Yellow Breeches Creek Watershed Assessment

DRAFT

Cumberland, York and Adams Counties, Pennsylvania

April 2005

HRG Project No. 0243.180

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REVISED DRAFT

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PENNSYLVANIA

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FUNDED BY GROWING GREENER GRANTS
PROVIDED BY PA DEP AND PA DCNR

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APPENDICES

ACRONYMS

ACCD – Adams County Conservation District
ACPC – Adams County Planning Commission
CAPSEC- Capital Region Senior Environment Corps
CCCD – Cumberland County Conservation District
CCPC – Cumberland County Planning Commission
CREP – Conservation Reserve Enhancement Program
CSREES – Cooperative State Research, Education, and Extension Service
DER – Department of Environmental Resources
EASI –Environmental Alliance for Senior Involvement
FEMA – Federal Emergency Management Agency
HQ-CWF – High Quality–Cold Water Fishes
NRCS – Natural Resources Conservation Service
NAWQA – National Water Quality Assessment
NPDES – National Pollutant Discharge Elimination System
NWI – National Wetlands Inventory
PA DCNR – Pennsylvania Department of Conservation and Natural Resources
PA DEP – Pennsylvania Department of Environmental Protection
PAWC – Pennsylvania American Water Company
PCB – Polychlorinated Biphenyl
PEC – Pennsylvania Environmental Council
PENNDOT – Pennsylvania Department of Transportation
PFBC – Pennsylvania Fish and Boat Commission
PGC – Pennsylvania Game Commission
PIMAR – Pennsylvania Integrated Water Quality Monitoring and Assessment Report
PNDI – Pennsylvania Natural Diversity Index
RBP – Rapid Bioassessment Protocols
SCS – Soil Conservation Service
SRBC – Susquehanna River Basin Commission
US EPA – United States Environmental Protection Agency
USACE – United States Army Corps of Engineers
USDA – United States Department of Agriculture
USFWS – United States Fish and Wildlife Service
USGS – United States Geologic Survey
WQS – Water Quality Standard
YBWA – Yellow Breeches Watershed Association
YCCD – York County Conservation District
YCPC – York County Planning Commission

TAB A

PREFACE

This report was prepared by the Yellow Breeches Watershed Association (YBWA) as a collaborative effort with Herbert, Rowland & Grubic, Inc. and subconsultant Gannett Fleming, Inc. YBWA would like to acknowledge the contributions of numerous government agencies, individuals, and other organizations that provided valuable information used to complete this report. YBWA thanks the following organizations and individuals:

YBWA thanks Lower Allen Township for all of its support from the very beginning, when the watershed association was still only a concept idea, through the completion of the Watershed Assessment and the Rivers Conservation Plan. Lower Allen Township is recognized as a leader in its area and a strong supporter of cutting edge programs to protect the environment. The administration of the grants necessary to complete this work, in addition to numerous other efforts, was instrumental to the completion of this project. YBWA looks forward to a continued strong relationship with Lower Allen Township on future projects within the Yellow Breeches Creek Watershed.

YBWA also thanks the following organizations and individuals:

- Yellow Breeches Watershed Association
- Pennsylvania Department of Environmental Protection (PA DEP)
- Pennsylvania Department of Conservation and Natural Resources (PA DCNR)
- 22 Municipalities within the Yellow Breeches Creek Watershed
    - Camp Hill Borough
    - Carroll Township
    - Cooke Township
    - Dickinson Township
    - Dillsburg Borough
    - Fairview Township
    - Franklin Township
    - Hampden Township
    - Lemoyne Borough
    - Lower Allen Township
    - Mechanicsburg
    - Menallen Township
    - Monaghan Township
    - Monroe Township
    - Mount Holly Springs Borough
    - New Cumberland Borough
    - Penn Township
    - Shiremanstown Borough
    - Southampton Township

    - South Middleton Township
    - South Newton Township
    - Upper Allen Township
- Susquehanna River Basin Commission (SRBC)
- Capital Region Senior Environment Corps (CAPSEC)
- United States Geological Survey (USGS)
- Cumberland County Conservation District (CCCD)
- Cumberland County Planning Commission (CCPC)
- York County Planning Commission (YCPC)
- York County Conservation District (YCCD)
- Adams County Planning Commission (ACPC)
- Adams County Conservation District (ACCD)
- Bob Rowland
- Messiah College, Jeff Erickson
- Dickinson College
- Environmental Alliance for Senior Involvement (EASI)
- Appalachian Audubon Society
- Cumberland Valley Chapter of Trout Unlimited
- Pennsylvania Environmental Council
- Alliance for the Chesapeake Bay
- Shippensburg University
- Oakes Museum

Homeland Security has become a major concern in the United States. In our post 9-11 world, it is everyone's responsibility to safeguard lives and valuable resources in our own communities. Potential threats can come in many different forms and shapes. One of those forms is the intentional contamination of drinking water, known as water terrorism. Safeguarding sensitive water related information can diminish the risk of this and similar attacks. Sensitive water related data has been omitted from this report and these areas noted accordingly. The YBWA is committed to safeguarding the lives and valuable resources within the Yellow Breeches Creek Watershed.

EXECUTIVE SUMMARY

The PA DEP Title 25, Chapter 93, Water Quality Standards protected use for the Yellow Breeches Creek is for High-Quality Cold Water Fishes (HQ-CWF). In 1992, the Yellow Breeches Creek was given the Pennsylvania Scenic River designation[1]. The Yellow Breeches Creek and its tributaries consist of 368 river miles that start in the South Mountain area, Cumberland County, and flows east through Adams, York, and Cumberland Counties before draining into the Susquehanna River. The Yellow Breeches Creek Watershed drains a total area of 219 square miles.

A Watershed Assessment was completed for the Yellow Breeches Creek Watershed. The Watershed Assessment included a physical characterization of the stream, a habitat assessment, an erosion and channelization assessment, water quality testing, and a benthic study. The final report includes a detailed analysis of all technical data collected. Secondary data was collected from various organizations and agencies and was considered in this assessment. Best management practices specific to the most impaired areas have been selected as part of this assessment.

Statement of Need

Technical data collected from the Watershed Assessment is essential to the development of the Yellow Breeches Creek Rivers Conservation Plan and will be used as a foundation to identify the most valuable resources within the watershed. The key components of the Watershed Assessment are the collection and analysis of technical data pertaining to the entire watershed. Grants have been awarded by both the PA DCNR and PA DEP with each set of funds spent on compiling information sought by the specific agency. The PA DEP Growing Greener Grant is an environmental stewardship and watershed protection program grant. The PA DCNR grant is a Keystone recreation, park, and conservation fund planning grant.

Goals and Objectives

The short-term goal for this project is to complete a Watershed Assessment, including the collection and analysis of technical data. The long-term goal of the Watershed Assessment is the utilization of technical data collected to prioritize projects in the Yellow Breeches Creek Rivers Conservation Plan that will benefit, improve and protect the watershed, and therefore improve life for those who have a stake in the resource.

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[1] Classification Criteria: Rivers included in the Scenic Rivers System will be classified, designated and administered as Wild, Scenic, Pastoral, Recreational and Modified Recreational Rivers (Sections 4; (a) (1) of the Pennsylvania Scenic Rivers Act). A designated river may have more than one classification; each segment will have its own classification, and must be long enough to provide a meaningful experience. The number of different classified segments within the river should be kept to a minimum. *Scenic* rivers shall be free-flowing and capable of, or under restoration, to support water-cased recreation, fish and aquatic life. The view from the river or its banks shall be predominately wild, but may reveal some pastoral countryside. The segment may be intermittently accessible by road.

PROJECT PARTNERS

Many partnerships have formed to ensure the success of both the project and the management of the Yellow Breeches Creek Watershed. Groups that have partnered and expressed interests in contributing to the watershed assessment project include the following:

- Yellow Breeches Watershed Association
- Pennsylvania Department of Environmental Protection (PA DEP)
- Pennsylvania Department of Conservation and Natural Resources (PA DCNR)
- 22 Municipalities within the Yellow Breeches Creek Watershed
  - Camp Hill Borough
  - Carroll Township
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  - Fairview Township
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  - Hampden Township
  - Lemoyne Borough
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- Oakes Museum

INTRODUCTION

The purpose of the Yellow Breeches Creek Watershed Assessment is to serve as a guide for the future character and development of the Yellow Breeches Creek Watershed. Coupled with the Yellow Breeches Creek Rivers Conservation Plan, these reports will address long-range conservation, land management, and recreation development and will continue the drive toward providing increased and varied economic, recreation and conservation opportunities for residents.

The specific tasks of the watershed assessment are the following:

- To perform a physical characterization of the stream.
- To perform a habitat assessment of the stream.
- To perform a streambank stabilization evaluation.
- To perform a macroinvertebrate benthic study.
- To perform water quality testing.
- To define the characteristics, attributes and assets of the Yellow Breeches Creek Watershed.
- To guide the future conservation and management of the Yellow Breeches Creek Watershed and its resources.
- To recommend ways to promote the value and importance of the Yellow Breeches Creek to the quality of life of the residents, and to encourage awareness and use of its resources.
- To identify and prioritize the needs for the protection of the Yellow Breeches Creek.
- To identify and prioritize the needs for the use of the Yellow Breeches Creek.
- To involve all stakeholders, including citizens, residential property owners, municipalities, local governments, county governments, industrial and commercial lands managers, agricultural landowners, water and wastewater utilities, and other community based conservation organizations.

TAB B

GENERAL CHARACTERISTICS

Location

The Yellow Breeches Creek Watershed is located in Cumberland, Adams, and York Counties, Pennsylvania. The headwaters of the Upper Yellow Breeches Creek begin just west of the small town of Walnut Bottom and flow eastward toward Mount Holly Springs Borough. The headwaters of Mountain Creek begin in the northern portion of Adams County. The Upper Yellow Breeches Creek and Mountain Creek converge to form the Yellow Breeches Creek. The Yellow Breeches Creek continues to flow eastward until it converges with the Susquehanna River in New Cumberland Borough. For the purposes of this project, the Yellow Breeches Creek Watershed will be defined by the Main Stem, located in Cumberland and York Counties, and its tributaries located in Cumberland, Adams and York Counties.

Size

The Yellow Breeches Creek Watershed drains a total area of 219 square miles and consists of 368 total river/stream miles. The total length of the main stem and the named tributaries totals approximately 120 miles. The Yellow Breeches Creek itself is approximately 49 miles in length as it flows through Cumberland and York Counties. For approximately 21.6 miles of its length, it serves as the boundary between Cumberland and York Counties.

Topography

Landforms of similar surface characteristics are classified into physiographic provinces, divisions, and sections. The Yellow Breeches Creek Watershed lies within three physiographic provinces. The major portion of the creek lies within the Great Valley section of the Valley and Ridge Province. The Great Valley is characterized by low, rolling topography with gentle slopes that incline westward at 100 to 150 feet per mile. This portion of the Great Valley, known locally as the Cumberland Valley, is underlain by soft carbonate rocks which are more susceptible to weathering than the rocks that comprise the ridges and hillsides. The headwaters region is in the Blue Ridge Province along the South Mountain. A short segment of the Yellow Breeches Creek along the York County boundary is in the Triassic Lowland section of the Piedmont province.

The Yellow Breeches Creek flows northeastward from its source on the crest of South Mountain south of the Village of Lees Cross Roads to the Borough of New Cumberland where it enters the Susquehanna River. The topography is characterized by moderate to steep mountain slopes in the headwater region and Cumberland Valley with rolling hills of relatively low relief.

A vertical drop from an elevation of 2,060 feet to an elevation of 290 feet over the creek's length gives the channel an overall slope of 8.8 feet per mile. However, this statement does not reflect the actual topographic relief, which exists. The headwater streams and the Yellow Breeches Creek drop sharply from Big Flat Tower (elevation 2,060 feet) to Brookside (elevation 735 feet). The majority of the Yellow

Breeches Creek then flows over gentle slopes producing its characteristic long pools interspersed with various dams and riffles.

Table B.1 Lengths and Drainage Areas of Main Tributaries within the Yellow Breeches Creek Watershed

Tributary	Approximate Length	Drainage Area
Main Stem, Source to Locust Point Road	26.0 mi.	91,153 ac.
Hairy Springs Hollow	4.3 mi.	2,318 ac.
Sthromes Hollow	5.0 mi	2,451 ac.
Watery Hollow	4.6 mi.	2,592 ac.
Peach Orchard Hollow	3.4 mi.	2,708 ac.
Bettem Hollow	3.8 mi.	2454 ac.
State Road Hollow	2.3 mi.	672 ac.
Irishtown Gap Hollow	3.4 mi.	2,116 ac.
King's Gap Hollow	3.0 mi.	1,340 ac.
Spruce Run	2.0 mi.	3,164 ac.
Mountain Creek (Source to Toland)	12.1 mi.	21,605 ac.
Mountain Creek (Toland to Mt. Holly Springs)	4.5 mi.	7,225 ac.
Mountain Creek (Mt. Holly Springs to Mouth)	1.5 mi.	1,539 ac.
Old Town Run	3.4 mi.	6,906 ac.
Main Stem, Locust Point Road to Mouth	23.0 mi.	51,073 ac.
Dogwood Run	5.7 mi.	5,561 ac.
Stony Run	7.2 mi.	8,132 ac.
Pippins Run	3.4 mi.	1,748 ac.
Cedar Run	4.5 mi.	8,195 ac.

LAND RESOURCES

A complete understanding of the soils and geology of the Yellow Breeches Creek Watershed is necessary for development and land use planning purposes. Water quality characteristics of a watershed are closely linked to the geology and soils of the region. Geology and soils also play an important role in determining stream chemistry.

Soils

The U.S. Department of Agriculture (USDA), Soil Conservation Service (SCS), has made detailed soil surveys of Adams, Cumberland, and York Counties. These surveys classify the soils according to depth, texture, natural drainage, thickness, and arrangement of the various layers, kind of parent material, slope, erosion, flooding, and other characteristics.

Using soil associations, general soil information can be provided. Soil associations are groups of soils, which ordinarily occur together in the landscape. Each soil has its characteristic place depending on slope or kind of material. The following soil associations occur in the Yellow Breeches Creek Watershed:

Athol-Neshaminy Association - Consists of deep, gently sloping and sloping, well-drained soils that formed in material weathered from conglomerate, breccias, and diabase; on uplands. (SCS, 1963, 1967, and 2002)

Berks-Weikert-Bedington Association – Consists of shallow to deep, gently sloping to very steep, well-drained soils that formed in material weathered from gray and brown shale, siltstone, and sandstone; on uplands. (SCS, 1963, 1967, and 2002)

Edgemont-Highfield Association – Consists of moderately deep and deep, well-drained, and medium textured soils that developed from basic rock on the slopes of ridges. (SCS, 1963, 1967, and 2002)

Hagerstown-Duffield Association – Consists of deep, nearly level to moderately steep, well-drained soils that formed in material weathered from limestone; on uplands. (SCS, 1963, 1967, and 2002)

Hazelton-Laidig-Buchanan Association – Consists of deep, nearly level to very steep, well-drained to somewhat poorly drained soils that formed in material weathered from gray and brown quartzite, sandstone, siltstone, and shale; on uplands. (SCS, 1963, 1967, and 2002)

Hazleton-Clymer Association - Consists of deep, nearly level to very steep, well-drained soils that formed in material weathered from gray sandstone and quartzite; on uplands. (SCS, 1963, 1967, and 2002)

Highfield-Glenville Association - Consists of deep, nearly level to moderately steep, well-drained to somewhat poorly drained soils that formed in material weathered from schist and rhyolite; on uplands. (SCS, 1963, 1967, and 2002)

Highfield-Myersville-Catoctin Association - Deep and well-drained, channery and stony soils on ridges, developed from metabasaltic and other basic rock. (SCS, 1963, 1967, and 2002)

Lewisberry-Steinsburg Association - Gently sloping to moderately steep, well-drained soils on dissected ridges and low hills, formed dominantly in residuum derived from sandstone and conglomerate. (SCS, 1963, 1967, and 2002)

Monongahela-Atkins-Middlebury Association – Consists of deep, nearly level and gently sloping, moderately well-drained to poorly drained soils that formed in alluvium; on terraces and floodplains. (SCS, 1963, 1967, and 2002)

Murrill-Laidig-Buchanan Association – Consists of deep, nearly level to moderately steep, well-drained to somewhat poorly drained soils that formed in colluvium from gray sandstone, conglomerate, quartzite, and limestone; on uplands. (SCS, 1963, 1967, and 2002)

Neshaminy-Lehigh Association – Consists of nearly level to very steep, deep, well-drained to somewhat poorly drained soils on ridges and hills, formed in residuum derived from diabase and porcelanite. (SCS, 1963, 1967, and 2002)

Penn-Lansdale-Readington Association – Consists of nearly level to strongly sloping, moderately deep, well-drained soils on rolling uplands, formed in residuum derived from shale, siltstone, sandstone, and conglomerate. (SCS, 1963, 1967, and 2002)

Hydric Soils

The definition of a hydric soil is a soil that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part. The concept of hydric soils includes soils developed under sufficiently wet conditions to support the growth and regeneration of hydrophytic vegetation. Soils that are sufficiently wet because of artificial measures are included in the concept of hydric soils. Also, soils in which the hydrology has been artificially modified are hydric if the soil, in an unaltered state, was hydric. Some series, designated as hydric, have phases that are not hydric depending on water table, flooding, and ponding characteristics. (Natural Resources Conservation Service (NRCS), 2003) See Table B.2 for a complete list of hydric soils occurring in the Yellow Breeches Creek Watershed. The majority of the hydric soils are generally distributed along the streams and within the floodplains, especially in the upper reaches of the watershed west of S.R. 15. The definition of prime soils includes prime farmland and farmland of statewide importance. These prime soils are well distributed throughout the watershed with the exception of the steeper areas west of S.R. 15, in the upper reaches of Mountain Creek and between Mountain Creek and Yellow Breeches Creek. See the Soils Map for the locations of hydric soils within the watershed.

Table B.2 Hydric Soils Occurring in the Yellow Breeches Creek Watershed (ACCD, CCCD, YCCD, 2004)

Map Unit	Soil
AnB	Andover gravely loam 0 to 8 percent slopes
Aob	Andover very stony loam 0 to 8 percent slopes
Aw	Atkins silt loam 0 to 3 percent slopes
BrA	Brinkerton silt loam 0 to 3 percent slopes
BrB	Brinkerton silt loam 3 to 8 percent slopes
Me	Melvin silt loam 0 to 3 percent slopes
Ba	Baile silt loam 0 to 3 percent slopes
Bo	Bowmansville silt loam 0 to 3 percent slopes
CrA	Croton silt loam 0 to 3 percent slopes
CrB	Croton silt loam 3 to 8 percent slopes
Hc	Hatboro silt loam 0 to 3 percent slopes
WaA	Watchung silt loam 0 to 3 percent slopes
WbB	Watchung bouldery silt loam 0 to 8 percent slopes

Agricultural Capability

Soils affect a variety of human activities from agriculture to the engineering and construction of roads, buildings, and sewage disposal systems within the Yellow Breeches Creek Watershed. Soils are critical in determining the productivity and viability of agricultural operations within the Yellow Breeches Creek Watershed. The USDA NRCS evaluates soils in terms of their capacity to support agriculture. These range from Class I soils, which are productive and easy to work, to Class VIII soils, which are not suitable for growing crops, pasture, or trees for profit. The eight classes in the capability system are:

Class I (Prime) - Soils that have few limitations that restrict their agricultural use. (NRCS, 2004)

Class II (Good) - Soils that have some limitations that reduce the choice of plants and require moderate conservation practices. (NRCS, 2004)

Class III (Fair) - Soils that have severe limitations that reduce the choice of plants, require special conservation practices, or both. (NRCS, 2004)

Class IV (Poor) - Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both. (NRCS, 2004)

Class V (Poor) - Soils that are not likely to erode but have other limitations, impractical to remove without major reclamation, that limits their use largely to pasture, woodland, or wildlife food and cover. (NRCS, 2004)

Class VI (Poor) - Soils that have severe limitations that make them generally unsuitable for cultivation and that limit their use largely to pasture, woodland, or wildlife food and cover. (NRCS, 2004)

Class VII (Poor) - Soils that have very severe limitations that make them unsuitable for cultivation without major reclamation and that restrict their use largely to grazing, woodland, or wildlife. (NRCS, 2004)

Class VIII (Poor) - Soils and landforms that have limitations that preclude their use, without major reclamation, for commercial protection of plants and that restrict their use to recreation, wildlife, or esthetic purposes. (NRCS, 2004)

Prime soils are generally distributed across the majority of the lower watershed and the northern portion of the upper watershed.

See Table B.3 for a complete list of Capability Class I and II soils occurring in the Yellow Breeches Creek Watershed. (SCS, 1963, 1967, and 2002) See the Soils Map for the locations of prime soils.

Table B.3 Capability Class I and II Soils Occurring in the Yellow Breeches Creek Watershed

Soil Series	**Map Unit**	**Capability Class**
ALLEGHENY	AgA	I
ALLEGHENY	AgB	II
ATHOL	AtB	II
BEDINGTON	BdB	II
BERKS	BeB	II
BIRDSBORO	BoA	I
BIRDSBORO	BgB	II
BRECKNOCK	BrB	II
BUCHANAN	BuB	II
CHAGRIN	Cd	II
CHAVIES	Ch	I
CLARKSBURG	CkA	II
CLARKSBURG	CkB	II
CODOROUS	Cm	II
DUFFIELD	DuA	I
DUFFIELD	DuB	II
DUFFIELD	DuC	II
DUNCANNON	DxA	I
DUNCANNON	DxB	II
EDGEMONT	EdB	II
EDOM	EdB	II
ELK	EkA	I
ELK	EkB	II
ERNEST	EtB	II
GLENVILLE	GnB	II
GLENVILLE	GdA	II
GLENVILLE	GdB	II
HAGERSTOWN	HaA	I
HAGERSTOWN	HaB	II
HAZLETON	HeB	II
HIGHFIELD	HgB	II
HUNTINGTON	HuA	I
LAIDIG	LdB	II
LANSDALE	LeB	II
LEGORE	LgB	II
LEHIGH	LhA	II
LEHIGH	LhB	II
LEWISBERRY	LrB	II
LINDSIDE	Ls	II
LINDSIDE	Lw	II
MIDDLEBURY	Mf	II
MONONGAHELA	MnA	II
MONONGAHELA	MnB	II
MORRISON	MoB	II
MOUNT LUCAS	MdA	II
MURRILL	MuA	I
MURRILL	MuB	II
MURRILL	MvB	II
NESHAMINY	NeB	II
NESHAMINY	NaB	II
PENN	PeB	II
PENN	PoB	II
RARITAN	RaB	II
READINGTON	ReA	II
READINGTON	ReB	II
ROWLAND	Rw	II
TIOGA	Tg	I

Steep Slopes

Overcoming constraints and hazards of structural development on steep slopes in the Yellow Breeches Creek Watershed can be very difficult and expensive. Municipalities, recognizing threats to resident life and health, can restrict inappropriate structural development on steep slopes (over 25%), as well as more moderate slopes where structural problems are likely for the landowner or municipality. These steep slopes are generally distributed throughout the central area of the upper portion of the Yellow Breeches Creek Watershed. Steep slopes have been plotted on the Topography Map based on soils data. Recommendations regarding steep slopes are being offered only as a guideline, as each municipality may have regulations that are specific to the needs of that respective area. The following are some guidelines often considered in controlling the development of sloping land:

Any site disturbance exceeding 15% shall be minimized. No site disturbance shall be allowed on slopes exceeding 25% except under the following circumstances: logging and woodcutting shall be by specific approval and shall be limited to highly selective removal of trees. Maximum precautions shall be taken to avoid destruction or injury of understory brush and trees, and grading for a portion of a driveway accessing a single-family dwelling when it can be demonstrated that no other routing which avoids slopes exceeding 25% is feasible. On slopes of 20-25%, the only permitted grading or earthmoving shall be in conjunction with the siting of a single-family dwelling unit and the access driveway. Tillage and nursery operations shall not be conducted on slopes exceeding 15%, and sod operations shall not be conducted on slopes exceeding 8%, except where minimum tillage methods approved by SCS or the County Soil Conservation District are followed. Grading or earthmoving on all sloping lands exceeding 15% shall not result in earth cuts or fills whose highest vertical dimension exceed 10 feet, except where no reasonable alternatives exist for construction of public roads, drainage structures, and other public improvements, in which case such vertical dimensions shall not exceed 20 feet. Finished slopes of all cuts and fills shall not exceed 3:1, unless the applicant can demonstrate that steeper slopes can be stabilized and maintained adequately. Soil maps can be used to develop stormwater management plans for areas as large as watersheds or as small as construction sites. The amount of water that runs off an area is dependent upon the soil's ability to absorb water and the amount of the land that is covered by vegetation. The type of soil found in an area is largely determined by the underlying rock strata. (Department of Environmental Resources (DER), 1992)

Erosion and Sedimentation

Erosion is the process by which soil or rock material is loosened and moved from place to place on the surface. Erosion and sedimentation is a natural process, even in forested areas, but anthropogenic, or human influences, increase the rate of erosion and sedimentation. Through weathering, frost action, flowing water, wind and other causes, the cohesive properties of the soil are overcome. The loosened particles are then vulnerable to being transported by water, wind, or other forces. Flowing water tends to have the greatest erosion capability. Composition and cohesiveness, slope, vegetation, erosion control practices, and the intensity and duration of rainfall are factors that affect the amount of soil loss from water erosion in the Yellow Breeches Creek Watershed. Not only does erosion result in the loss of valuable soil, but it also allows particles to be deposited as sedimentation in stream channels. Eroded material that reaches the stream becomes a serious form of water pollution. The flooding potential also increases as the stream channel capacity decreases due to an increased sediment load. Stream health is also affected by sediment that destroys spawning grounds and aquatic habitat and alters the species composition of fish populations. The ecological balance of the stream is affected, as sediment reduces the depth of light penetration in the stream. (DER, 1992)

Erosion rates in the Yellow Breeches Creek Watershed are increased by disturbing the soil. Soil disturbances can be caused by agricultural practices, construction activity, removal of ground cover, and soil compaction. Carelessly plowed fields, uncontrolled construction procedures, and poor site stabilization contribute to substantial loss of soil. Erosion is increased when disturbed sites are located on steep slopes. Some farming processes can be harmful to the Yellow Breeches Creek. For example, grazing many cows on too small an acreage makes it difficult for vegetation to thrive. Lack of vegetation allows soil to flow in the stream when loosened by rainfall. Animal access to stream channels can also contribute to erosion and sedimentation. Nutrient build-up is another problem associated with cattle. After a rainstorm, runoff from fertilized fields can contribute high levels of nitrogen and phosphorous to the stream. Terracing the pasture areas along the Yellow Breeches Creek can help decrease erosion; however, the best practice is to reduce the number of cows and allow vegetation to become established. It is particularly important to establish a vegetative buffer or strip along the stream, to prevent soil and nutrients from entering the stream. (DER, 1992)

Soil erosion can be greatly reduced through conservation practices such as strip farming, terraces, crop rotation, and improved pastures. Contour farming and strip cropping are common erosion control practices adopted for crop and pasture lands containing smooth, uniform slopes similar to those of Berks, Hagerstown, and Neshaminy soils. Minimizing tillage, cover cropping, and leaving crop residue on the surface help increase filtration and reduce the hazard of erosion. Any time soil is disturbed in the Yellow Breeches Creek Watershed, it is susceptible to erosion. Construction activities that strip vegetative cover and compact soils can pollute nearby streams with sediment. To decrease the potential detrimental effects that erosion and sedimentation can cause, state laws require erosion and sedimentation control plans for all soil disturbance activities. County conservation districts administer the erosion and sedimentation control program. Techniques for controlling erosion from disturbed terrain include decreasing the amount of land exposed at any one time, rerouting runoff into vegetation-lined channels around exposed areas with diversion terraces, slowing and diverting runoff into sedimentation basins, and replanting exposed areas as soon as possible. (DER, 1992)

Highly erodible soils in the Yellow Breeches Creek Watershed are associated with steep slopes generally distributed in the central portion of the upper watershed. See the Soils Map for locations of highly erodible soils. Development in the locations of these highly erodible soils should be discouraged.

Geology

The valley area of the Yellow Breeches Creek Watershed is composed largely of limestone. This less resistant rock creates small hills with gentle to rolling slopes. The area between the valley and the mountain is called colluvium. These are soils that were part of the South Mountain, but have fallen to this transition zone over time from gravity, wind, and erosion on the landscape. South Mountain is composed largely of resistant quartzite and sandstone. These resistant rocks create steep to moderate slopes and deep cut valleys. Rocks of three geologic periods are exposed along the Yellow Breeches Creek. From oldest to youngest, they are Cambrian, Ordovician, and Triassic. The Great Valley section is underlain by sedimentary, metamorphic, and igneous rocks, ranging from Early Cambrian to Triassic Age spanning millions of years from 190 million to 550 million years ago. South Mountain is composed of parallel ridges trending northeastward and separated by valleys. These ridges are formed by resistant quartzites, metabasalt, metarhyolite, and volcanic greenstone. The valleys are often different from each other and depend on the rock type which underlies them. The flattest and most fertile valleys are floored by limestone. (DER, 1992)

The Cambrian rocks are metamorphic quartzite, quartzitic conglomerate, and quartzitic schist. In addition, sedimentary rocks include purple shale and silicious limestone. The oldest exposed rock in the watershed is the Weverton and Loudoun Formations, undivided, of Early Cambrian Age, which is exposed in the uppermost headwaters portion of the stream along the western side of South Mountain in South Newton Township. Most of these rocks contain marine fossils, indicating early signs of life on the earth. The Ordovician rocks are sedimentary in origin and include limestone, conglomerate, dolomite, chert, and shale; these rocks form the floor of the Cumberland Valley. A small area in southeastern Cumberland County, along the York County boundary, has exposed rock from the Triassic age. The rocks are mostly coarse-grained quartzose sandstone with shale interbeds and quartz conglomerate. An intermittent diabase sill of gray plagioclase feldspar and black and green augite bisects the survey area. The youngest rock unit, Triassic-Age diabase, was originally molten magma that was intruded as dikes and sheets into the surrounding older rocks. An excellent example of this phenomenon is found at Boiling Springs. (DER, 1992)

The major structural features found within the Yellow Breeches Creek Watershed are two folds, the South Mountain anticlinorium on the east and the Massanutten synclinorium on the west. The South Mountain fold is a large asymmetrical overturned anticline, which dips to the southeast, while the Massanutten is a large scale downfold comprising locally the Cumberland Valley carbonates. Most of the major faults in the area are high-angle, reverse faults, some of which can be traced for tens of miles. The Yellow Breeches Creek thrust sheet, however, is a nearly horizontal structure, which truncates South Mountain structural features along the Yellow Breeches Creek fault. (DER, 1992)

Formations

The geology of the Yellow Breeches Creek Watershed is classified according to geological formations. The following geological formations occur in the Yellow Breeches Creek Watershed:

Annville Formation (Oan): Light-gray, high-calcium limestone, mottled at base; maximum thickness is about 250 feet. (Socolow, 1982)

Antietam Formation (Ca): Light-gray, buff-weathering quartzite and quartz schist; some ferruginous quartzite; fine-grained; maximum thickness is about 300 feet. (Socolow, 1982)

Chambersburg Formation (Oc): Dark-gray limestone at the top, gray argillaceous limestone in the middle, and dark-gray cobbly limestone at the base; maximum thickness is about 770 feet. (Socolow, 1982)

Diabase (Jd): Occurs primarily as dikes and sheets; the dikes are generally 5 to 100 feet thick and the sheets much thicker; in most places, the rock is dark gray to black, dense, and very fine grained, and consists of 90 to 95 percent labradorite and augite. (Socolow, 1982)

Elbrook Formation (Ce): Light-gray to yellowish-gray, finely laminated, siliceous limestone having interbeds of dolomite; cherty; thickness is about 3,000 feet. (Socolow, 1982)

Epler Formation (Oe): Very finely crystalline, medium-gray limestone interbedded with gray dolomite; coarsely crystalline limestone lenses are present; approximately 1,000 feet thick. (Socolow, 1982)

Gettysburg Formation (Trg and Trgc): Coarse quartz conglomerate containing rounded pebbles and cobbles in a matrix of red sand; maximum thickness is 7,300 feet. (Socolow, 1982)

Greenstone Schist (vs): Greenish-gray, lustrous phyllite and schist; some finely banded, light greenish gray, dusky yellow green, and grayish yellow green; thickness is generally less than 100 feet, locally up to 150 feet. (Socolow, 1982)

Hamburg Sequence Rocks (Oh): Transported rocks of the Hamburg overthrust; gray, greenish-gray, and maroon shale, silty and siliceous in many places; dark-gray, and maroon shale, silty and siliceous in many places; dark-gray impure sandstone; medium to light-gray, finely crystalline limestone and shaly limestone; total thickness is about 3,000 feet. (Socolow, 1982)

Harpers Formation (Ch): Dark-greenish gray phyllite and albite-mica schist; coarse-grained; abundant quartz; maximum thickness is about 1,500 feet. (Socolow, 1982)

Heidlersburg Member of Gettysburg Formation (Trgh): Gray to white sandstone having interbeds of red shale and sandstone; some green, gray, and black shale; near diabase sheets; these rocks have been altered to white quartzite, white sandstone, and dark-purplish argillite; thickness is 4,800 feet. (Socolow, 1982)

Hershey Formation (Ohm): Dark-gray to black, argillaceous limestone; weathers medium gray to light brown, finely crystalline; basal conglomerate contains angular boulders of dolomite; maximum thickness may reach 1,000 feet. (Socolow, 1982)

Limestone Fanglomerate (Trfl): Composed chiefly of limestone and dolomite pebbles and fragments; fragments are angular and up to 8 inches in diameter; fragments and pebbles are mostly yellow gray to light medium gray; a few shale Fanglomerate interbeds; very fine grained, red quartz matrix; approximately 200 feet thick. (Socolow, 1982)

Loudoun Formation (Cwl): Dark-gray, dusky-blue, and very dusky-red purple phyllite interbedded with fine-grained sandstone; phyllite may contain elongated, ivory-colored spots; contains conglomerate with gray quartz pebbles and pinkish-gray granite fragments, surrounded by a gray to greenish, micaceous to sandy matrix; maximum thickness is about 150 feet. (Socolow, 1982)

Martinsburg Formation (Om and Oml): Buff-weathering, dark-gray shale, and thin interbeds of siltstone, metabentonite, and fine-grained sandstone; brown-weathering, medium-grained sandstone containing shale and siltstone interbeds that occurs in the middle of the formation; basal part grades into limy shale and platy-weathering, silty limestone; may be 12,800 feet thick. (Socolow, 1982)

Metabasalt (mb): Characteristically green, greenish-gray, and dark-gray; fine to medium grained; medium to coarse color banding; veins and masses of quartz; estimated thickness is in excess of 1,000 feet. (Socolow, 1982)

Metarhyolite (mr): Moderate bluish-gray to grayish-blue, and grayish-red; some is banded; uniformly fine grained; some is porphyritic, containing phenocrysts of both quartz and feldspar; at least 1,000 feet thick. (Socolow, 1982)

Montalto Member of Harpers Formation (Chm): Light-gray, vitreous quartzite; sometimes green to bluish gray; dark-gray phyllite at top; approximately 75 feet thick, including 10+ feet of phyllite. (Socolow, 1982)

Myerstown Formations (Ohm): Medium to dark-gray, medium-crystalline limestone; dark-gray to black carbonaceous limestone at base; coarse calcarenite beds are common; average thickness is about 220 feet. (Socolow, 1982)

Pinesburg Station Formation (Ops): Light to medium-gray, laminated to banded dolomite; contains black chert nodules and white quartz rosettes; interbeds of medium-gray limestone; maximum thickness is about 300 feet. (Socolow, 1982)

Quartz Fanglomerate (Trfq): Coarse conglomerate containing rounded cobbles and boulders of quartzite, sandstone, quartz, and some metarhyolite in a matrix of red sand; thickness is unknown. (Socolow, 1982)

Rockdale Run Formation (Orr): Very light gray, finely laminated, fine-grained limestone; pink to brown lenses of chert; a few dolomite beds; white quartz rosettes near the top of the formation; estimated to be 2,000 to 2,500 feet thick. (Socolow, 1982)

Shadygrove Formation (Csg): Light-gray to pinkish-gray, finely crystalline limestone; fossiliferous; abundant nodules of brown chert; few sandstone beds; few beds of laminated dolomite; estimated maximum thickness of 1,000 feet. (Socolow, 1982)

St. Paul Group (Osp): Buff-colored, magnesium limestone containing numerous layers of chert; high-calcium limestone in part; 580 feet thick. (Socolow, 1982)

Stonehenge Formation (Os): Gray, finely crystalline limestone and dark-gray laminated limestone; contains numerous flat-pebble breccia beds and shaly interbeds; maximum thickness is 1,500 feet. (Socolow, 1982)

Tomstown Formation (Ct): Upper part is medium-dark-gray to dark-gray, medium-crystalline dolomite, oolitic and laminated; lower part is medium-light-gray to pinkish-gray, finely crystalline, sandy dolomite; maximum thickness is approximately 1,000 feet. (Socolow, 1982)

Waynesboro Formation (Cwb): Sandy dolomite, containing fine-grained to silt-sized quartz; interbanded limestone and dolomite; chert and white vein quartz are common; limestone is dark gray to very light gray; near the top, beds of dark-red to purple sandy shale, siltstone, and sandstone occur; maximum thickness is approximately 1,000 feet. (Socolow, 1982)

Weverton Formation (Cwl): Gray to purplish-gray, coarse-grained, feldspathic quartzite and quartzose conglomerate, containing rounded pebbles; maximum thickness is 1,200 feet. (Socolow, 1982)

Zullinger Formation (Cz): Interbanded medium-gray limestone and dolomite; interlaminated limestone and dolomite; thin dolomite; local thin quartzsand beds; probably 2,500 feet thick. (Socolow, 1982)

See the Geology Map for the locations of geological formations within the watershed.

