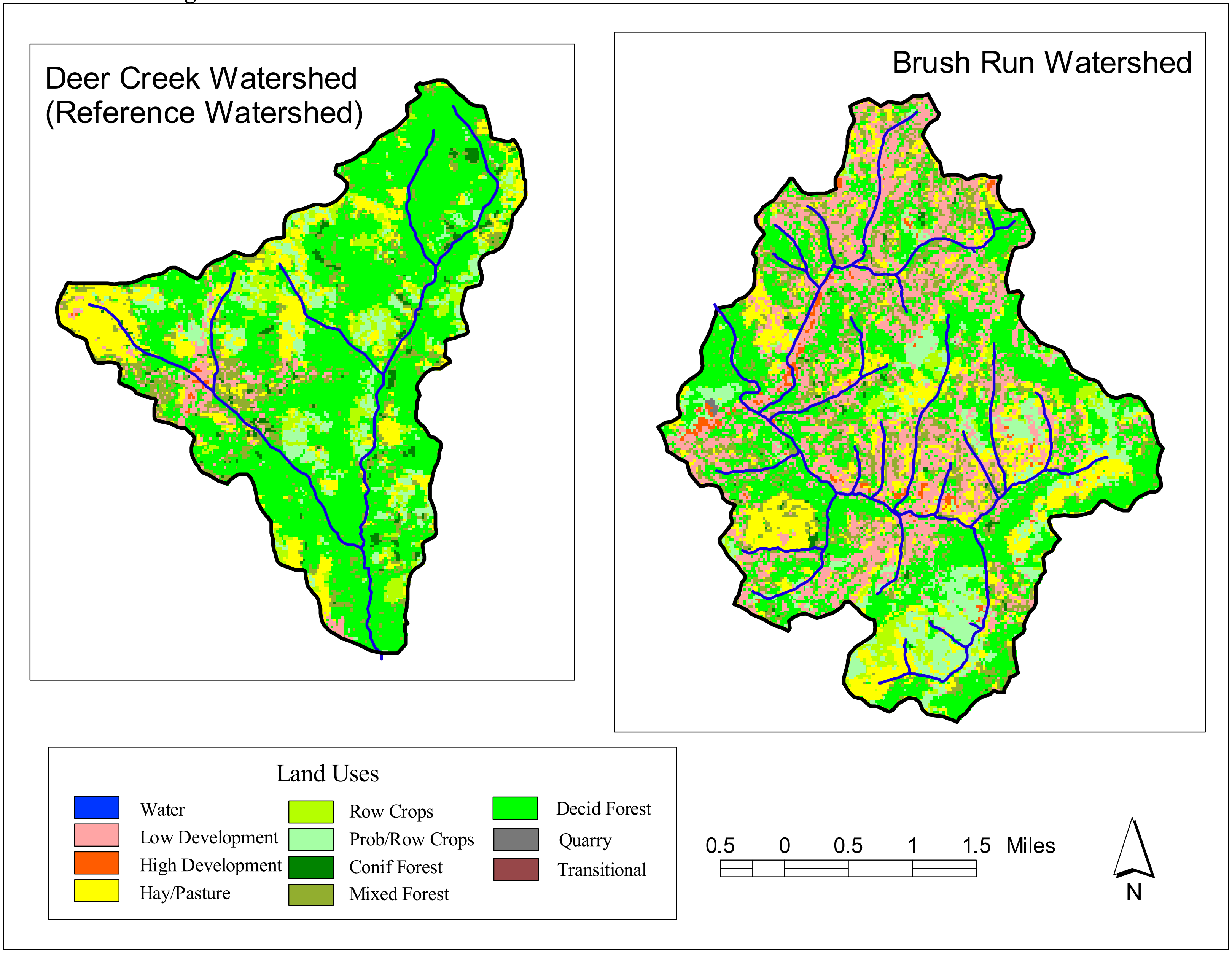


Figure 5 - Land Uses for Brush Run Watershed and Deer Creek Reference Watershed



III. Watershed Assessment and Modeling

TMDLs for the Brush Run watershed were developed using the ArcView Generalized Watershed Loading Function (AVGWLF) model. Appendix B provides and overview of the AVGWLF model, including a description of the Revised Universal Soil Loss Equation, and the GIS-based derivation of input data. The AVGWLF model was calibrated for the state of Pennsylvania using data from representative watersheds throughout the state. The reader is referred to AVGWLF for further details of the application of the model.

The AVGWLF model was used to establish existing loading conditions for the Brush Run watershed and the Deer Creek reference watershed. The Pittsburgh weather station was used in the model. Daily time steps are used for weather data and water balance calculations, and monthly calculations are made for sediment and nutrient loads, based on the daily water balance accumulated to monthly values. The model requires specification of the growing season and hours of daylight for each month. The model also considers the months of the year when manure is applied to the land.

PADEP staff visited the Brush Run and Deer Creek watersheds in November 2002. These field visits were conducted to get a better understanding of existing conditions that might influence the AVGWLF model. Figures 5 to 12 show examples of the observations made during the visit to Brush Run watershed.

Significant differences were observed between the Brush Run and Deer Creek watersheds. First, there is far more impervious surface in the Brush Run watershed than in the Deer Creek watershed. Also, the Brush Run watershed is more densely populated than the Deer Creek watershed and the houses were not as close to the stream banks of Deer Creek as in the Brush Run watershed. Also, roads follow Brush Run almost its entire length, while Deer Creek has several sections without road access. Overall, there is noticeably less bank erosion and sediment deposition on Deer Creek than on Brush Run.

There are poor farming practices in the steep headwaters of the Brush Run watershed. This leads to high sediment and nutrients loads that are easily transported to the stream channels. A tributary in the headwaters of Brush Run has cropping and steep slopes that are not vegetated, and erosion gullies are visible in the fields. The headwaters of Deer Creek have a llama farm that is well fenced. The stream does not travel through the center of the farm, as with the farm at the headwaters of the Brush Run watershed. All corn fields in the Deer Creek watershed have a buffer zone that allows filtering of runoff.

Minor adjustments were made to specific parameters used in the AVGWLF model based on observations made while touring the watershed.

Figure 6 - Typical of the armored banks necessary to convey high water events without causing damage to roads.

Figure 7 - Increased water velocity and increased bank scour results in the undercutting of trees.

Figure 8 - Typical incised bank on the outside of a turn in the stream due to high flow bank scour.

Figure 9 - Eroded bank and sediment impacted stream channel.

Figure 10 - Surface film in the headwaters of Brush Run.

Figure 11 - Field drain from uncertain source.

Figure 12 - Example of development on steep slopes with little or no runoff controls or retention.

Figure 13 - Gullies are present in covered cropland on steep slopes in the headwaters of Brush Run.

The AVGWLF model produced information on watershed size, land use, sediment loading, and total phosphorus loading (Table 5 and 6). Modeling outputs have been attached to this TMDL as Appendices C and D. The sediment and total P loads represent an annual average over the 23-year period simulated by the model (April 1975 to March 1998). This information was then used to calculate existing unit area loading rates for the land uses of the Brush Run and Deer Creek reference watersheds. There are different loading rates associated with each land use as a result of the different practices occurring on these lands.

Note that the Brush Run watershed downstream of the sewage treatment plant, although not addressed in this TMDL, experiences hydrologic conditions largely different that that of the reference Deer Creek watershed. These differences strongly impact the method of analysis which is appropriate in this bottom reach, which why these two portions of Brush Run are being addressed separately.

Unit area loading rates for sediment and total phosphorus were estimated for each watershed by dividing the mean annual loadings (lbs/yr) by the total area (acres). Unit area load estimates for sediment and total phosphorus in the Brush Run watershed are 94.5 lbs/acre/yr and 0.13 lbs/acre/yr, respectively (Table 5). Unit area load estimates for sediment and total phosphorus in the Deer Creek reference watershed are 35.1 lbs/acre/yr and 0.12 lbs/acre/yr, respectively (Table 6).

