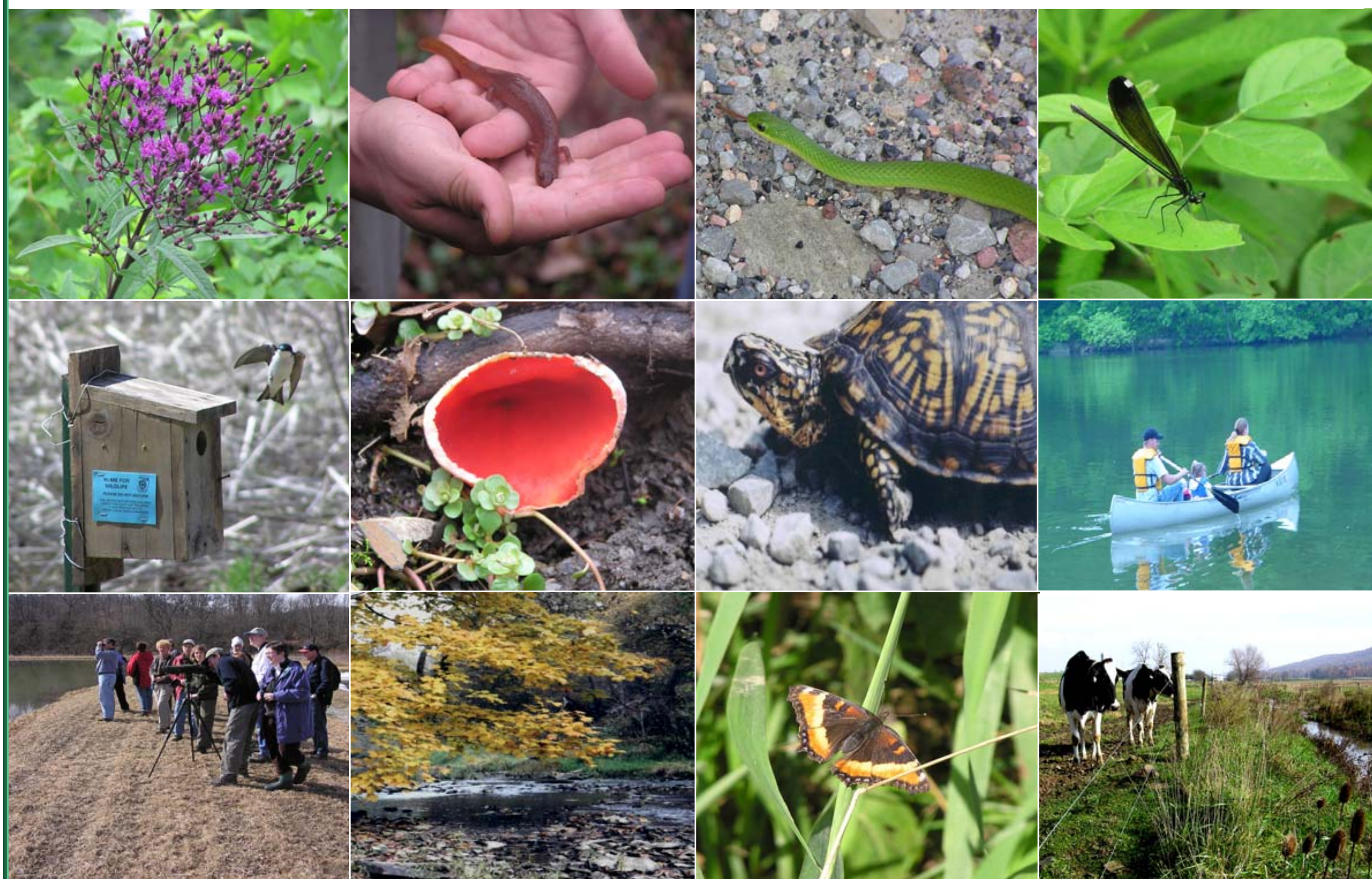
# Buffalo Creek Watershed Assessment and Protection Plan

*(Washington County, PA and Brooke and Ohio Counties, WV)*

June 2005



Buffalo Creek Watershed Association

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# Buffalo Creek Watershed Assessment and Protection Plan

*June 2005*

**Prepared for:**

Buffalo Creek Watershed Association

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# INTRODUCTION

## The Buffalo Creek Watershed

Located in southwestern Pennsylvania and the panhandle of West Virginia, the Buffalo Creek watershed is highly rural, containing a mixture of agricultural, residential, and forested land uses. Within the Pennsylvania portion, Buffalo Creek is designated a High Quality watershed by Pennsylvania Department of Environmental Protection (DEP). Though many of its habitats have been altered from natural, pristine conditions, the watershed still contains remnants of natural communities that were once abundant in Washington County, PA. The Buffalo valley was recently named the 80$^{th}$ Important Bird Area in Pennsylvania and, during a Natural Heritage Inventory of Washington County in 1994, Western Pennsylvania Conservancy (WPC) identified two exceptionally ranked Biodiversity Areas within the watershed's boundaries.

## A Case for Future Planning

Despite recognition by public and private agencies in Pennsylvania, little information about the water quality or biodiversity of the watershed existed before this plan was prepared. The only updated water quality information available was Pennsylvania DEP's 2001 Unassessed Waters investigations, from which sections of Buffalo Creek and one of its tributaries were added to DEP's 303(d) list of impaired streams due to excess nutrients and sedimentation.

An understanding of the value and location of terrestrial and aquatic resources, as well as their importance to humans, can aid in wise land-use planning. A vision for protection of the Buffalo Creek watershed is timely, as both mining and development activities may threaten the resources of the watershed in the future. Successful planning most often involves a dialogue among residents to develop a vision for their communities. Community goals may include objectives such as conserving natural resources, preserving agricultural land, developing public services, and increasing outdoor recreational opportunities. Successful planning involves designing land controls that allow for a variety of these uses while recognizing the limitations of the natural environment and its importance to the overall well-being of a community. The development of this protection plan is an important step towards achieving these goals.

## Evolution of *Buffalo Creek Watershed Assessment and Protection Plan*

In February 2003, the Buffalo Creek Watershed Association (BCWA), in conjunction with the Washington County Watershed Alliance, received a Pennsylvania Growing Greener Grant from the Pennsylvania Department of Environmental Protection. Western Pennsylvania Conservancy was then contracted to develop the *Buffalo Creek Watershed Assessment and Protection Plan*.

This plan is among the first of its kind to be developed through the Pennsylvania Growing Greener Program. Though similar to a restoration plan, a protection plan is intended to provide recommendations towards protection of positive attributes of an area that currently exist rather than simply restoring these attributes in an area that has been negatively impacted by activities such as mining and development. A **Watershed Protection Plan** could be defined as:

*An inventory of the health and diversity of natural resources in a watershed and accompanying recommendations to be used by public and private entities in decision-making involving the wise use of these natural resources.*

To put it simply, a protection plan is a guide to help people protect aspects of their watershed that are important to them. This plan not only takes into account water quality, but also the protection of cultural resources, natural habitats, and opportunities for continued monitoring. Because of the recognized natural assets of the Buffalo Creek watershed, it is an ideal candidate for such a project. However, the watershed's landscape, or pattern of land use, has influenced the health of natural resources in the watershed. For these reasons, the protection plan also includes elements of a restoration plan. One of the biggest impacts of land use has been increased levels of nutrients and sedimentation entering streams, resulting from a lack of agricultural best management practices and the presence of malfunctioning septic systems.

The watershed is at a crucial point at which decisions made now may significantly affect its future. Further collection of water quality data and other information will be necessary well after the completion of the plan to continue the development of restoration and management objectives. Partnerships among local groups, including those with both similar and competing interests, may be important in following through on these objectives.

This protection plan is not intended to be a mandate for municipalities about how development should occur, nor is it enforceable. However, it can be used as a guide in decision-making involving natural resources or an eco-tourist's manual to wildlife areas. It may also be a good resource for both public and private groups within the watershed searching for funding or contact information for watershed projects.

The goal of this protection plan is not to stop development, agriculture, or any other similar practice important to the local economy. In many cases, conservation goals are compatible with these objectives and can also have benefits such as reducing flooding potential, improving drinking water quality, increasing recreational opportunities, and making a community a more attractive place to live. The benefits of a protection plan include:

- A comprehensive source of past and present natural resource and water quality data;
- A guide to important natural and historic sites;
- A source for potential restoration/protection projects and future funding sources; and
- A reference to add credibility when applying for grants/loans to conduct restoration/protection projects.

Informed recommendations for the protection of the watershed were developed from resident surveys, two public meetings, recently collected scientific data, and suggestions from experts. New data collected includes a visual assessment of accessible streams in the watershed; quarterly water quality and stream flow information; and results of macroinvertebrate, plant, fish, and other sampling. This new information was obtained through surveys conducted by WPC, local colleges and universities, and community and regional volunteers.

Because of the requirements of the funding sources for this plan, new data could not be collected for the West Virginia portion of the watershed. However, a best effort was made to include any previously collected information, whenever possible, pertaining to this area of the watershed. It was found that, in most cases, little data exists about the water quality and wildlife within the Buffalo Creek watershed in West Virginia and that more collaboration is needed between individuals and groups in Pennsylvania and West Virginia.

## Protection Plan Timeline

| | |
|---|---|
| January 2003 | Growing Greener Grant awarded to BCWA |
| February- June 2003 | Background data collected |
| May 2003 | Partner meeting held |
| June 2003 | First public meeting held |
| June 2003 | Field work begins |
| December 2004 | Field work ends |
| March 2005 | Pre-Draft plan presented to BCWA steering committee |
| April 2005 | Draft public meeting held, plan presented to public and reviewers |
| May 2005 | Edited plan completed and information presented at BCWA festival |
| June 2005 | Final hard copies and CD copies given to BCWA for distribution |

## Acknowledgements

This project was completed through a partnership among Buffalo Creek Watershed Association, Western Pennsylvania Conservancy, and the numerous individuals and organizations listed below. We would like to thank the individuals and organizations that gave notable volunteer time and resources to this project, as well as any other contributors that we may have missed.

Individuals
Doug Dunkerley, Pennsylvania Game Commission
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Organizations and Groups
Buffalo Township, Washington County
Buffalo Valley Alliance
California University of Pennsylvania
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Pennsylvania Department of Environmental Protection
Pennsylvania Game Commission
Three Rivers Birding Club
Washington and Jefferson University
Washington County Conservation District
Washington County Planning Commission
Westmoreland Bird and Nature Club
Western Pennsylvania Botanical Society

Advisory Reviewers*

(*provided advisory guidance on one or more sections of the plan)

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Image Data Sources

Sources of GIS Data Layers included Southwestern Pennsylvania Commission, National Land Cover Dataset, U.S. Census Bureau, and West Virginia GIS Data Center. All uncredited photos were taken by current WPC employees.

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# EXECUTIVE SUMMARY

## Project Area Characteristics

The 164-square mile Buffalo Creek watershed is located in Washington County, Pennsylvania, and Brooke and Ohio counties in West Virginia. The headwaters of Buffalo Creek originate in the vicinity of Pleasant Grove, Pennsylvania, flow north to merge with East Buffalo Creek at the intersection of Routes 221 and 3009, and continue northwest where they eventually empty into the Ohio River near Marshall Terrace in West Virginia.

This section describes important natural features, land-use characteristics, and municipal planning information relative to the watershed. This information may be useful in identifying agricultural preservation areas, flood-prone areas, and regional development trends. Maps are included for many natural features. This chapter also gives examples of strategies being used by other municipalities in Pennsylvania to preserve open space and maintain attractive communities while managing development pressures.

The Buffalo Creek watershed is located in the Waynesburg section of the Appalachian Plateau physiographic province. Horizontal folds of alternating sandstone, limestone, and shale characterize this geologically young section. Due to the inability of limestone and shale to hold water, groundwater yields are typically low and water is quickly lost to streams. Water penetrates through sandstone but is forced to travel horizontally when it hits limestone and shale, causing it to come out of hillsides. Flooding events are common.

Approximately 52 percent of the watershed is forested and 47 percent is agricultural, with less than one percent developed. Washington County leads Pennsylvania in sheep, goats and related products and is ranked fifth in equine-related farming. This is reflected in the agricultural activities within the watershed. There are numerous agricultural security areas and two agricultural easement areas in the Pennsylvania portion of the watershed. Agriculture is also important in the West Virginia section of the watershed. However, low depth to bedrock and steep slope limit agricultural activities. Forestry has historically been an important industry within the watershed, though much of the forest on private land has been recently logged and is not currently economically viable. The Pennsylvania Game Commission owns approximately six percent of the Pennsylvania portion of the watershed, or 4,400 acres. In the West Virginia portion, West Virginia Department of Natural Resources operates the 486-acre Castleman Run Wildlife Management Area.

Many active and abandoned oil and gas wells are present in the Pennsylvania portion of the watershed. These can leak salt and other minerals to groundwater, causing safety hazards. Abandoned wells pose the most serious hazard and can be reported to the Pennsylvania Department of Environmental Protection (DEP) Southwest Regional Office. Coal mining activities, as well as other types of mining, have been minimal within the watershed, though past records of underground and surface mining are available. Surface mining potential is limited within the watershed because of the hilly land surface, while the potential for future longwall mining in the watershed is high. Longwall mining is currently occurring at locations near the watershed at Bailey Mine, Enlow Fork Mine, and Mine 84. The DEP's California District Office is responsible for underground and longwall mining permits and information in Pennsylvania, while the Greensburg District Mining Office is responsible for surface mining information. The DEP Bureau of Abandoned Mine Reclamation has records of three problem areas in the Pennsylvania portion. "Problem Areas" are areas of past mining that pose environmental or safety hazards. None of these three areas is considered to be of high concern.

Recent surveys and personal communication with residents suggest that illegal dumping is a common concern. This mainly occurs on State Game Lands 232, where it poses a safety issue and can be visually displeasing. Many of the dumped items contain harmful chemicals or attract mosquitoes and other insect pests. The Pennsylvania Game Commission has hidden cameras and penalizes violators, if identified. However, there is no PA CleanWays chapter in Washington County and more efforts are needed to clean up current illegal dumping areas.

Sensitive areas are places where development and/or agricultural activities should be reduced or eliminated because they pose a safety or environmental hazard. These include floodplains, steep slopes, and wetland areas. There are few municipal measures to prevent activities in these areas. Although most of the municipalities within the watershed have a floodplain ordinance, most are not enforced on a regular basis. Building should especially be limited in these sensitive areas.

According to the last census, the watershed has not experienced a dramatic change in population. However, populations outside of the watershed's borders are increasing, and municipalities may soon be faced with tough decisions regarding development and appropriate visions for their communities. Development most often follows the path of sewer and water services, which are currently limited within the Buffalo Creek watershed. This should be considered in future planning efforts. All of the municipalities within the watershed have a comprehensive plan and most have a zoning ordinance. Joint municipal comprehensive plans, which involve communities working together, can give municipalities more options and help preserve important open space and agricultural areas by placing land uses in the most appropriate locations. There is currently only one joint zoning document in the Pennsylvania portion of the watershed, the Independence-Hopewell Township Comprehensive Plan.

Important issues cited by local municipalities in questionnaires and phone interviews included sewer and water infrastructure for development, zoning issues, dirt and gravel roads, stormwater management, impacts of longwall mining, and money for open space and recreation.

Other tools that have been used by municipalities to direct development and protect sensitive areas are easements, environmental advisory boards, and riparian zone ordinances. Regardless of the planning tools used, it is important to involve residents in the process of developing a community vision.

## Natural Resources Assessment

The fertile lands and abundant geologic resources of southwestern Pennsylvania have caused alterations to the natural landscape. This is evident in Washington County, which is the second leading producer of coal and has one of the highest levels of agricultural land use in Pennsylvania. Though it has also been heavily impacted from disturbance, the Buffalo Creek watershed contains example habitats of what was once abundant in this region. This, and the current lack of mining impacts, contributes to the uniqueness of this watershed.

WPC's Natural Resources Assessment of the Pennsylvania portion of the watershed involved inventories of plants and plant communities, wildlife, and key forest and other lands important to biodiversity. Little information of this kind was available before this study. One previous source of information was the 1996 Washington County Natural Heritage Inventory, a survey of unique wildlife and habitats found in the county. Buffalo Creek watershed was found to contain two exceptionally ranked Biological Diversity Areas (BDA), Dutch Fork Lake BDA and Buffalo Creek BDA. These sites were chosen because of exemplary floodplain forest, acidic cliff, and mesic central plant communities. Both BDAs are located within State Game Lands 232.

Because of the watershed's location and unique geologic history compared to the rest of Pennsylvania, plant communities and other wildlife more typical of West Virginia, and locations farther south, can be found within the watershed. Plant communities include red oak-mixed hardwood forest, dry oak-mixed forest, tulip tree-elm-maple forest, sugar maple-beech forest, post-agricultural successional shrubland, post-agricultural early-successional woodlands, sycamore-box elder floodplain forests, shrub-dominated floodplain wetlands, black maple-elm creek floodplains, and streambanks and sandbars. During WPC's recent inventory of plant species, the watershed was found to house many species at or near the edge of their ranges. This included species like crepis rattlesnake-root, toadshade, appendaged waterleaf, and yellow and smooth buckeye tree species.

Due to its variety of habitats, the watershed is home to an abundance of wildlife. In 2003, Buffalo Creek Valley was named the 80th Important Bird Area in Pennsylvania, and at least 20 bird species found within the watershed are considered to be declining or of conservation concern. Factors contributing to the IBA's designation included the watershed's role in supporting significant populations of wading and migratory forest-interior birds, and its variety of habitat types exemplary of the region. At least five bird species found in the watershed are on the Audubon Watch List of Birds of Concern. Additionally, recent surveys conducted in partnership with Westmoreland Bird and Nature Club and Three Rivers Birding Club identified over 39 species of butterflies and 21 species of odonates (dragonflies/damselflies). These included the bronze copper, a butterfly of special concern in Pennsylvania, and the Milbert's tortoiseshell, a Washington County record. Uncommon odonates identified included the calico pennant, citrine forktail, and wandering glider. During the development of the plan, 14 new species of amphibians or reptiles were identified within the watershed. This included a county record for the eastern spiny softshell turtle and a potential county record for Fowler's toad. Numerous box turtles were encountered, as well as woodfrogs and spring salamanders. No formal investigation of mammals was conducted for this plan. However, it is estimated that at least 45 of the 70 mammal species found in Pennsylvania can be found within the watershed.

Photo Courtesy of Matt Sarver

WPC conducted limited surveys of fish, macroinvertebrate, and mussel populations during the development of the plan. It was found that the watershed contains macroinvertebrates common to agricultural streams in the southwestern United States. Fish sampling identified 48 species, of which 18 percent were found to be non-native, introduced species. The most common species identified was the creek chub, and many species were considered to be characteristic of lake or reservoir systems. Popular sport fish, such as largemouth and smallmouth bass and rainbow trout were also identified. A review of available mussel information showed that the watershed once contained diverse mussel communities indicative of high water quality. Indications are that many of these species have now disappeared or have low populations. One species that may still remain is the paper pondshell. It is not considered threatened or endangered, but is rather rare in Pennsylvania.

Five species of concern have been identified within the Buffalo Creek watershed, including one species from the Pennsylvania portion and five from the West Virginia portion. The bronze copper butterfly is considered imperiled in Pennsylvania. In West Virginia, the hellbender salamander, slender wheatgrass, barn owl, and meadow jumping mouse are considered to be of concern. The barn owl is considered of highest concern, with the ranking of critically imperiled. Both the meadow jumping mouse and hellbender are also found in the Pennsylvania portion but are not considered of concern in the state.

One of the goals for the plan was to identify additional areas of conservation concern, both on public and private lands. The term "Watershed Conservation Areas" was given to areas deserving of special conservation consideration because of their unique species assemblages and natural communities. Identified areas are located in proximity to Dog Run, Narigan Run, Welch Run, Buck Run, Dutch Fork Lake, and Green Cove Wetland. Several of these areas are within State Game Lands 232. Common threats to these areas include inappropriate forestry management and invasive species. WPC also used Geographic Information Systems and on-the-ground investigations to identify high quality forest blocks within the watershed. These are healthy forest areas exceeding 100 acres. Because such forest areas are limited within the watershed, they are essential to protecting the area's IBA designation and its importance for wildlife. Included in these are areas named "Sugarcamp Run tract," "Dog Run tract," "Polecat Hollow tract," "Dutch Fork Lake tract," and "Chapel Hill Road tract" for their proximity to certain natural or manmade features. Several sites were considered to be both Watershed Conservation Areas and high quality forest blocks.

Key needs for protection of natural resources and biodiversity within the watershed are the conservation of high quality forest areas and riparian zones, prevention of invasive species, reduction of sediment to Buffalo Creek and its tributaries, and maintenance of hydrological cycles.

Currently, most of the forested areas are in an early-successional state and are not adequate to support migratory forest-interior birds. Most of the higher quality forest is located in State Game Lands 232. However, management plans developed by the Pennsylvania Game Commission do not adequately address the requirements of these species, many of which require older-aged stands and a layered canopy structure. Maintaining a core area of State Game Lands 232 in mature, uneven-aged forest will be important for protecting forest-interior bird species, whose presence is a key reason for the designation of the Important Bird Area. Other areas of State Game Lands 232 could continue to be harvested and kept in even-aged management. Additionally, many private forest owners within the watershed are not aware of available sustainable forestry options available to them. For example, some logging practices can cause enough light to penetrate through the canopy to encourage the spread of species such as multiflora rose and ailanthus. This can have a negative effect on wildlife and reduce the value of the forest for future logging. Invasive species can also be carried in on logging equipment and affect the future health of a forest.

Removal of riparian zones, especially along headwater streams, is likely one of the main contributors of sediment to Buffalo Creek. Grazing on steep slopes and lack of best management practices near streams are also contributing factors. Sediment can affect the survival of mussels, fish, and other aquatic organisms. The Natural Resources Conservation Service, Partners for Fish and Wildlife, and other programs provide financial assistance to landowners who use best management practices or keep marginal (i.e. steeply sloped or near streams) land out of production.

## Water Quality Assessment

The entire Buffalo Creek watershed is a DEP-designated High Quality Warm Water Fishery. This is the highest designation that can be given to a warm-water fishery. Its High Quality designation grants it special protection under the Clean Water Act. However, prior to this study, little up-to-date water quality information existed for the watershed. One exception includes observations by the Fish and Boat Commission and others suggesting that sedimentation and nutrients may be threatening water quality. In the Water Resources section of the plan, WPC provides previously collected water quality information and the results of recent stream surveys of the

chemical, biological, and physical health of the watershed's streams. The significance of the watershed's High Quality designation and other laws protecting water quality are also discussed.

Important components of water quality include floodplains, riparian zones (vegetated stream edges), groundwater, and stormwater. Many people do not realize that maintaining vegetation along streams and leaving floodplains undeveloped can help prevent flooding. Riparian zones help retain groundwater during dry periods and prevent bank failures and soil loss during flood events, while floodplains dissipate energy from high flows. In addition, groundwater is linked to stream water quality because streams are essentially where groundwater comes to the surface. Because of this, polluted streams can cause polluted groundwater. The reverse is also true.

High Quality streams are those that are able to accommodate all DEP-designated uses, including aquatic life, fish consumption, shellfish harvesting, drinking water supply, primary contact recreation (swimming), secondary contact recreation, and agriculture. If a stream in a high quality watershed does not meet one of these uses, DEP is required by United States Environmental Protection Agency to put in place measures to restore it to these uses. Direct pollutants, or point sources, are not permitted if they violate these designated uses. Total Maximum Daily Loads (TMDL) are studies that identify the maximum amount of pollution that can enter a stream in order to meet water quality standards. In 2001, DEP studied macroinvertebrate populations, an indicator of stream health, and found that four sections of the watershed are not meeting water quality standards. These included 1) a section of Dutch Fork Creek, 2) a tributary to Bonar Creek, 3) a tributary to Buffalo Creek South, and 4) a section of Buffalo Creek near the S-Bridge. TMDLs must be developed for the tributary to Buffalo Creek South and the section near the S-Bridge, but will not be developed for the other two because they are a result of point sources (Figure 3-2). Point sources are discharges to a waterbody that are direct and identifiable. In the case of point sources, DEP imposes fines or works with polluters to reduce pollution levels. Eight National Pollution Discharge Elimination System (point source) permits have been issued for the Pennsylvania portion of the watershed and numerous permits have been issued for the West Virginia portion.

Besides DEP's recent sampling, other water quality information available includes United States Geological Survey sampling conducted from 1983 through 1985, Pennsylvania Fish and Boat Commission fish surveys in 1983 and 1992, California University graduate projects measuring chemical and biological parameters in 2001 and 2003, and chemical information from 14 groundwater wells sampled in 1983. Generally, the streams within the watershed have high levels of alkalinity, which can buffer against acidic conditions such as acid rain and mine drainage. However, this high alkalinity can also contribute to algal blooms under high nutrient conditions, which can have a negative effect on stream organisms. Though past mining within the watershed has been limited, groundwater is extremely prone to metal contamination where mining activities occur.

Recent efforts to improve water resources within the watershed include the Buffalo Creek Watershed Restoration Project, a partnership between National Fish and Wildlife Federation and multiple organizations to fund and implement best management practices on private land. At the beginning of the project, it was determined that there was a need to treat 10,000 acres of pasture, 1,000 acres of riparian corridor, and to stabilize 40 miles of streams in the northern portion of the watershed. To date, the project has fenced over 27 miles of streams, protected over 90 acres of wetland, created 45 livestock crossings, and planted over 311 acres of warm season grasses. Farmers interested in this program can contact the Partners for Fish and Wildlife office at California University of Pennsylvania.

Additional efforts within the watershed include a Partners for Fish and Wildlife stream restoration project, which improved a section of stream for fishing and wildlife on Buffalo Creek; the Dirt and Gravel Roads Program offered to municipalities by the Washington County Conservation District; and soil and erosion control and other permitting through the conservation district.

WPC's watershed assessment involved investigation of water flows, chemistry, macroinvertebrate populations, fish populations, and general stream health. It was found that stream discharge varied greatly throughout the sampling period, with extremely low flows in the summer. This is possibly due to high groundwater withdrawals, removal of streamside vegetation, and the geological characteristics of the watershed. The watershed is prone to extreme flood events and continued monitoring is needed. Related to chemical health, WPC found that water quality standards were met the majority of the time. However, probable water quality problems were identified at sites including Buffalo Creek near the S-Bridge, at the mouth of Dunkle Run, in an agricultural tributary of Brush Run, in Buffalo Creek near Taylorstown, and in Dutch Fork Creek before entering former Dutch Fork Lake. Four sites out of 51 exceeded pH standards, which is possibly caused by nutrient enrichment. Additionally, fecal coliforms exceeded standards 13 out of 16 times. This group of bacteria found in the intestines of humans and other animals may carry harmful microorganisms and is related to livestock access to streams and faulty on-lot septic systems.

WPC collected macroinvertebrates at six sites within the watershed, which were different from sites sampled by DEP. It was found that two of these sites were impaired due to high levels of organisms tolerant to pollution. These findings suggest that two sections designated as "impaired" by DEP, namely Buffalo Creek near Taylorstown and Dutch Fork Creek downstream of Claysville, may need to be extended upstream and that further investigation should be made into the sources of these impairments. The portion of Dutch Fork Creek downstream from Claysville, which is currently not scheduled for a TMDL, should be re-evaluated. Currently, the only waterbody within the watershed for which a TMDL has been completed is Dutch Fork Lake Reservoir, and this is not entirely applicable because the reservoir has been drained.

In addition to chemical and macroinvertebrate sampling, WPC conducted visual assessments of all accessible streams within the watershed. Accessible streams were those that could be evaluated from nearby roadways or on foot, with the permission of the landowner. Streams were evaluated based on 10 parameters, including channel condition, riparian zone, bank stability, water appearance, nutrient enrichment, fish barriers, instream fish cover, invertebrate habitat, canopy cover, and embeddedness (sedimentation). The area with the highest, or best, score was Lower Buffalo Creek subwatershed. This includes all streams entering Buffalo Creek west of where its meets Buck Run and Brush Run. Tributaries to Buck Run also received a high average score. The lowest scoring area was Buffalo Creek East, which is basically all streams entering the east branch of Buffalo Creek before it meets Buffalo Creek South at the intersection of Route 221 and Route 3009. The lowest scoring parameter overall was embeddedness (sedimentation) and the second lowest scoring parameter was instream fish cover. Nutrient enrichment and bank stability often received low scores in areas where embeddedness was high.

The visual assessment suggests that the biggest contributors of sediment to streams within the watershed are bank erosion from cattle access to streams and steep slopes and the removal of riparian zones. In the tributaries to Brush Run and Dunkle Run, extensive streambank fencing and use of best management practices are decreasing sediment loads. However, there are portions of the watershed where these practices are lacking. This is particularly noticeable in the Buffalo Creek East and Castleman Run subwatersheds, which are highly agricultural. There are many programs offered by the United States Department of Agriculture and other agencies that can help farmers develop best management practices on their properties. One such program is the Conservation Reserve Enhancement Program, which pays farmers to keep marginal land, such as streamsides and steep slopes, out of production. Many areas of Buffalo Creek are a high priority for this program because of the high number of marginal areas and the watershed's High Quality designation.

Faulty on-lot septic systems may also contribute sediment and nutrients to streams. The stream surveys, including the high levels of fecal coliform bacteria, suggested that there are numerous faulty systems in the watershed. Under no circumstances are direct sewage discharges to streams legal. Municipalities should be encouraged to follow local 537 plans (which detail needed future improvements) and enforce upgrades to on-lot systems, if this is a requirement of their plans.

One of the biggest concerns encountered during this assessment was the lack of landowner awareness. Many landowners thought that removing riparian zones (or streamside vegetation) and straightening the stream would improve conditions during flooding, when these activities more commonly make conditions worse by increasing the amount of runoff entering streams and decreasing the capability of streams to transport sediment during flood events, which causes bank failures. Municipalities could encourage the revegetation of riparian zones by offering tax incentives or other benefits to those who maintain these zones and by stating the benefit of these areas in municipal planning documents.

## Outdoor Recreation and Tourism

Outdoor recreation is becoming increasingly popular within the watershed. Many people come from outside the watershed to enjoy its natural settings. Visitation has increased with the nomination of the Buffalo Valley Important Bird Area, which brings frequent visits from bird enthusiasts. Other recreational opportunities exist, including hunting, fishing, biking, and hiking. State Game Lands 232 is considered one of the best public hunting areas in the region. The Pennsylvania Game Commission recently created four wetlands on State Game Lands 232 and maintains fields to support wild game, with crops such as corn, sorghum, buckwheat, rye, millet, and oats. In addition, fishing is available at Pennsylvania Fish and Boat Commission trout-stocked and artificial lures only sections of Buffalo Creek and Dutch Fork Creek. In the West Virginia portion, a trout-stocked section of Buffalo Creek is maintained near the border with Pennsylvania. Additional fishing and hunting opportunities are available at the nearly 500-acre Castleman Run Wildlife Area in West Virginia.

Before Dutch Fork Lake Reservoir was drained in 2004, this trout-stocked lake was extremely popular for fishing. Interviews conducted with visitors to the lake in 2003 found that most people visited from outside the watershed and that some came up to 50 times a year. If the reservoir is restored, some considerations cited by visitors were the lack of litter control, the poor quality road and lack of business facilities at the farthest access (which was also the favorite), and the possibility for campgrounds or bait shops in the area.

Residents of Donegal Township have been working to open a trail along the old Baltimore and Ohio Railway, which travels through the southern portion of the watershed. Unfortunately, due to ownership issues, this has not yet been possible. However, in the future, such a trail could increase opportunities for biking and walking. This trail could also provide an alternative route for bikers traveling along the "S" bike route, which travels through the watershed along historic Route 40.

Though visitors generally like the watershed for its remoteness and rural character, many have suggested the benefits of a public bathroom facility on State Game Lands 232 or at the S-bridge historic site. Others suggested that local restaurants or stores for visitors would be beneficial. In many cases, visitors would prefer not to leave the area to have access to bathrooms or restaurants. However, they also noted that large, chain stores would detract from the quaintness of the area.

Baseball parks and community parks are present, though not abundant, within the watershed. Several municipalities suggested the need for these parks to serve residents and suggested that funding was a limitation to having additional open space.

# HISTORY OF THE BUFFALO CREEK VALLEY

*Contributors: Michael A. Vacca and Ron Eisert*

## The Importance of History

Debate exists over the origin of the name "Buffalo" Creek, although some believe that the general area was named for an old buffalo trace passing through it, which later become part of the Historic National Road. Whatever the origin, it is clear that Buffalo Creek watershed has a diverse history, from its importance in supporting early North American travelers, to its role in the Revolutionary War, to its place along the earliest transcontinental road, and finally to its location as the birthplace of the largest religious movement originating in the United States. Throughout this time, the people of the watershed depended on its streams and wildlife resources for their livelihoods.

Members of the Buffalo Creek Watershed Association and Buffalo Valley Alliance feel that there is a need to continue exploring and documenting this history and its inextricable link to the natural resources in the area. The potential also exists to utilize this heritage to promote eco-tourism opportunities in the area. For this reason, the following section, much of which was developed using contributions of two local historians, discusses some notable historical events and sites leading to the settlement of the Buffalo Creek valley.

## Earliest Human Travelers

Archaeological evidence in and around the Buffalo Creek watershed suggests that this area had a role in supporting early North American civilizations. Only miles away from the watershed, in the town of Avella, is the Meadowcroft Rock Shelter, an archaeological site considered to be one of the first places of human habitation in the United States. The rock shelter was a stopping-off point for prehistoric nomadic peoples and was occupied since at least 12,000 B. C., until Native Americans abandoned it during the Revolutionary War. Archaeological evidence suggests that nomadic tribes stopped periodically in the Buffalo Creek watershed to the south, depending on resources along Buffalo Creek and its floodplain.

## Europeans Settlers Arrive in Buffalo Creek Valley

At the dawn of the historical period of Pennsylvania, various Native American tribes, including the Iroquois who owned almost all of the land, inhabited most of the eastern portion of the state. Other tribes, such as the Delaware and Shawnee, used the land by permission of the Iroquois. The western portion of Pennsylvania was used primarily as hunting grounds and as a highway for war parties, but was not permanently inhabited. This included the area between the Susquehanna Valley and the Ohio Valley.

William Penn and the Pennsylvania Assembly (formerly the Provincial Council) entered into numerous treaties with the Six Nations of the Iroquois to obtain land that would ultimately be settled by early European and English colonists. These treaties continuously forced the Delaware and Shawnee to migrate westward. By the 1720s, these peoples had permanent villages at places like Ambridge, New Castle, and Kittanning. However, there is no historical record or archaeological evidence that these native groups permanently lived in the Buffalo Creek watershed of Washington County.

The most important treaty was the Treaty of Fort Stanwix in 1768. The treaty conveyed to Pennsylvania all land extending from the New York border, up to the West Branch of the Susquehanna River, over to Kittanning, and as far south as the mouth of the Tennessee River. The Delaware and Shawnee did not agree with this sale of their hunting grounds by the Iroquois. For this purchase, Pennsylvania acquired parts of 18 counties and nine entire counties, including Washington County. Pennsylvania and Virginia both recognized claims for farms up to 400 acres on these lands, and land was offered as a reward for military service after the French and Indian War. Thousands of claims were filed.

The Buffalo Creek valley, similar to the rest of western Washington County, was devoid of mountains. However, it was rugged, hilly, and uneven with deeply forested valleys and irregular uplands that had the potential to be highly fertile and productive. Early settlers were faced with the challenge that this wilderness presented, as well as the challenge of facing the native peoples that had been pushed into the area. The first records of settlers on Buffalo Creek were in 1770 and 1771. Mr. James Caldwell is recorded as one of the earliest settlers. Most settlers were of English or Scotch-Irish decent, with names like McGurie, Carpenter, Williamson, Smith, Taylor, Wells, Carlson, and Doddridge. Germans settled along Dutch Fork Creek, with names like Ault, Wolff, Stricker, Hupp, Ricer, Winter, and Leffler. Thomas Clark was the first to settle Dutch Fork Creek in 1773.

## Revolutionary War Forts

During the Revolutionary War (1775-1783), Washington County (known as part of Westmoreland County until 1781), was one of the most exposed areas of frontier. The closest regular continental troops were at Fort Pitt (Pittsburgh), Fort McIntosh (Beaver), Fort Henry (Wheeling, WV), or Holiday's Cove (present day Weirton, WV). The settlers were compelled to defend themselves from attacks by British-allied Native Americans from across the Ohio River. Present day Washington County had approximately 40 frontier forts, making it one of the most heavily fortified counties in United States history. Most of these consisted of a "blockhouse" or some kind of fortified house. Of these 40 forts, at least eight were located in the Buffalo Creek watershed. These include Wolff, Stricker, Taylor, Williamson, Lamb, River, Miller, and Doddridge forts. Teeter's Fort in Independence Township and Reynold's Fort in Cross Creek Township were located near the watershed's northern boundary. A brief description of prominent forts found within the watershed follows:

<u>Wolff's Fort</u>: Located in Buffalo Township along Route 40, Jacob Wolff settled here on 200 acres in the 1770s. This large fort consisting of a stockade fence surrounding Wolff's cabin was well utilized by the frontiersmen and women during Native American raids.

<u>Stricker's Blockhouse</u>: Located in Buffalo Township approximately 1.5 miles south of Wolff's Fort and off of East Buffalo Church Road, this fort consisted of two blockhouses on a property of 369 acres.

<u>Taylor's Fort</u>: Located in Blaine Township about 1.5 miles north of Taylorstown on State Route 221, this fort overlooked Buffalo Creek and was adjacent to Walker Hill Bridge. Robert Taylor, a captain in the Pennsylvania militia, owned 331 acres adjacent to the fort side, which is the present day location of the village of Taylorstown.

<u>Williamstown Station</u>: Located in Blaine Township approximately four miles north of Taylorstown on Camp Buffalo Road, this fort consisted of a triple log cabin structure and a springhouse. Lt. Colonel David Williamson owned this fort, along with 376 acres. Williamson is probably one of the most significant figures to settle in the Buffalo Creek watershed and is best known as the leader of the famous Gnadenhutten Expedition.

<u>Lamb's Fort</u>: Frederick Lamb erected this log structure, located in Independence Township on State Route 331, in 1774.

<u>Rice's Fort</u>: Around 1774 Jacob Rice settled a 400-acre tract of land currently located in Donegal Township on Lake Road. His fort consisted of three square log blockhouses connected to each other at different angles. Rice's Fort was a refuge for 12 families in the immediate area and was well used throughout the Revolutionary War. This fort was the last attack made by the Britsh-allied Native

Americans during the Revolutionary War, when it successfully repelled attacks from over 70 Native Americans.

Miller's Blockhouse: Located on the site of the recently drained Dutch Fork Lake Reservoir, Jacob Miller settled 400 acres of land on this site in the 1770s. There is much documented action at this fort, which was used as a rendezvous point for scouts and rangers. A notable attack was the heroic defense of the blockhouse for over 24 hours by Ann Hupp after both her husband and father were killed by hostile Native Americans.

Doddridge's Fort: Located in Independence Township near the intersection of State Route 844 and Sugarcamp Run Road, this site was situated on a ridge dividing the Cross Creek and Buffalo Creek valleys. John Doddridge settled this area in 1773. This large, substantial fort provided refuge for 12 families and was still standing in 1913.

## A Chronology of Events

Numerous events during the 1700s led to the settlement of the Buffalo Creek valley. A brief chronology listing these events is provided below.

| | |
|---|---|
| 1724 | Delaware tribes begin westward migration and settle in Kittanning.<br>Shawnee begin westward migration. |
| 1754 | French advance down the Allegheny Valley, occupy the forks of the Ohio, and begin to erect Fort Dusquesne.<br>French and Indian War begins. |
| 1756 | Pennsylvania declares war against the Delaware and Shawnee. Rewards given for Native American scalps. |
| 1758 | French abandon Fort Dusquesne and British take possession (Fort Pitt). |
| 1763 | Peace treaty ends French and Indian War. |
| 1764 | Delaware and Shawnee submit; Pontiac's War ends. |
| 1768 | Treaty of Fort Stanwix is signed and immigrants from eastern Pennsylvania, Maryland, and Virginia begin to legally occupy western Pennsylvania. |
| 1770 | First settlement appears in Buffalo Creek valley. |
| 1771 | Two more settlements appear. |
| 1772 | Jessie Martin settles in present day Hopewell Township on 405 acres in the Brush Run-Buffalo Creek area. |

| | |
|---|---|
| | Thomas Clark settles on Dutch Fork and James Caldwell settles on Buffalo Creek. |
| 1773 | John Doddridge erects fort on Sugarcamp Run in Buffalo Creek valley in Independence Township. |
| | Sam Buchman settles 300 acres on Buffalo Creek in Independence Township. |
| | Charles McRoberts settles on the mainstem of Buffalo Creek in Buffalo Township. |
| 1774 | William Smiley settles in Hopewell. |
| | Jacob Lefler settles in Donegal. |
| | Ezekial Boggs settles in present day Blaine Township. |
| | Frederic Lamb builds fort on Buffalo Creek in Independence Township. |
| | Rice's Fort is established on Dutch Fork Creek. |
| | Beginning and end of Lord Dunmore's War. |
| | Pioneers of the Buffalo Creek valley fortify themselves. |
| 1775 | American Revolutionary War begins. |
| | Thomas Chapman settles in Donegal on Dutch Fork Creek. |
| | British enlist Delaware, Shawnee, and other western tribes to attack along the frontier. |
| | Col. David Williamson erects fort on land he owns along Buffalo Creek (Blaine). |
| | 8th Pennsylvania Regiment created to defend western frontier. |
| 1777 | 8th Pennsylvania Regiment marches to join the Continental Army in the east, leaving the western frontier exposed to Native American attacks. |
| | British Army orders their allied Native Americans to attack the western frontier, and places bounties for Native American scalps. |
| 1778 | Native American attacks occur in counties surrounding Washington County, within the western frontier. |
| | 8th Pennsylvania Regiment marches to defend western frontier. |
| 1779 | Native Americans attack Reynold’s Fort, killing and scalping his wife and child. |
| | Native Americans outraged in Washington County. |
| | Robert Taylor purchases land and builds a fort near site of present day Taylorstown. |

1780 Native Americans attack at Raccoon Creek, Chartiers Valley, Ten Mile Creek, West Findley, and Robinson Township.

1781 Native Americans attack Raccoon Creek.

Attack at Jon Lin's cabin near West Alexander and the cabin of Presley Peake on Buffalo Creek; several pioneers killed and captured.

Col. David Williamson leads Washington County Militia (many of whom reside in the Buffalo valley) on the infamous Gnadenhutten Massacre campaign.

Miller's Blockhouse attacked at Dutch Fork.

Priscilla Peake is scalped, escapes death, and makes her way to Wolff's Fort in Buffalo Township.

Col. Williamson leads an orderly retreat of Washington County Militia after they are defeated by hostiles on the Sandusky Plains of Ohio. Col.William Crawford, commander, is brutally tortured and burned at the stake.

1783 Uprisings continue in Washington County.

Revolutionary War ends.

1784 Inhabitants of Buffalo valley petition the Washington County court for, "A road from Washington to the state line, intersecting with the Wheeling Road."

Native American raids continue in Washington County as post-Revolutionary War border warfare continues.

Thomas Walker purchases land where present-day Claysville sits.

Native American attacks in Washington County gradually end in the years leading up to 1795. Raids continue at a reduced rate in surrounding counties as the hostiles, U. S. Army, and militia battle in the lands of Ohio.

Washingon County court, in the December session, orders a road to be built from Valentine's Mill on Indian Camp Run, to the mouth of Buffalo Creek.

1795 William Taylor buys land from his father, upon which the plat for the new town New Brunswick (Taylorstown) is laid out.

Buffalo Creek valley has not had a hostile incident since 1783. People settle into their lives as blacksmiths, carpenters, etc.

James Martin and Samuel Gill purchase adjacent parcels of land at the present-day site of West Middletown.

Western tribes capitulate and sign the Treaty of Greenville, signifying the end to all warfare in western Pennsylvania and the Ohio Valley.

Sixty years (1775 to 1835) of border warfare endured by the pioneer settlers of the Buffalo Creek valley ends.

1796 Robert Humphreys purchases 400 acres in western Donegal Township near the West Virginia border. Here he lays out the site for a town he named West Alexander, in honor of his wife Martha Alexander.

## Early History of Local Towns

### Claysville

Claysville was a town that emerged to accommodate the needs of travelers on the National Road. Acreage in what is now the borough of Claysville was originally purchased by Thomas Walker in 1785. Walker sold his 400-acre parcel to John Purviance, and in 1800, Purviance opened a tavern in a large, two-story log cabin along the new Wheeling Road (predecessor of the National Pike Road, or U. S. Route 40). Purviance advertised lots in 1817, in anticipation of the construction of the National Road, and attracted numerous businesses. Among the first to settle in Claysville were Samuel Sherr, William Brownlee, and James Sawhill. Claysville became an incorporated borough on April 2, 1832.

### Taylorstown

In the spring of 1875, William Taylor purchased a tract of land from Robert Taylor, his father and builder of Taylor's Fort. Taylor sold lots on his land, which he named New Brunswick. After selling 214 acres to Thomas McKinstry in 1807, New Brunswick became known as Taylorstown. When oil was discovered in the 1800s, Taylorstown became the most prosperous town in Washington County.

### West Middletown

West Middletown, a portion of which lies within the watershed's borders, was one of the most important stations of the Underground Railroad preceding the Civil War. James Brown, the famous abolitionist, preached in the town and underground tunnels can still be found between some of the houses. The family of Robert Fulton, inventor of the steamboat, lived in Hopewell Township near West Middletown.

## Religious Movements

The Buffalo Creek valley is the birthplace of the restoration movement, the largest religious movement originating in the United States, which was the basis for the Disciples of Christ or Christian Church denomination. Several other church denominations have a long history in the watershed.

The restoration movement in the United States was initiated as a response to human-created doctrine and authority. It grew out of the joining of two Presbyterian ministers, Barton W. Stone and Thomas Campbell, individuals whose liberal views at the time included the right to serve communion to Christians of other denominations and the longing for a return to simple teachings of the scripture, with each person interpreting the bible for himself/herself. This denomination began with the establishment of the "Christian Association of Washington, PA" within the Buffalo Creek watershed on August 17, 1809 and the building of a worship house in the Brush Run valley.

| Historical Religious Events | |
|---|---|
| 1778 | Reverend Matthew Henderson organizes a congregation under the name "Buffalo." Their creed: "Trust in God and keep your powder dry." This church was renamed "The North Buffalo United Presbyterian Church" in 1811. |
| 1788 | 1. Lower Buffalo Presbyterian Church organized in Independence Township.<br>2. Presbyterian Church of West Alexander is formed. |
| 1800 | Zion Chapel of United Brethren Church forms in Donegal Township. |
| 1809 | Thomas Campbell forms "The Christian Church Association of Washington, PA" in Brush Run valley. |
| 1811 | 1. South Buffalo Presbyterian Church forms.<br>2. First baptisms performed by the Campbells in a deep pool of Buffalo Creek. |

Thomas Campbell's son, Alexander Campbell, is considered the principal founder of the movement, and its followers are often called "Campbellites." Baptisms, which are essential to the faith, were conducted on the David Bryant Farm in a deep pool of Buffalo Creek. This site is now located in proximity to the Green Cove Wetland Area owned by the Pennsylvania Game Commission.

In 1818, Alexander Campbell opened his Buffalo Seminary, a school for young men to learn the teachings of the church. In 1840, he founded Bethany College, at nearby Bethany, West Virginia with the hopes of sending out advocates to spread the word of God. The denomination has split several times over the years into the Independent Christ Churches, Churches of Christ, and Disciples of Christ (Christian Church). The Christian Church has remained in the forefront of social activism, has a global network of missions coordinated by the Christian Missionary Society, and maintains two colleges, Bethany College and Transylvania College in Lexington, Kentucky. There are more than 800,000 members of the Christian Church in the United States and Canada. Bethany College is located in the West Virginia portion of Buffalo Creek watershed.

## McGuffey Reader

The McGuffey Reader is likely the best known series of school books in the history of American education. It is estimated that at least 120 copies of McGuffey's Readers were sold between 1836 and 1960. The author of the reader, William Holmes McGuffey, was born in 1800 near Claysville, Pennsylvania but moved to Youngstown, Ohio as a child. McGuffey was eventually appointed Professor of Languages at Miami University in Oxford, Ohio and went on to hold a series of esteemed positions at other universities in the eastern portion of the U.S. In 1827, the Cincinnati firm Truman and Smith hired McGuffey to create the series of four graded Readers for primary level students. Harriet Beecher Stowe recommended him for the job. McGuffey High School bears the name of this notable original resident of the watershed.

## Important People

Among the most significant individuals in the history of the Buffalo Creek valley, many of whom have been recognized in this chapter, are Thomas and Alexander Campbell, John and Joseph Doddridge, Anne Hupp, the Honorable Hugh Brackenridge, Esq., Captain Robert Taylor, Captain Isaac Cox, John W. Garrett, Thomas and Matthew McKeever, General Wallace McWilliams, and Colonel David Williamson.

One of the most notable is David Williamson. David Williamson convinced his parents and family to relocate west to Blaine Township in 1773. Williamson was a true frontiersman with a military career spanning over 20 years. He fought the Shawnee in Dunmore's War in the Battle of Point Pleasant in 1774, was the colonel in the 1st Moravian Campaign to the Muskingum River towns in Ohio, and in 1782 led the famous Gnadenhutten Massacre of Christian Delaware Native Americans. Later on in life, Williamson faced great difficulty. He was elected sheriff of Washington County in 1787. But, between 1790 and 1805 Williamson was in court for debt over two dozen times. He died in jail in 1809, after which he was buried with full military honors in the old Washington County Cemetery.

## National Historic Sites

The National Register of Historic Places is the nation's official list of cultural resources worthy of preservation. Authorized under the National Historic Preservation Act of 1966, the National Register is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect our historic and archeological resources. Properties listed in the Register include districts, sites, buildings, structures, and objects that are significant in American history, architecture, archeology, engineering, and culture. The National Register is administered by the National Park Service, which is part of the U.S. Department of the Interior. There are nine National Historic Sites located within the boundaries of the Buffalo Creek watershed:

<u>S-Bridge</u>: Thought to have developed from an old Buffalo trace, the National Road was the first multi-state federally funded highway and is considered by many to be the most historic road in the United States. Exemplary of the stone masonry of its day, the S-Bridge carried travelers along the National Road and was located across from Kelly's S-Bridge Tavern. It was built in 1815.

<u>Montgomery House</u>: An exemplary Italianate house located along the National Road in Claysville, and built in 1880.

<u>Margaret Derrow House</u>: A historic gothic revival house along the National Road, built in 1855.

<u>Valentine House</u>: A dwelling that housed travelers on the National Road.

<u>Taylorstown Historic District</u>: This historic town, which is itself considered a national historic site, retains many of its 19th century buildings exemplifying the Greek Revival architecture in the United States at the time of its settlement. It was the most prosperous town in Washington County during part of the 1800s.

<u>Sawhill Covered Bridge</u>: An example of covered bridge architecture in Washington County built in 1915.

<u>Bridge Over Buffalo Creek</u>: A Historic bridge over Dutch Fork Creek.

<u>Acheson Arch</u>: A historic bridge over Brush Run.

<u>West Middletown Historic District</u>: This historic town, considered a national historic site, retains many of its 19th century buildings exemplifying the Greek Revival architecture in the United States at the time of its settlement. It was one of the most significant stations of the Underground Railroad.