Karst Topography

The Yellow Breeches Creek flows through an area of Pennsylvania that is known for its karst topography. The term karst is used to describe a type of topography that is formed over limestone or dolomite through dissolving or solution of the carbonate bedrock. A weak acid, known as carbonic acid, forms when water mixes with carbon dioxide in the atmosphere. As the water percolates through the soil, additional carbon dioxide is introduced from decaying organic material and bacterial activity to form more carbonic acid.

When this weak acid comes in contact with carbonate bedrock, it begins to slowly dissolve the limestone and dolomite. This dissolution of the carbonate bedrock occurs along natural breaks or fractures within the bedrock. Over long periods of time, thousands to millions of years, the bedrock is continually dissolved. The fractures become enlarged allowing more of the acidic water to enter the system. Voids in the bedrock cause sinkholes and caves to be formed. Numerous sinkholes, depressions, and caves are found within the Yellow Breeches Creek Watershed. The presence of this type of topography presents constraints to development, placement of utility systems (sewer and water lines), and a greater tendency for water contamination where development occurs. (DER, 1992)

Freestone Versus Limestone

A unique hydrogeology exists within the corridor of the Yellow Breeches Creek, which originates in the Michaux State Forest and extends approximately 49 miles to the Susquehanna River. The character of the creek changes as it flows from western, freestone areas to eastern, limestone areas. The differences between a freestone and limestone stream are formation, underlying bedrock, and source of water. Freestone streams gather their flow gradually as they grow from a tiny trickle into a broad river. Their main water source is from overland runoff, which causes these streams to have high fluctuations in water level. Limestone streams originate from underground sources like springs and form rather quickly. The limestone streams fluctuate very little due to a constant flow of groundwater. These streams also maintain a constant year-round temperature in the 50 to 60 degree range. (DER, 1992)

The headwaters of the Yellow Breeches Creek originates in the Michaux State Forest as a freestone stream. Freestone waters have naturally low fertility and are susceptible to acid precipitation, as well as other forms of pollution. While the state forest lands provide protection from some pollution sources, many of the freestone, headwater streams originating on South Mountain are impacted by acid rain. As the Yellow Breeches Creek flows into the limestone bedrock of the Cumberland Valley, the carbonate rocks dissolve to form carbonic acid that releases carbon dioxide and water. This nutrient-rich water is good for building viable natural communities accommodating increased plant photosynthesis and growth of microplankton, which enhances the food chain and provides for higher level biotic communities. The limestone along the main channel has allowed the stream to flourish not only because of its carbonate and carbon dioxide producing capabilities, but also its neutralizing capabilities, which protect the water from increased acidity. Being alkaline, it is a very good buffer of acidity and the source of the stream's natural fertility. (DER, 1992)

Geological Features

Numerous outstanding geological features are present in the Yellow Breeches Creek Watershed. The following features occur within the area of study:

Boiling Springs Caves is a group of three caves located near an abandoned limestone quarry in Boiling Springs.

Boiling Springs is located at the head of a small lake, serving as the site of a community park in South Middleton Township. Boiling Springs has a median flow of 11,500 gallons per minute and ranks seventh in size within Pennsylvania. It is one of the most picturesque springs in Pennsylvania attributable to its unique origin. Boiling Springs was formed from folded limestones and dolomites, which were injected by a near vertical, thin diabase dike. This configuration forms a hydrologic barrier and confines the groundwater between the dikes creating pressure which sends its waters to the surface producing a bubbling/boiling effect.

Bowmansdale Cave is located in the limestone quarry at the west end of Bowmansdale in Upper Allen Township. The cave is a crooked crevice along one or more joints in the Jacksonburg limestone, with smooth flowstone walls. Stalagmites and stalactites are present. Access to the cave can be made by rope or ladder.

Centerville Cave is located off Route 233 at Centerville in Penn Township. The entrance is in a low outcrop, which opens into a 30-foot long room with an irregular and pitted ceiling and walls covered by flowstone.

Chimney Rocks is located in the southwestern corner of Penn Township. Chimney Rocks is a spire of quartzite in the shape of a chimney that rises above the surrounding ridge line. A USGS triangulation station and bronze marker are located at this site.

Craighead Cave is a small cave located four miles south of Carlisle in South Middleton Township in the north bank of the Yellow Breeches Creek. Craighead Cave, commonly referred to as "Bear Hole", is often used as a retreat for wild animals and is frequently flooded by the creek.

Hammonds Rocks is located 4.4 miles southwest of Mount Holly Springs Borough on the crest of South Mountain and provides a magnificent overlook and view of the Blue Ridge province. Outcrops of Weverton conglomerate show pebbles that have been elongated due to deformation.

Huntsdale Hatchery Springs is located in Penn Township. These springs are owned and used by the Pennsylvania Fish Commission for its Huntsdale Hatchery. This group of three springs is the sixth largest in Pennsylvania, with a combined median flow of 12,000 gallons per minute.

Lewis Rocks is located in Southampton Township, approximately 13 miles north of Caledonia and Route 30, on Big Hill on South Mountain, within Michaux State Forest.

Lisburn Cave is located on the York County side of the Yellow Breeches Creek in Fairview Township. This cave formed in sediments containing limestone conglomerate and consists of approximately 700 feet of passages.

Pole Steeple is located in Cooke Township about two miles east of the Village of Pine Grove Furnace, 0.3 miles north of the Appalachian Trail and 0.4 miles south of the Laurel Lake and Pine Grove Furnace State Park. This magnificent pillar of rock rises over South Mountain and provides an exceptional view of Mountain Creek Valley and the surrounding highlands. Pole Steeple is a hard, light-gray quartzite (Montalto member of the Harpers Formation, Cambrian age). Less resistant rocks in the valley to the north around Laurel Lake are metarhyolite and dolomite. These two rock types were faulted upward against the quartzite, and, because they erode more rapidly than the quartzite, they now occupy a lower topographic position.

Sunset Rocks is located in Cooke Township on Little Rocky Ridge, about one mile west of Pine Grove Furnace State Park. A balanced pinnacle about 15 feet high is a striking solitary feature of Sunset Rocks. Different rates of erosion have caused this hard, dense, light gray, coarse-grained sandstone and quartzite (Weaverton Formation, Cambrian age) to weather in relief against the surrounding rocks. Individual beds also may weather faster than others, causing the balanced pinnacle.

Walnut Bottom Cave is a small cave located 0.5 mile north of Walnut Bottom in South Newton Township. The cave has been filled and is no longer accessible.

White Rocks is located west of Dillsburg Borough on the north rim of South Mountain in Monroe Township. White Rocks is a pinnacle ridge of quartzite of the Antietam Formation crossed at Center Point Knob by the Appalachian Trail.

Williams Grove Caves is a group of two small caves located in an abandoned Williams Grove quarry in Carroll Township. Cave #1 is 70 feet long and ranges in height from 5 to 10 feet; it contains smoothly rounded walls that have thin, sharp, projecting quartz veins. Cave #2 is a 3-foot high fissure that dips downward for approximately 30 feet.

Yellow Breeches Cave is located north of Lisburn and 1,000 feet downstream from a steel truss bridge over the Yellow Breeches Creek in Fairview Township. The cave is a fissure in limestone at creek level that extends approximately 50 feet.

WATER RESOURCES

An inventory of water resources within the Yellow Breeches Creek Watershed was completed as part of this report. The inventory of water resources included a review of Chapter 93 criteria and the 2004 Pennsylvania Integrated Water Quality Monitoring and Assessment Report (PIMAR). Scenic resources including lakes, ponds, and wetlands were located on available maps. Available information related to water supply, groundwater, permitted dams, and floodplains was collected as part of this inventory. See the Water Features Map for the location of water resources within the watershed.

Chapter 93 Criteria

Chapter 93 sets forth water quality standards for surface waters of the Commonwealth, including wetlands. These standards are based upon water uses which are to be protected and will be considered by the Department in its regulation of discharges. When an interstate or international agency under an interstate compact or international agreement establishes water quality standards applicable to surface waters of the Commonwealth, including wetlands, more stringent than those in this title, the more stringent standards apply. See Table B.4 for a summary of the Chapter 93 criteria for the watershed. The following list of symbols applies specifically to protected uses of the Yellow Breeches Creek and its tributaries:

Aquatic Life

(CWF) Cold Water Fishes—Maintenance or propagation, or both, of fish species including the family Salmonidae and additional flora and fauna that are indigenous to a cold water habitat.

(TSF) Trout Stocking—Maintenance of stocked trout from February 15 to July 31, and maintenance and propagation of fish species and additional flora and fauna that are indigenous to a warm water habitat.

Special Protection

(HQ) High Quality Waters

Table B.4 Chapter 93 Criteria (PA DEP, 2003)

Stream	***Class***	***Zone***	***County***	***Water Uses Protected***	***Exceptions***
Yellow Breeches Creek	2	Main Stem, Source to LR 21012	Cumberland	HQ-CWF	None
Unnamed Trib to Yellow Breeches Creek	3	Basin, Source to LR 21012	Cumberland	HQ-CWF	None
Hairy Springs Hollow	3	Basin	Cumberland	HQ-CWF	None
Sthromes Hollow	3	Basin	Cumberland	HQ-CWF	None
Watery Hollow	3	Basin	Cumberland	HQ-CWF	None
Peach Orchard Hollow	3	Basin	Cumberland	HQ-CWF	None
Bettem Hollow	3	Basin	Cumberland	HQ-CWF	None
State Road Hollow	3	Basin	Cumberland	HQ-CWF	None
Irishtown Gap Hollow	3	Basin	Cumberland	HQ-CWF	None
Kings Gap Hollow	3	Basin	Cumberland	HQ-CWF	None
Spruce Run	3	Basin	Cumberland	HQ-CWF	None
Mountain Creek	3	Basin, Source to Toland	Cumberland	HQ-CWF	None
Mountain Creek	3	Basin, Toland to Mt. Holly Springs	Cumberland	CWF	None
Mountain Creek	3	Basin, Mt. Holly Springs to Mouth	Cumberland	TSF	None
Old Town Run	3	Basin	Cumberland	HQ-CWF	None
Yellow Breeches Creek	2	Main Stem, LR 21012 to Mouth	Cumberland, York, Dauphin	CWF	Delete DO1, Add DO4
Unnamed Trib to Yellow Breeches Creek	3	Basin, LR 21012 to Mouth	Cumberland, York	CWF	None
Dogwood Run	3	Basin	Cumberland	CWF	None
Stony Run	3	Basin	York	CWF	None
Pippins Run	3	Basin	York	CWF	None
Cedar Run	3	Basin	Cumberland	CWF	None

Notes: Locust Point Road is L.R. 21012.
Class 2 is tributary to the Susquehanna River.
Class 3 is tributary to Class 2.

2004 PIMAR

For 2004, PA DEP has adopted an integrated format for Clean Water Act Section 305(b) reporting and Section 303(d) listing. This new report is entitled the “2004 Pennsylvania Integrated Water Quality Monitoring and Assessment Report” and satisfies the requirements of both Sections 305(b) and 303(d). The narrative report contains summaries of various water quality management programs including water quality standards, point source control and nonpoint source control. It also includes descriptions of programs to protect lakes, wetlands and groundwater quality. (PA DEP, 2004)

PA DEP has an ongoing program to assess the quality of waters in Pennsylvania and identify streams and other bodies of water that do not meet water quality standards (WQSs) as “impaired.” Water quality standards are comprised of the uses (including antidegradation) that waters can support and goals established to protect those uses. Uses include, among other things, aquatic life, human health, and recreation, while the goals are numerical or narrative water quality criteria that express the in-stream levels of substances that must be achieved to support the uses. (PA DEP, 2004)

Section 303(d) of the Act requires states to list all impaired waters not supporting uses even after appropriate and required water pollution control technologies have been applied. For example, a waterbody impacted by a point source discharge that is not complying with its effluent limits would not be listed on the 303(d) list. The Department would correct the water impairment by taking a compliance action against the discharger. If the waterbody still did not meet water quality standards after achieving compliance with its permit requirements, it would be included on the 303(d) list of impaired waters. The 303(d) list includes the reason for impairment, which may be one or more point sources (like industrial or sewage discharges), or non-point sources (like abandoned mine lands or agricultural runoff). (PA DEP, 2004)

Table B.5 summarizes tributaries within the Yellow Breeches Creek Watershed that are included on the 2004 PIMAR.

Table B.5 2004 PIMAR (PA DEP, 2004) Chapter 93 Tributaries

Tributary	Length	List Impaired Study Length	Impairment	Cause of Impairment
Hairy Springs Hollow	4.3 mi.	4.3 mi.	pH	Atmospheric Deposition
Sthromes Hollow	5.0 mi.	3.3 mi.	pH	Atmospheric Deposition
Watery Hollow	4.6 mi.	4.6 mi.	pH	Atmospheric Deposition
Peach Orchard Hollow	3.4 mi.	1.9 mi.	pH	Atmospheric Deposition
Bettem Hollow	3.8 mi.	2.1 mi.	pH	Atmospheric Deposition
State Road Hollow	2.3 mi.	0.4 mi.	pH	Atmospheric Deposition
Irishtown Gap Hollow	3.4 mi.	1.1 mi.	pH	Atmospheric Deposition
King's Gap Hollow	3.0 mi.	1.1 mi.	pH	Atmospheric Deposition
Old Town Run	3.4 mi.	2.3 mi.	Siltation	Unknown
Dogwood Run	5.7 mi.	2.6 mi.	Suspended Solids, Organic Enrichment, Low D.O.	Municipal Point Source
Stony Run	7.2 mi.	1.4 mi.	Siltation, Organic Enrichment, Low D.O.	Agriculture
Cedar Run	2.7 mi.	1.2 mi.	Siltation, Nutrients	Natural Sources, Urban Runoff/Storm Sewers, Unknown Source
Total Impaired River Miles		**26.3 mi.**		

Wetlands

Wetlands within the Yellow Breeches Creek Watershed were identified through a review of the National Wetlands Inventory. (NWI, 2004) Wetlands are defined in terms of a combination of hydrology, soils, and vegetation. The definition used the U.S. Environmental Protection Agency (US EPA) and the U.S. Army Corps of Engineers (USACE) is as follows:

> *Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adopted for life in saturated soil conditions, including swamps, marshes, bogs, and similar areas.*

Types of wetlands are described based on their vegetation. Forested Wetlands are wet habitats where large woody trees such as American Sycamore, American Elm, Box Elder, Red or Silver Maple, River Birch, Blackgum, and Green Ash exist. Scrub-Shrub Wetlands are inhabited by small trees and low shrubby plants such as spice bush, swamp honeysuckle, highbush blueberry, winterberry, alder and willows. Emergent wetlands are vegetated by grasses, sedges, rushes, and other herbaceous plants that emerge from the water or soil surface. Emergent wetlands are only one-third as abundant as the forested, and only half as common as the scrub-shrub wetlands.

Wetlands have unique environmental characteristics. They act as natural flood control devices to store floodwaters, slow and help purify runoff, and act to recharge groundwater. Wetlands also provide critical wildlife habitat and recreational opportunities in the Yellow Breeches Creek Watershed. The most notable wetland area in the Yellow Breeches Creek Watershed is the *Mount Holly Preserve*. The 913-acre Mount Holly Preserve is an exceptional value wetland area along South Mountain. This unique site, located in the Borough of Mount Holly Springs, South Middleton and Dickinson Townships, supports a diverse community of species. (Tri-County Regional Planning Commission, 2000) In March 1992, The Nature Conservancy donated the preserve to Cumberland County as the county's first dedicated open space. The Nature Conservancy continues to manage the core 200-acre wetland and conduct trail maintenance. Hunting, fishing, and hiking is permitted on upland portions of the preserve. The majority of the wetlands within the watershed are found west of S.R. 15 and predominantly within the floodplains and along major streams such as Yellow Breeches Creek, Mountain Creek, Dogwood Run and Old Town Run. See the Water Features Map for the locations of mapped wetlands within the watershed.

Floodplains

Floodplains are defined as low-lying, flat areas adjacent to streams, which are subject to frequent, periodic flooding. For the purpose of land use planning, those areas delineated by the Federal Emergency Management Agency (FEMA) as within the 100-year flood boundary and those areas delineated as floodplain soils in the Soil Survey of Cumberland and Perry Counties, Pennsylvania, issued April 1986, should be considered as floodplains.

Floodplains are an intrinsic and beneficial aspect of the natural landscape. They allow for an increase in drainage during rainy periods and buffer the stream from any detrimental effects of surrounding land uses.

Benefits to preserving floodplains include the following:

- To prevent unnecessary property damage
- To minimize danger to the public health by protecting the water supply and promoting safe and sanitary drainage
- To reduce the financial burdens imposed on communities by flooding
- To comply with provisions of the National Flood Insurance Program and the Pennsylvania Flood Plain Management Act
- To provide sufficient drainage courses to carry abnormal flows of stormwater during periods of heavy precipitation
- To provide areas for groundwater absorption for recharge of subsurface water supplies

See the Water Features Map for the 100-year floodplain boundaries within the watershed.

Lakes and Ponds

Significant lakes and large ponds were identified on USGS topographic maps as part of the water resources for this report. See Table B.6 for a summary of the lakes and ponds in the Yellow Breeches Creek Watershed. These waterbodies are valuable recreation areas for residents of the Yellow Breeches Creek Watershed. Laurel Lake and Fuller Lake, in particular, cater to a variety of recreational activities including fishing, swimming, boating, camping and ice skating. See the Water Features Map for the location of lakes and large ponds within the watershed.

Table B.6 Significant Lakes and Large Ponds (USGS, 2004)

Name	County	Municipality
Big Pond	Cumberland	Southampton/South Newton Twp.
Children's Lake	Cumberland	South Middleton Township
Fuller Lake	Cumberland	Cooke Township
Laurel Lake	Cumberland	Cooke Township

Water Supply

Community water services are provided throughout the Yellow Breeches Creek Watershed by community water systems. These systems are owned by various entities including authorities, investors, water associations, and municipal governments. Some of the smaller water systems service mobile home parks. These smaller systems are self-contained and allow for minimal expansions to surrounding areas. Pennsylvania American Water Company (PAWC) is the largest water company in the Yellow Breeches Creek Watershed. A table listing twenty-nine (29) water suppliers was compiled as part of the scope of this project, but this information is not included in the final report as a result of water related security concerns. (PA DEP, 2004; ACCP; CCCP; YCCP, 2004)

Population growth projections for the three counties were taken from the respective comprehensive plans; these trends were then applied to the municipalities within the watershed. Current approximate total permitted water use within the Yellow Breeches Creek Watershed, as per PA DEP records, is 17 million gallons per day. Assuming a constant per capita water use, it is estimated that total permitted water use by the year 2020 could be as high as 20.75 million gallons per day. (PA DEP, 2004)

Groundwater

The topography of the Yellow Breeches Creek Watershed determines the drainage patterns and surface flow characteristics. Steeper slopes can contribute to increased runoff and erosion and decreased infiltration of water. The direction of groundwater flow is controlled in part by the topography. Bedrock geology has ultimate control on the storage and flow of groundwater. Geologic factors such as rock type, porosity, permeability, rock strata inclination, faults, joints, folds, bedding planes, and solution channels affect the supply and flow of groundwater. Natural groundwater quality is a result of interaction between the groundwater and the bedrock with which it is in contact. The more soluble bedrock types will allow more compounds to become dissolved in the groundwater. Groundwater quality will eventually affect surface water quality as it percolates into surface streams as base flow. (DER, 1992)

The Yellow Breeches Creek Watershed is primarily located within the Ridge and Valley physiographic province. The mountains forming the northern and southern borders of Cumberland County are part of the ridge portion of the province. Rock types in the ridge section are quartzite, sandstones, and conglomerates. Most of these rock types are tightly cemented and have a low primary porosity; they are hard and brittle so that numerous joints have developed. In general, the number and size of joint openings decrease with depth. With quartzite, jointing is the most important factor in groundwater production. A major portion of the Yellow Breeches Creek Watershed is recognized at the Great Valley, composed of limestone and dolomite. Often in the Great Valley, where limestone and dolomite occur at the surface or subsurface, serious problems may be expected from subsidence and sinkholes. Surface drainage passes directly into the groundwater systems through sinkholes creating a high potential for groundwater pollution. (DER, 1992)

Limestone geology usually produces a high groundwater yield. One of the highest yielding springs in Pennsylvania is located in the Yellow Breeches Creek Watershed – Boiling Springs in South Middleton Township. The remaining portion of the watershed is composed of Martinsburg shale. The Martinsburg shale provides about half of the wells of the Great Valley with an adequate amount of groundwater for domestic needs. The pore spaces in these shales are very small. Fortunately, joints break the shale and it is these joints, as well as spaces between bedding planes, that allow for some water movement. In hard, brittle shale, joints are more open and tend to have somewhat greater yields. (DER, 1992) See Table B.7 for a summary of the groundwater recharge rates within the watershed.

Table B.7 Groundwater Recharge Rates[1] (Taylor, Larry E. and William H. Werkheiser, 1984)

Hydrogeologic Unit	**Average Annual Groundwater Recharge (million gallons/day/mile^2)**
Shale in the western Great Valley and shale containing significant graywacke in the eastern Great Valley	0.53
Shale of the eastern Great Valley not containing significant graywacke	.44
Carbonate rocks in the eastern Great Valley	.75
Carbonate rocks in the western Great Valley	.64
Sedimentary rocks of the western Triassic Lowland section	.34
Sedimentary rocks of the eastern Triassic Lowland section	.51
Carbonate rocks of the western Conestoga Valley section	.51
Carbonate rocks of the eastern Conestoga Valley section	.70
Shale of the northern Conestoga Valley section	.53
Metamorphic rocks of the Conestoga Valley section (west of the Susquehanna River)	.31
Metamorphic rocks of the Piedmont Uplands section	.47

[1]The combination of dominant lithology and physiographic location was used to define hydrogeologic units.

Permitted Dams

Many dams are located within the Yellow Breeches Creek Watershed. Historically, these dams were used to provide water power to mills, factories and butcher shops.

Dam heights in the Yellow Breeches Creek Watershed are generally moderate to low, usually 10 feet or less. Most of the dams on the Yellow Breeches Creek are considered to be minor structures primarily used for irrigation, water supply, intakes, recreation, fish propagation, landscaping, water power, etc. The flood hazard potential is essentially nonexistent on these dams. Property losses would occur only in the reach just upstream from the dam. Four (4) dams in the Yellow Breeches Creek Watershed have larger drainage areas and are considered to have an intermediate flood hazard potential. These dams include Spanglers Mill, Yellow Breeches Milling Company, Mechanicsburg Gas and Water Company, and Riverton Water Company. The permitted dams in the Yellow Breeches Creek Watershed are constructed of a variety of materials such as earth, masonry, concrete, timber, and rockfill. (DER, 1992)

A table listing twenty-five (25) permitted dams within the Yellow Breeches Creek Watershed was compiled as part of the scope of this project and is shown on the Water Features Map. (PA DEP, 2004) Information in the table includes dam name, permittee, and location.

BIOLOGICAL RESOURCES

Habitat

The Yellow Breeches Creek Watershed supports an abundance of wildlife. There are a variety of non-game species of birds, amphibians, reptiles, and small mammals. Game species include white-tailed deer, gray squirrel, cottontail rabbit, turkey, ruffed grouse, ring-neck pheasant, woodcock, mourning dove, and various waterfowl. There are also red and gray fox, mink, muskrat, raccoon, weasel, opossum, black bear, bobcat, and beaver. (DER, 1992)

The Yellow Breeches Creek is respected as an outstanding fishery resource. The limestone waters of the Yellow Breeches Creek provide an excellent habitat for trout. While brown trout are more commonly present throughout the portion of the Yellow Breeches Creek which extends from the PAWC intake in New Cumberland Borough to the vicinity of the Route 233 bridge approximately 41 miles upstream, other trout species including rainbow trout are found in the lower reaches as well and brook trout constitute an important resource in the headwaters. The trout stocking and special catch and release areas provide diversity for the fishermen. The Yellow Breeches Creek attracts fishermen from the local area, state, and surrounding states to its banks to enjoy this valuable fishery resource. (DER, 1992)

The portion of Michaux State Forest in the Yellow Breeches Creek Watershed is designated as an important bird area by the Audubon Society and provides habitat to many interior forest bird species. This area supports a mix of both northern and southern bird populations, including high densities of Hooded Warbler, Eastern Wood-Pewee, Canada Warbler, Hermit Thrush, Kentucky Warbler, and Worm-Eating Warbler. During migration and summers, the mixed forests attract Wood Thrush, Veery, and Ovenbirds. Laurel Lake and two large reservoirs attract waterfowl and wading birds including Wood Duck, Common Loon, Pied-Billed Grebe, Common Merganser, Canada Goose, Mallard, Great Blue Heron, and Green Heron. Whip-poor-wills are also present. Several rock outcroppings in this area provide views of raptors during the fall migration season. (National Audubon Society, 2004)

The United States Fish & Wildlife Service (USFWS) and the Pennsylvania Game Commission (PGC) were contacted as sources of additional information for habitats of concern, but no additional information was available at the time of the writing of this report.

The Nature Conservancy lists two protected places within the Yellow Breeches Creek Watershed. The first is the Mount Holly Preserve which was donated by the Nature Conservancy to Cumberland County in 1992. The second is the Kings Gap Environmental Education Center which was purchased in 1973 and then transferred to the Pennsylvania DER. (Nature Conservancy, 2005)

Vegetation

Forests surrounding the Yellow Breeches Creek are composed of second and third-growth hardwoods. The primary forest cover type is the oak-hickory association, which consists mainly of white oak, red oak, and hickory, although black oak and chestnut oak are dominant in places. The principal associated species are yellow-poplar, shagbark hickory, white ash, red maple, and American beech. Table B.8 shows other tree species located in the Yellow Breeches Creek Watershed. The soils within the watershed are capable of supporting good stands of red oak, sugar maple, yellow-poplar, and white pine. Trees grow better in the deeper, well-drained soils than on the soils that are shallow to bedrock and poorly drained.

The Michaux State Forest covers approximately 43.6 square miles within the Yellow Breeches Creek Watershed, or 20% of the total watershed area. These woods provide recreational, wildlife and aesthetic value, while also helping to reduce erosion. American sycamores can be found along the streambanks of the Yellow Breeches Creek. Black walnut and pin oak are also species found within the watershed. (DER, 1992)

The Yellow Breeches Creek Watershed also provides habitat to numerous species of trees, shrubs, vines, and other herbaceous plants. See *Threatened and Endangered Species* below for vegetative species of special concern within the Yellow Breeches Creek Watershed.

Table B.8 Trees in the Yellow Breeches Creek Watershed (DER, 1992)

Common Name	Scientific Name
Ash, White	*Fraxinus americana*
Aspen, Bigtooth	*Populus grandidentata*
Aspen, Quaking	*Populus tremuloides*
Basswood	*Tilia Americana*
Beech, American	*Fagus grandifolia*
Birch, Black	*Betula lenta*
Birch, Gray	*Betula populifolia*
Birch, Yellow	*Betula alleghaniensis*
Cherry, Black	*Prunus serotina*
Cherry, Pin	*Prunus pennsylvanica*
Cucumbertree	*Magnolia acuminata*
Elm, American	*Ulmus Americana*
Elm, Slippery	*Ulmus rubra*
Gum, Black	*Nyssa sylvatica*
Hemlock, Eastern	*Tsuga Canadensis*
Hickory, Shagbark	*Carya ovata*
Maple, Red	*Acer rubrum*
Maple, Sugar	*Acer saccharum*
Oak, Black	*Quercus velutina*
Oak, Chestnut	*Quercus prinus*

Common Name	Scientific Name
Oak, Pin	*Quercus palustris*
Oak, Red	*Quercus rubra*
Oak, Scarlet	*Quercus coccinea*
Oak, White	*Quercus alba*
Pine, Pitch	*Pinus rigida*
Pine, Shortleaf	*Pinus echinata*
Pine, Virginia	*Pinus virginiana*
Pine, White	*Pinus strobes*
Poplar, Tulip	*Liriodendron tulipifera*
Sycamore, American	*Platanus occidentalis*
Walnut, Black	*Juglans nigra*

Wildlife

The Yellow Breeches Creek Watershed supports a broad variety of mammal, bird, reptile, amphibian, and fish species. The following tables summarize species known to exist within the watershed.

Table B.9 Mammals in the Yellow Breeches Creek Watershed (DER, 1992)

Common Name	Scientific Name
Bat, Big Brown	*Eptesicus fuscus*
Bat, Evening	*Nycticeius humeralis*
Bat, Hoary	*Lasiurus cinereus*
Bat, Red	*Lasiurus borealis*
Bat, Silver-Haired	*Lasionnycteris noctivagans*
Bear, Black	*Ursus americanus*
Beaver	*Castor canadensis*
Bobcat	*Lynx rufus*
Chipmunk, Eastern	*Tamias striatus*
Cottontail, Eastern	*Sylvilagus floridanus*
Coyote	*Canis latrans*
Deer, Whitetail	*Odocoileus virginianus*
Fox, Gray	*Urocyon cinereoargenteus*
Fox, Red	*Vulpes vulpes*
Mink	*Mustela vison*
Mole, Eastern	*Scalopus aquaticus*
Mole, Star-Nosed	*Condylura cristata*
Mouse, Deer	*Peromyscus maniculatus*
Mouse, House	*Mus musculus*
Mouse, Meadow Jumping	*Zapus hudsonius*
Mouse, White-Footed	*Peromyscus leucopus*
Muskrat	*Ondatra zibethica*
Myotis, Keen’s	*Myotis keenii*
Myotis, Little Brown	*Myotis lucifugus*

Common Name	Scientific Name
Myotis, Northern	*Myotis septentrionalis*
Opossum	*Didelphis virginiana*
Pipistrel, Eastern	*Pipistrellus subflavus*
Raccoon	*Procyon lotor*
Rat, Norway	*Rattus norvegicus*
Shrew, Least	*Cryptotis parva*
Shrew, Least	*Sorex dispar*
Shrew, Maryland	*Sorex fontinalis*
Shrew, Masked	*Sorex cinereus*
Shrew, Northern Shorttail	*Blarina brevicauda*
Shrew, Pygmy	*Sorex hoyi*
Shrew, Smoky	*Sorex fumeus*
Skunk, Striped	*Mephitis mephitis*
Squirrel, Eastern Gray	*Sciurus carolinensis*
Squirrel, Red	*Tamiascuiruus hudsonicus*
Squirrel, Southern Flying	*Glaucomys volans*
Vole, Meadow	*Microtus pennsylvanicus*
Vole, Pine	*Pitymys pinetorum*
Vole, Southern Red-backed	*Clethrionomys gapperi*
Weasel, Longtail	*Mustela frenata*
Woodchuck	*Marmota monax*
Woodrat, Eastern	*Neotoma magister*

Table B.10 Birds in the Yellow Breeches Creek Watershed (DER, 1992)

Common Name	Scientific Name
Bittern, American	*Botaurus lentiginosus*
Blackbird, Red-Winged	*Agelaius phoeniceus*
Blackbird, Rusty	*Euphagus carolinus*
Bluebird, Eastern	*Sialia sialis*
Bufflehead	*Bucephala albeola*
Canvasback	*Aythya valisineria*
Coot, American	*Fulica americana*
Cormorant, Double-Crested	*Phalacrocorax auritus*
Cowbird, Brown-Headed	*Molothrus ater*
Crow, Fish	*Corvus ossifragus*
Dickcissel	*Spiza americana*
Dove, Mourning	*Zenaida macroura*
Dowitcher, Short-Billed	*Limnodromus griseus*
Duck, American Bolack	*Anas rubripes*
Duck, Ring-Necked	*Aythya collaris*
Duck, Ruddy	*Oxyura jamaicensis*
Duck, Wood	*Aix sponsa*
Dunlin	*Calidris alpina*
Eagle, Bald	*Haliaeetus leucocephalus*

Common Name	Scientific Name
Egret, Cattle	*Bubulcus ibis*
Egret, Great	*Casmerodius albus*
Egret, Snowy	*Egretta thula*
Falcon, Peregrine	*Falco peregrinus*
Finch, House	*Carpodacus mexicanus*
Gadwall	*Anas strepera*
Gallinule, Common	*Gallinula chloropus*
Goldeneye, Common	*Bucephala clangula*
Goose, Canada	*Branta canadensis*
Goose, White-Fronted	*Anser albifrons*
Grackle, Common	*Quiscalus quiscula*
Grebe, Pied-Billed	*Podilymbus podiceps*
Grosbeak, Blue	*Guiraca caerulea*
Gull, Bonaparte's	*Larus Philadelphia*
Gull, Herring	*Larus argentatus*
Gull, Ring-Billed	*Larus delawarensis*
Hawk, Red-Shouldered	*Bueteo lineatus*
Heron, Black-Crowned Night	*Nycticorax nycticorax*
Heron, Great Blue	*Ardea herodia*
Heron, Green	*Butorides striatus*
Heron, Yellow-Crowned Night	*Nyctanassa violacea*
Ibis, Glossy	*Plegadis falcinellus*
Kestrel, American	*Falco sparverius*
Kingfisher, Belted	*Megaceryle alcyon*
Kinglet, Golden-Crowned	*Regulus satrapa*
Kinglet, Ruby-Crowned	*Regulus calendula*
Loon, Common	*Gavia immer*
Mallard	*Anas platyrhynchos*
Merganser, Common	*Mergus merganser*
Merganser, Hooded	*Laphodytes cucullatus*
Merganser, Red-Breasted	*Mergus serrator*
Merlin	*Falco columbarius*
Oldsquaw	*Clangula hyemalis*
Oriole, Northern	*Icterus galbula*
Oriole, Orchard	*Icterus spurius*
Ovenbird	*Seiurus aurocapillus*
Owl, Short-eared	*Asio flammeus*
Pintail, Northern	*Anas acuta*
Pipit, Water	*Anthus spinoletta*
Plover, Black-Bellied	*Pluvialis squatarola*
Plover, Lesser-Golden	*Pluvialis dominica*
Plover, Semipalmated	*Charadrius semipalmatus*
Rail, Virginia	*Rallus limicola*
Redhead	*Aythya americana*
Sandpiper, Pectoral	*Calidris melanotos*
Sandpiper, Semipalmated	*Calidris pusilla*

Common Name	Scientific Name
Sandpiper, Solitary	*Tringa solitaria*
Sandpiper, Spotted	*Actitis macularia*
Sapsucker, Yellow-Bellied	*Sphyrapicus varius*
Scaup, Greater	*Aythya marila*
Scaup, Lesser	*Aythya affinis*
Scoter, Black	*Melanitta nigra*
Shrike, Loggerhead	*Laniu ludovicianus*
Shrike, Northern	*Lanius excubitor*
Snipe, Common	*Capella gallinago*
Sora	*Porzana carolina*
Sparrow, Henslow’s	*Ammodramus henslowii*
Sparrow, White-Throated	*Zonotrichia albicollis*
Starling, European	*Strunus vulgaris*
Swallow, Rough-Winged	*Stelgidopteryx ruficollis*
Swallow, Tree	*Iridoprocne bicolor*
Swan, Mute	*Cygnus olor*
Swan, Whistling	*Olor columbianus*
Teal, Blue-Winged	*Anas discors*
Teal, Green-Winged	*Anas crecca*
Tern, Black	*Chlidonias niger*
Thrush, Gray-Cheeked	*Catharus minimus*
Thrush, Hermit	*Catharus guttatus*
Thrush, Swainson’s	*Catharus ustulatus*
Thrush, Wood	*Hylocichla mustelina*
Veery	*Catharus fuscescens*
Vireo, White-Eyed	*Vireo griseus*
Vulture, Black	*Coragyps atratus*
Warbler, Canada	*Wilsonia canadensis*
Warbler, Hooded	*Wilsonia citrina*
Warbler, Kentucky	*Oporornis formosus*
Warbler, Worm-eating	*Helmitheros vermivora*
Warbler, Yellow	*Dendroica petechia*
Waterthrush, Louisiana	*seiurus motacilla*
Waterthrush, Northern	*Seiurus noveboracensis*
Waswing, Cedar	*Bombycilla cedrorum*
Wigeon, American	*Anas americana*
Whip-poor-will	*Caprimulgus vociferous*
Woodcock, American	*Philohela minor*
Woodpecker, Pileated	*Dryocopus pileatus*
Wood-Pewee, Eastern	*Contopus virens*
Wren, Carolina	*Thryothorus ludovicianus*
Wren, Marsh	*Cistothorus palustris*
Wren, Sedge	*Cistothorus platensis*
Wren, Winter	*Troglodytes troglodytes*
Yellowlegs, Greater	*Tringa melanoleuca*
Yellowlegs, Lesser	*Tringa flavipes*