Table 5 - Existing Sediment and Total Phosphorus Loads for the Brush Run Watershed

		Sediment		Total Phosphorus	
Pollutant Source	**Area (ac)**	**Mean Annual Loading (lbs/yr)**	**Unit Area Loading (lbs/ac/yr)**	**Mean Annual Loading (lbs/yr)**	**Unit Area Loading (lbs/ac/yr)**
Hay/Pasture	813.0	152,600	18.77	44.1	0.05
Cropland	835.2	194,320	232.66	163.1	0.20
Conifer Forest	37.1	20	0.54	0.1	0.00
Mixed Forest	825.3	1,020	1.24	1.6	0.00
Deciduous Forest	2,073.2	5,940	2.87	5.7	0.00
Quarry	9.9	4,260	430.30	2.0	0.20
Low Intensity Development	1,744.6	780	0.45	73.1	0.04
High Intensity Development	59.3	0	0.00	0.4	0.01
Stream bank	--	382,760	--	88.8	--
Groundwater	--	--	--	447.7	--
Point Sources	--	--	--	0.0	--
Septic Systems	--	--	--	7.5	--
Total	**6,397.6**	**604,360**	**94.47**	**834.2**	**0.13**

Table 6 - Existing Sediment and Total Phosphorus Loads for the Deer Creek Reference Watershed					
		Sediment		**Total Phosphorus**	
Pollutant Source	**Area (ac)**	**Mean Annual Loading (lbs/yr)**	**Unit Area Loading (lbs/ac/yr)**	**Mean Annual Loading (lbs/yr)**	**Unit Area Loading (lbs/ac/yr)**
Hay/Pasture	568.3	8,360	14.71	35.3	0.06
Cropland	724.0	127,660	176.33	133.5	0.18
Conifer Forest	74.1	20	0.27	0.1	0.00
Mixed Forest	417.6	340	0.81	0.8	0.00
Deciduous Forest	2,611.9	4,640	1.78	6.4	0.00
Low Intensity Development	163.1	20	0.12	0.2	0.00
High Intensity Development	9.9	0	0.00	0.0	0.00
Stream bank	--	19,180	--	4.2	--
Groundwater	--	--	--	362.5	--
Point Sources	--	--	--	0.0	--
Septic Systems	--	--	--	18.8	--
Total	**4,568.9**	**160,220**	**35.07**	**561.8**	**0.12**

IV. TMDLs

Targeted TMDL values for the Brush Run watershed were established based on current loading rates for sediment and total phosphorus in the Deer Creek reference watershed. The entire lengths of both Brush Run and Deer Creek are currently designated as Warm Water Fishes - maintenance and propagation of fish species and additional flora and fauna, which are indigenous to a warm water habitat. Recent assessments have determined that Deer Creek is attaining its designated uses. Reducing the loading rates of sediment and total phosphorus in the Brush Run basin to levels equal to, or less than, the Deer Creek reference watershed will provide conditions favorable for the reversal of current use impairments.

A. Background Pollutant Conditions

There are two separate considerations of background pollutants within the context of these TMDLs. First, the reference watershed approach inherently assumes that, because of the similarities between the reference and impaired watershed, the background pollutant contributions of both will be similar. Therefore, the background pollutant contributions will be considered when determining the loads for the impaired watershed that are consistent with the loads from the reference watershed. Second, the AVGWLF model implicitly considers background pollutant contributions through the soil and the groundwater component of the model process.

B. Targeted TMDL

Targeted TMDL values for sediment and total phosphorus were determined by multiplying the total area of the Brush Run watershed by the appropriate unit area loading rates for the Deer Creek reference watershed (Table 7).

Table 7 - Targeted TMDLs for the Brush Run Watershed

Pollutant	Area (ac.)	Unit Area Loading Rate Deer Creek Ref. Watershed (lbs/ac./yr)	Targeted TMDL (lbs/yr)
Sediment	6,397.6	35.1	224,348.0
Total P	6,397.6	0.12	786.7

Targeted TMDL values were used as the basis for allocations and reductions in the Brush Run watershed, using the following equation:

$$\text{TMDL} = \Sigma\ \text{WLA} + \Sigma\ \text{LA} + \text{MOS}$$

where:

TMDL = Total Maximum Daily Load
Σ = Summation Symbol
WLA = Waste Load Allocation (point sources)
LA = Load Allocation (nonpoint sources)
MOS = Margin of Safety

C. Margin of Safety

The margin of safety (MOS) is that portion of the pollutant loading that is reserved to account for any uncertainty in the data and computational methodology used for the analysis. For this analysis, the MOS is explicit. Ten percent of the targeted TMDLs for sediment and total phosphorus were reserved as the MOS. Using 10% of the TMDL load is based on professional judgment and will provide an additional level of protection to the designated uses of Brush Run. The MOS for the sediment TMDL and the MOS for the total phosphorus TMDL were set at 22,435 lbs/yr and 78.7 lbs/yr, respectively.

MOS (Sediment) = 224,348 lbs/yr (TMDL) x 0.1 = 22,435 lbs/yr
MOS (Phosphorus) = 786.7 lbs/yr (TMDL) x 0.1 = 78.7 lbs/yr

D. Wasteload and Load Allocations

The waste load allocation (WLA) portion of the TMDL equation is the total loading of a pollutant that is assigned to point sources. In this watershed, the storm sewer discharges are considered as point sources of the parameters of concern. EPA's stormwater permitting regulations require municipalities to obtain permit coverage for all storm water discharges from separate storm sewer systems (MS4s). Because the entire Brush Run watershed is part of the Pittsburgh urbanized area, and for lack of clearly defined Municipal Separate Storm Sewer System (MS4s) drainage areas, the entire watershed is therefore assumed to be subject to MS4 storm water permits. The responsible parties are the townships of Peters, Upper Saint Clair and Bethel Park. The following sources were included in the waste load allocations: hay and pasture lands, croplands, coniferous forest, mixed forest, deciduous forest, transitional land, low intensity development; high intensity development. In addition, since the cause of the flow variability that results in streambank erosion is related to urban runoff, the sources of the impairments are considered point sources under the MS4 stormwater permits. Stormwater permits and their relationship to TMDLs are discussed further in Section VII.

The load allocation (LA) is that portion of the TMDL that is assigned to nonpoint sources. Since surface runoff and streambank erosion are subject to WLAs, only groundwater and septic systems are assigned a LA. After setting aside the MOS, a total of 201,913 lbs/yr of sediment are available for the wasteload and load allocations. Respectively, there are 786.7 lbs/yr of total phosphorus available for the wasteload and load allocations.

WLA + LA (Sediment) = 224,348 lbs/yr (TMDL) – 22,435 lbs/yr (MOS) = 201,913 lbs/yr
WLA + LA (Phosphorus) = 786.7 lbs/yr (TMDL) – 78.7 lbs/yr (MOS) = 708.0 lbs/yr

E. Adjusted Allocation

The adjusted allocation (AA) is the actual portion of the wasteload and load allocations distributed among those sources receiving reductions. It is computed by subtracting the loads from sources that are not being considered for reductions (loads not reduced or LNR) from the sum of WLAs and LAs. Since the Brush Run watershed TMDLs were developed to address impairments resulting from agricultural activities and urban areas, agriculture related sources and stream bank erosion due to increased flow from impervious surfaces were considered for reductions. Reductions were applied to hay/pasture, cropland, and stream bank erosion sources for both sediment and total phosphorus. Those land uses/sources for which existing loads were not reduced (Coniferous Forest, Mixed Forest, Deciduous Forest, Quarry, Low Intensity Development, High Intensity Development, Groundwater, and Septic Systems) were carried through at their existing loading values (Table 8). Note that load reductions were not necessary for areas of low or high intensity development due to their relatively insignificant sediment contributions. Although quarries have the highest loading rate, load reductions were not considered because their overall load contribution is only 0.7% of the total sediment load in the Brush Run watershed. The adjusted allocations for sediment and phosphorus were 189,893 lbs/yr and 81.0 lbs/yr, respectively.