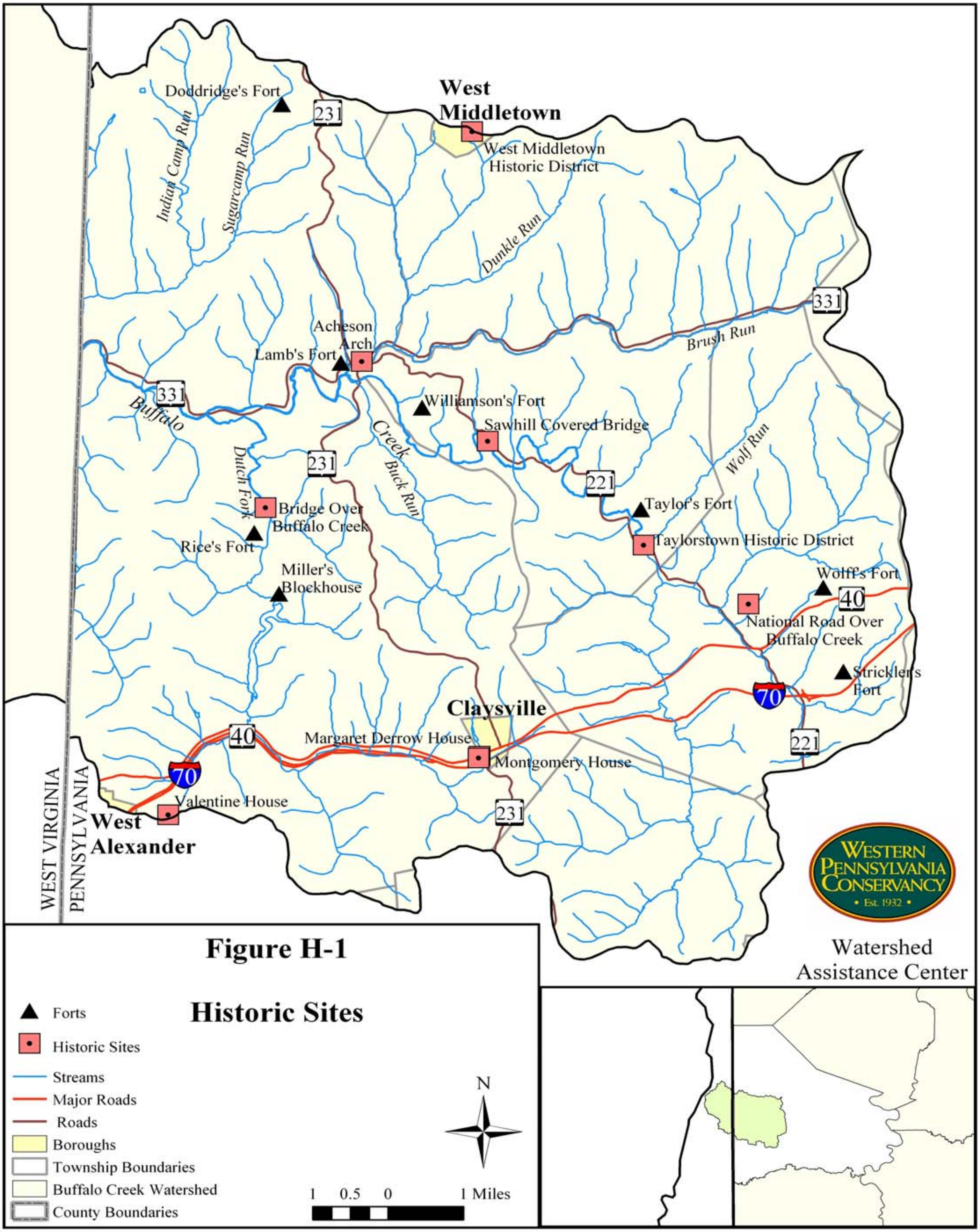


**Figure H-1**

**Historic Sites**

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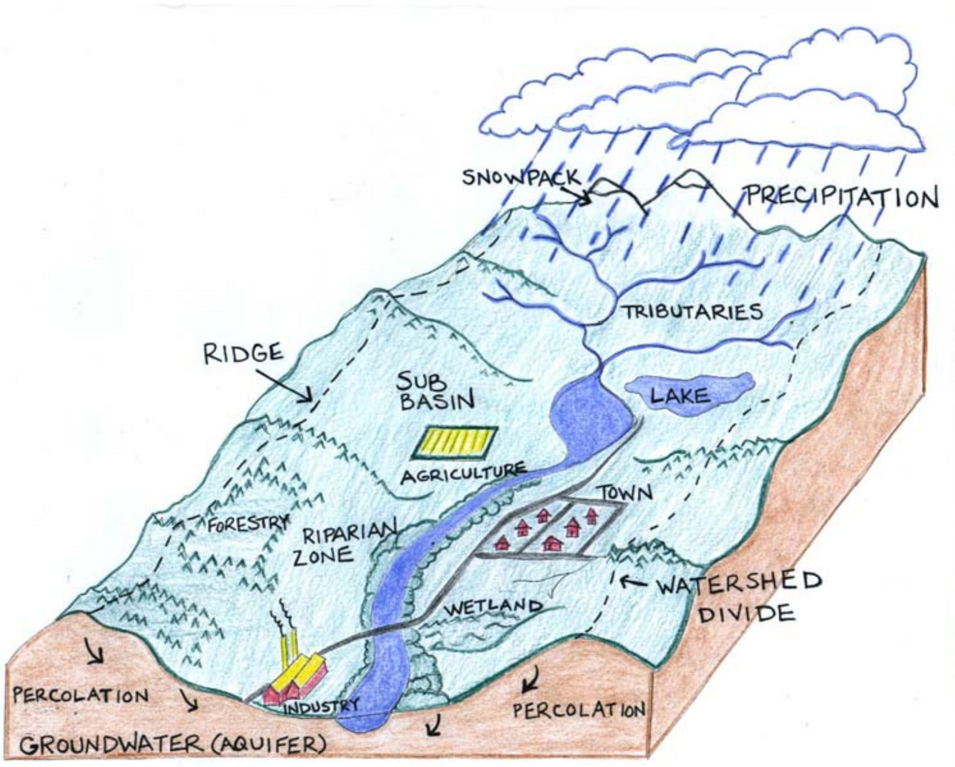
# PROJECT AREA CHARACTERISTICS

## Watershed Characteristics

### What is a Watershed?

A watershed can be defined as the area of land that drains to a particular stream. Each stream has its own watershed. Topography is the key element affecting this area of land. The boundary of a watershed is defined by the highest elevations surrounding the stream. A drop of water falling outside of the boundary will drain to another watershed. A watershed includes all of the people, places, and activities taking place in this area.




### Location and Size

The Buffalo Creek watershed includes the upper portion of the Buffalo Creek/Wheeling Creek watershed, which is ultimately a part of the larger Ohio River watershed, including all of the land draining into the Ohio River (Figure 1-1). It lies primarily in the West Middleton, PA United States Geographical Survey (USGS) topographical quadrangle, with portions extending to the Washington West, Prosperity, Claysville, Bethany, and Valley Grove quadrangles. The entire Buffalo Creek watershed, containing portions of Washington County, Pennsylvania and Brooke and Ohio counties in West Virginia, is approximately 164 square miles in size.

### Hydrology

#### *Hydrologic Unit Code*

The United States is divided and sub-divided into successively smaller hydrologic units, which are classified into four levels: regions, sub-regions, accounting units, and cataloging units. The hydrologic units are arranged within each other, from the smallest (cataloging units) to the largest (regions). Each hydrologic unit is identified by a unique hydrologic unit code (HUC) consisting of two to eight digits based on the four levels of classification in the hydrologic unit system (Seaber et al. 1987).

The eight-digit HUC for the Upper Ohio/Wheeling watershed, which includes Buffalo Creek and Wheeling Creek, is 05030106. The headwaters of Buffalo Creek originate at the vicinity of Pleasant Grove. Buffalo Creek then flows north until it merges with East Buffalo Creek at the intersection of Route 221 and State Route 3009. Buffalo Creek continues northwest into Brooke County, West Virginia, eventually emptying into the Ohio River in Wellsburg. The following describes the watershed's "hydrological address":

## HUC Code:

05 03 01 06

05: (region) All stream drainages eventually emptying into the Ohio River.

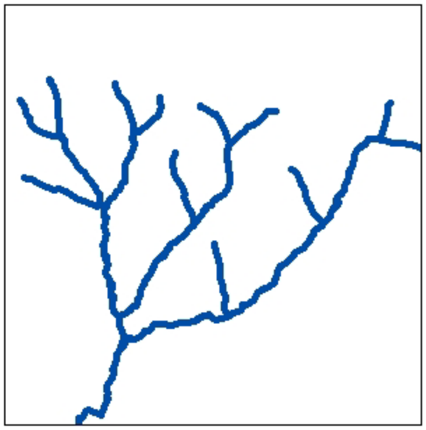
03: (sub-region) All stream drainages emptying in the Ohio River below the confluence of the Allegheny and Monongahela Rivers.

01: (accounting unit) All stream drainages below the confluence of the Allegheny and Monongahela Rivers to lock and dam 14.

06: (cataloging unit) The Buffalo Creek and Wheeling Creek drainages.

### *Water Movement*

The hydrologic characteristics of the Buffalo Creek watershed are particularly complex. Though the watershed receives a considerable amount of precipitation, generally greater than two inches each month, much of this precipitation is lost to streamflow and little is stored in the form of groundwater. The hillsides in the watershed serve as the most significant recharge areas, in which water is added to the system, and are considered "hydrologic islands." The highly permeable sandstone beds in the hillsides are alternated with largely impenetrable layers of limestone and shale. Because of the lack of pore space in the limestone and shale, called primary openings, water is forced to travel laterally until it discharges in the form of springs and seeps along the hillsides or encounters a fracture and travels vertically to discharge into stream valleys. The interconnected fractures in rock, caused by past mountain-building activity, are therefore the basis for most of the movement of the water in the watershed. Most of the water is transmitted from hillsides to valleys through the system by these secondary openings. This results in high movement of groundwater below the surface and "flashy" streams, in which large amounts of sediment and water are transported to streams during storm events. Groundwater yields are often low, except in areas with both high primary and secondary openings in rock, such as large sandstone areas and alluvial (or floodplain-deposited) areas (Newport 1973; Williams 1993).



***The dendritic drainage pattern of Dunkle Run subwatershed***

### *Drainage Patterns*

Drainage patterns are formed by the interactions between geology and topography within a landscape. Streams in Buffalo Creek primarily take on a dendritic drainage pattern, which closely resembles the branching of a tree if looked at from


**Figure 1-1**

**Buffalo Creek Watershed**

above. Dendritic patterns form when the geology of an area is relatively uniform, which is exemplified in the horizontal strata of sedimentary rock in the watershed (Berryhill et al. 1971). A primary example of this is the drainage pattern of the Dunkle Run subwatershed. During the formation of dendritic drainage patterns, streams split in an apparently random manner, producing stream patterns of no particular orientation. Some portions of the watershed, primarily those along steep valleys, also take on a trellis pattern, consisting of streams that join perpendicularly. This pattern can be seen in the subwatershed of Brush Run.

## Major Tributaries

The Buffalo Creek watershed contains eleven subwatersheds within the Pennsylvania portion (Figure 1-2). These subwatersheds include Buffalo Creek itself (Upper Buffalo East, Upper Buffalo South, Middle Buffalo Creek, Lower Buffalo Creek), and also the major tributaries (Sugarcamp Run, Dunkle Run, Brush Run, Castleman Run, Lower Dutch Fork, Buck Run, Upper Dutch Fork). Table 1-1 lists percentage area for each of these subwatersheds. Tributaries of Buffalo Creek in West Virginia include North Prong Run, Longs Run, Camp Run, Hukill Run, Mingo Run, Grog Run, Greens Run, Titt Run, and Painters Run (Figure 1-1).

**Table 1-1. Pennsylvania Subwatershed Areas**

| Subwatershed | Acres | % Area |
|---|---|---|
| Castleman Run | 2,299.783 | 3.174 |
| Buck Run | 3,604.057 | 4.974 |
| Lower Dutch Fork | 4,098.216 | 5.656 |
| Dunkle Run | 5,089.645 | 7.024 |
| Lower Buffalo Creek | 6,295.105 | 8.688 |
| Sugarcamp Run | 6,646.447 | 9.173 |
| Middle Buffalo Creek | 7,437.640 | 10.264 |
| Brush Run | 8,066.479 | 11.132 |
| Upper Buffalo Creek East | 8,105.870 | 11.187 |
| Upper Buffalo Creek South | 9,542.013 | 13.169 |
| Upper Dutch Fork | 11,274.715 | 15.560 |
| **Total** | **72,459.97** | **100** |

## Climate

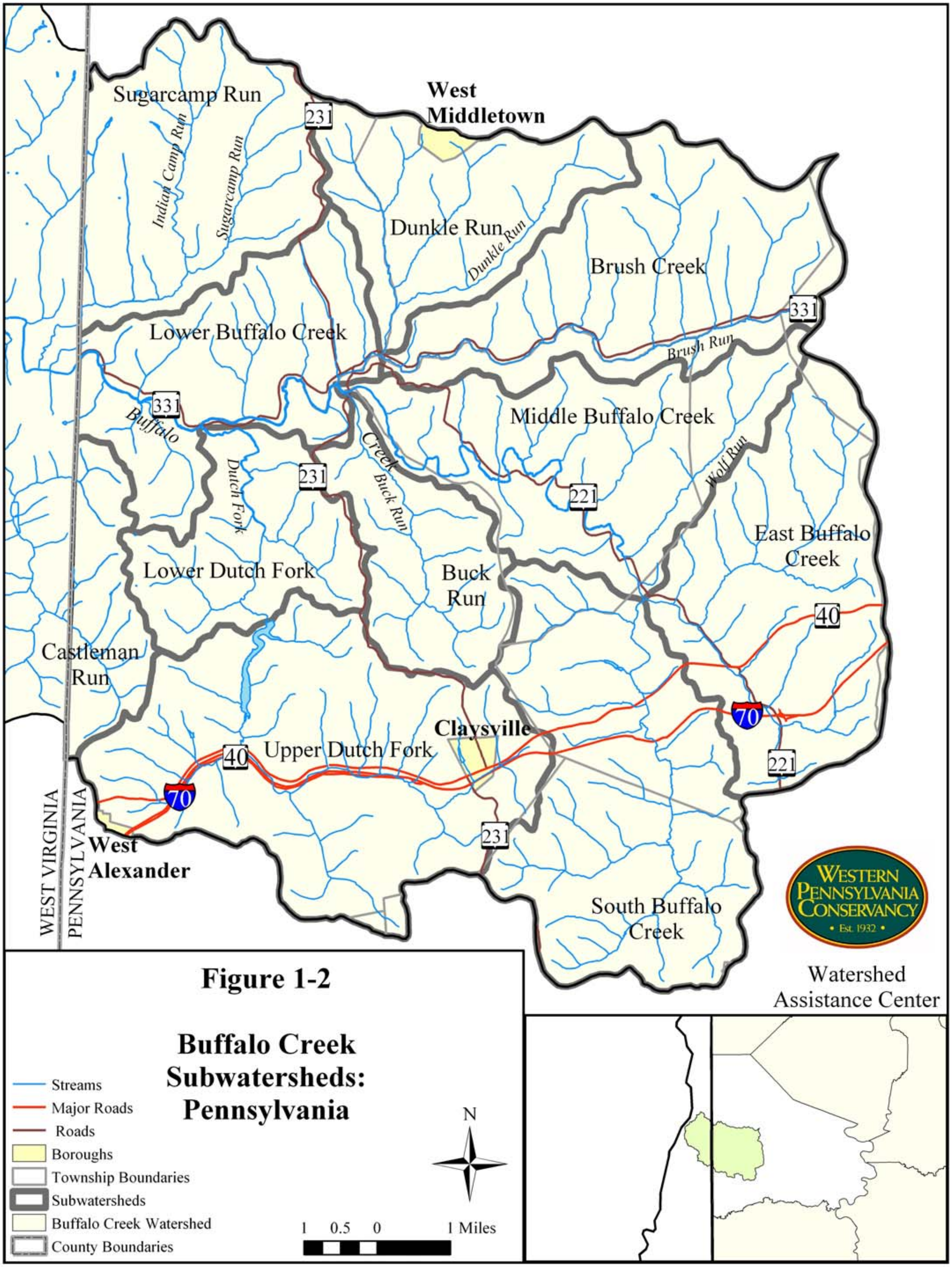
Climate is a long-term average of weather parameters occurring in an area, including aspects such as temperature, precipitation, humidity, and sunlight. It is affected by a variety of factors, including topography, latitude, and soil characteristics. Climate can greatly affect a region's ability to grow crops, maintain roads, and engage in other activities that help build communities. The Buffalo Creek watershed has a climate similar to southwestern Pennsylvania and northeastern West Virginia, characterized by rather consistent rain events throughout the year and fairly mild summers. According to measurements taken at the Washington County Airport, highest average temperatures occur in August and lowest temperatures occur in December and January (Figures 1-3 and 1-4). Average rainfall exceeds two inches for every month of the year and the highest snowfall most commonly occurs in December.

**Table 1-2. Climate Information for Buffalo Creek Area**

| | |
|---|---|
| Hardiness Zone | -5 ° F to –10 ° F |
| Average Date of Last Frost | May1-May 31 |
| Prime Planting Times | March 15-May 15 (spring);<br>September 15-November 1 (fall) |

Source: U. S. National Arboretum

The Buffalo Creek watershed and surrounding area is in a different hardiness zone (milder) than the remainder of western Pennsylvania, more closely resembling portions of West Virginia (Table 1-2). Hardiness zones are used to describe the distribution of lowest temperatures that vegetation in an area can withstand in order to survive the winter. However, numerous other factors affect plant growth (U.S. Arboretum website).


Sugarcamp Run
Indian Camp Run
Sugarcamp Run
West
Middletown
231
Dunkle Run
Dunkle Run
Brush Creek
331
Lower Buffalo Creek
Brush Run
331
Buffalo
Creek
Middle Buffalo Creek
Wolf Run
Dutch Fork
231
Buck Run
221
East Buffalo
Creek
Lower Dutch Fork
Buck
Run
40
Castleman
Run
70
Claysville
40
Upper Dutch Fork
221
70
WEST VIRGINIA
PENNSYLVANIA
West
Alexander
231
South Buffalo
Creek
WESTERN PENNSYLVANIA CONSERVANCY
• Est. 1932 •
Watershed
Assistance Center
Figure 1-2
Buffalo Creek
Subwatersheds:
Pennsylvania
Streams
Major Roads
Roads
Boroughs
Township Boundaries
Subwatersheds
Buffalo Creek Watershed
County Boundaries
N
1 0.5 0 1 Miles

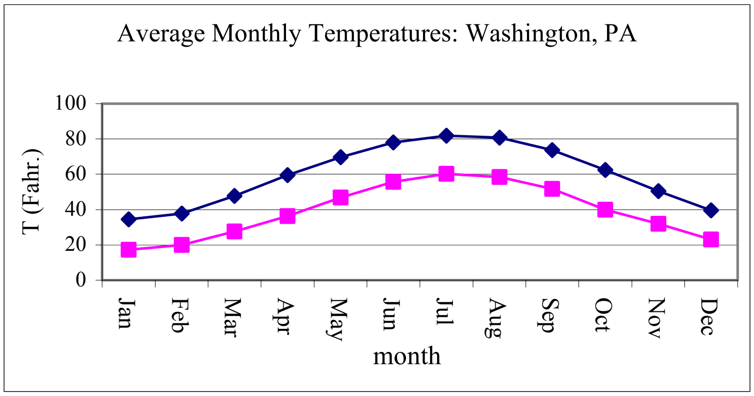



Figure 1-3. Average Temperatures

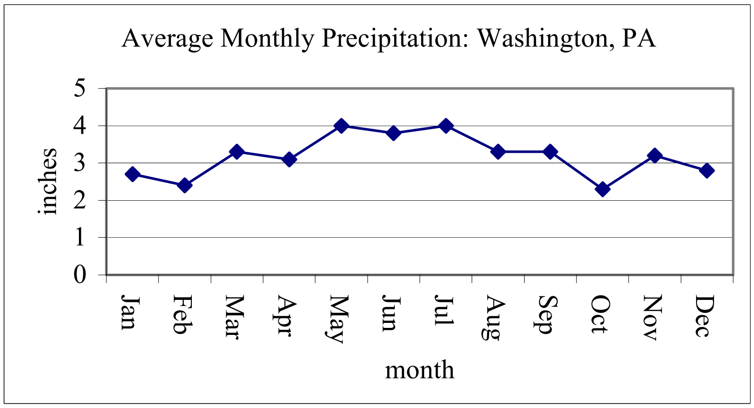



Figure 1-4. Average Precipitation

## Air Quality

Ambient concentrations of pollutants in outdoor air are measured at more than 4,000 monitoring stations owned and operated mainly by state environmental agencies. They forward the hourly or daily measurements of pollutant concentration to U. S. Environmental Protection Agency's (EPA) database, and EPA computes a yearly summary for each monitoring station (maximum value, average value, number of measurements, etc.). There are three EPA air quality monitoring stations in Washington County, Pennsylvania and one in Brooke County, West Virginia. Although no stations are located within the watershed, results from nearby stations may be somewhat indicative of air quality.

The Clean Air Act of 1970 defined six criteria pollutants and established ambient concentration limits to protect public health. EPA periodically has revised the original concentration limits and methods of measurement, most recently in 1997 (USEPA). These include ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, airborne particulates, and lead. From 1999 to 2004, the annual mean at all of the monitoring stations in Pennsylvania exceeded air quality standards for both small airborne particulates and ozone. The total air quality was unhealthy for sensitive groups approximately four days a year in Brooke County and 11 days a year in Washington County. It was unhealthy for all groups zero days a year in Brooke County and one day a year in Washington County.

Ozone pollution is caused by nitrogen and organic compounds from motor vehicles and industry and usually occurs in summer. Particulates are most commonly caused by pollution from cars, trucks, and wood construction. Traffic on Route 70, which travels through the southern portion of the watershed is likely a contributor of some of these pollutants.

## Land Use

Land use has a direct impact on the natural resources, economy, and general well being of a watershed. If land is used in a sustainable manner, natural resources will continue to benefit residents. The Buffalo Creek watershed is a mosaic of forested and agriculture lands, with agriculture comprising over 47 percent of land cover and forests comprising over 52 percent of land cover (Figure 1-5). The remaining lands in the watershed comprise less than one percent of the total area (Table 1-3).

| Table 1-3. Land Cover | | | |
|---|---|---|---|
| **Land Cover Type** | **Pennsylvania Area (acres)** | **West Virginia Area (acres)** | **% Cover** |
| deciduous forest | 78,724.12 | 17,489.98 | 52.30 |
| evergreen forest | | 228.19 | 0.12 |
| pastureland | 56,459.58 | 9,118.09 | 35.65 |
| cropland | 14,621.67 | 170.49 | 8.04 |
| transportation/commercial | 586.23 | 3.61 | 0.32 |
| open water | 92.35 | 269.00 | 0.20 |
| low-density residential | 235.80 | 395.00 | 0.34 |
| non-residential/mixed development | 233.51 | | 0.13 |
| quarries/strip mines/gravel pits | | 216.82 | 0.12 |
| high-density residential | 164.36 | 0.55 | 0.09 |
| wetland/nonforested | 35.93 | 2.89 | 0.02 |
| maintained grass | 19.89 | | 0.01 |
| wetlands/forested | 15.66 | 18.20 | 0.02 |
| mixed forest | 4.02 | 4,836.55 | 2.63 |
| transitional | | 6.953 | 0.00 |
| **Total** | 151,193.12 | 32,756.33 | 100.00 |

### Agriculture

#### *Importance*

Historically, agriculture has been a significant industry in Washington County and throughout the Pennsylvania portion of the Buffalo Creek watershed. Although statistics do not exist for the watershed specifically, Pennsylvania's 2003 agricultural statistics show that Washington County ranked first in the number of sheep, goats, and related products sold, and third in total number of farms for Pennsylvania. The number of farms in 2003 was 2,490, a less than one percent decrease since 2002.

According to the 2002 agricultural census, average farm size was 104 acres in 2002, down 11 percent since 1997 (USDA 1997; USDA 2002). In 2002, farming had a yearly contribution of 30.16 million dollars to the local economy, up eight percent from 1997. The county was also fifth in total equine sales in 2002 (Table 1-4). Statistical information is not available for the West Virginia portion of the watershed, but the land cover map illustrates that a large portion is in agricultural use (Figure 1-5). Observations generally reflect farming trends in the watershed, with the majority of farming in small livestock and cattle operations. However, personal communication with residents suggests that the amount of active farmland may be decreasing. More information is needed to support this assertion.

Practices such as streambank fencing, rotational grazing, and crop rotation minimize the impact of agricultural practices on aquatic resources. The Conservation Reserve Enhancement Program and other programs offer incentives for farmers to keep marginal lands, such as that on steep slopes and streambanks, out of production. The Washington County United States Department of Agricultural

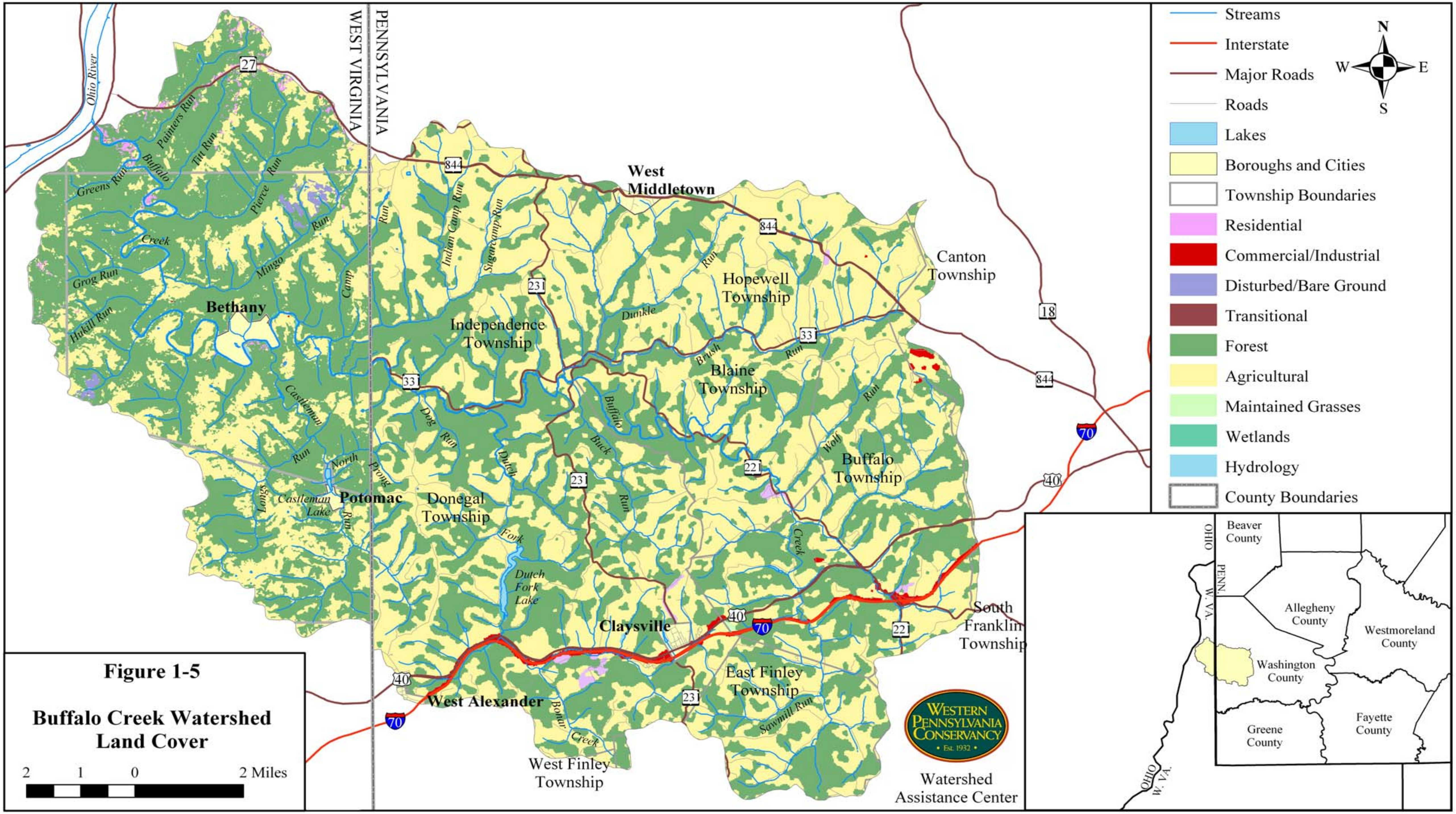



**Figure 1-5**

**Buffalo Creek Watershed Land Cover**

Office or Conservation District Office may be contacted for more information about these and other opportunities.

**Table 1-4. Statistics for Select Agricultural Products in Washington County**

**USDA 2002 Statistics**

| Commodity Group | ($) Total Value | State Rank | Increase or Decrease (since 1997) |
|---|---|---|---|
| grains, oilseeds, dry beans, and peas | 826,000 | 45 | no record |
| vegetables, melons, and potatoes | 1,738,000 | 24 | decrease |
| fruits, tree nuts, and berries | 1,514,000 | 13 | no record |
| nursery, greenhouse, and related products | 5,504,000 | 20 | increase |
| crops and hay | 3,682,000 | 5 | increase |
| cattle and calves | 5,389,000 | 25 | increase |
| hogs and pigs | 195,000 | 41 | no record |
| sheep, goats, and related products | 544,000 | 1 | no record |
| equine products | 1,089,000 | 5 | no record |
| milk and dairy products | 8,836,000 | 39 | decrease |

**Pennsylvania Ag Board 2003 Statistics**

| Characteristic | Acreage | State Rank | |
|---|---|---|---|
| number of farms | 2,490 | 2 | |
| farmland acreage | 259,500 | 4 | |
| acres of hay | 77,200 | 1 | |
| acres of all forage | 79,600 | 3 | |

### ***Agricultural Security Areas***

Pennsylvania Act 43 (amended in 1981, 1989, 1994, and May 2004), "provides a means by which agricultural lands may be protected and enhanced as viable segments of the Commonwealth's economy, and as an economic and environmental source of major importance." This is done through the creation of **Agricultural Security Areas** (ASAs), which protect farmers from nuisance laws and local building ordinances. A parcel of land that is 250 acres or more and is used for agricultural purposes is eligible to be considered for ASA status. This protects farmers from lawsuits associated with smell, noise, insects, and aesthetics. ASA status is obtained through application to the corresponding township or borough and is reviewed every seven years. Most ASAs in the watershed are illustrated in Figure 1-6. However, more recent ASAs may have been added that are not included on the map.

Along with protecting the landowner, ASA status can help protect the rural nature of an area by making ASA lands eligible for the Easement Purchase Program. An easement is a legal document in which a landowner assures that the use of his/her land be limited to specific activities forever, even if the land is sold. In Washington County, farmers can receive up to $2,000 an acre from the county if they choose to place an easement on their property limiting their land to agricultural activities. Land which meets the requirements must be at least 50 contiguous acres, produce $15,000 a year, have 50 percent of soils in Capability classes I-IV (highly suitable for agriculture), and be located within a 500-acre ASA. The Buffalo Creek watershed contains portions of two agricultural easements located on the northern tip of the watershed, in Independence and Hopewell townships. These two easements make up approximately 50 per cent of the agricultural easements in Washington County and encompass over 300 acres (Pers. Comm., Conservation District).

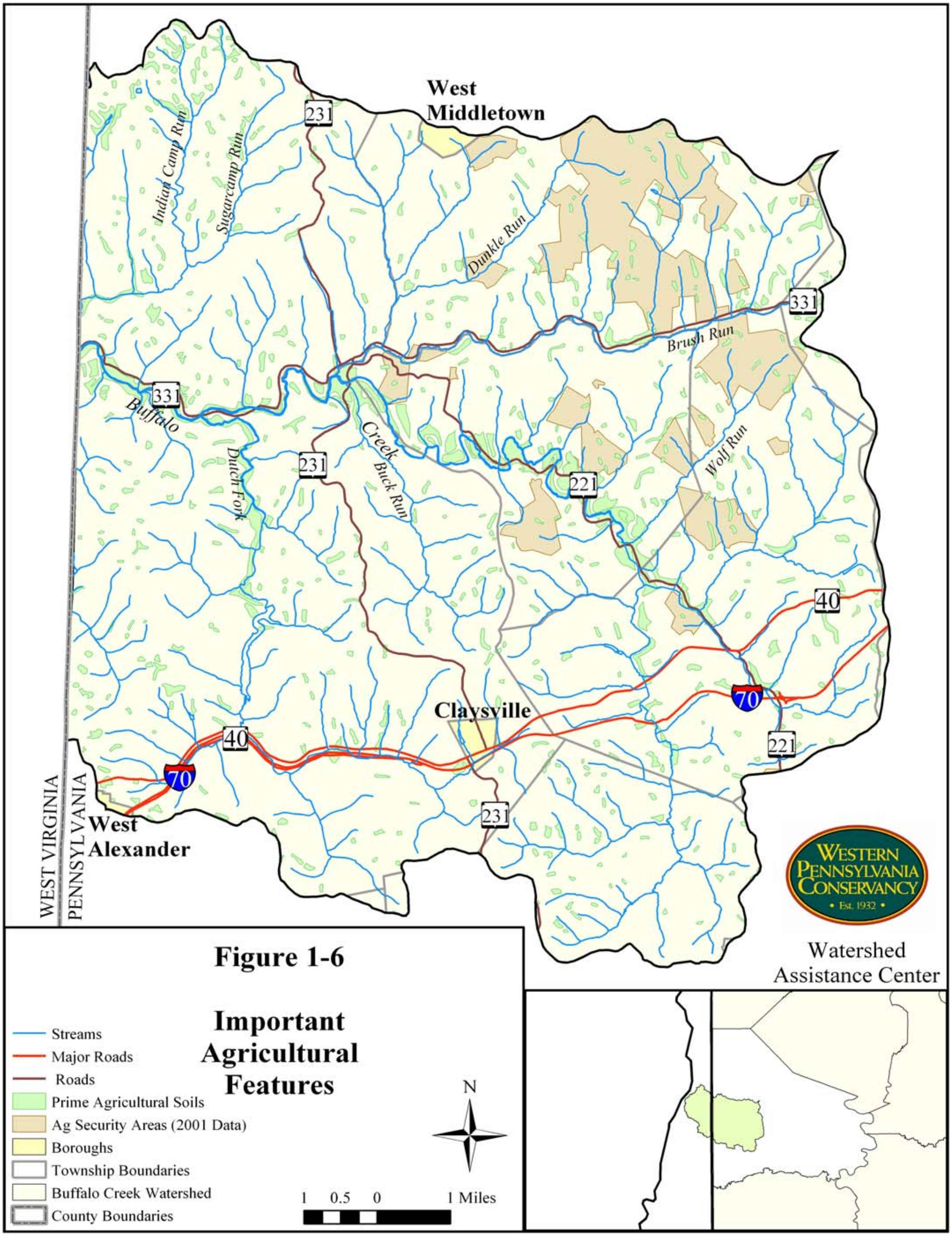



**Figure 1-6**

**Important Agricultural Features**

## Forestry

Forestry has also been an important industry in the Buffalo Creek watershed. Though little statistical information exists, the annual value of timber harvested in Washington County was 3.92 million dollars in 1993, and the value of standing timber in the county was estimated at 127.70 million dollars (Jacobsen 1993). Statistical information is not available for the West Virginia portion of the watershed.

### *Forestry Management*

Forest management is the art and science of treating a forest to promote a desired outcome. The skilled forester uses the art of silvics (principles of tree and forest biology and development) to achieve goals set forth by the landowner and/or society. The treatment type used may differ depending on these goals. Common treatment types used in Pennsylvania often fall under the categories of “even-aged” versus “uneven-aged” management.

**Even-aged management** methods harvest all trees in a stand at one time or in several cuttings over a short time to produce stands of all or nearly the same age. This management method is commonly applied to achieve a forest comprised of shade-intolerant trees such as black walnut, cherry, poplar, and oak.

**Uneven-aged management** is used to maintain a stand with trees of varying ages, from seedlings to mature. Trees are harvested selectively to maintain shaded conditions. It is most often used to promote stands comprised largely of shade-tolerant species such as sugar maple and beech (Penn State 2005).

Though even-aged management practices are most often utilized in Pennsylvania, these practices may not be appropriate for all types of stands. For instance, an area overpopulated with deer may not be able to regenerate after even-aged cuts. Uneven-aged management is often a good strategy if both timber and wildlife benefits are desired. From a wildlife perspective, the “best” approach depends on the availability of habitats and sensitive species in the area. If a landowner has one of the only large forested tracts in an area, wildlife may rely heavily on that forested area and uneven-aged practices may be best. However, if the parcel is within a highly forested area, an open or shrubby harvested stand produced by even-aged techniques may provide important early-successional forest habitat (Rodewald and Brittingham 2001). Though even-aged cuts initially provide more economic returns, studies have shown that well-managed uneven-aged stands can produce just as many, if not more, economic returns over a number of years (Treiman et al. 2005).

Uneven-aged Management Examples:

**Individual Selective Cutting:** Cutting of scattered individual trees, including both large, economically valuable trees and weak trees, in order to maintain the health of the forest and multi-dimensional forest structure.

**Group Selective Cutting:** Similar to Individual Selection but involves cutting small groups of trees.

**High-Grading:** Involves cutting of only the biggest, most profitable trees in a stand; this is not a good forestry management practice because only smaller, weak trees remain.

**Improvement Thinning:** Trees of different sizes are removed to provide more space and resources for desirable trees.

**Thinning From Below:** All trees below a certain size are cut. This method does not consider the requirements of different tree species and may be negative for the forest. It also produces a park-like appearance not beneficial to wildlife.

**Thinning From the Middle**: Seldom used in Pennsyvlania, this method removes trees of intermediate size, leaving both smaller trees and older growth trees; this provides some income while maintaining the aesthetics of the forest.

Even-aged Management Examples:

**Clearcutting:** The removal of all trees and most, if not all, vegetation from an area, leaving all growing space and resources available for the next generation. If done in an appropriate area, it can allow for rapid seedling growth and recolonization.

**Shelterwood:** A heavy thinning in which some trees are left uncut to provide a seed source for regeneration.

**Seed True:** Similar to a shelterwood cut, except fewer trees are left for regeneration purposes and these trees are often cut after regeneration is established.

*Forestry Management Assistance*

The Pennsylvania Bureau of Forestry, administered by Pennsylvania's Department of Conservation and Natural Resources, offers a cost-free Forest Stewardship Program. Landowners can receive forestry management advice and develop a Forestry Management Plan for their properties. For more information contact Mr. Bill Wentzel, state forester for Washington and Greene counties.

**Public Lands**

Pennsylvania State Game Lands 232 make up nearly six percent of the Pennsylvania portion of the watershed (Figure 1-7). Including a recent tract acquired from Penn Power in 2004, the total area under the control of the Pennsylvania Game Commission is approximately 4,423 acres. Public lands in the Pennsylvania portion of the watershed also include the area of land once encompassing the Dutch Fork Lake Reservoir, which is owned by the Pennsylvania Fish and Boat Commission.

Similar to what are called State Game Lands in Pennsylvania, West Virginia operates Wildlife Management Areas that are open to hunting and fishing. The 486-acre Castleman Run Wildlife Area is located in the West Virginia portion of the watershed. More information can be found in Chapter 4.

## Topography

A physiographic province is a region with parts having a similar geologic structure and climate and consequently had a unified geomorphic history. These provinces are made up of smaller sections, which themselves have unique characteristics. The Buffalo Creek watershed is part of the Appalachian Plateaus Province, which extends over most of West Virginia, approximately half of Pennsylvania and New York, and small parts of westernmost Maryland, eastern Ohio, eastern Kentucky, southwestern Virginia, east-central Tennessee, and northern Alabama (Pers. Comm., J. Harper). Millions of years ago, orogenic (mountain-building) activity created the Allegheny Mountains in eastern Pennsylvania and low, broad folds in western, Pennsylvania. The province was formed by rapid erosion of the faulted and folded mountains to the east, which left the less eroded flat rocks of western Pennsylvania relatively unaffected (Figure 1-8). This geology consists of sequences of shale, siltstone, sandstone, and coal with limestone intermingled (Berryhill 1971). The landscape of the Appalachian Plateaus Province typically has broad to narrow hilltops and irregular, steep-sided to V-shaped valleys.

***This picture illustrates the flat-lying nature of the underlying rock throughout the watershed.***

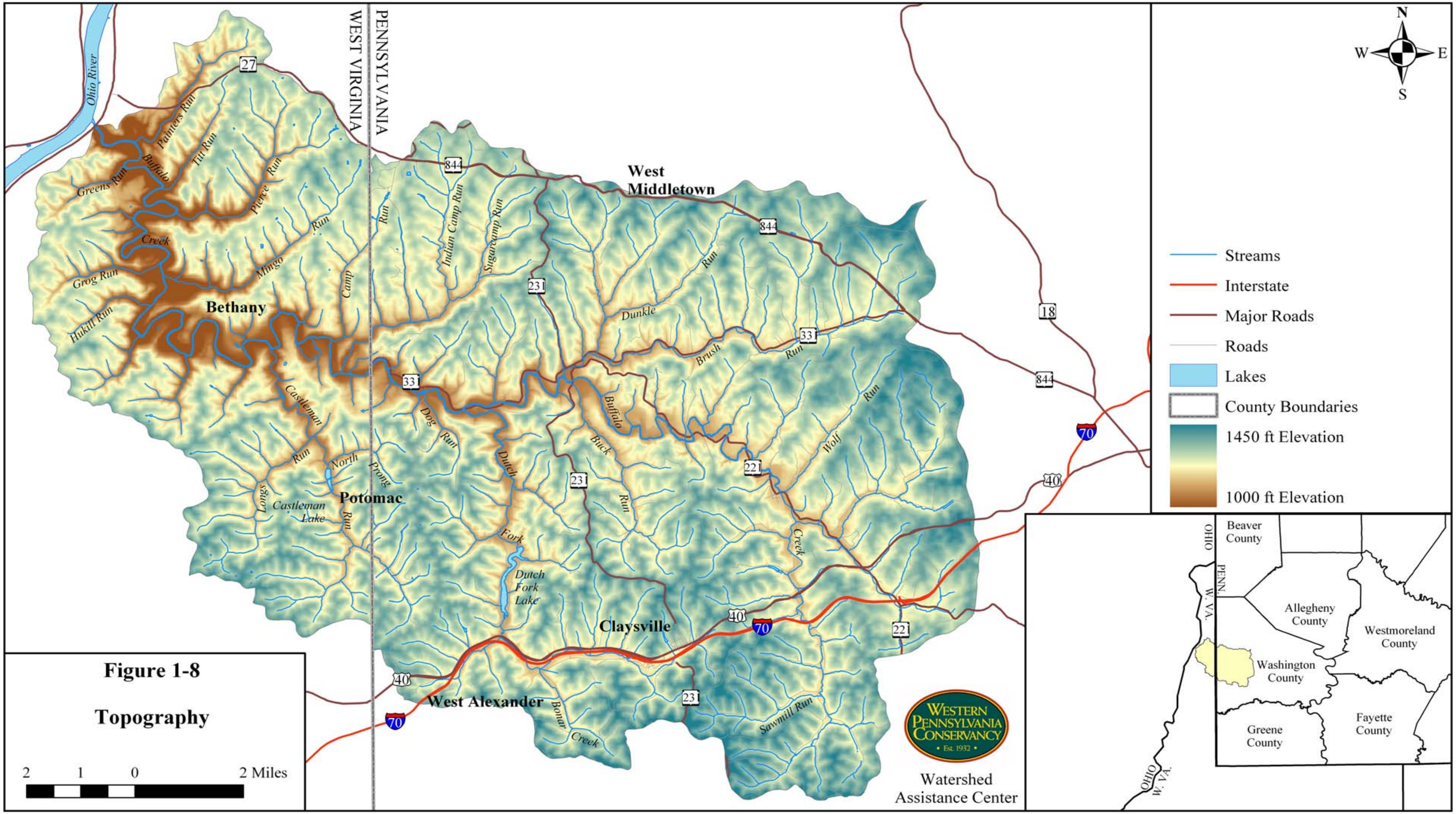
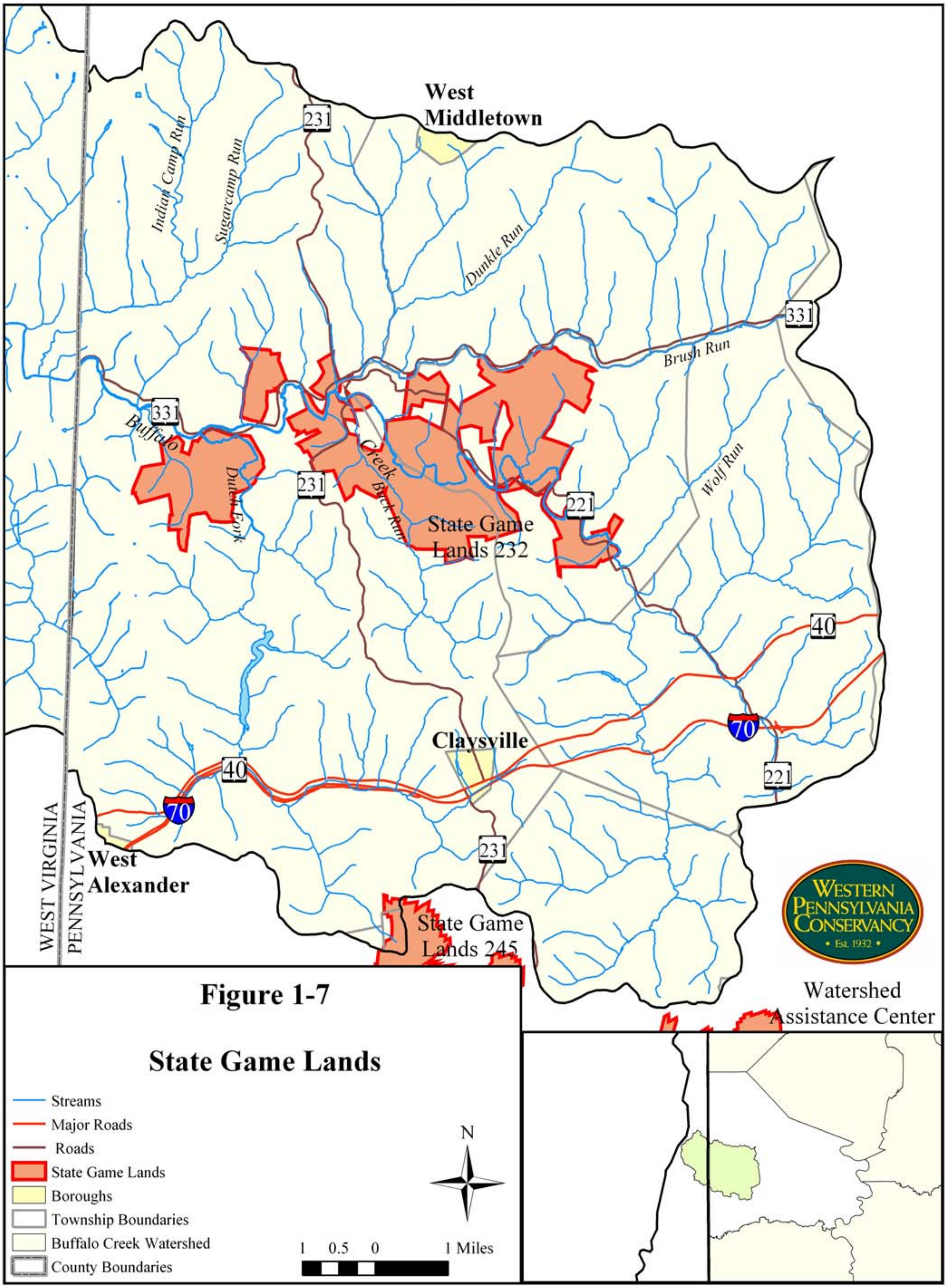



**Figure 1-8**

**Topography**


West Middletown
231
Indian Camp Run
Sugarcamp Run
Dunkle Run
331
Brush Run
Buffalo
Creek
Dutch Fork
Buck Run
Wolf Run
221
State Game Lands 232
40
70
Claysville
West Alexander
WEST VIRGINIA
PENNSYLVANIA
State Game Lands 245
Western Pennsylvania Conservancy
• Est. 1932 •
Watershed Assistance Center
Figure 1-7
State Game Lands
Streams
Major Roads
Roads
State Game Lands
Boroughs
Township Boundaries
Buffalo Creek Watershed
County Boundaries
N
1 0.5 0 1 Miles

The watershed is located within the Waynesburg Hills Section of the Appalachian Plateaus Province. This newly designated section (Sevon 2000), which in Pennsylvania primarily includes Washington and Greene counties with portions in Allegheny, Fayette, and Westmoreland counties, was until recently considered part of the Pittsburgh Low Plateau. Both sections occur on a plateau that has been dissected everywhere by rivers and streams. However, the underlying strata of the Waynesburg Hills Section contains more fine-grained rocks (shale, mudstone, and claystones) than the Pittsburgh Low Plateau Section. Generally, in contrast to the gently folded rocks of the Pittsburgh Low Plateau and other portions of the Appalachian Plateaus to the east, these rocks are flat-lying (Pers. Comm., J. Harper). The Waynesburg Hills Section, including the Buffalo Creek watershed, is characterized by topography dictated more by the resistance of different rocks to weathering and erosion than it is by the geologic structure and thickness of individual rock strata. This is evident in the angular hills and V-shaped valleys with slopes susceptible to erosion and landslides. The result is a more deeply incised and intricate drainage pattern than in surrounding areas (Berryhill et al. 1971).

## Geology

During the Permian and late Pennsylvanian time periods (300 million years ago), Washington (and nearby Buffalo Creek watershed) was near the center of a large, depositional basin that received sediment from numerous slow-moving streams. The burial of sediment and plant remains deposited at the time occurred from continued erosion of the eastern highlands that existed before the Allegheny Mountains were built. The accumulation of the dead plant debris that grew and died in the swampy area became the coal deposits that exist in the area today, while the drying up of algal mats created limestone masses within largely sandstone beds (Berryhill et al. 1971). Over the years, drainages cut down through the series of uplifted strata, and wind and water wore away uplifted areas to form relatively level surfaces, which continue to be eroded. These characteristics have made Greene and Washington counties the most prolific coal-producing counties in Pennsylvania.

***The resistance of sandstone to erosion often results in small waterfalls such as this one along a tributary of Buffalo Creek***

The underlying geology is comprised mainly of cyclical sequences of sandstone, shale, limestone, clay, and coal (PA DEP). In general, sandstone, siltstone, and mudstone increase upward through the sequences of rocks towards the surface relative to the amount of limestone. Though part of distinct layers, these rock types grade vertically and laterally into each other (Berryhill et al. 1971).

The underlying geology of an area can have direct effects on water characteristics and land use. The impermeability of siltstone, sandstone, and mudstone layers contributes to seepage and landslides at the surface and, during certain times of year, high water tables. However, periods of high water are short-lived because there are few primary openings within the rock to hold water in place. Large secondary openings (or pores) dominate, through which water is lost to streams (Berryhill et al. 1971).

Limestone rock, found in elongated lenses in the watershed, contains calcium carbonate ($CaCO_3$), explaining the naturally high alkalinity of the streams and groundwater in the watershed. Dolomite rocks, which are present in the watershed, also have a high magnesium content ($CaMgCO_3$) and are considered good for agriculture (Pers. Comm., J. Harper). Alkalinity refers to the ability of water to buffer changes in pH, which can be caused by sources such as acidic rainwater or mine drainage water. Soils formed from the weathering of limestone rocks are often well suited for agriculture, but steep slopes and shallow depth to bedrock may limit agricultural activities. The naturally high sulfate concentrations that have been reported in the rivers and streams in the watershed may be caused by the combination of naturally occurring calcium and the oxidation of sulfur from coals.

Because of its geology and geologic history, this section's natural communities share more similarities with parts of West Virginia and Ohio than with Pennsylvania. Some of the plants and animals that can be found in or near the Buffalo Creek watershed are unique to this portion of the state.

### Rock Groups

The surface bedrock groups within the watershed include the Conemaugh Group, the Monongahela Group, and the Dunkard Group (Figure 1-9) (PADEP). A "group" refers to two or more rock formations which may or may not have similar characteristics, but are bounded by distinct geological beds. Within groups are "formations," which are sequences of rock that, because of certain characteristics such as rock type, fossil content, or color, are mappable over large areas (Pers. Comm., J. Harper).

#### *Dunkard Group*

The Dunkard Group, including the Greene, Washington, and Waynesburg Formations, is found only in the most southwestern corner of Pennsylvania. Its maximum thickness is 1,120 feet. The primary components of the Dunkard Group include shale, sandstone, siltstone, limestone, and coal. The Washington and Waynesburg Formations of this group are most evident at the surface in the southern portion of the watershed along hillsides following the major river valleys and many smaller tributaries of steeper valleys in the watershed. The Greene Formation occurs along hilltops.

#### *Monongahela Group*

The Monongahela Group underlies the Dunkard Group and is found at the surface in the valleys of larger stream courses such as Buffalo Creek, Brush Run, and Indian Camp Run, where the rocks of the Dunkard Group have been eroded away by these streams. Within this group are the Uniontown and Pittsburgh Formations. The Pittsburgh Formation most often contains thick, mineable coals and the largest production of underground coal in Pennsylvania comes from this group. The principal rock components of this group are sandstone, limestone, dolostone (a limestone-like rock containing magnesium), shale, siltstone, and coal.

#### *Conemaugh Group*

This group cannot be found at the surface in Buffalo Creek watershed but immediately underlies the Monongahela Group. It includes the Glenshaw and Casselman Formations and is comprised of sandstone and shale, with some limestone and coal intermingled.

### Coal formations

The Pittsburgh and Waynesburg coals are the two major coals of Washington County and the only two mined in the Buffalo Creek watershed area. Of these, only the Pittsburgh Coal is economically viable. The coal is about 200 to 250 feet below the surface and over 600 feet deep in some areas. (Pers. Comm., J. Harper). The "Coal and Other Minerals" section of this chapter provides information about current and past coal mining in the watershed.

## Soils

### General Characteristics

Soils in the watershed have been created by hundreds of years of erosion of the level plains from the Pennsylvania and Permian periods to form rounded hills and ridges. They are relatively young compared to other areas of the Appalachian Plateaus Physiographic Province, and show this in their shallow depth to bedrock. Erosion is the major soil management concern on cropland and pastureland. Contour farming and strip-cropping are common soil erosion control practices. Dormont and Culleoka soils have the best combination of soil properties for farming in the watershed. The Soil Conservation Service completed a

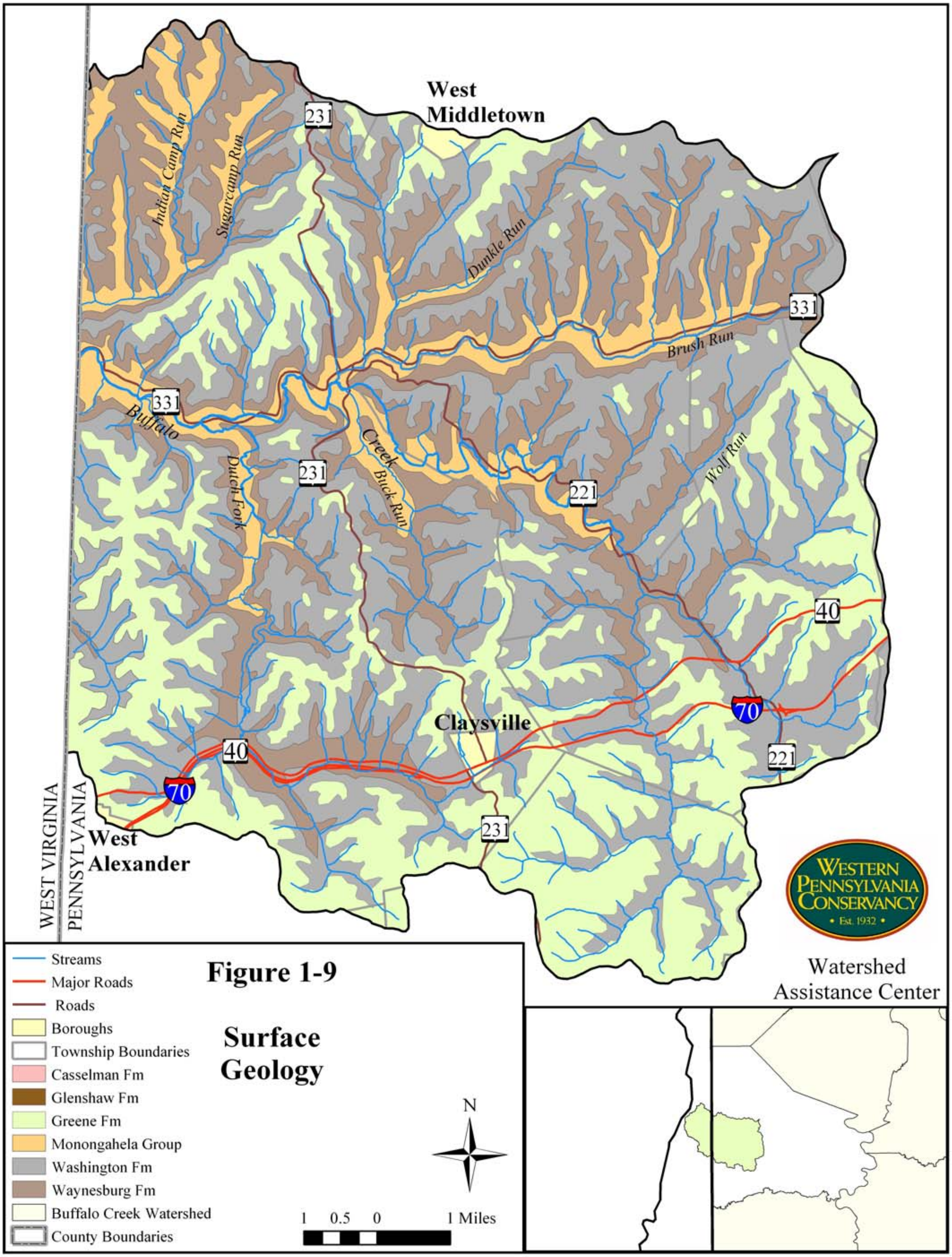



**Figure 1-9**

**Surface Geology**

Soil Survey of Greene and Washington counties in 1983, and a digitized map of the Buffalo Creek watershed portion of this survey is now available from the Natural Resources Conservation Service. However, only a general map of soil associations is shown in Figure 1-10 due to the high level of detail in the digitized map (Seibert et al. 1983).