Table B.11 Reptiles in the Yellow Breeches Creek Watershed (DER, 1992)

Common Name	Scientific Name
Lizard, Northern Fence	*Sceloporus undulates hyacinthinus*
Northern Copperhead	*Agkistrodon contortrix mokasen*
Skink, Five-lined	*Eumeces fasciatus*
Snake, Black Rat	*Elaphe obsoleta obsoleta*
Snake, Eastern Garter	*Thamnophis sirtalis sirtalis*
Snake, Eastern Hognose	*Heterodon platyrhinos*
Snake, Eastern Milk	*Lampropeltis triangulum triangulum*
Snake, Northern Black Racer	*Coluber constrictor constrictor*
Snake, Northern Brown	*Storeria dekayi dekayi*
Snake, Northern Redbelly	*Storeria occipitomaculata occipitomaculata*
Snake, Northern Ringneck	*Diadophis punctatus edwardsii*
Snake, Northern Water	*Nerodia sipedon*
Snake, Ribbon	*Thamnophis sauritus*
Snake, Queen	*Regina septemvittata*
Timber Rattlesnake	*Crotalus horridus*
Turtle, Bog	*Clemmys muhlenbergi*
Turtle, Common Snapping	*Chelydra serpentina*
Turtle, Eastern Box	*Terrapene carolina*
Turtle, Map	*Graptemys geographica*
Turtle, Painted	*Chrysemys picta*
Turtle, Spotted	*Clemmys guttata*
Turtle, Stinkpot	*Sternotherusu odoratus*
Turtle, Wood	*Clemmys insculpta*

Table B.12 Amphibians in the Yellow Breeches Creek Watershed (DER, 1992)

Common Name	Scientific Name
Bullfrog	*Rana catesbeiana*
Frog, Eastern Gray Tree	*Hyla versicolor versiculor*
Frog, Northern Cricket	*Acris crepitans*
Frog, Northern Green	*Rana clamitans melanota*
Frog, Northern Leopard	*Rana pipiens*
Frog, Pickerel	*Rana palustris*
Frog, Wood	*Rana sylvatica*
Hellbender	*Cryptobranchus alleganiensis*
Newt, Red-Spotted	*Notophthalmus viridescens*
Peeper, Northern Spring	*Hyla crucifer*
Salamander, Eastern Mud	*Pseudotriton montanus montanus*
Salamander, Four-toed	*Hemidactylium scutatum*
Salamander, Jefferson	*Ambystoma jeffersonianum*
Salamander, Longtail	*Eurycea longicauda*
Salamander, Marbled	*Ambystoma opacum*
Salamander, Northern Dusky	*Desmognathus fuscus*

Common Name	Scientific Name
Salamander, Northern Red	*Pseudotriton rubber*
Salamander, Northern Spring	*Gyrinophilus porphyriticus*
Salamander, Northern Two-Lined	*Eurycea bislineata*
Salamander, Redback	*Plethodon cinereus*
Salamander, Slimy	*Plethodon glutinosus glutinosus*
Salamander, Spotted	*Ambystoma maculatum*
Toad, Eastern American	*Buto americanus americanus*
Toad, Eastern Spadefoot	*Scaphiopus holbrookii holbrookii*
Toad, Fowler's	*Bufo woodhousii fowleri*

Table B.13 Fish Species (S.R. 233 to Boiling Springs) (Pennsylvania Fish and Boat Commission (PFBC), 1978)

Common Name	Scientific Name
Blacknose Dace	*Rhinichthys Atratulus*
Bluegill	*Lepomis Macrochirus*
Bluntnose Minnow	*Pimephales Notatus*
Brook Trout	*Salvelinus fontinalis*
Brown Bullhead	*Ameiurus nebulosus*
Brown Trout	*Salmo trutta*
Central Stoneroller	*Campostoma anomalum*
Chain Pickerel	*Esox niger*
Common Carp	*Cyprinus carpio*
Common Shiner	*Luxilus cornutus*
Creek Chub	*Semotilus atromaculatus*
Cutlips Minnow	*Exoglossum maxillingua*
Fallfish	*Semotilus corporalis*
Fathead Minnow	*Pimephales promelas*
Golden Shiner	*Notemigonus crysoleucas*
Longnose Dace	*Rhinichthys cataractae*
Margined Madtom	*Noturus insignis*
Mottled Sculpin	*Cottus bairdi*
Northern Hog Sucker	*Hypentelium nigricans*
Pumpkinseed	*Lepomis gibbosus*
Rainbow Trout	*Oncorhynchus mykiss*
Rock Bass	*Ambloplites rupestris*
Shield Darter	*Percina peltata*
Smallmouth Bass	*Micropterus dolomieui*
Spotfin Shiner	*Cyprinella spiloptera*
Spottail Shiner	*Notropis hudsonius*
Tessellated Darter	*Etheostoma olmstedi*
White Sucker	*Catostomus commersoni*
Yellow Bullhead	*Ameiurus natalis*

Table B.14 Fish Species (Boiling Springs to Mouth) (PFBC, 1978)

Common Name	Scientific Name
Blacknose Dace	*Rhinichthys atratulus*
Bluegill	*Lepomis macrochirus*
Bluntnose Minnow	*Pimephales notatus*
Brown Bullhead	*Ameiurus nebulosus*
Brown Trout	*Salmo trutta*
Central Stoneroller	*Campostoma anomalum*
Chain Pickerel	*Esox niger*
Common Carp	*Cyprinus carpio*
Common Shiner	*Luxilus cornutus*
Creek Chub	*Semotilus atromaculatus*
Cutlips Minnow	*Exoglossum maxillingua*
Fallfish	*Semotilus corporalis*
Fantail Darter	*Etheostoma flabellare*
Golden Shiner	*Notemigonus crysoleucas*
Green Sunfish	*Lepomis cyanellus*
Largemouth Bass	*Micropterus salmoides*
Longnose Dace	*Rhinichthys cataractae*
Margined Madtom	*Noturus insignis*
Mottled Sculpin	*Cottus bairdi*
Northern Hog Sucker	*Hypentelium nigricans*
Pumpkinseed	*Lepomis gibbosus*
Rainbow Trout	*Oncorhynchus mykiss*
Redbreast Sunfish	*Lepomis auritus*
River Chub	*Nocomis micropogon*
Rock Bass	*Ambloplites rupestris*
Rosyface Shiner	*Notropis rubellus*
Shield Darter	*Percina peltata*
Smallmouth Bass	*Micropterus dolomieui*
Spotfin Shiner	*Cyprinella spiloptera*
Spottail Shiner	*Notropis hudsonius*
Swallowtail Shiner	*Notropis procne*
Tessellated Darter	*Etheostoma olmstedi*
White Sucker	*Catostomus commersoni*
Yellow Bullhead	*Ameiurus natalis*

Fish species lists were compiled from stream survey data provided by PFBC.

Threatened and Endangered Species

Pennsylvania endangered species are in imminent danger of extinction or extirpation throughout their range in Pennsylvania if the deleterious factors affecting them continue to operate. These are: 1) species whose numbers have already been reduced to a critically low level or whose habitat has been so drastically reduced or degraded that immediate action is required to prevent their extirpation from the Commonwealth; or 2) species whose extreme rarity or peripherality places them in potential danger of precipitous declines or sudden extirpation throughout their range in Pennsylvania; or 3) species that have been classified as Pennsylvania extirpated, but which are subsequently found to exist in Pennsylvania as long as the above first and second conditions are met; or 4) species determined to be endangered pursuant to the Endangered Species Act of 1973, Public Law 93-205. (PNDI, 2004)

Pennsylvania threatened species may become endangered within the foreseeable future throughout their range in Pennsylvania unless the casual factors affecting the organism are abated. These are: 1) species whose populations within the Commonwealth are decreasing or have been heavily depleted by adverse factors and, while not actually endangered, are still in critical condition; 2) species whose populations may be relatively abundant in the Commonwealth but are under severe threat from serious adverse factors that have been identified and documented; or 3) species whose populations are rare or peripheral and in possible danger of severe decline throughout their range in Pennsylvania; or 4) species determined to be threatened pursuant to the Endangered Species Act of 1973. (PNDI, 2004)

The Yellow Breeches Creek Watershed provides habitat to several threatened and endangered species. The Bog Turtle and Eastern Mud Salamander are listed as Pennsylvania endangered species. The Sedge Wren is listed as a Pennsylvania threatened species.

The bog turtle is among the smallest North American turtles. Adults are 4 to 4½ inches long. The upper shell is dark brown with yellow to orange markings and covered with ridged plates that are eventually worn smooth; the lower shell is dark brown or black, sometimes with scattered light markings. A large red-orange or yellow blotch behind each eye is the most conspicuous color feature of an otherwise brown body lightly marked with orange or yellow. Mating takes place in May and early June. Each female then digs a nest and lays a clutch of three to five eggs during June or July. Eggs receive no parental care, and hatchlings leave the nest several months later. Adults and young feed on a variety of plant and animal food, such as berries, insects and even carrion. They do not wander far from hibernating sites in spring seepage, which they leave in April or May and return to in late summer. Summer hibernation (aestivation) may occur during July and August; individuals are otherwise encountered basking on sedge tussocks or moving slowly about in spring runs under concealing vegetation. When danger threatens, individuals burrow rapidly into the mucky bottom of spring runs. Bog turtles live in relatively open portions of sphagnum bogs, swamps or marshy meadows with slow moving, spring fed streams or spring runs with soft bottoms. The primary reason for the bog turtle’s status is the draining or other destruction of its habitat. Because bog turtles have always been considered the rarest of North American turtles, they are highly valued by turtle fanciers in this country, and possibly twice as much overseas. Many, therefore, have been illegally removed for commercial purposes. Since their habitats are widely separated, other turtles are not likely to move in and replace those removed. (PFBC, 2004)

Bog Turtle

The eastern mud salamander ranges from 3½ to 6 inches. It most closely resembles the northern red salamander, but its eye color is brown, not yellow, and the dark spots are fewer in number and more circular. The back color is a darker red-brown that does not blend into the lighter red of the sides and belly. Nothing has been recorded concerning this species in Pennsylvania. In Virginia and the Carolinas, eastern mud salamanders engage in courtship in the fall and breed in early winter. Females deposit up to 200 eggs every other year. Transformation from larva to adult normally occurs in 17 months, but some take an additional year. Males mature in three years, females in four. Eastern mud salamanders may be found in the fine, black muck under stones and logs, or burrowing in spring seepages, spring-fed brooks or swamps, along the coastal plain or Piedmont regions from southern New Jersey to Georgia. The first specimen of the eastern mud salamander to be described was taken from South Mountain near Carlisle, Cumberland County. Despite repeated searches, additional specimens from this locality have not been found, but the animal has been found at a nearby site. Although occurring at higher elevations at the southern edge of its range, its occurrence in mountainous country in the north is unusual. (PFBC, 2004)

Eastern Mud Salamander

Sedge wrens (*Cistothorus platensis*) may appear and possibly breed in Pennsylvania almost any time from late spring to early fall. They are absent from much of their historic range in the state, even where there is suitable habitat. Sedge wrens are rare, irregular migrants and breeders, not known to occur at any particular location in Pennsylvania on a regular basis. Their apparent decline in Pennsylvania seems to parallel a slipping population in the northeastern United States. This presumed decline may be attributable to habitat loss, but could also be related to the difficulty in seeing them in their preferred habitat, dense grass. The bird was designated threatened in 1985's Species of Special Concern in Pennsylvania, published by the Pennsylvania Biological Survey. Its status has not changed since then. The sedge wren, formerly known as the short-billed marsh wren, can best be distinguished from other wrens by its relatively small size and streaked head. It is only 4½ inches high, has a six-inch wingspan, streaked crown and back, faint buff-colored eye stripes, and a short tail that is often held upright. In summer, sedge wrens are found from southern Saskatchewan and Minnesota across the Great Lake states to the east. They winter along the Atlantic and Gulf coasts, as far south as Mexico. Sedge wrens arrive in Pennsylvania in April and May, and migrate south to brackish coastal marshes from August to October. Among the last birds to nest in the state, sedge wrens may be found nesting here as late as August. They nest in wetland areas; a typical clutch of six or seven white eggs is laid in a globular nest built up to two feet off the ground. Young hatch in 12 to 14 days, and leave the nest at two weeks of age. Two broods can be produced each year. For nesting, sedge wrens require damp meadows and marshes where sedges and grasses are interspersed with small shrubs. They apparently do not thrive in cattail marshes. Sedge wrens are rare throughout their range. They used to be found nesting in scattered locations across Pennsylvania. Over the past several decades, however, they have disappeared from many of their former haunts, and numbers have dropped significantly in others. The loss of habitat and changing agricultural practices are thought to be responsible for this decline. (PFBC, 2004)

Sedge Wren

The Pennsylvania Natural Diversity Inventory (PNDI) information system is maintained within the Ecological Services division of the PA DCNR. The inventory is a resource on species of special concern within the Commonwealth. Table B.15 lists the species of special concern within the Yellow Breeches Creek Watershed.

Table B.15 Species/Communities of Special Concern (PNDI, 2004)

Common Name	Scientific Name
A noctuid moth	*Apharetra purpuea*
A noctuid moth	*Elaphria festivoides*
A noctuid moth	*Platyperigia meralis*
A zale moth	*Zale submediana*
Acidic broadleaf swamp	*Acidic broadleaf swamp*
Allegheny woodrat	*Neotoma Magister*
American dragonhead	*Dracocephalum parviflorum*
Bog turtle	*Clemmys muhlenbergii*
Broad sallow moth	*Xylotype capax*
Bull sedge	*Carex bullata*
Cranefly Orchid	*Tipularia discolor*
Dickcissel	*Spiza americana*
Dwarf iris	*Iris verna*
Eastern coneflower	*Rudbeckia fulgida*
Ephemeral/fluctuating natural pool	*Ephemeral/fluctuating natural pool*
Erosional remnant	*Erosional remnant*
Footpath sallow moth	*Metaxaglea semitaria*

Common Name	Scientific Name
Forked-chickweed	*Paronychia fastigiata var. nuttallii*
Glade spurge	*Euphorbia purpurea*
Lance-leaf loosestrife	*Lsimachia hybrida*
Lion's-foot	*Prenanthes Serpentaria*
Long-eared owl	*Asio otus*
Lupine	*Lupinus perennis*
Marsh wren	*Cistothorus palustris*
Netted chainfern	*Woodwardia areolata*
Nodding Trillium	*Trillium cernuum*
Northeaster bulrush	*Scirpus ancistrochaetus*
Northern appalachian acidic seep community	*Northern appalachian acidic seep community*
Northern myotis	*Myotis septentrionalis*
Northern water-milfoil	*Myriophyllum sibiricium*
Pine woods underwing	*Catocala sp*
Quercus icilifolia-kalmia latifolia-P. rigida	*Ridgetop dwarf-tree forest*
Quillwort	*Isoetes valida*
Red-head pondweed	*Potamogeton richardsonii*
Rough-leaved aster	*Aster radula*
Sedge wren	*Cistothorus platensis*
Short-leaf pine	*Pinus Echinata*
Showy goldenrod	*Solidago speciosa var speciosa*
Southern bog clubmoss	*Lycopodiella appressa*
Southern pine looper moth	*Caripeta Aretaria*
Southern variable dart moth	*Anomogyna elimata*
Springs	*Springs*
Sweet bay magnolia	*Magnolia virginiana*
Thyme-leaved pinweed	*Lechea minor*
Timber rattlesnake	*Crotalus horridus*
Tooth-cup	*Rotala ramosior*
Twisted yellow-eyed grass	*Xyris torta*
Variable sedge	*Carex polymorphia*
Virginia bunchflower	*Melanthium virginicum*
White water-crowfoot	*Ranunculus aquatilis var. diffuses*
Yellow-fringed orchid	*Platanthera ciliaris*

WATERSHED CONCERNS

Upon review of all land, water, biological, and cultural resources inventoried as part of this report, the following areas were identified as valuable areas of scenic or historic importance. These areas are identified by number on the Watershed Concerns Map. The intent of the Watershed Concerns Map is to correlate the location of these valuable resources to the location of stream impairments. These areas of importance are being considered as "concerns", as they are areas that should be targeted first for preservation efforts. Additional areas of importance not identified on the Watershed Concerns Map include areas inhabited by bog turtles and the locations of prime soils.

1. Appalachian Trail (Cultural Resource)
2. Boiling Springs (Land Resource)
3. Boiling Springs Caves (Land Resource)
4. Boiling Springs National Historic District (Cultural Resource)
5. Camp Michaux (Cultural Resource)
6. Children's Lake (Water Resource)
7. Chimney Rocks (Land Resource)
8. Churchtown Historic District (Cultural Resource)
9. Fuller Lake (Water Resource)
10. Hammonds Rocks (Land Resource)
11. Huntsdale Hatchery Springs (Land Resource)
12. Kings Gap Environmental Center (Cultural Resource)
13. Laurel Lake (Water Resource)
14. Lisburn Historic District (Cultural Resource)
15. Michaux State Forest (Land Resource)
16. Mount Holly Preserve (Water Resource)
17. Pine Grove Furnace State Park (Land Resource)
18. Pole Steeple (Land Resource)
19. Rose Garden Historic District (Cultural Resource)
20. Shepherdstown Historic District (Cultural Resource)
21. McCormick Road Historic District (Cultural Resource)
22. Trout Run Nature Preserve (Biological Resource)
23. White Rocks (Land Resource)
24. Various Bog Turtle Habitat Areas[1]
25. Prime Soils (Capability Class I) Areas[2]

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[1] Bog turtles are a valuable and protected resource within the Yellow Breeches Watershed. The locations of areas known to be inhabited by bog turtles are not being released, as this is sensitive information related to the preservation of these reptiles.

[2] Prime soils (Capability Class I) are of great agricultural value within the watershed and are identified on the Soils Map.

TAB C

COLLECTION AND ANALYSIS OF NEW DATA

This portion of the report contains information including physical characterization, habitat assessment, streambank stabilization evaluation, water quality testing, and a benthic study.

The following notes and addenda apply specifically to this portion of the report:

- Stream sampling occurred over a two and a half month period. Ideally, sampling should be conducted in as short a period as possible under consistent hydrologic conditions. However, this scenario was made infeasible in 2003 due to several major hydrologic events that caused large fluctuations in streamflow. For most of Pennsylvania, 2003 was one of the wettest years on record. High flows caused by the excessive rainfall produced unsafe wading conditions in most of the study area streams throughout the study period. The field team was forced to wait for safe wading conditions on several occasions. Benthic and water quality samples were collected as close to baseflow conditions as possible, and therefore the time required to sample thirty-three (33) sites was extended past the ideal period.
- A Rapid Bioassessment Protocols (RBP) Level II (family-level identification) approach was approved by the study team. RBP II was chosen for its efficient use of time, resources, and ability to provide useful metrics and evaluation results.
- The US EPA RBP for Use in Streams and Wadeable Rivers (section 7.3.1) indicates that the fixed-count approach to subsampling and sorting macroinvertebrates can be used for any subsample size. A 100-organism subsample approach was chosen for analysis due to budgetary and time limitations.
- The choice of classifying a stream as high-gradient was largely based on the estimated slope of the stream as the sampling reach at the time of the field investigation. Sites classified as high-gradient had steep slopes and typically also possessed associated habitat such as a larger substrate size and a predominance of riffles and runs. Sites classified as low-gradient had near-level slopes and possessed associated habitat such as sand or silt substrate and lacked riffles and runs. All Yellow Breeches Creek sites (YB1-0.28 through YB7-29.12) were estimated to have near-level slopes and possessed a combination of habitat features typical of both high-gradient and low-gradient streams. The low-gradient habitat assessment field data sheets were more appropriate for assessing habitat characteristics at these sites. By classifying all seven (7) Yellow Breeches Creek mainstem sites as low-gradient, the results were standardized and mainstem sites were compared to each other.
- Site selection was performed to reflect habitat features that are representative of the drainage area and stream class. In addition, the study team avoided choosing sites in locations that were obviously affected by physical influences such as roads, bridges, or other structures.

- The biological and habitat data were collected simultaneously with the water quality data. However, it should also be noted that the water quality data collected during this study are one-time grab samples and may not be indicative of chronic conditions that exist at a site, whereas macroinvertebrates are indicators of long-term conditions.

Methods

This study employed the use of benthic macroinvertebrate and physical habitat data collected and analyzed following RBP II protocols to evaluate the overall condition of the Yellow Breeches Creek Watershed.

The US EPA RBP II methods (Barbour et al. 1999) was used to achieve the project goals. The primary objective of RBP II is to provide a basis for assessing and ranking stream segments based on consistent levels of effort among sampling sites. Readily available and relevant benthic macroinvertebrate data was collected, chemical data was collected, and physical and biological conditions at each of the thirty-three (33) stations was characterized. Through RBP II analysis, these data are then evaluated to provide a more comprehensive review of the biological conditions of the watershed.

Site Selection

Through coordination with the YBWA Natural Resources Committee and watershed reconnaissance, thirty-three (33) discrete 100-meter sampling reaches for Yellow Breeches Creek and tributaries within the watershed (Table C.1) were established. These stations represent a modification of the originally proposed sampling locations due to the inability to access some stream locations and the discovery of several dry streams at the time of the field study. The latter was the case for Kellers Gap Hollow, Watery Hollow, Bettem Hollow, and State Road Hollow.

The site selection process was performed to reflect habitat features that are representative of the drainage area and stream class. Whenever possible, the selection of sites avoided locations less than 100 feet upstream or downstream from any road or bridge crossing or other physical structure to minimize the potential effect on stream velocity, depth, and overall quality.

Field Methods

Benthic Macroinvertebrate Sampling - This study employed a multihabitat approach to the collection of benthic macroinvertebrates. Different habitat types, including cobble, snags, vegetated banks, submerged macrophytes, sand, etc., were sampled in relative proportion to their occurrence within the sampling reach. Benthic macroinvertebrates were collected systematically from all available instream habitats by kicking the substrate or jabbing with a 500-micron D-frame dip net. A total of twenty (20) jabs (or kicks) were taken from all major habitat types based on proportion of occurrence in the reach, resulting in a composite sample of approximately 3.1 m^2 of habitat. The collected material was carefully placed in plastic sample jars and preserved with 95% ethanol.

Habitat Assessment - The characterization of the instream and riparian physical habitat within the selected 100-meter reach was performed to supplement biological surveys following RPB II protocols. Each site was characterized by field staff as either high- or low-gradient, and its condition was determined through the qualitative RBP scoring system. Physical characterization included documentation of general land use, description of the stream origin and type, summary of the riparian vegetation features, and measurements of instream parameters such as width, depth, flow, and substrate.

Water Chemistry Sampling - In-situ water chemistry measurements of standard parameters such as temperature, pH, dissolved oxygen, and conductivity were taken with a water quality instrument at the time of benthic macroinvertebrate sampling. In addition, water samples were collected at each site for selected chemical laboratory analysis. Grab samples were collected at the thalweg of each site, labeled, and stored in a cooler. At the conclusion of each field day, water samples were transported to Microbac Laboratories, Camp Hill, PA, for analysis. Variables selected for testing included fecal coliform, biological oxygen demand, ammonia nitrogen, nitrate nitrogen, Kjehdahl nitrogen, total phosphorus, total suspended solids, and sulfate.

Benthic Macroinvertebrate Assessment Laboratory Methods

Laboratory personnel subsampled each benthic macroinvertebrate sample using a fixed-count approach. The contents of each sample were rinsed and spread out in a white pan marked with twenty-seven (27) grids, each approximately 2.5-inches square. A random-numbers table was used to select a grid, the contents of the grid were sorted, and organisms were removed with the aid of a dissecting microscope. This process continued until complete sorting of a grid resulted in the estimated collection of approximately 100 organisms (+/- approximately 20%). The organisms were then stored in 70% ethanol in separate specimen jars. Sorted residue and unsorted residue were stored in 95% ethanol in separate, marked containers.

Each organism was then identified to the lowest level of taxonomy possible with the aid of a dissecting microscope and various published keys (Merritt and Cummins 1996 and Wiggins 1996). Insects were typically identified to family, with the exception of Collembola, which was identified to order because of their extremely small size. Other invertebrates were commonly identified to either class or order, with the exception of Isopoda and Amphipoda, which were identified to family. Because of their small size, Gastropods were classified into nonspecified family categories (Family 1 and Family 2) based on observable differences in morphology. The identity and number of organisms were recorded on laboratory bench sheets. Other notes and comments regarding the quality of the organisms were also recorded on these bench sheets. Insects, other than Collembola, that could not be definitely identified to family were taken to SRBC for verification. Identification data were entered into an Excel spreadsheet to aid in data analysis.

The identity of macroinvertebrates in three (3) samples (10% of the thirty-three (33) samples) was verified by laboratory personnel as part of quality assurance/quality control. These samples were selected using a random-numbers table and included sample locations IG1-0.88, YB6-24.44, and YB7-29.12.

Data Analysis

Biological Metrics - The macroinvertebrate data were first used to generate eighteen (18) metrics, derived from the best candidate metrics listed in USEPA's Rapid Bioassessment Protocol (Barbour et al. 1999). Each of these metrics allows some basic inferences to be made regarding the health and structure of the macroinvertebrate community and suspected levels of environmental stress at each of the sites. These metrics include the following:

- Total number of individuals
- Number of EPT[1] taxa
- Number of Ephemeroptera (mayfly) taxa
- Number of Plecoptera (stonefly) taxa
- Dominant taxon and percent dominance
- Percent of tolerant organisms
- Percent of Filterers
- Percent of Clingers
- Modified Hilsenhoff Biotic Index[2]
- Total number of taxa
- Percentage of EPT organisms
- Percentage of Ephemeroptera
- Number of Trichoptera (caddisfly) taxa
- Number of intolerant taxa
- Percent of Chironomidae (midges)
- Percent of Scrapers
- Number of Clinger taxa
- Shannon diversity index[3]

[1] Ephemeroptera (E), Plecoptera (P), and Trichoptera (T)
[2] Plafkin et al. 1989
[3] Shannon and Weaver 1949

Family-level Hilsenhoff (tolerance) values were derived from field sheets used for PA DEP's State Surface Water Assessment Program. Family-level Functional Feeding Group and habit/behavioral determinations were derived from Appendix B in Barbour et al. 1999.

Each of these eighteen (18) metrics was illustrated through boxplots (created through Minitab v. 11). Boxplots are useful tools for visualizing the range and distribution of data, as they illustrate the median, maximum, and minimum values as well as 25th and 75th percentiles. The box represents the middle 50% of the data, with the median depicted by the line across the box. The median is the middle value of a set of data. The 25th and 75th percentiles are indicated by the whiskers extending from the box. Outliers, or extreme values that fall outside the general pattern of the data (the limits of which are represented by the 25th or 75th percentiles), are represented by "*".

The boxplots were organized among three (3) site classifications: low-gradient tributary, high-gradient tributary, and mainstem. In this way, the boxplots illustrate the characteristics of the benthic communities throughout the Yellow Breeches Creek Watershed. Boxplots were created for each metric at each of the three (3) site classifications.

Habitat Evaluation - The total score of the thirteen (13) habitat features evaluated in the field and recorded on the habitat assessment field data sheets was calculated. A boxplot was generated to illustrate these total habitat scores among the three (3) site classifications.

Reference Site Determination and Condition Category Determination - One reference site was chosen for each of the three (3) site classifications: low-gradient tributary, high-gradient tributary, and mainstem. Each of these reference sites was determined by reviewing the eighteen (18) calculated biological metrics and total habitat condition scores within each of the site classifications and choosing the site that had the most metrics representing the greatest biological and habitat integrity.

Once a reference site in each of the three (3) site classifications was chosen, a comparative analysis of the health of the remainder of the sites was performed. This comparative analysis is based on a scoring technique introduced in the first RBP edition (Plafkin et al 1989). A modified version of this technique was used as outlined in SRBC's Assessment of Interstate Streams in the Susquehanna River Basin (SRBC 2003). This analysis is performed by scoring each site's biological metrics and total habitat condition scores and comparing them to those of a corresponding reference site. More specific details for this technique and scoring criteria are presented as part of Appendix E and Appendix F.

The biological metrics and total habitat scores for each site were compared to its appropriate reference site to assign a condition category to each site. As a result, two (2) assessment scores, one biological and one for habitat, are calculated for each site and appear as percentages of biological and habitat conditions at each corresponding reference site. Each Biological Assessment Score is then converted into a Biological Condition Category compared to the appropriate reference site. These Biological Condition Categories include nonimpaired, slightly impaired, moderately impaired, and severely impaired compared to the corresponding reference site. Similarly, each habitat percentage score is converted into a Habitat Condition Category. These Habitat Condition Categories include excellent, supporting (of the habitat quality seen in the reference site), partially supporting, and nonsupporting.

Scatterplots were also created by plotting each site's Biological Assessment Score against its Habitat Assessment Score in each of the three (3) site classifications. These scatterplots visually present the biological condition category and habitat condition category of each site.

Results and Discussion

Sampling Site Selection

Thirty-three (33) sites were sampled from August to October 2003 for benthic macroinvertebrates, habitat, and water chemistry. Seven (7) of these sites were located on the Yellow Breeches Creek mainstem, thirteen (13) were located on low-gradient tributaries, and thirteen (13) were located on high-gradient tributaries (Table C.1). Details regarding each site and stream are explained in the individual site assessment below.

Biological Metrics

Approximately 3,500 organisms comprised of fifty-three (53) taxa were identified during this study. The raw identification data is included in Appendix B, and the bench sheets containing the numbers and identity of these organisms are presented in Appendix C.

Eighteen (18) metrics were calculated for each of the thirty-three (33) sites (Tables C.2, C.3, and C.4), and boxplots were created for each metric at each of the three site classifications. "TR LOW" refers to the low-gradient tributary sites (n=13), "TR HIGH" refers to the high-gradient tributary sites (n=13), and "MAIN" refers to the mainstem sites (n=7).

Two (2) general metrics, the number of all taxa and the number of EPT (Ephemeroptera, Plecoptera, and Trichoptera—mayflies, stoneflies, and caddisflies) taxa, tend to decrease with increasing levels of stress. Consequently, evaluating these two (2) metrics reveals information about the occurrence of macroinvertebrates overall as well as generally pollution-sensitive insects.

High-gradient tributary sites tended to have the highest median number of all taxa (15) and EPT taxa (7) (Figures C.1 and C.2). Low-gradient tributary sites tended to have the fewest median number of taxa (13) and EPT taxa (2). Mainstem sites had median values of between high- and low-gradient tributary sites of 14 and 5, respectively.

Table C.1 Descriptions of Study Sites

Site	Stream	Stream Class[2]	Designated Use[3]	Designation	Reference Site	Photo ID[1]	Sampling location
CR1-0.28	Cedar Run	3	CWF	Low-gradient tributary		1	60 m upstream from 17th Street, Camp Hill
CR2-4.09	Unnamed Trib to Cedar Run	4	CWF	Low-gradient tributary		2	60 m upstream from Rossmoyne Road
CR3-2.17	Cedar Run	3	CWF	Low-gradient tributary		3	60 m upstream from Hartzdale at Yamaha
CR4-0.39	Unnamed Trib to Cedar Run	4	CWF	Low-gradient tributary		4	60 m downstream from Harzdale (Theos) (top of reach)
CSR1-0.82	Cold Spring Run	3	HQ-CWF	Low-gradient tributary		5	30 m upstream from Pine Road crossing
CSR2-2.09	Cold Spring Run	3	HQ-CWF	High-gradient tributary		6	30 m upstream from Cold Spring Road crossing
DR1-0.70	Dogwood Run	3	CWF	High-gradient tributary		7	40 m upstream from Yellow Breeches confluence
DR2-1.85	Dogwood Run	4	CWF	Low-gradient tributary		8	30 m downstream from Route 74 crossing (top of reach)
DR3-5.08	Dogwood Run	3	CWF	High-gradient tributary		9	30 m downstream from Green Road crossing (top of reach)
HSH1-1.61	Hairy Spring Hollow	3	HQ-CWF	High-gradient tributary		11	30 m upstream from Furnace Hollow Road
IRG1-0.88	Irishtown Gap Hollow	3	HQ-CWF	High-gradient tributary		12	400 m upstream from Leeds Road crossing
KH1-1.09	King's Gap Hollow	3	HQ-CWF	High-gradient tributary		13	30 m upstream from King's Gap Road crossing
LD1-0.97	Little Dogwood Run	4	HQ-CWF	Low-gradient tributary		14	30 m upstream from Wayne Noss Flowers
MN1-1.09	Mountain Creek	3	TSF	Low-gradient tributary		15	150 m from confluence, Mount Holly
MN2-4.77	Mountain Creek	3	CWF	High-gradient tributary		16	3.2 km south of Mt. Holly Springs, Route 34, across from PENNDOT maintenance pulloff
MN3-15.10	Mountain Creek	3	HQ-CWF	High-gradient tributary		17	120 m upstream from Route 233
OR1-0.51	Old Town Run	3	HQ-CWF	Low-gradient tributary	REF	18	30 m downstream of Tangers Road crossing (top of reach)
OR2-2.74	Old Town Run	4	HQ-CWF	High-gradient tributary		19	30 m downstream Whiskey Spring Road crossing (top of reach)
PH1-2.10	Peach Orchard Hollow	3	HQ-CWF	High-gradient tributary		20	60 m downstream of Peach Orchard Hollow crossing
PR1-0.17	Pippins Run	3	CWF	High-gradient tributary		21	45 m downstream from Lewisbury Road crossing (top of reach)
SR1-0.43	Stony Run	3	CWF	Low-gradient tributary		22	30 m upstream of Grantham Road crossing
SR2-5.09	Stony Run	3	CWF	Low-gradient tributary		23	30 m downstream from Old York Road crossing (top of reach)
SR3-1.06	Fishers Run	3	CWF	Low-gradient tributary		10	30 m upstream Filey's Road crossing
STH1-1.72	Sthromes Hollow	3	HQ-CWF	High-gradient tributary		24	60 m upstream of Sand Hill Road crossing
TR1-0.85	Tom's Run	3	HQ-CWF	High-gradient tributary	REF	25	60 m downstream of Rt. 233 crossing (top of reach)
UNT1-0.11	Unnamed Trib to Yellow Breeches	3	CWF	Low-gradient tributary		26	600 m upstream of Lisburn Road crossing
YB1-0.28	Yellow Breeches	2	CWF	Mainstem		27	60 m upstream of Main St. bridge crossing, New Cumberland
YB2-42.48	Yellow Breeches	2	HQ-CWF	Mainstem		28	90 m upstream of Enck's Mill Road crossing
YB3-47.21	Yellow Breeches	2	HQ-CWF	Mainstem		29	30 m upstream of Hay's Grove Road crossing
YB4-10.32	Yellow Breeches	2	CWF	Mainstem		30	60 m upstream of Sheepford Road crossing
YB5-15.26	Yellow Breeches	2	CWF	Mainstem		31	150 m downstreamof McCormick Road crossing, west of Lisburn (top of reach)
YB6-24.44	Yellow Breeches	2	HQ-CWF	Mainstem		32	45 m upstream of Creek Road/Rt. 74
YB7-29.12	Yellow Breeches	2	HQ-CWF	Mainstem	REF	33	60 m downstream from Mtn Rd bridge crossing, Boiling Springs (top of reach)

[1] Photo ID in Appendix H
[2] See Section 93.9(c) and Section 93.9o in PADEP, Title 25, Chapter 93, Water Quality Standards.
[3] See Section 93.9o in PADEP, Title 25, Chapter 93, Water Quality Standards.

Table C.2 Biological Metrics for High-Gradient Ttributary Sites.