Table 8 - Adjusted Allocations and Loads Not Reduced for Brush Run TMDLs		
	Sediment (lbs/yr)	**Total Phosphorus (lbs/yr)**
WLA + LA	**201,913**	**708.0**
Loads Not Reduced (LNR)	**12,020**	**627.0**
Conifer Forest	20	0.1
Mixed Forest	1,020	1.7
Deciduous Forest	5,940	5.7
Quarry	4,260	2.0
Low Intensity Development	780	73.1
High Intensity Development	0	0.4
Stream bank	*(Reduced for Sediment)*	88.8
Groundwater	--	447.7
Point Sources	--	0.0
Septic Systems	--	7.5
Adjusted Allocation = (WLA + LA) - LNR	**189,893**	**81.0**

F. Calculation of Sediment and Nutrient Load Reductions

Adjusted allocations established in the previous section represent the sediment and total phosphorus loads that are available for allocation between contributing sources in the Brush Run watershed. Data needed for load reduction analyses, including land use distribution, were obtained by GIS analysis. The Equal Marginal Percent Reduction (EMPR) allocation method (Appendix E) was used to distribute the AA between the appropriate contributing sources.

The EMPR procedures were performed using a spreadsheet analysis and results are presented in Appendix F. Table 11 contains the results of the EMPR for sediment and total phosphorus for the appropriate contributing land uses in Brush Run watershed. The load allocation for each land use is shown, along with the percent reduction of current loads necessary to reach the targeted TMDL.

Table 9 - Sediment and Phosphorus Loading Allocations & Reductions for the Brush Run Watershed						
Sediment						
Pollutant Source	**Acres**	**Unit Area Loading Rate (lbs/ac./yr)**		**Pollutant Loading (lbs/yr)**		**% Reduction**
		Current	**Allowable**	**Current**	**Allowable Loadings**	
Hay/Pasture	813.0	19	9	15,260	7,335	52%
Cropland	835.2	233	109	194,320	91,277	53%
Stream Bank	-	-	-	382,760	91,277	76%
Total				**592,340**	**189,890**	**68%**
Total Phosphorus						
Pollutant Source	**Acres**	**Unit Area Loading Rate (lbs/ac./yr)**		**Pollutant Loading (lbs/yr)**		**% Reduction**
		Current	**Allowable**	**Current**	**Allowable Loadings**	
Hay/Pasture	813.0	0.054	0.035	44.07	28.54	35%
Cropland	835.2	0.195	0.063	163.12	52.47	68%
Total				**207.19**	**81.01**	**61%**

G. Calculation of Individual Waste Load and Load Allocations

To determine the WLA assigned to each municipality, the loads from those sources receiving WLAs were assigned evenly, based on the percentage of the particular land use in that falls in the section of the watershed under the individual township jurisdiction. For streambank erosion loads, the total area of the township section was used. Appendix C shows the percentage of each land use per township, along with the corresponding load. Table 10 presents a summary of the WLAs and LAs by type and/or responsible party.

Table 10 - Wasteload and Load Allocations		
Component / Source	**Sediment (lbs/yr)**	**Total Phosphorus (lbs/yr)**
WLAs	**201,913**	**252.8**
Peters Township	175,384	200.2
Upper Saint Clair Township	23,419	47.1
Bethel Park Township	3,107	5.6
LAs	**0**	**455.3**
Groundwater	0	447.7
Septic Systems	0	7.5
WLA + LA	**201,913**	**708.0**

H. TMDLs

The total phosphorus and sediment TMDLs established for the Brush Run watershed consists of a Wasteload Allocation (WLA), a Load Allocation (LA) and a Margin of Safety (MOS). No TMDL was established for nitrogen because the stream is phosphorus-limited. The individual components of the TMDLs are summarized in Table 11.

Table 11 - TMDL, WLA, MOS and LA for Brush Run 0.9 miles above the confluence with Chartiers Creek		
Component	**Sediment (lbs/yr)**	**Total Phosphorus (lbs/yr)**
TMDL (Total Maximum Daily Load)	224,348	786.7
MOS (Margin of Safety)	22,435	78.7
WLA (Wasteload Allocation)	201,913	252.8
LA (Load Allocation)	0	455.3

Table 11 shows the components of the TMDL for Unnamed Tributary to Brush Run 0.9 miles upstream the confluence with Chartiers Creek, just above the discharge of the Peters Township wastewater treatment plant. The unit-area loading rates for individual sources established for the TMDL conditions of Brush Run were applied to drainage area of Unnamed Tributary to Brush Run to obtain its TMDL. Appendix G presents the TMDL calculations for the Unnamed Tributary to Brush Run.

Table 12 - TMDL, WLA, MOS and LA for Unnamed Tributary to Brush Run		
Component	**Sediment (lbs/yr)**	**Total Phosphorus (lbs/yr)**
TMDL (Total Maximum Daily Load)	6,491	24.76
MOS (Margin of Safety)	649	2.48
WLA (Wasteload Allocation)	5,842	7.55
LA (Load Allocation)	0	14.74

V. Consideration of Critical Conditions

The AVGWLF model is a continuous simulation model, which uses daily time steps for weather data and water balance calculations. Monthly calculations are made for sediment and nutrient loads, based on the daily water balance accumulated to monthly values. Therefore, various flow conditions (low flow, average flow, and are taken into account for loading calculations. Because there is generally a significant lag time between the introduction of sediment and nutrients to a waterbody and the resulting impact on beneficial uses, establishing these TMDLs using average annual conditions is protective of the waterbody.

VI. Consideration of Seasonal Variations

The continuous simulation model used for this analysis considers seasonal variation through a number of mechanisms. Daily time steps are used for weather data and water balance calculations. The model requires specification of the growing season and hours of daylight for each month. The model also considers the months of the year when manure is applied to the land. The combination of these actions by the model accounts for seasonal variability.

VII. Reasonable Assurance and Recommendations for Implementation

There is reasonable assurance that the goals of this TMDL can be met with proper watershed planning, aggressive implementation of storm water flow and pollutant reduction best management practices (BMPs), and strong political and financial mechanisms. Reasonable assurance that the TMDLs established for sediment will require a comprehensive, adaptive approach that addresses:

- point and nonpoint source pollution,
- existing and potential future sources,
- regulatory and voluntary approaches.

TMDLs represent an attempt to quantify the pollutant load that may be present in a waterbody and still ensure attainment and maintenance of water quality standards. The Brush Run TMDLs identify the necessary overall load reductions for those pollutants currently causing use impairments and distribute those reduction goals to the appropriate nonpoint sources. Reaching the reduction goals established by these TMDLs will only occur through changes in current land use practices, including the incorporation of more best management practices (BMPs). BMPs that would be helpful in lowering the amount of sediment and nutrients reaching Brush Run include stream bank fencing, riparian buffer strips, strip cropping, contour plowing, conservation crop rotation, and heavy use area protection, among many others.

The Natural Resources Conservation Service maintains a National Handbook of Conservation Practices (NHCP), which provides information on a variety of BMPs. The NHCP is available online at http://www.ncg.nrcs.usda.gov/nhcp_2.html. Many of the practices described in the handbook could be used on agricultural lands in the Brush Run watershed to help limit siltation and nutrient impairments. Determining the most appropriate BMPs, where they should be installed, and actually putting them into practice, will require the development and implementation of a comprehensive watershed restoration plan. Development of any restoration plan will involve the gathering of site-specific information regarding current land uses and existing conservation practices. The required level of detail is outside the scope of this TMDL document and is an activity best accomplished at the local level. Successful implementation of the activities necessary to address current use impairments to Brush Run will require local citizens taking an active interest in the watershed and the enthusiastic cooperation of local landowners.