## Soil Associations

Soils in the watershed primarily are comprised of three associations, or "groups of soils geographically associated in characteristic repeating patterns." These include the Dormont-Culleoka-Newark Association, Dormont-Culleoka Association, and Guernsey-Dormont-Culleoka Association. Within these associations, varying slopes and depths to water table determine the suitability for agriculture and other activities.

### ***Dormont-Culleoka-Newark Association***

This soil association is found along floodplains and hills next to major stream courses, such as Buffalo Creek, Brush Run, and Dutch Fork Creek. Slopes are usually zero to 50 percent. The Dormont soils are on hillsides, Culleoka soils are on hilltops and ridges, and Newark soils are on floodplains. Dormont and Culleoka soils are fairly well drained while the Newark soils are poorly drained and characteristic of hydric (wetland) areas. The less sloping soils are suitable for farming, but the majority of the upland areas are too steep. Flooding and shallow depth to bedrock are the main limitations for most uses.

### ***Guernsey-Dormont-Culleoka Association***

This association, consisting of rolling hills and ridges, is drained by small streams and is one of the better farming associations in Washington and Greene counties. Slopes are usually three to 25 percent. This association is found primarily in Blaine and Buffalo townships. The Guernsey soils are on hillsides and hilltops with weathered clay, siltstone, shale, and limestone; Dormont soils are on hillsides benches; and Culleoka soils are on ridges and hilltops. All are moderately well drained. The soils of this association have high suitability for agriculture and forestry, but have limitations for other uses because of seasonal high water tables, moderate depth to bedrock, and slower permeability.

### ***Dormont-Culleoka Association***

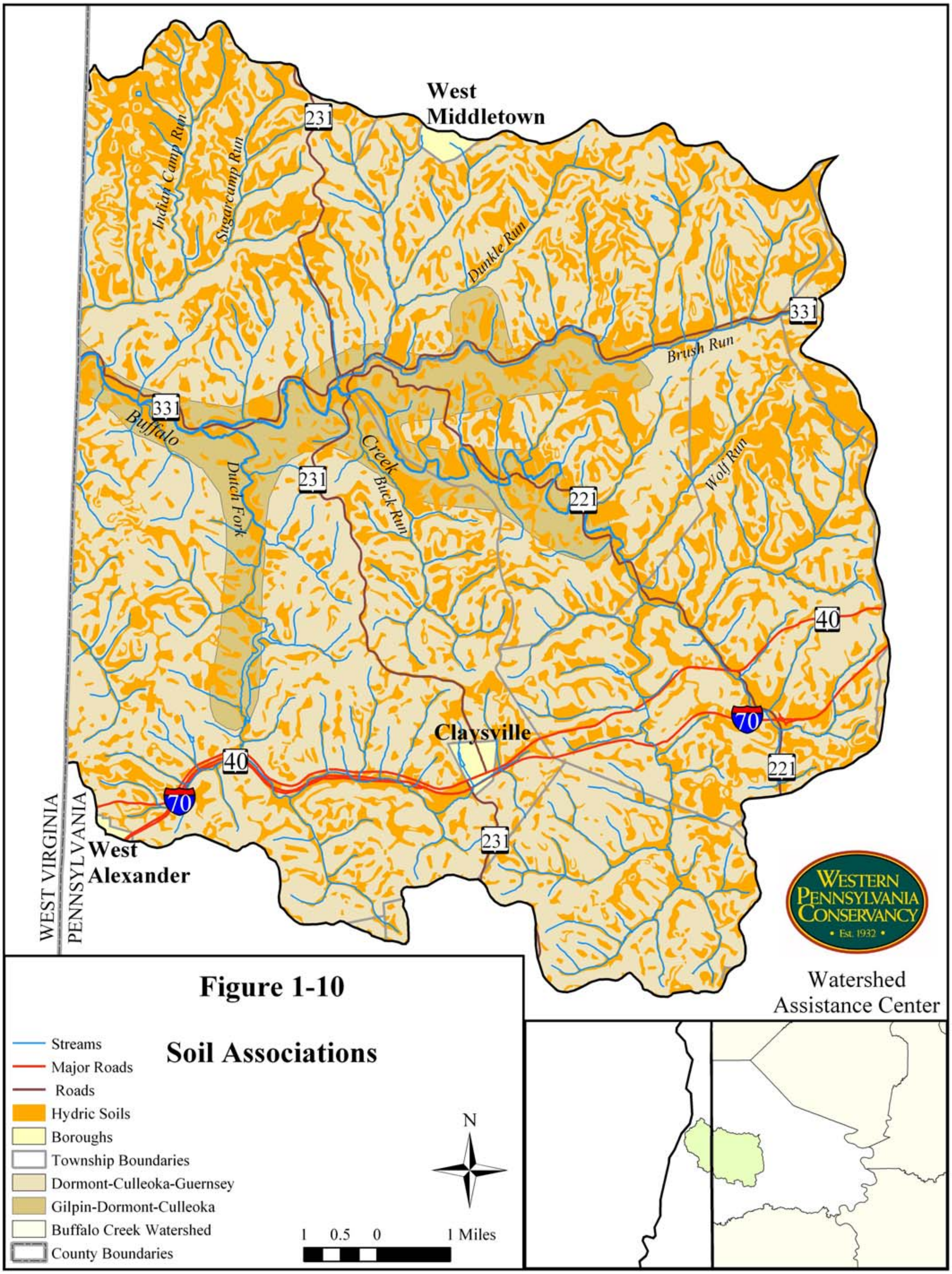
This association consists of steeper slopes from three to 50 percent that are often drained by small streams. The Dormont soils are commonly on hillsides and benches, and Culleoka soils are mainly on hillsides. Most of these soils are moderately well drained, with less-drained soils on floodplains. The less-sloping areas are suitable for farming, but slope and erosion are limitations for use of steeper areas. The shallow depth to bedrock and high water table during some months also limits non-farm uses.

## Prime Agricultural Soils

Prime farmlands are those having chemical and physical properties suitable for growing food, forage, fiber, and oilseed crop (Figure 1-6). They have adequate growing season, temperatures, and soils, and are not easily eroded or flooded. In Pennsylvania, prime agricultural soils are designated for each county by the United States Department of Agriculture Natural Resources Conservation Service (NRCS) based on predetermined criteria, including level slopes, a well-drained structure, deep horizons, and an acceptable level of alkaline or acid components. There are seven soil units in the

**Table 1-5. Prime Farmland Soils**

| Symbol | Soil Name | Slope |
|---|---|---|
| CaB | Culleoka silt loam | 3-8% |
| Ckb | Culleoka-upshur complex | 3-8% |
| Agb | Allegheny silt loam | 3-8% |
| BoB | Brooke silty clay loam | 3-8% |
| GdA | Glenford silt loam | 0-3% |
| GdB | Glenford silt loam | 3-8% |
| Hu | Huntington silt loam | 0-3% |


West Middletown
231
Indian Camp Run
Sugarcamp Run
Dunkle Run
331
Brush Run
331
Buffalo
Creek
Dutch Fork
231
Buck Run
221
Wolf Run
40
70
Claysville
40
70
221
231
West Alexander
WEST VIRGINIA
PENNSYLVANIA
Western Pennsylvania Conservancy
• Est. 1932 •
Watershed Assistance Center
Figure 1-10
Soil Associations
Streams
Major Roads
Roads
Hydric Soils
Boroughs
Township Boundaries
Dormont-Culleoka-Guernsey
Gilpin-Dormont-Culleoka
Buffalo Creek Watershed
County Boundaries
N
1 0.5 0 1 Miles

watershed that are classified as prime agricultural soils (Table 1-5). Because these soils are sometimes suitable for development, planning efforts are often necessary to maintain these areas in agricultural uses.

### 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 (moisture-loving) 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 generally considered hydric if the soil, in an unaltered state, was hydric. Some types of soils, designated as hydric, have phases that are not hydric depending on water table, flooding, and ponding characteristics. There are numerous soil types in the watershed that have a hydric component. Table 1-6 lists some examples, but there are many more. Hydric soils are depicted in Figure 1-10. The only soil type with a "major" hydric component is purdy silt loam.

Hydric conditions give the best indication that an area of land is a wetland, though hydric characteristics are only one of three criteria for an area to be called a wetland. Due to their inability to drain water, hydric soils are inappropriate for most types of building and development and are considered sensitive areas.

**Table 1-6. Common Hydric Soils**

| Symbol | Soil Name | General Characteristics | Management Concerns |
|---|---|---|---|
| Fa | Fluvaquents, loamy | Nearly level, poorly drained or somewhat poorly drained soils on floodplains; suitable for pasture and woodland | Susceptible to flooding and overgrazing; high water table; seedling and crop mortality; unsuitable for development |
| Nw | Newark silt loam | Nearly level, somewhat poorly drained; suitable for crop, pasture, and woodland | Susceptible to flooding; high water table; unsuitable for development |
| Py | Purdy silt loam | Nearly level, drained or poorly drained; suitable for pastureland and woodland | Susceptible to flooding; high water table; unsuitable for development |

## Eco-region

In 1992-1993, the United States Department of Agriculture Forest Service adopted a consistent approach to ecosystem classification and mapping. Ecological types were classified and ecological units were mapped based on associations of those biotic and environmental factors that directly affect or indirectly express energy, moisture, and nutrient gradients regulating the structure and function of ecosystems. These factors include climate, physiography, water, soils, air, hydrology, and potential natural communities. These designated areas, termed eco-regions and sub-regions, allow managers, planners, scientists in the Forest Service, and others to study management problems on a multi-forest and statewide basis; organize data collected during broad-scale resource inventories; and interpret these data among regions (McNab et al. 1994).

The Buffalo Creek watershed is in the Eastern Broadleaf Forest (Oceanic) Province, or eco-region. This region has a strong annual temperature cycle, with cold winters and warm summers. Temperate deciduous forests dominated by tall broadleaf trees that provide a dense canopy in summer and shed their leaves completely in winter characterize this region. In spring, a rich plethora of groundcover develops, but is greatly reduced after trees reach full foliage and shade them out. Forest vegetation primarily takes on the form of mixed mesophytic, Appalachian oak and pine-oak forests (McNab et al. 1994).

The watershed is in the southern unglaciated Allegheny plateau sub-region, which includes primarily the unglaciated portion of the Eastern Broadleaf Forest Province, and is characterized by dendritic drainage and sharp hills. Community types, other than the dominant three mentioned previously, historically have included mixed oak forest, oak-hickory-chestnut forest, oak-pine forest, hemlock forest, beech forest, floodplain forest, and swamp forest. Mammal populations commonly include whitetail deer deer, gray fox, woodchuck, opossum, gray squirrel, white-footed mouse, short-tailed shrew, and the more uncommon hairy-tailed mole, smoky shrew, and eastern woodrat. The bison, elk, black bear, mountain lion, timber wolf, and bobcat generally no longer exist in this sub-region. Typical amphibians include the red-spotted newt, dusky salamander, American toad, wood frog, box turtle, and black rat snake (McNab et al. 1994). Prior to 1850, this section contained large numbers of fish and mussel species. Historic records show large catches of muskellunge, sturgeon, catfish, buffalo, drum, spotted bass, walleye, and sauger. Some of these populations still occur. Once numerous mussel populations have generally decreased (McNab et al. 1994).

## Oil and Gas Wells

There are a significant number of oil and gas wells in the Buffalo Creek watershed. Figure 1-11 shows records of oil and gas wells according to the Pennsylvania Department of Environmental Protection (DEP). In the mid 1880s, the area around Taylorstown was one of the most significant oil-producing areas in the county and many of these old wells still exist.

The watershed contains the following oil or gas well types: wells for general oil and gas extraction (labeled oil, gas, oil and gas in Figure 1-11); study areas for inspection of rock for potential drilling (core); wells where no oil or gas was found (dry); gas and water injection wells, in which either gas or water is used to flush oil out (gas injection, water injection); wells to observe gas fields to insure that there are no leaks (observation); and wells where gas is stored, which are often wells which are no longer producing (storage). Partially plugged wells are those where the deepest parts have been filled with cement, but gas or oil is probably still extracted at the shallower depths. Plugged wells are those where the well bore (drilled hole) has been filled with a non-porous material and cement is used to seal off portions of the well.

Oil and gas well creation and operation are now regulated by DEP. However, only since 1965 has the state begun granting permits for new drilling, and only since 1985 were old oil and gas wells required to be registered by operators. DEP now requires that all oil and gas wells have a cement casing which protects potable water zones (drinking water) and coal seams, and wells are dug deep enough that they rarely pollute ground and surface waters (Pers. Comm., J. Harper, DCNR). However, many oil and gas wells operated before 1965 were never registered, were not properly plugged, and were abandoned. As a result, there are numerous oil and gas wells within the watershed for which no record exists.

Abandoned wells are the most serious hazards to health and safety posed by gas and oil wells. Rusted-out casings can contribute to explosions or well-water contamination. An old well may be a mechanism for brine (salt) to get into freshwater and groundwater. In 1992, the Pennsylvania legislature amended the Gas Act of 1984 to call gas wells abandoned before 1985 “orphan wells.” This gives DEP the authority to plug orphan wells and creates funds for this by adding a surcharge to applications for new oil and gas wells. If an abandoned oil or gas well is discovered, this should be reported to the Oil and Gas Southwest Regional Manager of DEP (412-442-4024) to ensure safety and protect landowners from

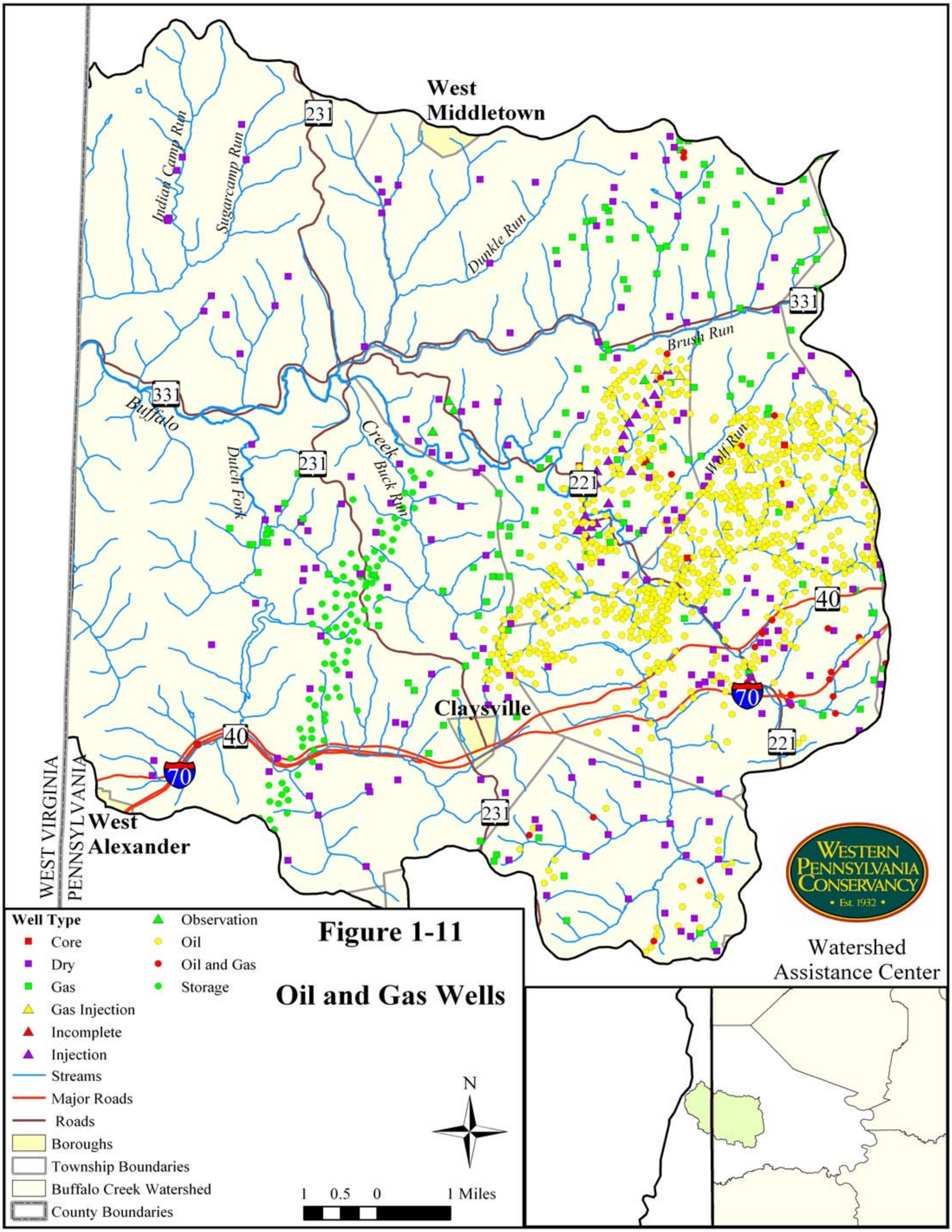



**Figure 1-11**

**Oil and Gas Wells**

future liability for the well. Numerous abandoned wells potentially exist within the Buffalo Creek watershed because of the history of oil and gas production in the area.

## Coal and other Minerals

### Permits

DEP regulates both coal and non-coal mining activities through its district mining offices. Permits are required by various state laws (Table 1-7). In Washington County, underground mining, coal refuse disposal, and coal preparation is regulated through the California District Mining Office (in McMurray). Coal surface mining, refuse reprocessing, and industrial minerals surface and underground mining are regulated through the Greensburg District Mining Office. Presently, there are no mining permits in the watershed, though both surface and underground coal-mining permits have been issued in the past and are currently active near the watershed (Figure 1-12). There is the potential for mining of sandstone and siltstone rock, but this is currently not an active industry within the watershed.

### Coal Mining

Mining is commonplace throughout other areas of Washington County, which is historically one of the largest coal-producing counties in Pennsylvania. Cumulative coal production in the county reached 1,000-1,500 million tons in 1999 (the only other counties with this magnitude of cumulative production are Cambria, Westmoreland, and Fayette counties). However, coal production in southwestern Pennsylvania has been experiencing a general decrease. In 2000, production in Washington County was 8,175 tons. Longwall mining techniques have contributed to the county's high rate of production. The only other county with this level of production was Greene County, which produced many times this level in 2000 (U.S. Dept. of Labor).

As of 2004, mining was occurring approximately 1.16 miles from the watershed's southeastern boundary and within 6.91 miles of its eastern boundary. These operations include the Bailey Mine, Enlow Fork Mine, and Mine 84 (eastern boundary). Information about current longwall mining permits can be found by surfing the DEP E-map PA website (http://dep.state/pa.us, keyword: emap). However, it should be noted that this information is only updated every few years. For instance, as of 2004 Enlow Fork Mine actually extended to the intersection of East Findley and Franklin townships, but E-map did not recognize this extent (Pers. Comm., K. Prevac).

### Types of Coal Mining

Of the 17 coal beds that exist in Washington County, only two of them are mineable, having economic viability and reaching the necessary thickness. These include the Waynesburg Coal and the Pittsburgh Coal beds. However, the Waynesburg Coal is relatively discontinuous and not economically viable on a large scale. Records indicate that the Waynesburg (Brush Run), Washington (Sugarcamp Run), and Pittsburgh Coals (eastern section) have been mined in the Buffalo Creek watershed. The Pittsburgh coal bed is the primary bed mined in the area (Berryhill et al. 1973).

Coal found close to the surface is uncovered and removed by large machines through surface mining. Underground mining methods are used where the coal seam is too deep or the land too hilly for surface mining. Common underground mining methods are shaft mining, room and pillar mining, and longwall mining. Shaft mining involves excavating a path to the coal seam. The room and pillar method requires that large columns of coal remain between mined-out areas. In longwall mining, a rectangular panel of coal is "blocked out" by excavating passageways around its perimeter. As coal is removed, the roof is allowed to collapse (Energy Information Administration).

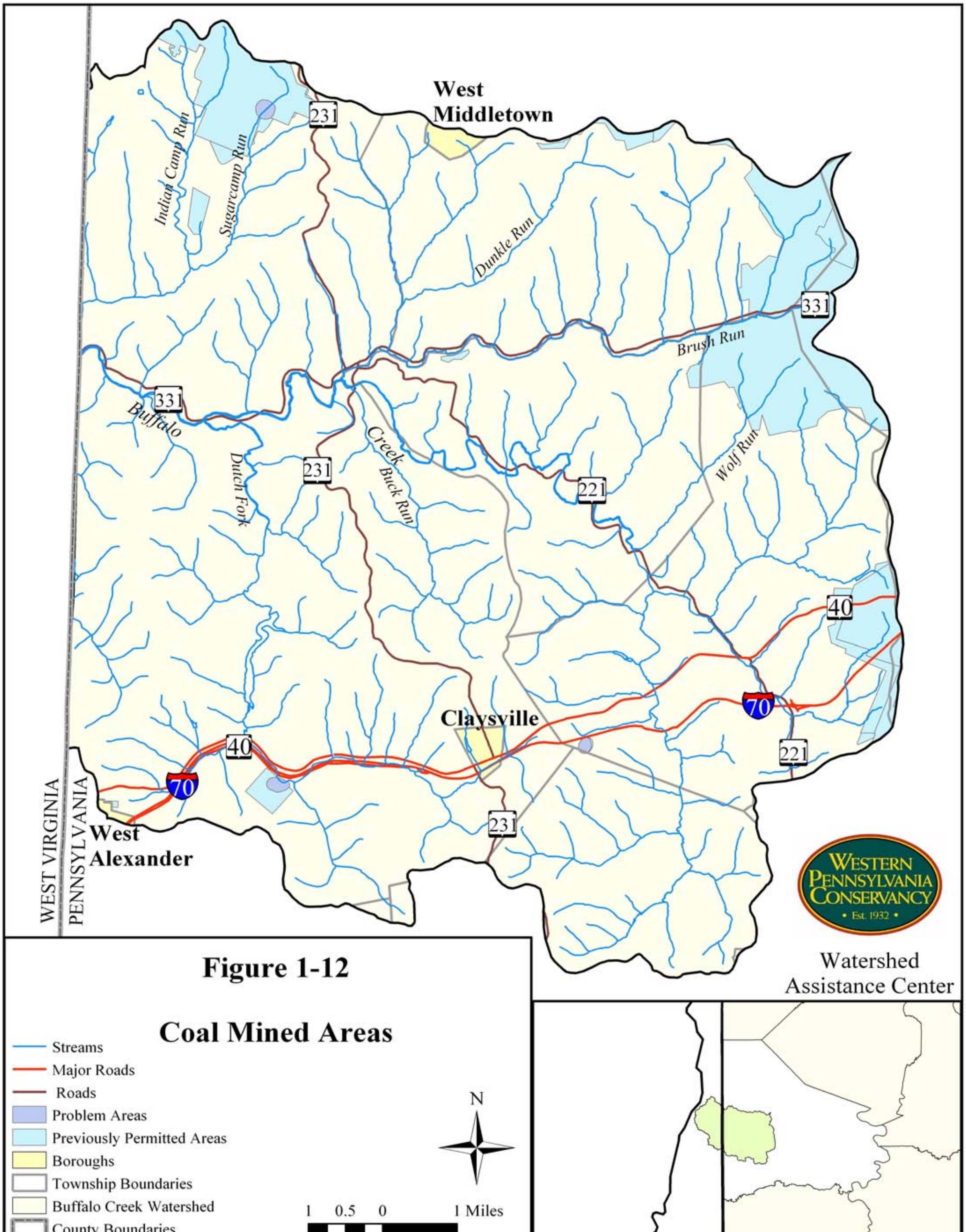



**Figure 1-12**

**Coal Mined Areas**

## Environmental and Other Concerns

Acid or alkaline mine drainage is the most common environmental problem associated with mining. In the mining process, pyrite and other metal compounds are exposed to oxygen and water, causing weathering and a series of chemical reactions that can produce elevated concentrations of iron, manganese, sulfate, and other constituents (Koryak 1997). High sulfate is one of the most reliable indicators of mine drainage because sulfate, unlike metals, remains in solution. Most mine drainage is caused by underground mining, but longwall mining may produce less mine drainage because most of the pyrite is removed. Problems related to longwall mining primarily include subsidence and impacts to surface and groundwater hydrology. Since 2001, companies have been required to get separate permits for mining under streams under federal Act 54.

Subsidence is the downward movement of the ground surface due to physical weathering or movement of bedrock. It often occurs due to pumping of water or underground mining. In active underground mining using longwall or room and pillar recovery methods, subsidence can usually occur in a predictable manner. DEP will no longer authorize underground mining beneath structures where the depth of overburden (rock material above the mine) is less than 100 feet.

Sinkholes are subsidence areas that form rapidly and result in a hole or cavity. They are most common in areas of carbonate bedrock and would not occur in the Buffalo Creek watershed unless caused by mining activities.

Currently, none of the past mining in the Pennsylvania portion of the watershed appears to be causing serious water quality, hydrological, or other problems. The exception to this is some possible groundwater contamination in the eastern portion of the watershed, which showed up in chemical sampling and may be linked to either mine drainage or gas and oil wells (see Water Sampling Results, Chapter 3). Zoning ordinances can sometimes prevent or regulate mining in areas containing important cultural and natural resource areas.

According to West Virginia Division of Mining and Reclamation, there is no history of mining in the West Virginia portion of the watershed. However, aerial photography indicates some type of mineral resource extraction at several locations within the West Virginia portion. Although this does not appear to be a result of mining for coal, further research is needed to identify the cause of these disturbed areas.

Future longwall mining activities in the watershed are a significant issue of concern among residents. The watershed's High Quality designation does not guarantee that future mining will not occur. However, stricter requirements must be met in order for mining permits to be issued for areas containing High Quality or Exceptional Value streams. In issuing permits for longwall mining, factors considered include depth to coal, location of the mine, and type of rocks. In the cases where adverse effects to the stream are predicted, the mining may be restricted or prohibited from occurring by DEP (Pers. Comm., Jim Welch). Permit applications for mining activities are updated in the Washington County Recorder of Deeds office every six months. In addition, applications for permits are listed in the "PA Bulletin" or residents can sign up to receive regular e-mails with such information from "PA E-facts." The California District Mining Office can also be contacted for updated information regarding which portions of Washington County are scheduled to be "mined under." The Surface Subsidence Program, located at the California District Mining Office, was created to answer residents' questions and provides liaisons between mining companies and residents. Mining companies must give six months notice to all residents whose properties are above an area scheduled for mining.

Watershed residents should also be aware of state and federal laws to protect water and land resources from negative impacts of mining, especially the Clean Water Act of 1972, the Surface Mining Act of 1977, and the Bituminous Mine Subsidence and Land Conservation Act (Table 1-7).

| Table 1-7. Pertinent State and Federal Laws Affecting Mining Activities | |
|---|---|
| **State or Federal Law** | **Important points** |
| State Clean Streams Law of 1937, 1945, 1965 | Allows for point discharges and enforcement of water-related environmental regulations by DEP |
| Surface Mining Conservation and Reclamation Act of 1945, 1992, 1996 | Provides methods and incentives for reclaiming areas impacted by mining |
| Act 54 Amendment to the Surface Mining Conservation and Reclamation Act | Requires DEP to assess the impacts of coal mining on structures, water supplies, and streams every five years |
| Bituminous Subsidence and Land Conservation Act of 1966, 1994 | Protects structures and water supplies from the effects of deep mining (including surface subsidence agent program) |
| Coal Refuse Disposal Control Act of 1968 | Helps control pollution from refuse piles |
| Air Pollution Control Act of 1959, 1992, 1999 | Provides provisions for regulation of air quality, including "targets" and stakeholder participation |
| Noncoal Surface Mining Conservation and Reclamation Act of 1984 | Requires a separate permitting process for non-coal surface mining |
| Dam and Encroachments Act of 1978 | Regulates the construction of stream barriers and filling in of wetlands |
| Solid Waste Management Act of 1980 | Provides provisions for regulation by DEP of residual, municipal, and hazardous wastes, including the application of sewage sludge |
| Federal Clean Water Act of 1948, 1972,1977 | Among other things, requires that activities must not degrade streams to the extent that they are not suitable for any uses obtained since 1971 |
| Federal Mining Control and Reclamation Act of 1977 (1978-1992) | Funds are provided by current coal companies for restoring areas degraded by mining before 1977 |

Sources: [1] WREN. Groundwater: A Primer for Pennsylvanians. Website: pa./lwv.org/wren/pubs.
[2] DEP. "A Citizens Guide to the Mining Process." Website: http://www.dep.state.pa.us/dep/deputate/minres/bmr/a_citizens_guide.htm. Updated 1/22/2004.

## Problem Areas

The Bureau of Abandoned Mine Reclamation administers and oversees the Abandoned Mine Reclamation Program in Pennsylvania. The bureau is responsible for resolving problems such as mine fires, mine subsidence, dangerous highwalls, and other hazards which have resulted from past mining practices, and for abating or treating drainage from abandoned mines.

| Table 1-8. Problem Areas | | | | |
|---|---|---|---|---|
| **ID** | **Name** | **Location** | **Description** | **Code** |
| 5044 | McGill Southwest | adjacent to Route 70 near woodland | highwall | 3 |
| 355 | Sugarcamp Run | private property in Independence Township | capped air shaft | 2 |
| 356 | Coon Island | Donegal Township | gob pile | 3 |

Abandoned Mine Lands (AMLs) are areas that have been mined prior to 1977 in which the mine operator has no continuing reclamation responsibility. AML problem types from surface and underground mining operations include: dangerous highwalls and impoundments, landslides, mine spoil, mine subsidence, mine openings, flooding, mine drainage, mine gas, and other mining-related hazards. Problem Areas are those areas identified as being safety or environmental hazards. Priority for clean up is given to Code 1 areas, which have extreme safety issues. There are no Code 1 Problem Areas in the watershed. However, one Code 2 (minor safety hazard) area, and two Code 3 areas (environmental hazard areas) exist (Table 1-8).

## Illegal Dumping

Illegal trash and animal carcass dumping is a frequent problem cited by residents. This dumping most commonly occurs within State Game Lands 232 because the area is infrequently traveled. However, the Pennsylvania Game Commission maintains a number of video cameras and will enforce its no dumping policy if violators are identified. Locations of dump piles that were identified during this plan existed mainly along Buffalo Camp Road and the path leading to Polecat Hollow. These roads have been closed, and as of publication remain closed, likely decreasing the ease of dumping. Trash piles were also identified at the intersection of Dutch Fork Creek and Buffalo Creek. This trash often enters the stream during rain events. Besides being an eyesore, trash piles can be environmental and safety hazards. Old tires are breeding grounds for mosquitoes and many old refrigerators and other appliances contain dangerous chemicals.

***An old trailer foundation and trash at Polecat Hollow***

In addition to illegal dumping, trash exists on the State Game Lands that was left there by residents who leased land from its former owner, Penn Power. The Buffalo Valley Alliance usually holds at least one cleanup day a year. Volunteers are always needed to assist with this and other trash cleanups. PA CleanWays is a non-profit organization that helps people take action against illegal dumping in their Pennsylvania communities. There is no PA CleanWays Chapter in Washington County, though other PA CleanWays chapters have assisted with efforts there. Forming such a chapter could greatly benefit Buffalo Creek and many similar rural areas in the county.

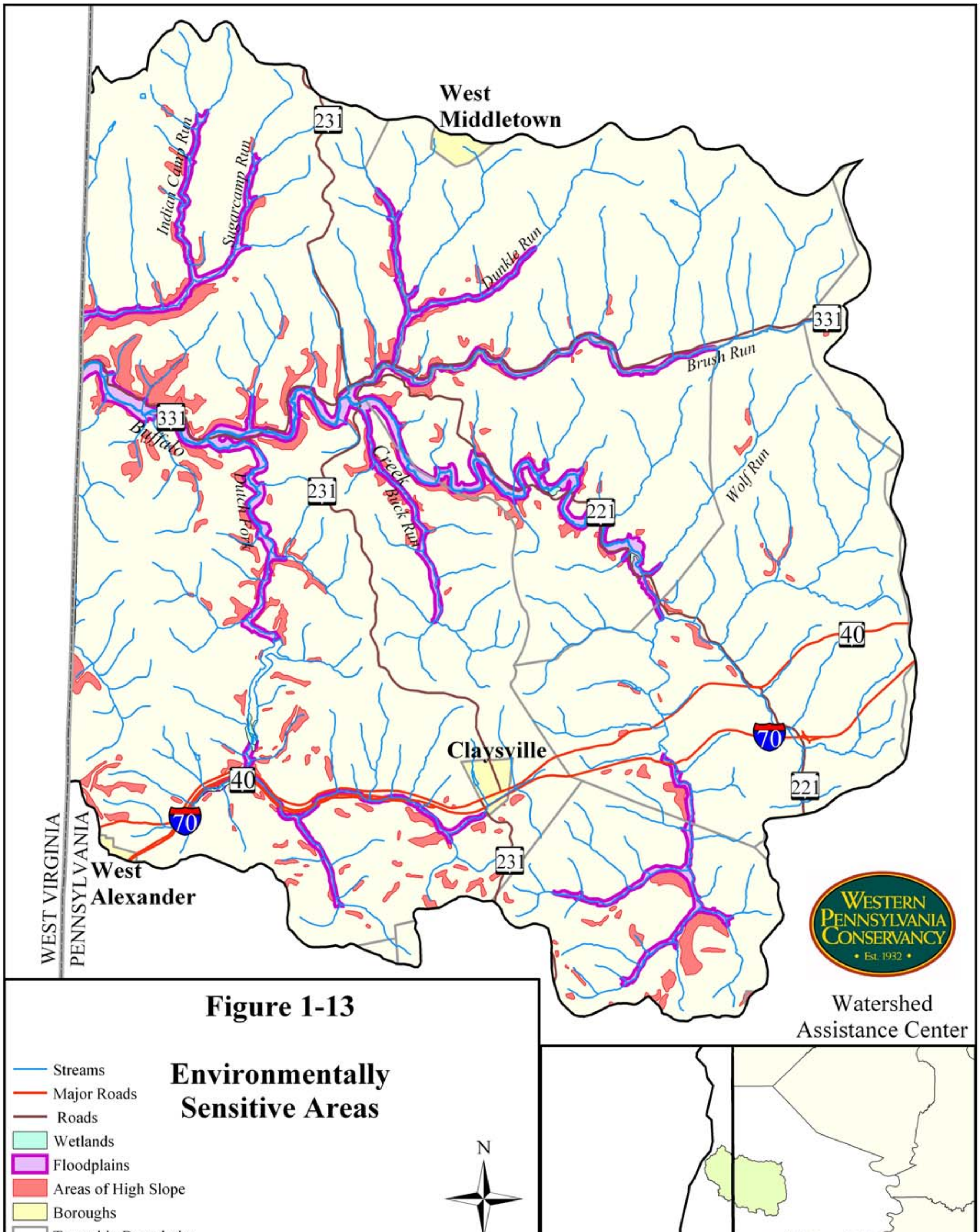
## Sensitive Areas

Sensitive areas are areas in which development or intensive agriculture should be limited because of safety issues from flooding or other hazards. These include floodplains and steep slopes greater than 20 percent. Hydric soils are potential sensitive areas because they may contain wetlands, though further research may be needed to determine if a wetland is present. Although virtually any floodplain is inappropriate for development, Figure 1-13 only illustrates areas along large floodplains encompassing the 100-year floodplain. It is recommended that development be restricted along even smaller streams in the watershed, as these contribute the most sediment to larger creeks. The Green Cove Wetland is also included as a sensitive area because it contains the bronze copper, a butterfly species of special concern, and Pennsylvania law requires that consideration of this species is made in any development plans.

### Wetlands

In order for an area of land to be called a wetland, it must have: 1) anaerobic/hydric soils, 2) wetland vegetation, and 3) a physical indication that it has been under water at least part of the year. Though hydric soils are a necessary component of wetlands, many areas of hydric soils have been altered and can no longer be considered wetlands because they do not have the other two components. Figure 1-10 includes hydric soils, or potential wetland areas.

Many wetland areas may exist that are not included in the National Wetlands Inventory map, which is created using aerial photography. Aerial photography may not be able to detect wetland areas that do not have standing water during the time of the inventory. The wetlands identified during the inventory include those in Figure 1-13, Environmentally Sensitive Areas.


West Middletown
Claysville
West Alexander
WEST VIRGINIA
PENNSYLVANIA
Indian Camp Run
Sugarcamp Run
Dunkle Run
Brush Run
Buffalo
Creek
Dutch Fork
Buck Run
Wolf Run
231
331
221
40
70
Western Pennsylvania Conservancy • Est. 1932 •
Watershed Assistance Center
Figure 1-13
Environmentally Sensitive Areas
Streams
Major Roads
Roads
Wetlands
Floodplains
Areas of High Slope
Boroughs
Township Boundaries
Buffalo Creek Watershed
County Boundaries
N
1 0.5 0 1 Miles

### Floodplains

Floodplains are the land along a stream onto which water flows when the stream rises. See the Water Resources chapter for more information about how floodplains are important for water quality. Every stream or river has some type of floodplain, though water may rarely reach the floodplain in some cases. Areas of land in the 100-year floodplain are included on the sensitive areas map. These are areas where there is a one percent chance of water reaching this zone each year. Though this information is not available for smaller streams, it is generally recommended for financial and safety reasons that development not occur in the floodplain of any stream. The Washington County Conservation District or Planning Office can be consulted in order to obtain more information about the floodplain zone.

### Steep Slopes

As a result of its geologic history, the watershed contains numerous steep slopes. The biggest threat to agriculture is the loss of soil from steep slopes during rain events. This most commonly happens when vegetation that holds the soil in place is removed due to grazing or other practices. For this reason, the Conservation Reserve Enhancement Program grants priority to areas of steep slopes. Through this program offered by the Washington County NRCS office, farmers can receive money for keeping steep slopes and stream floodplains out of production. Generally, slopes greater than 20 precent are considered the most vulnerable to erosion. These are included as sensitive areas. Development and agricultural practices should be limited in these areas because of safety issues and potential for loss of soil.

## Socio-economic profile

### Municipalities

Municipalities in Pennsylvania that are partly or entirely located in the watershed include Buffalo, Donegal, Blaine, Hopewell, South Franklin, Canton, East Finley, West Finley, and Independence townships and Claysville, West Alexander, and Hopewell boroughs. Table 1-9 lists the percentage of each municipality in Pennsylvania that is located in the watershed. Municipalities that have shown a general increase in population since 1980 are depicted in red.

Though municipal boundary information was not available for the West Virginia portion of the watershed, towns include Beech Bottom, Bethany, Marshall Terrace, Wellsburg, Power, Dunsfort, and Potomac.

### Population

The watershed's population has not experienced any dramatic changes in the last 20 years. Table 1-9 shows population trends in the Pennsylvania portion of the watershed and in towns in West Virginia for which information was available. Municipalities that have experienced a general increase are depicted in red. However, despite these population trends, urban sprawl is evident in areas surrounding the watershed, as depicted in Figure 1-15.

The Buffalo Creek watershed has limited public services, including sewage and water, road maintenance, and garbage disposal. For instance, it is estimated that less than five percent of people within Buffalo Creek watershed have public water or sewage, and no municipalities offer garbage disposal. There are no landfills or other types of waste storage sites in the watershed. Figure 1-14 shows water and sewer service according to the Washington County Planning Office. Though additional public water and sewage services are proposed in the near future, many people would still not receive these services. In many cases, municipalities in the watershed have low populations and do not have the tax base to support improving this infrastructure.

### Major Employers

A major employer is designated as a company having a minimum of 200 employees. There are no major employers within the Pennsylvania portion of the watershed. However, there are 10 major employers within a five-mile radius of the watershed, including Pitt Manufacturing Company, Superior Valve Company, Washington Penn Plastics, Penn Mould Industries, Lukens, Inc. (now vacant), Mac Plastics, Cerdec Corporation, Allegheny Ludlum Steel, Observer Publishing Company, and Ross Mould, Inc.

**Table 1-9 . Population Information**

| | | population persons/ sq. mile | | |
|---|---|---|---|---|
| | **% in watershed** | **1980** | **1990** | **2000** |
| Blaine Township | **100** | 734 | 682 | 597 |
| Buffalo Township | **99** | 2,022 | 2,148 | 2,100 |
| Canton Township | **8.8** | 10,311 | 9,256 | 8,826 |
| Claysville Borough | **100** | 1,029 | 962 | 724 |
| Donegal Township | **87** | 2,361 | 2,347 | 2,428 |
| East Finley Township | **24** | 1,430 | 1,479 | 1,489 |
| Hopewell Township | **79** | 919 | 942 | 992 |
| Independence Township | **72** | 1,784 | 1,868 | 1,676 |
| South Franklin Township | **.7** | 3,548 | 3,665 | 3,796 |
| West Alexander Borough | **40** | 286 | 301 | 320 |
| West Finley Township | **.2** | 964 | 972 | 951 |
| West Middleton Borough | **58** | 215 | 166 | 144 |
| Green Hills Borough | **2.9** | 18 | 21 | 18 |
| Beech Bottom | **100** | unavailable | 415 | 606 |
| Wellsburg | **100** | unavailable | 1,139 | 985 |
| Bethany | **100** | unavailable | 3,385 | 2,891 |

## Transportation Corridors

The biggest transportation corridor in the watershed is Interstate Route 70, which runs east to west through the southern portion. The National Road (U.S. Route 40), runs parallel to Route 70. In the 1950s, the National Road carried more traffic than any transcontinental highway and ran from Atlantic City to San Francisco (National Road website). Cities such as Claysville and West Alexander developed to accommodate the needs of travelers. Today, however, the historic road carries primarily local traffic.

***Road failure in Donegal Township***

State routes include Routes 844, 331, and 221, which run east to west, and Route 231, running north to south. Large-vehicle traffic is limited because of small, one-lane bridges and road failures. Township roads, which often reflect the last names of residents or key features, are found primarily along stream courses. As with state roads, large storms often cause road failures and dangerous conditions.

### Schools

There are ten schools found within the boundaries of the Buffalo Creek watershed (Table 1-10). Of these, five are in Pennsylvania and five are in West Virginia. All of the Pennsylvania schools, excluding the private Grace Christian Bible and Southwood School, are in the McGuffey School District.

| Table 1-10. Schools |
|---|
| **Pennsylvania** |
| Claysville Elementary |
| Southwood School |
| McGuffey High |
| McGuffey Middle |
| Grace Christian Bible |
| **West Virginia** |
| Bethany Primary |
| Beech Bottom Primary |
| Franklin Primary |
| Brooke County Alternative |
| Bethany College (WV) |

## Land-Use Controls and Planning Issues

### Types of Planning Documents

In Pennsylvania, the power to regulate land use lies exclusively with local governments. Though no municipality is mandated by the Pennsylvania Municipalities Planning Code (MPC) to plan or zone, all municipalities in the Buffalo Creek watershed have some type of land-use document. The three most common planning documents are the comprehensive plan, the zoning ordinance, and the subdivision and land development ordinance. All of the municipalities in the watershed have comprehensive plans, several have a subdivision ordinance, and most have a zoning ordinance.

•A **comprehensive plan** is basically a blueprint for the future and includes consideration of the location, timing, and character of development. A comprehensive plan provides a good basis for zoning and other land use, but is not enforceable and local laws and private actions are necessary to implement its concepts and recommendations.

•A **zoning ordinance** is a document to regulate the use of land and location and intensity of development. The two parts of the ordinance include 1) text: community development objectives, provisions, and regulations 2) map: delineates boundaries of specific districts of zones in ordinance. Land ordinance disputes may be disputed using mitigation techniques involving a neutral party.

•A **subdivision and land development ordinance** regulates design standards on new buildings and coordinates public improvements with private development by requiring reviews and inspections. Such an ordinance can regulate areas such as distance of new building from roads, street widths, and design of new housing developments.

•Some of the other land planning mechanisms that can be incorporated in these other documents include **official maps** (areas of future planning), **alternative zoning techniques**, **planned residential development provisions**, and **mobile home provisions**.

Though a comprehensive plan is not enforceable, it is required in order for either a subdivision or zoning ordinance to be valid (Pers. Comm., J. Litehauser). A map included in a comprehensive plan can provide guidance but is not a legal document, as is a zoning ordinance map. A subdivision ordinance can regulate how activity proceeds, but only a zoning ordinance can control where specific uses can occur (such as residential, commercial, or industrial). All municipalities are required by the municipal code to have provisions for an industrial zone, unless they are part of a joint comprehensive plan. Table 1-11 illustrates the types of land-use plans in place by major municipalities within the Pennsylvania portion of the watershed. This information was developed from municipal questionnaires.

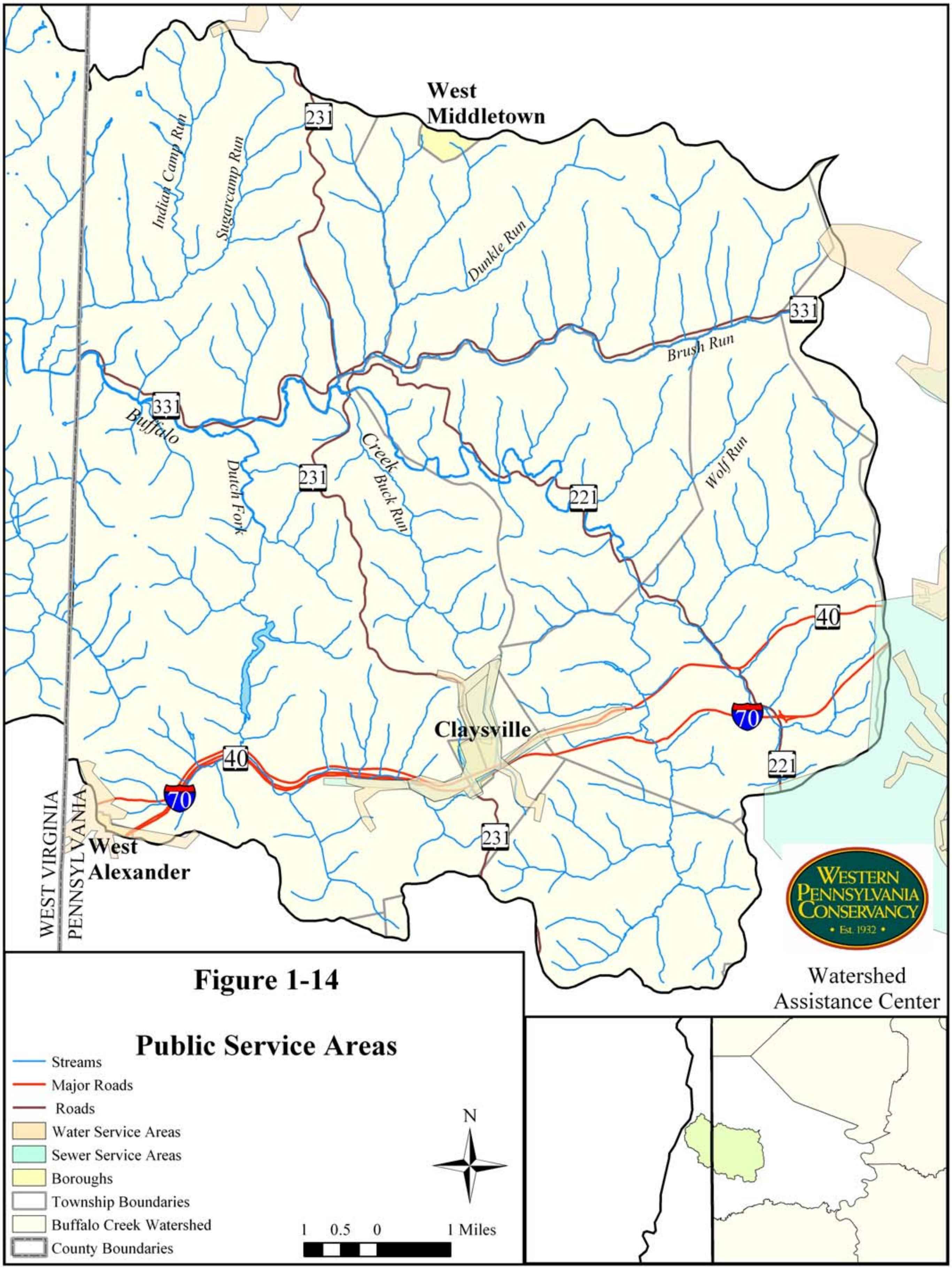



**Figure 1-14**

**Public Service Areas**

## Foreseeing Development Pressures

Foreseeing development pressures can help municipalities tailor their municipal ordinances and practices to reflect a community vision. Though most municipalities in the Pennsylvania portion of the watershed have some type of zoning ordinance, few incorporate conservation objectives into their planning through conservation zoning and other efforts. There are a number of tools that municipalities can utilize to encourage wise development and maintain natural resources and open space. Some of the best ways that municipalities learn about options available to them is by contacting their county planning office, other municipalities that have utilized these options, or organizations dedicated to helping them plan for development.

| Ten Smart Growth Principles |
|---|
| 1. Mix Land Uses |
| 2. Take Advantage of Compact Building Design |
| 3. Create a Range of Housing Opportunities and Choices |
| 4. Create Walkable Neighborhoods |
| 5. Foster Distinctive, Attractive Communities with a Strong Sense of Place |
| 6. Preserve Open Space, Farmland, Natural Beauty, and Critical Environmental Areas |
| 7. Strengthen and Direct Development Towards Existing Communities |
| 8. Provide a Variety of Transportation Choices |
| 9. Make Development Decisions Predictable, Fair, and Cost Effective |
| 10. Encourage Community and Stakeholder Collaboration in Development Decisions |
| Source: Smart Growth Network 1996 |

More and more communities are turning towards *smart growth* principles, which involve development that serves the economy, the community, and the environment by planning for where and when it should occur. Though these principles are, in many cases, most appropriate for urban areas, rural areas should keep them in mind when considering future planning. The goals of smart growth are:

•Healthy communities that provide families with a clean environment and balance development and environmental protection by preserving open space and critical habitat, reusing land, and protecting water supplies and air quality.

•Economic development and jobs that create more business opportunities, provide neighborhood services, and create economically competitive communities.

•Strong neighborhoods that provide a range of housing options and maintain and enhance existing neighborhoods and communities.

| Table 1-11. Land-Use Controls Within Pennsylvania Municipalities | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Blaine | Donegal | Buffalo | East Finley | Hopewell | Independence | West Alexander | West Middletown | Canton |
| Comprehensive Plan | yes (2003) | yes (2002) | no | no | yes | yes (2003) | yes | yes | yes (2000) |
| Zoning Ordinance | yes (1989) | no | yes (1984) | yes | yes | yes (1983) | no | yes | yes(1997) |
| Subdivision Ordinance | no | yes (1988) | yes | no | yes | yes (1998) | no | yes | yes (1996) |
| Conservation Zoning | no | no | yes-ag easements | no | yes-ag easeme nts | yes-ag easements | no | no | no |
| Floodplain, well-head, or stormwater management | yes-FP | yes-FP | yes-FP | no | yes-FP | yes-FP | no | no | yes-FP |
| Public Sewer or water | no | yes | water (<20%) | Yes-100% | <1% | <10% | 100% | water only | yes; >50% |
| Sewer and water expansion | proposed | proposed | proposed | none | desired | proposed | no | none | proposed |
| Key issues | sewer, water, zoning, roads | sewer, water, zoning, roads | sewer and water service for develop-ment | longwall mining, develop-ment issues | sewer, water, dirt roads | none given | none given | money for open space/rec. | stormwater, sewage, water |

## Recommended Planning Tools

### ***Develop and Enforce Floodplain Ordinances***

Though flooding is a serious issue in the watershed, none of the municipalities surveyed stated that they had a floodplain ordinance. However, according to the Federal Emergency Management Agency, most of the municipalities do have such an ordinance (Table 1-11). Many of these may be outdated and not properly explained and passed on as municipal leadership has changed. If adhered to, these ordinances can eventually reduce flooding potential and protect from flood damage by prohibiting future building and other activities in floodplain zones.

Existing floodplain ordinances should be enforced, especially for new industry and subdivisions that are proposed. Some municipalities in Pennsylvania, such as Montgomery County, are developing riparian zone ordinances. These prevent activities and removal of vegetation next to streams for new developments. The ordinance also encourages educating landowners about the importance of riparian zones for flood protection and stream health and suggests that current landowners maintain riparian zones on their properties. A riparian zone ordinance can help protect smaller streams, which might not be included in a floodplain ordinance. Because of the hydrology of the watershed, extreme flooding events may occur on these small streams. Additionally, studies have shown that smaller streams contribute a disproportionate amount of sediment in a watershed, which is a good reason to protect them.

Among the municipalities in the watershed that do have an ordinance and designated Special Flood Hazard Areas, none have designated regulatory floodways developed from actual stream flow measurements. Therefore, there may be additional floodplain areas in the watershed that are not considered part of the Special Flood Hazard Area and not protected by a floodplain ordinance. Efforts should be made to encourage the use of actual stream flow information in the development of these regulatory floodplains by FEMA or to obtain alternative financial assistance for such a study of floodplain areas and flood levels.