High-gradient tributary site:	CSR2-2.09	DR1-0.70	DR3-5.08	HSH1-1.61	IRG1-0.88	KH1-1.09	MN2-4.77	MN3-15.10	OR2-2.74	PH1-2.10	PR1-0.17	STH1-1.72	TR1-0.85
Total # individuals	109	97	91	120	129	113	115	126	100	81	113	92	**114**
Total # taxa	10	14	15	16	13	15	16	16	14	7	16	9	**20**
# EPT taxa	4	4	8	7	6	7	9	9	7	1	5	3	**13**
% EPT	67.9	10.3	29.7	40.0	24.0	51.3	59.1	36.5	34.0	1.2	48.7	32.6	**46.5**
# Ephemeroptera taxa	1	1	2	0	1	1	4	1	2	0	3	0	**4**
% Ephemeroptera org.	1.8	4.1	6.6	0.0	0.8	3.5	27.0	1.6	2.0	0.0	29.2	0.0	**21.9**
# Plecoptera taxa	1	0	3	4	2	3	2	3	2	0	1	1	**4**
# Trichoptera taxa	2	3	3	3	3	3	3	5	3	1	1	2	**5**
Dominant taxon	L/P/B [1]	Chironomidae	Chironomidae	Chironomidae	Chironomidae	Chironomidae	Chironomidae	Chironomidae	Chironomidae	Chironomidae	Chironomidae	Simuliidae	**Chironomidae**
% Dominance	22.0	35.1	34.1	22.5	57.4	31.9	27.8	36.5	45.0	76.5	23.0	38.0	**28.9**
# Intolerant taxa	4	2	7	7	6	7	7	9	5	0	5	3	**10**
% Chironomidae	10.1	35.1	34.1	22.5	57.4	31.9	27.8	36.5	45.0	76.5	23.0	20.7	**28.9**
% Tolerant organisms	0.0	2.1	2.2	0.8	0.0	0.0	0.9	0.0	1.0	0.0	1.8	1.1	**0.9**
% Filterers	56.0	9.3	40.7	42.5	18.6	32.7	32.8	20.6	33.0	0.0	20.4	68.5	**21.9**
% Clingers	58.7	9.3	53.8	49.2	22.5	40.7	57.8	33.3	35.0	0.0	30.1	71.7	**43.0**
# Clinger taxa	5	3	8	7	7	8	8	9	5	0	6	5	**10**
% Grazers & Scrapers	0.0	4.1	5.5	0.0	0.0	0.0	14.7	1.6	1.0	0.0	8.8	0.0	**7.0**
Hilsenhoff	3.63	5.18	5.07	4.58	5.25	4.09	4.54	4.49	4.98	4.84	5.09	5.16	**4.61**
Shannon	1.88	1.93	2.02	2.10	1.48	2.03	2.22	2.04	1.82	0.78	2.19	1.65	**2.49**
REFERENCE SITE													**REF**

[1] Leuctridae, Hydropsychidae, and Philopotamidae are each at 22.0%

Table C.3 Biological Metrics for Low-Gradient Tributary Sites

Low-gradient tributary site:	CR1-0.28	CR2-4.09	CR3-2.17	CR4-0.39	CSR1-0.82	DR2-1.85	LD1-0.97	MN1-1.09	OR1-0.51	SR1-0.43	SR2-5.09	SR3-1.06	UNT1-0.11
Total # individuals	103	128	112	93	127	108	95	92	**95**	111	99	119	104
Total # taxa	7	5	6	9	13	18	13	15	**13**	13	14	13	11
# EPT taxa	0	0	0	1	5	3	1	6	**8**	5	1	6	2
% EPT	0.0	0.0	0.0	3.2	15.0	7.4	1.1	18.5	**52.6**	48.6	21.2	52.1	4.8
# Ephemeroptera taxa	0	0	0	0	0	1	0	4	**3**	4	1	2	1
% Ephemeroptera org.	0.0	0.0	0.0	0.0	0.0	3.7	0.0	13.0	**28.4**	36.0	21.2	40.3	2.9
# Plecoptera taxa	0	0	0	0	2	0	0	1	**2**	0	0	1	0
# Trichoptera taxa	0	0	0	1	3	2	1	1	**3**	1	0	3	1
Dominant taxon	Gammaridae	Asellidae	Chironomidae	Gastropoda	Chironomidae	Chironomidae	Chironomidae	Chironomidae	**Chironomidae**	Chironomidae	Chironomidae	Baetidae	Gammaridae
% Dominance	89.3	85.9	37.5	39.8	49.6	55.6	60.0	54.3	**22.1**	35.1	30.3	26.9	38.5
# Intolerant taxa	0	0	0	0	4	2	2	4	**6**	3	0	4	0
% Chironomidae	1.0	0.8	37.5	19.4	49.6	55.6	60.0	54.3	**22.1**	35.1	30.3	21.8	5.8
% Tolerant organisms	4.9	0.8	32.1	48.4	0.0	11.1	8.4	5.4	**0.0**	0.0	22.2	0.0	1.0
% Filterers	0.0	0.0	6.3	12.9	35.4	16.7	13.7	6.5	**29.5**	14.4	1.0	21.0	11.5
% Clingers	0.0	0.0	6.3	11.8	37.0	8.3	14.7	14.1	**40.0**	21.6	0.0	37.0	10.6
# Clinger taxa	0	0	1	2	5	3	3	3	**6**	5	0	7	2
% Grazers & Scrapers	2.9	0.0	32.1	43.0	0.0	0.9	1.1	8.7	**13.7**	7.2	2.0	15.1	0.0
Hilsenhoff	4.30	5.75	5.86	6.40	5.43	5.93	6.07	5.57	**4.66**	5.47	6.15	5.23	4.88
Shannon	0.52	0.50	1.48	1.74	1.54	1.86	1.44	1.72	**2.19**	1.79	1.97	2.04	1.61
REFERENCE SITE									**REF**				

Table C.4 Biological Metrics for Mainstem Sites.

Mainstem site:	YB1-0.28	YB2-42.48	YB3-47.21	YB4-10.32	YB5-15.26	YB6-24.44	YB7-29.12
Total # individuals	98	157	100	86	115	105	**109**
Total # taxa	13	8	10	14	14	16	**18**
# EPT taxa	4	3	4	5	6	7	**8**
% EPT	16.3	4.5	22.0	33.7	35.7	34.3	**34.9**
# Ephemeroptera taxa	2	1	2	3	4	5	**5**
% Ephemeroptera org.	4.1	2.5	15.0	30.2	23.5	26.7	**29.4**
# Plecoptera taxa	0	0	0	0	0	0	**0**
# Trichoptera taxa	2	2	2	2	2	2	**3**
Dominant taxon	Gammaridae	Asellidae	Chironomidae	Elmidae	Elmidae	Elmidae	**Chironomidae**
% Dominance	26.5	48.4	67.0	33.7	33.0	23.8	**33.0**
# Intolerant taxa	1	0	2	3	3	3	**4**
% Chironomidae	22.4	5.7	67.0	3.5	4.3	10.5	**33.0**
% Tolerant organisms	18.4	0.0	5.0	16.3	11.3	25.7	**13.8**
% Filterers	13.3	5.1	10.0	5.8	13.9	9.6	**7.3**
% Clingers	13.3	5.1	19.0	25.6	15.7	20.2	**19.3**
# Clinger taxa	3	2	4	5	5	6	**6**
% Grazers & Scrapers	1.0	0.0	10.0	19.8	6.1	9.6	**13.8**
Hilsenhoff	5.86	5.37	5.62	5.09	5.41	6.23	**5.42**
Shannon	1.94	1.44	1.29	2.11	2.03	2.16	**2.22**
REFERENCE SITE							**REF**

Figure C.1 Number of all taxa

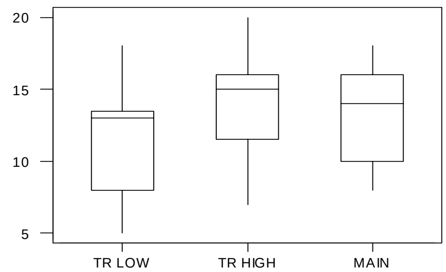
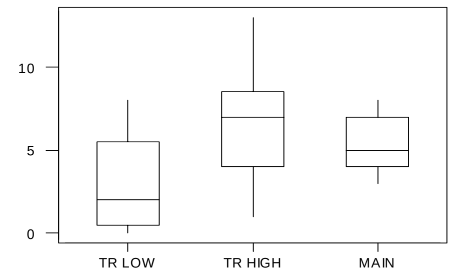


Figure C.2 Number of EPT taxa



Since EPT organisms are generally pollution-sensitive, the percent composition of EPT organisms tends to decrease with increasing levels of environmental stress. Environmental stress can cause shifts in a normally balanced macroinvertebrate community towards adaptable organisms. Consequently, the presence of a stressor is often reflected in higher percent dominance of one or more taxa. The percent dominance of a taxon tends to increase with increasing levels of stress.

High-gradient tributary sites had the highest median percentages of EPT organisms (36.5%), and low-gradient tributary sites had the lowest (7.4%) (Figure C.3). Mainstem sites tended to have the lowest percent dominance by a taxon (33%) (Figure C.4), with 43% of these sites dominated by Elmidae (riffle beetles). High-gradient tributaries had the second lowest median percent dominance (34.1%), with 85% of these sites dominated by Chironomidae (midges). Low-gradient tributary sites had the highest median percent dominance (39.8%), with 62% of sites dominated by Chironomidae. Low-gradient tributary sites also tended to have the widest range of percent dominance. The high outlier depicted in Figure C.4 corresponds to a 76.5% dominance of Chironomidae at PH1-2.10.

Figure C.3 Percent of EPT Organisms

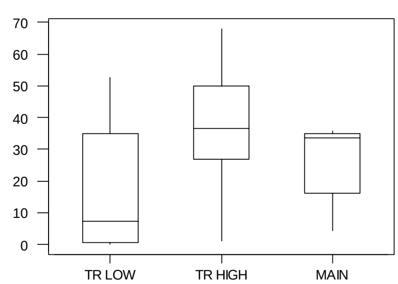
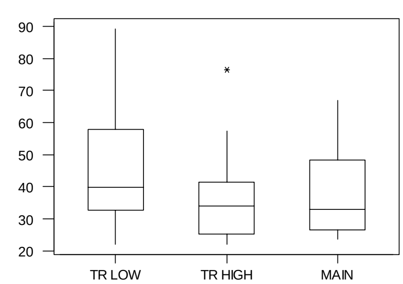


Figure C.4 Percent Dominance by One Taxon



Ephemeroptera (mayflies) are one of the most pollution-sensitive macroinvertebrates. Consequently, the number of Ephemeroptera taxa and the percent composition of Ephemeroptera would generally be expected to decrease with increasing environmental stress.

Mainstem sites had the highest median number of Ephemeroptera taxa (3) and median percent Ephemeroptera composition (23.5%) (Figures C.5 and C.6). Both low- and high-gradient tributary sites had the same median number of Ephemeroptera taxa (1) and the same range (0 to 4). Similarly, both low- and high-gradient tributary sites had similar, relatively low median percent composition of Ephemeroptera (2.9 and 2.0%, respectively), but low-gradient tributary sites demonstrated the widest range (0 to 29%).

Figure C.5 Number of Ephemeroptera taxa

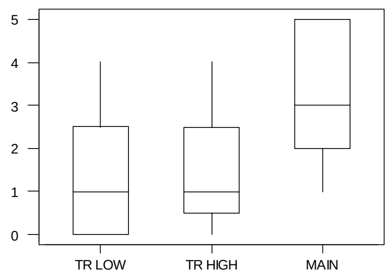
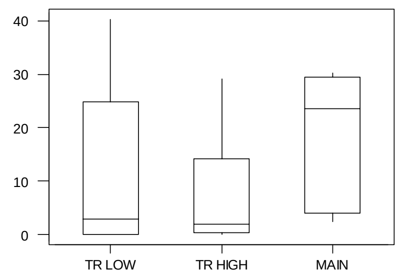


Figure C.6 Percentage of Ephemeroptera organisms



Plecoptera (stoneflies) and Trichoptera (caddisflies) are also pollution-sensitive organisms. The number of Plecoptera and Trichoptera taxa tends to decrease with increasing levels of environmental stress.

High-gradient tributary sites had the greatest median number of Plecoptera and Trichoptera taxa (2 and 3, respectively) (Figures C.7 and C.8), as well as the widest range of Plecoptera taxa (0 to 4). No Plecoptera were identified at any of the mainstem sites. While the median number of Plecoptera taxa was zero at the low-gradient tributary sites, up to two (2) Plecoptera taxa were identified at some of these sites. Low-gradient tributary sites had the lowest median number of Trichoptera taxa (1), as well as the widest range of Trichoptera taxa (0 to 3). Mainstem sites largely tended to have only two (2) Trichoptera taxa. The two (2) high outliers depicted in Figure C.8 correspond to five (5) Trichoptera taxa at MN2-4.77 and three (3) at YB7-29.12.

Figure C.7 Number of Plecoptera taxa

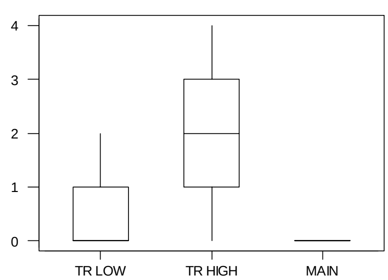
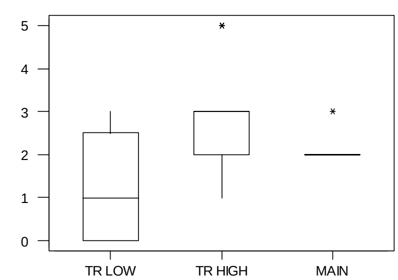


Figure C.8 Number of Trichoptera taxa



Analysis of the feeding behavior of macroinvertebrates can also indicate the presence of environmental stress. Scrapers are specialized organisms who feed only on periphyton. Filterers are generalists who feed on a broad range of food material. Consequently, a large amount of filterers in a sample can indicate that environmental stress has eliminated specific food sources for specialized feeders like scrapers.

High-gradient tributary sites had the greatest median percentage of filterers (32.7%) and the lowest median percentage of scrapers (1.0%) (Figures C.9 and C.10). Oppositely, mainstem sites had the lowest median percentage of filterers (9.6%) and the greatest median percentage of scrapers (also 9.6%). High-gradient tributary sites had the widest range of filterer percentages (0 to 69%), while low-gradient tributary sites had the widest range of scraper percentages (0 to 32.1%). The high outlier in Figure C.10 corresponds to a 43.0% scraper presence at CR4-0.39.

Figure C.9 Percentage of Filterers

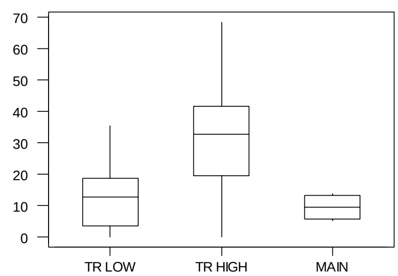
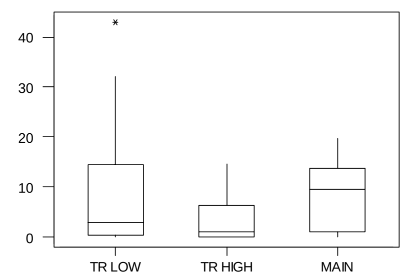


Figure C.10 Percentage of Scrapers



The habit measures of the macroinvertebrate community can indicate how environmental stress has affected the habitat of a stream and the ability of macroinvertebrates to position themselves in the stream environment. Clingers form fixed retreats or create attachment structures to allow them to remain in one position in the stream environment. Generally, the number of clinger organisms decrease with increasing environmental stress.

High-gradient tributary sites had the greatest median percentage of clingers (40.7%) as well as the highest median number of clinger taxa (7) (Figures C.11 and C.12). Low-gradient tributary sites had the lowest median percentage of clingers (11.8%) and number of clinger taxa (3). Mainstem sites showed the least variability in the percentage of clingers (5.1 to 25.6%). The low outlier depicted in Figure C.12 corresponds to the absence of clinger taxa at PH1-2.10.

Figure C.11 Percentage of clingers

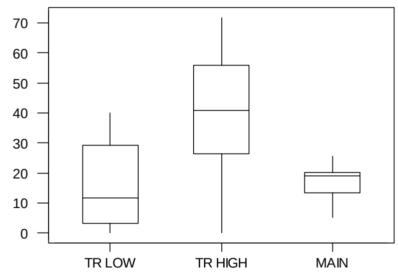
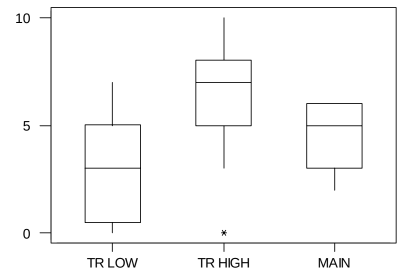


Figure C.12 Number of clinger taxa



The modified Hilsenhoff Biotic Index is a reflection of the diversity of tolerance values that were assigned to each taxon. Tolerance values reflect a macroinvertebrate's ability to survive a level of pollution or environmental stress. A larger Hilsenhoff value indicates the presence of more tolerant macroinvertebrates. The Shannon Diversity Index is another reflection of the level of diversity within a sample. A larger Shannon value indicates more diversity.

High-gradient tributary sites had the lowest median Hilsenhoff Biotic Index value (4.58), and low-gradient tributary sites had the highest (5.57) (Figure C.13). Both high-gradient tributary and mainstem sites had the same median Shannon Diversity values (2.03) (Figure C.14). The lowest Hilsenhoff value and highest Shannon value observed in the study occurred at high-gradient tributary sites. The low outliers depicted in Figure C.14 correspond to Shannon values of 0.5 at CR1-0.28 and CR2-4.09 and 0.78 at PH1-2.10.

Figure C.13 Hilsenhoff Index values

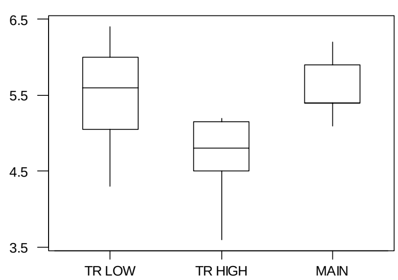
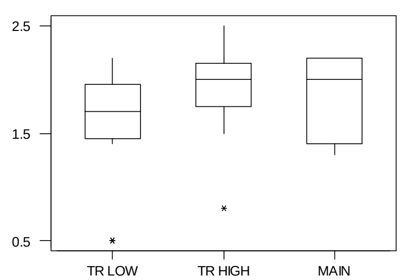


Figure C.14 Shannon Index values



The presence of intolerant taxa tends to decrease with increasing levels of environmental stress. The percent composition of tolerant organisms tends to increase with increasing levels of stress as the community shifts towards those organisms who can adapt.

High-gradient tributary sites had the highest median number of intolerant taxa (6) as well as the widest range (0 to 10) (Figure C.15). Low-gradient tributary sites had the lowest median number of intolerant taxa (2). High-gradient tributary sites had the lowest median percent composition of tolerant organisms (0.9%) (Figure C.16), with an extremely narrow range (0 to 2.2%). Mainstem sites had the highest median percent composition of tolerant organisms (13.8%). The high outlier depicted in Figure C.16 corresponds to a 48.4% dominance of tolerant Gastropoda at CR4-0.39.

Figure C.15 Number of intolerant taxa

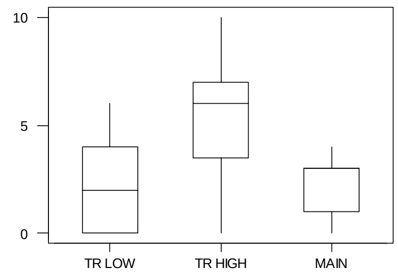
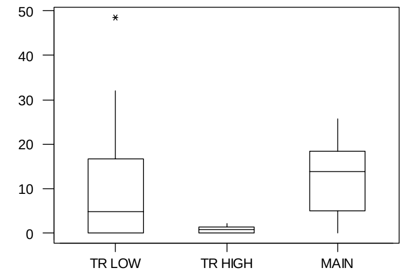


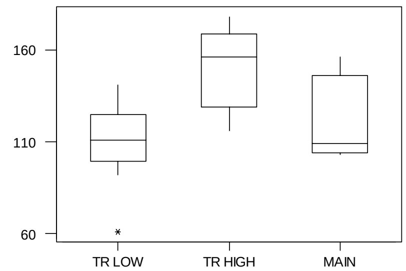
Figure C.16 Percentage of tolerant organisms



Habitat Assessment

A total of thirteen (13) habitat features were evaluated in the field at each site and assigned a score applicable to its quality (field data sheets are included in Appendix D). These scores were totaled to calculate an overall total habitat score for each site (Appendix E). A boxplot was also generated to illustrate the range of data among the three (3) site classifications (Figure C.17). This boxplot illustrates that high-gradient tributary sites had the highest median total habitat score (156), followed by low-gradient tributary sites (111) and mainstream sites (109). The outlier depicted in Figure C.17 corresponds to a total habitat score of 61 at DR2-1.85.

Figure C.17 Total Habitat Scores



Each of the thirteen (13) habitat features were also assigned quality descriptors based upon the score received (Tables C.5, C.6, and C.7).

Table C.5. Habitat Assessment Results for High-Gradient Tributary Sites

High-gradient tributary site:	CSR2-2.09	DR1-0.70	DR3-5.08	HSH1-1.61	IRG1-0.88	KH1-1.09	MN2-4.77	MN3-15.10	OR2-2.74	PH1-2.10	PR1-0.17	STH1-1.72	TR1-0.85
Habitat Feature (HF)													
1 Epifaunal Substrate/Available Cover	OPT	OPT	SUB	OPT	OPT	OPT	OPT	OPT	OPT	SUB	OPT	SUB	OPT
2 Embeddedness	OPT	OPT	OPT	OPT	SUB	SUB	OPT	OPT	OPT	OPT	OPT	SUB	OPT
3 Velocity/Depth Regime	SUB	SUB	SUB	SUB	MAR	OPT	SUB	OPT	MAR	POOR	SUB	MAR	OPT
4 Sediment Deposition	OPT	MAR	MAR	OPT	MAR	SUB	SUB	OPT	SUB	OPT	OPT	OPT	SUB
5 Channel Flow Status	SUB	SUB	MAR	SUB	SUB	SUB	OPT	OPT	MAR	POOR	OPT	MAR	OPT
6 Channel Alteration	OPT	SUB	OPT	OPT	SUB	OPT	OPT	OPT	SUB	OPT	OPT	OPT	OPT
7 Frequency of Riffles (or bends)	OPT	OPT	OPT	OPT	SUB	OPT	OPT	OPT	OPT	OPT	OPT	OPT	OPT
8 Left Bank Stability	OPT	SUB	POOR	SUB	SUB	OPT	MAR	SUB	MAR	SUB	SUB	POOR	SUB
9 Right Bank Stability	OPT	MAR	POOR	SUB	SUB	OPT	SUB	SUB	MAR	SUB	SUB	POOR	SUB
10 Left Bank Vegetative Protection	OPT	SUB	SUB	SUB	MAR	SUB	MAR	OPT	POOR	SUB	SUB	MAR	SUB
11 Right Bank Vegetative Protection	SUB	SUB	SUB	SUB	SUB	SUB	SUB	OPT	POOR	SUB	SUB	MAR	OPT
12 Left Bank Riparian Vegetative Zone	POOR	MAR	SUB	SUB	POOR	OPT	OPT	OPT	SUB	SUB	OPT	SUB	OPT
13 Right Bank Riparian Vegetative Zone	OPT	SUB	OPT	OPT	SUB	OPT	OPT	OPT	OPT	OPT	OPT	SUB	SUB
Reference Site (REF)													**REF**

Table C.6 Habitat Assessment Results for Low-Gradient Tributary Sites

Low-gradient tributary site:	CR1-0.28	CR2-4.09	CR3-2.17	CR4-0.39	CSR1-0.82	DR2-1.85	LD1-0.97	MN1-1.09	OR1-0.51	SR1-0.43	SR2-5.09	SR3-1.06	UNT1-0.11
Habitat Feature (HF)													
1 Epifaunal Substrate/Available Cover	SUB	SUB	MAR	MAR	OPT	POOR	MAR	MAR	OPT	SUB	POOR	MAR	MAR
2 Pool Substrate Characterization	SUB	SUB	SUB	SUB	SUB	SUB	SUB	MAR	OPT	OPT	SUB	SUB	MAR
3 Pool Variability	POOR	POOR	POOR	MAR	SUB	POOR	POOR	POOR	POOR	POOR	SUB	SUB	SUB
4 Sediment Deposition	MAR	MAR	POOR	MAR	MAR	POOR	SUB	MAR	OPT	OPT	MAR	MAR	MAR
5 Channel Flow Status	OPT	SUB	SUB	OPT	SUB	MAR	SUB	OPT	OPT	SUB	SUB	OPT	SUB
6 Channel Alteration	SUB	OPT	OPT	OPT	MAR	POOR	OPT	MAR	OPT	OPT	OPT	SUB	OPT
7 Channel Sinuosity	MAR	SUB	MAR	POOR	MAR	MAR	SUB	POOR	SUB	MAR	MAR	SUB	OPT
8 Left Bank Stability	MAR	SUB	MAR	SUB	MAR	POOR	SUB	SUB	SUB	OPT	MAR	MAR	POOR
9 Right Bank Stability	SUB	SUB	SUB	SUB	SUB	POOR	SUB	SUB	SUB	MAR	MAR	MAR	MAR
10 Left Bank Vegetative Protection	MAR	SUB	SUB	OPT	SUB	MAR	SUB	SUB	SUB	SUB	SUB	MAR	SUB
11 Right Bank Vegetative Protection	SUB	POOR	MAR	OPT	MAR	MAR	SUB	SUB	SUB	MAR	SUB	MAR	SUB
12 Left Bank Riparian Vegetative Zone	POOR	MAR	POOR	SUB	MAR	MAR	SUB	MAR	SUB	SUB	SUB	POOR	OPT
13 Right Bank Riparian Vegetative Zone	SUB	POOR	POOR	OPT	POOR	SUB	SUB	SUB	SUB	POOR	SUB	POOR	OPT
Reference Site (REF)									**REF**				

Condition Class		HF 1-7	HF 8-13
OPT = Optimal	**Score**	16-20	9-10
SUB = Suboptimal	**Score**	11-15	6-8
MAR = Marginal	**Score**	6-10	3-5
POOR = Poor	**Score**	0-5	0-2

Table C.7 Habitat Assessment Results for Mainstem Sites

Mainstem site:	**YB1-0.28**	**YB2-42.48**	**YB3-47.21**	**YB4-10.32**	**YB5-15.26**	**YB6-24.44**	**YB7-29.12**
Habitat Feature (HF)							
1Epifaunal Substrate/Available Cover	MAR	OPT	SUB	SUB	OPT	SUB	**SUB**
2Pool Substrate Characterization	MAR	OPT	SUB	MAR	SUB	SUB	**SUB**
3Pool Variability	SUB	SUB	POOR	POOR	POOR	POOR	**SUB**
4Sediment Deposition	SUB	OPT	MAR	SUB	MAR	SUB	**OPT**
5Channel Flow Status	OPT	OPT	OPT	OPT	MAR	OPT	**OPT**
6Channel Alteration	SUB	OPT	SUB	OPT	OPT	OPT	**OPT**
7Channel Sinuosity	MAR	MAR	POOR	MAR	POOR	MAR	**MAR**
8Left Bank Stability	MAR	OPT	SUB	POOR	SUB	MAR	**SUB**
9Right Bank Stability	MAR	OPT	MAR	SUB	MAR	SUB	**SUB**
10Left Bank Vegetative Protection	MAR	OPT	SUB	MAR	SUB	MAR	**SUB**
11Right Bank Vegetative Protection	MAR	OPT	SUB	SUB	SUB	MAR	**SUB**
12Left Bank Riparian Vegetative Zone	POOR	OPT	SUB	SUB	POOR	POOR	**SUB**
13Right Bank Riparian Vegetative Zone	POOR	MAR	MAR	MAR	POOR	POOR	**SUB**
Reference Site (REF)							**REF**

Reference Site Selection and Condition Category Determination

One reference site was chosen for each of the three (3) site classifications: TR1-0.85 (high-gradient tributary), OR1-0.51 (low-gradient tributary), and YB7-29.12 (mainstem). Each of these sites ranked overall as having the best metrics among other sites in the same classifications. The biological metrics and total habitat scores for each site were compared to its appropriate reference site to assign a Biological Condition Category and a Habitat Condition Category to each site. Worksheets detailing the calculations and resulting scores for each of these sites are included in Appendix E and Appendix F .

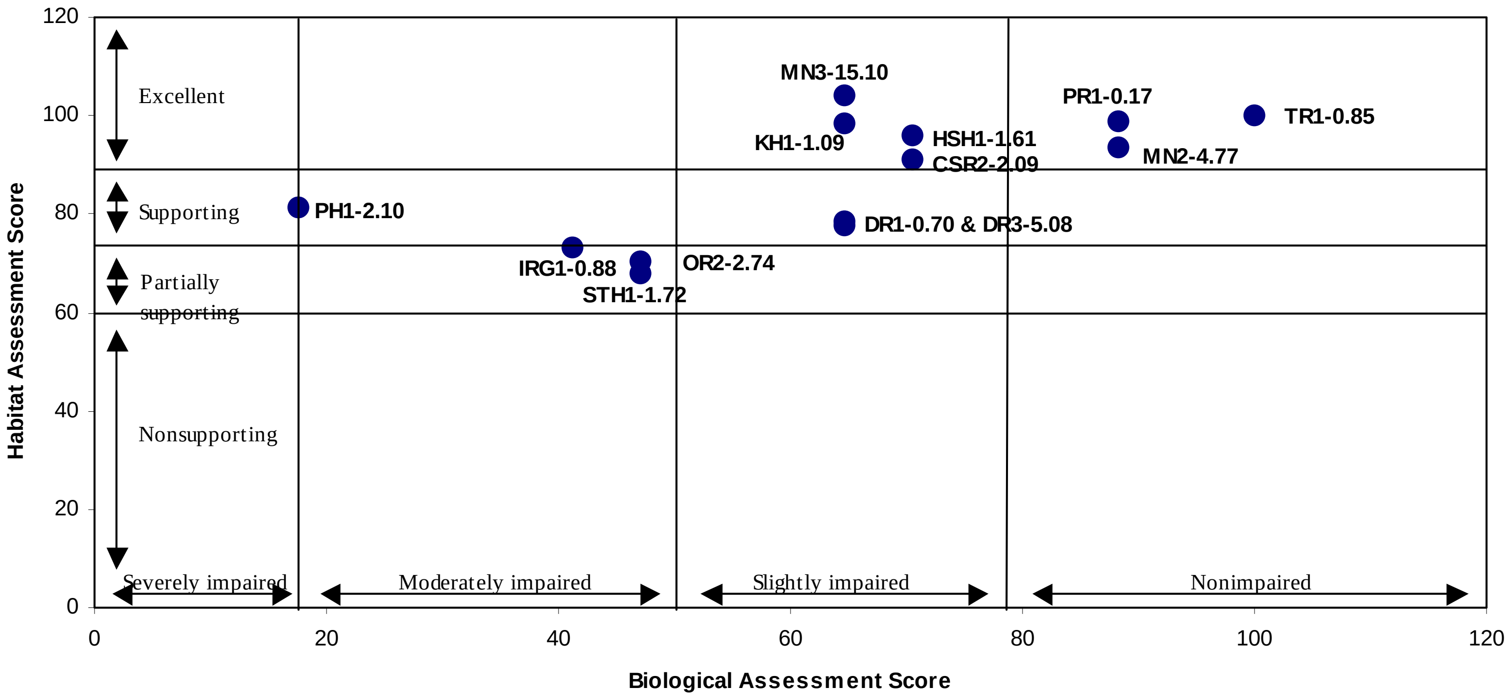
High-Gradient Tributary Sites - The habitat assessment scores for high-gradient tributary sites range from 68 to 104%, indicating habitat condition categories ranging from partially supporting to excellent (Table C.8 and Figure C.18). Biological Assessment Scores range from 18 to 88%, indicating Biological Condition Categories ranging from moderate impairment to nonimpairment. Two (2) sites other than the reference site ranked as having excellent habitat and nonimpaired biological communities (MN2-4.77 and PR1-0.17). Four (4) sites had excellent habitat and slightly impaired communities (CSR2-2.09, HSH1-1.61, KH1-1.09, and MN3-15.10). Three (3) sites had supporting habitat, two (2) with slightly impaired communities (DR1-0.70 and DR3-5.08) and one with a moderately impaired community (PH1-2.10). Three (3) sites had partially supporting habitat with moderately impaired communities (IG1-0.88, OR2-2.74, and STH1-1.72).

Table C.8 Condition Category Determination for High-Gradient Tributary Sites

Site ID	Habitat Assessment Score[1]	Habitat Condition Category[2]	Biological Assessment Score[1]	Biological Condition Category[2]
CSR2-2.09	91	Excellent	71	Slightly impaired
DR1-0.70	78	Supporting	65	Slightly impaired
DR3-5.08	78	Supporting	65	Slightly impaired
HSH1-1.61	96	Excellent	71	Slightly impaired
IG1-0.88	73	Partially supporting	41	Moderately impaired
KH1-1.09	98	Excellent	65	Slightly impaired
MN2-4.77	94	Excellent	88	Slightly impaired
MN3-15.10	104	Excellent	65	Slightly impaired
OR2-2.74	70	Partially supporting	47	Moderately impaired
PH1-2.10	81	Supporting	18	Moderately impaired
PR1-0.17	99	Excellent	88	Nonimpaired
STH11.72	68	Partially supporting	47	Moderately impaired
TR1-0.85 (reference)	100	Excellent	100	Nonimpaired

[1] as percentage of reference site
[2] compared to reference site

Figure 18. Biological and Habitat Condition Category Determination for High-gradient Tributary Sites



Low-Gradient Tributary Sites - The Habitat Assessment Scores for low-gradient tributary sites range from 43 to 90%, indicating Habitat Condition Categories ranging from nonsupporting to excellent (Table C.9 and Figure C.19). Biological Assessment Scores range from 28 to 89%, indicating Biological Condition Categories ranging from moderate impairment to nonimpairment. One site other than the reference site had excellent habitat, but with a slightly impaired community (SR1-0.43). Eight (8) sites had supporting habitat, one with a nonimpaired biological community (SR3-1.06), two (2) with slightly impaired communities (SR2-5.09 and UNT1-0.11), and four (4) with moderately impaired communities (CR1-0.28, CR2-4.09, CR4-0.39, and LD1-0.97). Three (3) sites had partially supporting habitat, one with a slightly impaired community (MN1-1.09), and two (2) with moderately impaired communities (CR3-2.17 and CSR1-0.82). One site had nonsupporting habitat and a moderately impaired biological community (DR2-1.85).

Table C.9 Condition Category Determination for Low-Gradient Tributary Sites

Site ID	Habitat Assessment Score[1]	Habitat Condition Category[2]	Biological Assessment Score[1]	Biological Condition Cagetory[2]
CR1-0.28	84	Supporting	39	Moderately impaired
CR2-4.09	78	Supporting	28	Moderately impaired
CR3-2.17	67	Partially supporting	33	Moderately impaired
CR4-0.39	87	Supporting	50	Moderately impaired
CSR1-0.82	74	Partially supporting	44	Moderately impaired
DR2-1.85	43	Not supporting	50	Moderately impaired
LD1-0.97	88	Supporting	39	Moderately impaired
MN1-1.09	65	Partially supporting	61	Slightly impaired
OR1-0.51 (reference)	100	Excellent	100	Nonimpaired
SR1-0.43	90	Excellent	78	Slightly impaired
SR2-5.09	77	Supporting	72	Slightly impaired
SR3-1.06	79	Supporting	89	Nonimpaired
UNT1-0.11	89	Supporting	67	Slightly impaired

1 as percentage of reference site
2 compared to reference site

Mainstem Sites - The Habitat Assessment Scores for mainstem sites range from 71 to 107% of the reference site, indicating Habitat Condition Categories ranging from partially supporting to excellent (Table C.10 and Figure C.20). Biological Assessment Scores range from 59 to 100% of the reference site, indicating Biological Condition Categories ranging from moderate impairment to nonimpairment. One site had excellent habitat with a slightly impaired biological community (YB2-42.48). Two (2) sites had supporting habitat, one with a nonimpaired biological community (YB6-24.44), and one with a slightly impaired community (YB4-10.32). Three (3) sites had partially supporting habitat but slightly impaired communities (YB1-0.28, YB3-47.21, and YB5-15.26).