By developing TMDLs for the Brush Run watershed, the stage has been set for local citizens to design and implement restoration plans to correct current use impairments. PADEP will support local efforts to develop and implement watershed restoration plans based on the reduction goals specified in the TMDLs. Interested parties should contact the appropriate Watershed Manager in PADEP's Southcentral Regional Office (717-705-4700) for information regarding technical and financial assistance currently available. Individuals and/or local watershed groups interested in helping to solve the identified problems in the Brush Run watershed are strongly encouraged to avail themselves of funding sources available through DEP and other state and federal agencies (e.g., Growing Greener or 319 Program).

The relative contribution of sediment and phosphorous varies throughout the watershed according to the distribution of land uses between urbanized and other sources, such as agriculture, and the amount of impervious cover in the watershed. Instream bank erosion is the most significant contributor. Therefore, reductions in the sediment and phosphorus entrained in overland flow must be accompanied by substantial reductions in the volume of water delivered to the stream in order to achieve the water quality objectives of the TMDL. Efforts must also be taken to control future potential sources of sediment and stormwater as new construction and redevelopment occurs. Because of the complexity of the problem and the potential solutions, an adaptive approach will be needed to achieve the TMDLs.

Pennsylvania's Approach to Control Stormwater

Both regulatory and nonregulatory approaches will be needed to achieve the necessary load reductions. Pennsylvania's program is being constructed to integrate State requirements under Act 167 for stormwater management planning, Federal requirements for permitting through the National Pollutant

Discharge Elimination System (NPDES) program, and voluntary financial incentives provided to communities and project sponsors. Pennsylvania also recently adopted a *Comprehensive Stormwater Management Policy* (September 28, 2002).

Pennsylvania's Comprehensive Stormwater Management Policy

Stormwater management was identified as a priority in Pennsylvania during 15 water forums held throughout the State during 2001. As a result, DEP proposed a compressive stormwater management policy to more fully integrate post-construction stormwater planning requirements, emphasizing the use of ground water infiltration and volume and rate control best management practices (BMPs), into the National Pollutant Discharge Elimination System (NPDES) permitting program. The Policy also emphasizes the obligation under Pennsylvania's water quality standards (25 Pa. Code Section 93.4a) for stormwater management programs to maintain and protect existing uses and the level of water quality necessary to protect those uses.

Pennsylvania's Stormwater Management Act of 1978 (Act 167)

In Pennsylvania, Act 167 requires each county to develop plans for each of its watersheds within its boundaries. This would be an excellent mechanism to properly plan watershed improvement projects in the Brush Run. The watershed covered by an Act 167 Plan may cover a number of municipalities and could also cross county boundaries. Act 167 Plans must include provisions for improved water quality, groundwater recharge, post-construction storm water control standards, and stream bank protection strategies in addition to other storm water controls. In addition, a community must enact, administer, and enforce storm water ordinances within six months of PADEP's approval of the Act 167 Plans. Since 1985, Pennsylvania has beenauthorized to provided grants to counties up to 75% of costs of preparing the plans. Funds also authorized to provide municipalities with grants for implementation.

The Act 167 regulations specify that stormwater management plans be undertaken in two phases: Phase I, preparation of the Scope of Study; and Phase II, the actual plan preparation. Participation in Act 167 to date has been limited and most existing plans were developed to address flooding and not water quality. Pennsylvania is hopeful that participation in the program will increase now that more than 700 communities in Pennsylvania will need to have stormwater management plans in place to meet NPDES Program requirements. As of February 2003, 84 Act 167 plans have been completed by 46 counties, requiring 764 municipalities to implement ordinances. Also, 35 plans by 21 counties are underway (498 municipalities). To receive DEP approval, Act 167 plans must include water quality, groundwater recharge, post-construction stormwater control standards, and stream bank protection strategies in addition to stormwater quantity control. A community must enact, administer, and enforce its stormwater ordinances within six months of DEP approval. An Act 167 plan has not yet been prepared for the Brush Run watershed. Several benefits can accrue to communities who pursue Act 167 planning. As stated earlier, State funds are available for plan development. In addition, once a community has enacted its stormwater ordinances, the community may be eligible for PENNVEST Low Interest Loans to correct existing stormwater drainage problems. Projects may include transport, storage and infiltration of stormwater and best management practices to address point or nonpoint source pollution associated with stormwater.

Phase II Stormwater Permits or MS4s

Under the Federal National Pollutant Discharge Elimination System (NPDES) storm water program, operators of large, medium and regulated small municipal separate storm sewer systems (MS4s) require authorization to discharge pollutants under an NPDES permit. The NPDES permitting program is implemented by the Pennsylvania Department of Environmental Protection (DEP) under a delegation agreement with EPA. Phase I of the Federal Stormwater NPDES Program began in 1990 and covered municipalities having a municipal separate storm sewer system (MS4) and having a population greater than 100,000 (including portions of Philadelphia). Phase I also extended to construction activities which disturbed more than 5 acres of land and to 11 categories of industrial activity. In Pennsylvania, the City of Philadelphia is one of two cities covered under the Phase I program. Phase II implementation is underway. Phase II requirements for the Federal NPDES stormwater program were described in Federal regulations at 40 CFR 122(a)(16) issued in December 1999. Phase II extended the requirement to small MS4s in urbanized areas as defined by the 1990 and 2000 census data and for construction activities requiring stormwater permits reduced the threshold for the land area disturbed to one acre. As a result, the 3 municipalities in the Brush Run watershed are now being required to hold NPDES permits for stormwater.

MS4s were required to apply for permit coverage by March 10, 2003. The application must describe the stormwater management program they intend to implement, including a schedule, best management practices and measurable goals for each element of the municipal program.

MS4 communities are required to implement a stormwater management program in their jurisdictions by the end of their 5-year permit term in March 2008. Pennsylvania issued a general permit to be used for MS4 permits (PAG-13). MS4s encompassing Special Protection watersheds in Pennsylvania will be covered through individual permits. The MS4 permittees in the Brush Run watershed have all applied for permit coverage and their applications are under review. Implementation of the Best Management Practices (BMPs) consistent with the stormwater management program and the Minimum Control Measures outlined in 40 CFR 132.34 is considered to constitute compliance with the standard of compliance, maximum extent practicable or MEP. To achieve reductions in stormwater discharges, EPA regulations establish six categories of Minimum Control Measures BMPs that must be met by permittees (these are "narrative" permit effluent limitations). The six BMP categories, also called "minimum control measures" in the Federal regulations, are:

1. Public education and outreach on stormwater impacts
2. Public involvement/participation consistent with state/local requirements in the development of a stormwater management plan.
3. Illicit discharge detection and elimination, including mapping of the existing stormwater sewer system (including at least the outfalls) and adoption of an ordinance to prohibit illicit connections and control erosion and sedimentation from development. .
4. Control of runoff from construction sites when one to five acres of land are disturbed. (Phase I covered sites larger than five acres.)
5. Post-construction stormwater monitoring and management in new development and redevelopment, and
6. Pollution prevention and good housekeeping for municipal operations and maintenance facilities

Under Phase II, permittees are also required to establish measurable goals for each BMP. Pennsylvania has also developed a "Protocol" which MS4s covered under the general permit can adopt to satisfy the requirements of the permit. MS4s can also choose to develop their own programs, but they must seek DEP approval. EPA has developed a National Menu of BMPs available for meeting the minimum control measures. Information can be found on EPA's website at: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/menu.cfm.