### ***Locate Development in Locations with Existing Public Services***

Once public services do come to the watershed, it is likely that development will proceed at a much faster rate. Currently, public sewer and water services are available to a small proportion of the watershed's population (Figure 1-14). Figure 1-15 illustrates the potential for growth and development in the watershed. Population density is increasing from the cities of Wheeling and Washington. If zoning ordinances are not adequate to dictate the nature of development that is desired, residents will have very little stake in decision-making involving the location and nature of new businesses that enter the watershed. By designing zoning ordinances that place locations of desired growth in areas with existing public services and limiting development in other areas, municipalities can more easily shape the direction of their communities.

### ***Develop Joint Planning Documents***

One factor that has contributed to urban sprawl in Pennsylvania is the large number of municipalities. According to a report by the Brookings Institute, Pennsylvania has one of the highest numbers of municipalities in the nation. The Pennsylvania Municipal Code does not require zoning ordinances to conform to regional comprehensive plans or goals. Each municipality is required to have provisions for certain types of zoning, including areas of higher density development. This contributes to sprawl. Recently, there has been a movement in Pennsylvania towards joint-comprehensive planning that has a more regional approach. Joint municipal planning is permitted and described in Section 8A of the Pennsylvania Municipal Planning Code. Municipalities that share a joint document may not be required to have all types of zoning, allowing them to better plan for growth in areas that make sense and to maintain rural communities. Currently, the Hopewell-Independence Joint Comprehensive Plan is the only joint planning document in the watershed.

### ***Form Environmental Advisory Boards***

Some communities in eastern Pennsylvania are incorporating environmental advisory panels into their planning processes. An environmental advisory board is a group of residents who meet regularly to develop recommendations regarding environmental issues. Municipal officials can choose whether or not to follow the recommendations. The advisory board may make suggestions such as upgrades to the floodplain ordinance, or the municipal officials may consult the environmental advisory board about an application for subdivision. In some cases, advisory boards are developed at the watershed level and may work to share ideas between municipalities. For instance, they may help one municipality who offers agricultural easements share information with another municipality that desires to offer them. Though this concept is new to western Pennsylvania, it may be useful as development increases.

### ***Easements***

A conservation easement is a written legal agreement between a landowner and a government or land trust (a private, non-profit conservation organization) that permanently restricts a property's uses to protect conservation values. They can be used to protect scenic vistas, farms, and woodlands. Easements keep land on municipal tax rolls, can be tailored to specific needs of the municipality and landowner, and are completely voluntary on the part of the landowner.

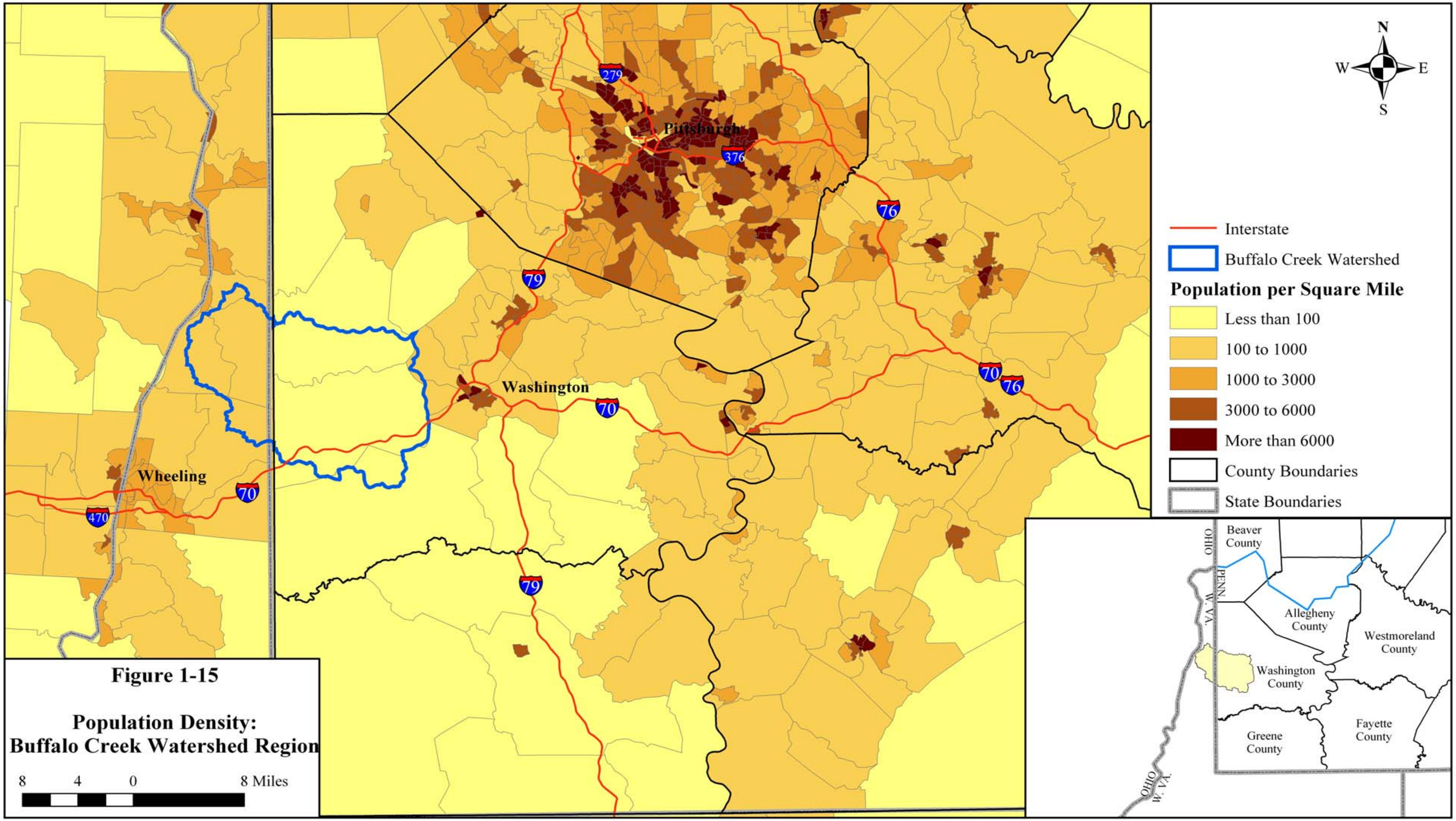



**Figure 1-15**

**Population Density: Buffalo Creek Watershed Region**

When a landowner donates or sells an easement, the easement holder continues to own the property and pay taxes but gives up certain rights. For instance, an easement might specify that a landowner gives up the right to subdivide land and construct additional residences; build barns, sheds, or other structures; or engage in agricultural production. Because eased property cannot be fully used or developed as zoning would otherwise allow, the market value is lessened. The easement holder may choose to fully or partially compensate the landowner for this reduction by paying for the easement. The reduction in market value may be considered a charitable donation that makes the landowner eligible for a federal income tax deduction and estate tax benefits. Easements usually do not open the property for public use. This is only granted if the landowner and easement holder agree to it in the easement document.

In Pennsylvania, farmland that is designated as an Agricultural Security Area is eligible for an Agricultural Conservation Easement through the County Agricultural Preservation Program. In addition, Act 153 grants municipalities the right to purchase open space in order to protect water resources and watersheds, farms and forests, natural resources such as floodplains and steep slopes, scenic areas, and historic areas. Municipalities can establish an additional property or earned income tax to fund open space and agricultural preservation in excess of current rates (with approval of voters) or adopt a millage freeze on school taxes for those holding easements.

### ***Sensitive Areas***

Sensitive areas are highly susceptible to degradation caused by disturbance. Failure to protect these areas can result in loss of property, structure failures, environmental damage, and high financial costs. These areas include floodplains, steep slopes, wetlands, and many hydric soil areas. Riparian zones could also be called sensitive areas. Municipal ordinances can limit certain types of building and development in these areas through floodplain and other ordinances. Maps of sensitive areas can also be included in municipal plans.

### ***Open Space and Greenway Protection***

Open space refers to undeveloped land that is utilized for recreation, environmental protection, or farming. Greenways are corridors of protected open space that are managed for conservation or recreation. Greenways all lead to somewhere, following natural features, such as ridges, rivers, or other features such as railroad corridors. The protection of open space and greenway areas can help maintain the rural character of an area, maintain migration routes for wildlife, and provide important areas for community activities and recreation. A recent study by the National Park Service found that properties located near greenways had values up to 35 percent higher than similar areas not near greenways. However, values differed depending on the type of greenway and other factors related to the character of the area.

> A recent study by the National Park Service found that properties located near greenways and open space have values of five to 35 percent more than similar properties located near development.

There are a variety of ways that local municipalities can protect open space. Most planning commissions are not as involved in development decisions as they could be. In Pennsylvania, planning commissions are able to commission studies, hold hearings, and gather information to present to municipal officials about open space preservation.

In many municipalities, a development plan can be approved even if a community does not want it. Conditional use applications can be developed by municipalities, which require the public to be informed of certain types of zoning applications.

Financial and administrative limitations are an obstacle that can prevent a municipality from preserving open space. However, municipalities can enact provisions that require a developer to maintain a percentage of land as open space or to donate to an open space fund. Pennsylvania Department of Conservation and Natural Resources and other organizations also offer grants for the purchase of land for open space and greenways. Pennsylvania municipalities can offer agricultural easements for prime farmland areas through participation in the county program administered by Washington County's NRCS office.

One popular source of greenways in Pennsylvania is old railway corridors. DCNR's Rails to Trails grant program provides 50 percent match for such projects. Additional funding is available through the Pennsylvania Department of Transportation's Transportation Enhancement Program, as well as other funding sources. A former portion of the Baltimore and Ohio Railroad travels through the watershed and some effort has been made by local townships to convert this into a public trail.

## Recommendations

### Planning

- Plan for industrial zones and high-density development only in areas with available sewage and water services.
- Commission a study of scientifically determined floodplains in floodprone communities within the watershed.
- Utilize existing floodplain ordinances and enact ordinances to protect sensitive areas where needed.
- Enact Riparian Conservation Zone Ordinances to protect these areas from development pressures and reduce flooding potential.
- Distribute pamphlets and hold information sessions to inform landowners of the importance of keeping riparian zones intact; consider incentives for those who follow conservation practices in riparian zones.
- Maintain greenspace by requiring developers to set aside a certain amount of land for open space or to donate to an "open space fund."
- Develop a watershed environmental board to provide suggestions to local municipalities and share information about conservation practices.
- Form municipal partnerships to develop joint planning documents and coordinate meetings with representatives from municipalities throughout the watershed.
- Restrict certain kinds of development in sensitive areas such as floodplains, wetlands, and steep slopes.
- Utilize agricultural and other easements, where appropriate, to maintain the rural character of local municipalities.
- Contact other municipalities and organizations dedicated to development to research other planning options.

### Illegal Dumping

- Work to develop a PA CleanWays chapter in Washington County.
- Increase the number of garbage cleanups in the watershed and involve more groups and individuals in these activities.
- Conduct an inventory of illegal dumping areas in the watershed.
- Host special bulk waste days where people can bring items like tires, paint cans, or old appliances for a minimal fee.

### Other

- Report abandoned oil and gas tanks and other problems to DEP's Oil and Gas Southwest Regional Manager.

- Increase efforts to improve conditions of state roads, which are negatively impacted by flooding events and may pose safety hazards.

- Gather information about current mining permits in the watershed from the California District Mining Office, County Recorder of Deeds, and other sources, and maintain knowledge and information about special measures that can be taken by mining companies to minimize mining impacts, and landowner rights.

- Encourage landowner involvement in DCNR's Bureau of Forestry program to assist landowners in maintaining healthy forests and developing forestry management plans.

- Encourage landowner participation in the Conservation Reserve Enhancement Program and other programs offered by the local Natural Resource Conservation Service and Washington County Conservation District office to help agricultural landowners with implementing streambank fencing, crop rotation, and other best management practices on their properties.

# NATURAL RESOURCES ASSESSMENT

## Overview

The fertile lands and abundant geological resources, important to local economies in southwestern Pennsylvania, have also greatly altered the natural landscape. Nowhere is this more evident than in Washington County, which is the second leading producer of coal and is only 52 percent forested compared to approximately 60 percent for the state as a whole (Dominion study 2004). Though it also has been impacted by past disturbance, the Buffalo Creek valley is considered by residents and visiting naturalists to contain example habitats of what once abounded in Washington County. A number of natural areas in the Buffalo Creek watershed have recovered or are beginning to recover from disturbance, and the lack of mining impacts make this watershed unique in the county.

Prior to this study, little information existed about the communities and species of the valley and surrounding area. This plan is different from usual watershed assessments in that a goal of the plan is to describe some of these attributes. This is considered necessary in order to identify possible threats to natural resources and to have a record of the area's natural heritage for future generations.

This chapter presents results of Western Pennsylvania Conservancy's (WPC) efforts to describe plants and animals in the Buffalo Creek watershed.

- The first section discusses "Plants and Plant Communities," including a list of plants identified through survey work by WPC's Botanist and descriptions of natural communities compiled by WPC's Community Ecologist.

- The second section discusses the "Wildlife" of the watershed, including diversity of birds, butterflies, mammals, amphibians and reptiles, mollusks, snails, and dragonflies, along with discussing requirements for these species.

- The third section discusses "Species of Concern," including those found in the West Virginia and Pennsylvania portions of the watershed.

- The fourth section describes "Areas Important For Conservation," including Natural Heritage Areas, Watershed Conservation Areas, High Quality Forest Areas, and the Buffalo Valley Important Bird Area.

- Finally, the chapter ends with a summary of findings and accompanying recommendations for protecting the natural resources of the Buffalo Creek watershed.

## Plants and Plant Communities

### Vascular Flora

#### *Scope of Work*

The term "vascular flora" refers to what most people typically consider to be "plants," those containing specialized tissues for transporting water and nutrients. A Checklist of Vascular Flora of the Buffalo Creek Watershed (Appendix A) was developed primarily from survey work performed for the Buffalo Creek Watershed Assessment and Protection Plan. It is supplemented by species reported by members of the Botanical Society of Western Pennsylvania. The list does not represent a comprehensive list of the species present in the watershed. The habitats most covered are floodplains and rock outcrops located in areas such as Buffalo Creek, Buck Run, and Dutch Fork Creek and tributaries such as Polecat Hollow.

The majority of the records on the plant list are based on sightings by experienced botanists, without supporting specimens. In some cases, especially when needed for confident determination to species, specimens were collected. These specimens are housed at the herbarium at the Carnegie Museum of Natural History.

***A rock outcrop along Buffalo Creek***

Appendix A also provides name and habitat information for each species in the hope that it will be useful to students of the flora of the area. If a habitat is checked, it does not necessarily mean that the species was observed in that habitat, but only that based on experience, the species could be expected in that habitat in this region. Typically, species do not necessarily restrict themselves to the habitats accorded to them on the list.

The habitat designation "Stream Banks and Sand Bars" was used for species that are characteristic of the edges of streams, i.e. a species that seem to be favored at the edge of a stream or on a sand bar, and is thus found in this habitat more frequently than elsewhere. However, almost any plant on the checklist could be found on a streambank, as streams border all of the other habitats listed.

The rock outcrops that were surveyed were mostly composed of sandstone or, in a few cases, shale. There are limestone-containing formations in the surface geology of the watershed, but no outcrops were encountered that appeared to be composed of limestone. In some cases, the presence of calciphiles (calcium-requiring plants) suggested that the sandstone is calcareous, and such calcareous sandstones are sometimes referred to as limestone. In the right-hand column of the checklist the letter "c" is included to indicate calciphiles. This designation was not used for species like basswood (*Tilia americana*), sugar maple (*Acer saccharum*), sharp-lobed hepatica (*Hepatica nobilis* var. *acuta*), and others that appear to have a preference, rather than a requirement, for such alkaline conditions.

### ***Species of Special Concern***

No plant species of conservation concern were encountered during this study, which was done only in the Pennsylvania portion of the watershed, and no populations of such are known in the Pennsylvania portion. Slender wheatgrass (*Elymus trachycaulus*) is known from the West Virginia portion of the watershed from a 1958 specimen (Pers. Comm., B. Sargent)). This grass is listed in West Virginia as rare, and there is a proposal in Pennsylvania to add the species as Tentatively Undetermined, with the suggestion that it most likely fits the criteria for a designation of Pennsylvania Rare. Close by, the watersheds of Enlow Fork to the south and Raccoon Creek to the north each harbor numerous populations of state-rare plant species. Additional floristic work is warranted in this watershed, where much of the area currently occupied by early-successional forest has potential for recovery from past land-use impacts (mostly logging and agriculture). Several plant species that are not rare are worthy of some discussion as representative of the unique biota of the watershed.

Crepis rattlesnake-root (*Prenanthes crepidinea*) was thought to be quite rare until a few years ago (Isaac 2000). However, the species was significantly under-documented, probably due largely to the fact that individual plants live for several to many years, but flower only once in their last season of life (monocarpic) and individuals that are not yet of flowering age senesce (die off) well before flowering time in the fall. Since plants with only leaves present are ignored by many botanists, and are even less likely to be collected, the species often went unnoticed in the spring and early summer, the only period during which all individuals are apparent. *Prenanthes crepidinea* was not reported within the Buffalo

Creek watershed until collected by Bonnie Isaac et al. in April of 2000 (Isaac 12118; Isaac CM; Isaac YUO). During this study, crepis rattlesnake-root was found not only in floodplains, to which it is usually restricted in Pennsylvania, but also on a steep slope containing many groundwater seeps. Isaac (pers. comm.) concurs that the species is found above the floodplains more frequently in the southwest corner of Pennsylvania than in other parts of the state. From the sparse habitat data available from specimens collected further south and west (compiled in Isaac, 2000), this might reflect greater ecological amplitude of the species closer to the center of its distribution.

***Trillium sessile, found in a seep at Polecat Hollow***

A number of species found within the Buffalo Creek watershed are near the northern (and sometimes eastern) limit of their range, and are absent or rare further north or east in Pennsylvania. The most conspicuous of these species are the buckeyes (*Aesculus flava* and *A. glabra*). Other species in this category include dwarf larkspur (*Delphinium tricorne*), appendaged waterleaf (*Hydrophyllum appendiculatum)*, toadshade (*Trillium sessile*), valerian (*Valeriana pauciflora*), Canada leafcup (*Polymnia canadensis*), one of the small-flowered crowfoots (*Ranunculus micranthus*), Short's aster (*Symphyotrichum shortii*), and goose-foot corn-salad (*Valerianella chenopodiifolia*). Canada waterleaf (*Hydrophyllum canadense*) is sporadically distributed around Pennsylvania, but only in the three most southwestern counties does it so dominate some floodplains that at first one might think it forms a monoculture in the herbaceous layer, until a closer examination reveals the high diversity of herbaceous species intermingled.

### ***Non-native exotic plant species***

Of the 337 species found in the watershed (Appendix A), 61 (or 18 percent) are not native to the region. This figure is considerably lower than the 37 percent reported for Pennsylvania as a whole by Rhoads and Klein (1993). This is partly due to the high number of introduced species in the Philadelphia area, which, in addition to being the most urbanized area in the state, hosts major international port facilities. Mostly, though, the low proportion of non-native species on the list is due to the fact that recording all species in highly disturbed areas, such as roadsides or residential areas, was not attempted. Furthermore, non-native conifer species found in plantations were not included.

Some of the most common invasive species in the watershed include bush honeysuckle (*Lonicera morrowii*), multiflora rose (*Rosa multiflora*), autumn olive (*Elaeagnus umbellata*), and Japanese barberry (*Berberis thunbergii*). They are most prevalent in old fields, somewhat open forests (forests dominated by oak species), and along roadsides. These species are of greatest concern in red oak-mixed hardwood forest and dry oak-mixed hardwood forest communities and any forest following logging (clear-cutting or otherwise). The native understory, which is adapted to the higher light conditions characteristic of oak-dominated forests may suffer from increased shade following invasion of non-native shrub species.

Additional invasive species in the watershed include garlic mustard, tree of heaven, Japanese knotweed, and mile-a-minute weed. Garlic mustard (*Alliara petiolata*) is a common invader of partly shaded forest understories and forest and stream edges. In the watershed, it appears to concentrate along dirt roads next to forests, where it eventually enters the understory and may alter habitat for species of butterflies, birds, and other animals. Tree of heaven (*Ailanthus altissma*) is a fast-growing and dispersing tree that spreads in disturbed areas, altering natural habitats. It is common in the watershed in early-successional forests that have been recently logged and is often accidentally introduced by way of contaminated logging equipment. Japanese knotweed (*Polygonum cuspidatum*) is one of the most serious threats to natural habitats in Pennsylvania. It spreads quickly in disturbed areas along streams to form dense thickets that exclude native vegetation. Though it is not yet prevalent in the watershed, populations of Japanese knotweed have been found mainly in the Indian Camp subwatershed and in the Upper Dutch

Fork Creek subwatershed. Finally, mile-a-minute weed (*Polygonum perfoliatum*) is another dominant invasive species in the immediate Buffalo Creek valley area. It has become the most abundant species in the area surrounding the Green Cove Wetland Area where its seeds are likely dispersed by both birds and water.

Many of the non-native species in the watershed represent significant ecological problems. Others, while non-native, do not greatly threaten native plant and animal species and communities. Control programs for these non-native plant species vary depending on the size of the population, the habitat (i.e. wetland or upland), etc. While this report does not identify specific management techniques, general management recommendations for all non-native invasive plant species should include identification and mapping of all non-native plant epicenters when found, and possible removal through means such as physical removal, burning, and use of herbicides. Though the spread of most invasive species in general is difficult to prevent, concentrated efforts could protect important ecological areas. Examples include mechanical removal of garlic mustard at Polecat Hollow and use of herbicides on alianthus in the Narigan Run valley. Efforts aimed at preventing the spread of Japanese knotweed would be one of the most important steps towards protecting native species in the Buffalo Creek valley. This species is not yet common within the watershed, although its spread could greatly alter native communities.

## Plant Communities

One of the goals set in developing this plan was to identify characteristic plant communities within the Buffalo Creek watershed. A plant community is an assemblage of plant populations sharing a common environment and interacting with each other, with animal populations, and with the physical environment (Fike 1999). The objective of this section is to classify and describe the terrestrial and palustrine (wetland) plant communities within the Buffalo Creek watershed. This section attempts to describe all of the human-created and managed communities, excluding agricultural lands, residential property, and pine plantations.

### *Scope of Work*

Plant communities in the three main sections of the Buffalo Creek watershed were visited from August to October 2003 and again in May and September 2004. Plant species inventories were conducted and vegetation communities were determined according to Fike (1999). The three main areas visited during this time were State Game Lands 232 (newly acquired Allegheny Power lands), and an area in the vicinity of Dutch Fork Reservoir. Limited surveys were conducted on private land throughout the watershed. GPS locations were taken at each of the sites and the structure, composition, and quality of the vegetative communities was assessed. At each GPS point, the dominant species in the overstory, sub-canopy, shrub, and herbaceous layers were identified and recorded. Physical site characteristics recorded included the following: slope aspect and percent, topographic position, estimated soil drainage, estimated soil texture, and percent of un-vegetated surface (estimated by percent coverage of bedrock, litter, rocks, sand, bare soil, and water). Invasive species were documented, as well as successional state. The quality of the community was estimated by numbers of exotic species present and number of early-successional species versus late-successional species (i.e. black cherry and black walnut versus sugar maple). Points were downloaded and mapped in ArcView. Non-GPS monitoring points were noted on a paper map and then digitized in ArcView.

### *Community Descriptions*

The descriptions of the community types within the Buffalo Creek watershed are organized within the following broader categories: creeks and associated floodplain forests, open wetlands, mesic forests, dry hardwood forests, and early-successional plant communities. Within each broad community category, communities are described based on the dominant plant species and physiognomic state (i.e. woodland versus forest). There may be additional species found in the communities that are not listed. There is no dichotomous key to the community types presented. However, readers of this report should be able to use this to classify most plant communities found in the watershed.

## Dry Hardwood Forest Types

•**Red oak-mixed hardwood forest**: This forest type is common on low to mid slopes on well-drained soil throughout the watershed. Much of the remaining oak forests exist only because the percent slope was too high for logging activity. One important characteristic of these forests is that while the red oak and other oak species dominate the canopy layer, the subcanopy is often dominated by maples and beech, suggesting a successional shift towards hardwoods other than red oak.

Quality examples of this forest type are found in the Dog Run watershed along Dog Run Road and mid to lower slopes of tributaries to Dutch Fork Lake. Small patches of older growth red oak-mixed hardwood forests are found on steep slopes of small creeks and narrow ridge tops.

Canopy (overstory): red oak (*Quercus rubra*), white oak (*Q. alba*), sugar maple (*Acer saccharum*), red maple (*A. rubrum*), shagbark hickory (*Carya ovata*), American beech (*Fagus grandifolia*), and black walnut (*Juglans nigra*)

Subcanopy: often composed of tree species other than oaks, including, but not limited to, sugar maple, American beech, American elm (*Ulmus americana*), sassafras (*Sassafras albidum*), flowering dogwood (*Cornus florida*), shadbush (*Amerlanchier arborea*), and red maple

Shrubs: spice bush (*Lindera benzoin*) and blackhaw (*Viburnum prunifolium*)

Herbaceous species: halberd leaved violet (*Viola hastate*), bloodroot (*Sanicula Canadensis*), rattlesnake fern (*Botrychium virginianum*), woodland stone crop (*Sedum ternatum*), Jack in the pulpit (*Arisaema triphyllum*), bigleaf aster (*Aster macrophyllus*), longstyle sweetroot (*Osmorhiza longistylis*), Clayton's sweetroot (*O. claytonia*), Canadian clearweed (*Pilea pumila*), Christmas fern (*Polystichum acrostichoides*), flattened oat grass (*Danthonia compressa*), and roundleaf greenbrier (*Smilax rotundifolia*)

•**Dry mixed oak forest**: This type is found on mid to upper slopes on somewhat excessively drained soils. The presence of blueberries indicates that the soil is dry and acidic and their presence is an important distinction between this type and the red oak-mixed hardwood forest type. Soils are generally more acidic than those supporting either the red oak-mixed hardwood, sugar maple, or mesic sugar maple-basswood forest types.

Key examples of this forest type can be found on the upper slopes and ridge tops in the Buck Run watershed. Because of the value of oak lumber, only small patches of older growth dry oak forest remain.

Canopy: white oak (*Quercus alba*), red oak (*Q. rubra*), chestnut oak (*Q. montana*), and pignut hickory (*Carya glabra*)

Shrubs: witch hazel (*Hamamelis virginiana*), flowering dogwood (*Cornus florida*), alternate-leaved dogwood (*C. alternifolia*), and blueberries (*Vaccinium sp.*)

## Mesic Hardwoods Forest Types

•**Tulip tree-elm-maple forest**: This type is found at lower slopes along creek bottoms in the upper reaches of tributaries to Buffalo Creek where no developed floodplain exists. Soils are rich in organic matter and are often saturated due to the prevalence of seeps. There is often evidence of relatively recent logging (decaying stumps, logging roads, etc.). Good examples of this forest type can be found on the lower slopes in the Narigan Run ravine valley.

Canopy: American elm (*Ulmus americana*), slippery elm (*U. rubra*), sugar maple (*Acer saccharum*), tulip tree (*Liriodendron tulipifera*), red ash (*Fraxinus pennsylvanica*), and red maple (*A. rubrum*)

Shrubs: spice bush (*Lindera benzoin*) and elderberry (*Sambucus nigra ssp. Canadensis*)

Herbaceous species: common violet (*Viola sororia*), Virginia springbeauty (*Claytonia virginiana*), dogtooth violet (*Erythronium americanum*), woodland stone crop (*Sedum ternatum*), chickweed (*Stellaria sp*.), common cinquefoil (*Potentilla simplex*), white wood aster (*Aster divaricatus*), Pennsylvania sedge (*Carex pensylvanica*), hoary vervain (*Verbana Stricta),* skunk cabbage (*Symplocarpus foetidus*), and bristly greenbrier (*Smilax tamnoides*)

•**Sugar maple-beech forest**: Sugar maple and American beech dominate the canopy of this type found on mid to upper slopes with mesic (wetter) conditions. There are often seeps and saturated soils associated with this forest type, but it is not restricted to lower slopes along small tributaries.

***Jumpseed, Polygonum virginianum, is a common plant species in the watershed***

Canopy: primarily sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia),* also including tulip tree (*Liriodendron tulipifera*), red oak (*Quercus rubra*), American elm (*Ulmus americana*), slippery elm (*U. rubra*), and red ash (*Fraxinus pennsylvanica*)

Shrubs: alternate-leaved dogwood (*Cornus alternifolia*), spice bush (*Lindera benzoin*), multiflora rose (*Rosa multiflora*), and elderberry (*Sambucus nigra ssp. Canadensis*)

Herbaceous species: spinulose wood fern (*Dryopteris carthusiana*), smooth and hairy sweet cicely (*Osmorhiza longistylis, O. claytonii*), hairy Solomon's seal (*Polygonatum pubescens*), littleleaf buttercup (*Ranunculus abortivus*), white avens (*Geum canadense*), waterleaf (*Hydrophyllum sp.*), king of the meadow (*Thalictrum pubescens*), garlic mustard (*Alliaria petiolata*), purple phlox (*Phlox divaricata*), jewelweed (*Impatiens sp.*), white wood aster (*V.stricta*), common blue violet (*V. sororia*), dwarf larkspur (*Delphinium tricorne*), large-flowered trillium (*Trillium grandiflorum*), ground-ivy (*Glechoma hederacea*), eastern woodland sedge (*Carex blanda*), and mayapple (*Podophyllum peltatum*)

•**Mixed mesophytic**: This type is specific to the southwestern part of Pennsylvania and includes several species at their northern and eastern limits (Fike 1999). This forest has a high diversity of canopy trees including Ohio buckeye and yellow buckeye. It is very challenging to distinguish this type from beech and sugar maple types that happen to be close to the river floodplain. More work needs to be done to find specific examples of this forest type within the watershed and to distinguish it from other types with uncharacteristically high species diversity.

Canopy: Ohio buckeye (*Aesculus glabra*), yellow buckeye (*A. flava*), black walnut (*Juglans nigra*), cucumber tree (*Magnolia acuminata*), white ash (*Fraxinus americana*) shagbark hickory (*Carya ovata*), and all of those mentioned in the sugar maple-beech forest type

Shrub and herbaceous species: Pawpaw (*Asimina triloba*), red bud (*Cercis canadensis*), bladdernut (*Staphylea trifolia*), witch hazel (*Hamamelis virginiana*), spicebush (*Lindera benzoin*). There is great diversity in the herbaceous species.

**Disturbed Habitats**

There are several former agricultural fields within the Buffalo Creek watershed that have been out of active agriculture production for many years. Commonly located on ridge tops, plant communities vary greatly with respect to dominant species, but, generally, these types consist of an open canopy of small (<20 cm diameter at breast height) trees and shrubs that are able to colonize former crop and pastureland. Many non-native plant species dominate the shrub and herbaceous layers.

•**Old field:** This type can be described as a meadow dominated by forbs and grasses that occurs on a site that has been cleared and plowed for farming or development, and then abandoned. Shrubs may be present but comprise less than 50 percent cover in the community, and exotic shrubs sometimes dominate. Within the Buffalo Creek watershed, these occur primarily on low to moderate slopes and ridge tops where forests were cleared for crop and pastureland. Following abandonment, former agricultural land has succeeded from old field to woodland and may, in time, develop once again into forest. The old field type is distinguished from the post-agricultural black walnut-early-successional woodland type by the absence of a canopy.

Shrubs: patches of hawthorns (*Cretaegus sp.)*, gray dogwood (*Cornus foemina*), arrowwood (*Viburnum dentatum*), raspberries and blackberries (*Rubus spp.*), sumac (*Rhus typhina, R. glabra*), eastern red cedar (*Juniperus virginiana*), and exotic shrubs such as honeysuckle (*Lonicera spp*.), multiflora rose (*Rosa multiflora*), Japanese barberry (*Berberis thungbergii*), bush honeysuckle (*Lonicera sp.),* and autumn olive (*Elaeagnus umbellatus*)

***Wild grapes are found in some early-successional areas***

Herbaceous species: goldenrods (*Solidago altissima, S. nemoralis, S. rugosa, S. canadensis, S. juncea, S. canadensis,* and *Euthamia graminifolia*), bluegrass (*Poa pratensis*), timothy (*Phleum pratense*), sweet vernal grass (*Anthoxanthum ododatum*), orchard grass (*Dactylus glomerata*), calico aster (*Aster lateriflorus*), wild strawberry (*Fragaria virginiana*), Queen Anne's lace (*Daucus carota*), ragweeds (*Ambrosia spp.*), hawkweeds (*Hieracium spp.*), and dandelion (*Taraxicum officinale*)

•**Post-agricultural-successional shrubland**: This habitat type occurs on sites that have been cleared and plowed for farming or development, and then abandoned, or otherwise disturbed. Shrubs comprise over 50 percent cover. This community usually contains species from the old field forest type and is the result of succession from this type over time. These areas are often heavily impacted by exotic species, such as honeysuckle, multiflora rose, Japanese barberry, and others. A similar community type defined by Fike is the Black Locust Community (1999). However, few places surveyed in State Game Lands 232 were dominated by black locust.

Common species: hawthorns (*Cretaegus spp*.), serviceberries (*Amelanchier spp.),* raspberries and blackberries (*Rubus spp.*), sumac (*Rhus typhina, R. glabra*), eastern red cedar (*Juniperus virginiana*), honeysuckle (*Lonicera spp*), multiflora rose (*Rosa multiflora*), and Japanese barberry (*Berberis thungbergii)*

•**Post-agricultural black walnut-early-successional woodland**: This type is found primarily on low to moderate slopes and ridge tops where forests were cleared for crop and pastureland. Following abandonment, former agricultural land succeeded from old field to woodland and may, in time, develop once again into forest. This type is most often characterized by the dominance of small (<10 cm), early-successional species in the overstory.

There are many good examples of this type throughout the Buffalo Creek watershed. The best examples are found on ridge tops and slopes surrounding Dutch Fork Lake and other areas on State Game Lands 232. There is often evidence of agricultural activities associated with these communities.

Canopy: black walnut (*Juglans nigra*), black locust (*Robinia pseudoacacia*), black cherry (*Prunus serotina*), and elms (*Ulmus americana* and *U. rubra*)

Subcanopy: black raspberry (*Rubus occidentalis*), blackberry (*R. allegheniensis*), multiflora rose (*Rosa multiflora*), poison ivy (*Toxicodendron radicans*), and riverbank and summer grapes (*Vitis riparia* and *V. aestivalis*)

Herbaceous species: striped cream violet (*Viola striata*), tall hairy agrimony (*Agrimonia gryposepala*), jumpseed (*Polygonum virginianum*), spotted lady's thumb (*Polygonum persicaria*), avens (*Geum canadensis*), black snakeroot (*Sanicula canadensis*), calico aster (*Aster lateriflorus*), garlic mustard (*Alliaria petiolata*), white snakeroot (*Eupatorium rugosum*), Christmas fern (*Polystichum acrostichoides*), and spotted water hemlock (*Cicuta maculate*)

### Floodplains

•**Sycamore–box elder floodplain forest:** Floodplains of the larger creeks of the Buffalo Creek watershed (Buffalo Creek, Buck Run) are broad with little or no slope. Several micro sites occur within the floodplain and may affect water relations, and thus species composition. Sycamore and eastern cottonwood dominate this forest type found within the floodplains of Buffalo Creek, Buck Run, and other larger creek systems.

Good examples of this type are found along Buck Run Creek.

Canopy: sycamore (*Platanus occidentalis*) and eastern cottonwood (*Populus deltoids*)

Subcanopy: black willow (*Salix nigra*), box elder (*Acer negundo*), yellow buckeye (*Aesculus octandra*), and Ohio buckeye (*A. glabra*)

Shrub: spice bush (*Lindera benzoin*), black raspberry (*Rubus occidentalis*), willows (*Salic* sp.), and multiflora rose (*Rosa multiflora*)

Herbaceous species: clearweed (*Pilea pumilla*), jewelweed (*impatiens sp*.), lady's thumb (*Polygonum persicaria*), deer tongue grass (*Panicum clandestinum*), calico aster (*Aster lateriflorus*), crooked-stem aster (*Aster prenanthoides*), woodreed (*Cinna arundinacea*), wingstem (*Verbesina alternifolia)*, bottlebush grass (*Elymus histrix*), beggarticks (*Bidens sp*.), purpleleaf willowherb (*Epilobium coloratum*), bitter dock (*Rumex obtusifolius*), nettle (*Urtica dioica*), whitegrass (*Leersia virginiana)*, and white snakeroot (*Eupatorium rugosum*)

•**Herbaceous/Shrub-dominated floodplain wetlands**: This type is characterized by saturated soils and a lack of canopy; it is dominated by shrubs and herbaceous species.

Shrubs: willows (*Salix spp.*), silky dogwood (*Cornus amomum*), and black raspberry (*Rubus occidentalis*), as well as non-native multiflora rose (*Rosa multiflora*) and bush honeysuckle (*Lonicera sp*.)

Herbaceous species: wingstem (*Verbensia alternifolia*), stinging nettles (*Urtica dioica*), Canada nettle (*Laportea canadensis*), false nettle (*Boehmeria cylindrica*), jewelweed (*Impatiens sp.*), lady's thumb (*Polygonum persicaria*), deer tongue grass (*Panicum clandestinum*), calico aster (*Aster lateriflorus*), crooked-stemmed aster (*Aster prenanthoides*), sweet woodreed (*Cinna arundinacea*), bottlebush grass (*Elymus histrix*), beggarticks (*Bidens sp.*), purpleleaf willow herb (*Epilobium coloratum*), poke weed (*Phytolacca americana*), clearweed (*Pilea pumilla*), bitter dock (*Rumex obtusifolius*), white grass (*Leersia virginiana*), sedges (*Carex spp.*), and white snakeroot (*Eupatorium rugosa*)

Good examples of this type are found along Buck Run creek.

•**Black maple-elm creek floodplain**: This type is found along the floodplain and lower slopes of smaller creeks and streams of the Buffalo Creek watershed. Streams are usually on top of bedrock and the floodplains are characteristically narrow with very steep slopes. Species in this type are often a combination of the forested and herbaceous floodplain types and upland sugar maple and red oak types. Species composition varies considerably and includes species from both types. Soils are often somewhat high in pH (~6.5) and there are usually seeps flowing from the slopes. Furthermore, there is the chance that in these sites, water comes in contact with limestone.

There are many good examples of this type throughout the Buffalo Creek watershed. The best examples are found along small tributaries of Dutch Fork Lake.

Overstory: black maple (*Acer nigrum*), sugar maple (*A. saccharum*), tulip tree (*Liriodendron tulipifera*), American elm (*Ulmus Americana*), and slippery elm (*Ulmus rubra*)

Understory: sugar maple and black maple saplings dominate

Herbaceous species: Virginia creeper (*Parthenocissus quinquefolia*), large-flowered trillium (*Trillium grandiflorum*), smooth and hairy sweet cicely (*Osmorhiza longistylis*, *O. claytonii*), cut-leaved grape fern (*Botrychium dissectum*), Christmas fern (*Polystichum acrostichoides*), trout lily (*Erythronium americanum),* false Solomon's seal (*Smilacina racemosa*), stinging nettle (*Urtica dioica*), and smooth rock cress (*Arabis laevigata*)

### Streambanks and sandbars

There are numerous species that depend on the changing environment of streambanks and sandbars. Some of these are the same species that are found in the floodplain communities. Further surveys for these species are needed.

## Wildlife

### Birds

#### *Birds of Buffalo Creek Watershed*

The diversity of habitats in the Buffalo Creek watershed support a wide range of bird life, including an abundance of migratory birds, wintering birds, wading birds, hawks, and owls, according to recent surveys by PA Audubon and the Three Rivers Birding Club. It was because of this diversity that the Buffalo Creek valley was recently named the 80th IBA in Pennsylvania. The Three Rivers Birding Club has adopted the watershed and conducts bird outings there on a regular basis. Additionally, the first annual winter bird count was held in January 2004, and a second event was held in December 2004.

***Barn Swallows utilize the new bluebird boxes at Green Cove Wetlands***

The Buffalo Creek watershed is part of the Ohio Hills Bird Conservation Region, which is designated by Partners in Flight, an agency dedicated to bird conservation in North America. It is considered one of the highest priority regions for conservation in the northeastern United States due to its concentration of high priority and declining bird species. Within Pennsylvania, much of the landscape surrounding the watershed has been altered due to development. Portions of the Buffalo Creek valley contain important remaining habitats appropriate for forest-interior bird species.

Forest-interior species require a certain number of relatively intact, forested acres for viable, breeding populations. Among the species of highest concern in the Buffalo Creek watershed is the Cerulean Warbler, of which 54 pairs were found during a June 2003 survey. The Ohio Hills remains the most critical physiographic province for Cerulean Warblers in the United States, containing at least 50 percent of the breeding habitat (Ohio Hills Conservation Plan). Forest management planning, including the protection of forest corridors, is badly needed to protect this and other forest species, which also include the Worm-eating Warbler, Acadian Flycatcher, Louisiana Waterthrush, and Eastern Wood Pe-wee. Forestry management in the watershed must allow for contiguous acres of mature forest to support these species into the future. Much of the forested land in the watershed is under ownership of the Pennsylvania Game Commission (PGC). However, there are currently no management plans in place by the PGC to protect these species. Future action should include detailed management plans by the PGC to protect forest-interior birds on State Game Lands 232.

In addition to these migratory forest birds, the watershed has a large population of year-long residents, including many scrub/shrub species. In January 2004, volunteers from the Three Rivers Birding Club, BCWA, and other conservation groups joined together for the first annual winter bird count focused on the watershed. Unfortunately, severe flood conditions prevented a thorough count. Despite this, 2,570 birds were counted, with 51 winter species documented, including large populations of song sparrow and white-crowned sparrow. On December 26, 2004 the second winter count, under cold but drier conditions, tallied 4,367 birds of 59 species. Notable in both counts are the sparrow populations, averaging the following during both counts: White-Crowned Sparrows (150), Tree Sparrows (70), Song Sparrows (110). December 2004 yielded much higher numbers of Northern Mockingbirds (92), American Bluebirds (65), Redtailed Hawks (46), American Kestrels (16), and four species of owls. A few other species of interest during the second count were Rough-legged hawk, Rusty Blackbird, Chipping Sparrow, and American Phoebe.

***The Northern Parula, pictured along Buck Run, rarely nest in forests that do not contain moss and lichens***

Buffalo Creek also contains possibly the largest population of wading birds that can be found in Washington County. Heron rookeries (nesting areas) have been found along undisturbed areas around Dutch Fork Creek and Buffalo Creek, where the birds feed primarily on small fish. Volunteers have identified over 50 nests. The presence of these birds is somewhat controversial, as they compete with humans for fish within rivers and ponds.

The PGC has improved the habitat for herons and other wading birds by restoring wetlands in the watershed, attracting species like Green Herons and Spotted Sandpipers, also migrating birds such as bitterns and egrets and shorebirds such as Greater and Lesser Yellowlegs. The seasonal lowering of the pools also creates habitat for many species.

In total, at least 180 species of birds have been recorded in the Buffalo Creek watershed, with close to 100 breeding species. See Appendix B for a complete list of birds that have been identified.

### ***Important Habitats***

#### **Forests**

Although approximately 50 percent of the land in the watershed is forest, much of this is early-successional growth, containing habitat undesirable for birds requiring more mature and intact forests. Important areas for these forest birds include State Game Lands 232 along Buck Run Road, the Camp Buffalo Road area, Narigan Run, Dog Run (lower, near waterfall), Welch Run, and Polecat Hollow. These tend to be mid-successional, healthy sugar maple and oak mixed hardwood forests with a layered forest structure. These species also need corridors between large forest fragments to migrate. When many of the other forests in the watershed were surveyed, they were found to contain early-successional species such as locusts, young hickories, and multiflora rose. Few interior forest specialist bird species were found. However, these more successional areas may provide a buffer that contributes to the high diversity of the more mature forest areas. Much of this forested acreage is part of a tract recently acquired by the PGC from West Penn Power and have remained relatively untouched in the last 30 years. Portions of some of the important forest habitat for birds, such as Narigan Run and Polecat Hollow, are privately owned.

#### **Wetlands**

Most of the current wetland habitat is a result of restoration projects undertaken by the PGC. Though each one of the restored wetlands creates a unique habitat, the Green Cove Wetland has been the most successful and abounds in bird life. Waterfowl species include breeding Wood Ducks; waders include Great Blue Herons, Green Herons, raptors, Nighthawks, swifts, and Belted Kingfishers. Passerines include Tree Swallows, Kingbirds, vireos, warblers, blackbirds, and others, which forage for food in and around the wetlands. Additionally, a pair of American Bitterns and a Great Egret were identified during spring migration in 2004. Two other wetland areas present near the intersections of Buffalo Creek and Buck Run have been gradually becoming more popular among waterfowl, but have yet to be as preferred by birds as Green Cove.

#### **Grasslands**

Succession is the most serious threat to grassland habitat in the watershed, as lack of removal of woody vegetation results in the conversion of abandoned fields to scrub/shrub habitat. Pastures and hayfields can serve as habitat for grassland birds, if hay is harvested later in the season and pastures are not heavily grazed. The PGC periodically mows some of its fields, such as the Camp Buffalo area, during non-breeding seasons to maintain them as grasslands. The Camp Buffalo grassland/wet meadow supports a variety of sparrows, blackbirds, and ground-nesting species. Many of the grassland birds are likely inhabiting non-intensively managed private fields. For instance, a Bobolink pair is routinely spotted in such a field along Post Road in Blaine Township. Intensively managed areas, such as yards and most pastures and cropland, do not provide appropriate habitat for grassland birds.

***A pasture providing appropriate habitat for this Bobolink, found along Post Road***

#### **Scrub/shrub**

There is currently no shortage of scrub/shrub areas for birds. Clear-cuts and old fields eventually become scrub/shrub, if not managed otherwise. Management for game species usually supports scrub/shrub habitats. These habitats can be found almost anywhere in the watershed, such as along agricultural streams and Buck Run Road, where a previous clear-cut has encouraged species such as multiflora rose to invade. Notable bird species found in these types of habitats include the Blue-winged Warbler, Yellow-breasted Chat, Indigo Bunting, Blackbird, Song Sparrow, White-crowned Sparrow, and Wood Thrush. These species often nest low to the ground. During the winter bird survey, a birder observed that the watershed may have one of the highest concentrations of wintering scrub/shrub species, including the Song Sparrow and White-crowned Sparrow, in Pennsylvania. These high populations were observed in PGC land near the Green Cove Wetlands and the new wetlands on State Game Lands 232.

***Bird Species of Conservation Concern***

In Pennsylvania, wetland and grassland habitats are considered the most threatened. Forest species are considered to face a much smaller threat because most of the state is forested. However, because many species have ranges that comprise only a section of the state, regional trends are often more indicative. This is true for migratory forest-interior species found in the Ohio Hills Bird Conservation Region.. Although species such as the Acadian Flycatcher, Worm-eating Warbler, Louisiana Waterthrush, and Cerulean Warbler can be found within a larger range, a core of their population is found in the Ohio Hills, which in Pennsylvania includes the southwestern portion. These forest-interior species are the most significant birds of concern in the watershed and require more forested acreage to survive as the fragmentation of forested land increases. For example, research shows that in a 40 percent forested landscape, 476 acres are needed to maintain a large Scarlet Tanager population, while only 62 acres are needed if the area is 60 percent forested. This species is considered an umbrella species, or good indicator of bird diversity: a recent study showed that 12 other species of high conservation priority were commonly found in plots containing Scarlet Tanagers (Rosenberg 1999).

The quality of habitat available can be just as important as the acres of forest. For instance, the Cerulean Warbler requires more mature forests of an uneven structure, with distinct canopy layers (Rosenberg 2000). The Louisiana Waterthrush is found along smaller streams with intact riparian zones and good water quality, where it feeds on aquatic macroinvertebrates. Grassland birds, which are considered to be declining in Pennsylvania, are not as common in the watershed. Most of the abandoned fields have reverted to scrub/shrub habitats, pastures receive intense grazing pressure, and few strip mine grasslands exist. Uncommon species such as Bobolink, Henslow's Sparrow, and Field Sparrow are present, but in small numbers.

The Red-headed Woodpecker, which was positively identified in the watershed in 2004, is a species of conservation concern. Its decline has been attributed to road mortality and loss of habitat, including clear-cuts, agricultural development, channelization, and the loss of orchards. Red-headed Woodpeckers inhabit multiple habitats containing large forest fragments with dead trees for nesting, often located near agricultural fields where they forage for food.

Table 2-1 lists birds of conservation concern found in the Pennsylvania portion of the watershed, according to their PA Audubon and Partners in Flight status and the Audubon Society, an organization dedicated to bird conservation in the United States. Birds of Conservation Concern are considered to be those that are thought to be declining in all or part of their range or to have significant threats within their migratory or breeding ranges. In addition to these species, which are also likely inhabitants of the West Virginia portion, the barn owl was positively identified in the West Virginia portion in 2004. This species is considered rare in West Virginia. There is no current confirmation of barn owls in the Pennsylvania portion.

| Table 2-1. Birds of Conservation Concern | | |
|---|---|---|
| *Cerulean Warbler | Field Sparrow | Bobolink |
| *Worm-eating Warbler | Henslow's Sparrow | Scarlet Tanager |
| *Wood Thrush | Blue-gray Gnatcatcher | Chimney Swift |
| *Blue-winged Warbler | Yellow-breasted Chat | Black-billed Cuckoo |
| *Willow Fly-catcher | Indigo Bunting | Yellow-throated Warbler |
| *Acadian Flycatcher | Eastern Phoebe | Red-headed Woodpecker |
| Louisiana Waterthrush | Great-crested Flycatcher | American Bittern (non-breeding) |
| Yellow-throated Warbler | Eastern Towhee | Great Egret (non-breeding) |
| Great Blue Heron | | |

* these birds are on the Audubon Watch List

## Butterflies

### Butterflies of the Buffalo Creek Watershed

Indicator species are those that either signal the presence or abundance of other species or changes in the physical environment through their presence. Butterflies are becoming more widely accepted as ecological indicators because of their habitat, light, and temperature requirements. Many butterflies feed and lay their eggs on specific plant species. They are also at a low trophic level, which allows them to respond quickly to environmental stress. Changes in the presence or abundance of certain species of butterflies may indicate shifts in key habitat necessary for their survival.

***Milbert's tortoiseshell butterfly, photographed at Green Cove Wetland Area***

Two butterfly walks were held (in conjunction with dragonfly/damselfly walks) in order to obtain baseline information on butterfly species found in the Buffalo Creek watershed. Data was qualitative, and numbers of individuals from each species were not recorded in most cases. Organizations partnering with WPC included BCWA, the Buffalo Valley Alliance, the Three Rivers Birding Club, and Westmoreland Bird and Nature Club. Dramatic shifts in the presence of some of the species identified in the future could indicate changes in habitat availability. Continued monitoring of the butterflies in the watershed will provide important insight into the health of these areas.

| Table 2-2. Distribution of Butterfly Species By Family | | |
|---|---|---|
| **Family** | **Description** | **#** |
| nyphalidae | brush-legged butterflies | 13 |
| hesperiidae | skippers | 11 |
| lycaenidae | gossamer-winged butterflies | 8 |
| papilionidae | swallowtails | 4 |
| pieridae | whites and sulfurs | 3 |

A total of 39 species of butterflies were identified in the Buffalo Creek watershed according to Table 2-2. A complete list can be found in Appendix C. Brush-legged butterflies make up the majority of species that can be found in Pennsylvania and in the watershed. These include fritillaries, satyrs, monarchs, and tortoiseshells. Probably the most unique find was Milbert’s tortoiseshell, which meets the southernmost point of its range in the watershed and has never before been recorded for Washington County. Skippers were also abundant, and there are likely many more species of skippers in the watershed yet to be identified. The majority of these small, fast butterflies identified were in the subfamily Hesperinae, called grass skippers because they feed on grasses as larvae. The firey skipper, identified during the second butterfly walk, is a grass skipper that breeds in the southern United States and South America. This species is likely a "stray," just passing through the watershed. Among the gossamer butterflies, a butterfly of special concern, the bronze copper, was identified. The bronze copper, a species of water edges that feeds primarily on curly dock as a caterpillar, is a species of concern in Pennsylvania.

The butterfly assemblage is often directly related to the types of habitat available. The butterfly walks surveyed only a small number of areas in the watershed, including primarily the areas surrounding Green Cove, Buck Run, and Route 232 wetlands, as well as forest and meadow habitat along Buck Run Road. Butterflies such as the monarch and American snout are migratory species that may breed in the watershed but depend on a variety of habitats over a large geographic area. Species such as eastern tiger swallowtail, black swallowtail, pearl crescent, and great spangled fritillary have a wide variety of weedy larval hosts and are found in numerous areas, such as gardens and roadsides.

**Table 2-3. Example Requirements of Some Butterflies Identified within the Buffalo Creek Watershed**

| | Hosts | Adult Food | Habitat |
|---|---|---|---|
| Milbert's tortoiseshell | nettles | thistles, goldenrods, wet areas, rotting fruit | wet areas near woodlands, moist pastures |
| bronze copper | herbs of the buckwheat family | blackberries, red clover | low, wet areas |
| American snout | hackberry | nectar from asters, dogbane, dogwood, goldenrods | forest clearings and edges |
| Aphrodite fritillary | violets | nectar from milkweeds and other flowers | prairies, high mountains, dry fields |
| eastern tiger swallowtail | leaves of basswoods, tulip, birch, ash, cottonwood, and willow trees | a variety of flowers, including wild cherry | deciduous woods, forests, parks, suburbs |
| northern pearly eye | grasses such as white grass, bearded shorthusk, and bottlebrush | dung, fungi, carrion, sap | damp woods near marshes or waterways |
| monarch | milkweeds | milkweed nectar, a variety of flowers | open habitats like fields and meadows |

***Pearl crescent is another common butterfly in Buffalo Creek, usually found in weedy woodland edges as was this individual seen along Colby-Young Road***

Among the butterflies sampled, two of the most dependent on local habitats include the meadow fritillary (open meadows) and common wood nymph (forests). The bronze copper is considered to be specific to pond edges containing its host plant, curly dock. Though Milbert's tortoiseshell inhabits a variety of habitats, it tends to be found in areas near nettles, which serve as host plants for the caterpillars of the species. Most of the species sampled, with the exception of the skippers (many of which were grass skippers), require an area near some type of woodlot or forest. These include question marks, red admirals, red-spotted purples, and eastern commas. Table 2-3 gives example requirements for some butterflies found in the watershed.