Figure 19. Biological and Habitat Condition Category Determination for Low-gradient Tributary Sites

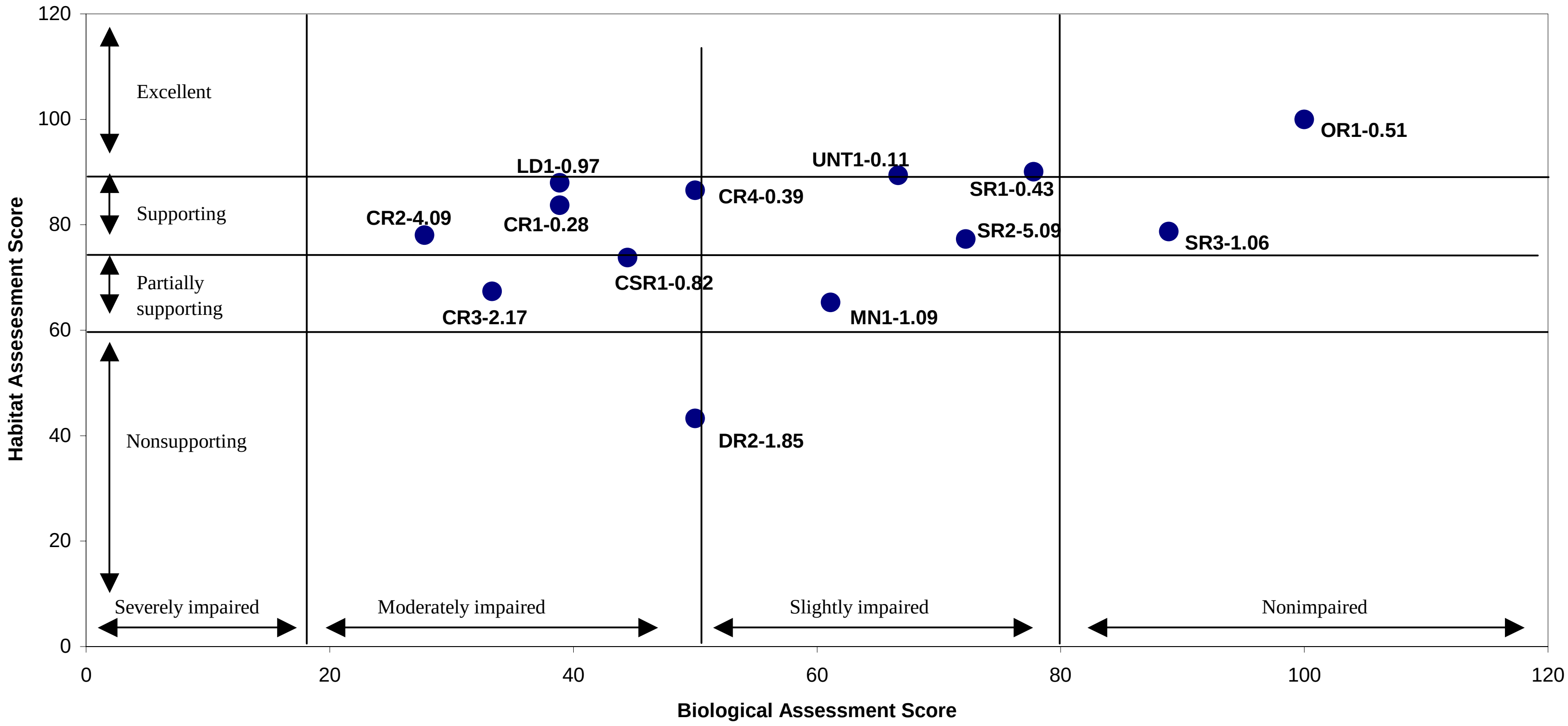


Table C.10 Condition Category Determination for Mainstem Sites

Site ID	Habitat Assessment Score[1]	Habitat Condition Category[2]	Biological Assessment Score[1]	Biological Condition Category[2]
YB1-0.28	71	Partially supporting	71	Slightly impaired
YB2-42.48	107	Excellent	53	Slightly impaired
YB3-47.21	71	Partially supporting	59	Slightly impaired
YB4-10.32	77	Supporting	76	Slightly impaired
YB5-15.26	73	Partially supporting	76	Slightly impaired
YB6-24.44	75	Supporting	100	Nonimpaired
YB7-29.12 (reference)	100	Excellent	100	Nonimpaired

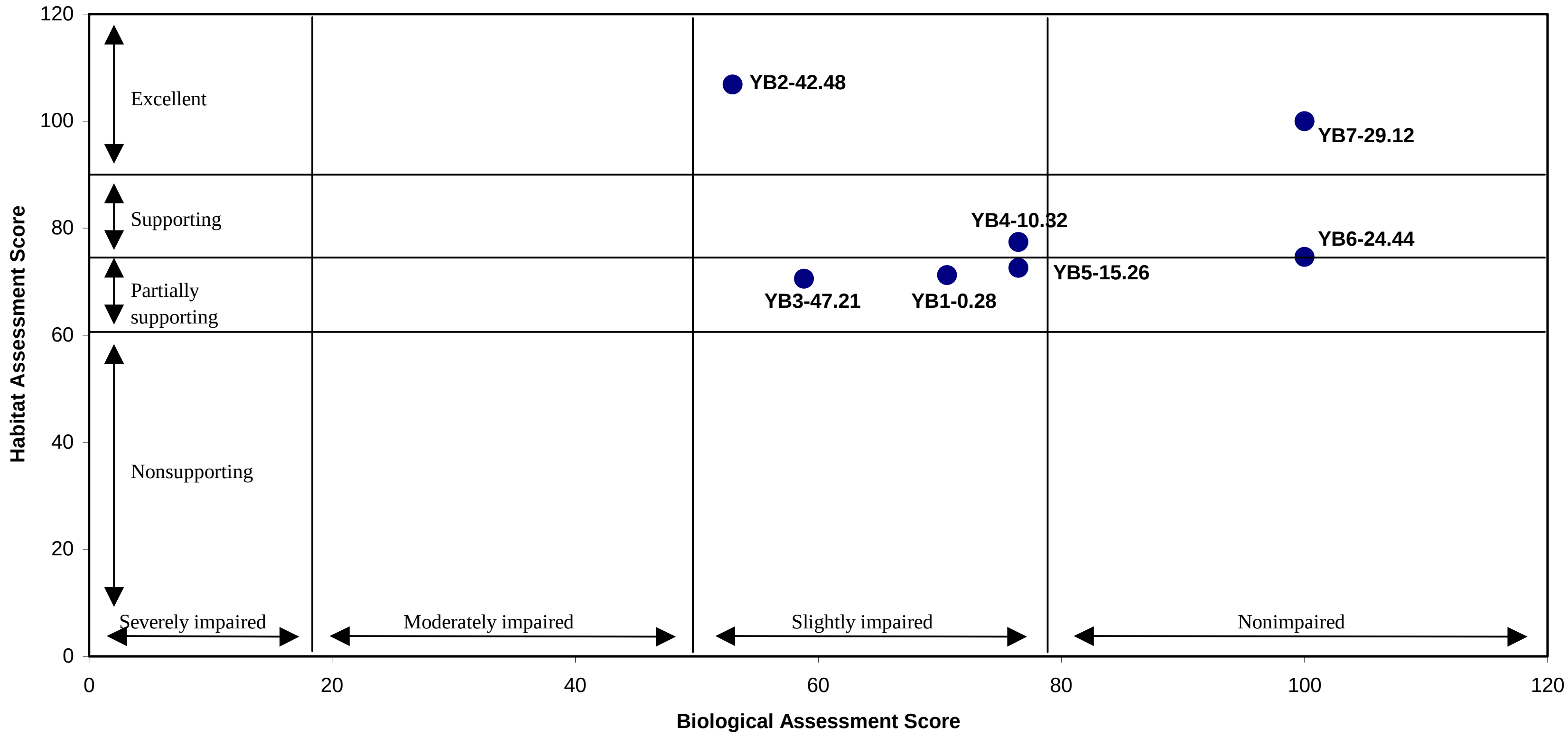
[1] as percentage of reference site
[2] compared to reference site

Individual Site Assessment

A total of thirty-three (33) sites on seventeen (17) streams were assessed as part of this study. Details and observations for each of the sites that were noted during the field portion of the study are presented below. Field data sheets are included in Appendix G.

Cedar Run - Two (2) sites were chosen on Cedar Run (CR1-0.28 and CR3-2.17), and two (2) sites were chosen on unnamed tributaries to Cedar Run (CR2-4.09 and CR4-0.39). All four (4) of these sites were classified as low-gradient sites.

Figure 20. Biological and Habitat Condition Categoriy Determination for Mainstem Sites



CR1-0.28 was located approximately 60 meters upstream of the 17th Street Bridge crossing in Camp Hill, PA, which is the same location of a USGS National Water Quality Assessment (NAWQA) study site. Residential development, managed lawn, and occasional trees are located along the left bank. The left bank was marginally stable and exhibited undercutting. The right bank is steep, with suboptimal stability, and consists of a woody riparian buffer of approximately 12-18 meters. Moderate sediment deposition was noted near the top of the reach. Substrate was suboptimal and dominated by cobble and sand. Snags, submerged macrophytes, vegetated banks, and gravel were also present. The stream at this site was approximately 15 meters in width, 0.35 meters in depth, and was largely dominated by run. Data analysis indicated that CR1-0.28 had supporting habitat and a moderately impaired benthic macroinvertebrate community. See Photo C.1.

Photo C.1 Cedar Run (CR1-0.28)

CR2-4.09 was located approximately 60 meters upstream of the Rossmoyne Road crossing. Land use in the vicinity consisted of active and fallowed agriculture and residential. The left bank riparian zone consisted of a mix of lawn, shrubs, trees, and emergent wetland plant species and exhibited a moderately stable bank. The right bank was dominated by managed lawn to the edge of water, yet stability was also moderate. Moderate sediment deposition was noted in select locations of the reach. Substrate was suboptimal and dominated by cobble, submerged macrophytes, and vegetated banks. The stream at this site was approximately 1 meter in width, 0.10 meters in depth, and consisted entirely of run. Data analysis indicated that CR2-4.09 had supporting habitat and a moderately impaired benthic macroinvertebrate community. See Photo C.2.

Photo C.2 Cedar Run (CR2-4.09)

CR3-2.17 was located approximately 60 meters upstream of the Hartzdale Drive crossing. A trailer park was located along the left bank, and industrial land use was located along the right bank. Riparian zone width on both banks was poor due to human activities up to the edge of water, including evidence of debris dumping on the left bank. Bank stability along the site was marginal to suboptimal, with instability evident in several locations. Sediment deposition was significant throughout the reach. This site was dominated by a heavy abundance of submerged macrophytes and periphyton. Substrate was marginal. The stream at this site was approximately 8 meters in width, 0.33 meters in depth, and consisted entirely of run. Data analysis indicated that CR3-2.17 had partially supporting habitat and a moderately impaired benthic macroinvertebrate community. See Photo C.3.

Photo C.3 Cedar Run (CR3-2.17)

CR4-0.39 was located approximately 60 meters downstream of the Hartzdale Drive crossing adjacent to Theo's Restaurant. Both the left and right bank riparian zones were 12 to greater than 18 meters in width and showed minimal signs of disturbance. Bank stability was moderate, with small and infrequent areas of erosion. Sediment deposition was present in the pool section of the reach, but was not excessive. Substrate was marginal and dominated by cobble, sand, and submerged macrophytes. Stream sediments had the odor of volatile organic carbons (VOCs), specifically gasoline. Tadpoles and blacknose dace were abundant in the pool. The stream at this site was estimated to be approximately 0.5 meters in width, 0.15 meters in depth, and consisted of an even distribution of riffle and run. Data analysis indicated that CR4-0.39 had supporting habitat and a moderately impaired benthic macroinvertebrate community. See Photo C.4.

Photo C.4 Cedar Run (CR4-0.39)

Cold Spring Run - Two (2) sites were chosen on Cold Spring Run, with one classified as low-gradient (CSR1-0.82) and the other classified as high-gradient (CSR2-2.09).

CSR1-0.82 was located approximately 30 meters upstream of the Pine Road crossing, which is near Yellow Breeches Road. Land use along this reach was dominated by active row crops on the left bank and forest and Pine Road on the right bank. As such, riparian width for the right bank was poor and only marginal for the left bank. Bank stability was marginal for the left bank as erosion was present and suboptimal for the right bank due to the forested area. Moderate sediment deposition was evident, especially in the pool portions of the reach. Substrate was optimal and dominated by cobble and root wads with occasional snags and submerged macrophytes. The stream at this site was approximately 1.5 meters in width, 0.10 meters in depth, and consisted of an even distribution of riffle and run. Data analysis indicated that CSR1-0.82 had partially supporting habitat and a moderately impaired benthic macroinvertebrate community. See Photo C.5.

Photo C.5 Cold Spring Run (CSR1-0.82)

CSR2-2.09 was located approximately 30 meters upstream of Cold Spring Road. Land use in the area was dominated by residential on the left bank and forest on the right bank. Correspondingly, the riparian zone for the left bank was minimal due to human activities while the right bank was undisturbed. Debris dumping and direct discharge of rooftop runoff via an above-ground corrugated pipe were observed along the left bank. Bank stability was optimal for both banks, and sediment deposition was not readily evident. Cobble, snags, and root wads comprised the majority of the substrate, which was optimal. The stream at this site was approximately 0.3 meters in width, 0.10 meters in depth, and consisted of an even distribution of riffle and run. Data analysis indicated that CSR2-2.09 had excellent habitat and a slightly impaired benthic macroinvertebrate community. See Photo C.6.

Photo C.6 Cold Spring Run (CSR2-2.09)

Dogwood Run - Three (3) sites were chosen on Dogwood Run. Two (2) of these sites were classified as high-gradient (DR1-0.70 and DR3-5.08) and the third classified as low-gradient (DR2-1.85).

DR1-0.70 was set approximately 40 meters upstream of its confluence with the Yellow Breeches Creek. While the majority of the surrounding land use was forest, significant clearing was observed on the right bank approximately 20 meters from the edge of water. The left bank was moderately more stable than the right bank. Sediment deposition was moderate throughout the reach. Substrate was optimal and dominated by cobble, woody debris, and root wads. The stream at this site was approximately 2 meters in width, 0.20 meters in depth, and was dominated by riffle, run, and pool. Data analysis indicated that DR1-0.70 had supporting habitat and a slightly impaired benthic macroinvertebrate community. See Photo C.7.

Photo C.7 Dogwood Run (DR1-0.70)

DR2-1.85 was situated approximately 30 meters downstream of the Rt. 74 crossing. Fallowed agricultural land was located along the right bank. While residential land use was located along the left bank, approximately 15 feet of undisturbed and native vegetation separated the left edge of water from the managed residential lawn. Sediment deposition was significant throughout and bank stabilities were poor. Substrate was poor and consisted of cobble, vegetated banks, and muck. Tadpoles and blacknose dace were abundant. The stream at this location was approximately 2 meters in width, 0.1 meters in depth, and consisted entirely of run. Data analysis indicated that DR2-1.85 had no supporting habitat and had a moderately impaired benthic macroinvertebrate community. See Photo C.8.

Photo C.8 Dogwood Run (DR2-1.85)

DR3-5.08 was located 30 meters upstream of the Green Road crossing. The surrounding land use consisted of undisturbed forest and was represented by a good-quality riparian zone. However, bank stability was poor because of frequent and unstable areas. Undercut banks and sandbar formation were observed throughout the reach, particularly in meanders. Sediment deposition was moderate. Substrate was suboptimal and dominated by cobble. The stream at this site was approximately 2 meters in width and 0.25 meters in depth. Data analysis indicated that DR3-5.08 had supporting habitat and a slightly impaired benthic macroinvertebrate community. See Photo C.9.

Photo C.9 Dogwood Run (DR3-5.08)

Fishers Run - The site SR3-1.06 was classified as low-gradient and was originally thought to be located on Stony Run. After sampling, however, SR3-1.06 was determined to be located on Fishers Run, a tributary to Stony Run. SR3-1.06 was located approximately 30 meters upstream of Filey's Road crossing. Surrounding land use consisted of field and pasture. Herbaceous vegetation dominated the riparian zones, which were significantly impacted. Bank stability and sediment deposition were marginal. Substrate was also marginal and was dominated by cobble. The stream at this site was approximately 1.5 meters in width and 0.25 meters in depth. Data analysis indicated that SR3-1.06 had supporting habitat and a nonimpaired benthic macroinvertebrate community. See Photo C.10.

Photo C.10 Fishers Run (SR3-1.06)

Hairy Spring Hollow - One site was chosen on Hairy Spring Hollow (HSH1-1.61) and was classified as high-gradient. HSH1-1.61 was located approximately 30 meters upstream of Furnace Hollow Road. Surrounding land use consisted largely of undisturbed forest, and riparian zone widths for both banks were suboptimal to optimal. Bank stability was moderate with infrequent areas of erosion. Little or no evidence of sediment deposition was observed. Substrate was optimal and consisted of cobble, root wads, and snags. The stream at this site was approximately 7.5 meters in width and 0.3 meters in depth. Data analysis indicated that HSH1-1.61 had excellent habitat and a slightly impaired benthic macroinvertebrate community. See Photo C.11.

Photo C.11 Hairy Spring Hollow (HSH1-1.61)

Irishtown Gap Hollow - One site was chosen on Irishtown Gap Hollow (IG1-0.88) and was classified as high-gradient. IG1-0.88 was located approximately 400 meters upstream of the Leeds Road crossing, parallel with Irishtown Gap Road. Residential land use and managed lawn was located along the left bank to the edge of water, whereas the right bank consisted of forest. Sediment deposition was moderate. Substrate components were dominated by cobble, sand, and gravel. Approximately 5% of the reach consisted of organic substrate of woody debris. The stream at this site was approximately 2 meters in width and 0.2 meters in depth. Local residents indicated that the stream has not gone dry in recent memory and rises only approximately one meter during high precipitation. Data analysis indicated that IG1-0.88 had partially supporting habitat and a moderately impaired benthic macroinvertebrate community. See Photo C.12.

Photo C.12 Irishtown Gap Hollow (IG1-0.88)

King's Gap Hollow - One site was chosen on King's Gap Hollow (KH1-1.09) and was classified as high-gradient. KH1-1.09 was located 30 meters upstream of the King's Gap Road crossing in the King's Gap State Park. Since the surrounding land use consisted of forest, riparian zones were excellent and undisturbed. Bank stability was also excellent, with little or no evidence of erosion or bank failure. Sediment deposition was evident in some locations, but was dominated by cobble and gravel. Large woody debris was located in several sections of the reach. Substrate was largely dominated by cobble and snags and was optimal. The stream at this site was approximately 2 meters in width and 0.2 meters in depth. Data analysis indicated that KH1-1.09 had excellent habitat and a slightly impaired benthic macroinvertebrate community. See Photo C.13.

Photo C.13 Kings Gap Hollow (KH1-1.09)

Little Dogwood Run - One site was chosen on Little Dogwood Run (LD1-0.97) and was classified as low-gradient. LD1-0.97 was located approximately 30 meters upstream of Wayne Noss Flowers, a private business. The upper half of the reach was dominated by forest, and a mix of pasture and forest was observed along the remainder of the reach. Riparian zones were adequate, but disturbance from the pasture was evident in the lower portions of the reach. Bank stability was suboptimal, as some evidence of erosion was observed along with sediment deposition. Substrate was marginal and dominated by cobble. The stream at this site was approximately 1 meter in width and 0.05 meters in depth. Data analysis indicated that LD1-0.97 had supporting habitat and a moderately impaired benthic macroinvertebrate community. See Photo C.14.

Photo C.14 Little Dogwood Run (LD1-0.97)

Mountain Creek - Three (3) sites were chosen on Mountain Creek. Two (2) of these sites were classified as high-gradient (MN2-4.77 and MN3-15.10) and the third classified as low-gradient (MN1-1.09).

MN1-1.09 was located approximately 150 meters upstream of the confluence with Yellow Breeches Creek in Mount Holly Springs Borough. Land use consisted of a mixture of pasture, cropland, and residential lawn. Consequently, the riparian zone on the left bank exhibited the influence of human activities. Bank stabilities for the reach were suboptimal and with only minor areas of erosion evident. Sediment deposition, however, was quite evident throughout the reach. Substrate was marginal and consisted of cobble, snags, and root wads. The stream at this site was approximately 11 meters in width and 0.2 meters in depth. Data analysis indicated that MN1-1.09 had partially supporting habitat and a slightly impaired benthic macroinvertebrate community. See Photo C.15.

Photo C.15 Mountain Creek (MN1-1.09)

MN2-4.77 was located adjacent to Rt. 34, approximately 3.2 kilometers south of Mount Holly Springs Borough. The site is located in a forested area that is protected by the Nature Conservancy. The left bank was steep, while the right bank expanded into an extensive floodplain. Bank stability varied with the left bank marginally more unstable than the right. Sediment deposition was evident in some locations. Substrate was optimal and dominated by cobble and snags. The stream at this site was approximately 13 meters in width and 0.5 meters in depth. Data analysis indicated that MN2-4.77 had excellent habitat and a slightly impaired benthic macroinvertebrate community. See Photo C.16.

Photo C.16 Mountain Creek (MN2-4.77)

MN3-15.10 was located approximately 120 meters upstream of the Rt. 233 crossing in the Michaux Road vicinity. Land use in the reach area was dominated by forest with a road running along the right bank (20 meters from edge of water). Consequently, human disturbance was not evident. Evidence of erosive high flows was noted, as bank stabilities were suboptimal and sediment deposition was minimal. Substrate was optimal and dominated by cobble, root wads, and snags. The stream at this site was approximately 3.5 meters in width and 0.4 meters in depth. Data analysis indicated that MN3-15.10 had excellent habitat and a slightly impaired benthic macroinvertebrate community. See Photo C.17.

Photo C.17 Mountain Creek (MN3-15.10)

Old Town Run - Two (2) sites were chosen on Old Town Run. One site was classified as high-gradient (OR2-2.74). The second site (OR1-0.51) was classified as low-gradient and serves as the low-gradient tributary reference site.

OR1-0.51 was located approximately 30 meters downstream of the Tangers Road crossing and serves as the low-gradient reference site. Land use was dominated by forest, and suboptimal riparian zones were present. Banks were moderately stable as only infrequent erosion was noted. Sediment deposition was not evident, and the substrate was optimal. Sampled substrate was dominated by cobble, root wads, and sand. The stream at this site was approximately 2 meters in width and 0.2 meters in depth. Data analysis indicated that OR1-0.51 had excellent habitat and a nonimpaired benthic macroinvertebrate community. See Photo C.18.

Photo C.18 Old Town Run (OR1-0.51)

OR2-2.74 was located approximately 30 meters downstream of Whiskey Spring Road crossing. This tributary was dominated by forest and abutted by steep terrain. Substrate was optimal and dominated by cobble, snags, and root wads. Some sediment deposition and marginal bank stability was observed. Vegetative protection of the streambanks was poor. Approximately 90% of the reach was riffle with the remainder as pool. The stream at this site was approximately 1 meter in width and 0.05 meters in depth. Data analysis indicated that OR2-2.74 had partially supporting habitat and a moderately impaired benthic macroinvertebrate community. See Photo C.19.

Photo C.19 Old Town Run (OR2-2.74)

Peach Orchard Hollow - One site was chosen on Peach Orchard Hollow (PH1-2.10) and was classified as high-gradient. PH1-2.10 was located approximately 60 meters downstream of the Peach Orchard Hollow Road crossing. Surrounding land uses were dominated by forested land use. Bank stability was suboptimal, and no evidence of sediment deposition was noted. Substrate was optimal and was dominated by cobble. Despite lying within a forested area, no large woody debris and only small amounts of detritus were observed. The flow at this site was extremely slow, and the stream appears to submerge underground approximately 100 meters downstream of the bottom of the reach. The stream at this site was approximately 0.5 meters in width and 0.2 meters in depth. Data analysis indicated that PH1-2.10 had supporting habitat and a moderately impaired benthic macroinvertebrate community. See Photo C.20.

Photo C.20 Peach Orchard Hollow (PH1-2.10)

Pippins Run - One site was chosen on Pippins Run (PR1-0.17) and was classified as high-gradient. PR1-0.17 was located approximately 45 meters downstream of the Lewisberry Road crossing. Surrounding land uses were dominated by fallowed pastureland. The reach was largely dominated by riffle and cobble. Sediment deposition was not evident, and bank stabilities were good. Blacknose dace were abundant at the site. The stream at this site was approximately 2 meters in width and 0.2 meters in depth. Data analysis indicated that PR1-0.17 had excellent habitat and a nonimpaired benthic macroinvertebrate community. See Photo C.21.

Photo C.21 Pippins Run (PR1-0.17)

Stony Run - Two (2) sites were chosen on Stony Run (SR1-0.43 and SR2-5.09) and were both classified as low-gradient. Site SR3-1.06 was originally thought to be on Stony Run but, after sampling, it was determined that SR3-1.06 was actually located on Fishers Run.

SR1-0.43 was located approximately 30 meters upstream of the Grantham Road crossing. Surrounding land use was forested, and no evidence of nonpoint source pollution was noted. The riparian zone on the left bank was intact. Right bank stability was notably lower than the left bank, largely due to the presence of a road along the right bank. Overall, the site exhibited no signs of sedimentation. Substrate was found to be suboptimal and largely consisted of cobble. The reach was dominated by riffle. The stream at this site was approximately 6 meters in width and 0.60 meters in depth. Data analysis indicated that SR1-0.43 had excellent habitat and a slightly impaired benthic macroinvertebrate community. See Photo C.22.

Photo C.22 Stony Run (SR1-0.43)

SR2-5.09 was located approximately 30 meters downstream of the Old York Road crossing. Land use within the reach was agricultural and nonpoint source pollution was evident. The riparian zone was suboptimal and dominated by grasses and herbaceous vegetation. Bank stabilities were marginal, with rather significant undercutting and sedimentation. Substrate was poor and consisted of sand, cobble, snags, macrophytes, and root wads. The stream at this site was approximately 3 meters in width and 0.75 meters in depth. Data analysis indicated that SR2-5.09 had supporting habitat and a slightly impaired benthic macroinvertebrate community. See Photo C.23.

Photo C.23 Stony Run (SR2-5.09)

Sthromes Hollow - One site was chosen on Sthromes Hollow (STH1-1.72) and was classified as high-gradient. STH1-1.72 was located approximately 60 meters upstream of Sand Hill Road crossing. Land use in the vicinity was forested, and some nonpoint source pollution was noted. Riparian zones were suboptimal, and vegetative protection was only marginal. Bank stability for both banks was poor, but little increased sedimentation was noted. Substrate was suboptimal and consisted of cobble and snags. The site was dominated by riffles. The stream at this site was approximately 2.5 meters in width and 0.42 meters in depth. Data analysis indicated that STH1-1.72 had partially supporting habitat and a moderately impaired benthic macroinvertebrate community. See Photo C.24.

Photo C.24 Sthromes Hollow (STH1-1.72)

Tom's Run - One site was chosen on Tom's Run (TR1-0.85), was classified as high-gradient, and serves as the high-gradient tributary reference site. TR1-0.85 was located approximately 60 meters downstream of the Rt. 233 crossing. Surrounding land use consisted of pine forest, and the riparian zone was optimal, with the exception of the presence of a road along the right bank. Bank stability was suboptimal with minimal sedimentation. Vegetative protection on the right bank was greater than the left, but only marginally. Substrate was optimal and was dominated by cobble and snags. The stream at this site was approximately 2.5 meters in width and 0.3 meters in depth. Data analysis indicated that TR1-0.85 had excellent habitat and a nonimpaired benthic macroinvertebrate community. See Photo C.25.

Photo C.25 Toms Run (TR1-0.85)

Unnamed Tributary to Yellow Breeches Creek- One site was chosen on an unnamed tributary to Yellow Breeches Creek (UNT1-0.11) and was classified as low-gradient. UNT1-0.11 was located approximately 600 meters upstream of the Lisburn Road crossing. Forest was located along the right bank, and residential land use was located along the left bank. However, disturbance on both banks was minimal and the riparian zone was greater than 18 meters in width. The reach was dominated by run. Some of the pools that were present were deep and contained eroded and undercut banks. Stability was poor for the left bank and marginal for the right. Vegetative cover along the banks was suboptimal. Sediment deposition was moderate. Substrate appeared marginal and consisted largely of cobble, snags, and vegetated banks. Evidence of high flows (highwater mark of 2 meters) was noted. The stream at this site was approximately 3 meters in width and 0.3 meters in depth. Data analysis indicated that UNT1-0.11 had supporting habitat and a slightly impaired benthic macroinvertebrate community. See Photo C.26.

Photo C.26 Unnamed Tributary to Yellow Breeches Creek (UNT1-0.11)

Yellow Breeches Mainstem - Seven (7) sites were chosen along the mainstem of the Yellow Breeches (YB1-0.28 through YB7-29.12). All seven (7) sites were classified as low-gradient.

YB1-0.28 was located approximately 60 meters upstream of the Bridge Street crossing in New Cumberland Borough. Surrounding land use consisted of high density residential and commercial, with a trailer park on the right bank and a business on the left. The riparian zone for both banks was disturbed, less than 6 meters in width, and of poor quality. Vegetative protection on each bank was marginal with obvious disruption. The reach was largely dominated by run. Substrate was dominated by cobble, gravel, and bolder with a nominal amount of sand present. Three corrugated pipe outfalls were present, each presumably a stormwater outfall. A pair of great blue herons (*Ardea herodias*) was observed at the site. The stream at this site was approximately 20 meters in width and 2.4 meters in depth. Data analysis indicated that YB1-0.28 had partially supporting habitat and a slightly impaired benthic macroinvertebrate community. See Photo C.27.

Photo C.27 Yellow Breeches Creek (YB1-0.28)

YB2-42.48 was located approximately 90 meters upstream of Enck's Mill Road crossing. The majority of the surrounding land use was forested. Bank stability and vegetative protection for each bank was excellent. Sediment deposition was minimal, and large woody debris was present throughout the reach. The reach was equally distributed between riffle and run. The substrate was largely dominated by gravel, with some cobble and organic detritus. The stream at this site was approximately 13 meters in width and 0.3 meters in depth. Data analysis indicated that YB2-42.48 had excellent habitat and a slightly impaired benthic macroinvertebrate community. See Photo C.28.

Photo C.28 Yellow Breeches Creek (YB2-42.48)

YB3-47.21 was located approximately 30 meters upstream of Hays Grove Road crossing. Surrounding land use was dominated by forest with lesser amounts of field and pasture. The riparian zone was suboptimal for the left bank and only marginal for the right due to pastureland. Vegetative bank protection and bank stability were suboptimal. Sediment deposition was moderate throughout the reach. The reach was largely dominated by run with some riffle. The substrate consisted of cobble, gravel, some sand, and detritus. The site included noticeable amounts of litter, including a tire and an empty 55-gallon plastic drum. The stream at this site was approximately 3 meters in width and 0.15 meters in depth. Data analysis indicated that YB3-47.21 had partially supporting habitat and a slightly impaired benthic macroinvertebrate community. See Photo C.29.

Photo C.29 Yellow Breeches Creek (YB3-47.21)

YB4-10.32 was located approximately 60 meters upstream of the Sheepford Road bridge crossing. Land use within the vicinity was mostly forested, but residential development was also present. The right bank had a moderately high slope, and the left bank consisted of floodplain. The riparian zone was marginal due to some anthropogenic influences on both banks. Vegetative bank protection was marginal for the left bank, and bank stability was poor. Both vegetative bank protection and bank stability were suboptimal for the right bank, primarily due to floodplain influences. Substrate was dominated by cobble and gravel, with some detritus and muck/mud. The majority of the reach consisted of run with some riffle, with extensive large woody debris. The stream at this site was approximately 25 meters in width and 0.30 meters in depth. Data analysis indicated that YB4-10.32 had supporting habitat and a slightly impaired benthic macroinvertebrate community. See Photo C.30.

Photo C.30 Yellow Breeches Creek (YB4-10.32)

YB5-15.26 was located approximately 150 meters downstream of McCormick Road, west of Lisburn Road. Land use within the reach was a mix of forest and large-lot residential. The riparian zone on each bank was poor and influenced by the presence of a road. Bank stabilities were marginal to suboptimal while vegetative bank protection was suboptimal. Sediment deposition was moderate throughout the reach and appeared recent. Riffles made up the predominant stream morphology with some run. Substrate was dominated by cobble and gravel. The stream at this site was approximately 25 meters in width and 0.33 meters depth. Data analysis indicated that YB5-15.26 had partially supporting habitat and a slightly impaired benthic macroinvertebrate community. See Photo C.31.

Photo C.31 Yellow Breeches Creek (YB5-15.26)

YB6-24.44 was located approximately 45 meters upstream of Creek Road/Rt. 74. Land use within the reach was dominated by residential with the presence of agricultural activities upstream. A cobble/boulder dam was present upstream of the reach. The left bank riparian zone was poor due to the presence of a road. The right bank was also poor due to residential influences. Vegetative protection on both banks was marginal, bank stability was marginal to suboptimal, and sediment deposition was evident in some locations. Substrate was dominated by cobble with some gravel. The majority of the reach consisted of riffle with some run. The stream at this site was approximately 18 meters and 0.25 meters in depth. Data analysis indicated that YB6-24.44 had supporting habitat and a nonimpaired benthic macroinvertebrate community. See Photo C.32.

Photo C.32 Yellow Breeches Creek (YB6-24.44)

YB7-29.12 was located approximately 60 meters downstream of the Mountain Road Bridge crossing and serves as the mainstem reference site. Surrounding land use consisted of forest with some residential and agricultural uses present. The riparian zone was suboptimal because of a road along the right bank of the stream and human use along the left. Vegetative cover and bank stability were suboptimal. Sediment deposition was not readily noticeable within the reach, and several overhanging trees were present. The reach was dominated by run, with some pool and riffle. Substrate was dominated by gravel, with some cobble, boulder, sand, and detritus. Fish were abundant within the reach.   The stream at this site is approximately 14 meters in width and 1.5 meters in width. Data analysis indicated that YB7-29.12 had excellent habitat and a nonimpaired benthic macroinvertebrate community. See Photo C.33.

Photo C.33 Yellow Breeches Creek (YB7-29.12)

Comparative Historical Data Review

Several other studies that have been conducted in the Yellow Breeches Creek Watershed were reviewed to assess historical stream health and provide perspective to the current findings.

PA DEP 303(d) Listed Waters - Section 303(d) of the Clean Water Act requires states to list all impaired waters (streams and other waterbodies) not supporting designated uses such as aquatic life, recreation, and drinking water. Portions of twenty-seven (27) streams within the Yellow Breeches Creek Watershed are listed as impaired for aquatic life use on the 2002 Pennsylvania 303(d) List. PA DEP used a modified RBP approach to sample benthic macroinvertebrates and habitat to make determinations of impairment. In their summary data forms, PA DEP lists benthic macroinvertebrates as being very abundant, abundant, common, present, or rare, based on the number of individuals within a taxon that were collected. Habitat was evaluated by assigning scores to each of twelve (12) instream and riparian features, which were summed for a maximum total score of 240. Bob Schott, PA DEP Biologist, provided the data represented below (R. Schott, personal communication).

Approximately half (14) of the streams listed on the 303(d) List were sampled during the course of this study. However, the sites on four (4) of these fourteen (14) streams were on non-impaired stream segments located downstream from the 303(d) listed impaired segments. These streams include Cold Spring Run, Mountain Creek, Peach Orchard Hollow, and Stony Run. Study sites were located on twelve (12) impaired segments along ten (10) of the listed streams.

On Cedar Run, CR2-4.09 is located on a segment impaired by agricultural practices, and CR3-2.17 is located on a segment affected by urban runoff, storm sewers, and resulting habitat modification. However, PA DEP macroinvertebrate data are lacking at the CR2-4.09 segment because access to the segment was prohibited or the segment was dry. Macroinvertebrate data at CR3-2.17 are lacking because the low flow and hazardous mucky conditions prohibited collection. Consequently, no PA DEP data from the State Surface Water Assessment Project pertaining to macroinvertebrates or habitat specific to sites in this study on Cedar Run exist.

On Dogwood Run, DR1-0.70 is located on a segment impaired by municipal point sources, and DR2-1.85 is located on a segment impaired by agricultural practices. The data used for impairment determination for the DR1-0.70 segment are based on an older report investigating effluent discharge from the Dillsburg Sewage Treatment Facility. The PA DEP community largely consists of Amphipoda and Hydropsychidae (Trichoptera) with a few mayflies. At DR1-0.70, this study found that the community consisted of a predominance of Chironomidae (35%, Diptera) followed by Amphipoda and Elmidae (Coleoptera) with some Hydropsychidae and a few mayflies. At the DR2-1.85 impaired segment, PA DEP noted that Simuliidae (Diptera) were very abundant, Hydropsychidae (Trichoptera) were common, and Cambaridae (Decapoda) and Oligochaeta were rare. At DR2-1.85, this study found a large predominance of Chironomidae (56%) and only a few Hydropsychidae and Simuliidae.

The entire length of Hairy Springs Hollow, where HSH1-1.61 is located, is listed as being impaired by atmospheric deposition. Along this segment, PA DEP noted that Simuliidae (Diptera) were common, Rhyacophilidae (Trichoptera) and Nemouridae (Plecoptera) were present, and Aeshnidae (Odonata), Elmidae (Coleoptera), and Amphipoda were rare. Like other streams affected by atmospheric deposition, the low pH at Hairy Springs Hollow does not support the presence of mayflies. At HSH1-1.61, this study found a predominance of Chironomidae (23%) and Simuliidae (21%, Diptera) followed by Hydropsychidae (Trichoptera). It was also noted the presence of Rhyacophilidae, Nemouridae, Elmidae, and Amphipoda. This study did not find any Odonata at HSH1-1.61.

King’s Gap Hollow, where KH1-1.09 is located, is also listed as being impaired by atmospheric deposition. Along this segment, PA DEP noted that Nemouridae (Plecoptera) were abundant, Perlidae (Plecoptera), Hydropsychidae, Rhyacophilidae (both Trichoptera), Simuliidae (Diptera), and Amphipoda were present, and Corydalidae (Megaloptera), Philopotamidae, and Polycentropodidae (both Trichoptera) were rare. No mayflies were observed along this segment. At KHI-1.09, this study found a predominance of Chironomidae (32%, Diptera) followed by Hydropsychidae and Leuctridae (Plecoptera). Philopotamidae, Corydalidae, Rhyacophilidae, and Simuliidae as well as several Ephemerellidae (Ephemeroptera) and one Peltoperlidae (Plecoptera) exist at this site. This study did not find Polycentropodidae, Amphipoda, or Nemouridae.