The Relationship of MS4 Permits to TMDLs

The MS4 communities in the Brush Run watershed have received wasteload allocations for sediment. A November 22, 2002, EPA Memorandum entitled "Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Stormwater Source and NPDES Permit Requirements Based on Those WLAs" clarified existing regulatory requirements for MS4s connected with TMDLs. The Memorandum also affirms EPA's view that an iterative adaptive management BMP approach is appropriate. Some of the major points raised in the Memorandum include the following:

- NPDES-regulated stormwater discharges must be considered in the TMDL as Wasteload allocations and may not be addressed by the load allocation component of the TMDL.
- Most water quality based effluent limitations for NPDES-regulated municipal and small construction stormwater discharges will be in the form of BMPs.
- Numeric limits will be used in permits only in rare instances.
- EPA expects WLAs and LA's in TMDLs to be in numeric form, although EPA recognizes that these allocations might be fairly rudimentary because of data limitations and variability in the system.
- Stormwater discharges from sources that are not currently subject to NPDES requirements may be listed as LAs.
- The NPDES permit should specify monitoring necessary to comply with effluent limitations, to determine if expected load reductions from BMPs are expected to achieve the WLA in the TMDL, i.e., BMP performance data.
- The permit should also provide a mechanism to make adjustments to the required BMPs as necessary to insure adequate performance.

In order to carry out the NPDES program, DEP developed a General Permit for Stormwater Discharges from Small MS4s (PAG-13) to provide NPDES coverage to the more than 700 municipalities in Pennsylvania, which EPA reviewed and approved. As described by PAG-13, the MS4 permittee must, within the permit term, implement and enforce a stormwater management program approved by DEP which is designed to reduce the discharge of pollutants from its MS4 to the maximum extent practicable, with the goal of protecting water quality and satisfying the appropriate water quality requirements of the Federal Clean Water Act and the Pennsylvania Clean Streams Law. The program must contain a schedule, Best Management Practices (BMPs) and measurable goals for the six Minimum Control Measures as described in the Federal regulations and in PAG-13 and the program be approved by DEP. Communities who wholly or in part encompass Special Protection Watersheds are expected to apply for individual permits.

In accordance with Phase II NPDES Stormwater requirements, the municipalities in the

Brush Run watershed were required to apply for a permit by March 10, 2003 and are required to implement a stormwater management program by March 10, 2008. All have done so and their Notices of Intent are under review. PAG-13 outlines the following schedule for the next five years and includes the six minimum measures and measures of success.

VIII. Public Participation

Public notice of the TMDL was published in the *Pittsburgh Post-Gazette* on October 21, 2003. The comment period commenced on October 21, 2003 and public input was accepted during this time through November 19, 2003. This was the second public comment period being conducted on the Brush Run Watershed TMDL, as PADEP posted notice of an earlier version in the *Pennsylvania Bulletin* on December 14, 2002. A public meeting was held on January 15, 2003 at the Chartiers Valley High School in Bridgeville, PA. In revising the TMDL, EPA considered comments received on PADEP's proposed TMDL, as well as PADEP's response to comments; these comments and responses are available upon request. No comments were received on this TMDL during EPA's public comment period.

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Appendix A - Information Sheet from PADEP's Brush Run Watershed TMDLs (original TMDL)

What is being proposed?
Total Maximum Daily Load (TMDL) plans have been developed to improve water quality in the Brush Run watershed.

Who is proposing the plans? Why?
The Pennsylvania Department of Environmental Protection (PADEP) is proposing to submit the plans to the U.S. Environmental Protection Agency (U.S. EPA) for review and approval as required by federal regulation. In 1995, U.S. EPA was sued for not developing TMDLs when Pennsylvania failed to do so. PADEP has entered into an agreement with U.S. EPA to develop TMDLs for certain specified waters over the next several years. These TMDLs have been developed in compliance with the state/U.S. EPA agreement.

What is a TMDL?
A TMDL sets a ceiling on the pollutant loads that can enter a waterbody so that it will meet water quality standards. The Clean Water Act requires states to list all waters that do not meet their water quality standards even after pollution controls required by law are in place. For these waters, the state must calculate how much of a substance can be put in the water without violating the standard, and then distribute that quantity to all sources of the pollutant on that water body. A TMDL plan includes waste load allocations for point sources, load allocations for nonpoint sources, and a margin of safety. The Clean Water Act requires states to submit their TMDLs to U.S. EPA for approval. Also, if a state does not develop the TMDL, the Clean Water Act states that U.S. EPA must do so.

What is a water quality standard?
The Clean Water Act sets a national minimum goal that all waters are to be "fishable" and "swimmable." To support this goal, states must adopt water quality standards. Water quality standards are state regulations that have two components. The first component is a designated use, such as "warm water fishes" or "recreation." States must assign a use, or several uses to each of their waters. The second component relates to the instream conditions necessary to protect the designated use(s). These conditions or "criteria" are physical, chemical, or biological characteristics such as temperature and minimum levels of dissolved oxygen, and maximum concentrations of toxic pollutants. It is the combination of the "designated use" and the "criteria" to support that use that make up a water quality standard. If any criteria are being exceeded, then the use is not being meet and the water is said to be in violation of water quality standards.

What is the purpose of the plans?
Brush Run is impaired by excess siltation and nutrients. These TMDL plans include a calculation of sediment and nutrient loadings that will meet water quality objectives.

Why was the Brush Run watershed selected for TMDL development?
In 1996, PADEP listed a portion of the Brush Run watershed under Section 303(d) of the federal Clean Water Act as impaired due to excess nutrients and suspended solids. In 1998, the entire watershed was listed as impaired due to a combination of nutrients and siltation impairments.

What pollutants do these TMDLs address?
The proposed plans provide calculations of the stream's total capacity to accept sediment and phosphorus. Based on an evaluation of the concentrations of nutrients in Brush Run, phosphorus is the cause of nutrient impairment to the stream. Sediment loading is being used to address siltation impairments.

Where do the pollutants come from?
The sediment and nutrient related impairments in the Brush Run watershed come from nonpoint sources (NPS) of pollution, primarily overland runoff from agricultural land uses and stream bank erosion.

How was the TMDL developed?
PADEP used a reference watershed approach to estimate the necessary loading reduction of sediment and phosphorus that would be needed to restore a healthy aquatic community. The reference watershed approach is based on selecting a non-impaired watershed that has similar land use characteristics and determining the current loading rates for the pollutants of interest. This is done by modeling the loads that enter the stream, using precipitation and land use characteristic data. For this analysis, PADEP used the AVGWLF model (the Environmental Resources Research Institute of the Pennsylvania State University's ArcView based version of the Generalized Watershed Loading Function model developed by Cornell University). This modeling process uses loading rates in the non-impaired watershed as a target for load reductions in the impaired watershed. The impaired watershed is modeled to determine the current loading rates and determine what reductions are necessary to meet the loading rates of the non-impaired watershed. The reference stream approach was used to set allowable loading rates in the affected watershed because neither Pennsylvanian nor U.S. EPA has water quality criteria for sediment or phosphorus.

How much pollution is too much?
The allowable amount of pollution in a water body varies depending on several conditions. TMDLs are set to meet water quality standards at the critical flow condition. For a free flowing stream impacted by nonpoint source pollution loading of sediment and nutrients, the TMDL is expressed as an annual loading. This accounts for pollution contributions over all stream flow conditions. PADEP established the water quality objectives for sediment and phosphorus by using the reference watershed approach. This approach assumes that the impairment is eliminated when the impaired watershed achieves loadings similar to the reference watershed. Reducing the current loading rates for sediment and phosphorus in the impaired watershed to the current loading rates in the reference watershed will result in meeting the water quality objectives.

How will the loading limits be met?
Best Management Practices (BMPs) will be encouraged throughout the watershed to achieve the necessary load reductions.