#### ***Butterflies of Conservation Concern***

Bronze copper (*Lycaena hyllus*) is an "S2" species in Pennsylvania, meaning that there are only six to 20 occurrences, or locations where the species has been documented in Pennsylvania. The species has been found in various standing water edges throughout the watershed. It is considered by some butterfly researchers to be "remnant dependent," which means it depends on and seeks out specific remaining habitats for its survival, likely water edges containing its host plant. Its caterpillar host plants are plants of the buckwheat family. In Pennsylvania, this primarily is curly dock (*Rumex crispus*), which is actually an exotic species that is rather abundant. It may be the mowing of host plants, on which the butterfly overwinters, that has contributed to its low numbers.

### Mammals

#### ***Mammals of the Buffalo Creek Watershed***

##### *Pennsylvania Mammal Records*

Many mammals are nocturnal and/or secretive in their habits, making them difficult to study without sophisticated or costly equipment and methods. As a result, the distribution of mammal species in Pennsylvania has not been thoroughly researched in most cases. The distribution depends largely on the presence of available habitats, current and historic. Many mammals, once extirpated (eliminated), may not easily re-colonize an area unless suitable habitat remains nearby. For instance, grassland-specialist mammals, such as the least shrew, are declining throughout the northeast as grasslands disappear due to succession and development.

##### *Important Mammal Area Project*

The Important Mammal Area Project recognizes areas with diverse populations of mammals and mammals of special concern. It is being carried out through an alliance of conservation organizations, sportsmen, wildlife professionals, and scientists. Important Mammal Areas are nominated by members of a community and determined by a board of experts called the Mammal Technical Committee. The decisions are based on five criteria, including the presence of diverse or unique mammal populations, high-density populations, the existence of threatened or endangered species, the existence of declining species, and the importance for public education (IMAP). The Buffalo Valley Alliance recommended the Buffalo valley for Important Mammal Area Status in 2003. The nomination reached level I, meaning that suitable habitat was found. The Buffalo valley ultimately did not move to level II of the process to reach Important Mammal Area status because of a lack of data available on the mammals in the watershed.

Though there is virtually no documentation on the mammals species in the watershed, a probable list of resident mammals can be extrapolated based on habitat availability and mammal specimens at the Carnegie Museum of Natural History's Mammals Section. The Buffalo Creek watershed has the potential to harbor a high diversity of mammals because of its varied habitats, including woodlands, wetlands, grasslands and meadows, scrub/shrub areas, and rock overhangs.

Based on specimens housed at the Carnegie Museum of Natural History Mammals Section, the Buffalo Creek watershed potentially houses 45 of the 70 species currently or historically found in Pennsylvania. Of the 70 Pennsylvania mammals, four (wolf, mountain lion, lynx) have either been extirpated or rarely occurred in the state, and their original distribution is not well known (Carnegie Museum of Natural History).

In general, the Buffalo Creek watershed potentially houses the common species of mammals found across Pennsylvania, as well those confined to either the western or southern portion of the state. The evening bat potentially reaches its northern limit in the watershed, while the fox squirrel is generally confined to the western portion of Pennsylvania, which includes the Buffalo Creek watershed. A number of species found throughout the rest of Pennsylvania, such as the star-nosed mole and short-tailed weasel, are conspicuously absent from Washington County, or southwestern Pennsylvania in general, because of climate or topography.

### ***Mammal Species of Special Concern***

No mammal species of special concern have currently been identified in the Pennsylvania portion of the Buffalo Creek watershed. In West Virginia, the meadow jumping mouse is considered a species of special concern and records show a 1987 occurrence from the Castleman Run Wildlife Management Area (Pers. Comm., B. Sargent). This species is likely found in the Pennsylvania portion, but is not considered a species of concern in Pennsylvania. Distribution records indicate endangered Indiana bat, least shrew, and Allegheny woodrat could potentially be in the watershed, though none of these species has yet been identified there.

### ***Important Habitats***

Forest edge refers to the portion of a forest that is adjacent to shrubland, residential land, or other non-forest habitats. Core forest, generally considered to be forested areas greater than 300 feet (100 meters) from a forest edge, is minimal in the watershed. Therefore, mammal species with large home ranges that require large forest areas--including the fisher, black bear, and bobcat, are unlikely residents (though the black bear has been seen using the area as a corridor) (Debinski, D. M. and R. D. Holt 2000). The forest tracts are large enough to easily support a variety of other forest-dwelling mammal species, especially small mammals with smaller ranges including woodland jumping mouse, fox squirrel, and smoky shrew (Grzimek 1975).

Interconnected forest fragments provide refuge for species requiring multiple habitats such as the red fox and the big brown bat. Conservation efforts to protect a mammal should take into consideration both home range (generally related to body size) and habitat constraints. Most of the larger tracts of forest in the watershed are located in the western portion of the watershed in State Game Lands 232. Mammals requiring larger forest tracts would likely be found mostly in this area (Trapp 1975). However, many of the smaller mammals additionally inhabit smaller forest tracts throughout the watershed, including near areas of human habitation. Mammals such as raccoons, opossums, minks, and shrews show an affinity for woodlands close to water with macroinvertebrates.

***Wet meadow located in the old Boy Scout camp, likely important for various small mammal species***

A large proportion of mammals require environments such as forest edges, grasslands, wet meadows, riparian zones, and scrub/shrub areas, or have multiple habitat requirements. Historically, southwestern Pennsylvania has been important for small mammals, which once depended on grasslands confined to that portion of the state (Pers. Comm., J. Hart). Now that grassland areas are disappearing in western Pennsylvania, strip mines (which are not regularly cultivated, interfering with breeding habits) constitute the majority of grasslands.

The primary habitats for grassland species in the watershed are recently abandoned and lightly used fields. Generally, cultivated fields do not provide good habitat for small mammals because tilling destroys small mammal breeding areas. An exception is the marmot or woodchuck (*Marmota monax*), which can be found occupying many such areas. No-till agriculture, or carefully timed tilling practices, may reduce the negative impact on small mammals. The PGC mows areas such as the former Boy Scout camp along Camp Buffalo Road to maintain them as grasslands. It is important to mow these areas in non-breeding seasons, such as late summer or early winter, to avoid destroying breeding habitat for birds and small mammals. Grasslands in the watershed potentially contain mammals such as herbivorous meadow voles and deer mice. The evening bat, which is likely a resident of the watershed, does not utilize caves but trees with loose bark near such areas for its hibernacles.

Though mammals are considered foremost as terrestrial animals, many of them actually are semi-aquatic, depending on wetland plants and animals for food (Carnegie Museum of Natural History). Some of these, like the muskrat, southern bog lemming, and meadow jumping mouse, which can be found in the watershed, are good swimmers. Additionally, most shrews (with the exception of the least shrew) rely on damp, wooded areas characteristic of the floodplain forest along Buffalo Creek. This potentially includes the northern short-tailed shrew, the pygmy shrew, and the smoky shrew. Dozens of small mammals were observed escaping their streamside burrows along the Buffalo Creek floodplain during a 2004 flood. Wet meadows, which retain wet soils and could in some cases be considered wetlands, are important for the wetland mammal species, which eat bulbs and tubers of wetland plants to supplement their aquatic diets.

The most abundant mammal habitats in the watershed are edge habitat and reverting grassland habitat, commonly referred to as "scrub/shrub." These habitats often provide a variety of cover for game species, such as whitetail deer, and also provide cover for mammals such as the red fox, white-footed mouse, and eastern cottontail rabbit. The extensive scrub/shrub habitat has likely created high densities of mammal species requiring edge and multiple habitats. This can be postulated based on the extensive edge species of birds that have been documented, which point to possible trends in mammal and other groups. Though often thought of as undesirable, partly because it contributes to invasive species, scrub/shrub is a habitat type that can contribute to biodiversity if a proper balance is maintained between it and other habitats such as intact forest. Examples of mammals that would utilize this type of habitat include opossums, masked shrews, eastern cottontail rabbits, white-footed mice, gray fox, and whitetail deer. Though edge species thrive in this environment, specialist forest and grassland species do not. The succession of old pastures will ultimately result in scrub/shrub habitat if management options are not implemented.

Rock overhangs, which include acidic cliff communities, are present along Camp Buffalo Road, Buck Road, and various small tributaries in the watershed. There is also evidence that caves, which provide similar habitat and are usually formed through the dissolution of rock material, are present in the watershed along Dog Run and other tributaries. However, these are likely limited and difficult to find, due to the sporadic nature of calcareous rock deposits in the watershed. Sandstone rock, which is much more present, does not dissolve as easily.

Bats such as the Indiana bat (Endangered) and eastern pipistrelle rely exclusively on caves for a part of the year, while other bats, such as the northern long-eared bat, prefer these hibernacles, but often end up using hollow trees and manmade structures (Humphrey 1978). The Indiana bat, specifically, almost exclusively utilizes caves in proximity to intact riparian areas. Though there have been no Indiana bats positively identified in the watershed, the habitat exists for this endangered species. The state-endangered Allegheny woodrat, which has been identified in nearby Greene and Westmoreland counties, is also a possible inhabitant of the watershed's caves and overhang areas.

Given the large home ranges of many mammals and the expansion of humans, humans and mammals are bound to come into conflict. For instance, a gray fox's home range is about 1,300 acres, which means that it will eventually encounter private lands. The big brown bat, which was once a forest dweller, has now become accustomed to living near people in places like church belfries and loose shelters (Banfield 1974). Raccoons, whose home range can be from 10 to 20 square miles, are often found in human buildings, instead of its usual rock crevices, abandoned dens, and old stumps (Lotze 1979). Woodchucks, deer mice, squirrels (gray, fox, and red), whitetail deer, and white-footed

***Northern spring salamander found by W & J students at Narigan Run***

mice are common in our back yards, especially in rural areas. There is even the possibility of mammals such as weasels, beavers, and flying squirrels living near houses, depending on the kinds of habitat that surrounds residential areas. In many cases, humans can live in conjunction with mammals (as with other organisms) in private lands by providing wooded corridors next to streams and along old fields. Bat boxes, which are constructed roosting structures, can provide alternative bat roosting sites for many bat species.

## Amphibians and Reptiles

### *Amphibians and Reptiles of the Buffalo Creek Watershed*

Amphibian and reptile distributions tend to be dependent on climate, habitat availability, and historical dispersal routes among major river basins (Hulse et al.). The Pennsylvania Gap Analysis Project estimates that amphibian and reptile populations in southwest Pennsylvania are comparatively lower than in much of the state (PA GAP). This is attributed partly to the effects of development and fragmentation.

Limited emphasis was put on investigating the amphibians and reptiles of the watershed for the protection plan. Efforts included several days of investigation of headwater streams and major tributaries by WPC staff, and student salamander field days at Narigan Run conducted by Washington and Jefferson University students. Results are shown in Appendix D. Vernal pools encountered during other field activities were searched briefly for individuals. The Amphibians and Reptiles of Pennsylvania study was consulted, and its author, Dr. Arthur Hulse, was contacted personally for additional accounts of species in the watershed.

Dr. Hulse, or volunteers, identified a total of eight species of amphibians and reptiles during the course of the Amphibian Atlas Project. Seventeen additional species were documented within the watershed by WPC staff and volunteers during the course of this study (Table 2-4). Twenty additional species are considered to potentially occur in the watershed based on published distributions (Hulse et al.).

***A smooth green snake found along Camp Buffalo Road***

There are a number of species found in southwest Pennsylvania that are not commonly found elsewhere in the state. These include the mudpuppy, ravine salamander, seal salamander, mountain chorus frog, eastern spiny soft-shelled turtle, and shorthead garter snake. Of these species, the soft-shelled turtle was identified during the course of the study. The ravine salamander is a likely resident of the watershed because of its preference for areas under large, flat sheets of limestone. However, it is an extremely difficult salamander to find because these rock layers cannot be lifted manually (Pers. Comm. , A. Hulse.).

Neither the spotted salamander nor the related Jefferson salamander was identified during the course of the study, but both are likely residents of the watershed. A larva of the ambystomid family was found in a vernal pool and was thought to be either a Jefferson or spotted salamander. However, this individual could not be positively identified to species.

Though actively searched for, the slimy salamander was conspicuously absent during sampling efforts. Slimy salamanders were identified in the watershed during the Amphibian Atlas Project but, after further study, they do not appear to be particularly abundant.

A Fowler's toad was identified during this study, which is a new record in Washington County. This individual was identified in a wetland near Polecat Hollow. However, no specimen was collected and further sampling is needed to verify that this individual was accurately identified.

***Important Habitats***

One of the most significant findings was that salamanders, and not fish, seem to be the dominant top predator in most of the forested, headwater streams. It is expected that fish populations are limited in many of these ecosystems because of the high gradients of these streams and natural barriers to fish movement. Salamanders were commonly found under rocks, along riverbanks, and between rocks in outcrops adjacent to streams where fish numbers were low or absent. The most common species identified in these habitats was the northern dusky, followed by the two-lined salamander. Mountain duskies were identified occasionally, while northern spring salamanders and long-tail salamanders were rare, but present. Redbacks were common under leaves and logs of forested hillsides. Forested seep areas were other important salamander habitats in the watershed, containing primarily northern duskies.

**Table 2-4. Amphibian and Reptile Records**

| Scientific Name | Common Name | Observer |
|---|---|---|
| *Apalone spinifera spinifera* | eastern spiny softshell* | WPC, PGC |
| *Bufo americanus americanus* | eastern American toad | WPC |
| *Bufo woodhousii fowleri* | Fowler's toad | WPC |
| *Chelydra serpentina serpentina* | common snapping turtle | WPC |
| *Cryptobranchus alleganiensis alleganiensis* | eastern hellbender | A. Hulse, Amphibian Atlas Project |
| *Desmognathus fuscus fuscus* | northern dusky salamander | WPC |
| *Desmognathus ochrophaeus* | mountain dusky salamander | WPC |
| *Diadophis punctatus edwardsii* | ringneck snake | Amphibian Atlas Project |
| *Eurycea bislineata* | two-lined salamander | WPC |
| *Eurycea longicauda longicauda* | longtail salamander | WPC, Amphibian Atlas Project |
| *Gyrinophilus porphyriticus porhyriticus* | northern spring salamander | WPC |
| *Nerodia sipedon sipedon* | northern water snake | Amphibian Atlas Project |
| *Notophthalmus viridescens viridescens* | red-spotted newt | WPC |
| *Opheodrys vernalis* | smooth green snake | WPC |
| *Plethodon cinereus* | redback salamander | WPC, Amphibian Atlas Project |
| *Plethodon glutinosus* | northern slimy salamander | Amphibian Atlas Project |
| *Pseudacris crucifer crucifer* | northern spring peeper | WPC |
| *Rana catesbeiana* | bullfrog | WPC, Amphibian Atlas Project |
| *Rana clamitans melanota* | green frog | WPC |
| *Rana palustris* | pickerel frog | Three Rivers Birding volunteers |
| *Rana pipiens* | northern leopard frog | WPC |
| *Rana sylvatica* | wood frog | WPC |
| *Regina septemvittata* | queen snake** | Amphibian Atlas Project |
| *Terrapene carolina carolina* | eastern box turtle | WPC |

* of conservation concern according to Pennsylvania Gap Analysis Project

** potential indicator of good water quality

Species most encountered in vernal pools and the newly constructed wetlands included wood frogs, pickerel frogs, and spotted newts. Wet meadows within the former Boy Scout camp along Camp Buffalo Road and along Lower Dutch Fork Creek are popular breeding sites for wood frogs in the spring.

The spiny-softshell turtle was identified both in Buffalo Creek and Lower Dutch Fork Creek. This may be the first documentation of this species in Washington County (Hulse et al.). This is typical habitat, since they generally prefer slow-moving rivers and ponds. They can be found basking in the sun, especially in late summer. There is some anecdotal evidence that they were also present in Dutch Fork Lake Reservoir before it was drained.

Amphibians are often considered particularly vulnerable to pollution and sedimentation. Of those found in the watershed, northern dusky salamanders are considered to be especially sensitive to sedimentation. Fortunately, many headwater streams in the watershed have yet to be affected by development, logging, and other pressures that could affect this and other species.

#### ***Species of Concern***

The hellbender, which was identified in the West Virginia portion of the watershed, is considered a rare species in West Virginia. This species has also been identified in the Pennsylvania portion but is not considered to be rare in Pennsylvania.

## Aquatic Mollusks of Buffalo Creek

#### ***Overview***

Information was obtained for two groups of aquatic mollusks in the Buffalo Creek system – freshwater snails and mussels. Freshwater mollusks are important indicators of habitat and water quality in streams. Factors such as excessive siltation derived from agricultural runoff and riparian siviculture can clog gill-breathing species such as mussels and operculate snails. Other factors that can be problematic for freshwater mollusks include agricultural chemical runoff, road runoff, altered hydrological cycles due to dams, loss of woody riparian areas, and stream channelization.

#### ***Freshwater Mussels***

There are historical records for 12 species of freshwater mussels in the Buffalo Creek watershed (Table 2-5). Mussels should be regarded as an important component of riverine ecosystems where they have historically occurred. Besides being an important filter-feeding part of nutrient cycling, they are long-lived and relatively immobile, which makes them wholly dependent on a clean riverine environment and susceptible to degradation of water and habitat quality.

Virtually all species of freshwater mussels in North America are obligate parasites, meaning they must have a host animal with which to reproduce. The host animal is typically a fish. Mussels typically disperse their larvae onto the gills of the fish. The larvae will mature and metamorphose into juvenile adults, drop off the gills, and settle into the substrate. Some rare mussels are specific to certain species of fish, which also may be rare, while other mussels tend to use a wide array of hosts. The current mussel communities in Buffalo Creek are mostly more sediment-tolerant and tolerant of poorer habitat and water quality (Table 2-6). Historically, several of the species present required high-quality water and habitat. Even if there are remnant populations of historical species, unless the host fish has survived, they cannot maintain viable, reproducing populations.

The fatmucket is mostly found in slackwater areas in streams and lakes. It typically burrows in softer substrates, such as sand, fine gravel, or mud, but can also be found in firmer gravel/sand characteristic of flowing areas. Recent research on freshwater mussel communities in Pennsylvania shows this species to be more of a generalist species with regard to flow and habitat (Nightingale et al. 2003). The fatmucket frequently occurs alone and is considered its own mussel community (termed *Fatmucket Mussel Community*).

The white heelsplitter and the giant floater occur together frequently enough in Buffalo Creek that they are considered their own unique community (called a *Slackwater Ohio Basin Mussel Community*).

This community is typically found in sluggish areas of streams and also in lakes and reservoirs. They prefer to burrow in mud and sand in areas of slow flow; their fish hosts are fairly pollution-tolerant.

The creeper (*Strophitus undulatus*) is another mussel species that occurs often enough by itself that it is considered its own mussel community in portions of Pennsylvania (*Creeper Mussel Community*), although it is somewhat rare in Buffalo Creek and does not form a true community within the watershed. This species can be located in small creeks and streams and is often associated with increasing forest cover in Pennsylvania (Nightingale et al. 2003).

*Species of Concern*

Of note in Buffalo Creek is the presence of the paper pondshell (*Utterbackia imbeccilus*). This species is somewhat rare in Pennsylvania, though it is not considered threatened or endangered. It is commonly encountered in ponds, reservoirs, and sluggish areas of streams.

**Table 2-5. Mussels Species Historically Found in the Watershed**

| Scientific and Common Name | Fish Hosts |
|---|---|
| *Lampsilis cardium* (plain pocketbook)* | green sunfish, smallmouth bass, largemouth bass, yellow perch, white crappie, walleye, sauger |
| *Lampsilis fasciola* (wavyrayed lampmussel)* | smallmouth bass |
| *Lampsilis siliquoidea* (fatmucket) | bluegill, longear sunfish, smallmouth bass, largemouth bass, sand shiner, bluntnose minnow, rockbass, white sucker, pumpkinseed, striped shiner, common shiner |
| *Lasmigona complanata* (white heelsplitter) | common carp, banded killifish, green sunfish, orangespotted sunfish, white crappie, largemouth bass |
| *Lasmigona costata* (flutedshell) | northern hogsucker, longnose dace, common carp |
| *Pleurobema clava* (clubshell)*† | central stoneroller, striped shiner, logperch, blackside darter |
| *Pleurobema sintoxia* (round pigtoe)* | spotfin shiner, southern redbelly dace, northern redbelly dace, bluntnose minnow, spotfin shiner, bluegill |
| *Ptychobranchus fasciolaris* (kidneyshell)* | unknown |
| *Pyganodon grandis* (giant floater) | > 30 species, including many listed above |
| *Strophitus undulatus* (creeper) | > 25 species, including many listed above |
| *Utterbackia imbeccilus* (paper pondshell) | > 30 species, including many listed above |
| *Villosa iris* (rainbow)* | streamline chub, greenside darter, rainbow darter, bluebreast darter, green sunfish, striped shiner, smallmouth bass, largemouth bass, yellow perch, rock bass, mosquitofish, striped bass |

* = no longer found in the watershed
† = federally endangered species as per the United States Endangered Species Act

| Table 2-6. Mussel Communities | |
|---|---|
| **Community Name** | **Dominant Species** |
| Creeper Community | creeper |
| Fatmucket Community | fatmucket |
| Ohio Basin Slackwater Community | giant floater; white heelsplitter |

### ***Freshwater Snails***

Many of the species of freshwater snails in Buffalo Creek are fairly ubiquitous throughout Pennsylvania. Recent limited studies within the watershed by Pennsylvania Natural Heritage Program (PNHP) biologists have located five species of snails. Table 2-7 shows freshwater snails that have been recently located in Buffalo Creek watershed (Evans 2003). More work is needed to get a better picture of the freshwater snail fauna of this watershed. All species found in the watershed to date are pulmonates. This group of snails is ancestrally derived from land snails and occupies freshwater habitats secondarily. Due to the adaptations for living on land, freshwater pulmonates are able to breath atmospheric air. This is different from operculate, or gill-breathing snails, which are entirely dependent on adequate supplies of dissolved oxygen in the water to respire. Several pulmonates are also less affected by sedimentation than the gill-breathers, many of which are relatively inefficient feeders.

The following freshwater snails have been recently located in Buffalo Creek (Evans 2003):

| Table 2-7. Freshwater Snails | |
|---|---|
| **Scientific Name** | **Common Name** |
| *Ferrissia rivularis* | creeping ancylid |
| *Ferrissia walkeri* | cloche ancylid |
| *Fossaria modicella* | rock fossaria |
| *Physella acuta* | European physa |
| *Physella gyrina* | tadpole physa |

*Ferrissia rivularis* and *Ferrissia walkeri* are within the family Ancylidae, the freshwater limpets. These are small (< 6 mm in length) oval-shaped snails that have a pointed apex, or top. They are found in running water or on the edge of flow. Typical substrate for these species is woody debris (submerged tree limbs, sticks), flat rocks, and trash. These species can be found throughout the watershed in areas ranging from small creeks to the mainstem of Buffalo Creek. These species are able to tolerate some elevated levels of sedimentation.

*Physella gyrina* and *Physella walkeri* are in the family Physidae, and are among the most abundant aquatic snails in Pennsylvania (Evans 2003). They can be found in lakes, reservoirs, and streams. These species typically are found feeding along muddy or sandy edges of streams. While *Physella gyrina* is a native species, *Physella acuta* is European in origin and has apparently spread across the North American continent. It was formerly thought to be two separate species. These species are common throughout the watershed, and are among the hardiest freshwater snail species found in North America.

*Fossaria modicella* was located in one section of Buffalo Creek. This species was located on a sand/mud flat along the edge of the stream. *Fossaria* in general are typically found in floodplains or on the edge of streams in mud or softer substrate, but can also be found on vegetation (Clarke 1973).

## Dragonflies and Damselflies

### ***Odonates of Buffalo Creek Watershed***

Dragonflies and damselflies (odonates) are two of the more charismatic insects. Due to misconceptions about their anatomy, they have received names such as "devil's darning needle" and "horse stingers" (Needham et al. 2000). Several species are superb fliers and can often be observed putting on fantastic aerial displays. All odonates, however, begin their life in aquatic environments. There are two major groups of odonates: dragonflies and damselflies. Dragonflies (Odonata: Anisoptera) spend anywhere from a month up to eight years in the water (Dunkle 2000). The larvae of damselflies (Odonata: Zygoptera) can also spend a great deal of their life in water. An easy to way to distinguish between dragonfly and damselfly larvae is by looking at the gills. Damselfly larvae have external gills that protrude from the abdomen (resembling small handheld fans), while dragonfly larvae have internal gills.

***A slender spreadwing, identified at Green Cove wetland area***

In general, the greatest impacts to odonates in headwater streams and upland streams are soil stability and vegetative cover (Corbett 1999). For the most part, reducing siltation, providing woody perches in wet areas (such as planting trees or shrubs), and not rapidly drawing down artificial impoundments are management actions that can establish and promote odonates.

During dragonfly and butterfly outings held in the watershed in summer 2004, 21 species of odonates were identified (Table 2-8).

### ***Important Habitats***

Odonates can be found in nearly every type of aquatic habitat in the watershed. Damselflies can be observed flitting among vegetation on the edges of lakes and streams. Along Buffalo Creek and several tributaries, the ebony jewelwing (*Calopteryx maculata*) is a common sight. Even temporary wetlands that only hold water for part of the year can be important habitats for odonates, particularly species such as the ruby meadowhawk (*Sympetrum rubicundulum*) and the slender spreadwing (*Lestes rectangularis*).

In the spring, one can locate the bluet damselflies in meadows near wet areas, while in the autumn these same areas are dominated by meadowhawks. Many species in the Buffalo Creek watershed, particularly the twelve-spotted and the common whitetail skimmers, are excellent colonizers of new habitats. This can be observed in newly created wetland areas, ponds, and other aquatic environments. This rapid colonization potential of new habitats has been documented numerous times in dragonflies. Damselflies are slightly less agile fliers and not as prolific as some of the dragonflies in colonizing new habitats.

### ***Interesting Odonates***

There are no threatened or endangered odonates in the Buffalo Creek watershed. However, the citrine forktail damselfly (*Ischnura hastate*) is one of the rarer findings. While it is found throughout western Pennsylvania, its northeastern U.S. range extends only up into New York. This is the smallest damselfly in Pennsylvania and can easily be overlooked. It tends to be found in dense vegetation in ponds or backwater areas in streams (Westfall and May 1996). They can be distinguished by their very small size and bright yellow-orange abdomen.

Carolina saddlebags (*Tramea Carolina*) is rarer statewide than many other dragonflies. It is ranked S4S5? by the PNHP, which means its conservation ranking is estimated to be between S4 (apparently stable) and S5 (common and widespread). More research on the distribution of this species may be instructive in assisting scientists to evaluate its true status.

| **Table 2-8. Odonates of the Buffalo Creek Watershed** | | | |
|---|---|---|---|
| **Scientific Name** | **Common Name** | **WPC Staff** | **Volunteer Naturalists** |
| *Anax junius* | green darner | x | x |
| *Calopteryx maculata* | ebony jewelwing | x | x |
| *Celithemis elisa* | calico pennant | | x |
| *Enallagma civile* | familiar bluet | x | x |
| *Enallagma signatum* | orange bluet | x | x |
| *Epitheca cynosura* | common baskettail | | x |
| *Epitheca spiniceps* | prince baskettail | x | x |
| *Erythemis simplicicollis* | eastern pondhawk | | x |
| *Ichnura verticalis* | eastern forktail | x | x |
| *Ischnura hastata* | citrine forktail | x | x |
| *Lestes rectangularis* | slender spreadwing | x | x |
| *Libellula cyanea* | spangled skimmer | x | x |
| *Libellula luctuosa* | widow skimmer | x | x |
| *Libellula lydia* | common whitetail | x | x |
| *Libellula pulchella* | twelve-spotted skimmer | x | x |
| *Pachidiplax longipennis* | blue dasher | x | x |
| *Pantala flavescens* | wandering glider | | x |
| *Perithemis tenera* | eastern amberwing | x | x |
| *Sympetrum rubicundulum* | ruby meadowhawk | x | x |
| *Tramea carolina* | Carolina saddlebags | x | x |
| *Tramea lacerata* | black saddlebags | x | x |

One of the more dramatic species in the watershed is the green darner (*Anax junius*). This is one of the more easily distinguished species. It is a very large dragonfly, about three inches long. Males have a turquoise blue abdomen with a green thorax; females look similar but have some striping on the abdomen. This species is an excellent flier and can be seen defending territories and feeding on insects in ponds, lakes, wetlands, and reservoirs.

The skimmers are common residents of standing water areas in the watershed. The twelve-spot skimmer (*Libellula pulchella*) is easily identified by the alternating white and black spots on the wings. Other skimmers found in the same habitats include the common whitetail (*Libellula lydia*), characterized by the frosted white abdomen, and the widow skimmer (*Libellula luctuosa*), with males having dark basal bands bordered by a broad white stripe and females simply having the dark bands at the base of the wings. Male spangled skimmers (*Libellula cyanea*), are blue with white marks near the wingtips; females have black wingtips and yellowish markings on the sides of the thorax.

## Fish

### *Fish of the Buffalo Creek Watershed*

A list of fish species was constructed based on WPC surveys of three previously unsampled stream reaches in the watershed and studies by Pennsylvania Fish and Boat Commission and California

University of Pennsylvania. Though fish can be used to estimate stream health using biological indices, the different methodologies used and the lack of a proven system for evaluating Pennsylvania streams did not allow for this. DEP is currently working to develop an index of stream health based on fish populations, but this index is not yet available for general use.

The fish assemblage of the Buffalo Creek watershed includes many fish species common to warm-water streams in the Ohio River drainage. A total of 48 species were identified based on sampling of Buffalo Creek, Brush Run, Buck Run, and Dutch Fork Creek. These species are listed in Appendix E. Of these species, approximately 18 percent of those found are considered to be non-native, introduced species. Approximately 28 percent are considered tolerant to pollution and 14 percent are considered intolerant. The remaining species are considered of intermediate tolerance. The number of species identified generally increased with increasing stream size, as expected (Figure 2-1). Brush Run had a lower number of species and total number of fish than any other stream sampled, despite being similar in size to Buck Run and Dutch Fork Creek. This might be explained by the lower habitat quality of the Brush Run segment, which had fewer sequences of pools and riffles.

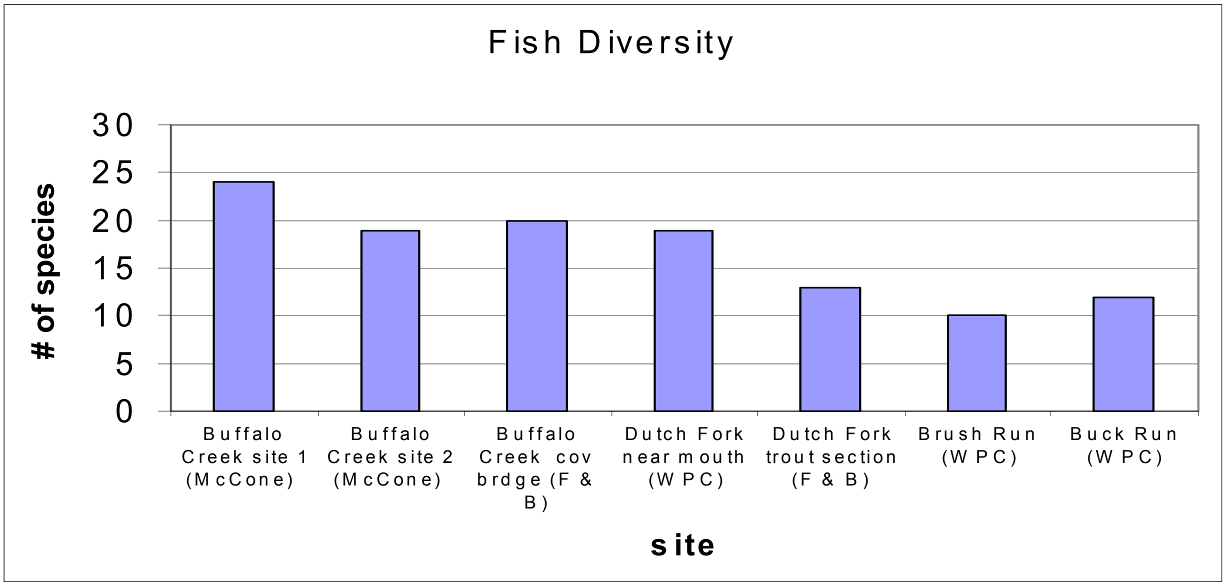



**Figure 2-1. Fish Diversity at sampled sites.**

The most common species identified was the creek chub, which usually comprised at least 50 percent of samples. Many of the identified species were more characteristic of lake or reservoir systems, likely reflecting the number of introduced species and movement of species from Dutch Fork Lake Reservoir. These included the black crappie, bluegill, gizzard shad, muskellunge, northern pike, saugeye, tiger muskie, walleye, and white crappie. A total of seven darter species were identified, including the banded, blackside, fantail, greenside, johnny, rainbow, and variegated darter species. In Pennsylvania, the blackside, rainbow, and variegated darters are only native to the Lake Erie and Ohio River drainages. The redside dace, though fairly common in Pennsylvania, is characteristic of cooler, headwater streams (Michigan DNR). This species is distributed discontinuously throughout the landscape and is susceptible to changes in temperature, oxygen, and shade resulting from land cover changes (MNFI 2000).

A number of popular sport fish are common in the Buffalo Creek watershed and were identified during surveys, including largemouth bass, smallmouth bass, brown trout, and rainbow trout.

***Species of Concern***

No fish species of concern have been identified in the Buffalo Creek watershed.

## Species of Concern

Species are ranked at the state and global levels based on the number of occurrences that have been documented in that geographic area. Most plant and animal species have a rank assigned to them that indicates their level of occurrence in the state or globally, even if they are not considered threatened or endangered. Table 2-9 describes the ranking systems used at the state and local levels. A species is commonly considered to be of "special concern" in Pennsylvania if it has a ranking of "vulnerable" or lower (Table 2-10). The Pennsylvania Natural Heritage Program (PNHP) is responsible for collecting and managing data related to species in the commonwealth and establishing these rankings. PNHP is a partnership among WPC, Department of Conservation and Natural Resources, and The Nature Conservancy. The West Virginia Natural Heritage Program is responsible for tracking species in West Virginia. Global ranks are assigned based on data collected at similar state offices nationwide as part of a network called NatureServe.

**Table 2-9. State and Global Species Rankings**

| **State Rank Codes** | | **Global Rank Codes** | |
|---|---|---|---|
| SX | Extirpated | GX | Presumed Extinct |
| SH | Historical | GH | Possibly Extinct |
| S1 | Critically Imperiled | G1 | Critically Imperiled |
| S2 | Imperiled | G2 | Imperiled |
| S3 | Vulnerable | G3 | Vulnerable |
| S4 | Apparently Secure | G4 | Apparently Secure |
| S5 | Secure | G5 | Secure |
| SU | Unrankable | GU | Unrankable |
| S? | Unranked | G? | Unranked |
| HYB | Hybrid | HYB | Hybrid |
| SE | Exotic | | |
| SA | Accidental | | |
| SZ | Zero Occurrence | | |
| SP | Potential | | |
| SR | Reported | | |
| SRF | Reported Falsely | | |

Five species are listed as species of special concern in the Buffalo Creek watershed by either Pennsylvania or West Virginia (Table 2-10). Information about these species is further described in this chapter. The hellbender and meadow jumping mouse are found in the Pennsylvania portion but are not considered of special concern there. If identified in Pennsylvania, slender wheatgrass and barn owl would also be a species of special concern in Pennsylvania. If identified in West Virginia, bronze copper would be a species of special concern in West Virginia.

State and global rankings are used to establish endangered, threatened, and rare statuses. Endangered species are those species that are in danger of extinction within either a state (state endangered) or its entire range (globally endangered). Threatened species are species that may soon become endangered if critical habitat is not maintained. The classification "rare" is used by states to indicate species that are uncommon in the state or restricted to only certain habitats. Pennsylvania uses the "rare" designation only for plant species, while West Virginia uses the designation for both plant and animal species.

| Table 2-10. Buffalo Creek Watershed Species of Concern | | | | |
|---|---|---|---|---|
| **Scientific Name** | **Common Name** | **Where Seen** | **State Status** | **Global Status** |
| *Cryptobranchus alleganiensis* | hellbender | WV, near border | S2 | G4 |
| *Elymus trachycaulus trachycaulus* | slender wheatgrass | WV | S2, rare | G5 |
| *Lycaena hyllus* | bronze copper | PA, wetland areas | S2 | G5 |
| *Tyto alba* | barn owl | WV, near Bethany College | S1BS1N | G5 |
| *Zapus hudsonius* | meadow jumping mouse | WV, Castleman WMA | S3 | G5 |

## Important Areas for Conservation

### Core Forest Areas

Forests comprise about 52 percent of the landscape in the Buffalo Creek watershed. However, most of this is low-quality early-successional forest or is heavily fragmented. The watershed is highly agricultural, with over 47 percent of land devoted to crop or pastureland. Wetlands comprise less than one percent of land cover. Because of the importance of large, intact forest blocks as corridors for migratory birds and other wildlife in an otherwise agricultural and fragmented landscape, a general assessment was done of the health and location of larger forest blocks in the watershed. These blocks are given the designation "core forest areas."

#### *Forestry Analysis Scope of Work*

Large contiguous blocks of core forest habitat were identified from the SEC National Land Cover Database using Geographical Information Systems (GIS). To select and analyze the core forests, the land cover data was reclassified to forest (deciduous, coniferous, mixed, transitional, and forested wetland) and non-forest in GIS. Fragmenting features, including roads, large rivers, and obvious right of ways, were removed, resulting in a map depicting contiguous forest in the Buffalo Creek watershed. Buffers of 100 meters (representing edge) were removed from each forest block to generate a map of core forest area within the Buffalo Creek watershed. The largest forest blocks and those separated only by small roads or streams were visited to assess the quality and contiguousness.

Assessments for quality and contiguousness took place in conjunction with surveys for plant species and communities in the area. In addition to PNHP site survey protocols for rare species, forest quality and contiguity were assessed qualitatively at several points throughout each polygon (forest block) or group of polygons. GPS locations were recorded to document location for later analysis in GIS. Forest quality was determined by size and type of trees, and type of shrub and groundcover species. Presence or absence of non-native species was noted at each point and used to determine habitat quality.

##### *Findings*

GIS analysis identified several areas containing over 100 acres of contiguous interior forest habitat. Other areas were identified that have many small blocks of core forest fragmented only by small dirt roads (Narigan Run, Buck Run). Forest blocks identified as containing large contiguous tracts of interior forest varied greatly in quality and type. When field checked, areas identified as forest interior were not always high quality. Forest quality ranged from patches of relatively undisturbed forests, composed of large trees with few non-native species, to areas of low-quality, early-successional woodlands and shrublands with high concentrations of non-native vegetation. Evidence of logging activity, in the form of stumps, roads, and early-successional species such as black cherry and tulip tree, was present in even the highest quality sites. In many cases, logging activity over the past 10 years has markedly reduced the amount of core forest, and ecologists often found early-successional community types (old fields and woodland types) where high-quality forest interior was expected from the data.

Two areas identified by WPC botanists and stream ecologists, and members of the Audubon Society, as high-quality habitats (Buck Run and Narigan Run) were not identified in the GIS analysis as containing or being a part of large, contiguous forest habitats. This further demonstrates that the landscape analysis techniques used are not sufficient to determine habitat quality without sufficient fieldwork to assess the quality and character of the blocks.

Despite inaccuracies in the land cover data, the forest blocks identified in the GIS analysis did include some of the highest quality forest habitat in the watershed (Table 2-11; Figure 2-2). Dog Run, Polecat Hollow, Chapel Hill Road, and Dutch Fork Lake are all large blocks of contiguous forestland, and also contain some of the highest quality forest in the watershed. Therefore, it can be assumed that even though GIS analysis was unable to distinguish between varying types of forest or measure forest quality, the largest remaining blocks of contiguous forest determined from the analysis do indeed contain patches of the highest quality habitat. The large blocks of forestland identified by GIS as containing interior forest habitat are presented in Table 2-11, along with factors identified in the field.

A number of species require large sections of contiguous forest as part of their home range requirements or for migration corridors. These include migratory birds such as the Cerulean Warbler, Scarlet Tanager, and Worm-eating Warbler.

**Table 2-11. Core Forest Areas**

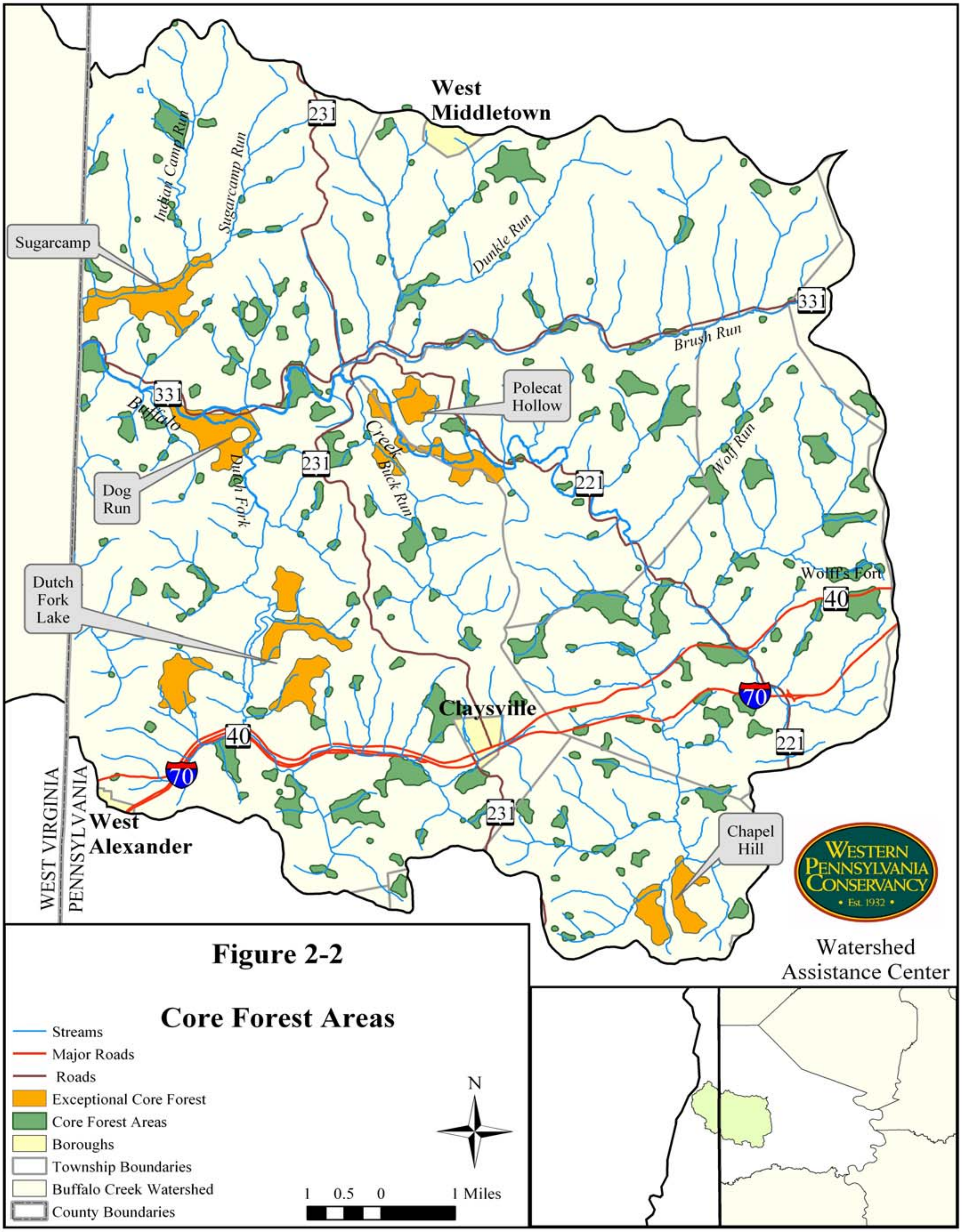
| Forest Block | Acres Core Forest | Ownership | Quality Characters |
|---|---|---|---|
| Sugarcamp | 410 acres | Private | Large contiguous river floodplain and associated slopes; parts developed; large populations of invasive plant species |
| Dog Run | 355 acres | Public/ private | High quality streamside forest and associated slopes; headwaters developed/cleared; headwater area contains large tree of heaven and Japanese knotweed clones; much of the forest composed of early successional forest |
| Polecat/Buffalo | 408 acres | Public/ private | High quality streamside forest and associated slopes; ridge tops developed/cleared for agriculture |
| Dutch Fork Lake | 473 acres | Public/ private | High quality streamside forest and associated slopes; steep slopes with more or less old growth oak forest; post-ag ridge tops* |
| Chapel Hill Road | 303 acres | Private | Undisturbed red oak mixed hardwoods forest; two areas divided by Chapel Hill Road * |

*non-contiguous areas

## Natural Heritage Areas

Natural Heritage Inventories (NHIs) are surveys conducted by WPC to identify important natural communities and species of special concern in a county. The 1994 Washington County NHI was a joint effort of the Pennsylvania Department of Community Affairs, the Washington County Planning Commission, and WPC. NHIs are a best effort to evaluate important natural areas based on aerial images and on-the-ground investigations, but important areas may exist that are not included in the inventories. WPC continues to collect additional data to update its databases and NHIs. In the 1994 Washington County NHI, WPC identified natural heritage areas, termed BDAs, LCAs, and DAs.

***WPC employees investigate Buffalo Creek BDA***


West Middletown
Sugarcamp
Indian Camp Run
Sugarcamp Run
Dunkle Run
Brush Run
Buffalo
Creek
Polecat Hollow
Dog Run
Dutch Fork
Buck Run
Wolf Run
Wolff's Fort
Dutch Fork Lake
Claysville
West Alexander
WEST VIRGINIA
PENNSYLVANIA
Chapel Hill
231
331
221
40
70
Western Pennsylvania Conservancy
Est. 1932
Watershed Assistance Center
Figure 2-2
Core Forest Areas
Streams
Major Roads
Roads
Exceptional Core Forest
Core Forest Areas
Boroughs
Township Boundaries
Buffalo Creek Watershed
County Boundaries
N
1 0.5 0 1 Miles

A **BDA** (or **biological diversity area)** is an area of land recognized as supporting populations of state, nationally, or globally significant species or natural communities, high-quality examples of natural communities or ecosystems, or natural exceptional native diversity. These areas are typically small and contain a buffer that takes into account the natural community or habitat that is the focus of the site.

A **LCA** (or **landscape conservation area**) is a larger area of land that contains minimal human disturbance and allows ecosystems to function on a landscape level. These areas often contain multiple BDAs.

A **DA** (or **dedicated area**) is an area of land recognized because of an owner's specific intention to protect it, which could result in the site improving to become either a BDA in the future or an even better high-quality area within an already designated BDA. Numerous areas in the watershed could be DAs in the future through landowner agreements, special programs, or other methods.

A total of 27 BDAs and five LCAs were identified in Washington County (Wagner 1994). No DAs were identified. Two BDAs and one LCA are located within the Buffalo Creek watershed (Figure 2-3). BDAs and LCAs are given a ranking based on their importance to biological diversity and ecological integrity in the county according to definitions in Table 2-12. All of the Natural Heritage Areas in the Buffalo Creek watershed were given an "exceptional" ranking. It is recommended that appropriate buffers be established around BDAs to protect wildlife, maintain hydrology, and prevent invasive species from entering the sites.

**Table 2-12. Significance Rankings for BDAs**

| Significance Rank | Explanation |
|---|---|
| Exceptional | Sites are of exceptional importance for the biological diversity and ecological integrity of the county or region, containing one or more occurrences of state or national species of special concern or a rare natural community of good size, condition, and extent. These areas deserve complete and strong protection. |
| High | Sites are highly important for biological diversity of county or region and, just like exceptional sites, contain species of special concern or natural communities that are highly ranked; these sites are also of relatively large extent and are primarily undisturbed, but are of slightly less importance in terms of rare species or condition than exceptional sites. These sites deserve strong protection. |
| Notable | Sites in this category contain occurrences of species of special concern or natural communities that are either more common or of smaller size and extent than exceptional or high-ranking areas, or have activity and disturbance. These sites deserve special protection within the context of their characteristics, degree of disturbance, and place in the community. |
| County | These sites have great potential for protecting biodiversity but have not yet been found to contain species of special concern or state-significant natural communities. Because of their size, undisturbed character, or proximity to other significant areas, these sites deserve further study and investigation as possible future high or exceptional sites. |

### ***Buffalo Creek BDA***

Located along Buffalo Creek in a portion of State Game Lands 232, this exceptional BDA contains three high-quality natural communities including a floodplain forest community, acidic cliff community, and mesic central forest community (Wagner 1994).

Sycamore (*Platanas occidentalis*), smooth buckeye (*Aesculus glabra*), and sugar maple (*Acer saccharum*) dominate the floodplain forest community, which is beginning to regain some of the diversity lost from past logging practices with species such as black walnut (*Juglans nigra*) and bitternut hickory (*Carya cordiformis*) growing back in significant numbers. Herbaceous species such as false mermaid (*Floerkea proserpinacoides*), trout lily (*Erythronium Americana*), and spring beauty (*Claytonia virginica*), as well as a thick blanket of Virginia waterleaf (*Hydrophyllum virginicum*), can be found at the site.

On the steep north-facing slopes of the valley are sandstone and shale outcrops that support acidic cliff communities comprised of species such as Christmas fern (*Polystichum acrostichiodes*), marginal wood fern (*Dryopteris marginalis*), bloodroot (*Sanguinaria canadensis*), and walking fern (*Asplenium rhizophyllum*). Sections of the forest on the north-facing slopes are dominated by sugar maple and contain shrubs such as black cohosh (*Caulophyllum thalictriodes*), goldenseal (*Hydrastis canadensis*), and black snake root (*Cimicifuga racemosa*). At the top of the slopes are red and white oak (*Quercus rubruma and Q. alba*) communities. The forested tributaries to the north are drier with larger amounts of down juneberry. Although these northern tributary watersheds are more disturbed than the other slopes, they are an important aspect of the site.

An opportunity exists to preserve and enhance the natural resources of this site. Surrounded by and even including some agricultural fields, a large portion of this BDA was logged within the last 15 to 25 years. It is recommended that no further logging should take place in the floodplain including this BDA, and other key pieces of the surrounding area should be allowed to revert to forest. Other parts of the upland areas and adjacent areas could still be managed for game species or continue as agriculture (Wagner 1994).

### ***Dutch Fork Valley BDA***

Beginning at Dutch Fork Lake reservoir, a large portion of the Dutch Fork Creek valley is designated as part of the Dutch Fork Valley BDA. Including a portion of State Game Lands 232, this BDA contains significant natural communities, is a significant nesting site for great blue herons, and is a historic area for a mussel species of special concern (Wagner 1994).

The floodplain forest community along the mainstem portion of Dutch Fork Creek supports tree species such as cottonwood (*Populus deltoids*), sycamore (*Platanus occidentalis*), black willow (*Salix nigra*), black walnut, and smooth buckeye *(Aesculus glabra)*. To the west, two small, high-gradient streams flow across the floodplain to the creek. Sugar maple (*Acer saccharum*), red oak (*Quercus rubra*), tulip tree (*Liriodendron tulipifera*), and slippery elm (*Ulmus rubra*) form the canopy of the valleys of these small streams and are a medium age example of a mesic central forest community. Lush growth of glade fern (*Athyrium pyncocarpon*) and pale touch-me-not (*Impatiens pallida*) covers the ground, and a series of short waterfalls make this area unique.

Access to the northern part of this area is well developed, with a road running along the eastern upland and a telephone line cutting across the northern section. A recommendation for the Pennsylvania Game Commission is that, as part of the establishment of a core area within State Game Lands 232, activities within this area should be limited to passive recreation. Agricultural areas, if abandoned or located on steep slopes, should be allowed to undergo natural succession. Routing of utility lines through the BDA should be discouraged when possible. Timbering, creation of food plots, and general wildlife management activities could take place outside the BDA, allowing an appropriate buffer for this special area.

#### ***Buffalo Creek LCA***

This Natural Heritage Area includes most of the Dutch Fork watershed and a large portion of the Buffalo Creek watershed, contains both the Buffalo Creek and Dutch Fork BDAs, and encompasses much of State Game Lands 232. The predominately agricultural landscape and open fields and woodlots of this BDA allow for the potential to utilize this LCA for protection of biodiversity in the county. Buffering and expanding the significant BDAs within the LCA, as well as limiting fragmentation by roads and utilities, will allow for a viable ecological system. There is an opportunity for townships, local organizations, and the PGC to work together in protecting the assets of this LCA (Wagner 1994).

### **Watershed Conservation Areas**

Important natural areas containing unique species assemblages and ecological features in the watershed were identified as Watershed Conservation Areas during stream visual assessment surveys and forest analysis surveys. While these sites do not meet the requirements for a BDA designation according to the Washington County NHI (Wagner 1994), they represent areas of higher-quality natural communities with little non-native plant species presence, and have a high probability of supporting plants and animals of special concern. For example, several conservation areas were selected because they include relatively good quality forest habitat or include areas designated as part of the Important Bird Area that supports migratory forest-interior birds requiring large contiguous tracts of mature forest. Whereas core forest areas were selected based on strict scientific criteria, these conservation areas were selected based on qualitative information and the judgement of WPC staff, and therefore may not contain all of the important areas for conservation in the watershed. In some cases, important core forest areas and Watershed Conservation Areas contain portions of the same areas, though not all of the conservation areas selected were large enough to be considered important core forest.

Much of the remaining high-quality forest areas are owned by PGC, which has the goal of managing land for the best diversity of habitats for both game and non-game species (Pers. Comm., M. Kammerdiener). All forestlands, except for those on steep slopes or riparian zones, are kept on a 100-year or less rotation and even-aged management is employed. Forest areas to be logged are considered on a case-by-case basis, with little consideration for the role of that parcel as part of the landscape as a whole. This strategy, which protects many species having more generalist requirements, provides no special protections from logging and fragmentation for forest-interior species. These species, including many of those important to the valley's Important Bird Area designation, require older forests of multiple age structure that are contiguous and unfragmented.

It is recommended that the PGC develop a management plan including provisions for protection of forest-interior birds in State Game Lands 232. This may include establishment of a core area of contiguous forest. Logging in this area should be limited and only occur if adjacent areas have reverted back to appropriate interior-forest habitat. Logging practices should include those that allow for uneven-aged forests, which these species prefer. Because forest-interior birds are considered to have some of the most stringent habitat requirements, these practices would protect additional species of other taxonomic groups, such as mammals and butterflies that prefer similar habitats. The adoption of such a management strategy would likely benefit game species as well, as areas surrounding the core area could continue to be managed using current management strategies.