Like Hairy Springs Hollow and King’s Gap Hollow, Little Dogwood Run, where LD1-0.97 is located, is also listed as being impaired by atmospheric deposition. Along this segment, PA DEP noted that Rhyacophilidae (Trichoptera) and Tipulidae (Diptera) were present, and Siphlonuridae (Ephemeroptera), Nemouridae (Plecoptera), Limnephilidae (Trichoptera), Chironomidae (Diptera), and Oligochaeta were rare. At LD1-0.97, this study found a large predominance of Chironomidae (60%) followed by Simuliidae and Empididae (both Diptera). Rhyacophilidae, Limnephilidae, or any mayflies or stoneflies were found at this site.

One segment of Old Town Run, where site OR2-2.74 is located, is listed as being impaired by an unknown source, which is causing siltation. Along this segment, PA DEP noted that Gomphidae (Odonata), Elmidae (Coleoptera), and Simuliidae (Diptera) were present and that Ephemerellidae (Ephemeroptera), Leuctridae (Plecoptera), Limnephilidae (Trichoptera), Tipulidae (Diptera), Cambaridae (Decapoda), and Oligochaeta were rare. At OR2-2.74, this study found a predominance of Chironomidae (45%, Diptera) followed by Hydropsychidae (Trichoptera) and Simuliidae. This study also found Gomphidae, Elmidae, Leuctridae, and Tipulidae, but did not find any Ephemerellidae. Two other Ephemeroptera representatives (Baetidae and Heptageniidae) were found in this study. No Limnephilidae were found, but two (2) other Trichoptera representatives (Philopotamidae and Lepidostomatidae) were noted.

One segment of Fishers Run, where SR3-1.06 is located, is listed as being impaired by construction and agricultural practices. Along this segment, PA DEP noted that Hydropsychidae (Trichoptera) were very abundant, Isonychiidae (Ephemeroptera) and Elmidae (Coleoptera) were common, Heptageniidae (Ephemeroptera), Psephenidae (Coleoptera), and Philopotamidae (Trichoptera) were present, and

Baetidae (Ephemeroptera), Aeshnidae (Odonata), and Capniidae (Plecoptera) were rare. At SR3-1.06, this study found a predominance of Baetidae (22%, Ephemeroptera) followed by Chironomidae (Diptera) and Heptageniidae. Hydropsychidae, Elmidae, Psephenidae, and Philopotamidae were also found in this study. No Isonychiidae, Odonata, or Capniidae were found, but a Plecoptera representative (Perlidae) was noted.

UNT1-0.11 is located on an unnamed tributary to the Yellow Breeches Creek that is listed as being impaired by agricultural practices. Along this segment, PA DEP noted that Asellidae (Isopoda) were very abundant, Elmidae (Coleoptera) were abundant, Hirudinea, Turbellaria, and Simuliidae (Diptera) were common, and Lestidae (Odonata) and Tipulidae (Diptera) were rare. At UNT1-0.11, this study found a predominance of Gammaridae (39%, Amphipoda) followed by Elmidae (34%). Simuliidae was found, but Hirudinea, or Turbellaria was not observed. No Lestidae were found, but two (2) other Odonata representatives (Coenagrionidae and Calopterygidae) were noted.

Irishtown Gap Hollow and Sthromes Hollow are two (2) streams that are impaired because of atmospheric deposition. IRG1-0.88 and STH1-1.72 are located along their impaired segments. However, PA DEP's determination of impairment for these two (2) streams was based on macroinvertebrate data collected at nearby Hairy Springs Hollow and not on data collected at the streams themselves. Consequently, no benthic macroinvertebrate or habitat data specific to Irishtown Gap Hollow or Sthromes Hollow exist for 303(d) listing.

PA DEP Hatchery Investigation - A study was conducted in June 2003 by PA DEP to determine the quality of the macroinvertebrate community at several stations on the Yellow Breeches Creek, downstream of the PA Fish and Boat Commission Hatchery (Botts 2003). PA DEP determined that several of these stations were severely impaired and contained large populations of Isopoda. One of these stations, Station 3, is located slightly downstream from YB2-42.48. In the PA DEP study, Station 3 was determined to be severely impaired due to the lack of sensitive EPT taxa, low taxa richness, and a large abundance of Isopoda (65% dominance). At YB2-42.48, three (3) moderately tolerant EPT taxa were collected (Baetidae, Hydropsychidae, and Limnephilidae), taxa richness was similar, and Isopoda constituted approximately 48% of the identified individuals. It was determined in this study that YB2-42.48 had a slightly impaired benthic community. The differences in impairment level classification likely result from the different reference sites that were used as well as different thresholds for metric calculation. While PA DEP used an established ecoregion-based reference site, this study used a specific study-based reference site.

Undergraduate Study of Cedar Run - In 1982, Richard Pugh conducted an undergraduate study of Cedar Run which assessed its biological community and documented some historical events that had affected the water quality and biological integrity of the stream (Pugh 1982). While the study largely analyzed the fish community, the presence of macroinvertebrates such as Baetidae (Ephemeroptera), Glossosomatidae, Hydropsychidae (both Trichoptera), Chironomidae, Simuliidae (both Diptera), Gammaridae (Amphipoda), Asellidae (Isopoda), Planariidae, and Gastropoda was noted at two (2) study stations. At the Cedar Run sites, this study confirmed the presence of Chironomidae, Simuliidae (only at CR3-2.17

and CR4-0.39), Gammaridae (overwhelming dominance at CR1-0.28), Asellidae (overwhelming dominance at CR2-4.09), and Gastropoda (but not at CR2-4.09). With the exception of a few Hydropsychidae individuals at CR4-0.39, no other Trichoptera were found. In addition, this study did not find Baetidae, Glossosomatidae, or Planariidae.

SRBC Biological Assessment - As part of the SRBC's subbasin survey program, SRBC assessed habitat and biological conditions in 1996 at one site on Mountain Creek (MNTN 3.0) and two (2) on the Yellow Breeches Creek mainstem (YLBR 35.7 and YLBR 3.4) (Traver 1997). MNTN 3.0 was located on Mountain Creek upstream of the Route 34 bridge. MN2-4.77 was located in the same vicinity, slightly downstream of the Route 34 bridge. Many of the benthic macroinvertebrate families collected at MNTN 3.0 were also collected at MN2-4.77. SRBC determined that the habitat at MNTN 3.0 was excellent and that biological conditions were nonimpaired. This study determined that the habitat at MN2-4.77 was excellent and that biological conditions were slightly impaired. Both SRBC and this study used different reference sites for condition category determination. Both IG1-0.88 and STH1-1.72 were determined to have moderately impaired communities in this study.

YLBR 35.7 was located on the Yellow Breeches Creek upstream of the Mountain Creek confluence. YLBR 3.4 was located on the Yellow Breeches Creek at the USGS gage, near Green Lane Farms. SRBC determined that the habitat at YLBR 35.7 and YLBR 3.4 was supporting. Biological conditions at YLBR 35.7 were determined to be slightly impaired, while they were determined to be moderately impaired at YLBR 3.4. None of the sites in this study was located in the vicinity of these SRBC stations.

USGS Study - In 1993, as part of the NAWQA Program, the USGS sampled benthic macroinvertebrates at a site on Cedar Run (Brightbill, personal communication). This site was located downstream of the 17th Street bridge in Camp Hill. This site is in the same vicinity as CR1-0.28, which was also located upstream of the 17th Street bridge. Biological conditions appear to have degraded greatly over the past ten (10) years at this site. In 1993, the NAWQA site experienced a 24% dominance of Hydropsychidae (Trichoptera), 37% composition of EPT organisms, a Shannon Diversity value of 2.3, seven (7) Ephemeroptera taxa, one Plecoptera taxa, and six (6) Trichoptera taxa. In contrast, this study found that CR1-0.28 in 2003 experienced 89% dominance in Gammaridae (Amphipoda), a Shannon Diversity value of 0.52, and the complete absence of any EPT organisms. It should be noted that the USGS did not use subsampling in its analysis.

Messiah College Assessments - Jeff Erikson at Messiah College collected data at fourteen (14) sites in the Yellow Breeches Creek Watershed in 2001 (J. Erikson, personal communication). Eleven (11) of these sites were located on the Yellow Breeches Creek mainstem, and three (3) were located on tributaries. Two (2) sites in this study are in the same vicinities as the Messiah College sites. Pursuant to an agreement with Mr. Erikson, detailed analysis of the data cannot be discussed as part of this report since the data are not yet published. However, review of the data indicates that the 2001 Messiah College data reflect many of the overall trends observed in the 2003 data of this study.

Thirty-three (33) sites, representing the various land use conditions in the Yellow Breeches Creek Watershed, were sampled for benthic macroinvertebrates, habitat, and water chemistry in this study from August to October 2003. Seven (7) of these sites were located on the Yellow Breeches Creek mainstem, thirteen (13) were located on low-gradient tributaries, and thirteen (13) were located on high-gradient tributaries.

Benthic macroinvertebrate data and habitat data were analyzed to determine the health and status of the benthic community, as well as the condition of riparian and instream features, throughout the Yellow Breeches Creek Watershed. One reference site was chosen in each of three classifications: OR1-0.51 (low-gradient tributary), TR1-0.85 (high-gradient tributary), and YB7-29.12 (mainstem). Benthic macroinvertebrate and habitat data for each study site were compared to an appropriate reference site to determine condition categories, or relative levels of impairment of the benthic community and habitat.

Of the thirteen (13) low-gradient tributary sites, two (2) had nonimpaired benthic communities, four (4) had slightly impaired communities, and seven (7) had moderately impaired communities. Of the thirteen (13) high-gradient tributary sites, two (2) had nonimpaired benthic communities, seven (7) had slightly impaired communities, and four (4) had moderately impaired communities. Of the seven (7) mainstem sites, two (2) had nonimpaired communities, and five (5) had slightly impaired communities.

Of the thirteen (13) low-gradient tributary sites, two (2) qualified as having excellent habitat, seven (7) had supporting habitat, three (3) had partially supporting habitat, and one had nonsupporting habitat. Of the thirteen (13) high-gradient tributary sites, seven (7) had excellent habitat, three (3) had supporting habitat, and three (3) had partially supporting habitat. Of the seven (7) mainstem sites, two (2) had optimal habitat, two (2) had supporting habitat, and three (3) had partially supporting habitat.

High-gradient tributary sites consistently had the best individual macroinvertebrate metric values, indicating a greater degree of macroinvertebrate community health and habitat quality among all the study sites. Low-gradient tributary sites largely had the worst individual metric values, indicating greater degrees of impairment. Mainstem sites tended to have metric values in between the high-gradient and low-gradient tributary sites.

Overall, the results of this study indicate that the Yellow Breeches Creek Watershed experiences moderately impaired to nonimpaired benthic communities, as well as nonsupporting to excellent habitat quality. Further analysis is required to correlate variables such as land use and water quality parameters with habitat quality and benthic macroinvertebrate data to determine specific causes of impairment.

TAB D

SECONDARY DATA COLLECTION

Secondary data was collected as part of the Yellow Breeches Creek Watershed Assessment. Data sources included the review of available information from PA DEP (E-Facts), as well as inquiries to other agencies and the municipalities within the watershed.

A list of NPDES permittees within the watershed, including industrial waste, municipal sewage, non-municipal sewage, and stormwater discharges was requested from PA DEP. Tables summarizing the NPDES data are included in this assessment as Appendix J.

The locations of known sinkholes within the watershed were obtained from USGS. The locations of sinkholes have been plotted on the Geology Map.

Information available from PA DEP was reviewed to determine the locations of permitted mining sites within the watershed, but a search of the E-Facts database did not show any mining permits within the watershed.

A list of soil disturbance activities under permit and major landowners without implemented conservation plans was requested from the Cumberland County Conservation District. Upon realizing the broad scope of this request, YBWA decided to consider including agricultural preservation areas and agricultural easements as an alternative in this assessment. Agricultural preservation areas and agricultural easements are shown on the Watershed Concerns Map.

The locations of stormwater piped outfalls, other point source discharges, and landfills/waste sites has not been included as part of this assessment, as this information was requested from the municipalities within the watershed, but there was a limited response. Additional inquiries to obtain landfill/waste site information were made to other agencies including PA DEP and the Cumberland County Solid Waste Coordinator, but these efforts were unsuccessful.

WATER QUALITY ASSESSMENT

The water quality assessment of the Yellow Breeches Creek Watershed consisted of the collection and analysis of both field and laboratory data. Field parameters considered included water temperature, specific conductance, dissolved oxygen, and pH. Laboratory parameters considered included suspended solids, biological oxygen demand, sulfate, nitrate nitrogen, total phosphorous, Kjeldahl nitrogen, ammonia nitrogen, and fecal coliform.

Field Parameters

Background information on the following field parameters was collected as part of the water quality assessment:

Water temperature should not be changed by human activities beyond natural seasonal fluctuations; cold water streams typically should not exceed 20 degrees Celsius. Often summer heat can cause fish kills in ponds, because high temperatures reduce available oxygen in the water. Lower temperature values indicate improved water quality.

Specific conductance is a measure of the ability of water to conduct an electrical current. Water itself does not conduct electricity, but the minerals dissolved in the water determine its conductivity. Specific conductance is an indirect measure of the presence of dissolved solids such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, and iron. Runoff from farms can contain fertilizers, which contain phosphates and nitrates that can lead to an increase in specific conductance. Runoff from roads can contain leaked automobile fluids and salts from chemicals used in road de-icing, resulting in an increase in specific conductance. Lower values indicate lower dissolved solids, but water quality could still be degraded by other contaminants. Water that is low in dissolved solids can become very corrosive.

Dissolved oxygen is a measure of the amount of gaseous oxygen dissolved in an aqueous solution. Total dissolved oxygen concentrations in water should not exceed 110 percent; concentrations above this level can be harmful to aquatic life. Adequate dissolved oxygen is necessary for good water quality, as oxygen is an essential element to all forms of life. As dissolved oxygen levels in water drop below 5.0 mg/liter, aquatic life is put under stress. Oxygen levels that remain below 1 to 2 mg/liter for a few hours can result in large fish kills. Generally higher values of dissolved oxygen indicate improved water quality.

pH is a measure of the acidic or basic (alkaline) nature of a solution. The concentration of the hydrogen ion [H+] activity in a solution determines the pH. A pH range of 6.0 to 9.0 appears to provide protection for the life of freshwater fish and bottom dwelling invertebrates; a pH of 8.7 is the maximum upper limit for good fishing waters. The optimum range of pH for fish eggs is 6.0 to 7.2, although trout eggs can develop normally at a maximum pH of 9.0.

Laboratory Parameters

Background information on the following laboratory parameters was collected as part of the water quality assessment:

Suspended solids settle to the bottom of a stream and become sediments, while also contributing to the turbidity of the water. Suspended solids consist of an inorganic fraction (silts, clays, etc.) and an organic fraction (algae, zooplankton, bacteria, and detritus) that are carried along by water as it runs off the land. Suspended solids contribute to turbidity or cloudiness of the water and are affected by the geology and vegetation of the watershed. Suspended solids can kill fish or reduce growth rates. Suspended solids also interfere with recreational use and aesthetic enjoyment of water. Lower values of suspended solids indicate improved water quality.

Biological oxygen demand is a measure of the rate at which oxygen is consumed in the water. Increase in biological oxygen demand results from organic material being introduced into streams from wastewater treatment plants, manufacturing plants, and urban runoff. Fertilizers in the form of nitrates and phosphates can flow into a stream, resulting in the overgrowth of plants and algae. Lower values of biological oxygen demand indicate improved water quality.

Sulfates can be naturally occurring or the result of municipal or industrial discharges. When naturally occurring, they are often the result of the breakdown of leaves that fall into a stream or of atmospheric deposition. Point sources include sewage treatment plants and industrial discharges such as tanneries, pulp mills, and textile mills. Runoff from fertilized agricultural lands also contributes sulfates to water bodies. Recommended limits for water used as a domestic water supply are below 250 mg/liter. Sulfates are not considered toxic to plants or animals at normal concentrations, but elevated levels can cause a temporary laxative effect. Lower values of sulfates indicate improved water quality.

Nitrogen is one of the most abundant elements and makes up about 80 percent of the air that we breathe. Nitrogen occurs in water in the inorganic forms as nitrate (NO_3), nitrite (NO_2), and ammonia or the ammonium ion (NH_4) and in the organic form. In water, nitrate is the most stable, soluble, and largest percentage of total nitrogen. Organic nitrogen is found in protein, and is continually recycled by plants and animals. Nitrogen-containing compounds act as nutrients in streams and cause oxygen depletion. The major routes of entry of nitrogen into streams are municipal and industrial wastewater, septic tanks, feed lot discharges, animal wastes, and discharges from car exhausts. Lower values of nitrogen indicate improved water quality.

Phosphorous is one of the key elements necessary for the growth of plants and animals. Rainfall can cause varying amounts of phosphates to wash from farm soils into nearby waterways. Phosphates will stimulate the growth of plankton and aquatic plants; if an excess of phosphates enters the waterway, algae and aquatic plants will grow wildly, choke up the waterway, and consume large amounts of oxygen. Phosphates are not toxic to people or animals unless they are present in very high levels. Generally, lower values of phosphorous indicate improved water quality.

The *Kjeldahl Nitrogen* determination method is the most accurate and fastest means to determine the nitrogen content in water. The Kjeldahl method is used to determine nitrogen content of both inorganic and organic substances.

Ammonia is colorless gas with a strong pungent odor and is easily liquefied and solidified, as well as being very soluble in water. Since ammonia is a very unstable form of nitrogen, it easily converts to nitrite and nitrate, thus high concentrations of ammonia are an indicator of a near source of contamination. About three-fourths of the ammonia produced in the United States is used in fertilizers, either as the compound itself or as ammonium salts such as sulfate and nitrate. Since ammonia is a decomposition product from urea and protein, it is found in domestic wastewater. Ammonia has been reported to be toxic to freshwater organisms at concentrations ranging from 0.53 to 22.8 mg/liter. Plants are more tolerant of ammonia than animals, and invertebrates are more tolerant than fish. Lower values of ammonia indicate improved water quality.

Fecal coliform bacteria live in large numbers in the intestines of warm-blooded organisms and aid in the digestion of food. These organisms have the ability to grow at elevated temperatures and are associated only with fecal material. The presence of fecal coliform bacteria in aquatic environments indicates that the water has been contaminated with the fecal material of man or other animals; the presence of fecal contamination is an indicator that a potential health risk exists for individuals exposed to this water. Fecal coliform may occur in ambient water, as a result of the overflow of domestic sewage or nonpoint sources of human and animal waste. Lower values of fecal coliform bacteria indicate improved water quality.

Analysis and Results

Values collected for each parameter were compared against Pennsylvania state standards where available. Table D.1 shows a summary of the standards utilized for this comparison. Standards utilized by SRBC and other agencies were utilized where state standards are not available. Table D.2 shows a summary of sampling locations and associated data.

A Pennsylvania state standard is available for ammonia that uses a calculation based on pH and temperature. A standard of 0.2 mg/l was provided by SRBC and was used as a limit in this study, as it provided a simpler approach without significantly changing the results. The Pennsylvania state standard for dissolved oxygen is 7.0 mg/l for high-quality cold water fishes. The upper reach of the Yellow Breeches Creek is designated as high quality, while the lower reach does not have the high quality designation. All of the dissolved oxygen data in this study was compared to the standard for high-quality cold water fishes although, as this is a more conservative approach.

Table D.1 Water Quality Levels of Concern and References

PARAMETER	LIMIT	REFERENCE
Temperature (August 1-15)	18.9 C	a
Temperature (August 16-31)	18.9 C	a
Temperature (September 1-15)	17.8 C	a
Temperature (September 16-30)	15.6 C	a
Temperature (October 1-15)	12.2 C	a
Dissolved Oxygen	7.0 mg/l	a
Conductivity	>800 µmhos/cm	b
pH	6-9	a
Total Suspended Solids	>15 mg/l	e
Ammonia	>0.2 mg/l	d
Nitrate	>1.0 mg/l	c
Phosphorus	>0.1 mg/l	c
Fecal Coliform (May 1-September 30)	200 Col/100ml	a
Fecal Coliform (October 1-April 30)	2000 Col/100ml	a
Biological Oxygen Demand	5 mg/l	f

REFERENCE CODES/REFERENCE

a http://www.pacode.com/secure/data/025/chapter93/s93.7.html
b http://www.uky.edu/WaterResources/Watershed/KRB_AR/wq_standards.htm
c http://www.uky.edu/WaterResources/Watershed/KRB_AR/krww_parameters.htm
d http://www.hach.com/h2ou/h2wtrqual.htm
e http://www.deq.state.va.us/pdf/watrregs/fish.pdf
f http://wilkes1.wilkes.edu/~eqc/surfacewater.htm

Table D.2 Summary Table

Station ID	Site Description	River Mile	Date Sampled	Latitude	Longitude	Gradient	Flow (cfs)	Drainage Area (acre)
YB1-0.28	Yellow Breeches Creek, upstream from Bridge Street	0.28	08/07/2003	40.2231	76.8617	Main Stem	206.66	139,301
YB4-10.32	Yellow Breeches Creek, upstream from Sheepford Road crossing	10.32	10/01/2003	40.1843	76.9120	Main Stem	267.74	123,734
YB5-15.26	Yellow Breeches Creek, along McCormick Road	15.26	08/07/2003	40.1636	76.9374	Main Stem	195.82	115,539
YB6-24.44	Yellow Breeches Creek, upstream from Creek Road at Route 74	24.44	08/21/2003	40.1430	77.0582	Main Stem	131.31	90,611
YB7-29.12	Yellow Breeches Creek, at Boiling Springs	29.12	08/28/2003	40.1475	77.1234	Main Stem	86.93	83,510
YB2-42.48	Yellow Breeches Creek, upstream from Encks Mill Road	42.48	08/25/2003	40.1067	77.2923	Main Stem	37.54	26,616
YB3-47.21	Yellow Breeches Creek, upstream from Hays Grove Road crossing	47.21	09/15/2003	40.0967	77.3743	Main Stem	0.77	12,558
CR1-0.28	Cedar Run, 17th Street, Camp Hill	0.28	08/01/2003	40.2252	76.9074	Low	20.73	8,410
CR3-2.17	Cedar Run, Hartzdale Drive	2.17	08/15/2003	40.2175	76.9385	Low	4.74	3,647
CR2-4.09	Cedar Run, Rossmoyne Road crossing	4.09	08/04/2003	40.1964	76.9454	Low	0.43	366
CR4-0.39	Unnamed tributary to Cedar Run, Hartzdale Drive	0.39	08/15/2003	40.2248	76.9229	Low	4.01	2,466
UNT1-0.11	Unnamed tributary to Yellow Breeches Creek, upstream from Lisburn Road	0.11	09/18/2003	40.1836	76.9304	Low	5.12	1,930
PR1-0.17	Pippins Run, downstream from Lewisberry Road crossing	0.17	08/12/2003	40.1616	76.9642	High	4.98	1,742
SR1-0.43	Stony Run, upstream from Grantham Road crossing	0.43	08/18/2003	40.1508	76.9881	Low	16.17	8,109
SR2-5.09	Stony Run, downstream from Old York Road crossing	5.09	08/18/2003	40.1019	77.0058	Low	2.01	2,042
SR3-1.06	Fishers Run, upstream from Fileys Road crossing	1.06	08/18/2003	40.1256	76.9831	Low	5.12	1,887
DR1-0.70	Dogwood Run, upstream from confluence with Yellow Breeches Creek	0.70	08/19/2003	40.1466	77.0306	High	9.75	5,622
DR2-1.85	Dogwood Run, downstream from Route 74 crossing	1.85	08/19/2003	40.1331	77.0390	Low	0.24	5,054
DR3-5.08	Dogwood Run, upstream from Green Road crossing	5.08	08/19/2003	40.1085	77.0710	High	3.70	2,053
OR1-0.51	Old Town Run, downstream from Tangers Road crossing	0.51	08/21/2003	40.1338	77.1376	Low	3.69	6,626
OR2-2.74	Old Town Run, downstream from Whiskey Spring Road crossing	2.74	08/21/2003	40.1088	77.1317	High	0.16	599
LD1-0.97	Little Dogwood Run, upstream from Wayne Noss Flowers	0.97	08/21/2003	40.1229	77.1270	Low	0.04	1,481
MN1-1.09	Mountain Creek, upstream from confluence at Mt. Holly Springs	1.09	08/22/2003	40.1312	77.1851	Low	24.16	30,122
MN2-4.77	Mountain Creek, near Route 34	4.77	10/01/2003	40.0853	77.1912	High	53.03	26,996
MN3-15.10	Mountain Creek, upstream from Route 233 crossing	15.10	09/17/2003	40.0211	77.3302	High	7.26	7,456
TR1-0.85	Toms Run, downstream from Route 233 crossing	0.85	09/17/2003	40.0359	77.3041	High	1.57	2,398
CSR1-0.82	Cold Spring Run, Pine Road crossing	0.82	08/22/2003	40.1146	77.2365	Low	0.95	2,968
CSR2-2.09	Cold Spring Run, upstream from Cold Spring Road	2.09	08/22/2003	40.0992	77.2427	High	1.27	972
KH1-1.09	Kings Gap Hollow, upstream from Kings Gap Road crossing	1.09	08/25/2003	40.0981	77.2799	High	0.49	1,136
IG1-0.88	Irishtown Gap Hollow	0.88	09/15/2003	40.0951	77.3053	High	0.28	1,823
PH1-2.10	Peach Orchard Hollow, near Peach Orchard Hollow Road	2.10	08/28/2003	40.0741	77.3490	High	0.02	1,121
HSH1-1.61	Hairy Springs Hollow, upstream from Furnace Hollow Road	1.61	09/15/2003	40.0440	77.4041	High	0.49	1,780
STH1-1.72	Sthromes Hollow, upstream from Sand Hill Road crossing	1.72	09/09/2003	40.0450	77.4221	High	0.92	1,824

Note: Data collected for watershed assessment not intended for use in permitting or enforcement actions.

Water temperature ranged from 12.5 to 21.7 degrees Celsius for all monitoring sites. The highest values were recorded at Little Dogwood Run (LD1-0.97) and Peach Orchard Hollow (PH1-2.10), as a result of human influence locally raising the water temperature. The lowest temperatures were recorded at Yellow Breeches Creek (YB4-10.32) and Mountain Creek (MN2-4.77). Temperatures exceeding the Pennsylvania state standard were noted at multiple monitoring sites. See Table D.3 for water temperature data. Temperatures exceeding the standard as shown on Table D.1 are highlighted on Table D.3.

Specific conductance ranged from 24 to 794 micro-siemens/cm for all monitoring sites. The highest values were recorded at Cedar Run (CR1-0.28, CR3-2.17, and CR4-0.39). Cedar Run is an urbanized area subject to industrial influences, including the State Correctional Institution at Camp Hill. The lowest values were recorded at Kings Gap Hollow (KH1-1.09) and Irishtown Gap (IG1-0.88). Kings Gap Hollow (KH1-1.09) and Irishtown Gap (IG1-0.88) are located in the upper watershed in forested areas, not being subject to many of the factors that introduce minerals into the tributaries located in the lower watershed. Kings Gap Hollow (KH1-1.09) and Irishtown Gap (IG1-0.88) have good bank stability, as well as good vegetative cover. Specific conductance values for all monitoring sites were below the standard, 800 umhos/cm, as shown in Table D.1. See Table D.3 specific conductance data.

Dissolved oxygen ranged from 6.7 to 11.1 mg/l for all monitoring sites. The lowest values recorded were at Cedar Run (CR1-0.28 and CR4-0.39). Cedar Run has an overgrowth of aerobic microorganisms consuming the available oxygen supply, as a result of increased runoff secondary to poor vegetative protection and poor bank stability. The highest value of dissolved oxygen recorded was at Mountain Creek (MN2-4.77). See Table D.3 for dissolved oxygen data.

pH values ranged from 5.1 to 8.8 for all monitoring sites. pH values were compared to the Pennsylvania state standard of 6.0 to 9.0. The lowest value recorded was 5.1 at Hairy Springs Hollow (HSH1-1.61). The values for all monitoring sites were within the optimum range for fish and bottom dwelling invertebrates, except for Hairy Springs Hollow (HSH1-1.61). Hairy Springs Hollow (HSH1-1.61) is suboptimal for maintaining fish eggs, as a pH of less than 6.0 can be harmful. The highest value recorded was at Tom's Run (TR1-0.85), as limestone within the streambed is likely buffering the pH of the water at this monitoring site. See Table D.3 for pH data.

Table D.3 Field Parameters

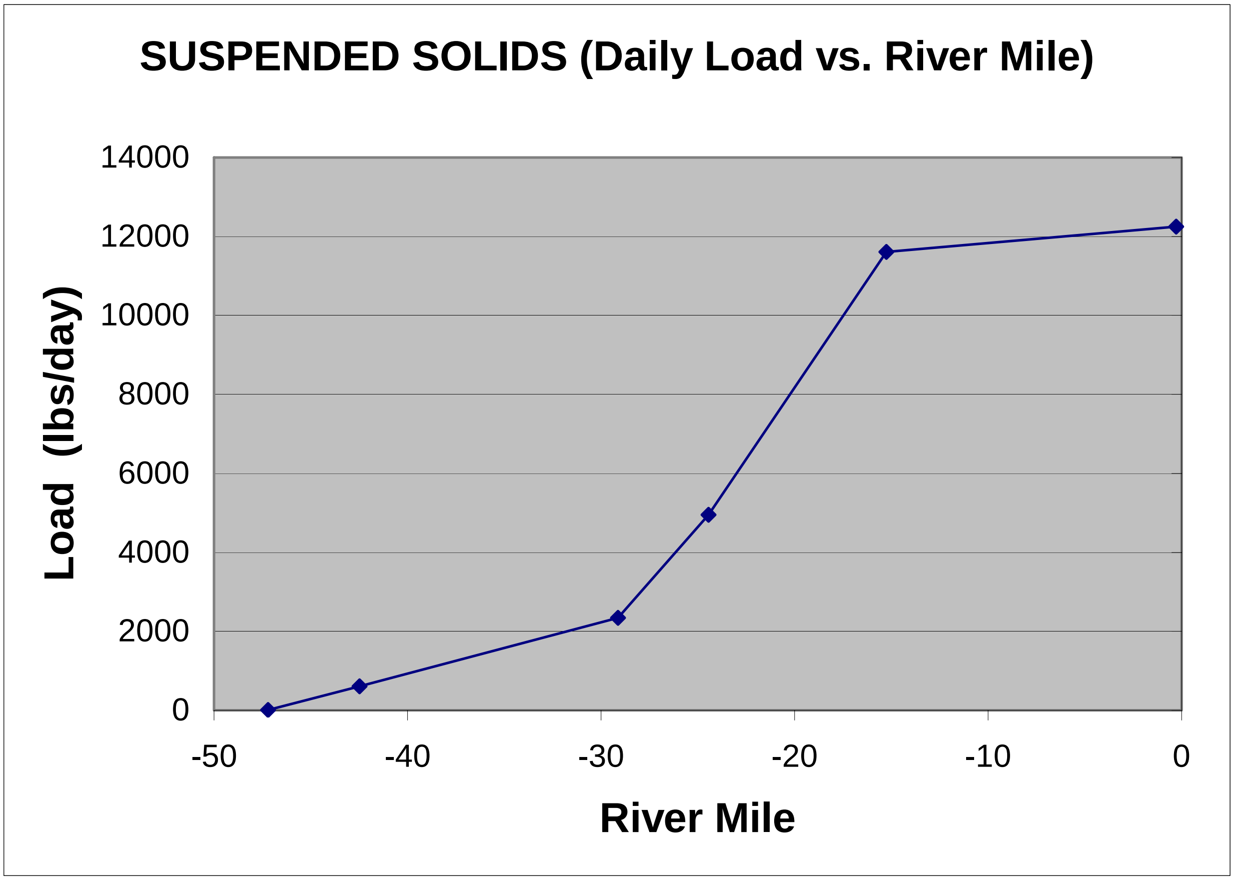
Station ID	**Water Temperature**	**Specific Conductance**	**Dissolved Oxygen**	**Dissolved Oxygen**	**pH**
-	(degrees C)	(umhos/cm)	(percent)	(mg/l)	(standard)
YB1-0.28	**20.3**	359.0	93.3	8.3	8.2
YB4-10.32	**13.3**	288.0	103.0	10.8	8.1
YB5-15.26	**19.3**	291.0	103.0	9.6	8.2
YB6-24.44	18.9	258.0	100.5	9.4	8.4
YB7-29.12	18.4	219.0	98.0	9.1	8.0
YB2-42.48	16.3	224.0	101.0	9.9	8.1
YB3-47.21	15.1	298.0	97.5	9.7	8.1
CR1-0.28	17.0	618.0	67.0	6.7	7.8
CR3-2.17	14.7	639.0	78.0	7.8	7.6
CR2-4.09	16.2	570.0	71.0	7.3	7.3
CR4-0.39	16.8	794.0	70.0	6.8	7.8
UNT1-0.11	14.2	555.0	103.3	10.7	8.3
PR1-0.17	**19.6**	211.0	109.3	10.0	8.1
SR1-0.43	**19.8**	294.0	98.9	8.9	8.3
SR2-5.09	**20.6**	339.0	92.0	8.3	7.6
SR3-1.06	**19.3**	192.0	102.0	9.3	8.3
DR1-0.70	17.2	324.0	90.0	8.7	8.2
DR2-1.85	**19.9**	511.0	78.2	7.1	7.8
DR3-5.08	**19.4**	50.3	98.0	9.0	7.8
OR1-0.51	**20.4**	128.0	102.0	9.1	8.1
OR2-2.74	17.9	46.3	100.5	9.3	8.5
LD1-0.97	**21.7**	33.4	97.6	8.5	8.4
MN1-1.09	**19.0**	153.0	105.0	9.8	8.3
MN2-4.77	**12.5**	72.0	103.0	11.1	8.5
MN3-15.10	14.0	25.4	102.0	10.5	8.1
TR1-0.85	13.5	30.5	99.0	10.2	8.8
CSR1-0.82	**20.4**	28.0	96.9	8.6	6.9
CSR2-2.09	**20.0**	N/A	99.0	8.9	6.6
KH1-1.09	15.8	24.0	103.0	10.1	7.8
IG1-0.88	**18.3**	21.9	98.0	9.0	7.1
PH1-2.10	**21.2**	29.3	86.0	7.8	8.1
HSH1-1.61	16.7	28.1	97.0	9.2	5.1
STH1-1.72	16.5	29.0	96.0	9.1	8.7

Notes: Temperatures shown in bold type exceed the Pennsylvania state standards as shown in Table D.1.
Data collected for watershed assessment not intended for use in permitting or enforcement actions.

Suspended solids ranged from less than 1 to 45 mg/liter in concentration for all monitoring sites. Daily loads and yields were calculated for all monitoring sites. Load versus river mile was plotted as shown in Graph D.1, indicating an increase in daily load as the Yellow Breeches Creek flows toward the mouth. The highest yields recorded were at Cedar Run (CR2-4.09) and Stony Run (SR3-1.06), resulting from increased runoff from surrounding agricultural and urban areas, stemming from poor vegetative protection, minimal riparian buffers, and suboptimal bank protection. Moderate to heavy sediment deposition was noted at Cedar Run

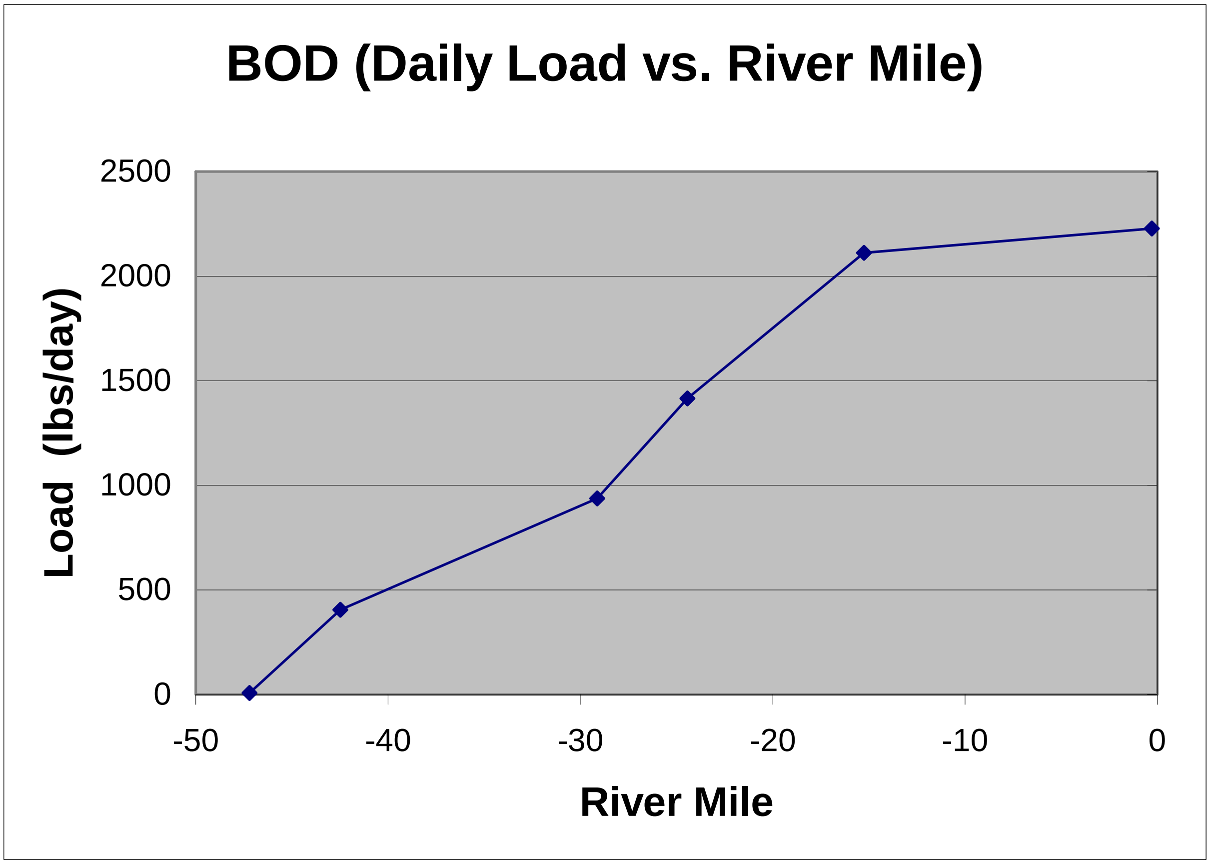
(CR2-4.09). The lowest normalized values were recorded at Yellow Breeches Creek (YB3-47.21) and Peach Orchard Hollow (PH1-2.10). Yellow Breeches Creek (YB3-47.21) and Peach Orchard Hollow (PH1-2.10) are characterized as forested areas that experience less runoff, as a result of better vegetative protection and larger riparian buffers. Concentrations of suspended solids were all below the standard as shown in Table D.1, with the exception of Cedar Run (CR2-4.09) and Little Dogwood Run (LD1-0.97). See Table D.4 for suspended solids data.