How can I get more information on the TMDL?
To request a copy of the full report, contact Carol Young at 717-783-2952 during the business hours of 8:00 a.m. to 3:00 p.m., Monday through Friday. You may also contact Ms. Young by mail at the TMDL and Modeling Section, Division of Water Quality Assessment and Standards, PADEP, 400 Market Street, Harrisburg, PA 17105 or by e-mail at cayoung@state.pa.us.

How can I comment on the proposal?
You may provide e-mail or written comments postmarked no later than February 12, 2003 to the above address.

Appendix B - AVGWLF Model Overview & GIS-Based Derivation of Input Data

TMDLs for the Brush Run watershed were developed using the Generalized Watershed Loading Function or GWLF model. The GWLF model provides the ability to simulate runoff, sediment, and nutrient (N and P) loadings from watershed given variable-size source areas (e.g., agricultural, forested, and developed land). It also has algorithms for calculating septic system loads, and allows for the inclusion of point source discharge data. It is a continuous simulation model, which uses daily time steps for weather data and water balance calculations. Monthly calculations are made for sediment and nutrient loads, based on the daily water balance accumulated to monthly values.

GWLF is a combined distributed/lumped parameter watershed model. For surface loading, it is distributed in the sense that it allows multiple land use/cover scenarios. Each area is assumed to be homogenous in regard to various attributes considered by the model. Additionally, the model does not spatially distribute the source areas, but aggregates the loads from each area into a watershed total. In other words, there is no spatial routing. For sub-surface loading, the model acts as a lumped parameter model using a water balance approach. No distinctly separate areas are considered for sub-surface flow contributions. Daily water balances are computed for an unsaturated zone as well as a saturated sub-surface zone, where infiltration is computed as the difference between precipitation and snowmelt minus surface runoff plus evapotranspiration.

GWLF models surface runoff using the Soil Conservation Service Curve Number (SCS-CN) approach with daily weather (temperature and precipitation) inputs. Erosion and sediment yield are estimated using monthly erosion calculations based on the Universal Soil Loss Equation (USLE) algorithm (with monthly rainfall-runoff coefficients) and a monthly composite of KLSCP values for each source area (e.g., land cover/soil type combination). The KLSCP factors are variables used in the calculations to depict changes in soil loss erosion (K), the length slope factor (LS) the vegetation cover factor (C) and conservation practices factor (P). A sediment delivery ratio based on watershed size and transport capacities based on average daily runoff are applied to the calculated erosion to determine sediment yield for each source area. Surface nutrient losses are determined by applying dissolved N and P coefficients to surface runoff and a sediment coefficient to the yield portion for each agricultural source area. Point source discharges can also contribute to dissolved losses to the stream and are specified in terms of kilograms per month. Manured areas, as well as septic systems, can also be considered. Urban nutrient inputs are all assumed to be solid-phase, and the model uses an exponential accumulation and washoff function for these loadings. Sub-surface losses are calculated using dissolved N and P coefficients for shallow groundwater contributions to stream nutrient loads, and the sub-surface sub-model only considers a single, lumped-parameter contributing area. Evapotranspiration is determined using daily weather data and a cover factor dependent upon land use/cover type. Finally, a water balance is performed daily using supplied or computed precipitation, snowmelt, initial unsaturated zone storage, maximum available zone storage, and evapotranspiration values. All of the equations used by the model can be viewed in GWLF Users Manuel, available from PADEP's Bureau of Watershed Conservation, Division of Assessment and Standards.

For execution, the model requires three separate input files containing transport-, nutrient-, and weather-related data. The transport (TRANSPRT.DAT) file defines the necessary parameters for each source area to be considered (e.g., area size, curve number, etc.) as well as global parameters (e.g., initial storage, sediment delivery ratio, etc.) that apply to all source areas. The nutrient (NUTRIENT.DAT) file specifies the various loading parameters for the different source areas identified (e.g., number of septic systems, urban source area accumulation rates, manure concentrations, etc.). The weather

(WEATHER.DAT) file contains daily average temperature and total precipitation values for each year simulated.

The primary sources of data for this analysis were GIS formatted databases. A specially designed interface was prepared by the Environmental Resources Research Institute of the Pennsylvania State University in ArcView (GIS software) to generate the data needed to run the GWLF model, which was developed by Cornell University. The new version of this model has been named AVGWLF (ArcView Version of the Generalized Watershed Loading Function).

In using the AVGWLF, the user is prompted to identify required GIS files and to provide other information related to "non-spatial" model parameters (e.g., beginning and end of the growing season, the months during which manure is spread on agricultural land and the names of nearby weather stations). This information is subsequently used to automatically derive values for required model input parameters, which are then written to the TRANSPRT.DAT, NUTRIENT.DAT and WEATHER.DAT input files needed to execute the GWLF model. For use in Pennsylvania, AVGWLF has been linked with statewide GIS data layers such as land use/cover, soils, topography, and physiography; and includes location-specific default information such as background N and P concentrations and cropping practices.

The AVGWLF model was calibrated to 16 watersheds throughout Pennsylvania and verified on an additional 16 watersheds. The Chartiers watershed was used as a verification watershed. A statistical evaluation of the accuracy of the load predictions was made. Nash-Sutcliffe coefficients of correlation derived for the calibration and verification watersheds ranged in value from 0.92 to 0.97 for both nitrogen and phosphorus when considering mean annual loads. The median N-S values for nitrogen varied between 0.64 to 0.70 for monthly, seasonal, and year-to-year load estimates; and for phosphorus they varied between 0.61 and 0.72.

Complete GWLF-formatted weather files are also included for eighty weather stations around the state. The following table lists the statewide GIS data sets and provides an explanation of how they were used for development of the input files for the GWLF model.
The reader is referred to the *AVGWLF User's Guide* for further details.

GIS Data Sets	
DATASET	DESCRIPTION
Censustr	Coverage of Census data including information on individual homes septic systems. The attribute *usew_sept* includes data on conventional systems, and *sew_other* provides data on short-circuiting and other systems.
County	The County boundaries coverage lists data on conservation practices, which provides C and P values in the Universal Soil Loss Equation (USLE).
Gwnback	A grid of background concentrations of N in groundwater derived from water well sampling.
Landuse5	Grid of the MRLC that has been reclassified into five categories. This is used primarily as a background.
Majored	Coverage of major roads. Used for reconnaissance of a watershed.
MCD	Minor civil divisions (boroughs, townships and cities).
Npdespts	A coverage of permitted point discharges. Provides background information and cross check for the point source coverage.
Padem	100-meter digital elevation model. This used to calculate landslope and slope length.
Palumrlc	A satellite image derived land cover grid that is classified into 15 different landcover categories. This dataset provides landcover loading rate for the different categories in the model.
Pasingle	The 1:24,000 scale single line stream coverage of Pennsylvania. Provides a complete network of streams with coded stream segments.
Physprov	A shapefile of physiographic provinces. Attributes *rain_cool* and *rain_warm* are used to set recession coefficient
Pointsrc	Major point source discharges with permitted N and P loads.
Refwater	Shapefile of reference watersheds for which nutrient and sediment loads have been calculated.
Soilphos	A grid of soil phosphorous loads, which has been generated from soil sample data. Used to help set phosphorus and sediment values.
Smallsheds	A coverage of watersheds derived at 1:24,000 scale. This coverage is used with the stream network to delineate the desired level watershed.
Statsgo	A shapefile of generalized soil boundaries. The attribute *mu_k* sets the k factor in the USLE. The attribute *mu_awc* is the unsaturated available capacity., and the *muhsg_dom* is used with landuse cover to derive curve numbers.
Strm305	A coverage of stream water quality as reported in the Pennsylvania's 305(b) report. Current status of assessed streams.
Surfgeol	A shapefile of the surface geology used to compare watersheds of similar qualities.
T9sheds	Data derived from a DEP study conducted at PSU with N and P loads.
Zipcode	A coverage of animal densities. Attribute *aeu_acre* helps estimate N & P concentrations in runoff in agricultural lands and over manured areas.
Weather Files	Historical weather files for stations around Pennsylvania to simulate flow.