In situations where conservation areas are wholly or partly under private ownership, it is recommended that landowners be educated about the ecological values of their properties and the opportunities for forest easements. Management plans, easements, or other efforts towards conservation are recommended for all of these areas.

### ***Dog Run, exceptional forest area***

Located within State Game Lands 232, this forest contains one of the higher quality sites within the watershed. The upper slopes generally support red oak-mixed hardwood species, while the lower slopes tend to be dominated by sugar maple and may contain species of the black maple creek and sycamore-box elder forest communities. While the headwaters are of poor quality, the central portion of Dog Run Creek, which includes a waterfall, is of higher quality. Although this area cannot be considered "old growth," steeper slopes support large maples and oaks and, in addition to the surrounding forest, provide significant habitat for species requiring core forest areas. Sugar maple appears to be dominant here in the understory in both red oak-mixed hardwoods and sugar maple-mixed hardwoods forests.

#### *Threats*

Of the total 355-acre contiguous forest block along Dog Run Creek, the area of high-quality sugar maple forest and mixed oak forest is rather small. It is surrounded by poorer quality, early-successional forest predominated by black locust (*Robinia pseudoacacia*) and other species common to a post-agricultural black walnut-early-successional woodland community. While the high-quality forest is relatively free of exotic invasive plants, with the exception of garlic mustard, the number of invasive non-native plants is considerably higher in the early-successional woodland area and may threaten the quality of the central portion of the Dog Run forest.

#### *Management Recommendations*

Further investigation into the condition of the site and extent of the high-quality forest communities is needed. Further investigation of the geology is also needed. Protection of this area would require a special management plan that includes measures to control invasive species in adjacent forest types in order to create a buffer for this conservation area. Logging activity should be limited in this area to curtail non-native species expansion.

### ***Narigan Run***

Located within a deep valley along Narigan Run Road, this rich, mesic site supports a number of plant community types, beginning with a black maple-elm creek floodplain forest community on either side of the creek and sugar maple-mixed hardwoods further up the slope. The tree canopy of the mid to upper slopes of Narigan Run is dominated by sugar maple. There are several seeps in the mid to upper slopes along Narigan Run that contribute a significant portion of the water flow to Narigan Run during wet months. While total core forest area is upwards of 200 acres along the stream, the area is fragmented by several small former logging roads and patches of early-successional and old field communities.

Salamander surveys of the PGC property found a dense population of northern dusky (*Demognathus fuscus fuscus*) salamanders in the hillside seeps. This species is sensitive to sedimentation and alteration of its habitat (Hulse et al.). Other species of salamanders within the site include the red-back (*Plethodon cinereus*), northern two-lined salamander (*Eurycea bislineata*), and northern-spring salamander (*Gyrinophilus porphyriticus porphyriticus*). Bird species identified at the site include many common species, as well as Cerulean Warblers (*Dendroica cerulea*), Scarlet Tanagers (*Piranga olivacea*), Louisiana Waterthrush (*Seiurus motacilla*), and Acadian Flycatchers (*Epidonax virescens*). The Narigan valley is considered an important component of Important Bird Area 80.

#### *Threats*

Garlic mustard is prevalent along the roadsides through Narigan Run and poses the most serious threat to native species at this site. Future management should consider the impact of this non-native species. This area is one of the best representations of an intact forest valley that can be found within the watershed. However, this area also contains some of the last remaining high-value timber. The upper portion of the watershed, which is privately owned, is currently being logged. This recent logging may decrease the value for wildlife habitat, including that for interior-forest birds, and will be an obstacle in protecting the area. The biggest water-quality problems are sediment from the nearby road and upstream logging practices.

*Management Recommendations*

Efforts should be made to convey the importance of this natural area to the PGC and private landowner. A more detailed forestry management plan, to maintain the diversity and extent of the forest, is recommended for this site.

## Polecat Hollow

This popular hiking and wildflower viewing area contains a variety of forest habitats. The valley supports a sugar maple-mixed hardwood forest with species such as slippery elm and hackberry.

***A seep along Polecat Hollow in winter***

The eastern-facing slope contains a middle-aged-mixed sugar maple stand. The hilltop appears to have been recently logged and is an early-successional forest containing invasive species such as multiflora rose. The western-facing slope can be best described as a later-successional white oak-mixed hardwood forest. Portions of the upper valley contain active pastureland. Seep areas contain important micro-communities with species including trillium sessile and a number of ferns.

Polecat Hollow is one of the most productive areas for salamanders in the watershed, which serve as the most significant predators in the small stream's food chain and are abundant in the seep areas.

*Threats*

Logging activity may alter the hydrology of the natural seeps found along the hillside and result in sedimentation to Polecat Hollow Creek. The seeps are also vulnerable to any increases in farming or intensive land use on the ridge tops, which may drain into the valley. These activities could affect the sensitive salamander populations in the creek.

Invasive plant species are present along the roadsides and any increase in light through the canopy will facilitate further invasion.

Polecat Hollow is a popular wildlife viewing and horseback riding area. In addition, there is evidence that the area is also utilized by All Terrain Vehicles (ATVs), which traverse the stream. Portions of Polecat Hollow have been used as garbage dumps in the past, which could increase when Camp Buffalo Road is re-opened. Development of a comprehensive management strategy for the Polecat Hollow valley is complicated by the fact that the valley is owned by both private and public entities.

*Management Recommendations*

Because of the high quality of the site, easy access, and public interest as a conservation area, Polecat Hollow should be a priority candidate for the Buffalo Creek Watershed Association (BCWA), or other group, for invasive species control, restoration, and trash removal efforts. BCWA has discussed the development of a more established trail leading to this site, and some kind of adoption of this site would be appropriate, as it is in need of restoration and protection. Efforts at the site could include physical removal of invasive garlic mustard plants by volunteers in early spring (before they go to seed). All ATVs should be banned from the site and barriers put in place to close the trails that already exist. Future logging at this site should consider the sensitive seep areas and the importance for migratory birds, such as Louisiana Waterthrush and Cerulean Warblers, which require blocks of mature forest. Forestland easements, which would restrict some activities that could negatively impact the site, would be a recommended action.

### *Welch Hollow*

This area, close to the West Virginia border, connects to the higher quality forest area along Sugarcamp Run, one of the largest blocks of contiguous high-quality forestland found on private lands within the watershed. The landscape and forests are similar to those of Buck Run and its tributaries, and the Welch Run floodplain contains a moderately well-developed sycamore-box elder floodplain forest. Like Buck Run and Narigan Run, the associated slopes contain sugar maple-mixed hardwoods and red oak-mixed hardwoods forest communities. The only population of bur oak (*Quercus macrocarpa*) was found along the lower slopes of this floodplain.

#### Threats

Because much of Welch Hollow is privately owned by multiple landowners, the floodplain and associated slopes are considerably more developed. Large clones of tree of heaven (*Ailanthus altissima*) are present on the floodplain and slopes.

#### Management Recommendations

Because of its close proximity to the West Virginia border, this area should be surveyed further for slender wheatgrass (*Elymus trachycaulus*), a species of concern known from the West Virginia portion of the watershed. Future monitoring should be conducted in this area to determine the extent of the tree of heaven population and its effects on the floodplain. Area landowners should be informed about the threat posed by tree of heaven. This, and other exotic species, should be removed and managed. Portions of the Buck Run watershed should be surveyed further to determine its potential to serve as a reference community/ecosystem for this and other degraded creek floodplains.

### *Dutch Fork Lake*

The forest communities surrounding Dutch Fork Lake are very similar to those in the Dog Run area. This includes a pattern of flat ridge tops supporting old fields and early-successional black walnut woodland communities, and also steep slopes supporting mixed oak forest types and ravines, as well as lower slopes supporting sugar maple-mixed hardwood forests. On either side of the lake are primarily sugar maple forests. However, small patches of red oak forests and early-successional forests are found in the vicinity and contain many species common to river floodplains, including sycamore and black maple.

A main tributary of Dutch Fork Reservoir appears to support the highest-quality forest communities surveyed in the Dutch Fork Lake area. This sugar maple forest contains many species of the sycamore-box elder floodplain forest. As with the previous sites, slopes are generally steep (>25%) and are dominated by red and white oaks. Ridge tops were most likely open pasture or agricultural land over 30 years ago and now support species of the post-agricultural black walnut early-successional woodland. Similar to State Game Lands 232, several former agricultural fields situated on high, gently sloping ridge tops within the Dutch Fork Lake area are now dominated by small (<20 cm diameter at breast height) black walnut, black locust, black cherry, and elms.

Although the dominant cover type of the high, level ridge tops is the early-successional forest type, one area along a small tributary east of Dutch Fork Lake consists of a very high-quality red oak-mixed hardwoods and red maple forest. This area contains trees roughly 40 centimeters in diameter, and although it is not considered old growth, it is generally undisturbed as it is relatively inaccessible by vehicle and foot traffic.

*Threats*

The more mature forests in this area are vulnerable to logging pressures, which has the potential to introduce light and invasive species. Deer could reduce the ability of early-successional forests to regenerate.

*Management Recommendations*

Management recommendations for this conservation area include monitoring and control of invasive species, particularly multiflora rose and other invasives. These may enter high-quality forest from adjacent old fields and early-successional forest, especially after logging. Controlling the deer population, which could prevent the regeneration of healthy early-successional forest, also should be a priority. Any logging that takes place should consider the importance of mature forest in this area for wildlife, and tracts of mature forest corridor should be maintained. Such management also has the potential of keeping the timber value of the site high by reducing invasives and increasing the value of standing timber.

### Buck Run Floodplain Forest and Associated Slopes

The Watershed Conservation Area consists of a stretch of the Buck Run creek floodplain, a major tributary of Buffalo Creek, along Buck Run Road. The floodplain supports one of Buffalo Creek watershed's most intact and highest-quality sycamore-box elder floodplain forests. Red oak-mixed hardwood forests and sugar maple-basswood forests occur on the slopes adjacent to the floodplain on either side. These forest patches are also of good quality as they most likely escaped logging due to the steep slopes. Slopes range from 15 to 30 percent on either side. Several smaller tributaries of Buck Run were identified and inventoried. There are several rock outcroppings throughout this area and several along small tributaries of Buck Run. Within the red oak-mixed hardwood forest or sugar maple-mixed hardwood forests on the associated slopes of the floodplain, many small micro-sites exist due to stream drainages or differences in topographic position and substrate. Rock outcrops in the area are mostly composed of sandstone or, in a few cases, shale. There are limestone-containing formations in the surface geology of the watershed, but there were no encounters with any outcrops that appeared to be composed entirely of limestone.

*Threats*

Threats to this area include invasive species. Although currently less common in this floodplain than others, monitoring and preventing invasive species from entering this Watershed Conservation Area should be a priority. Also, any decrease in the quality of forest in this area could affect its importance as an Important Bird Area, since Buck Run and its associated floodplains are considered to support the highest density of forest-interior birds found within the watershed (Pers. Comm., L. Helgerman).

*Management Recommendations*

Any future logging in this area should be part of an overall management strategy that considers the importance of mature forest habitats for migratory birds. Conservation organizations should take the lead in working with the PGC to develop such a strategy, which might include setting aside core areas for these species.

Portions of the Buck Run watershed should be surveyed further to determine its potential to serve as a reference community/ecosystem for this and other degraded creek floodplains.

***Green Cove Wetland Area contains important bird habitat***

## ***Green Cove Wetland Area***

Green Cove Wetland, created in 2003, is one of four wetland restoration projects planned by the PGC to create habitat for game species and other wildlife (Pers. Comm., D. Dunkerley). To date, this area has been the most successful of the wetland projects and has resulted in breeding and feeding habitat for many species of birds, amphibians, bats, dragonflies, and other wildlife. Several species of concern utilize the wetland during migration, including the Great Egret and American Bittern. A feature of the site includes a handicap-accessible observation area.

### *Threats*

Invasive species at the site are an issue, especially mile-a-minute weed, which has crowded out other native species that surround the wetland. Restoration was not successful at removing enough topsoil to access the native seed bank, and many plants at the site planted by the PGC are not necessarily native to the area. Frequent mowing, which is needed to maintain the site for visitors, has the potential to eliminate certain plant species required for the life cycles of butterflies and dragonflies.

### *Management Recommendations*

A future project could involve removing some of this topsoil to revive the natural seed bank. While still allowing a path for visitors, future mowing should consider the benefits of important plant species.

## **Important Bird Area**

In October 2003, the Buffalo Creek valley was designated the 80th Important Bird Area (IBA) by the Pennsylvania Audubon Society (PA Audubon). The goal of PA Audubon is to recognize and protect at-risk bird species and habitats before they reach threatened or endangered status. During the October 2003 IBA ceremony, the Three Rivers Birding Club announced that it adopted the IBA, which will ensure continued monitoring of the area. The Buffalo Creek valley meets three of the PA Audubon IBA criteria, including PA-1c (having at least 50 pairs of wading birds during the breeding season), PA1-e (having an exceptional concentration and/or diversity of birdlife), and PA 4-4b (having an exceptional representative natural habitat within its physiographic province) (Pers. Comm., S. Hoffman). The presence of significant concentrations of migratory interior-forest species was an important component to the designation.

***Members of the Three Rivers Birding Club at an outing in Buffalo Creek***

The new IBA primarily contains State Game Lands 232 and some surrounding private lands. PA Audubon surveys, conducted primarily throughout the newly acquired State Game Lands area and Dutch Fork Lake, identified over 80 species of birds in June 2003. Six of these species are on the Audubon Watch List and many more are listed as having high priority for conservation according to a Partners in Flight species assessment. Only private lands in which the owner grants access for birdwatching can be considered for inclusion in the IBA.

IBAs provide a scientifically determined method for prioritizing areas for conservation. Bird species are unique to specific habitats and their presence or absence reflects the health and extent of that habitat. An IBA designation also promotes local stewardship and advocacy. The designation does not limit development or specific land-use practices within the IBA, though it is the hope of PA Audubon that these areas are considered when developing management objectives.

Results of continued monitoring of the IBA through the Three Rivers Birding Club may reflect the success of conservation efforts in the watershed and also areas in which protection activities should be focused.

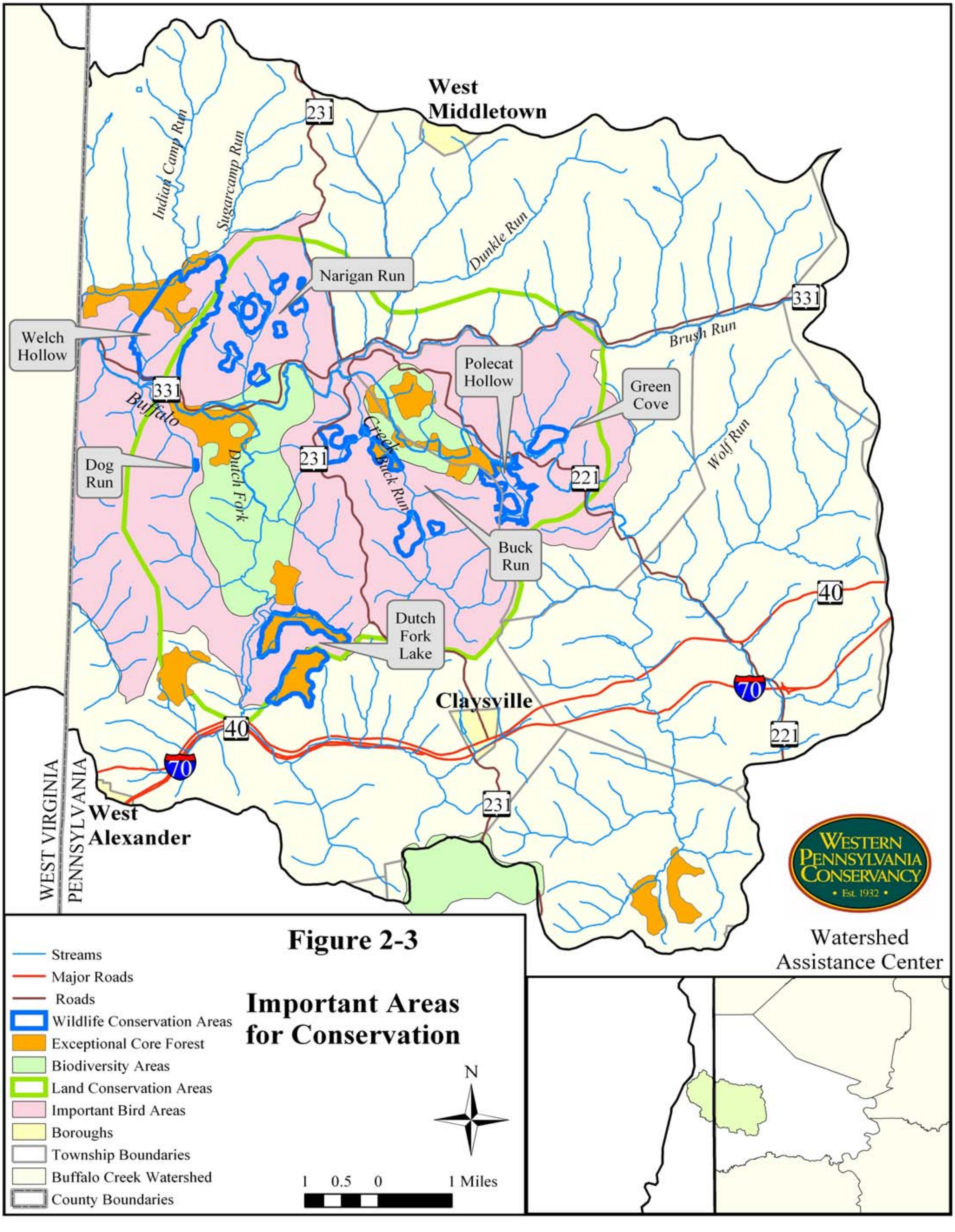



**Figure 2-3**

**Important Areas for Conservation**

## Recommendations

- Continue to monitor and document species occurrences, particularly species of special concern.
- Increase participation in streambank fencing and/or other best management practices on agricultural lands to encourage the growth of riparian zones (which often serve as corridors for wildlife) through involvement in the Conservation Reserve Enhancement Program and other programs.
- Allow areas between existing forest tracts to become reforested in order to increase habitat for wildlife requiring large forest tracts, which is limited in the watershed.
- Encourage the Pennsylvania Game Commission and private landowners to use management practices such as periodic mowing or burning on old fields that are no longer cropland or pasture (during appropriate times of the year, during non-breeding seasons), and use of warm-season grasses, to maintain habitat for grassland mammals.
- Develop a better understanding of mammal and other wildlife diversity and habitat requirements in the watershed through more intense study.
- Avoid large-scale clear-cutting activities in areas where older forest habitat is appropriate for wildlife, such as migratory birds.
- In areas where logging is occurring, forest health should be maintained by the Pennsylvania Game Commission and private landowners. Management options should take into consideration habitat for forest-interior species, including maintaining contiguous forest and mixed-age stands.
- In areas of development or logging, corridors should be maintained, especially along streams.
- Develop detailed management plans for Biological Diversity Areas and Watershed Conservation Areas.
- Educate owners of large forest blocks about the importance of their properties and possible management options. Inform forest landowners about management assistance through the DCNR Bureau of Forestry.

# WATER RESOURCES ASSESSMENT

## Overview

The Buffalo Creek watershed is a DEP-designated High Quality watershed, a designation ascribed to the watershed in 1979 after the passing of the Clean Water Act. However, little water quality monitoring has been conducted to investigate trends in water quality. The intent of this chapter is to provide a comprehensive source of past and present water quality information that can be used in restoration and protection activities and can form the basis for continued monitoring. This chapter discusses some important components affecting water quality; describes federal, state, and local laws that exist to protect the watershed; gives an overview of past water quality information collected within the watershed; and presents the results of stream assessments conducted by Western Pennsylvania Conservancy (WPC).

## Important Components of Water Quality

### Floodplains

**Floodplains** refer to areas of land adjacent to a stream onto which water spills when the water level in the stream rises. Floodplains increase the capacity of a stream to handle flood events by dissipating energy from high flows. Building on floodplains, or other alterations, can increase flooding downstream, cause bank failures, and be dangerous for residents.

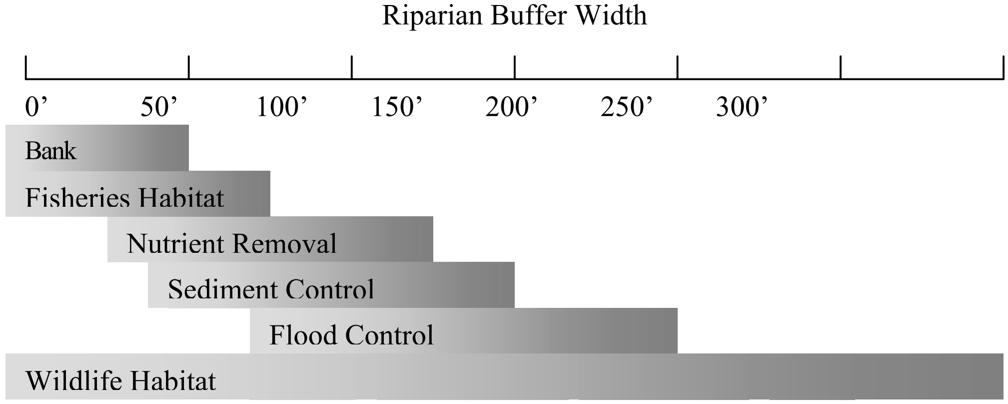
The National Flood Insurance Program (NFIP) was established in 1968 with the National Flood Insurance Act (NFIP 2002). This act enables property owners to purchase insurance as a protection against flood loss in exchange for communities agreeing to adopt ordinances that reduce flood damage, including limited building in floodplain areas. Only property owners living in such communities can purchase flood insurance. In communities that adopt such ordinances, building in Special Flood Hazard Areas may only occur if the owner agrees to purchase flood insurance. These hazard areas are areas within the 100-year flood zone, meaning that there is a one percent chance of a flood reaching this zone each year. Special subsidies are available for existing structures. Future structures built in 100-year floodplains must meet certain requirements. During declared national disasters, FEMA may also make grants and loans available to those not participating in the program (NFIP 2002). Floodplains can be considered “sensitive” areas because they are both inappropriate for building purposes and important for protection of streams and wildlife. Chapter 1 discussed such sensitive areas, and 100-year floodplains are depicted in Figure 1-13. Currently, most municipalities within the watershed have floodplain ordinances, though these provisions may not be adequately enforced.

***The riparian zone along Narigan Run provides important filtering functions and supports salamander populations***

### Riparian Zones

**Riparian zones** are vegetated buffers along streams, rivers, and lakes that filter runoff and provide a transition zone between water and land. A functioning riparian zone can reduce flooding by retaining water in its vegetation and soil. This also promotes retention of groundwater during dry periods. Vegetated riparian zones prevent soil loss and bank failures by holding soil in plant roots. They also provide important corridors for wildlife, enhance recreational activities, and provide fish habitat. Studies have shown that the wider and more substantial a riparian zone is, the better it can perform these functions (Kleppröth 2000). Figure 3-1 shows recommended riparian zone widths for bank support, fisheries habitat, nutrient removal, sediment control, flood control, and wildlife habitat.

**Figure 3-1. Recommended Riparian Buffer Widths**




## Groundwater

**Groundwater** refers to water stored beneath the land surface in the pores and openings of soil and rock formations. It is estimated that at least 95 percent of residents within the Buffalo Creek watershed rely on groundwater as their drinking water source.

Because water is constantly interchanged between ground and surface waters, surface water quality is often indicative of groundwater quality. Also, increases in groundwater withdrawals can lead to lower stream flows. Some common pollutants of surface waters that can lead to groundwater contamination include sewer and agricultural contamination (nutrients, bacteria), mining (metals, low pH), and abandoned oil and gas wells (chlorides). Iron (from mining) is the most common groundwater pollutant in Washington County.

Groundwater within the watershed is primarily held in larger openings consisting of sandstone fractures. Because of the scarcity of small openings, drinking water yields are low to moderate in Washington County (Table 3-1). Only alluvium, or materials deposited by streams (clay, silt, sand, gravel) during past storm events, have the potential for high yields. Therefore, the best groundwater yields are from wells near stream riparian zones (Newport 1973).

**Table 3-1. Approximate Groundwater Yields of Washington County Geologic Formations (Source: Newport 1973)**

| Geologic Formation | Characteristics | Approximate yields (may vary) |
|---|---|---|
| Alluvium | clay, silt, sand, gravel | ~200 gallons per minute (gpm) |
| Monongahela | limestone, shale, coal, sandstone | .1-5- gpm |
| Greene | sandstone | 2-35 gpm |
| Washington | soft shale | 1-70 gpm |
| Conemaugh | sandstone, shale | 5-50 gpm |

## Stormwater

The water running off streets, buildings, and land during storm events is referred to as **stormwater**. Besides causing flooding, stormwater can contribute a significant amount of pollution to waterways. Much of the unhealthy bacteria that enters streams from manure lots and faulty sewage systems enters during storm events. Many of Pennsylvania's urban areas have ordinances that include stormwater management. This involves activities such as regulating the size of culverts and ditches through which water travels to prevent flood events, and requiring the use of more pervious materials for sidewalks and parking lots to prevent ponding of water.

**Pennsylvania's Stormwater Management Act** of 1978 requires each county in Pennsylvania to develop stormwater management plans for each of its watersheds. As of May 2005, Washington County is in the initial stages of developing such a county-wide stormwater management plan. The development of such plans is usually considered more relevant to urban areas than to rural areas such as the Buffalo Creek watershed. However, stormwater management, especially for flood regulation purposes, may become more of an issue as development continues in the watershed. The DEP provides model stormwater management ordinances and funding options for stormwater management plans on its website, http://www.dep.state.pa.us (Keyword: stormwater). Municipalities may choose to adopt any one of these ordinances in order to prevent flooding and maintain safety for residents. None of the municipalities within the watershed currently have stormwater management provisions.

## Surface Water

**Surface water** refers to water found above the land surface during all or some parts of the year, in rivers, streams, lakes, ponds, and wetlands. Many of the streams within the Buffalo Creek watershed are small streams originating from seepage areas in hillsides that fill up during storm events. Larger streams within the watershed, including Buffalo Creek, are "flashy" in nature, quickly reaching high flows during rain events and nearly drying up during warm summers.

***Hillside seep entering a tributary of Buffalo Creek***

Due to the lack of glacial history in the region, there are no natural lakes in the watershed (NLCD 2003). Wetlands in the watershed consist mainly of current and past river floodplains, where river particles have been deposited, and temporary wetlands. Temporary wetlands contain water during only part of the year, usually during wetter months. **Vernal pools** are temporary wetlands in which the only source of water is rainwater. They are important ecological systems and often have high biodiversity. Because they do not contain fish, vernal pools support species that could not survive in permanent pools of water. These species include spotted and Jefferson salamanders, wood frogs, and fairy shrimp. As of 2005, Western Pennsylvania Conservancy is developing a volunteer monitoring program to identify and track these important wetlands in Pennsylvania.

Dutch Fork Lake, located in the southern portion of the watershed, was a 91-acre impoundment created from Dutch Fork Creek in 1958 by the Fish and Boat Commission to provide additional recreational fishing opportunities. The reservoir was drained in 2004 with the idea that another reservoir will be established when there are enough funds to repair the dam.

## Watershed Protection Laws

### Intermittent, Ephemeral, and Perennial Streams

Not all streams flow year-round. However, all streams within Pennsylvania are protected under the Pennsylvania Clean Streams Law of 1931, which gave the state of Pennsylvania the power to enact legislation and regulations pertaining to the protection of streams.

According to the Pennsylvania Code:

An *intermittent stream* is a, "body of water flowing in a channel or bed composed of substrates primarily associated with flowing water, which during periods of the year is below the local water table and obtains its flow from both surface runoff and groundwater discharges."

An *ephemeral stream* is a, "water conveyance which lacks substrates associated with flowing waters and flows only in direct response to precipitation in the immediate watershed or in response to melting snowpack and which is always above the local water table."

A *perennial stream* is a, "body of water flowing in a channel or bed composed primarily of substrates associated with flowing water and is capable, in the absence or pollution or other manmade stream disturbances, of supporting a benthic macroinvertebrate community composed of two or more recognizable taxonomic groups of organisms which are large enough to be seen by the unaided eye and live at least part of their life cycles within or upon available substrates in a body of water or water transport system." Streams that flow year-round are perennial streams.

Point discharge limits (as described later in this chapter) are estimated at the point where the stream supports a benthic macroinvertebrate community characterizing a "perennial stream."

In the past, mining operations in Pennsylvania could get streams to be reclassified as intermittent or ephemeral, classifications requiring no special protections under state mining regulations. In particular, longwall mining under these streams was thought to have no long-term impact because of the depth of the mines. However, recent findings have suggested that these streams are affected. As a result, DEP is shifting its policy to require detailed biological assessments before approving longwall mining operations. Under this new policy, non-permanent intermittent and ephemeral streams receive the same protections as permanent, perennial streams before mining can proceed.

Protection of intermittent and ephemeral streams is also included for logging and other earth-moving activities, although permitted activities may differ from those involving perennial streams. In cases where there is some question over what protections are in place for an activity, DEP's Southwest Regional Manager or Washington County Conservation District office should be consulted.

### Clean Water Act

The 1972 amendments to the Clean Water Act gave the United States Environmental Protection Agency the authority to regulate pollution to waterways of the United States. This includes issuing permits for any point source pollution to a waterbody, setting water quality standards, and implementing point source control measures. The Clean Water Act works to enforce these requirements by enacting existing and designated uses on a waterbody. **Existing uses** are defined as any use that has been attained or has occurred in a waterbody since November 1975. **Designated uses** (Table 3-2) are those that are currently recognized by the state, regardless of whether they have been attained since 1975 (Elder et al. 1999).

**Table 3-2. DEP Waterbody Designated Uses**

| DEP designated Uses | Description |
|---|---|
| Aquatic Life | The waterbody provides suitable habitat for survival and reproduction of desirable fish, shellfish, and other aquatic organisms |
| Fish Consumption | The waterbody supports a population of fish free from contamination that could pose a human health risk to consumers |
| Shellfish Harvesting | The waterbody supports a population of shellfish free from toxicants and pathogens that could pose a human health risk to consumers |
| Drinking Water Supply | The waterbody can supply safe drinking water with conventional treatment |
| Primary Contact Recreation (swimming) | People can swim in the waterbody without risk of adverse human health effects (like catching waterborne diseases from raw sewage contamination) |
| Secondary Contact Recreation | People can perform activities on the water (such as canoeing) without risk of adverse human health effects from occasional contact with the water |
| Agriculture | The water quality is suitable for irrigating fields or watering livestock |

Discharges are not permitted to streams or lakes if they violate the existing uses for that stream or lake. They may violate designated uses, but only if the use cannot be obtained through reasonable enforcement or without causing widespread social and economic costs. For instance, a stream may have "drinking water supply" as an existing use and not a designated use (it is currently not safe to drink). In this case, the state must take steps to restore the stream so that it can be used as a water supply. If a point source will violate a designated use, a public hearing must be held to inform the public before a permit can be issued. Citizens and non-profit organizations can gather information about their watersheds' existing uses, including pictures, newspaper articles, and personal letters, so that a stream can be protected for those uses. According to the Clean Water Act, point sources may not occur that degrade the Buffalo Creek watershed below its designation as a High Quality watershed, unless a special exception is granted. A high Quality watershed is considered to satisfy all designated uses.

***Buffalo Creek is designated a High Quality watershed by DEP***

The entire Buffalo Creek watershed is protected by DEP under the classification *High Quality Warm Water Fishery* (HQ-WWF), given to the watershed in 1979 (PA Code[1]). Though based largely on mere observation and not scientific data (Pers. Comm., D. Bogar), subsequent water quality information has supported this classification.

| Table 3-3. DEP High Quality Watershed or Stream Qualifications (Chapter 93) | |
|---|---|
| Chemistry (meet at least one condition) | The water has long-term water quality, based on one year of data, including being better than the water quality criteria in Chapter 93.7 at least 99 percent of the time. |
| | Additional chemical and toxicity information, which characterizes or indicates good water quality. |
| Biology (meeting at least one condition) | The surface water supports a high quality macroinvertebrate community, as determined by biological and physical habitat procedures outlined in EPA's "Protocols for Use in Streams and Rivers" and has a score of at least 83 percent when compared to a reference stream or watershed of high quality. |
| | The surface water supports a high quality aquatic community based on information gathered using approved biological assessment procedures. |
| | The surface water has been designated a Class A wild trout stream. |

Currently, "high quality" is the highest designation that can be given to a warm-water stream. A high quality waterway meets a number of criteria, including specific water quality and biological standards (Table 3-3). "Warm water" is described as a stream that has, "fish species and flora and fauna which are indigenous to a warm water habitat." Scientifically, in Pennsylvania, a Warm Water Fishery satisfies certain temperature requirements, including a maximum healthy water temperature of 87º F in August (versus 66º F for a Cold Water Fishery) (PA Code[1]). Typically, Warm Water Fisheries have more exposed surface and therefore receive more light than Cold Water Fisheries. However, Warm Water Fisheries often are often able to support species that are considered cold-water fish.

In order to satisfy the requirements of the Clean Water Act, DEP must report to the EPA every two years on the state of its waterways and provide a list of waterways either meeting or not meeting their EPA designated uses. Currently, this list is called the Integrated Waterbody List (PA DEP[3]) (Table 3-4). Streams are assigned five categories based on their status on the Integrated Waterbody List. DEP is required to develop a Total Maximum Daily Load (TMDL) assessment for all streams that are not meeting their designated uses, except when better enforcement of point source pollution can alleviate the problem. These streams are placed in category 5 of the Integrated Waterbody List.

| Table 3-4. Sections of the Integrated Waterbody List (PA DEP) | |
|---|---|
| **Category** | **Classification Description** |
| 1 | Streams in which all uses are attained |
| 2 | Streams in which at least one use is attained |
| 3 | Unassessed streams |
| 4 | Streams impaired for one or more designated use, not requiring TMDL Assessment |
| 5 | Impaired Streams requiring a TMDL |

A TMDL is an analysis of the maximum level of pollutants that can enter a waterbody while still meeting water quality standards and existing uses for that stream under the Clean Water Act. TMDLs must be developed for streams in category 5 of the Integrated Waterbody List. Currently, Dutch Fork Lake is the only stream or lake within the watershed for which a TMDL has been completed. The Integrated Waterbody List shows that four sections of the watershed are not meeting their aquatic life use

(PA Code[1]). This is discussed later in the chapter under Previous Studies, DEP Unassessed Waters Assessment (page 3-11). Within the West Virginia portion, Buffalo Creek is a Warm Water Fishery but does not have a high quality designation. No streams are listed as impaired in the West Virginia section.

The ultimate goal should be to have the entire watershed reflect a high quality designation. Despite impairments, the Buffalo Creek watershed is still granted the protection of its high quality designation within the Pennsylvania portion.

## NPDES Permits

State governments are required to enforce the requirements of the Clean Water Act. One of the ways that this is done is through the National Point Discharge Elimination System, or NPDES, whereby Pennsylvania DEP issues permits for point source discharges (PA DEP[4]). Point sources refer to discharges that enter a stream or lake directly via a pipe, culvert, container, or other means, whereas non-point sources do not have a defined source. In Pennsylvania, the DEP and local conservation districts are responsible for issuing point source permits to industrial operations, municipal wastewater treatment plants, concentrated animal feeding operations, and households. In addition, any disturbance of land from one to five acres requires an NPDES permit, whether it is a point source or not. The exception is for tilling and agricultural practices that are not part of a Concentrated Animal Feeding Operation (CAFO) and most logging disturbances less than 25 acres. However, any logging disturbance over 25 acres requires an NPDES permit. Eight NPDES permits are currently active, or have recently been active, in the Pennsylvania portion of the Buffalo Creek watershed (Table 3-5; Figure 3-1). NPDES permits in the West Virginia portion of the watershed are listed in Appendix G. Active NPDES permits may be found at the EPA Envirofacts website (http://www.epa.gov/enviro/index.html).

## Soil and Erosion Control

Pennsylvania's Clean Streams Act and regulations under the Pennsylvania Code create a role for local governments in protecting streams by developing Erosion and Sediment Control Plans, which include sediment control Best Management Practices, or BMPs. BMPs are practices that help protect the quality of the land and the environment by preventing erosion and pollution. They include such activities as contour farming, filter strips, and silt fences. Even though most agricultural and logging operations under 25 acres are exempt from NPDES permits, they still require a type of Erosion and Sediment Control Plan (PA Code [2]). Disturbances greater than 5,000 acres must have the plan on site. Farm operations must have either a Conservation Plan or Erosion and Soil Control Plan and can receive fines for either not having plans or being in non-compliance with a plan. Conservation plans are also required for farmers wishing to take part in incentive programs. The Washington County Conservation District assists in development of Erosion and Sediment Control Plans and Conservation Plans.

## Concentrated Animal Feeding Operations

In addition to these regulations, the Pennsylvania Nutrient Management Act requires agricultural operations called Concentrated Animal Feeding Operations (CAFOs), where there are more than two animal equivalent units per acre (or more than 2,000 pounds), to also develop nutrient management plans through the local Natural Resources Conservation Service (NRCS) office (PA DEP[5]). Nutrient management plans involve applying nutrients in such a way as to avoid over-application and pollution to water resources.

| Table 3-5. NPDES Permits in the Pennsylvania Portion | | | | |
|---|---|---|---|---|
| **Facility** | **Location** | **Description** | **Permitted Time** | **Receiving Waters** |
| Blaine Township Wastewater Treatment Plant | Taylorstown, PA | sewer systems | 12/13/2001 to 12/13/2006 | Buffalo Creek |
| Claysville/Donegal Jt. Municipal Authority | Claysville, PA | sewer systems | 11/22/2002 to11/22/2007 | Dutch Fork |
| Consolidated Truck Stops, Inc. | Interstate 70 Exit Claysville, PA | gasoline service stations | 1/18/2001 to 1/18/2006 | Dutch Fork |
| Green Valley Packing | Buffalo Township, PA | meat packing plants | 3/27/1998 to 3/27/2003 | UNT to Buffalo Creek |
| Grose Catering | Taylorstown, PA | private households | 6/28/2004 to 6/30/2009 | Wolf Run |
| Interstate RV Center, Inc. | Claysville, PA | RV sales | 1/23/2004 to 1/31/2004 | Dutch Fork |
| Interstate Village Mobile Home Park | Claysville, PA | mobile home dealers | 1/17/2003 to 7/15/2003 | UNT to Bonar Creek |
| McGuffey High School and Middle School | Claysville, PA | school | 11/18/2003 to 11/30/2008 | UNT to Buffalo Creek |

### 537 Municipal Sewage Plans

Act 537, the Pennsylvania Sewage Facilities Act, requires that all municipalities develop and implement an official sewage plan addressing present and future sewage disposal needs. DEP reviews official plans and revisions and issues necessary construction permits. DEP also provides grants and reimbursements for up to 50 percent of costs associated with Act 537 planning and permitting (PA DEP[6]).

Act 537 plans vary by municipality and may include plans for municipal sewage treatment facilities and upgrades to on-lot systems. Sewage Enforcement Officers within each municipality are responsible for issuing permits for new systems and repairs to old systems. All homes not serviced by a sewage treatment facility are required to have a functioning on-lot system that does not create an “obvious” discharge. Malfunctioning systems can be reported to DEP, as well as failure of municipalities to follow 537 plans (PA DEP[6]). PENNVEST, the Pennsylvania Infrastructure Investment Authority, offers loans, and some grants, to municipalities developing sewage treatment facilities. Loans are also available to individuals for development or improvements to on-lot systems.

## Previous Water Quality Sampling

### USGS chemical sampling: 1965-1969, 1983-1985

United States Geological Survey (USGS) undertook some of the first chemical sampling of the Buffalo Creek watershed during the 1960s and 1980s (USGS). This involved sampling of five locations within the watershed: Buffalo Creek, Brush Run, Sugarcamp Run, Upper Dutch Fork, and Dunkle Run. Some select results are given in Table 3-6. USGS maintained a stream flow gauging station along Brush Run from 1960 until 1985. More information can be found at http://waterdata.usgs.gov.nwis.

| Parameter | Minimum | Maximum | Average |
|---|---|---|---|
| conductivity (uS) | 303 | 650 | 440.5 |
| alkalinity (mg/L CaCo3) | 120 | 190 | 156 |
| chloride (mg/L) | 0 | 40 | 14.1 |
| sulfate (mg/L) | 40 | 79 | 55.28 |
| total iron (mg/L) | 0.13 | 3.1 | 0.555 |
| total manganese (mg/L) | 0.01 | 0.13 | 0.061 |

## Pennsylvania Fish and Boat Commission Fish Surveys

The Pennsylvania Fish and Boat Commission's 1992 assessment of habitat quality and fish abundance in Buffalo Creek stated that, "the excellent warm-water fishery described by DER has been degraded in some way," and that further measurement of water quality was needed (Miko and Lorson 1992). This conclusion was formed after noting a decrease in fish abundance and size compared to sampling done in 1983 (from 22 to 17 species), as well as high erosion. The 1983 assessment had deemed the watershed an excellent Warm Water Fishery worthy of special protection (Lorson 1983). The decline in fish population (primarily noted in Buffalo Creek near the West Virginia border) was attributed to increased sedimentation or possible decrease in the amount of fish entering the creek from Dutch Fork Lake due to low conditions (as most of the absent fish were lake species). The 1992 study also concluded that hardness and alkalinity had increased in Buffalo Creek since 1983 (Table 3-7). This assessment did not survey any other streams within the watershed.

**Table 3-7. Water Chemistry Measured in Buffalo Creek by Fish and Boat Commission**

| | Site 1 (near Taylorstown) | | Site 2 (near WV border) | |
|---|---|---|---|---|
| | 1983 | 1992 | 1983 | 1992 |
| **Chemical** | | | | |
| pH | 7.9 | 7.9 | 7.9 | 7.9 |
| Conductivity (uS) | N/A | 470 | N/A | 433 |
| Alkalinity (mg/L) | 120 | 158 | 130 | 155 |
| Hardness (mg/L) | 85 | 194 | 145 | 193 |
| Temperature °C | N/A | 25 | N/A | 23 |

## California University of Pennsylvania—graduate projects

Two graduate student projects, under the supervision of Dr. David Argent, studied the water quality of Buffalo Creek. Romanchak et al. documented the chemistry, as well as macroinvertebrate and fish assemblages, of five sites upstream and downstream of streambank fencing projects (Romanchak and Argent 2001). McCone et al. examined fish, macroinvertebrates, and water quality data from sections of Buffalo Creek (all near Camp Buffalo) with both high streambank erosion (reference sites) and minimal erosion (experimental sites) to see if they differed in water quality (McCone 2003). It was found that reference sections contained significantly higher macroinvertebrate and fish diversity than experimental sections. However, results varied between sites in both sections. For instance, reference reaches ranged from approximately 10 percent for percent Diptera to over 60 percent (possible impairment), while experimental reaches ranged from approximately 40 percent to over 70 percent (Figure 3-3). The percent EPT was over 10 percent in all cases, which is considered by most standards to indicate no impairment.

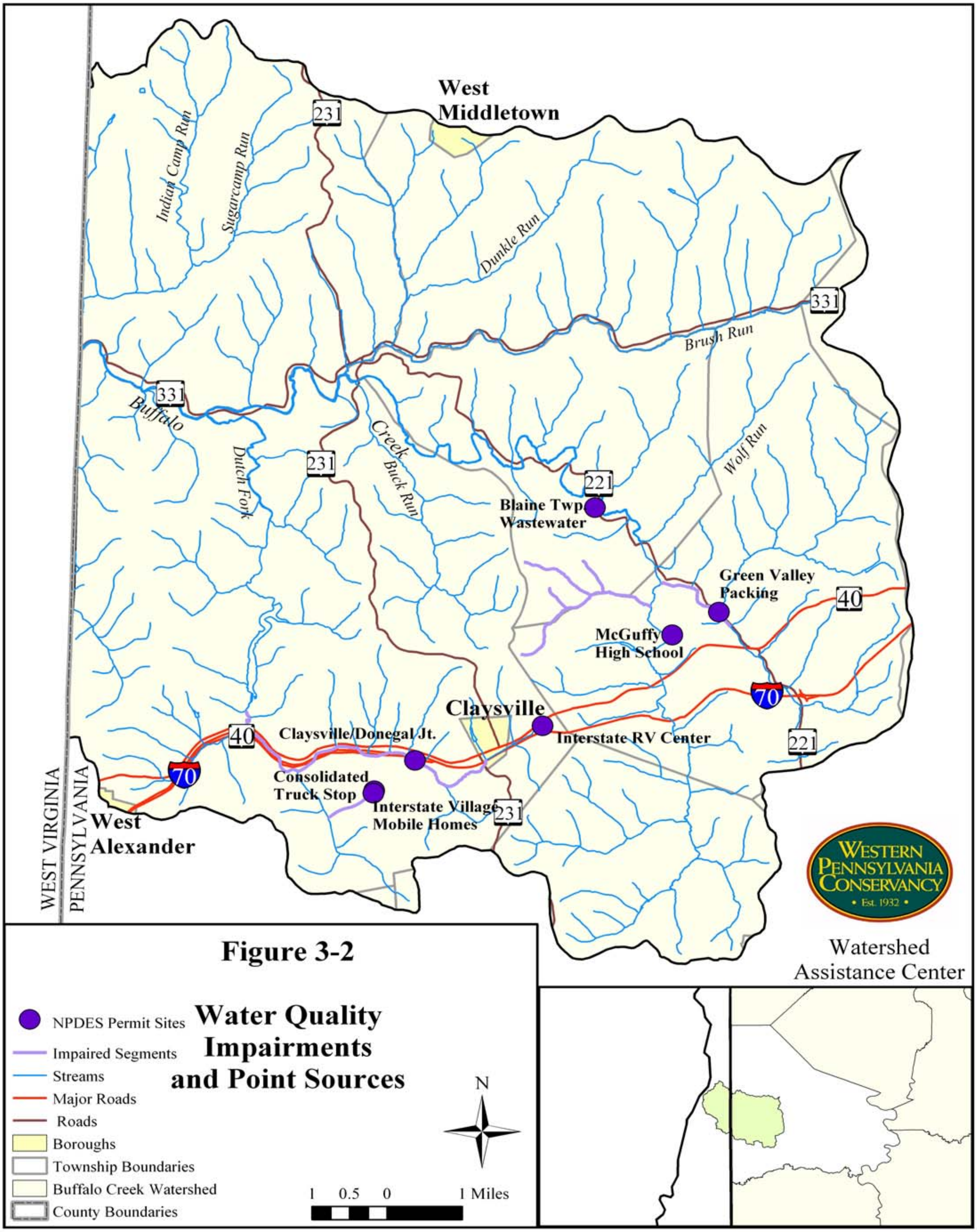



**Figure 3-2**

**Water Quality Impairments and Point Sources**

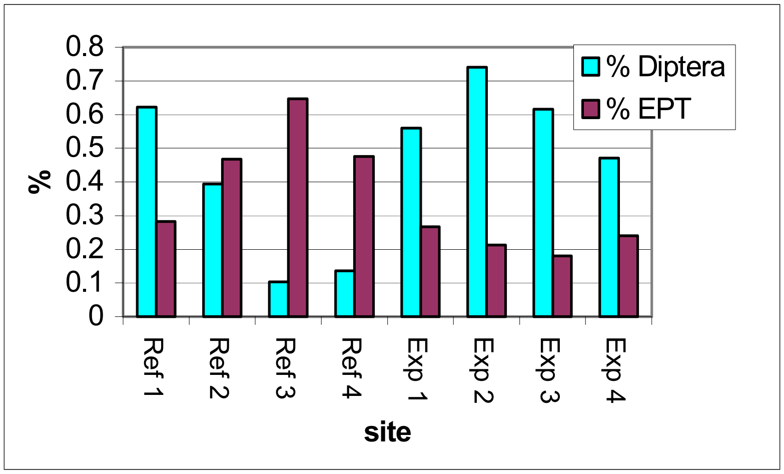



**Figure 3-3. Results of California University of PA Assessment.**

A total of 24 species of fish were identified in Buffalo Creek during the McCone et al. study, including seven species of darters—banded, blackside, fantail, greenside, Johnny, variegate, and rainbow.

## DEP Unassessed Waters Assessment

Investigations by DEP in 2001 during a "wadeable streams survey" placed four sections of the Buffalo Creek watershed on the 2004 list of impaired waterbodies reported to EPA, or Integrated Waterbody List (Table 3-8, Figure 3-2). Conducted in 2001, and based on habitat and the macroinvertebrate assemblage (not chemical data), this sampling was done to determine whether streams were meeting their Aquatic Life uses. Impaired sections of Type 5 are due to non-point sources and require a TMDL (Pers. Comm., A. Falcone).

**Table 3-8. Buffalo Creek Watershed Integrated Waterbody List Impaired Sections**

| DEP Type | Location | Description |
|---|---|---|
| 2 | Dutch Fork Creek, from Bonar to 32875 Trib | Suspected Impairments, but not significant |
| 4 | Trib 32867 to Bonar Creek | Municipal Point Source/Organic Enrichment/ Low D. O. |
| 5 | Trib 32967 to Buffalo Creek south and tribs | Grazing Related Agriculture/Siltation/Removal of Vegetation |
| 5 | Buffalo Creek-S Bridge to Taylorstown | Habitat Modification/Nutrients/Siltation |

## PAGWIS Groundwater Sampling

The Pennsylvania Groundwater Information System (PAGWIS) is a database managed by the USGS containing information about private and public water supplies. Information for the database was obtained by sources such as Pennsylvania DEP, USGS, Pennsylvania Department of Agriculture, private well water drillers, and others.

A review of the database found 14 wells within the Buffalo Creek watershed for which water quality information is available (PAGWIS). Records from Washington County indicate that wells in the Pittsburgh and Uniontown formations can be of poor water quality, containing iron and manganese. Because mining is minimal within the watershed, this contamination is not common. An exception to this was a record from 1983 showing iron concentrations as high as 17 mg/L compared to normal levels of less than 1 mg/L. This record was from the northeastern portion of the watershed, where previous mining has occurred. However, the exact source of the high iron level is unknown.

In general, groundwater yields within the watershed are poor to moderate because of the scarcity of fractures in bedrock material, consisting primarily of shale and sandstone. They are also prone to excessive mineralization if drilled too far below the surface, because water at this depth moves slowly and has had more time to dissolve minerals from rocks. Records also show that there may be numerous abandoned oil and gas wells within the watershed, which have the potential to cause pollution from chloride, iron, and other contaminants. However, no tests of groundwater to date have found chloride concentrations above the drinking water standard of 250 mg/L. Much more up-to-date information is needed on groundwater within the watershed, since all available data is from the 1980s.

## West Virginia DEP Sampling

In July 2000, the West Virginia Department of Environmental Protection (WVDEP) conducted water quality sampling at eight sites in the West Virginia portion of the Buffalo Creek watershed. Water quality standards were met for most parameters. However, four of the eight sites exceeded standards for fecal coliform, including two sites on Castleman Run and sites on Lazear Run and Pierce Run. In addition, though not exceeding standards, Grog Run and Titt Run had conductivity levels indicating possible water quality problems. Titt Run, Pierce Run, Lazear Run, and one of the Castleman Run sites also had nitrate levels of 1.5 mg/L or higher, indicating possible impairment due to agricultural run-off or faulty septic systems. Sedimentation was found to be a significant source of water quality impairments, especially at Titt Run, Grog Run and the two Castleman Run sites (WVDEP). Appendix O. shows results of these sampling efforts.

## Dutch Fork Lake

***Canoers enjoy Dutch Fork Lake***

The water quality of Dutch Fork Lake reservoir reflected the water quality of Dutch Fork Creek upstream, as nutrients and pollution upstream came to make up the resulting characteristics of the reservoir. Though the reservoir was drained in October 2004 and its future is questionable, past water quality of the reservoir provides useful information about the status of Dutch Fork Creek.

Dutch Fork Lake was included on Pennsylvania's 1996, 1998, and 2002 303(d) list of impaired waterbodies for not meeting its Aquatic Life use. Aquatic life was threatened due to excess productivity related to the phosphorous load to the reservoir. This productivity contributed to fish abundance, because the basis for the food web was algae. However, eutrophication (the process by which excess nutrients cause plants to take over a pond and eat up oxygen) can ultimately impair or kill fish and other organisms, which need oxygen for survival. In 2003, a TMDL study was completed for Dutch Fork Lake (PA DEP[7]). This study involved field and computer methods to estimate total loading and make recommendations for improvement, including regulation of point source permits and suggestions for elimination of non-point source pollution.

Lakes naturally evolve towards eutrophic, or "nutrient rich" conditions, such as those that existed in Dutch Fork Lake, as nutrients and sediment collect over time. However, Dutch Fork Lake, as a reservoir, did not meet the standard definition of a "lake" because it emptied into Dutch Fork Creek and was formed from the creek. According to the DEP definition, lakes have a retention time greater than 14 days, while Dutch Fork Lake only had a retention time of nine days. This means that if no water entered the lake, it would have been dry in nine days. Because water flowed through Dutch Fork Lake faster than a normal lake and water discharged from the dam at the epilimnion (top), some of the nutrients and algae entering Dutch Fork Lake traveled downstream. For these reasons, the highly productive nature of Dutch Fork Lake reservoir was largely attributed to pollution, not natural eutrophication.

When total phosphorous, a determinant of lake productivity, was measured in 1987 by DEP, the mean concentration of total phosphorous in Dutch Fork Lake was 112 ug/L. Average concentration decreased to 65.6 ug/L in 2003, suggesting that agricultural or other improvements were made upstream of the reservoir. A chlorophyll value over 20 ug/L is considered eutrophic, or high in nutrients. Chlorophyll a, which is a pigment in plants directly related to productivity, was nearly 30 ug/L in 2003. DEP estimated that chlorophyll a would need to be at 20 ug/L in order to meet water quality standards for the lake. Accordingly, phosphorous loads would have had to be decreased by 667 kg/yr in order to meet these standards (PA Code[1]).