Graph D.1 Suspended Solids



Biological oxygen demand ranged in concentration from 2 to 7 mg/liter for all monitoring sites. CSR1-0.82 exceeded the standard, 5 mg/l, as shown in Table D.1. Daily loads and yields were calculated for all monitoring sites. Load versus river mile was plotted as shown in Graph D.2, indicating an increase in daily load as the Yellow Breeches Creek flows toward the mouth. The highest yields recorded were at Cedar Run (CR1-0.28), Pippins Run (PR1-0.17), Stony Run (SR3-1.06), and Unnamed Tributary (UNT1-0.11), indicating increased oxygen consumption as a result of surrounding urban influences. The lowest yields were recorded at Little Dogwood Run (LD1-0.97) and Peach Orchard Hollow (PH1-2.10), indicating less urban influence in these primarily rural areas. See Table D.4 for biological oxygen demand data.

Graph D.2 Biological Oxygen Demand



Sulfates ranged from 3.4 to 27.7 mg/liter in concentration for all monitoring sites. Daily loads and yields were calculated for all monitoring sites. Load versus river mile was plotted as shown in Graph D.3, indicating an increase in daily load as the Yellow Breeches Creek flows toward the mouth. The highest yields were recorded at Unnamed Tributary (UNT1-0.11) and Cedar Run (CR1-0.28 and CR4-0.39). The Unnamed Tributary (UNT1-0.11) and Cedar Run (CR1-0.28 and CR4-0.39) are downstream from multiple industrial and municipal sites, possibly discharging sulfur-containing compounds into the stream. A yield of zero was recorded for multiple monitoring sites located in primarily rural areas. Values from all monitoring sites were below the Pennsylvania state standard of 250 mg/liter. See Table D.4 for sulfates data.

Graph D.3 Sulfate

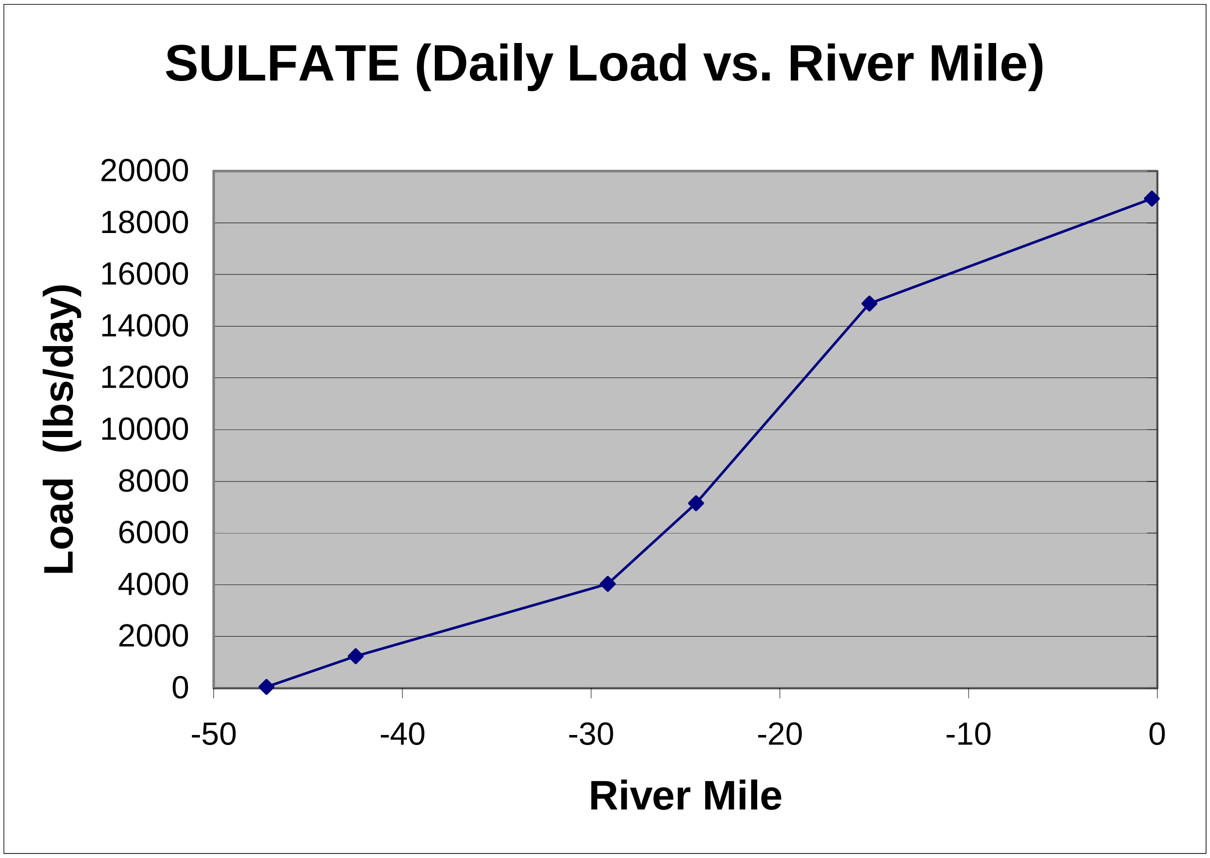


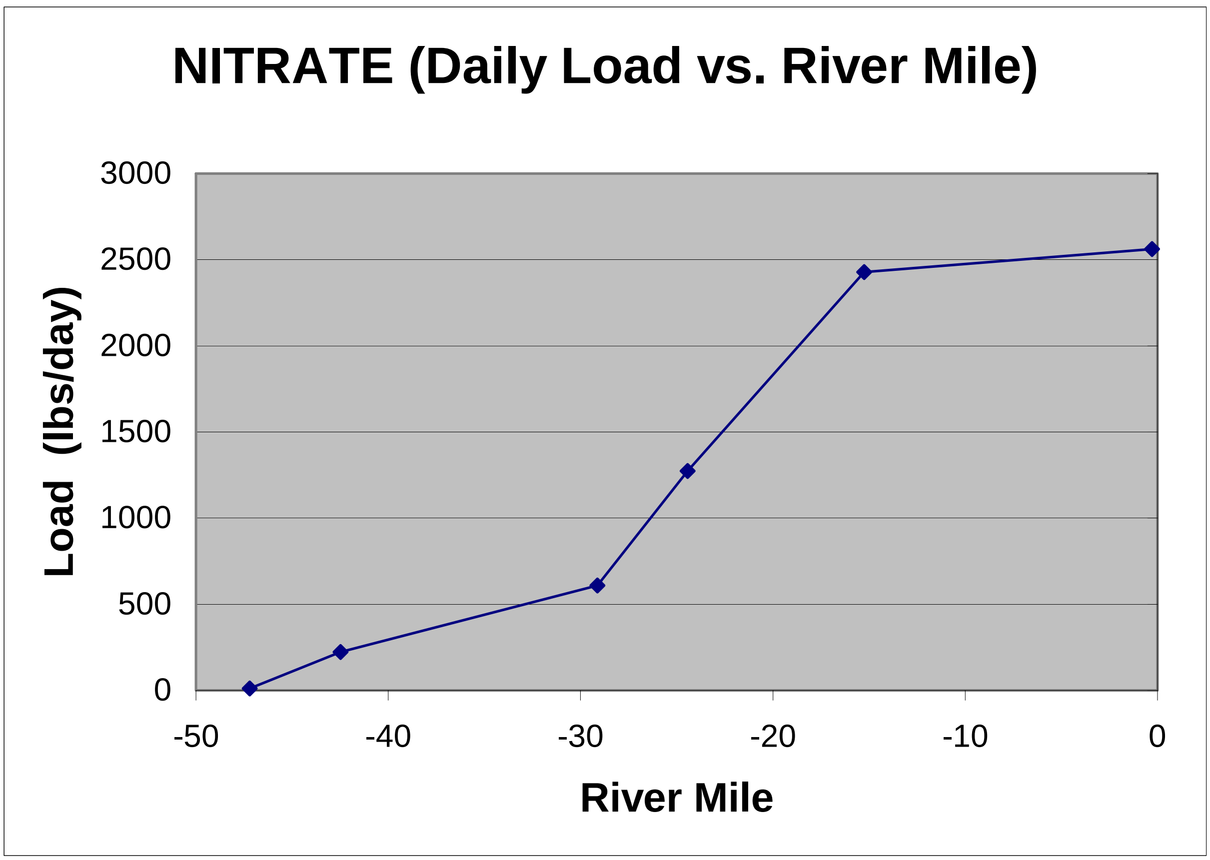
Table D.4 Laboratory Analysis

Station ID	Suspended Solids			Biological Oxygen Demand			Sulfate			Fecal Coliform
-	mg/l	load (lbs/day)	yield (lbs/day/acre)	mg/l	load (lbs/day)	yield (lbs/day/acre)	mg/l	load (lbs/day)	yield (lbs/day/acre)	Col/100 ml
YB1-0.28	11	12,253	0.088	2	2,228	0.016	17.0	18,936	0.136	800
YB4-10.32	4	5,772	0.047	2	2,886	0.023	14.0	20,204	0.163	72
YB5-15.26	11	11,610	0.100	2	2,111	0.018	14.1	14,882	0.129	100
YB6-24.44	7	4,954	0.055	2	1,416	0.016	10.1	7,148	0.079	410
YB7-29.12	5	2,343	0.028	2	937	0.011	8.6	4,030	0.048	600
YB2-42.48	3	607	0.023	2	405	0.015	6.1	1,234	0.046	140
YB3-47.21	1	4	0.000	2	8	0.001	12.4	51	0.004	190
CR1-0.28	7	782	0.093	3	335	0.040	23.4	2,615	0.311	4,500
CR3-2.17	2	51	0.014	2	51	0.014	24.9	636	0.174	170
CR2-4.09	45	104	0.285	2	5	0.013	24.2	56	0.153	30
CR4-0.39	1	22	0.009	2	43	0.018	27.7	599	0.243	20
UNT1-0.11	2	55	0.029	2	55	0.029	22.8	629	0.326	190
PR1-0.17	9	242	0.139	2	54	0.031	15.2	408	0.234	0
SR1-0.43	7	610	0.075	2	174	0.021	20.9	1,822	0.225	460
SR2-5.09	3	33	0.016	2	22	0.011	25.4	275	0.135	1,150
SR3-1.06	10	276	0.146	2	55	0.029	14.8	408	0.216	310
DR1-0.70	3	158	0.028	2	105	0.019	14.5	762	0.136	490
DR2-1.85	8	10	0.002	2	3	0.001	13.0	17	0.003	1,350
DR3-5.08	3	60	0.029	2	40	0.019	5.6	112	0.054	220
OR1-0.51	1	20	0.003	2	40	0.006	6.2	123	0.019	110
OR2-2.74	6	5	0.009	2	2	0.003	4.2	4	0.006	22
LD1-0.97	33	7	0.005	2	0	0.000	7.7	2	0.001	56
MN1-1.09	3	391	0.013	4	521	0.017	15.8	2,058	0.068	300
MN2-4.77	2	572	0.021	2	572	0.021	7.5	2,144	0.079	70
MN3-15.10	1	39	0.005	2	78	0.010	3.4	133	0.018	80
TR1-0.85	1	8	0.004	2	17	0.007	3.6	30	0.013	42
CSR1-0.82	4	20	0.007	7	36	0.012	5.6	29	0.010	54
CSR2-2.09	5	34	0.035	3	21	0.021	4.7	32	0.033	94
KH1-1.09	4	11	0.009	2	5	0.005	5.7	15	0.013	18
IG1-0.88	2	3	0.002	2	3	0.002	3.8	6	0.003	100
PH1-2.10	2	0	0.000	2	0	0.000	7.2	1	0.001	2
HSH1-1.61	4	11	0.006	2	5	0.003	6.5	17	0.010	220
STH1-1.72	1	5	0.003	2	10	0.005	6.7	33	0.018	26

Note: Data collected for watershed assessment not intended for use in permitting or enforcement actions.

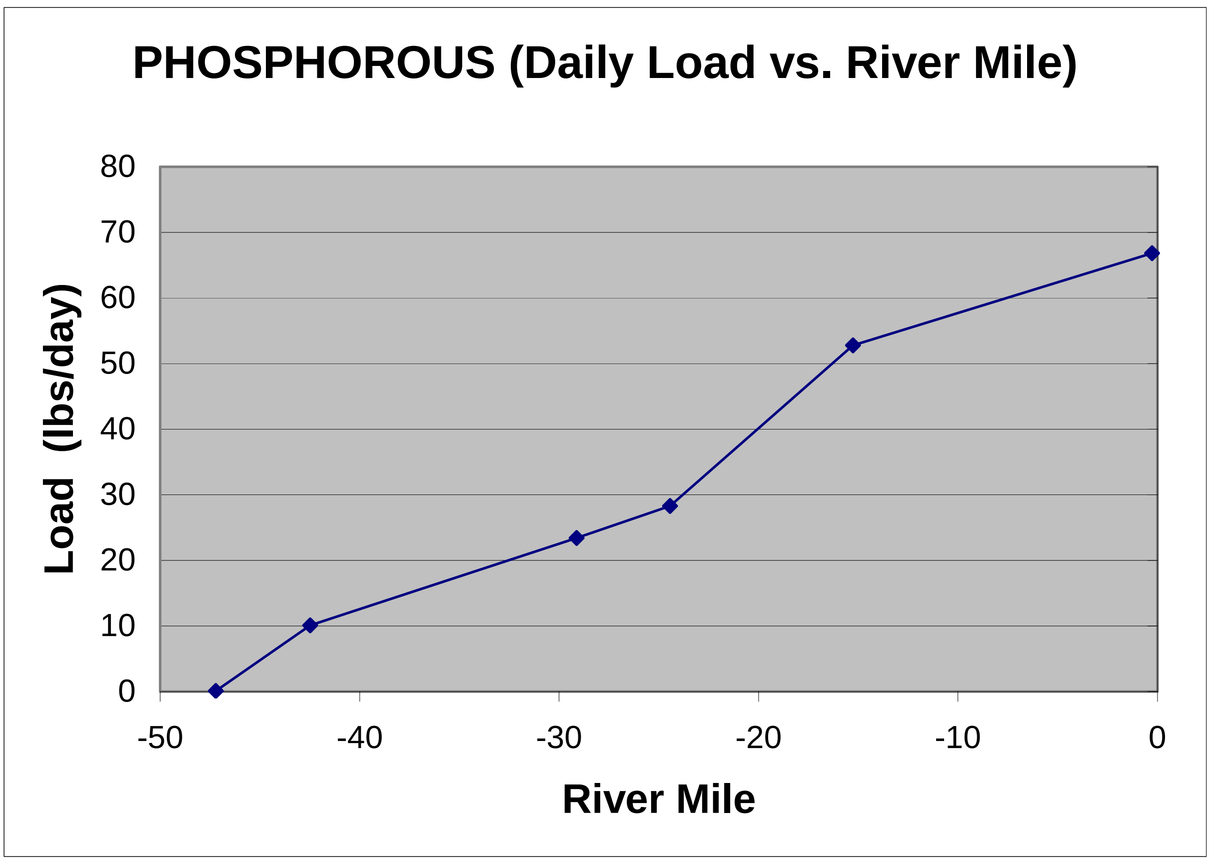
Nitrates ranged in concentration from less than 0.5 to 7.5 mg/liter for all monitoring sites. All concentrations were below the Pennsylvania drinking water standard of 10mg/l. Since this is such a high value, SRBC uses a value of 1.0 mg/l for determining potential impacts to aquatic life. Concentrations greater than the standard as shown in Table D.1 were noted at fifteen (15) monitoring sites. Daily loads and yields were calculated for all monitoring sites. Load versus river mile was plotted as shown in Graph D.4, indicating an increase in daily load as the Yellow Breeches Creek flows toward the mouth. The highest yields were recorded at the Unnamed Tributary (UNT1-0.11), Cedar Run (CR1-0.28, CR2-4.09, CR3-2.17), and Yellow Breeches Creek (YB4-10.32). All of these monitoring sites are subject to upstream agricultural influences, where runoff can wash animal waste into the stream as a result of poor vegetative protection and a minimal riparian buffer. A yield of zero was recorded for multiple monitoring sites located in primarily rural areas. See Table D.5 for nitrate data.

Graph D.4 Nitrate



Total phosphorous ranged from less than 0.02 to 0.11 mg/liter for all monitoring sites. There are no Pennsylvania state standards for phosphorous. SRBC uses a value of 0.1 mg/liter for determining potential impacts to aquatic life uses. The phosphorous concentrations were all below the standard as shown in Table D.1, with the exception of Dogwood Run (DR1-0.70 and DR2-1.85). Daily loads and yields were calculated for all monitoring sites. Load versus river mile was plotted as shown in Graph D.5, indicating an increase in daily load as the Yellow Breeches Creek flows toward the mouth. The highest yields were recorded at Dogwood Run (DR1-0.70), Pippins Run (PR1-0.17), and Stony Run (SR1-0.43). These monitoring sites are subject to upstream agricultural influences where increased runoff washes phosphates from farm soils into the stream, as a result of suboptimal to poor vegetative protection and riparian buffers. A yield of zero was recorded at Little Dogwood Run (LD1-0.97) and Peach Orchard Hollow (PH1-2.10), located primarily in areas with better vegetative protection. See Table D.5 for phosphorous data.

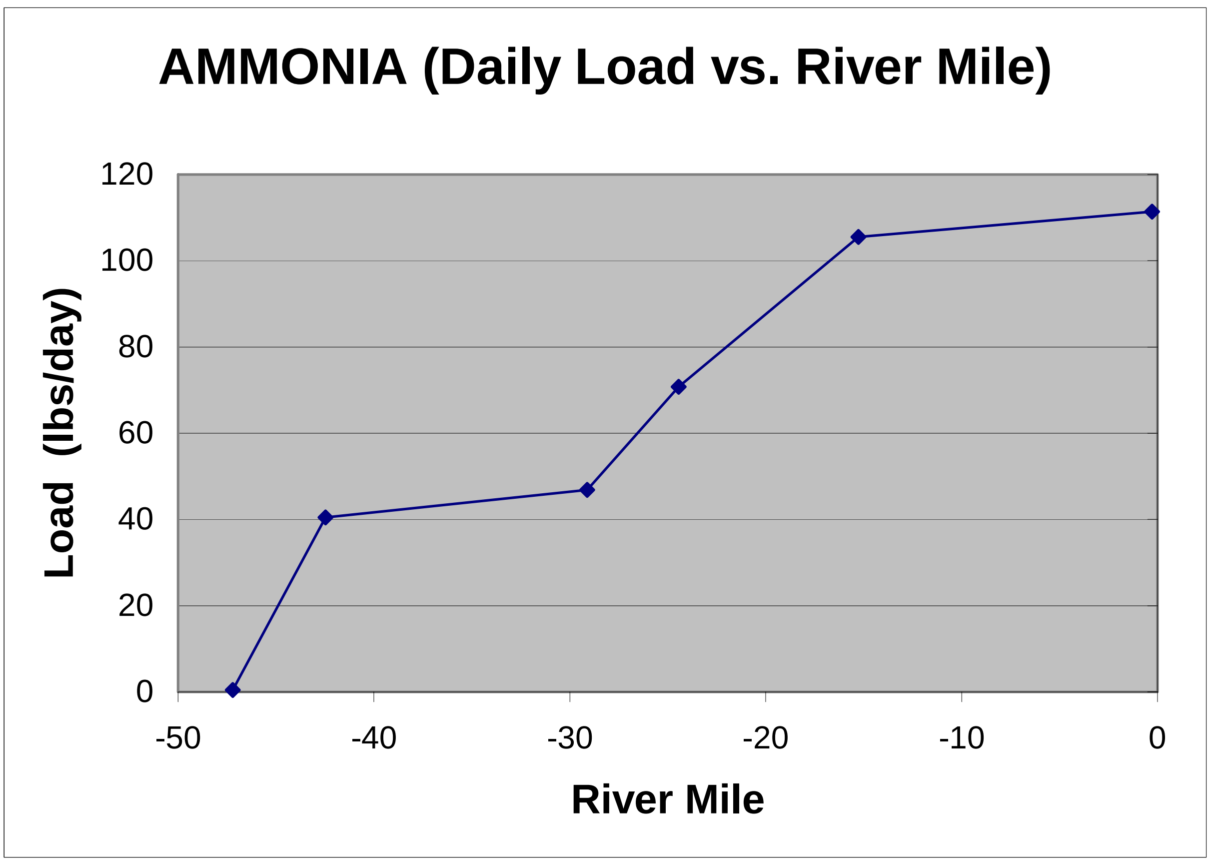
Graph D.5 Phosphorous



Total Kjeldahl nitrogen was recorded at less than 1.0 mg/liter in concentration for all thirty-three (33) monitoring sites. The analysis of nitrogen levels for this water quality assessment was based on nitrate nitrogen levels as described above. See Table D.5 for total Kjeldahl nitrogen data.

Ammonia nitrogen ranged from less than 0.1 to 0.2 mg/liter in concentration for all monitoring sites. All ammonia nitrogen values were below 0.2 mg/liter, the standard as shown in Table D.1. Daily loads and yields were calculated for all monitoring sites. Load versus river mile was plotted as shown in Graph D.6, indicating an increase in daily load as the Yellow Breeches Creek flows toward the mouth. The highest yields were recorded at Stony Run (SR1-0.43 and SR3-1.06), Pippins Run (PR1-0.17), Yellow Breeches Creek (YB2-42.48), and Dogwood Run (DR3-5.08). These monitoring sites are subject to upstream agricultural influences, where runoff containing ammonia-based fertilizers enters the streams. No ammonia nitrogen data was available for the Cedar Run monitoring sites. See Table D.5 for ammonia nitrogen data.

Graph D.6 Ammonia



Fecal coliform ranged from 0 to 4500 COL/100cc for all monitoring sites. The highest concentrations were recorded at Cedar Run (CR1-0.28), Dogwood Run (DR2-1.85), and Stony Run (SR2-5.09). Possible sources of fecal material contamination at these monitoring sites include agricultural waste and runoff; human fecal material from nearby septic systems; and large geese and duck populations that constitute a point source in certain areas. The lowest concentrations were recorded at Pippins Run (PR1-0.17) and Peach Orchard Hollow (PH1-2.10). These sites are protected by wider riparian buffers that offer better bank stability with good vegetative protection. Fecal coliform concentrations greater than the Pennsylvania state standard as shown in Table D.1 were noted at twelve (12) monitoring sites. See Table D.4 for fecal coliform data.

Table D.5 Nutrients

Station ID	Nitrate-N			Ammonia-N			Kjeldahl-N			Organic-N			Total Phosphorus		
-	mg/l	load (lbs/day)	yield (lbs/day/acre)	mg/l	load (lbs/day)	yield (lbs/day/acre)	mg/l	load (lbs/day)	yield (lbs/day/acre)	mg/l	load (lbs/day)	yield (lbs/day/acre)	mg/l	load (lbs/day)	yield (lbs/day/acre)
YB1-0.28	2.3	2,562	0.018	0.10	111.39	0.0008	1	1,114	0.008	0.90	1,003	0.007	0.06	66.83	0.00048
YB4-10.32	2.2	3,175	0.026	0.10	144.31	0.0012	1	1,443	0.012	0.90	1,299	0.010	0.05	72.16	0.00058
YB5-15.26	2.3	2,428	0.021	0.10	105.55	0.0009	1	1,055	0.009	0.90	950	0.008	0.05	52.77	0.00046
YB6-24.44	1.8	1,274	0.014	0.10	70.78	0.0008	1	708	0.008	0.90	637	0.007	0.04	28.31	0.00031
YB7-29.12	1.3	609	0.007	0.10	46.86	0.0006	1	469	0.006	0.90	422	0.005	0.05	23.43	0.00028
YB2-42.48	1.1	223	0.008	0.20	40.47	0.0015	1	202	0.008	0.80	162	0.006	0.05	10.12	0.00038
YB3-47.21	2.8	12	0.001	0.10	0.42	0.0000	1	4	0.000	0.90	4	0.000	0.02	0.08	0.00001
CR1-0.28	2.4	268	0.032	n/a	n/a	n/a	1	112	0.013	n/a	n/a	n/a	0.04	4.47	0.00053
CR3-2.17	5.1	130	0.036	n/a	n/a	n/a	1	26	0.007	n/a	n/a	n/a	0.02	0.51	0.00014
CR2-4.09	7.5	17	0.047	n/a	n/a	n/a	1	2	0.006	n/a	n/a	n/a	0.06	0.14	0.00038
CR4-0.39	1.5	32	0.013	n/a	n/a	n/a	1	22	0.009	n/a	n/a	n/a	0.02	0.43	0.00018
UNT1-0.11	4.7	130	0.067	0.10	2.76	0.0014	1	28	0.014	0.90	25	0.013	0.03	0.83	0.00043
PR1-0.17	0.7	19	0.011	0.10	2.68	0.0015	1	27	0.015	0.90	24	0.014	0.06	1.61	0.00092
SR1-0.43	1.4	122	0.015	0.15	13.07	0.0016	1	87	0.011	0.85	74	0.009	0.08	6.97	0.00086
SR2-5.09	0.9	10	0.005	0.15	1.63	0.0008	1	11	0.005	0.85	9	0.005	0.07	0.76	0.00037
SR3-1.06	1.5	41	0.022	0.15	4.14	0.0022	1	28	0.015	0.85	23	0.012	0.04	1.10	0.00058
DR1-0.70	1.7	89	0.016	0.14	7.36	0.0013	1	53	0.009	0.86	45	0.008	0.11	5.78	0.00103
DR2-1.85	1.0	1	0.000	0.16	0.21	0.0000	1	1	0.000	0.84	1	0.000	0.11	0.14	0.00003
DR3-5.08	0.5	10	0.005	0.15	2.99	0.0015	1	20	0.010	0.85	17	0.008	0.02	0.40	0.00019
OR1-0.51	0.5	10	0.002	0.10	1.99	0.0003	1	20	0.003	0.90	18	0.003	0.02	0.40	0.00006
OR2-2.74	0.5	0	0.001	0.10	0.09	0.0001	1	1	0.001	0.90	1	0.001	0.02	0.02	0.00003
LD1-0.97	0.5	0	0.000	0.10	0.02	0.0000	1	0	0.000	0.90	0	0.000	0.03	0.01	0.00000
MN1-1.09	0.7	91	0.003	0.10	13.02	0.0004	1	130	0.004	0.90	117	0.004	0.07	9.12	0.00030
MN2-4.77	0.7	200	0.007	0.10	28.58	0.0011	1	286	0.011	0.90	257	0.010	0.02	5.72	0.00021
MN3-15.10	0.5	20	0.003	0.10	3.91	0.0005	1	39	0.005	0.90	35	0.005	0.02	0.78	0.00010
TR1-0.85	0.5	4	0.002	0.10	0.85	0.0004	1	8	0.004	0.90	8	0.003	0.02	0.17	0.00007
CSR1-0.82	0.5	3	0.001	0.10	0.51	0.0002	1	5	0.002	0.90	5	0.002	0.02	0.10	0.00003
CSR2-2.09	0.5	3	0.004	0.10	0.68	0.0007	1	7	0.007	0.90	6	0.006	0.02	0.14	0.00014
KH1-1.09	0.5	1	0.001	0.10	0.26	0.0002	1	3	0.002	0.90	2	0.002	0.02	0.05	0.00005
IG1-0.88	0.5	1	0.000	0.10	0.15	0.0001	1	2	0.001	0.90	1	0.001	0.02	0.03	0.00002
PH1-2.10	0.5	0	0.000	0.10	0.01	0.0000	1	0	0.000	0.90	0	0.000	0.02	0.00	0.00000
HSH1-1.61	0.5	1	0.001	0.10	0.26	0.0001	1	3	0.001	0.90	2	0.001	0.02	0.05	0.00003
STH1-1.72	0.5	2	0.001	0.10	0.50	0.0003	1	5	0.003	0.90	4	0.002	0.02	0.10	0.00005

Note: Data collected for watershed assessment not intended for use in permitting or enforcement actions.

Streamflow Measurement Discrepancy

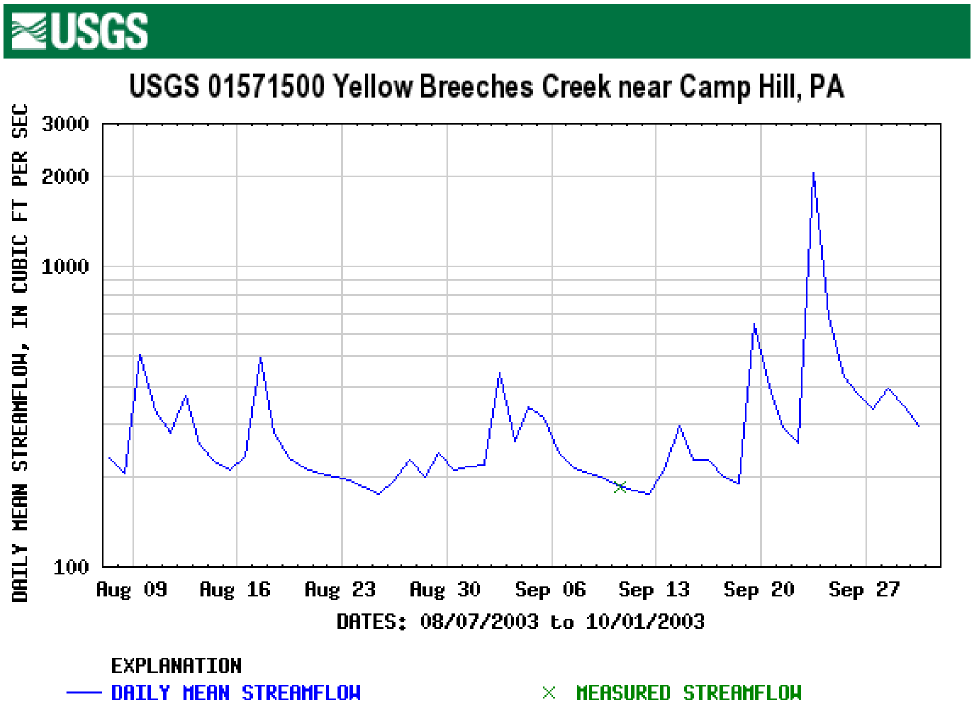
An apparent discrepancy in the streamflow measurement data was noted, as the value recorded for (YB4-10.32) was greater than the value recorded for (YB1-0.28). See Table D.6 for streamflow measurement data. In theory, the value recorded for (YB1-0.28) should be greater than the value for (YB4-10.32), as (YB1-0.28) is located downstream from (YB4-10.32). This discrepancy can be accounted for by comparing the dates of the streamflow measurements for both sites versus the peak discharge data recorded by the local USGS monitoring point (see Graph D.7 and D.8) for the same timeframe. The flow measurement value for (YB1-0.28) was collected on 8/07/03, while the value for (YB4-10.32) was collected on 10/01/03. An increase in peak discharge by approximately 100 cfs was noted during the same timeframe at the local USGS monitoring point, which accounts for the increased flow noted at (YB4-10.32) in October versus the decreased flow at (YB1-0.28) in August.

Table D.6 Flow Summary

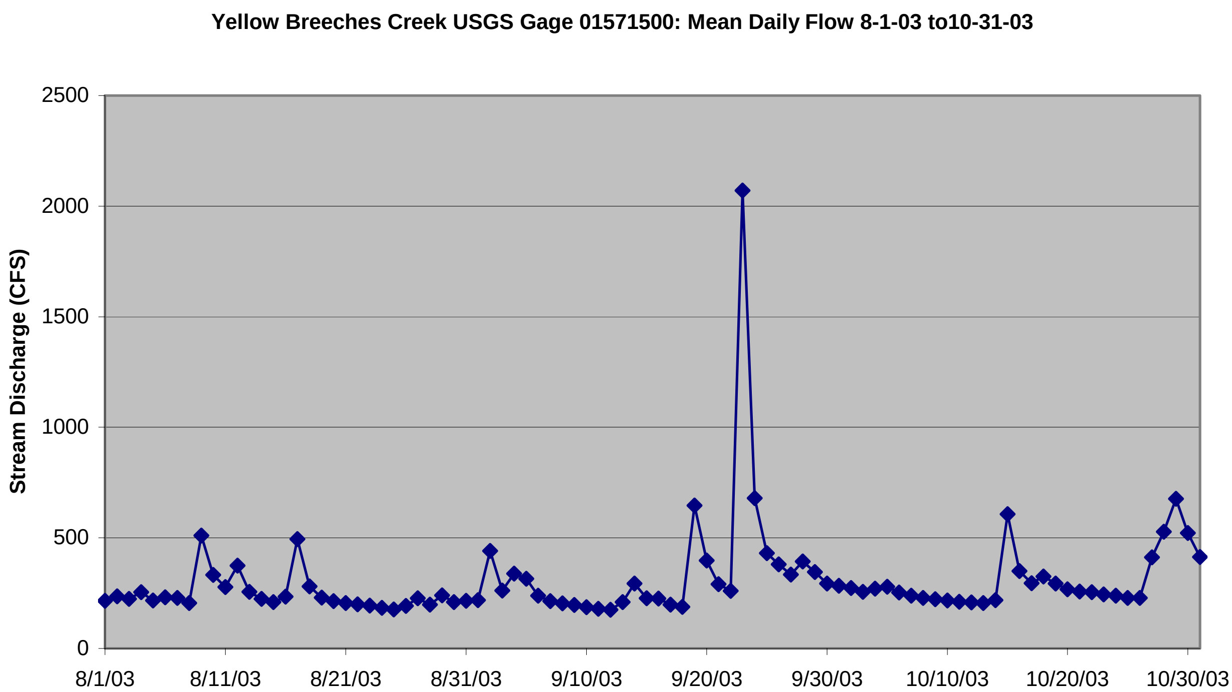
STREAM	SITE	FLOW (cfs)
Yellow Breeches Creek	YB4-10.32	267.74
Yellow Breeches Creek	YB1-0.28	206.66
Yellow Breeches Creek	YB5-15.26	195.82
Yellow Breeches Creek	YB6-24.44	131.31
Yellow Breeches Creek	YB7-29.12	86.93
Mountain Creek	MN2-4.77	53.03
Yellow Breeches Creek	YB2-42.48	37.54
Mountain Creek	MN1-1.09	24.16
Cedar Run	CR1-0.28	20.73
Stony Run	SR1-0.43	16.17
Dogwood Run	DR1-0.70	9.75
Mountain Creek	MN3-15.10	7.26
Stony Run	SR3-1.06	5.12
Unnamed Tributary	UNT1-0.11	5.12
Pippins Run	PR1-0.17	4.98
Cedar Run	CR3-2.17	4.74
Cedar Run	CR4-0.39	4.01
Dogwood Run	DR3-5.08	3.7
Old Town Run	OR1-0.51	3.69
Stony Run	SR2-5.09	2.01
Toms Run	TR1-0.85	1.57
Cold Spring Run	CSR2-2.09	1.27
Cold Spring Run	CSR1-0.82	0.95
Sthromes Hollow	STH1-1.72	0.92
Yellow Breeches Creek	YB3-47.21	0.77
Hairy Spring Hollow	HSH1-1.61	0.49
Kings Gap Hollow	KH1-1.09	0.49
Cedar Run	CR2-4.09	0.43
Irishtown Gap	IG1-0.88	0.28
Dogwood Run	DR2-1.85	0.24
Old Town Run	OR2-2.74	0.16
Little Dogwood Run	LD1-0.97	0.04
Peach Orchard Hollow	PH1-2.10	0.02

Note: Data collected for watershed assessment not intended for use in permitting or enforcement actions.