Appendix C - AVGWLF Model Outputs for the Brush Run Watershed

GWLF Total Loads for brush1

Period of analysis: 23 years, from Apr 1975 to Mar 1998

	(Acres)	(in)	(Tons)		Total Loads (Pounds)			
Source	Area	Runoff	Erosion	Sediment	Dis. Nitr.	Tot. Nitr.	Dis. Phos.	Tot. Phos.
HAY/PAST	813.0	1.27	46.26	7.63	1286.99	1332.79	36.99	44.07
CROPLAND	835.2	2.46	588.84	97.16	2522.80	3105.76	72.96	163.12
CONIF_FOR	37.1	1.05	0.05	0.01	1.68	1.74	0.05	0.06
MIXED_FOR	825.3	1.05	3.07	0.51	37.44	40.48	1.18	1.65
DECID_FOR	2073.2	1.05	17.99	2.97	94.06	111.87	2.97	5.73
QUARRY	9.9	5.10	12.93	2.13	0.14	12.94	0.02	2.00
LO_INT_DEV	1744.6	2.71	2.37	0.39	0.00	548.55	0.00	73.14
HI_INT_DEV	59.3	8.45	0.02	0.00	0.00	3.27	0.00	0.36
Stream Bank				191.38		574.15		88.80
Groundwater					19758.37	19758.37	447.74	447.74
Point Sources					0.00	0.00	0.00	0.00
Septic Syst.					1751.70	1751.70	7.51	7.51
Totals	6397.5	1.80	671.5	302.2	25453.19	27241.62	569.43	834.19

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GWLF Total Loads for Deer_Shed

Period of analysis: 23 years, from Apr 1975 to Mar 1998

			(Tons)		Total Loads (Pounds)			
Source	(Acres) Area	(in) Runoff	Erosion	Sediment	Dis. Nitr.	Tot. Nitr.	Dis. Phos.	Tot. Phos.
HAY/PAST	568.3	1.50	24.03	4.18	1129.84	1154.93	31.64	35.28
CROPLAND	724.0	2.93	366.81	63.83	2756.12	3139.07	77.85	133.51
CONIF_FOR	74.1	1.24	0.09	0.01	3.95	4.04	0.12	0.14
MIXED_FOR	417.6	1.24	1.00	0.17	22.24	23.28	0.70	0.85
DECID_FOR	2611.9	1.24	13.35	2.32	139.07	153.01	4.39	6.42
LO_INT_DEV	163.1	3.24	0.06	0.01	0.00	1.40	0.00	0.19
HI_INT_DEV	9.9	9.73	0.00	0.00	0.00	0.04	0.00	0.00
Stream Bank				9.59		28.76		4.18
Groundwater					17884.51	17884.51	362.47	362.47
Point Sources					0.00	0.00	0.00	0.00
Septic Syst.					4424.87	4424.87	18.78	18.78
Totals	4569.0	1.60	405.3	80.1	26360.60	26813.91	495.96	561.82

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Appendix E - Equal Marginal Percent Reduction Method

The Equal Marginal Percent Reduction (EMPR) allocation method was used to distribute Adjusted Allocations (AAs) between the appropriate contributing sources. The EMPR procedures were performed using MS Excel and results are presented in Appendix F. The 5 major steps identified in the spreadsheet are summarized below:

Step 1: Calculation of the TMDL based on impaired watershed size and unit area loading rate of reference watershed.

Step 2: Calculation of Adjusted Allocation based on TMDL, Margin of Safety, and existing loads not reduced.

Step 3: Actual EMPR Process.

a. Each land use/source load is compared with the total AA to determine if any contributor would exceed the AA by itself. The evaluation is carried out as if each source is the only contributor to the pollutant load of the receiving waterbody. If the contributor exceeds the AA, that contributor would be reduced to the AA. If a contributor is less than the AA, it is set at the existing load. This is the baseline portion of EMPR.

b. After any necessary reductions have been made in the baseline, the multiple analyses are run. The multiple analyses will sum all of the baseline loads and compare them to the AA. If the AA is exceeded, an equal percent reduction will be made to all contributors' baseline values. After any necessary reductions in the multiple analyses, the final reduction percentage for each contributor can be computed.

Step 4: Calculation of total loading rate of all sources receiving reductions.

Step 5: Summary of existing loads, final load allocations, and % reduction for each pollutant source.

Appendix F - Equal Marginal Percent Reduction Calculations for Brush Run

Sediment:

Step 1: *TMDL (lbs/yr)*
*= Ref. Loading Rate * Impaired Area*

224,344

Step 2: *Adjusted Allocation*
= (TMDL - MOS) - Uncontrollable Loads

189,890

Step 3:

Source	***Average Load (lbs/yr)***	***Load Sum (lbs/yr)***	***Check***	***Initial Adjustment***	***Recheck***	***Initial % Reduction***	***Load Reduction (lbs/yr)***	***Initial LA (lbs/yr)***	***Area (acres)***	***Allowable Loading Rate***	***% Reduction***
Hay / Pasture	15,260	592,340	good	15,260	ADJUST	4%	7,925	7,335	813	9	52%
Cropland	194,320		bad	189,890	205,150	48%	98,613	91,277	835	109	53%
Streambank	382,760		bad	189,890		48%	98,613	91,277	-	-	76%

Step 4: *Average Loading Rate for Agricultural Sources (lbs/acre/yr)* 60

Step 5:

Source	***Acres***	***Allowable Loading Rate***	***Final Load Allocation***	***Current Loading Rates***	***Current Load***	***% Reduction***
Hay / Pasture	813	9	7,335	19	15,260	52%
Cropland	835	109	91,277	233	194,320	53%
Streambank	-	-	91,277	-	382,760	76%

Phosphorus:

Step 1: *TMDL (lbs/yr)*
*= Ref. Loading Rate * Impaired Area*
786.7

Step 2: *Adjusted Allocation*
= (TMDL - MOS) - Uncontrollable Loads
81.0

Step 3:

Source	***Average Load (lbs/yr)***	***Load Sum (lbs/yr)***	***Check***	***Initial Adjustment***	***Recheck***	***Initial % Reduction***	***Load Reduction (lbs/yr)***	***Initial LA (lbs/yr)***	***Area (acres)***	***Allowable Loading Rate***	***% Reduction***
Hay / Pasture	44.1	207.2	good	44.1	ADJUST	35%	15.5	28.5	813	0.035	35%
Cropland	163.1		bad	81.0	44.1	65%	28.5	52.5	835	0.063	68%

Step 4: *Average Loading Rate for Agricultural Sources (lbs/acre/yr)* 0.05

Step 5:

Source	***Acres***	***Allowable Loading Rate***	***Final Load Allocation***	***Current Loading Rates***	***Current Load***	***% Reduction***
Hay / Pasture	813	0.035	28.5	0.054	44.1	35%
Cropland	835	0.063	52.5	0.195	163.1	68%

Appendix G - Wasteload and Load Allocations Calculations

Sediment Wasteload and Load Allocations

Source	*Total Allocated Sediment Load (lbs/yr)*	*Peters*		*Upper Saint Clair*		*Bethel Park*	
		% of Landuse	*Load (lbs/yr)*	*% of Landuse*	*Load (lbs/yr)*	*% of Landuse*	*Load (lbs/yr)*
Hay/Pasture	7,335	85.3%	6,261	14.2%	1,041	0.5%	34
Cropland	91,277	95.6%	87,247	3.9%	3,556	0.5%	474
Conifer Forest	20	90.0%	18	10.0%	2	0.0%	0
Mixed Forest	1,020	75.1%	766	23.9%	244	1.0%	10
Deciduous Forest	5,940	80.0%	4,754	16.0%	951	4.0%	235
Quarry	4,260	100.0%	4,260	0.0%	0	0.0%	0
Low Intensity Development	780	65.4%	510	31.0%	242	3.6%	28
High Intensity Development	0	85.3%	0	11.8%	0	2.9%	0
Streambank*	91,277	78.4%	71,568	19.0%	17,383	2.5%	2,326
Total WLA	**201,910**		***175,384***		***23,419***		***3,107***