Modeling efforts by DEP in 2003 pointed to direct runoff into the reservoir from cropland and pastureland as the biggest source of phosphorous pollution, and suggested BMPs were needed to improve the reservoir. However, the land immediately surrounding Dutch Fork Lake is mostly forested. If agricultural inputs were entering the reservoir, then Dutch Fork Creek and other tributaries, rather than direct runoff, were likely contributors. DEP suggests that BMPs, such as the following, would have improved conditions of the reservoir:

- reduction of excess fertilizers to row crops;
- streambank fencing to reduce the amount of organic matter entering the stream (which breaks down into phosphorous); and
- riparian revegetation to act as a buffer against phosphorous entering the stream.

Groundwater pollution from agricultural sources was considered another large contributor of phosphorous to Dutch Fork Lake in DEP's recent study. It is possible that other contributors, such as faulty sewer systems, are contributing a large proportion of phosphorous through groundwater that the model failed to show. Both the Claysville Mobile Home Park and Donegal Joint Municipal Authority had permits to discharge into either Dutch Fork Creek or one of its tributaries upstream of the reservoir. However, DEP considered contributions of phosphorous to be minimal.

Since the time that the reservoir was drained in 2004, sediment and nutrients that had built up in the reservoir have been traveling downstream into Dutch Fork Creek and eventually Buffalo Creek. This has degraded the quality of life in the stream, although some efforts have been made by DEP to use sediment and erosion controls to limit this degradation.

## Recent Water Quality Improvement Activities

### Buffalo Creek Watershed Restoration Project

The Buffalo Creek Restoration project is a partnership among numerous conservation organizations to reduce agricultural non-point pollution by fencing livestock from streams, restoring wetlands, and establishing warm-season grasses. Partners include California University of Pennsylvania, Tri-County Chapter of Pheasants Forever, Washington County NRCS, Ducks Unlimited, U. S. Fish and Wildlife Service, the Pennsylvania Game Commission, the Washington County Conservation District, the Pennsylvania Fish and Boat Commission, and the National Fish and Wildlife Federation. Pennsylvania DEP has also contributed funding through the Growing Greener Program (Pers. Comm., J. Teracido 2004).

The NRCS and cooperating agencies developed an assessment of water quality problems, determining that pasture and cropland erosion, animal waste, nutrient pollution, and stream erosion from livestock were the major natural resource concerns. They determined that there was a need to treat

10,000 acres of pasture, 1,000 acres of riparian corridor, and stabilize 40 miles of streams in the northern portion of the watershed. To date, the project has fenced over 27 miles of streams, protected over 90 acres of wetlands, created 45 livestock crossings, and planted over 311 acres of warm-season grasses within Buffalo Creek watershed (Pers. Comm., J. Teracido 2004).

## Partners for Fish and Wildlife Stream Stabilization

The Partners for Fish and Wildlife Stream Stabilization project, summer 2004, addressed fish habitat and stability of the streambank area of Buffalo Creek 5.2 miles downstream from Taylorstown. The project was designed to demonstrate the benefits of bank protection by installing rock vanes and root wads to protect from erosion and divert energy from the streambanks. Trees were planted to provide long-term stability. Pennsylvania DEP, NRCS, the National Fish and Wildlife Foundation, and the Fish America Foundation provided funding for this project (Putnam and McCone 2002).

## Dirt and Gravel Roads Program

The Pennsylvania State Conservation Commission Dirt and Gravel Road Pollution Prevention Program provides training and funding to local road-owning entities, mainly municipalities, to correct pollution problems on dirt and gravel roads. Sediment entering streams from roads can cause such negative consequences such as disrupting flow, suffocating organisms, accelerating filling up of dams and reservoirs, and decreasing spawning areas for fish (Penn State).

The Task Force on Dirt and Gravel Roads, including public and private agencies such as Trout Unlimited, Penn State University, and Pennsylvania DEP, created the commission and continues in an advisory capacity to the program. Pennsylvania's conservation districts administer the program. Municipalities may apply for funding after completing a two-day workshop. In 1996-1997, the Task Force developed a list of healthy streams (High Quality and Exceptional Value), being negatively affected by dirt and gravel roads. The Buffalo Creek watershed had the highest density of priority dirt and gravel roads in Washington County (Penn State).

***An inadequately designed culvert and endwall from a Buck Run tributary filled with sediment after a flood in 2004.***

Examples of improvements made through the Dirt and Gravel Road Program include grade breaks, french mattresses, headwall and endwall construction or improvements, and use of driving surface aggregate. Grade breaks increase the road elevation on a downhill slope, causing water to flow off the road surface and preventing erosion of road material. French mattresses are structures built under a roadway through which water can fully pass, allowing a non-erosive discharge of water. Headwalls and endwalls are walls built around culvert openings that can be modified to withstand higher flow capacities. Driving surface aggregate is a road surface containing fine particles that can be used in place of more common applications containing silt and clay. Unlike silt and clay, the fine particles settle out and can have less negative effects on aquatic life (Penn State). Figure 3-4 shows priority dirt and gravel roads within the Buffalo Creek watershed.

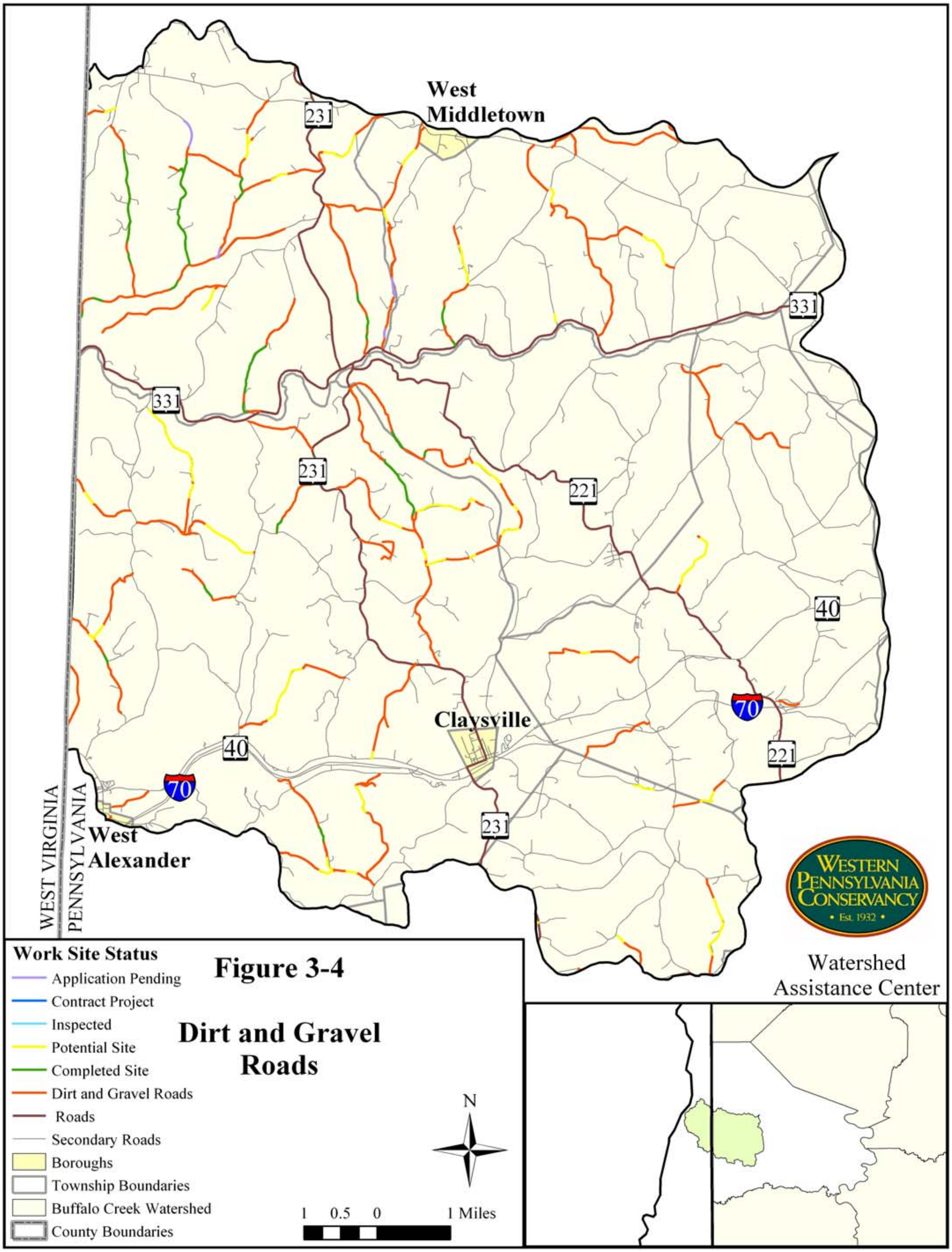



Figure 3-4

Dirt and Gravel Roads

# WPC Assessment

## Overview

To investigate the current health of the streams within the Buffalo Creek watershed, WPC collected data on the chemical, biological, and physical aspects of water quality. Stream flow estimates were made within major tributaries of Buffalo Creek. Chemical sampling was done using both test kits and laboratory analysis and conducted based on subwatershed boundaries. Macroinvertebrate sampling was done using EPA's rapid bioassessment protocol adapted for WPC use. A visual assessment was performed on every accessible stream within the watershed using the USDA protocol adapted for use in the Buffalo Creek watershed. The visual assessment results were used to determine whether streams exhibited excellent, good, fair, or poor quality based on a minimum of 10 variables. Recommendations based on findings are given at the end of each section.

## Stream Flow

### Objective

To quantify stream flow, or discharge, as measured by cubic feet/second of water in Buffalo Creek and its tributaries during low- and high-flow situations.

### Methods

A cross-sectional area of each selected stream was determined by measuring width and depth of the stream at various intervals. An FP 100 Global Flow Probe was used to measure stream flow in feet/second at each of these intervals. This information was used to estimate total discharge by summing the product of velocity and area of each interval.

### Results

Stream discharge varied greatly throughout the sampling period. This coincided with residents' reports of extremely low flow during dry, summer months of high evapo-transpiration and high flow during storm events. Because of dangerous flow, discharge was estimated for a spring storm event by using past estimates of the cross-sectional area and using the flow probe from the streambank. This may be an underestimate of flow. Table 3-9 shows stream flow estimates for major tributaries.

**Table 3-9. Stream Flow at Select Locations**

| Stream | Flow (cubic feet/second) | | |
|---|---|---|---|
| | 8/1/2003 | 10/23/2003 | 4/2/2004 |
| Sugarcamp | | 3.92 | |
| Buffalo Creek East | 12.15 | 5.71 | *78.29 |
| Buffalo Creek South | | 7.83 | *76 |
| Buffalo Creek (Taylorstown Gazebo) | 21.79 | | |
| Buck | 2.87 | | *75 |
| Buffalo Creek (mouth of Middle section) | 39.96 | 25.12 | *218.50 |
| Dunkle | 7.04 | 3.60 | *50.63 |
| Dutch Fork (mouth) | 5.18 | 17.5 | *193.60 |
| Upper Dutch Fork (mouth) | 6.08 | 3.68 | *133.950 |
| Buffalo Creek (near WV border) | 27.31 | 36.8 | too high |
| Brush | 12.79 | 8.16 | *148.5 |

*estimated because of dangerous sampling conditions

***Discussion***

Stream discharge is one of the most useful parameters measured in streams. Extreme changes in flow over time can indicate alterations in watershed hydrology due to such factors as well-water withdrawals, riparian buffer removal, and mining activities. Because of a lack of flow information collected in the watershed in the past, few conclusions can be drawn from the data collected in this study. Efforts should be made to continue monitoring stream flow into the future to look for changes that may be indicative of stream health.

Unnaturally low flows can decrease the capacity of a stream to buffer changes in temperature that can affect aquatic organisms. Low flows may also cause aquatic animals to be stranded in pool areas or have negative effects on organisms because of low oxygen levels. The same land-use activities that cause low flows during dry months can contribute to high flows during rain events, especially alterations occurring in floodplain areas. Floodplains are one of the most important places where stream water is transferred to groundwater. Instead of water being stored in groundwater, vegetation, and soil, floodplain alterations can cause water to be lost to a stream and increase flow during rain events.

Stream discharge can also be used in conjunction with pollution concentrations to estimate locations of pollution loading. In most cases, discharge can be roughly estimated by volunteers by measuring the time it takes to float a symmetrical object downstream a certain distance or by using a flow probe. Unfortunately, discharge is most difficult to measure during high storm events when it can be the most useful. "Dimensionless ratios" are sometimes used to estimate stream discharge during flows below the bankfull stage by estimating the probable discharge for different stream types at specific cross-sectional areas. The term **bankfull** describes the point at which a stream discharge begins to overflow onto its floodplains (Rosgen 1996). Dimensionless ratios are currently not available for most of Pennsylvania but are being developed by USGS and may one day be useful in estimates of stream flow.

Another useful way to measure stream flow, which is actually utilized in the development of dimensionless ratios, is the use of stream gauges. The USGS maintains permanent stations across the United States to monitor instantaneous stream flow, which is transmitted via satellite to the USGS office every four hours and then made available to the public on the USGS website. Stream discharge information provided through these gauges can help provide information to properly design dams, bridges, and wastewater treatment plants, as well as warn of flood events. From 1960 to 1985, USGS maintained a gauging station within the watershed on Brush Run (USGS). Due to budget constraints, the gauging station was eliminated.

***Recommendations***

- Continue to monitor and record stream discharge in Buffalo Creek and its tributaries.
- Develop a relationship between water height and stream discharge in major tributaries using dimensionless ratios, so that discharge can be estimated more easily and be used more readily to estimate flood levels and sediment loads.
- Encourage the re-establishment of a USGS gauging station within the watershed.

## Chemical Assessment

***Objective***

To evaluate water quality within the Buffalo Creek watershed by acquiring existing chemical data and conducting new investigations using test kits and laboratory analysis.

***Methods***

All known chemical data from studies within the Buffalo Creek watershed was collected, with emphasis on data collected within the last five years. WPC staff conducted further investigations using

Lamotte test kits and laboratory analysis (Table 3-10). New stream sites were chosen based on the following priorities:

(1) Sites on Buffalo Creek itself, based on changes in land use and accessibility.
(2) Sites at the mouths of major tributaries of subwatersheds entering Buffalo Creek in Pennsylvania.

(3) Smaller order streams that enter Buffalo Creek and its major tributaries.
(4) Sites on tributaries of major subwatersheds that enter Buffalo Creek in West Virginia.

| **Types of Analysis Performed** | **How Performed** | **Dates of Sampling** | **Sites** |
|---|---|---|---|
| conductivity, total dissolved solids, pH, sulfates, iron, nitrates, phosphates | test kits | quarterly (August 2003-2004) | Buffalo Creek mainstem and subwatersheds, a total of 13 sites |
| conductivity, total dissolved solids, pH, sulfates, iron, nitrates, phosphates | test kits | 1-3 times during 1 year period (August 2003-2004) | smaller tributaries, a total of 20 sites |
| TSS, chlorides | laboratory | October 2003 | 9 sites=TSS; 7 sites=chlorides |
| TSS, TP, some nitrates | laboratory | March 2004 | 9 sites=TSS, TP; 4 sites=nitrate |
| fecal coliforms | laboratory | August, October 2004 | 8 sites in August and 8 in October |

Chemical sampling results were compared to water quality standards to determine sites at which water quality standards were not being met. Results were compared to past data to estimate water quality trends over time and make recommendations. The following is a description of the chemical parameters measured during the study. The majority of sampling was done using test kits, which were adequate to determine whether water quality standards were being met. Further laboratory tests were used to investigate some of the sources of pollution.

**pH**: This measure of the number of hydrogen ions in solution is affected by natural geologic conditions as well as pollution. Higher pH may indicate nutrient and sediment pollution while lower pH may indicate acid rain or mine drainage. High pH's may result in algae blooms. Natural pH conditions often range from 5.5 to 8.5.

**Iron:** Naturally occurring iron may show up as red deposits in streams in Pennsylvania where iron has come into contact with oxygen and forms a rust-like precipitate. Processes used in mining and oil and gas well drilling can contribute to unnaturally high amounts being released into streams, which is toxic to wildlife.

**Temperature:** The temperature of a stream may affect dissolved oxygen concentrations (higher temp=lower DO), rates of photosynthesis, effects of pollutants, and aquatic species composition; removal of vegetation along the stream is the biggest contributor to increased temperature.

**Dissolved Oxygen:** Aquatic organisms require oxygen for survival. Factors such as high temperatures and algal growth can decrease the amount of oxygen available and decrease health of aquatic organisms.

**Conductivity:** This measure of electrical current carried by ions in solution is dependent on both natural and man-made sources; high conductivity or increases in conductivity can indicate faulty septic systems, or high urban or agricultural runoff, but often further investigation is needed. Total Dissolved Solids (TDS) is a comparable measurement, equal to roughly half the conductivity concentration.

**Total Suspended Solids (TSS)**: This measure of large particles suspended in solution can indicate soil erosion, waste system effluent, agricultural runoff, and soil erosion; particles can carry harmful bacteria and nutrients, block photosynthesis, and clog the gills of aquatic insects and fish.

**Phosphates**: This measurement of the phosphorous available to plants often is the key factor contributing to algal growth in streams, which can cause low oxygen concentrations; a measurement of phosphate at any one time may not yield valuable results because phosphate is quickly produced and utilized. Therefore, total phosphorous (TP) may be a more important measure.

**Nitrates:** A valuable component of amino acids necessary for life, high levels of nitrates may cause increased algal growth and low oxygen levels. This measurement of the nitrogen available for plants is, like phosphates, primarily caused by agricultural runoff and faulty sewer systems.

**Sulfates:** High levels of sulfate may be indications of sewer pollution or mine drainage pollution; natural sources may include naturally occurring sources found in gypsum within limestone rock.

**Chlorides:** High levels of chloride may be caused by abandoned oil and gas wells, agricultural runoff, and road salt.

**Fecal Coliforms:** This group of bacteria found in the intestinal tracts of humans and other warm-blooded animals may carry harmful micro-organisms. High levels may indicate faulty sewer systems and runoff from farm animal operations.

**Total Nitrogen and Total Phosphorous:** This measure of the total amount of phosphorous and nitrogen, including that which is not yet available to plants, can be helpful in estimating sources of nutrient loading.

### *Results*

The highest temperature recorded within the watershed during the sampling period was 74.2° F at the exit of Dutch Fork Reservoir in August 2002. Other sampling points with temperatures 70.0° F or higher included Buffalo Creek at the West Virginia border, Dutch Fork Creek at its mouth, and Dutch Fork Creek immediately before it enters Dutch Fork Lake. The lowest temperatures recorded during summer sampling were 68.1° F at the mouth of Buck Run and 67.3° F at the mouth of the south branch of Buffalo Creek. The Buffalo Creek watershed met the requirements of a Warm Water Fishery with respect to temperature according to these results.

***ents and sediment during a storm***

The lowest pH recorded within the watershed was a pH of 7.3 for Dutch Fork Creek before entering Dutch Fork Lake (summer). The highest reading was a pH of 8.8 for Dutch Fork Creek below the truck stop on Route 70 (spring). The average pH recorded within the watershed was 8.18.

Conductivity averaged 474 microsemens (uS). A conductivity reading from 550 to 600 uS was considered a possible sign of a water quality problem, while a reading above 600 uS was considered a more definite sign of a problem. Probable water quality problems were identified at the following sites: Upper Buffalo Creek, S bridge (spring 2004), Mouth of Dunkle Run (summer and fall 2003), a tributary to Brush Run (fall 2003), and Dutch Fork Creek before entering Dutch Fork Lake (summer 2003). A more definite problem was identified on Buffalo Creek at the gazebo area in Taylorstown in summer 2003, but no other readings at this site reached such levels.

Nitrate levels averaged about 0.25 mg/L in any stream within the watershed on any given sampling day. Highest levels were observed during spring runoff. Although no measurements exceeded water quality standards, levels over 1 mg/L were considered to be possible symptoms of a water quality problem. These levels were observed at the following sites: mouth of Upper Buffalo Creek, S Bridge (March 2004), Buffalo Creek at Taylorstown Gazebo (March 2004), Brush Run tributary along Hickory Run Road (March 2004), the mouth of Brush Run (March 2004), and a tributary to Dunkle Run (Spring 2004). A level of 4 mg/L in an agricultural tributary of Brush Run was the highest observed.

Sulfate levels ranged from 0-60 mg/L, and all were below the water quality standard of 250 mg/L. Chloride, measured at eight sites in 2003, remained far below the water quality standard of 250 mg/L. The highest chloride concentration measured was 66.5 mg/L at the mouth of Lower Dutch Fork subwatershed. Iron approached the water quality standard of 1.5 mg/L in a tributary to Brush Run along Maple Run Road and exceeded standards in a tributary to Buffalo Creek in Buffalo Township. No specific reason for this high iron level could be identified.

Total nutrient and suspended solid loading measurements made during a spring storm event were used to look for sources of sediment and nutrients within the watershed. Loading was estimated using the units commonly used in such studies of kilogram per day (kg/day) and kilogram/day/hectare. One hectare is equal to approximately 2.47 acres, and approximately 453.59 grams are equal to one pound.

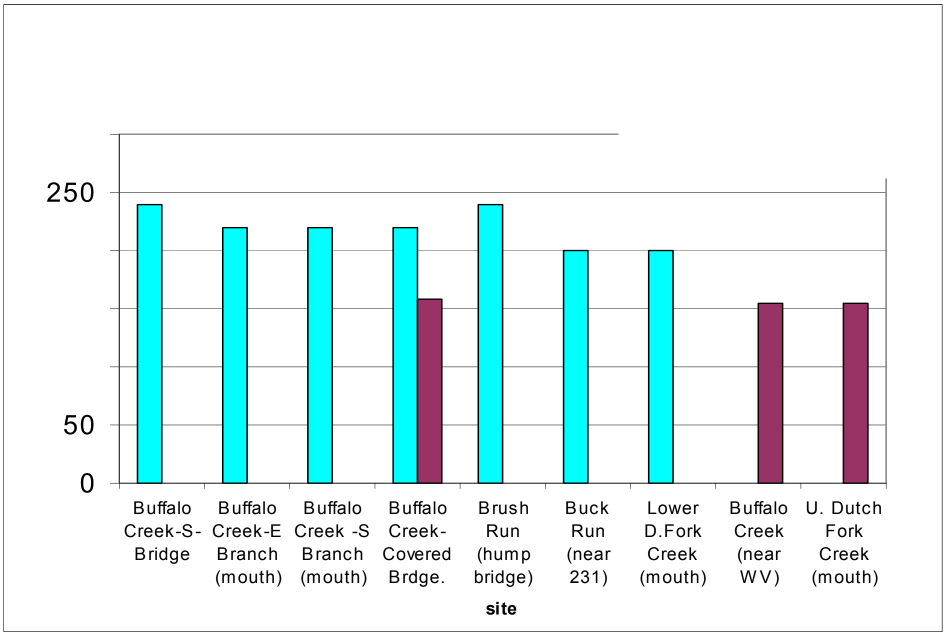
**Table 3-11. Net Contribution of Sediment and Phosphorous to Buffalo Creek (storm event)**

| Subwatershed | Area (hectares) | Phosphorous | | | Total Suspended Solids | | |
|---|---|---|---|---|---|---|---|
| ID | hectares | kg/day | rank | g/day/ha | rank | kg/day | g/day/ha |
| Buffalo East | 3,283 | 18 | 5 | 1 | 5 | 12,545 | 627 |
| Middle Buffalo Creek * | 3,012 | 4 | 7 | 0 | 1 | 22,249 | 1,212 |
| Brush Run | 3,267 | 68 | 1 | 4 | 2 | 17,840 | 896 |
| Buffalo Creek South | 3,865 | 26 | 4 | 1 | 3 | 15,586 | 662 |
| Dutch Fork mouth * | 1,660 | -17 | 9 | -2 | 8 | 896 | 89 |
| Buck Run | 1,460 | 33 | 3 | 4 | 7 | 4,456 | 501 |
| Dunkle Run | 2,061 | 12 | 6 | 1 | 6 | 6,016 | 479 |
| Dutch Fork upper | 4,566 | 43 | 2 | 2 | 4 | 12,642 | 454 |
| Lower Buffalo Creek* | 2,550 | -130 | 8 | -9 | 9 | -232 | -15 |

* These subwatersheds were adjusted for contributions from subwatersheds upstream, and values only represent the net gain or loss of sediment in that subwatershed.

Middle Buffalo Creek and Brush Run contributed the highest amounts of sediment to the mainstem of Buffalo Creek in terms of both total contribution and contributions/acre (Table 3-11). Lower Buffalo Creek served more as storage for sediment than a source, with less sediment leaving the subwatershed than entering it. The highest contributors of phosphorous were Buffalo Creek South and Upper Dutch Fork subwatersheds. On a per/area basis, Brush Run and Buck Run were the highest contributors. Lower Dutch Fork Creek and Lower Buffalo Creek served more as storage areas than source areas for phosphorous.

Alkalinity sampling done by the Buffalo Creek Watershed Association found that alkalinity averaged 220 mg/L over eight sites throughout the watershed (Figure 3-5). This appears to be an increase in the average of 155 mg/L during Fish and Boat Commission sampling in 1996, though few sites were looked at during that evaluation.




Fecal coliform sampling undertaken during rain events in swimming (August) and non-swimming (October) seasons exceeded water quality standards for the majority of the samples. Results are shown in Table 3-12. In August, eight out of nine samples exceeded standards of 200 mg/L, and the sample below standards was thought to be the result of a laboratory error. The maximum value that could be obtained during this first sampling was 200 mg/L because of the constraints of the laboratory test. In October, six out of eight samples exceeded standards of 2,000 mg/L. The sites with the highest levels were the mouth of Dunkle Run and Buffalo Creek at Taylorstown. Sites with the lowest levels and not exceeding standards were Buck Run and Buffalo Creek South.

| (units: coliform colonies/100 mL) | | |
|---|---|---|
| **Site** | **8/18/2004** | **10/19/2004** |
| Buffalo Creek East, S Bridge | >200* | 2540 |
| Buffalo Creek, Taylorstown | >200* | 3600 |
| Buffalo Creek, Route 3003 Bridge | >200* | 3100 |
| Dunkle Run, mouth | 0** | 3760 |
| Buck Run, near mouth | >200* | 1430 |
| UNT, Newman Road | >200* | 2460 |
| Upper Dutch Fork, before reservoir | >200* | 2340 |
| Upper Buffalo Creek, softball fields | not sampled | 1560 |
| UNT, Hickory Nut Road. | >200* | not sampled |
| * 200 mg/L was the maximum value that could be obtained<br>**suspected error in analysis<br>values in red exceed the water quality standard | | |

Water quality standards are set by DEP for the most common types of pollution to streams. Based on the water quality sampling done by WPC, water quality standards were exceeded very few times for most parameters (Table 3-13; Figure 3-6). Alkalinity may have been considered to impair water quality at the levels found based on other sources, but DEP does not set a maximum value for alkalinity. Fecal coliform was the exception, exceeding water quality standards the majority of the time. Though sampling was not done over a period of 30 days, which is required by the water quality standard requirements for fecal coliforms (Table 3-13), values could be expected to exceed standards at least during rain events, which normally occur at least five times per month. Figure 3-6 shows the results of sampling efforts. Sites that exceeded water quality standards for a standard parameter at least one time during the study are shown in red.

| Table 3-13. Number of Samples Exceeding Water Quality Standards | | | |
|---|---|---|---|
| **Parameter** | **Units (mg/L)** | **Source** | **# Exceeding Standards** |
| Alkalinity | x>20 | PA Code 25, Chapter 93.7 | 0/8 |
| Iron | 1.5 | PA Code 25, Chapter 93.7 | 1/48 |
| Nitrates | 10 | PA Code 25, Chapter 93.7 | 0/55 |
| pH | 6.0<x<8.5 | PA Code 25, Chapter 93.7 | 4/51 |
| Phosphate | 0.1 | EPA Water Quality Standards | 0/46 |
| Sulfates | 250 | PA Code 25, Chapter 93.7 | 0/36 |
| Chloride | 250 | PA Code 25, Chapter 93.7 | 0/7 |
| TSS | 500 avg; 750 max | PA Code 25, Chapter 93.7 | 0/10 |
| | | | |
| **Parameter** | **coliforms/100mL** | **Source** | **# Exceeding Standards** |
| Fecal Coliform | 200 during swimming season, based on 5 samples over 30 days | PA Code 25, Chapter 93.7 | 7/8 |
| Fecal Coliform | 2,000 during non-swimming season, based on 5 samples over 30 days | PA Code 25, Chapter 93.7 | 6/8 |

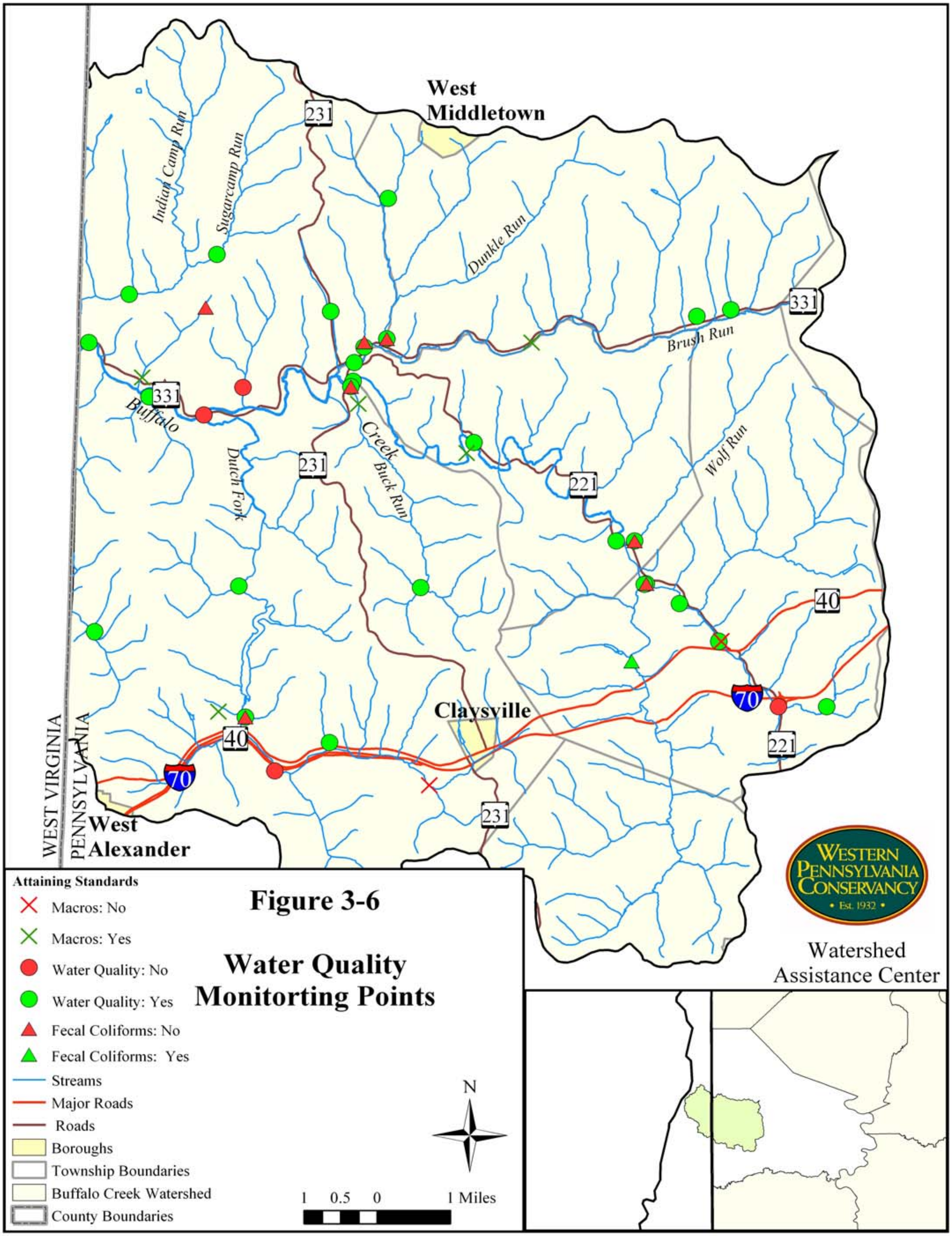



**Figure 3-6**

**Water Quality Monitorting Points**

***Discussion***

Results support observations made by WPC and residents that faulty sewage septic systems and agricultural runoff are probably the two major problems affecting water quality in Buffalo Creek. Suspended solids are largely comprised of sediment from streambank erosion, manure and crop runoff, and solids from faulty septic systems. Not surprisingly, areas of high total suspended solids were also some of the areas with the highest fecal coliform counts, which are symptoms of septic problems and agricultural runoff. These included Dunkle Run, Middle Buffalo Creek (Taylorstown), and Upper Dutch Fork Creek.

Though fecal coliform bacteria are not inherently harmful, they can be a symptom of other disease-causing bacteria. Drinking water standards are 200 mg/L, while standards for surface waters are much higher. Typically, streams carry the highest levels of fecal coliforms after storm events, when runoff enters streams. Levels were not measured during normal flow periods, when bacterial counts may have been lower. Though the high levels do not necessarily indicate that streams within the watershed are not safe for recreation purposes, efforts should be made to monitor coliform levels regularly and to determine sources of high levels. Septic system upgrades and additional streambank fencing efforts could help reduce fecal coliform counts.

Though standards were generally met for other parameters, levels may still be high enough that impairments to wildlife exist. For instance, studies have shown that nitrate levels below water quality standards may not kill amphibians and fish, but may cause other less notable impairments, such as nervous system dysfunctions. Additionally, nitrate and phosphate levels are constantly changing in response to storm events and natural processes. Sampling four times during one year may not have given a true picture of nutrient levels. Even small amounts of phosphate can contribute greatly to algal growth and potentially affect stream health.

Alkalinity in streams varies greatly based on the natural geology of an area and the presence of calcium carbonate and other alkalinity producing compounds. Though high alkalinity can benefit a stream by preventing the negative effects of acid rain and acid mine drainage, it can also have negative effects if combined with high nutrients. This is because carbonate and bicarbonate ions that make up alkalinity increase the amount of phosphorous utilized by plants, increasing primary production and algal blooms. Alkalinity in Buffalo Creek has increased by approximately 27 percent since 1996. Increases in alkalinity can occur as a result of anthropogenic inputs such as agricultural runoff and faulty septic systems, or any ion that increases buffering capacity.

***Severe erosion along a section of Buffalo Creek, resulting in significant loss of streambank each year***

Of the areas sampled, Buck Run continually presented itself as one of the higher quality streams within the watershed. The exception was that it had the highest total phosphorous load on a per acre basis. This suggests that there may be a substantial source of phosphorous in the subwatershed. The fact that fecal coliforms and suspended sediment were substantially lower than other areas suggests that the source may not solely be attributed to septic systems or animal waste. However, nutrient interactions in streams can be complicated and further study is needed to determine the source of phosphorous loading.

Water quality standards were exceeded approximately 10 percent of the time during the sampling period. High quality streams are expected to meet water quality standards at least 99 percent of the time. The foremost parameters that exceeded water quality standards were pH and fecal coliforms. Though there is a water quality standard for pH of 8.5, it is possible that natural conditions in a high quality stream could be near that level. More investigation would be needed to determine whether the high levels are normal or due to agricultural and other impacts. Additionally, there is no direct evidence that fecal coliforms exceeded water quality standards by being over 2,000 colonies during five sample periods in a month. Samples were not collected five times within a month and it can only be assumed that water standard levels are exceeded every time there is a medium to high rain event, which may occur at least five times in a month. What is known is that any efforts to reduce fecal coliforms would greatly benefit streams for humans and wildlife. Finally, only one site exceeded water quality standards due to iron levels, a possible indicator of abandoned mine drainage (AMD) or abandoned oil and gas well impacts. However, this 1.5 mg/L reading is much lower than many other AMD-impacted streams and there is no evidence of high iron levels elsewhere within the watershed.

***n***
***these areas may receive financial incentives***

Though there are no water quality standards for suspended solids (an indicator of sedimentation), sediment pollution can pose a serious threat to stream health. The lack of standards simply reflects the complicated nature of determining what levels should be considered harmful. Some streams received high suspended sediment loads but are able to transport this sediment downstream, where it is not deposited on streambeds. It is the natural meanders, or bends in the stream, that provide the energy for this transfer of the sediment. Streams that have been altered from their natural state due to building or roads, altered riparian zones, or other factors, often retain sediment on the streambed, which can smother aquatic organisms. This sediment deposited on the streambed is immobilized during high storm events, causing bank failures downstream and ultimately increasing flooding potential, which also poses problems for humans.

Results suggested that the Middle Buffalo Creek and Brush Run subwatersheds contributed the most sediment in total and on a per acre basis during a storm event. These may be the watersheds with the highest levels of streambank erosion and other sources of sediment. Both need further study and would be some key areas to benefit from additional streambank fencing, septic system upgrades, and streambank improvements to reduce sediment loads, though Brush Run already has the highest levels of streambank fencing within the Buffalo Creek watershed. Also notable was the use of marginal lands (steep slopes and floodplains) for grazing and cropland within many of the subwatersheds. These areas are priorities for the Conservation Reserve Enhancement Program (CREP) and other programs that pay farmers to keep these lands out of production. Best management practices such as streambank fencing and rotational grazing may reduce sediment loads in agricultural areas.

Fluvial geomorphology studies can investigate a stream's ability to transport sediment and make recommendations for improving sediment transport. Because of the [illegible] and cost associated with these studies, conducting them is often unrealistic, especially in rural areas. However, Buffalo Creek and its tributaries would benefit from any further studies of sediment dynamics and improvements to both reduce sediment loads and increase the ability to transport sediment downstream through repairing riparian areas and improving passage of sediment through culverts and bridges.

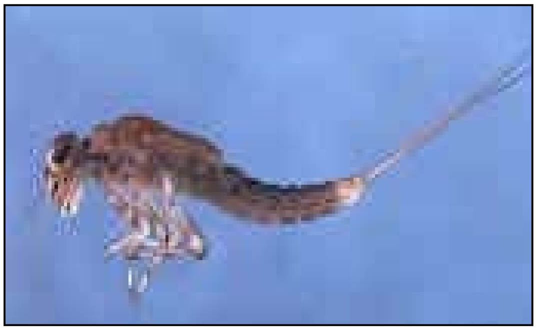
***Recommendations***

- Conduct further chemical monitoring within the Buffalo Creek watershed to look for potential problems and trends in water quality.
- Establish regular monitoring of fecal coliforms.
- Continue and expand BMPs within the watershed, including streambank fencing, the limiting of disturbances (mowing, agricultural, logging, etc.) in riparian zones, and discontinue agricultural activities on steep and other marginal areas; this can be done through landowner participation in CREP and other programs.
- Enforce Act 537, which requires all on-lot systems to have functioning sewage systems, and encourage municipalities to follow their Municipal Sewage Plans.
- Conduct more detailed analyses of fecal coliforms and other bacterial measures (such as Escherichia coli- E. coli) as technology becomes available that is able to determine the sources of bacteria in streams (human, livestock, wildlife).
- Conduct detailed studies on the transport of water and sediment within the watershed, based on the principles of fluvial geomorphology, to determine areas that could best benefit from restoration activities such as riparian plantings and the installation of root wads and crossvanes, in order to alleviate pressure on streambanks and reduce stream widening.

## Macroinvertebrate Assessment

***Background***

Aquatic macroinvertebrates include animals without backbones that are big enough to see with the naked eye and live in waterways such as streams, lakes, and wetlands. They include aquatic insects, snails, and crayfish. Macroinvertebrates are important indicators of health in aquatic ecosystems, often depending on unique habitat requirements to complete their life cycles. Physical characteristics such as external gills, siphons, and streamlined shapes are special adaptations to the aquatic environment. Typically, aquatic insects make up the majority of the macroinvertebrate assemblage. Larval, or immature, insects emerge as adults to lay their eggs on, or in close proximity to, streams and lakes. Common aquatic insect orders include mayflies, dragonflies, stoneflies, beetles, flies, and true bugs. Snails, clams, and worms are also common.



**This mayfly of the family Baetidae has a streamlined shape designed for maneuvering in running waters. (photo courtesy New York State Department of Environmental Conservation)**

Because a waterbody's chemistry can change from one day to the next, biological indicators such as macroinvertebrates are often better indicators of aquatic health than chemistry, especially in streams. Aquatic insects have life cycles of varying durations and unique tolerances to pollution, so that the presence and abundance of a group can say much about past and present stream health. Aquatic insect life cycles range from less than two weeks (some species of chironomids and other fly families) to several years (some species of stoneflies). Higher quality waters often have a larger proportion of longer-lived, more intolerant species (indicating a consistent period of good water quality). As a result of differences in geologies and background water chemistry, tolerance levels to pollution can also vary by geographic area. See Appendix K for a family level tolerance listing used by the Pennsylvania DEP.

***Objective***

To use the quantities and identities of macroinvertebrates and their varying tolerances to pollution to evaluate water quality within the Buffalo Creek watershed.

***Methods***

The sampling protocol used in collection was "Western Pennsylvania Conservancy's Standard Operating Procedure for Macroinvertebrate Sampling Using a D-Frame Net," which involves vigorously collecting debris 20 times (kicks) within a 100-meter sample reach, using a special net and dislodging debris .5 meters upstream of the net (Appendix I). Sorting and identification utilized "Western Pennsylvania Conservancy's Laboratory Macroinvertebrate Sample Sorting and Identification," which involves identifying a subset of the entire sample down to the genus or species level (the lowest level of identification). One additional site sampled by the Buffalo Creek Watershed Association during a macroinvertebrate training was sampled using only five kicks.

-

WPC macroinvertebrate sample sites identified to the lowest possible taxa included Buffalo Creek (S Bridge), Buffalo Creek (Covered Bridge), Welch Run, Dutch Fork North at SR 3019, Buck Run, and Brush Run at Coon Hunt Club. An additional site identified to family by the Buffalo Creek Watershed Association was the mouth of Upper Dutch Fork Creek.

DEP's Wadeable Streams Survey (Appendix J) was used to determine whether a site was impaired in order for results for the six sites to be compared with DEP's macroinvertebrate survey results obtained in 1999. Indices of Biological Integrity used to further evaluate stream health included Hielsenhoff Index of Biological Integrity, percent Diptera (fly) larvae, percent EPT (Ephemeroptera, Plecoptera, and Tricoptera), and Total Number of Taxa, as described below.

**Hilsenhoff Index of Biological Integrity:** This index measures stream health by considering the tolerances to pollution of the members of the macroinvertebrate community. Each family receives a specific tolerance score, and the tolerances are averaged to get an index score. A value of 7 or higher is considered impaired, 6-7 is possibly impaired, and less than 6 is unimpaired.

**Percent Diptera larvae:** Dipterans, or flies, are an important part of the stream community. However, many dipterans can withstand polluted conditions of low oxygen. The following gauge of stream health was used in this study: <15% or >50% dipterans = impaired; 15%-20% or 45%-50% dipterans = possibly impaired; 20%-45% dipterans = unimpaired.

**Percent EPT:** Most species of mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Tricoptera) require gravelly stream bottoms with good oxygen and high water quality. The presence of these groups indicates good habitat and water quality. In general, < 5% EPT species is impaired, 5%-10% EPT species is possibly impaired, and >10% EPT species is unimpaired.

**Total Number of Taxa:** If the site has a high number of taxa (in this case, families), then habitat and water quality can support a variety of life. Nutrients (such as from sewage) decrease the ability of the stream to support aquatic insect life. Generally, less than 13 families is considered impaired and greater than 13 is considered unimpaired.

A stream was considered impaired if it had an impaired score on two or more of the above indices or if it failed DEP's Wadeable Streams Evaluation, which considers various indicators of stream health (Appendix J).

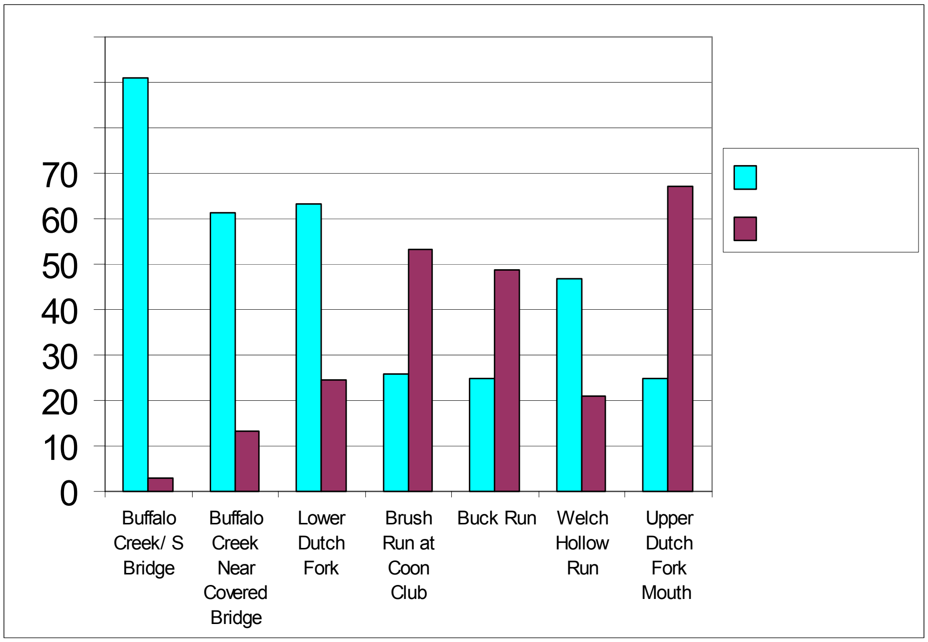



**Figure 3-7. % Diptera and % EPT at WPC macroinvertebrate sites**

***Results***

Figure 3-7 shows percent Diptera and percent EPT scores for each of the sites. The streams showing the greatest habitat quality and least amount of agricultural impacts, Buck Run and Welch Hollow Run, had the highest percent EPT scores and lowest percent Diptera scores. Upper Dutch Fork had a high percent EPT species but most of the sample was comprised of a tolerant mayfly taxa, heptagenidae. Sites with possible impairment according to percent Diptera included Buffalo Creek-S Bridge, Buffalo Creek-Covered Bridge, and Lower Dutch Fork. Brush Creek had a marginal percent Diptera score, which means that it scored between impaired and unimpaired.

A site was ultimately considered impaired if it received a negative in two or more of the four index categories (percent Diptera, percent EPT, Hilsenhoff, and Diversity) or if it failed DEP's Wadeable Stream Survey, which is an alternative method of evaluating stream integrity that is used by DEP (Appendix J). Table 4-14 shows the final results. The Upper Dutch Fork site (Route 3019) not only failed one of the indices, percent Diptera, but also failed the DEP survey and was therefore considered impaired. The Buffalo Creek East site failed all of the indices and was also considered impaired.

| Table 3-14. Results of Macroinvertebrate Survey | | | | | | | |
|---|---|---|---|---|---|---|---|
| Biological Index | Buffalo East (S Bridge) | Dutch Fork at Rt. 3019 | Dutch Fork (at lake inlet) | Buffalo Creek (near covered bridge) | Buck Run | Welch Hollow Run | Brush Run (near Coon Hunt Club) |
| Hilsenhoff Score | I | marginal | N | N | N | N | N |
| Percent Diptera | I | I | N | I | N | N | marginal |
| Percent EPT | I | N | N | N | N | N | N |
| Diversity | I | N | I | N | N | N | N |
| DEP Survey | I | I | N | N | N | N | N |
| Considered Impaired | I | I | N | N | N | N | N |

I=impaired, N=not impaired

***Discussion***

*Macroinvertebrate Communities*

Specific taxa of macroinvertebrates tend to occur together as a result of water quality and environmental characteristics. WPC, The Nature Conservancy, and other partner agencies have recently been working on a community classification system that will help determine what species most occur together within certain environments. Data collected for this plan was used in developing the classification. The study found that community “3” is a common community type characteristic of lower gradient, less forested streams containing the stonefly family Perlidae. A large percentage of streams with these characteristics contained members of this family. Community type “5” streams, usually containing Emidae, Hydrophilidae, and Empididae families, are associated with agricultural land use, and most of these streams are considered impaired. It was found that most streams in Buffalo Creek were type “3” streams, while Buffalo Creek also contained category type “5” streams. Community types in Buffalo Creek were fairly common throughout Pennsylvania (Nightingale 2004).

*Impaired Stream Sections*

In conjunction with its sampling done in 2001, as part of the Unassessed Waters Assessment, DEP used macroinvertebrates sampled at 42 sites within the watershed to determine whether water quality standards for aquatic life were being met yet. WPC sampling at different sites suggested that additional sections are impaired in addition to what was determined by DEP.

DEP has recognized a sewage problem at Taylorstown and the development of a sewage plant in the area is intended. However, the findings in this study suggest that the problem may extend far upstream of the 303(d) listed area, given that a poor macroinvertebrate score was found at the S Bridge. Raw sewage entering Buffalo Creek has been reported in the vicinity of the S Bridge. Consequently, the impaired section of Buffalo Creek near Taylorstown should likely be extended west along Buffalo Creek to the S Bridge, and potentially even farther upstream of this site. In addition, the eastern branch of Buffalo Creek, which impacts the downstream S Bridge site, should be a high priority for streambank fencing and other BMPs, as it has minimal fencing compared to other portions of the watershed, but has a high level of agricultural land use that may be contributing to the degradation.

An additional impaired site identified by WPC was upstream of the 303(d) section along Dutch Fork Creek. The source of water quality problems within the impaired portion of Dutch Fork Creek has yet to be identified, but has previously been attributed by DEP to point source pollution from the Route 70 truck stop. Though the truck stop may be contributing to the poor environmental quality, sampling suggested that problems may partially originate upstream of the truck stop and some non-point sources are contributing. For these reasons, it is recommended that this section be scheduled for a TMDL (which it currently is not).

There may be other impaired sites that were not sampled. The chemical and visual assessments assessed many areas that were not covered by the macroinvertebrate sampling. However, because of the importance of macroinvertebrate sampling in finding longer-term problems in water quality, the watershed group and other organizations should consider conducting more intensive macroinvertebrate sampling efforts in the future.

#### ***Recommendations***

- Develop a regular macroinvertebrate monitoring program for the Buffalo Creek watershed.
- Consider Buffalo Creek near the S Bridge and Dutch Fork Creek along Route 3019 as priorities for monitoring and future restoration activities, and expand streambank fencing programs to these portions of the watershed.

## Visual Assessment

#### ***Background***

There is often a need to assess a stream quickly without the need for large amounts of scientific data. One way to do this is through a visual assessment of stream health, which can give a general overview of problems that might be occurring within a stream reach. Streams are complex systems where a variety of biological, physical, and chemical processes interact, and a visual assessment cannot begin to predict these interactions. However, it may give a general view of both negatively impacted and healthy areas and aid in developing monitoring, protection, and restoration efforts.

Changes in physical structure often affect the health of a stream. Increases in sediment load beyond the transport capacity of a stream results in deposition, stream widening, and cutting into streambanks. This can be made worse by the alteration of the channel, such as roads too close to the stream and removal of the riparian zone. Often, these activities increase flooding and problems downstream. By looking at the characteristics of the channel and activities around it, one can begin to interpret the physical health of the stream. Chemical pollution is another factor influencing stream health. Though only directed chemical sampling can determine specific types of pollution, visual indicators of pollution may include high algal growth, water odors, and effluent pipes going into the stream. The presence and types of macroinvertebrates found by briefly picking up rocks and debris can indicate pollution problems. Less tolerant stoneflies, mayflies, and caddisflies are preferable to large numbers of tolerant species such as fly larvae and leeches.

#### ***Objective***

To estimate the health of streams within the Buffalo Creek watershed, by visually assessing components of stream health, in order to determine priority streams for restoration, protection, or further research.

***Methods***

The health of all accessible streams within the Buffalo Creek watershed was evaluated using USDA's Stream Visual Assessment Protocol adapted for WPC use. Accessible streams were those that could be evaluated from nearby roadways or through permission granted by landowners. If a stream was only partially evaluated and a score could not be formulated, it was given a "no score" rating. If a stream could not be identified at all due to landowner permission issues, it was considered "unassessed." The assessed streams were given a score from one to 10 based on an average of scores in 10 different categories related to stream health. The composition of land use and stream substrate was also estimated for each stream evaluated. The following stream parameters were evaluated:

**Channel Condition**: Channel alterations may increase the probability of flooding and bank erosion downstream and cause habitat loss for aquatic animals. Signs of channel alteration or straightening include an unnaturally straight stream, high banks, dikes, lack of riffles and pools, missing or altered vegetation, culverts, bridges, and riprap.

**Riparian Zone**: The riparian zone, or vegetated area along the stream from the active channel throughout the floodplain, keeps the stream cool, helps reduce erosion, dissipates energy during flood events, and provides woody debris for stream animals. A small or absent amount of vegetation in this area can be unhealthy for a stream.

**Bank Stability**: Excessive bank erosion occurs when riparian zones are degraded, hydrology is altered, sediment load is increased, or the floodplain is changed. Some streambank erosion is natural, but severe erosion on outside bends or erosion on inner bends of banks can be indicative of a problem.

**Water Appearance**: Turbid or green water can indicate sediment and nutrient impacts. Clarity can be estimated by looking at objects at different depths, and should never be estimated during a rain event (unless impacts during a rain event are being determined).

**Nutrient Enrichment**: High levels of nutrients promote overabundance of algae. Intense algal blooms and thick mats of algae may indicate nutrient problems.

**Fish Barriers**: Barriers that block the movement of fish or other organisms may affect survival and reproduction of these species. These include dams and raised culverts. Large culverts with little drop usually do not cause a problem for fish.

**Instream Fish Cover**: The potential for the maintenance of a healthy fish community and its ability to recover from disturbance can be estimated by looking at the number of habitat types available, including woody debris, deep pools, overhanging vegetation, and others.

**Embeddedness**: This measurement of the degree to which cobble and gravel are covered by fine sediment within a riffle or run is directly related to the suitability of substrate for macroinvertebrates, fish spawning, and egg incubation. It is influenced by stream erosion and other causes of sedimentation.

**Invertebrate Habitat**: The number of habitat types available for invertebrate colonization of the stream substrate can be related to the regularity of stream flows and other indicators of stream health. These include woody debris, submerged logs, leaf packs, boulders, and coarse gravel.