Graph D.7 USGS Weekly Stream Discharge Rate



Graph D.8 USGS Weekly Stream Discharge Rate



EASI

CAPSEC, an affiliate of EASI, is an organization that collects stream quality data on the Yellow Breeches Creek. EASI is the largest senior environmental action network in the world. Subsequently, the Pennsylvania Department of Aging and PA DEP entered into an agreement with EASI to form a Pennsylvania Senior Environment Corps. Most counties in Pennsylvania are currently represented by a local Senior Environment Corps chapter. The local chapter, CAPSEC, has provided environmental related opportunities to retired senior citizens in Cumberland, Dauphin, and Perry Counties through a local sponsoring agency, which provides administrative services to its volunteers. Initially, this service was provided by the Mechanicsburg Senior Center and since then by the local office of the Retired Senior Volunteer Program. Although CAPSEC offers its members various opportunities, the major thrust has been the monitoring of water quality parameters in various streams and their tributaries throughout the three county area.

Beginning on January 20, 1998 and utilizing standardized sampling equipment and procedures, volunteer teams (3 - 5 volunteers each) have conducted evaluations of various chemical, biological, and physical parameters on numerous streams, including the Yellow Breeches Creek. The data collected by CAPSEC on the Yellow Breeches Creek and its tributaries has been reviewed as part of this assessment.

Chesapeake Bay Strategy

Phosphorous and nitrogen loads calculated for the Yellow Breeches Creek Watershed Assessment were compared with load allocations projected by the Chesapeake Bay Strategy for 2002. YBWA data was specifically compared with data for Chesapeake Bay Watershed Team #24 -Lower Susquehanna West, covering all of Cumberland and York Counties, in addition to portions of Adams and Perry Counties. The Strategy allocated a daily load of approximately 42,400 pounds per day of nitrogen and 1,165 pounds per day of phosphorous. Based on data collected in this assessment, the Yellow Breeches Creek Watershed is contributing approximately 6% of the load for both nitrogen and phosphorous, as allocated for Team #24 per the Strategy. These loads include both point and non-point source discharges. The area of the Yellow Breeches Creek Watershed comprises about 10% of the area covered by Team #24.

Analysis of External Data

Analysis of data collected by other organizations was completed as part of the Yellow Breeches Creek Watershed Assessment.

Sampling data was obtained from EASI and analyzed as part of this assessment. EASI collected physical/chemical, habitat, and biological at multiple monitoring sites on the Yellow Breeches Creek and its tributaries from 1998 to the present. This data has been analyzed as part of this assessment to determine any trends and correlate the findings with the work of the YBWA. As part of the data collection procedure, EASI applies a biological condition score to each site per sampling date based on the findings. The biological condition scores for each site have been averaged to determine a composite biological condition score over the span of the sampling period. The average biological condition scores have been used to compare with the biological condition of similarly located YBWA monitoring sites. EASI monitoring sites will be referred to in this analysis by the tributary name and corresponding river mile. Example: *Yellow Breeches Creek (0.40)*. A review of the habitat condition of the monitoring sites as a whole was conducted to determine common problem areas noted across the Yellow Breeches Creek Watershed. Comprehensive EASI data is available at www.environmentaleducation.org. Following is the analysis for each EASI monitoring site:

Yellow Breeches Creek (0.49) is located in New Cumberland Borough Park. EASI collected biological data on seven (7) dates from 6/20/2000 to 4/27/2004. An average of the biological condition scores yielded a composite score of 28, denoting fair biological condition. The mean level for nitrates and phosphates for this site during the sampling period exceeded the standards as shown in Table D.1. A similarly located YBWA monitoring site, YB1, also exhibited elevated nitrate levels. The biological condition of YB1 was categorized as slightly impaired.

Yellow Breeches Creek (0.50) is located downstream from the dam in proximity to New Cumberland Borough Park. EASI collected biological data on one (1) date on 11/4/1998. An average of the biological condition score yielded a composite score of 35, denoting fair biological condition. The mean level for nitrates and phosphates for this site during the sampling period exceeded the standards as shown in Table D.1.

Yellow Breeches Creek (15.22) is located in proximity to the Spanglers Mill Road crossing in Lower Allen Township. EASI collected biological data on four (4) dates from 10/2/2001 to 4/29/2003. An average of the biological condition scores yielded a composite score of 37, denoting fair biological condition. The mean level for nitrates and phosphates for this site during the sampling period exceeded the standards as shown in Table D.1. A pH of 11, outside of the range (6-9) shown in the standard, was noted in the data from 10/29/2002.

Yellow Breeches Creek (16.10) is located at the Slate Hill Road crossing in Lower Allen Township. EASI collected biological data on six (6) dates from 1/20/2001 to 6/1/2004. An average of the biological condition scores yielded a composite score of 32, denoting fair biological condition. The mean level for nitrates and phosphates for this site during the sampling period exceeded the standards as shown in Table D.1.

Yellow Breeches Creek (17.2) is located 500 meters upstream from Ford Farm Road along McCormick Road in Monaghan Township. EASI collected biological data on ten (10) dates from 5/18/1999 to 10/12/2004. An average of the biological condition scores yielded a composite score of 37, denoting fair biological condition. The mean level for nitrates for this site during the sampling period exceeded the standards as shown in Table D.1. A dissolved oxygen value of 2 mg/l, outside the limit shown in Table D.1, was noted on 4/04/2000. A similarly located YBWA monitoring site, YB5, also exhibited elevated nitrate levels. The biological condition of YB5 was categorized as slightly impaired.

Yellow Breeches Creek (17.78) is located at the Craighead area in South Middleton Township. EASI collected biological data on five (5) dates from 6/5/2002 to 10/4/2004. An average of the biological condition scores yielded a composite score of 10, denoting poor biological condition. Elevated phosphate levels were noted in the sampling dates from 2001 and 2002.

Yellow Breeches Creek (20.36) is located at Messiah College in Upper Allen Township. EASI collected biological data on seven (7) dates from 10/12/2001 to 10/26/2004. An average of the biological condition scores yielded a composite score of 37, denoting fair biological condition. Elevated nitrate levels were noted in the sampling dates from 2003 and 2004.

Yellow Breeches Creek (22.98) is located at Ashford Farms in Upper Allen Township. EASI collected biological data on five (5) dates from 4/26/2002 to 11/2/2004. An average of the biological condition scores yielded a composite score of 36, denoting fair biological condition. Elevated nitrate levels were noted in the sampling dates from 2002 and 2003, and elevated phosphate levels were noted in the sampling dates from 2001 and 2002.

Yellow Breeches Creek (25.67) is located at the Stuart Road/Route 464 crossing in Dickinson Township. EASI collected biological data on four (4) dates from 5/14/2003 to 10/13/2004. An average of the biological condition scores yielded a composite score of 25, denoting fair biological condition. The mean level for nitrates and phosphates for this site during the sampling period exceeded the standards as shown in Table D.1.

Yellow Breeches Creek (27.19) is located at the Encks Mill Road crossing in Dickinson Township. EASI collected biological data on four (4) dates from 4/16/2003 to 10/13/2004. An average of the biological condition scores yielded a composite score of 25, denoting fair biological condition. The mean level for nitrates and phosphates for this site during the sampling period exceeded the standards as shown in Table D.1. A similarly located YBWA monitoring site, YB2, also exhibited elevated phosphate levels. The biological condition of YB2 was categorized as slightly impaired.

Yellow Breeches Creek (29.37) is located at the Route 233 crossing in Penn Township. EASI collected biological data on four (4) dates from 4/23/2003 to 10/27/2004. An average of the biological condition scores yielded a composite score of 16, denoting poor biological condition. The mean level for nitrates and phosphates for this site during the sampling period exceeded the standards as shown in Table D.1. A dissolved oxygen level of 4 mg/l, outside the standard, was noted on 9/26/2001.

Cedar Run (0.17) is located in Lower Allen Township. EASI collected biological data on one (1) date on 9/9/2003. An average of the biological condition score yielded a composite score of 7, denoting poor biological condition. The mean level for nitrates, phosphates, and specific conductance for this site during the sampling period exceeded the standards as shown in Table D.1. YBWA sampled four (4) different locations on Cedar Run, including CR1, CR2, CR3, CR4. These sites on Cedar Run exhibited elevated levels of phosphates and nitrates. Additionally, elevated levels of fecal coliform were noted at the YBWA sampling sites.

Dogwood Run (0.05) is located along Williams Grove Road in Carroll Township. EASI collected biological data on one (1) date on 7/6/2004. An average of the biological condition scores yielded a composite score of 34, denoting fair biological condition. The mean level for nitrates and phosphates for this site during the sampling period exceeded the standards as shown in Table D.1. A similarly located YBWA monitoring site, DR1, also exhibited elevated nitrate levels. The biological condition of DR1 was categorized as slightly impaired.

Mountain Creek (3.00) is located at the junction of Route 39 and the Gettysburg Railroad in Mount Holly Springs. EASI collected biological data on five (5) dates from 5/7/2003 to 10/6/2004. An average of the biological condition scores yielded a composite score of 21, denoting fair biological condition. The mean level for nitrates for this site during the sampling period exceeded the standards as shown in Table D.1. No chemistry values were of note for this sampling location. A similarly located YBWA monitoring site, MN1, exhibited a higher fecal coliform level than 2/3 of the YBWA sampling sites. The remaining chemistry values were unremarkable. The biological condition of MN1 was categorized as slightly impaired.

Mountain Creek (9.30) is located at the Laurel Lake Bridge in Cooke Township. EASI collected biological data on six (6) dates from 5/21/2003 to 9/22/2004. An average of the biological condition scores yielded a composite score of 18, denoting poor biological condition. The mean level for phosphates for this site during the sampling period exceeded the standards as shown in Table D.1.

Mountain Creek (10.2) is located in proximity to Ice House Road between Laurel and Fuller Lakes in Cooke Township. EASI collected biological data on four (4) dates from 5/21/2003 to 9/22/2004. An average of the biological condition scores yielded a composite score of 15, denoting poor biological condition. The mean level for phosphates for this site during the sampling period exceeded the standards as shown in Table D.1.

Mountain Creek (15.60) is located at the Woodrow Road Bridge in Cooke Township. EASI collected biological data on four (4) dates from 5/28/2003 to 9/29/2004. An average of the biological condition scores yielded a composite score of 12, denoting poor biological condition. The mean pH level for this site during the sampling period was 4.26, outside the standard as shown in Table D.1.

Stony Run (0.25) is located about 75 yards downstream from the Grantham Road Bridge in Carroll Township. EASI collected biological data on one (1) date on 6/29/2004. An average of the biological condition scores yielded a composite score of 49, denoting good biological condition. The mean level for nitrates and phosphates for this site during the sampling period exceeded the standards as shown in Table D.1. A similarly located YBWA monitoring site, SR1, exhibited elevated levels of nitrates and fecal coliform. The biological condition of SR1 was categorized as slightly impaired.

Trout Run (1.40) is located about 50 meters downstream from the Lisburn Road crossing in Upper Allen Township. EASI collected biological data on eight (8) dates from 5/21/2002 to 10/5/2004. An average of the biological condition scores yielded a composite score of 22, denoting fair biological condition. The mean level for nitrates and phosphates for this site during the sampling period exceeded the standards as shown in Table D.1.

Unnamed Tributary (0.60) is located in New Cumberland. EASI collected biological data on ten (10) dates from 10/1/1998 to 4/27/2004. An average of the biological condition scores yielded a composite score of 28, denoting fair biological condition. The mean level for nitrates and phosphates for this site during the sampling period exceeded the standards as shown in Table D.1.

Unnamed Tributary (1.60) is located along Stumpstown Road in Upper Allen Township. EASI collected biological data on four (4) dates from 4/6/1999 to 4/17/2001. An average of the biological condition scores yielded a composite score of 15, denoting poor biological condition. The mean level for nitrates and phosphates for this site during the sampling period exceeded the standards as shown in Table D.1.

The biological condition scores were summarized for the mainstem Yellow Breeches Creek sites and shown as Table D.7. The habitat data for all of the EASI monitoring sites was considered as a whole, but no distinct trends were noted. Consistent problem areas generally noted throughout included poor bank stability and vegetative protection. Lack of an adequate riparian buffer zone was noted at multiple EASI sampling locations. All of these problems were also noted at YBWA monitoring sites.

Table D.7 Biological Condition

River Mile	Score	Condition
0.49	28	Fair
0.50	35	Fair
15.22	37	Fair
16.10	32	Fair
17.20	37	Fair
17.78	10	Poor
20.36	37	Fair
22.98	36	Fair
25.67	25	Fair
27.19	25	Fair
29.37	16	Poor

Questionnaires were distributed to EASI team leaders to gather any additional information, including observations of trends, gross problem areas, etc. No gross problems areas were noted per the information. A possible trend showing an elevation in nitrates was offered by the team leaders.

In summary, EASI conducted sampling on the Yellow Breeches Creek and its tributaries. YBWA monitoring sites yielded similar findings. Elevated levels of nitrates and phosphates were a common finding amongst the sampling sites for both EASI and YBWA. Elevated specific conductance was common to both EASI and YBWA for sampling sites on Cedar Run. Problems including poor streambank stabilization and lack of adequate riparian buffer zones were common findings in both YBWA and EASI data sets. YBWA documented the presence of elevated levels of fecal coliform, particularly the highest at CR1, but EASI does not document levels of fecal coliform in its routine practice. A possible trend in elevated nitrates may exist in the EASI data. No distinct trends were otherwise noted in the EASI data, but common findings between the data of this study and the EASI data were observed.

The Alliance for Aquatic Resource Monitoring at Dickinson College has conducted water quality monitoring in the Yellow Breeches Watershed at several locations since 1990, although only one site on the main stem is still being monitored under the program.

Most of the sites have been monitored for pH and Alkalinity (Alk), while Cedar Run was also monitored for Dissolved Oxygen (DO) for a period of approximately one year. All average pH and Alk levels are within the Chapter 93 Criteria for Cold Water Fishes (CWF) for the period monitored, although some minimum levels for both parameters have been below the criteria. As the circumstances and times of these reduced levels are not known, it is not possible to comment on them. The average DO levels for Cedar Run were slightly below the Chapter 93 criteria for a CWF stream for the period monitored.

Exceedances

Data collected for each parameter was compared to the limits as shown in Table D.1. An exceedance is defined as a value outside of the limits of the standard. The number of exceedances for each monitoring site was calculated and shown in Table D.8. Exceedances for temperature, biological oxygen demand, and suspended solids are not shown in Table D.8. These three (3) parameters were not utilized in the scoring system used to identify and rank problem areas. Since multiple monitoring sites had temperatures outside the limits shown in Table D.1, this parameter would not be very predictive of impairment in the scoring system. Biological oxygen demand was not used in the scoring system, as there is not a generally accepted standard for this parameter. Suspended solids was not used in the scoring system, as it is difficult to conclude that suspended solids are an indicator of impairment without additional information. A greater focus was placed specifically on nutrient parameters in the scoring system, in addition to fecal coliform, specific conductance, dissolved oxygen, and pH.

Table D.8 Exceedances

Station ID	Nitrate-N	Ammonia-N	Phosphorous	Sulfates	Fecal Colliform	Specific Conductance	Dissolved Oxygen	pH	Total Exceedances
-	mg/l	mg/l	mg/l	mg/l	Col/100ml	umhos/cm	mg/l	standard	-
YB1-0.28	**2.3**	0.10	0.06	17.0	**800**	359.0	8.3	8.2	2
YB4-10.32	**2.2**	0.10	0.05	14.0	72	288.0	10.8	8.1	1
YB5-15.26	**2.3**	0.10	0.05	14.1	100	291.0	9.6	8.2	1
YB6-24.44	**1.8**	0.10	0.04	10.1	**410**	258.0	9.4	8.4	2
YB7-29.12	**1.3**	0.10	0.05	8.6	**600**	219.0	9.1	8.0	2
YB2-42.48	**1.1**	0.20	0.05	6.1	140	224.0	9.9	8.1	1
YB3-47.21	**2.8**	0.10	0.02	12.4	190	298.0	9.7	8.1	1
CR1-0.28	**2.4**	n/a	0.04	23.4	**4,500**	618.0	**6.7**	7.8	3
CR3-2.17	**5.1**	n/a	0.02	24.9	170	639.0	7.8	7.6	1
CR2-4.09	**7.5**	n/a	0.06	24.2	30	570.0	7.3	7.3	1
CR4-0.39	**1.5**	n/a	0.02	27.7	20	794.0	**6.8**	7.8	2
UNT1-0.11	**4.7**	0.10	0.03	22.8	190	555.0	10.7	8.3	1
PR1-0.17	0.7	0.10	0.06	15.2	0	211.0	10.0	8.1	0
SR1-0.43	**1.4**	0.15	0.08	20.9	**460**	294.0	8.9	8.3	2
SR2-5.09	0.9	0.15	0.07	25.4	**1,150**	339.0	8.3	7.6	1
SR3-1.06	1.5	0.15	0.04	14.8	**310**	192.0	9.3	8.3	1
DR1-0.70	**1.7**	0.14	**0.11**	14.5	**490**	324.0	8.7	8.2	3
DR2-1.85	1.0	0.16	**0.11**	13.0	**1,350**	511.0	7.1	7.8	2
DR3-5.08	0.5	0.15	0.02	5.6	**220**	50.3	9.0	7.8	1
OR1-0.51	0.5	0.10	0.02	6.2	110	128.0	9.1	8.1	0
OR2-2.74	0.5	0.10	0.02	4.2	22	46.3	9.3	8.5	0
LD1-0.97	0.5	0.10	0.03	7.7	56	33.4	8.5	8.4	0
MN1-1.09	0.7	0.10	0.07	15.8	**300**	153.0	9.8	8.3	1
MN2-4.77	0.7	0.10	0.02	7.5	70	72.0	11.1	8.5	0
MN3-15.10	0.5	0.10	0.02	3.4	80	25.4	10.5	8.1	0
TR1-0.85	0.5	0.10	0.02	3.6	42	30.5	10.2	8.8	0
CSR1-0.82	0.5	0.10	0.02	5.6	54	28.0	8.6	6.9	0
CSR2-2.09	0.5	0.10	0.02	4.7	94	N/A	8.9	6.6	0
KH1-1.09	0.5	0.10	0.02	5.7	18	24.0	10.1	7.8	0
IG1-0.88	0.5	0.10	0.02	3.8	100	21.9	9.0	7.1	0
PH1-2.10	0.5	0.10	0.02	7.2	2	29.3	7.8	8.1	0
HSH1-1.61	0.5	0.10	0.02	6.5	**220**	28.1	9.2	**5.1**	2
STH1-1.72	0.5	0.10	0.02	6.7	26	29.0	9.1	8.7	0

Note: Data collected for watershed assessment not intended for use in permitting or enforcement actions.

ANALYSIS OF FINDINGS

Data was collected from thirty-three (33) monitoring sites within the Yellow Breeches Creek Watershed. Monitoring sites were categorized as mainstem (7 sites), high-gradient (13 sites), and low-gradient (13 sites). The watershed was categorized into two (2) portions, the upper watershed and the lower watershed. The upper watershed begins at the headwaters and encompasses a largely rural area, including agricultural lands and forested areas. The lower watershed is characterized as more urban and is largely comprised of developed residential and commercial areas.

Municipalities in the upper watershed include South Newton Township, Southampton Township, Cooke Township, Penn Township, Dickinson Township, Mount Holly Springs Borough, and South Middleton Township. Monitoring sites in the upper watershed included two (2) mainstem sites, nine (9) high gradient sites, and two (2) low gradient sites.

The mainstem monitoring sites in the upper watershed, Yellow Breeches Creek (YB2-42.48) and (YB3-47.21), are located in rural areas of Dickinson Township and Penn Township, respectively. Both YB2-42.48 and YB3-47.21 are listed on the 2004 PIMAR as not impaired. YB2-42.48 was categorized as less impaired in the Yellow Breeches Creek Watershed Assessment, while YB3-47.21 was categorized as having a level of moderate impairment. YBWA results characterized greater impairment than previously reported on the 2004 PIMAR, potentially as a result of changes in surrounding land use as areas of the upper watershed are progressively becoming developed. YB3-47.21 exhibited suboptimal bank stability, vegetative protection and a suboptimal to marginal riparian buffer. There are two (2) permitted industrial waste discharges and one (1) permitted municipal sewage discharge in the Yellow Breeches Creek within the upper watershed.

The high-gradient monitoring sites in the upper watershed include Sthromes Hollow (STH1-1.72), Hairy Springs Hollow (HSH1-1.61), Mountain Creek (MN2-4.77 and MN3-15.10), Peach Orchard Hollow (PH1-2.10), Irishtown Gap Hollow (IG1-0.88), Kings Gap Hollow (KH1-1.09), Toms Run (TR1-0.85), Cold Spring Run (CSR2-2.09). STH1-1.72, PH1-2.10, and IG1-0.88 have been categorized as moderately impaired, as the remaining high-gradient sites exhibited less impairment. STH1-1.72 was categorized as impaired on the 2004 PIMAR. PH1-2.10 and IG1-0.88 were listed as unimpaired on the 2004 PIMAR, although areas upstream on both of these tributaries were listed on the 2004 PIMAR. This finding potentially indicates a further expanding impact in both of these areas, as the data collected in this assessment indicates a greater level of impairment. STH1-1.72 exhibited poor bank stability and marginal vegetative protection, while PH1-2.10 and IG1-0.88 exhibited suboptimal bank stability and vegetative protection. MN2-4.77, MN3-15.10, and TR1-0.85, categorized as less impaired, were reported on the 2004 PIMAR as unimpaired. KH1-1.09 and CSR2-2.09, categorized as less impaired, have been reported on the 2004 PIMAR as impaired. There is one (1) permitted industrial waste discharge into Irishtown Gap Hollow.

The low-gradient monitoring sites in the upper watershed include Cold Spring Run (CSR1-0.82) and Mountain Creek (MN1-1.09). CSR1-0.82, categorized as moderately impaired, was reported as unimpaired on the 2004 PIMAR. CSR1-0.82 exhibited marginal bank stability and vegetative protection. Areas upstream of this monitoring site are reported as impaired on the 2004 PIMAR although, potentially indicating an expansion of the impaired length of this stream. MN1-1.09, categorized as moderately impaired, is reported on the 2004 PIMAR as unimpaired, while upstream areas of this stream are reported as impaired, again potentially indicating an expanding impairment. The location of MN1-1.09 is in proximity to Mount Holly Springs Borough, an area experiencing increased development. MN1-1.09 exhibited suboptimal bank stability and vegetative protection with a suboptimal to marginal riparian buffer. There are three (3) permitted industrial waste discharges and one (1) municipal sewage discharge into Mountain Creek.

Municipalities in the lower watershed include New Cumberland Borough, Lemoyne Borough, Camp Hill Borough, Shiremanstown Borough, Lower Allen Township, Upper Allen Township, Mechanicsburg Borough, Monaghan Township, Carroll Township, Monroe Township, Fairview Township, and Dillsburg. Although the lower watershed is much more urban than the upper watershed, portions of Monaghan, Carroll, and Monroe Townships are more rural in characterization.

The mainstem monitoring sites in the lower watershed include YB1-0.28, YB4-10.32, YB5-15.26, YB6-24.44, and YB7-29.12. YB1-0.28, YB4-10.32, and YB5-15.26 are located in urbanized subwatersheds in Lower Allen Township, Upper Allen Township, and New Cumberland Borough. YB6-24.44 is located in Monroe Township, while YB7-29.12 is located in Boiling Springs. YB1-0.28, categorized as moderately impaired, is reported on the 2004 PIMAR as impaired. YB1-0.28 is located at the mouth of the Yellow Breeches Creek where it flows into the Susquehanna River. The finding of moderate impairment substantiates the finding reported on the 2004 PIMAR, demonstrating impairment present in the urbanized subwatersheds of the lower watershed. YB1-0.28 exhibited marginal bank stability and vegetative protection with a poor riparian buffer. YB5-15.26, categorized as moderately impaired, is reported as unimpaired on the 2004 PIMAR. The location of YB5-15.26 is in proximity to developing areas of the lower watershed. YB5-15.26 exhibited suboptimal bank stability and a poor riparian buffer. YB4-10.32, YB6-24.44, and YB7-29.12, categorized as less impaired, are reported as unimpaired on the 2004 PIMAR. There are two (2) permitted municipal sewage discharges, five (5) permitted non-municipal sewage discharges, and four (4) permitted industrial waste discharges into the Yellow Breeches Creek within the lower watershed.

The high gradient monitoring sites in the lower watershed include Old Town Run (OR2-2.74), Dogwood Run (DR1-0.70 and DR3-5.08), and Pippins Run (PR1-0.17). OR2-2.74, categorized as moderately impaired, is reported as impaired on the 2004 PIMAR. OR2-2.74 exhibited marginal bank stability and poor vegetative protection. DR3-5.08 and PR1-0.17, categorized as less impaired, are reported as unimpaired on the 2004 PIMAR. DR1-0.70, categorized as moderately impaired, is reported as impaired on the 2004 PIMAR. There is one (1) permitted municipal sewage discharge into Dogwood Run.

The low-gradient monitoring sites in the lower watershed include Old Town Run (OR1-0.51), Little Dogwood Run (LD1-0.97), Dogwood Run (DR2-1.85), Stony Run (SR1-0.43, SR2-5.09, and SR3-1.06), Unnamed Tributary (UNT1-0.11), and Cedar Run (CR1-0.28, CR2-4.09, CR3-2.17, and CR4-0.39). OR1-0.51 and SR1-0.43, categorized as less impaired, are reported as unimpaired on the 2004 PIMAR. SR2-5.09 and SR3-1.06, categorized as less impaired, are reported as impaired on the 2004 PIMAR, indicating the need to collect further data to verify these findings. LD1-0.97 and CR2-4.09 are categorized as moderately impaired and are listed as impaired on the 2004 PIMAR. UNT-0.11 is categorized as less impaired. LD1-0.97 exhibited suboptimal bank stability and vegetative protection. UNT1-0.11 exhibited poor bank stability and suboptimal vegetative protection. CR2-4.09 exhibited poor vegetative protection and a poor riparian buffer. CR1-0.28 and DR2-1.85, categorized as most impaired, are listed on the 2004 PIMAR as impaired. CR3-2.17 is categorized as moderately impaired. CR1-0.28 exhibited poor bank stability and vegetative protection. Both CR1-0.28 and CR3-2.17 exhibited a poor riparian buffer. DR2-1.85 exhibited poor bank stability with a marginal riparian buffer. CR4-0.39, categorized as moderately impaired, is listed as unimpaired on the 2004 PIMAR. There are seven (7) permitted stormwater discharges and one (1) permitted industrial waste discharge into Cedar Run and two (2) permitted non-municipal sewage discharges into Stony Run.

In summary, Cedar Run (CR1-0.28) and Dogwood Run (DR2-1.85) were categorized as most impaired. Cedar Run flows through the lower watershed, an urban area undergoing continued growth and development. Multiple large industrial and commercial complexes are located within the Cedar Run subwatershed. These facilities include the State Correctional Institution at Camp Hill, the Capital City Mall, Appleton Papers, Inc. and numerous other commercial businesses. Other potential impacts to this area include permitted stormwater and industrial waste discharges into Cedar Run. Dogwood Run flows through the lower watershed, but in an area less urbanized than the Cedar Run subwatershed. Dogwood Run is subject to impacts from surrounding and upstream agricultural influences, in addition to increasing development pressure. An additional potential impact is a permitted municipal sewage discharge into Dogwood Run. Data collected for all monitoring sites was compared with the 2004 PIMAR; YBWA results were generally consistent with the findings of the report.

TAB E

IDENTIFICATION AND RANKING OF WATERSHED NEEDS AND PROBLEM AREAS

The identification of watershed needs and problem areas was based on the analysis of habitat, biological, and water quality assessment scores. The following scoring system was used to determine a level of impairment for each monitoring site with the watershed.

For habitat condition, monitoring sites were categorized as supporting, partially supporting, or not supporting (see Tables C.8, C.9, and C.10). For the purposes of identification and ranking, the following values have been assigned to each of these categories.

Excellent	0
Supporting	1
Partially Supporting	2
Not Supporting	3

For biological condition, monitoring sites were categorized as nonimpaired, slightly impaired, or moderately impaired (see Tables C.8, C.9, and C.10). For the purposes of identification and ranking, the following values have been assigned to each of these categories.

Nonimpaired	1
Slightly Impaired	2
Moderately Impaired	3

For water quality condition, monitoring sites were categorized according to the number of water quality parameters with exceedances for each of the monitoring sites (see Table D.7). For the purposes of identification and ranking, the following values have been assigned to each of these categories.

Water quality parameters with 0-1 exceedances	0
Water quality parameters with 2 exceedances	1
Water quality parameters with $\geq$ 3 exceedances	2

Based on the scoring system developed for identification and ranking purposes, a total score for each monitoring site was determined by summing the values applied for biological condition, habitat condition, and water quality condition. These final scores were separated into categories by stream gradient: high, low, and mainstem. Levels of impairment were based on the final score for each monitoring based on the following criteria. See Table E.1 for a complete summary of the levels of impairment for each monitoring point.

Final Score 1-3	Less Impairment
Final Score 4-5	Moderate Impairment
Final Score 6-8	Most Impairment

Table E.1 Stream Impairment Summary

Monitoring Point	Tributary	Gradient	Biological	Habitat	Water Quality	Total	Impairment
IG1-0.88	Irishtown Gap Hollow	High	3	2	0	5	Moderate
OR2-2.74	Old Town Run	High	3	2	0	5	Moderate
DR1-0.70	Dogwood Run	High	2	1	2	5	Moderate
PH1-2.10	Peach Orchard Hollow	High	3	1	0	4	Moderate
STH1-1.72	Sthromes Hollow	High	2	2	0	4	Moderate
DR3-5.08	Dogwood Run	High	2	1	0	3	Less
CSR2-2.09	Cold Spring Run	High	2	0	0	2	Less
HSH1-1.61	Hairy Springs Hollow	High	2	0	1	3	Less
KH1-1.09	Kings Gap Hollow	High	2	0	0	2	Less
MN2-4.77	Mountain Creek	High	2	0	0	2	Less
MN3-15.10	Mountain Creek	High	2	0	0	2	Less
PR1-0.17	Pippins Run	High	1	0	0	1	Less
TR1-0.85	Toms Run	High	1	0	0	1	Less
DR2-1.85	Dogwood Run	Low	3	3	1	7	Most
CR1-0.28	Cedar Run	Low	3	1	2	6	Most
CR3-2.17	Cedar Run	Low	3	2	0	5	Moderate
CR4-0.39	Cedar Run	Low	3	1	1	5	Moderate
CSR1-0.82	Cold Spring Run	Low	3	2	0	5	Moderate
CR2-4.09	Cedar Run	Low	3	1	0	4	Moderate
LD1-0.97	Little Dogwood Run	Low	3	1	0	4	Moderate
MN1-1.09	Mountain Creek	Low	2	2	0	4	Moderate
UNT1-0.11	Unnamed Tributary	Low	2	1	0	3	Less
SR1-0.43	Stony Run	Low	2	0	1	3	Less
SR2-5.09	Stony Run	Low	2	1	0	3	Less
SR3-1.06	Stony Run	Low	1	1	0	2	Less
OR1-0.51	Old Town Run	Low	1	0	0	1	Less
YB1-0.28	Yellow Breeches	Main Stem	2	2	1	5	Moderate
YB3-47.21	Yellow Breeches	Main Stem	2	2	0	4	Moderate
YB5-15.26	Yellow Breeches	Main Stem	2	2	0	4	Moderate
YB4-10.32	Yellow Breeches	Main Stem	2	1	0	3	Less
YB6-24.44	Yellow Breeches	Main Stem	1	1	1	3	Less
YB2-42.48	Yellow Breeches	Main Stem	2	0	0	2	Less
YB7-29.12	Yellow Breeches	Main Stem	1	0	1	2	Less

Note: Data collected for watershed assessment not intended for use in permitting or enforcement actions.

BEST MANAGEMENT PRACTICES

Upon review of all data collected, best management practices (BMPs) specific to problems identified at each monitoring site were selected. The primary problems identified included:

- Poor bank stability
- Poor vegetative stability
- Lack of riparian buffers
- Streambank erosion

BMPs selected for the Yellow Breeches Creek Watershed Assessment are classified as either stream restoration measures or pollution control measures. Stream restoration measures can be utilized to enhance the appearance, stability, structure, and function of streams within the watershed. Both stream cleanups and stream repairs are important components of overall stream restoration. Pollution control measures reduce or prevent pollution from residential neighborhoods. These measures include a wide range of stewardship and pollution prevention practices that can be utilized in subwatersheds. Table E.2 shows a summary of the specific BMPs selected for each monitoring site.

Stream adoptions, stream cleanups, and measures to improve riparian buffers have been selected for all monitoring points, as these are important conservation activities that should be implemented across the entire watershed. Measures to diminish erosion and improve bank stability have been selected at monitoring sites exhibiting moderate or greater levels of impairment in both the upper and lower watershed. Structural measures including cross vanes, V-log drops, and streambank reshaping were selected at monitoring points with the highest level of impairment. Measures to develop forested riparian buffers were selected at monitoring sites in the upper watershed where current riparian buffers are either inadequate or absent entirely. Septic system maintenance has been selected as a practice for monitoring sites exhibiting moderate or greater levels of impairment within rural portions of the watershed. Pollution control measures including safe pool discharges, vehicle washing, parking lot maintenance, and driveway sweeping have been selected at monitoring sites exhibiting moderate or greater levels of impairment in the lower watershed. Regional stormwater management has been selected for monitoring points on Cedar Run; practices specific to agricultural management have been selected for monitoring sites on Dogwood Run. See the information sheets specific to each BMP following Table E.2.

Table E.2 Yellow Breeches Watershed Assessment – Best Management Practices

	Cedar Run (CR1-0.28)	Cedar Run (CR2-4.09)	Cedar Run (CR3-2.17)	Cedar Run (CR4-0.39)	Cold Spring Run (CSR1-0.82)	Cold Spring Run (CSR2-2.09)	Dogwood Run (DR1-0.70)	Dogwood Run (DR2-1.85)	Dogwood Run (DR3-5.08)	Hairy Spring Hollow (HSH1-1.61)	Irishtown Gap (IG1-0.88)	Kings Gap Hollow (KH1-1.09)	Little Dogwood Run (LD1-0.97)	Mountain Creek (MN1-1.09)	Mountain Creek (MN2-4.77)	Mountain Creek (MN3-15.10)	Old Town Run (OR1-0.51)	Old Town Run (OR2-2.74)	Peach Orchard Hollow (PH1-2.10)	Pippins Run (PR1-0.17)	Sthromes Hollow (STH1-1.72)	Stony Run (SR1-0.43)	Stony Run (SR2-5.09)	Stony Run (SR3-1.06)	Toms Run (TR1-0.85)	Unnamed Tributary (UNT1-0.11)	Yellow Breeches Creek (YB1-0.28)	Yellow Breeches Creek (YB2-42.48)	Yellow Breeches Creek (YB3-47.21)	Yellow Breeches Creek (YB4-10.32)	Yellow Breeches Creek (YB5-15.26)	Yellow Breeches Creek (YB6-24.44)	Yellow Breeches Creek (YB7-29.12)
Stream Cleanups (C-1)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Stream Adoption (C-2)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Riparian Buffer Restoration	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Boulder Revetment (R-3)	X		X					X								X		X			X					X	X			X	X		
Rootward Revetment (R-4)	X	X	X	X				X	X		X			X	X		X	X	X		X	X	X	X	X		X		X		X	X	X
Streambank Shaping (R-8)	X		X					X																									
Erosion Control Fabrics (R-10)	X	X	X	X	X			X	X		X			X	X		X	X	X	X	X			X		X	X		X	X	X		
Live Stakes (R-12)	X	X	X	X	X		X	X	X		X			X	X		X	X			X	X	X		X	X	X		X			X	X
Brush Mattresses (R-14)	X	X	X	X	X		X	X			X							X			X					X	X		X		X		
Log, Rock and J-Rock Vanes (R-17)	X		X					X																									
Rock Cross Vane (R-19)	X		X					X																									
V-Log Drops (R-21)																																	
Reduced Fertilizer Use (N-1)					X			X			X		X	X				X	X		X								X				
Natural Landscaping (N-4)	X		X																														
Yard Waste Composting (N-6)	X	X	X	X	X			X			X		X	X				X	X		X					X	X		X		X		
Septic System Maintenance (N-9)					X			X			X		X	X				X	X		X								X				
Safe Pool Discharges (N-10)	X	X	X	X				X																		X	X				X		
Driveway Sweeping (N-12)	X		X					X																									
Car Fluid Recycling (N-15)	X		X					X																									
Downspout Disconnection (N-16)	X	X	X	X				X																		X	X				X		
Storm Drain Marking (N-21)	X	X	X	X																							X						
Vehicle Washing (H-3)	X	X	X	X																						X	X				X		
Parking Lot Maintenance (H-11)	X		X																														
Regional Stormwater Management	X	X	X	X																													
Conservation Tillage							X	X	X																								
Grazing Management								X																									
Animal Feeding Operations							X	X																									

Most Impairment
Moderate Impairment
Less Impairment

TAB F

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