Groundwater	0
Septic Systems	0
Total LA	**0**

** Total watershed area used for calculations.*

Phosphorus Wasteload and Load Allocations

Source	*Total Allocated Phosphorus Load (lbs/yr)*	*Peters*		*Upper Saint Clair*		*Bethel Park*	
		% of Landuse	*Load (lbs/yr)*	*% of Landuse*	*Load (lbs/yr)*	*% of Landuse*	*Load (lbs/yr)*
Hay/Pasture	28.54	85.3%	24.36	14.2%	4.05	0.5%	0.13
Cropland	52.47	95.6%	50.16	3.9%	2.04	0.5%	0.27
Conifer Forest	0.06	90.0%	0.05	10.0%	0.01	0.0%	0.00
Mixed Forest	1.65	75.1%	1.24	23.9%	0.40	1.0%	0.02
Deciduous Forest	5.73	80.0%	4.59	16.0%	0.92	4.0%	0.23
Quarry	2.00	100.0%	2.00	0.0%	0.00	0.0%	0.00
Low Intensity Development	73.14	65.4%	47.82	31.0%	22.69	3.6%	2.63
High Intensity Development	0.36	85.3%	0.31	11.8%	0.04	2.9%	0.01
Streambank*	88.80	78.4%	69.63	19.0%	16.91	2.5%	2.26
Total WLA	**252.76**		***200.15***		***47.05***		***5.55***

Groundwater	447.74
Septic Systems	7.51
Total LA	**455.25**

** Total watershed area used for calculations.*

Appendix H - TMDL Calculations for Unnamed Tributary to Brush Run

Total Phosphorus

	Area (acres)	*Current Loading Rate (lbs/acre/yr)*	*Current Loading (lbs/yr)*	*Allowable Loading Rate (lbs/acre/yr)*	*Allowable Loading (lbs/yr)*	*Percent Reduction*
Hay/Pasture	32	0.054	1.7	0.035	1.1	35
Cropland	21	0.195	4.1	0.063	1.3	68
Mixed Forest	19	0.002	0.0	0.002	0.0	0
Deciduous Forest	83	0.003	0.2	0.003	0.2	0
Low Intensity Development	47	0.042	2.0	0.042	2.0	0
Streambank *	207	0.014	2.9	0.014	2.9	0
Groundwater *	207	0.070	14.5	0.070	14.5	0
Septic Systems *	207	0.001	0.2	0.001	0.2	0

WLA	7.55
LA	14.74

TMDL	24.76
MOS	2.48
WLA	7.55
LA	14.74

Sediment

	Area (acres)	*Current Loading Rate (lbs/acre/yr)*	*Current Loading (lbs/yr)*	*Allowable Loading Rate (lbs/acre/yr)*	*Allowable Loading (lbs/yr)*	*Percent Reduction*
Hay/Pasture	32	18.77	597	9.02	287	52
Cropland	21	232.66	4,936	109.29	2,319	53
Mixed Forest	19	1.24	24	1.24	24	0
Deciduous Forest	83	2.87	237	2.87	237	0
Low Intensity Development	47	0.45	21	0.45	21	0
Streambank *	207	59.83	12,390	14.27	2,955	76
Groundwater *	207	0.00	0	17.11	0	0
Septic Systems *	207	0.00	0	15.47	0	0

WLA	5842
LA	0

* Total watershed area used for calculations

TMDL	6491
MOS	649
WLA	5842
LA	0

Appendix I - Comment & Response Document
Brush Run Watershed TMDLs

EPA did not receive any comments during the public comment period for this TMDL.

Appendix J - Land Use Descriptions
Brush Run Watershed TMDLs

The land use categories used in the modeling effort are the following:

- *Water:* All areas of open water or permanent ice/snow cover generally with less than 30% cover of vegetation/land cover.

- *Low Intensity Development:* These areas include a mixture of constructed materials and vegetative cover. Constructed materials account for 50 to 80 percent of the land cover, while vegetation may account for 20 to 50 percent of the cover. Low intensity residential areas most commonly include single-family housing units.

- *High Intensity Development:* These highly developed areas include apartment complexes , row houses, and other locations where people live in large numbers. Vegetation accounts for less than 20 percent of the total land cover. Constructed/building materials account for 80 to 100 percent of the land cover.

- *Quarries:* This land cover includes all quarry areas, including sand and gravel operations, where there are extractive mining activities with significant surface expression.

- *Transitional:* Transitional areas are those that are dynamically changing from one land cover to another, often because of land use activities. These areas are usually sparsely vegetated (less than 25 percent of cover) and examples include forest clearcuts; a transition phase between forest and agricultural land; the temporary clearing of vegetation; and land cover changes due to natural causes, such as fires or floods.

- *Deciduous Forest:* This land cover is dominated by trees. Seventy percent or more of the trees are deciduous (tree species that shed foliage in response to seasonal change).

- *Evergreen Forest:* This land cover is dominated by trees. Seventy percent or more of the trees are conifers or evergreens.

- *Mixed Forest:* This land cover is dominated by trees, where neither deciduous nor conifer/evergreen species represent more than 70 percent of the cover present.

- *Pasture/Hay:* This land use coverage includes areas of grasses, legumes, or grass-legume mixtures that are planted for livestock grazing or the production of seed or hay crops. This coverage may include other areas with high percentages of grasses and other herbaceous vegetation such as golf courses and parks.

- *Row Crops:* These areas are regularly tilled and planted, often on an annual or biennial basis with corn, cotton, sorghum, vegetables, or other crops.

- *Probable Row Crops:* This land use cover may sometimes be confused with other areas, such as grasslands that were not green during times of spring data acquisitions.

Appendix K - Changes from previously submitted TMDL

This report is a revised version of the Brush Run Watershed TMDL, submitted by the Pennsylvania Department of Environmental Protection (PADEP) to the Environmental Protection Agency for final review and approval on March 14, 2003. The previous TMDL, as submitted by PADEP, did not meet all eight of the regulatory conditions required by Federal regulations for a TMDL and was disapproved by the EPA on September 19, 2003. The TMDL only included a load allocation (LA) and not a wasteload allocation (WLA) despite the presence of existing NPDES-regulated point sources. As Federal regulations require storm water discharges and other point sources to be addressed by the WLA component of a TMDL, the TMDL needed to be revised accordingly.

The TMDL was revised to include WLAs for the point sources in the Brush Run watershed. Specifically, the loadings in each TMDL were reallocated so as to include individual WLAs for the point sources in the watershed.

The previously submitted TMDL addressed all sources, but they had all been assigned LAs. However, there are three townships/municipalities in the watershed that are responsible for storm-related sources under MS4 regulations, and thus should be given WLAs. Therefore, the surface runoff loads were moved to the WLA component of the TMDL. The loads from the following land uses were included in the waste load allocations: hay and pasture lands, croplands, coniferous forest, mixed forest, deciduous forest, transitional land, low intensity development; high intensity development. In addition, since the cause of the flow variability that results in stream bank erosion is related to urban runoff, the sources of the impairments are considered point sources under the MS4 stormwater program regulations. Stream bank erosion loads were also assigned to the WLAs. The groundwater and septics loads were kept in the LA component of the TMDL. The loads were re-allocated based on the percentage of each landuse that was contributed by each municipality.

This TMDL does not address the lower 0.9 miles of the main stem of Brush Run, just above the discharge of the Peters Township wastewater treatment plant to the confluence with Chartiers Creek, as the original TMDL had. EPA will address this lower portion in the near future.