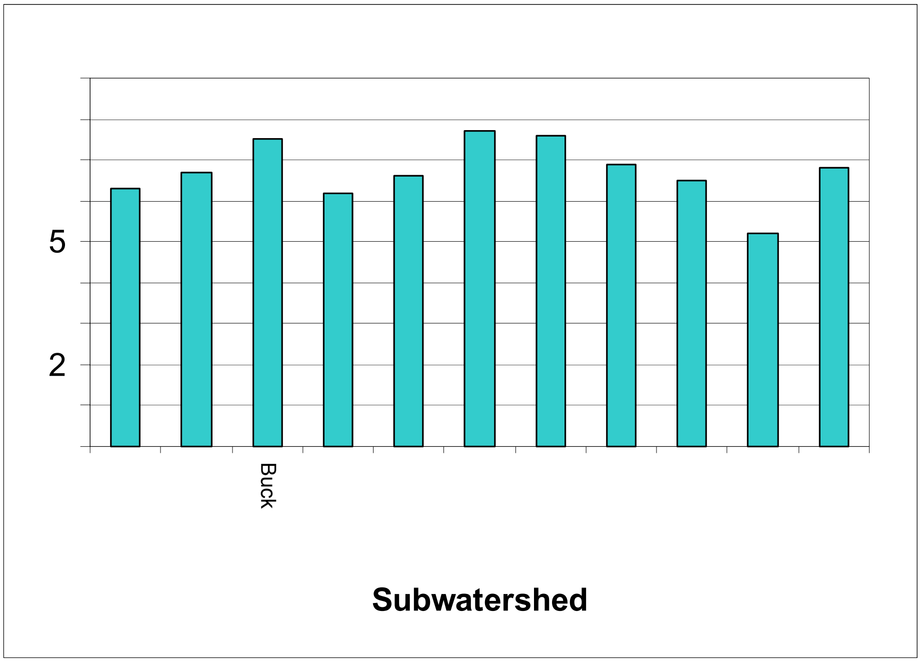
**Canopy Cover**: The amount of stream shaded when the sun is high and leaves are full can help determine the temperature and algal growth in a stream, which affects a stream's status as a Cold Water or Warm Water Fishery.

In addition to these 10 parameters, a stream was given an added negative score if sewage or manure presence was noted.

***Results***

Figure 3-9 shows the streams sampled during the visual assessment survey. Each stream assessed is given a different color based on its rating. Figure 3-8 shows the average stream score within each subwatershed. Scores within many of the subwatersheds varied greatly, and percentage area of each stream scored was not considered in the averaging. The subwatershed with the lowest average score was Buffalo Creek East, and the subwatershed with the highest score was Lower Buffalo Creek.

The lowest scoring category was "embeddedness," an indicator of sedimentation. Of the 11 subwatersheds, six had embeddedness as the lowest scoring category and two had embeddedness as the second lowest scoring category. The most common second lowest scoring categories were "instream fish cover" and "bank stability." Table 3-15 gives results for each parameter.




**ithin each subwatershed. A higher score indicates better stream health.**

| Table 3-15. Results for Lowest Scoring Visual Assessment Parameters | | | | |
|---|---|---|---|---|
| **Subwatershed** | **Lowest Category** | **Average Score** | **Second Lowest Category** | **Average Score** |
| BC South | Bank Stability | 5.1 | Embeddedness | 5.2 |
| Brush | Embeddedness | 6.2 | Instream Fish Cover | 6.3 |
| Buck | Water Appearance/Nutrient Enrichment | 6.5 | Bank Stability/Embeddedness | 6.6 |
| Castleman | Nutrient Enrichment/Riparian Zone | 5.0 | Canopy Cover | 5.1 |
| Dunkle | Embeddedness | 5.4 | Instream Fish Cover | 5.8 |
| Lower BC | Embeddedness | 6.8 | Nutrient Enrichment | 6.9 |
| Lower D. Fork | Embeddedness | 6.7 | Fish Barriers | 7.2 |
| Middle BC | Instream Fish Cover | 5.8 | Water Appearance | 6.2 |
| Sugarcamp | Embeddedness | 5.8 | Embeddedness | 5.8 |
| BC East | Embeddedness | 4.3 | Bank Stability | 4.4 |
| Upper D. Fork | Embeddedness | 5.5 | Instream Fish Cover | 6.1 |

The following gives a brief description of observations during visual assessment surveys:

**Buffalo Creek South**: The biggest apparent land use was agricultural/grazing. However, there were clusters of residential development in the portion south of Route 40. North of Route 40, reverting old fields surrounded the mainstem of South Buffalo Creek. Septic system problems were expected in the residential areas south of Route 40 due to the small size of lots and room for leach beds. Several septic discharges to streams were found. Many homes are built in floodplains and residents have removed riparian zones, mowed to streams, or in some instances actually dredged and straightened streams. Most livestock grazing areas are near small streams and streambank fencing efforts are greatly needed.

**Brush Run**: The biggest land use is agricultural, and Brush Run and Dunkle Run have the highest levels of agriculture within the watershed. However, streambank fencing efforts have been strong and appear to be greatly improving the conditions of many of the streams in Brush Run subwatershed. One of the bigger problems is that Route 331 is extremely close to Brush Run, which has contributed to flooding problems and streambank erosion due to straightening of the stream. In the upstream section and in some of the headwaters, the riparian zone has been removed, causing a reduction of debris to the stream and reducing habitat. In addition, there is still need for fencing in some areas.

**Buck Run**: Buck Run was observed to one of the highest scores in the visual assessment, receiving high scores for riparian zone and aquatic habitat. Much of the mainstem is under Pennsylvania Game Commission control, and the northern portion is highly forested. Despite this, sewage smells were observed along several of the headwater tributaries. Livestock access to streams and the use of lawn fertilizers were also noted. These impacts may have contributed to the lower scores given for water appearance and nutrient enrichment. In addition, the close proximity of Buck Run to the road appears to be contributing to sedimentation, and more efforts are needed to keep dirt and gravel out of the stream. Culverts of tributaries also did not appear to be adequate in accommodating sediment flows. Poorly maintained gas well roads crossed streams, and vehicle tracks caused considerable damage to stream riparian zones within these crossings.

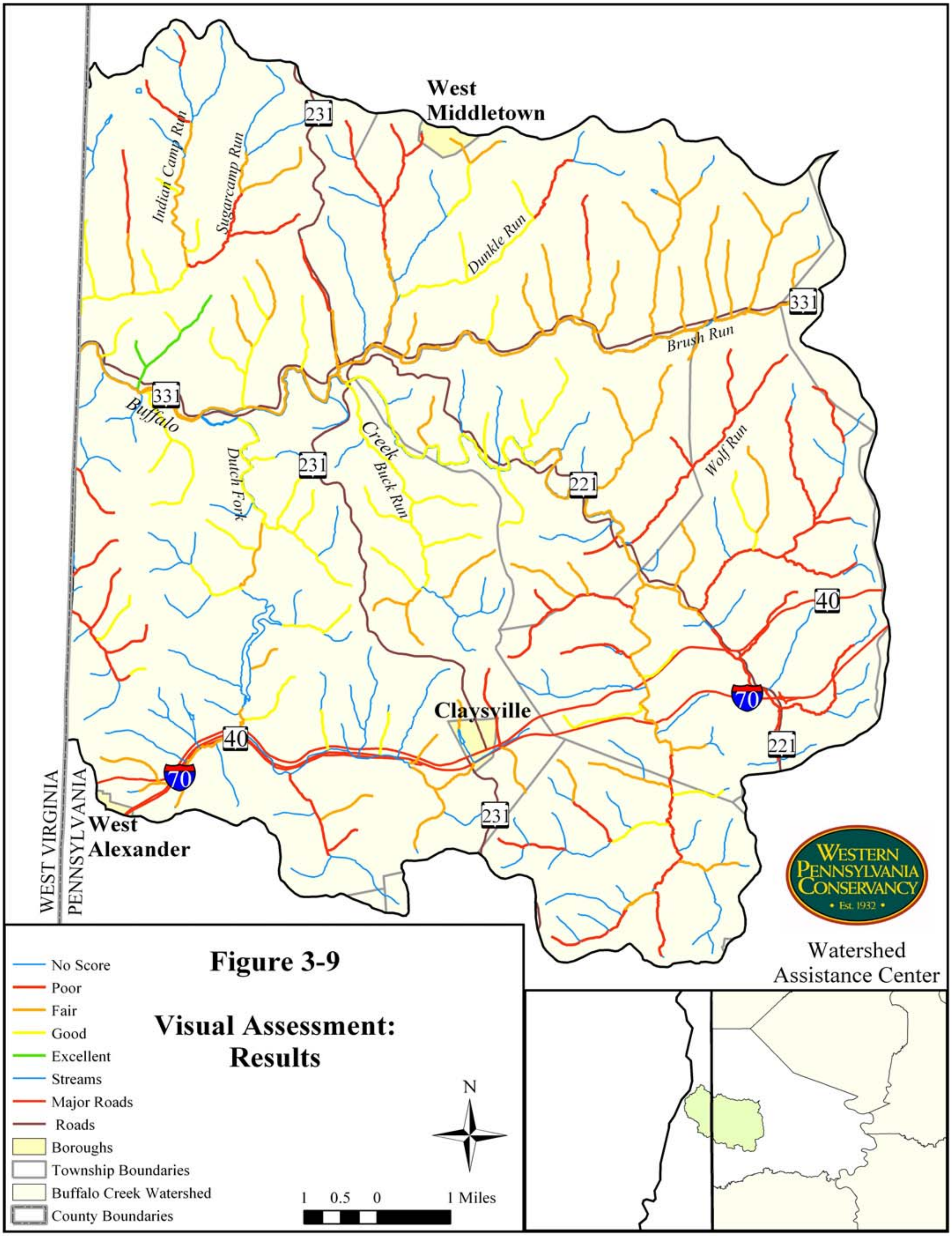



**Figure 3-9**

**Visual Assessment: Results**

**Castleman Run**: Castleman Run, which enters West Virginia, was observed to be a highly agricultural subwatershed. One stream received a "good" score and the others were considered impaired. In general, rocks were coated with algae, water was turbid, and riparian zones were lacking. Livestock had access to streams, and sewage smells were noted in several cases.

**Dunkle Run**: Dunkle Run had similar characteristics to Brush Run. Grazing-related agriculture dominated, but streambank fencing efforts were strong. However, a number of farms still in need of streambank fencing were noted. A section of Poplar Road poses a serious safety issue and is in need of repair. In several areas, livestock were being grazed along extreme slopes and severe erosion was noted.

**Lower Buffalo Creek**: Lower Buffalo Creek subwatershed received the highest overall stream score. However, this was primarily due to the quality of the tributaries and not of the mainstem. Several tributaries were located within State Game Lands; additional tributaries had been left forested by landowners. In general, the mainstem had high levels of streambank erosion and appeared to be widening in many areas because of sediment loads and lack of a riparian zone. In several areas, such as near the intersection of Lower Dutch Fork, the creek had better habitat quality for fish, with alternating pools and riffles. However, in most cases, these habitat types were not observed. Tributaries generally had good to excellent water quality, including Narigan Run and Welch Run. Extensive logging was observed in several areas along Narigan Run, possibly contributing to sedimentation. The proximity of the road to Narigan Run also appeared to be causing some channelization problems. Dog Run Road was found to be in disrepair, and the road crossed the stream many times, indicating that the road should be considered for closure or repair.

**Lower Dutch Fork**: This subwatershed generally exhibited good water quality and stream habitat. In several cases, houses on Dutch Fork Creek were built within the floodplain, but in most cases the mainstem was set far back from disturbance and surrounded by scrub/shrub and forest. The tributaries were generally of good quality and were highly forested, such as along Chapel Hill Road. However, culverts were found to be inadequate and residents had altered streams to accommodate water and sediment during floods. Small animal and horse farms were observed near the mainstem and often lacked streambank fencing or other best management practices.

**Middle Buffalo Creek**: This subwatershed contains a multitude of land uses, including agricultural, public (State Game Lands), and residential (Taylorstown). The Pennsylvania DEP has found high concentrations of fecal coliforms in the stream below Taylorstown and the township (Blaine) is considering building a sewage treatment facility. The subwatershed also likely receives agricultural inputs from the tributary of Wolf Run, where some streambank fencing is needed. Downstream from Taylorstown, riffles and pools in the mainstem of Buffalo Creek are evident and streambank erosion decreases, providing a good fishing area. Several smaller, good condition tributaries enter Buffalo Creek. However, above Taylorstown, erosion is a serious problem and the mainstem is widening. This is especially evident through Taylorstown, where it is expected that several feet of streambank is lost from Buffalo Creek each year. Residents mow along stream banks streams, and riparian zones are removed, contributing to the widening of the creek.

**Sugarcamp Run**: This subwatershed is comprised mainly of agricultural lands, but residential development and forest are also important land use types. The most striking observation was the need for streambank fencing along nearly every stream with agriculture, especially portions of Sugarcamp Run where the riparian zone was absent and streambank erosion was extreme. As Sugarcamp Run entered West Virginia, a forested, floodplain forest was observed and stream habitat improved. Most of Indian Camp Run was observed to be of good habitat quality, with natural meanders. Japanese knotweed was observed near the headwaters of Indian Camp Run by a golf course, one of the few places where it is beginning to enter the watershed.

**Buffalo Creek East**: This subwatershed, along with Castleman Run, was the most impacted within the watershed. It is evident that developmental pressures are emerging in this area, and there are few measures towards conservation planning. Streambank fencing and other BMPs are sorely needed throughout the subwatershed. Sewage smells and effluent into the stream were observed. Tributaries, such as along Gorby Road, have been essentially turned into ditches. The best quality tributary observed was along a reverting field on Reese Road.

**Upper Dutch Fork**: Though embeddedness and instream fish cover were the lowest scoring categories, this section is ultimately affected, physically and chemically, by Route 70. It very closely follows the highway and has been altered to cross under the road many times. A conductivity of nearly 1000 uS was found in a tributary near the road, possibly caused by road salt or another pollutant. Agriculture and clusters of residential development dominate the subwatershed. After a TMDL of Dutch Fork Lake revealed high nutrients, residents were required to implement BMPs, and streambank fencing is now evident throughout the subwatershed. However, faulty septic systems continue to be a primary source of nutrient additions to the stream. Invasive species, such as multiflora rose, were found to be significant surrounding many fenced streams. Higher quality areas included a tributary along Hicks Road and the trout-stocked area near the former reservoir. Many areas of this subwatershed were difficult to assess because of Route 70 and landowner access problems.

### *Discussion*

Though visual assessments can only give a basic overview of stream health, they can be used to make general recommendations about stream improvements and the focus of restoration efforts. In nearly every subwatershed, embeddedness was one of the lowest scoring categories. Any effort to decrease sediment loads will improve this aspect of stream health. Several areas of Buffalo Creek are high priorities under CREP, due to the proximity to streams and steep slope. This program may provide funding for streambank fencing or taking marginal land out of production. Other funding opportunities may be available through NRCS.

Landowner awareness was another big issue. Many landowners thought that removing riparian zones and straightening streams would improve conditions during flooding, when these activities usually make conditions worse by reducing the capability of the stream to handle the energy of flood events. Though mowed streambanks may look better to many people, mowing has an extremely negative impact on wildlife and contributes to flooding Municipalities could encourage maintaining riparian zones by providing some type of incentive to landowners who retain riparian zones. Additionally, many landowners said that they did not understand why protecting streams was important, yet groundwater issues were the biggest worry of respondents of the public survey. However, groundwater and surface water are constantly interchanging and affect each other.

### *Recommendations*

- Develop tax incentives or other incentives for landowners that maintain riparian zones and do not build within the 100-year floodplains.
- Encourage municipalities to follow local 537 Sewage Plans and to enforce upgrades to on-lot systems.
- Encourage farmers to use BMPs and to participate in USDA, CREP, and Partners for Wildlife streambank fencing programs.

## Recommendations (summary-all sections)

### Stream Flow

- Continue to monitor and record stream discharge in Buffalo Creek and its tributaries.
- Develop a relationship between water height and stream discharge in major tributaries using dimensionless ratios, so that discharge can be estimated more easily and be used more readily to estimate flood levels and sediment loads.
- Encourage the re-establishment of a USGS gauging station within the watershed.

### Water Quality

- Conduct further chemical monitoring within the Buffalo Creek watershed to look for potential problems and trends in water quality.
- Establish regular monitoring of fecal coliforms.
- Continue and expand BMPs within the watershed, including streambank fencing, the limiting of disturbances (mowing, agricultural, logging, etc.) in riparian zones, and discontinue agricultural activities in steep and other marginal areas; this can be done through landowner participation in CREP and other programs.
- Enforce Act 537, which requires all on-lot systems to have functioning sewage systems, and encourage municipalities to follow their Municipal Sewage Plans.
- Conduct more detailed analyses of fecal coliforms and other bacterial measures (such as Escherichia coli- E. coli) as technology becomes available that is able to determine the sources of bacteria in streams (human, livestock, wildlife).
- Conduct detailed studies on the transport of water and sediment within the watershed, based on the principles of fluvial geomorphology, to determine areas that could best benefit from restoration activities, such as riparian plantings and the installation of root wads and crossvanes, in order to alleviate pressure on streambanks and reduce stream widening.
- Be informed about construction, logging, and other earth-moving projects in the watershed and verify that Erosion and Soil Control or other necessary permits have been obtained for these activities.

### Water Quality (macroinvertebrates)

- Develop a regular macroinvertebrate monitoring program for Buffalo Creek watershed.
- Consider Buffalo Creek near the S Bridge and Dutch Fork Creek along Route 3019 as priorities for monitoring and future restoration activities, and expand streambank fencing programs to these portions of the watershed.

### Water Quality (visual assessment)

- Develop tax incentives or other incentives for landowners that maintain riparian zones and do not build within 100-year floodplains.
- Encourage municipalities to follow local 537 Sewage Plans and to enforce upgrades to on-lot systems.
- Encourage use of BMPs and participation in CREP, NRCS, and Partners for Wildlife streambank fencing programs.

# OUTDOOR RECREATION AND TOURISM

## Overview

Eco-tourism can be described as responsible travel to natural areas that conserves the environment and improves the well-being of local people. It can have the benefit of improving an area's economy while protecting local resources. The Buffalo Creek watershed is one of only two high quality watersheds in Washington County. The existence of extensive public lands and its recent designation as an Important Bird Area suggests the potential for eco-tourism to have a more prominent role in the local economy.

Outdoor recreation opportunities currently available in the watershed include hunting, hiking, fishing, birding, biking, horseback riding, and general nature viewing (Figure 4-1). However, currently, the potential for many of these activities is largely untapped. Few local businesses are taking advantage of the influx of visitors from outside the watershed.

## Recreational Opportunities

### Hunting

Public hunting opportunities exist both on State Game Lands 232 in Pennsylvania (approximately 4,000 acres) and Castleman Run Wildlife Management Area in West Virginia (486 acres). West Virginia or Pennsylvania state hunting regulations apply. Due to the watershed's variety of habitats, including riparian wetlands, hardwood forests, fields, and brush areas, these hunting areas are abundant with game animals, including deer, wild turkey, pheasant, and duck. The Pennsylvania Game Commission (PGC) has helped maintain wild game populations on State Game Lands 232 by planting crops such as corn, sweet corn, sorghum, buckwheat, rye, sunflower, millet, wild rice, and oats. Recently, the creation of four wetlands by the PGC has created additional habitat for ducks and non-game species. PGC plans to create two additional wetlands in the near future.

Popular events on State Game Lands 232 include youth turkey, duck, squirrel, and pheasant hunts. These events are held prior to the corresponding regular seasons. The PGC can be contacted for more information.

### Fishing

Public fishing opportunities are available on Buffalo Creek, Dutch Fork Creek, Castleman Lake, and formerly on Dutch Fork Lake. The Pennsylvania Fish and Boat Commission (PF&B) maintains trout-stocked sections on Dutch Fork Creek from the previous outlet of the dam to the mouth. PF&B also maintains a Delayed Harvest Artificial Lures Only section above the former reservoir to Claysville and a trout-stocked section below it. The West Virginia Division of Natural Resources maintains a three-mile trout-stocked section from the Pennsylvania border into West Virginia.

***A young fisherman at Dutch Fork Reservoir***

Fishing opportunities are available by permission of many landowners on private lands and throughout State Game Lands 232 and Castleman Run Wildlife Management Area. At one time, Dutch Fork Lake Reservoir was stocked for a variety of species, including trout, and was enormously popular. However, due to safety issues, the reservoir was recently drained and it is unclear when it will be repaired.

Before the dam broke, WPC employees visited Dutch Fork Lake Reservoir three times to ask fishermen and fisherwomen about the value of the resource and improvements that could be made to the fishing area. These visits were done in the spring, summer, and winter. A total of 11 groups of people were interviewed, for a total of 30 individuals. It was found that the majority of people fishing in Dutch Fork Lake were not residents of the watershed (Table 4-1). It was not uncommon to find someone who fished in Dutch Fork Lake over 20 times a year (Table 4-2).

When asked about improvements that could be made in the fishing area, responses were consistently similar. Suggestions included improving the littering problem by installing garbage cans or having a group "adopt" the area; improving the road leading to the far side of the lake; and installing portable toilets on both sides of the lake. There were also several suggestions for additional places to purchase bait and tackle. The suggestion of a camping facility nearby was presented. It was also recommended that a small building or pavilion could be erected where non-profit groups could sell bait and food regularly. These are some recommendations that could be considered if a new dam is ever installed. In addition, WPC staff noted that the former Dutch Fork Lake area is in close proximity to Route 70. The recreation area is protected by noise and pollution from several forested tracts of land. Were this forest area to be removed, the appeal of the area would likely decrease.

**Table 4-1. Residency of Visitors to Dutch Fork Lake During Recent Surveys**

| Town of Residency | Number of parties | Total Individuals |
|---|---|---|
| West Alexander, PA | 2 | 6 |
| Avella, PA | 2 | 4 |
| Washington, PA | 4 | 11 |
| Burgettstown, PA | 1 | 2 |
| Bentleyville, PA | 1 | 5 |
| Bethany, WV | 1 | 2 |

**Figure 4-2. Frequency of Visits to Dutch Fork Lake by Interviewees**

| Frequency | Number of Groups |
|---|---|
| unknown | 2 |
| 1-2 | 2 |
| first time | 2 |
| >5 | 1 |
| 20-50 | 2 |
| >50 | 2 |

## Birding

Interest in nature walking and hiking is gaining popularity in the watershed. Much of this began with the designation of the Buffalo Creek valley as an Important Bird Area (IBA) in 2004, after which the area was adopted by the Three Rivers Birding Club. Much of the IBA is part of State Game Lands 232, and portions on private lands may be visited with the permission of landowners. Popular locations for birding include Green Cove Wetland, Buck Run Wetland, Polecat Hollow area, Colby-Young Road, Narigan Run area, and others. The birding club holds regular outings in the watershed and often draws local residents and members of other nature organizations, such as Westmoreland Bird and Nature Club. A popular event is the Buffalo Creek Winter Bird Count, which was first held on January 3, 2004. The 2005 Bird Count event was held on December 26. Over 20 participants attended each of the counts. For more information about how to get involved in Three Rivers Birding Club outings in the watershed, contact member Larry Helgerman (feedback@3riversbirdingclub.org).

A stop at Green Cove Wetland is popular for short visits. For a longer visit (at least two hours), an option is to take a hike along Buffalo Camp Road, beginning at the Sawhill Covered Bridge (if it can be crossed). Visitors can follow this road, which is currently closed to traffic, taking a detour uphill to Polecat Hollow or traveling it all the way to Buck Run wetland (several miles). It is wise for visitors to keep in mind that most of these areas are part of State Game Lands 232 and to take needed precautions or to avoid visiting during hunting seasons.

## Hiking

No marked hiking trails exist in the watershed. However, there are several opportunities for hiking along relatively unused State Game Lands roads. Buffalo Camp Road is an old, approximately two-mile long road extending from the Sawhill Covered Bridge along Route 221 west to the mouth of Buck Run. Along this route, there are several old roads diverting to natural areas, such as Polecat Hollow and the location of a former Boy Scout Camp. In addition, there are several unmarked trails surrounding the former location of Dutch Fork Creek Reservoir in the southern portion of the watershed, which is owned by the Pennsylvania Fish and Boat Commission. These trails travel through a variety of habitats, including an old pine plantation and hardwoods stands.

A Rails to Trails project proposed along the former Baltimore and Ohio Railroad (National Pike Trail) at the southern end of the watershed has been put on hold until further landowner permissions can be obtained. It is planned that this trail will be open for public recreation and will extend across the southern portion of the watershed, connecting eventually to Washington, D. C.

## Biking

The longest "Bicycle PA" route travels through the Buffalo Creek watershed and extends 435 miles to the eastern boundary of Pennsylvania. Route "S" includes special Rails to Trails biking routes as well as areas where there are no specially designed lanes for bicyclists. Currently, a special bicycle lane does not exist throughout the portion including Buffalo Creek watershed, but in the future this route could include a portion of the National Pike Trail (once it is complete). Bicyclists are common in the watershed, often diverting from the "S" route to the area surrounding State Game Lands 232.

## Horseback Riding

Horseback riding is popular within the Buffalo Creek watershed. Washington County has one of the highest concentrations of horse farms in Pennsylvania. However, there are currently no public trails available for horseback riding in the watershed. Such a trail would likely be well utilized. There is the potential to allow horseback riding on a section of the National Pike Trail, should it be completed. Many other Rails to Trails areas within Pennsylvania designate a portion for horseback riding.

***Bluebells, a vibrant spring flower that can be observed along Buffalo Camp Road in the spring***

## General Nature Viewing

In addition to bird watching, residents and visitors can view a variety of spring wildflowers, search for salamanders in the watershed's many headwater streams, view an abundance of dragonflies and butterflies, and much more. Places to visit for these activities are similar to those frequented by birders. Butterflies and dragonflies can most often be viewed in the PGC's newly created wetland area. Salamanders and other stream critters can be explored in Buffalo Creek and Buck Run, as well as Polecat Hollow and Narigan Run nature areas within the State Game Lands.

## Farmstays/Agricultural Tourism

Within Europe, "farmstays" or agricultural tourism, is a booming industry bringing thousands of dollars or more to local economies. Though this idea is just now catching on the United States, in the future vacations may increasingly be made to rural countrysides, with the opportunity for tourists to appreciate farm life first-hand. The Pennsylvania Farm Vacation Association maintains a list of farmstay opportunities in Pennsylvania and one of these pioneer farms, Weatherbury Farm, is in Avella, PA—right next to the Buffalo Creek watershed. Visitors to these farms often take advantage of horseback riding, picking vegetables, and other farm activities, as well as hiking, fishing, hunting, and wildlife viewing opportunities in the area. Within the Buffalo Creek Watershed, visitors could also take advantage of local festivals such as the Buffalo Creek Watershed Festival and annual Claysville Peach Festival, and visit the many historic sites within the watershed.

## Cultural/Historic Opportunities

Because the area's natural resources and ecology is closely linked to its history, an opportunity exists to promote the historic and cultural sites and heritage along with eco-tourism activities. For instance, historic markers can be placed along trails, bike routes, and at natural areas. Likewise, importance of the natural resources can be considered at events and areas that promote history. Better placement of interpretative maps and signs can aid in linking the two. The History Section found earlier in this plan highlights some important events and sites. Washington County's Tourism and Promotion Bureau may be able to promote certain events or sites through its marketing activities or provide other assistance.

# Future Needs and Considerations

The lack of public services can be viewed as both positive and negative. Most visitors assert that the lack of chain stores and fast food restaurants is why they like to visit the area. However, visitors are discouraged by the fact that there are no easily accessible public restroom facilities, hotels, grocery stores, or restaurants in the watershed. This results in people spending their money outside of the watershed, and the area receives no economic boost from additional eco-tourism. Though most people would like to see the area retain its rural character, additional businesses that would be compatible with this goal could benefit local communities.

Because of the limited infrastructure, most people are unable to find their way to desired locations without assistance. If BCWA or other local organizations and communities wish to continue efforts to bring eco-tourism to the watershed, these groups may want to consider creating a map and guide to the watershed, with information about places to visit and facilities and businesses that do exist. It may be useful to place a kiosk with information about the watershed at the S-Bridge area or another appropriate location. A formal bird checklist might also be appropriate and could be made using information from this plan. It would also be prudent to consider the creation of some kind of bathroom facilities on State Game Lands 232, near the S-Bridge parking lot, or in some other location.

Small businesses could potentially improve the economies of local towns in the watershed. These may include bed and breakfasts and small grocery stores or restaurants, which could cater to both visitors and residents. However, it is ultimately up to local communities to make decisions about their futures.

## Recommendations

- Obtain a grant or other funding to install public bathroom facilities in the Buffalo Creek watershed.

- Publish a handout on recreational opportunities in the watershed and/or a bird checklist. A kiosk with a map and information about the watershed could be located near the S-Bridge or in another appropriate location.

- Encourage small businesses if they reflect a community's vision for the watershed.

- If Dutch Fork Lake is re-created, support the installation of garbage cans or other garbage cleanup measures and encourage the Fish and Boat Commission to repair the road to the far access and maintain portable toilet facilities on both sides of the lake.

- If Dutch Fork Lake is re-created, encourage the development of small businesses such as bait shops and low-impact campgrounds near the recreation area.

- Utilize the Washington County Tourism Promotion Agency to help promote eco-tourism activities taking place in the Buffalo Creek Watershed.

# OUTDOOR RECREATION AND TOURISM

## Overview

Eco-tourism can be described as responsible travel to natural areas that conserves the environment and improves the well-being of local people. It can have the benefit of improving an area's economy while protecting local resources. The Buffalo Creek watershed is one of only two high quality watersheds in Washington County. The existence of extensive public lands and its recent designation as an Important Bird Area suggests the potential for eco-tourism to have a more prominent role in the local economy.

Outdoor recreation opportunities currently available in the watershed include hunting, hiking, fishing, birding, biking, horseback riding, and general nature viewing (Figure 4-1). However, currently, the potential for many of these activities is largely untapped. Few local businesses are taking advantage of the influx of visitors from outside the watershed.

## Recreational Opportunities

### Hunting

Public hunting opportunities exist both on State Game Lands 232 in Pennsylvania (approximately 4,000 acres) and Castleman Run Wildlife Management Area in West Virginia (486 acres). West Virginia or Pennsylvania state hunting regulations apply. Due to the watershed's variety of habitats, including riparian wetlands, hardwood forests, fields, and brush areas, these hunting areas are abundant with game animals, including deer, wild turkey, pheasant, and duck. The Pennsylvania Game Commission (PGC) has helped maintain wild game populations on State Game Lands 232 by planting crops such as corn, sweet corn, sorghum, buckwheat, rye, sunflower, millet, wild rice, and oats. Recently, the creation of four wetlands by the PGC has created additional habitat for ducks and non-game species. PGC plans to create two additional wetlands in the near future.

Popular events on State Game Lands 232 include youth turkey, duck, squirrel, and pheasant hunts. These events are held prior to the corresponding regular seasons. The PGC can be contacted for more information.

### Fishing

Public fishing opportunities are available on Buffalo Creek, Dutch Fork Creek, Castleman Lake, and formerly on Dutch Fork Lake. The Pennsylvania Fish and Boat Commission (PF&B) maintains trout-stocked sections on Dutch Fork Creek from the previous outlet of the dam to the mouth. PF&B also maintains a Delayed Harvest Artificial Lures Only section above the former reservoir to Claysville and a trout-stocked section below it. The West Virginia Division of Natural Resources maintains a three-mile trout-stocked section from the Pennsylvania border into West Virginia.

***A young fisherman at Dutch Fork Reservoir***

Fishing opportunities are available by permission of many landowners on private lands and throughout State Game Lands 232 and Castleman Run Wildlife Management Area. At one time, Dutch Fork Lake Reservoir was stocked for a variety of species, including trout, and was enormously popular. However, due to safety issues, the reservoir was recently drained and it is unclear when it will be repaired.

Before the dam broke, WPC employees visited Dutch Fork Lake Reservoir three times to ask fishermen and fisherwomen about the value of the resource and improvements that could be made to the fishing area. These visits were done in the spring, summer, and winter. A total of 11 groups of people were interviewed, for a total of 30 individuals. It was found that the majority of people fishing in Dutch Fork Lake were not residents of the watershed (Table 4-1). It was not uncommon to find someone who fished in Dutch Fork Lake over 20 times a year (Table 4-2).

When asked about improvements that could be made in the fishing area, responses were consistently similar. Suggestions included improving the littering problem by installing garbage cans or having a group "adopt" the area; improving the road leading to the far side of the lake; and installing portable toilets on both sides of the lake. There were also several suggestions for additional places to purchase bait and tackle. The suggestion of a camping facility nearby was presented. It was also recommended that a small building or pavilion could be erected where non-profit groups could sell bait and food regularly. These are some recommendations that could be considered if a new dam is ever installed. In addition, WPC staff noted that the former Dutch Fork Lake area is in close proximity to Route 70. The recreation area is protected by noise and pollution from several forested tracts of land. Were this forest area to be removed, the appeal of the area would likely decrease.

**Table 4-1. Residency of Visitors to Dutch Fork Lake During Recent Surveys**

| Town of Residency | Number of parties | Total Individuals |
|---|---|---|
| West Alexander, PA | 2 | 6 |
| Avella, PA | 2 | 4 |
| Washington, PA | 4 | 11 |
| Burgettstown, PA | 1 | 2 |
| Bentleyville, PA | 1 | 5 |
| Bethany, WV | 1 | 2 |

**Figure 4-2. Frequency of Visits to Dutch Fork Lake by Interviewees**

| Frequency | Number of Groups |
|---|---|
| unknown | 2 |
| 1-2 | 2 |
| first time | 2 |
| >5 | 1 |
| 20-50 | 2 |
| >50 | 2 |

## Birding

Interest in nature walking and hiking is gaining popularity in the watershed. Much of this began with the designation of the Buffalo Creek valley as an Important Bird Area (IBA) in 2004, after which the area was adopted by the Three Rivers Birding Club. Much of the IBA is part of State Game Lands 232, and portions on private lands may be visited with the permission of landowners. Popular locations for birding include Green Cove Wetland, Buck Run Wetland, Polecat Hollow area, Colby-Young Road, Narigan Run area, and others. The birding club holds regular outings in the watershed and often draws local residents and members of other nature organizations, such as Westmoreland Bird and Nature Club. A popular event is the Buffalo Creek Winter Bird Count, which was first held on January 3, 2004. The 2005 Bird Count event was held on December 26. Over 20 participants attended each of the counts. For more information about how to get involved in Three Rivers Birding Club outings in the watershed, contact member Larry Helgerman (feedback@3riversbirdingclub.org).

A stop at Green Cove Wetland is popular for short visits. For a longer visit (at least two hours), an option is to take a hike along Buffalo Camp Road, beginning at the Sawhill Covered Bridge (if it can be crossed). Visitors can follow this road, which is currently closed to traffic, taking a detour uphill to Polecat Hollow or traveling it all the way to Buck Run wetland (several miles). It is wise for visitors to keep in mind that most of these areas are part of State Game Lands 232 and to take needed precautions or to avoid visiting during hunting seasons.

## Hiking

No marked hiking trails exist in the watershed. However, there are several opportunities for hiking along relatively unused State Game Lands roads. Buffalo Camp Road is an old, approximately two-mile long road extending from the Sawhill Covered Bridge along Route 221 west to the mouth of Buck Run. Along this route, there are several old roads diverting to natural areas, such as Polecat Hollow and the location of a former Boy Scout Camp. In addition, there are several unmarked trails surrounding the former location of Dutch Fork Creek Reservoir in the southern portion of the watershed, which is owned by the Pennsylvania Fish and Boat Commission. These trails travel through a variety of habitats, including an old pine plantation and hardwoods stands.

A Rails to Trails project proposed along the former Baltimore and Ohio Railroad (National Pike Trail) at the southern end of the watershed has been put on hold until further landowner permissions can be obtained. It is planned that this trail will be open for public recreation and will extend across the southern portion of the watershed, connecting eventually to Washington, D. C.

## Biking

The longest "Bicycle PA" route travels through the Buffalo Creek watershed and extends 435 miles to the eastern boundary of Pennsylvania. Route "S" includes special Rails to Trails biking routes as well as areas where there are no specially designed lanes for bicyclists. Currently, a special bicycle lane does not exist throughout the portion including Buffalo Creek watershed, but in the future this route could include a portion of the National Pike Trail (once it is complete). Bicyclists are common in the watershed, often diverting from the "S" route to the area surrounding State Game Lands 232.

## Horseback Riding

Horseback riding is popular within the Buffalo Creek watershed. Washington County has one of the highest concentrations of horse farms in Pennsylvania. However, there are currently no public trails available for horseback riding in the watershed. Such a trail would likely be well utilized. There is the potential to allow horseback riding on a section of the National Pike Trail, should it be completed. Many other Rails to Trails areas within Pennsylvania designate a portion for horseback riding.

### General Nature Viewing

In addition to bird watching, residents and visitors can view a variety of spring wildflowers, search for salamanders in the watershed's many headwater streams, view an abundance of dragonflies and butterflies, and much more. Places to visit for these activities are similar to those frequented by birders. Butterflies and dragonflies can most often be viewed in the PGC's newly created wetland area. Salamanders and other stream critters can be explored in Buffalo Creek and Buck Run, as well as Polecat Hollow and Narigan Run nature areas within the State Game Lands.

***Bluebells, a vibrant spring flower that can be observed along Buffalo Camp Road in the spring***

### Farmstays/Agricultural Tourism

Within Europe, "farmstays" or agricultural tourism, is a booming industry bringing thousands of dollars or more to local economies. Though this idea is just now catching on the United States, in the future vacations may increasingly be made to rural countrysides, with the opportunity for tourists to appreciate farm life first-hand. The Pennsylvania Farm Vacation Association maintains a list of farmstay opportunities in Pennsylvania and one of these pioneer farms, Weatherbury Farm, is in Avella, PA—right next to the Buffalo Creek watershed. Visitors to these farms often take advantage of horseback riding, picking vegetables, and other farm activities, as well as hiking, fishing, hunting, and wildlife viewing opportunities in the area. Within the Buffalo Creek Watershed, visitors could also take advantage of local festivals such as the Buffalo Creek Watershed Festival and annual Claysville Peach Festival, and visit the many historic sites within the watershed.

### Cultural/Historic Opportunities

Because the area's natural resources and ecology is closely linked to its history, an opportunity exists to promote the historic and cultural sites and heritage along with eco-tourism activities. For instance, historic markers can be placed along trails, bike routes, and at natural areas. Likewise, importance of the natural resources can be considered at events and areas that promote history. Better placement of interpretative maps and signs can aid in linking the two. The History Section found earlier in this plan highlights some important events and sites. Washington County's Tourism and Promotion Bureau may be able to promote certain events or sites through its marketing activities or provide other assistance.

## Future Needs and Considerations

The lack of public services can be viewed as both positive and negative. Most visitors assert that the lack of chain stores and fast food restaurants is why they like to visit the area. However, visitors are discouraged by the fact that there are no easily accessible public restroom facilities, hotels, grocery stores, or restaurants in the watershed. This results in people spending their money outside of the watershed, and the area receives no economic boost from additional eco-tourism. Though most people would like to see the area retain its rural character, additional businesses that would be compatible with this goal could benefit local communities.

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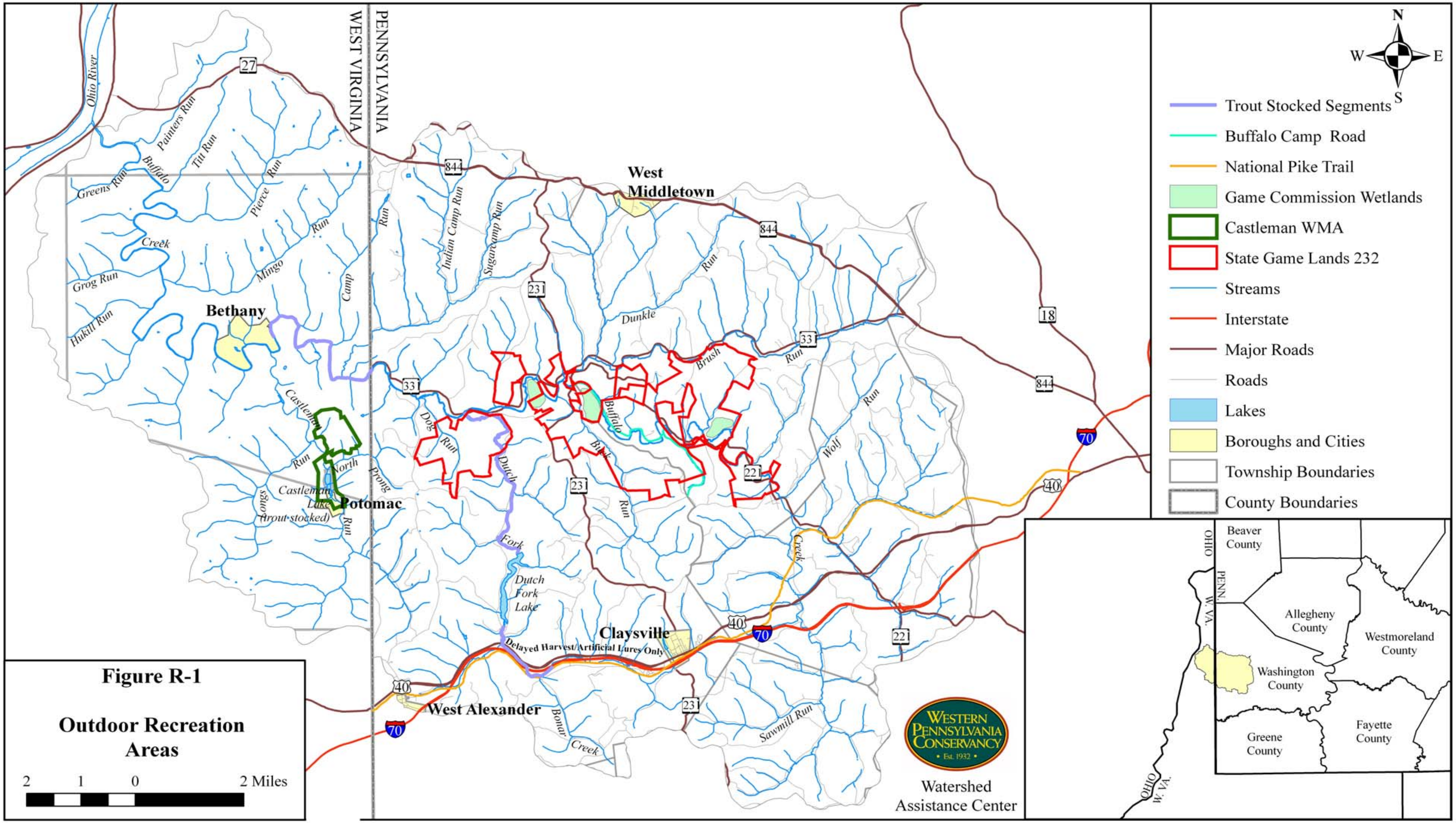


**Figure R-1**

**Outdoor Recreation Areas**

this plan. It would also be prudent to consider the creation of some kind of bathroom facilities on State Game Lands 232, near the S-Bridge parking lot, or in some other location.

Small businesses could potentially improve the economies of local towns in the watershed. These may include bed and breakfasts and small grocery stores or restaurants, which could cater to both visitors and residents. However, it is ultimately up to local communities to make decisions about their futures.

## Recommendations

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# Appendix A. Vascular Plants of the Buffalo Creek Watershed

<u>key</u>
W=wetlands F=floodplains R=rock outcrops S=stream banks M=mesic hardwoods
D=dry hardwoods H=highly disturbed C=characteristics

| **SPECIES** | **COMMONNAME** | **COLLECTED?** | **W** | **F** | **R** | **S** | **M** | **D** | **H** | **Characteristics** |
|---|---|---|---|---|---|---|---|---|---|---|
| | | check if yes | | | | | | | | c=calciphile; i=invasive |
| *Acer negundo* | boxelder | | | x | | x | | | x | |
| *Acer nigrum* | black maple | | | x | | | | | x | |
| *Acer rubrum* | Drummond's maple | | x | x | | | x | x | x | |
| *Acer saccharum* | sugar maple | | | x | | | x | | x | |
| *Achillea millefolium* | western yarrow | | | x | x | | | | x | |
| *Acorus calamus* | calamus | | x | | | | | | | i |
| *Actaea pachypoda* | white baneberry | | | x | | | x | | | |
| *Adiantum pedatum* | northern maidenhair | | | x | x | | x | | | |
| *Aesculus flava* | yellow buckeye | | | x | | | | | | |
| *Aesculus glabra* | Ohio buckeye | | | x | | | | | | |
| *Agrimonia gryposepala* | tall hairy agrimony | | | x | | | x | | | |
| *Agrimonia parviflora* | harvestlice | | | x | | | | | | |
| *Agrimonia pubescens* | soft agrimony | | | x | | | x | | | |
| *Agrostis gigantea* | redtop | | | | | | | | x | i |
| *Ailanthus altissima* | tree of heaven | | | | x | | | | x | i |
| *Alisma subcordatum* | American water plantain | | x | x | | | | | | |
| *Alliaria petiolata* | garlic mustard | | | x | | | x | x | x | i |
| *Allium tricoccum* | wild leek | | | x | | | x | | | |
| *Ambrosia artemisiifolia* | annual ragweed | | | | x | | | x | x | |
| *Ambrosia trifida* | great ragweed | | | x | | | | | x | |
| *Amelanchier arborea* | downy serviceberry | | | | | | | x | | |
| *Amphicarpaea bracteata* | American hogpeanut | | | x | | | | | | |

| **SPECIES** | **COMMONNAME** | **COLLECTED?** | **W** | **F** | **R** | **S** | **M** | **D** | **H** | **Characteristics** |
|---|---|---|---|---|---|---|---|---|---|---|
| *Apios americana* | groundnut | | x | | | | | | | |
| *Apocynum sp.* | | | | | | | | | | |
| *Arabis laevigatus* | | | | | x | | | | | |
| *Aralia nudicaulis* | wild sarsaparilla | | | x | | | x | x | | |
| *Arctium minus* | lesser burrdock | | | x | | | | | x | i |
| *Arisaema dracontium* | green dragon | | | x | | | | | | |
| *Arisaema triphyllum* | Jack in the pulpit | | | x | | | x | | | |
| *Artemisia vulgaris* | common wormwood | | | x | | | | | x | i |
| *Aruncus dioicus* | bride's feathers | | | | | | x | | x | |
| *Asarum canadense* | Canadian wildginger | | | x | x | | x | | | |
| *Asclepias incarnata* | swamp milkweed | | x | | | | | | | |
| *Asclepias syriaca* | common milkweed | | | x | | | | | x | |
| *Asimina triloba* | pawpaw | | | x | | x | | | | |
| *Asparagus officinalis* | garden asparagus | | | | | | | | x | i |
| *Asplenium platyneuron* | ebony spleenwort | | | | x | | | x | | |
| *Asplenium rhizophyllum* | walking fern | | | | x | | | | | c |
| *Asplenium trichomanes* | maidenhair spleenwort | | | | x | | | | | c |
| *Aster novae-angliae* | | | | | | | | | x | |
| *Athyrium filix-femina* | subarctic ladyfern | | | x | | | x | | | |
| *Barbarea vulgaris* | garden yellowrocket | | | x | | | | | x | i |
| *Berberis thunbergii* | Japanese barberry | | | | | | x | x | | i |
| *Betula lenta* | sweet birch | | | x | | | x | x | x | |
| *Bidens cernua* | nodding beggartick | | x | | | | | | | |
| *Bidens frondosa* | devil's beggartick | | x | | | | | | x | |
| *Blephilia hirsuta* | hairy pagoda-plant | | | x | | | | | | |
| *Boehmeria cylindrica* | smallspike false nettle | | x | | | | | | | |
| *Botrychium dissectum* | cutleaf grapefern | | | | | | x | x | | |
| *Botrychium virginianum* | rattlesnake fern | | | | | | x | | | |
| *Bromus ciliatus* | fringed brome | | | | | | | | x | i |
| *Calystegia sepium* | hedge false bindweed | | x | | | | | | x | |
| *Campanula americana* | | | | | | | x | x | x | |

| SPECIES | COMMONNAME | COLLECTED? | W | F | R | S | M | D | H | Characteristics |
|---|---|---|---|---|---|---|---|---|---|---|
| *Cardamine bulbosa* | bulbous bittercress | | x | x | | | | | | |
| *Cardamine concatenata* | cutleaf toothwort | | | x | | | x | x | | |
| *Cardamine hirsuta* | hairy bittercress | | x | x | | | x | | x | |
| *Cardamine pensylvanica* | Pennsylvania bittercress | | x | x | | | | | | |
| *Carex blanda* | eastern woodland sedge | | | x | | | x | | | |
| *Carex cristatella* | crested sedge | | x | | | | | | | |
| *Carex frankii* | Frank's sedge | x | x | | | | | | | |
| *Carex lurida* | shallow sedge | | x | | | | | | | |
| *Carex pensylvanica* | Pennsylvania sedge | | | | | | x | | | |
| *Carex rosea* | rosy sedge | | | | | | x | x | | |
| *Carex scabrata* | eastern rough sedge | | x | x | | x | | | | |
| *Carex stipata* | stalkgrain sedge | | x | x | | | | | | |
| *Carpinus caroliniana* | American hornbeam | | | x | | | x | | | |
| *Carya cordiformis* | bitternut hickory | | | x | | | x | | | |
| *Carya glabra* | pignut hickory | | | | | | | x | | |
| *Carya ovata* | shagbark hickory | | | x | | | x | | | |
| *Carya tomentosa* | | | | x | | | x | x | | |
| *Castanea dentata* | American chestnut | | | | | | | x | | |
| *Caulophyllum thalictroid* | | | | x | | | x | | | |
| *Celtis occidentalis* | common hackberry | | | x | x | | | | | |
| *Cercis canadensis* | eastern redbud | | | | | | x | x | | c |
| *Chaerophyllum procumbens* | spreading chervil | x | | x | | | x | | x | |
| *Chelone glabra* | white turtlehead | | x | x | | | | | | |
| *Chenopodium album* | lambsquarters | | | | | | | | x | i |
| *Chrysanthemum leucanthem* | | | | | | | | | x | i |
| *Chrysanthemum leucanthem* | | | | | | | | | x | i |
| *Cichorium intybus* | chicory | | | | | | | | x | i |
| *Cicuta maculata* | spotted water hemlock | | x | | | | | | | |
| *Cimicifuga racemosa* | black bugbane | | | | | | x | | | |
| *Circaea alpina* | small enchanter's nightshade | | x | x | | | | | | |
| *Circaea lutetiana* | broadleaf enchanter's nightshade | | | x | | | x | | | |

| SPECIES | COMMONNAME | COLLECTED? | W | F | R | S | M | D | H | Characteristics |
|---|---|---|---|---|---|---|---|---|---|---|
| *Cirsium arvense* | Canada thistle | | x | x | | | | | x | i |
| *Cirsium vulgare* | bull thistle | | | x | | | | | x | i |
| *Claytonia virginica* | Virginia springbeauty | | | x | | | x | x | | |
| *Clematis virginiana* | devil's darning needles | | x | x | | | | | | |
| *Clintonia umbellulata* | white clintonia | | | | | | | x | | |
| *Collinsia verna* | spring blue eyed Mary | | | | | | | | | |
| *Commelina communis* | Asiatic dayflower | x | | x | | | | | x | i |
| *Cornus alternifolia* | alternateleaf dogwood | | | x | | | x | | | |
| *Cornus amomum* | silky dogwood | | x | | | | | | | |
| *Cornus florida* | flowering dogwood | | | | | | | x | | |
| *Coronilla varia* | purple crownvetch | | | | | | | | x | i |
| *Corylus americana* | American hazelnut | | | | | | | x | | |
| *Crataegus punctata* | dotted hawthorn | x | | x | | | | | x | |
| *Cryptotaenia canadensis* | Canadian honewort | | | x | | | x | | x | |
| *Cuscuta gronovii* | scaldweed | | x | x | | | | | | |
| *Cyperus strigosus* | strawcolored flatsedge | | x | x | | | | | | |
| *Cystopteris bulbifera* | bulblet bladderfern | | | | | | | | | c |
| *Daucus carota* | Queen Anne's lace | | | | | | | | x | i |
| *Delphinium tricorne* | dwarf larkspur | | | x | | | | | | |
| *Dennstaedtia punctilobul* | | | | | | | x | x | | |
| *Deparia acrostichoides* | silver false spleenwort | | | | | | x | | | |
| *Dianthus armeria* | Deptford pink | | | | | | | x | x | i |
| *Diphasiastrum digitatum* | | | | | | | | x | | |
| *Diplazium pycnocarpon* | glade fern | | | | | | x | | | |
| *Dipsacus sylvestris* | | | | x | | | | | x | i |
| *Dryopteris carthusiana* | spinulose woodfern | | x | x | | | x | | | |
| *Dryopteris goldiana* | Goldie's woodfern | | | x | | | x | | | |
| *Dryopteris intermedia* | intermediate woodfern | | | x | | | x | | | |
| *Dryopteris marginalis* | marginal woodfern | | | | x | | | x | | |
| *Dryopteris x triploidea* | | | | x | | | x | | | |
| *Echinochloa crus-galli* | barnyardgrass | x | x | | x | | | | x | |

| SPECIES | COMMONNAME | COLLECTED? | W | F | R | S | M | D | H | Characteristics |
|---|---|---|---|---|---|---|---|---|---|---|
| *Echinocystis lobata* | wild cucumber | | | x | | | | | x | |
| *Elymus hystrix* | eastern bottlebrush grass | | | | | | | | | |
| *Elymus riparius* | riverbank wildrye | | | x | | x | | | | |
| *Elymus virginicus* | Virginia wildrye | | | x | | | | | | |
| *Epifagus virginiana* | beechdrops | | | | | | x | x | | |
| *Epilobium coloratum* | purpleleaf willowherb | x | x | | | | | | | |
| *Equisetum arvense* | field horsetail | | x | x | | | x | | x | |
| *Equisetum hyemale* | scouringrush horsetail | | x | x | | | | | x | |
| *Erigeron annuus* | eastern daisy fleabane | | | x | | | x | x | x | |
| *Erigeron philadelphicus* | Philadelphia fleabane | | | x | | | x | x | x | |
| *Erythronium americanum* | dogtooth violet | | | x | | | x | | | |
| *Eupatorium fistulosum* | trumpetweed | | x | | | | | | x | |
| *Eupatorium perfoliatum* | common boneset | | x | | | | | | | |
| *Eupatorium purpureum* | sweetscented joepyeweed | | | | | | x | | | |
| *Eupatorium rugosum* | | | | x | | | x | x | | |
| *Euthamia graminifolia* | flat-top goldentop | | x | x | | | | | x | |
| *Fagus grandifolia* | American beech | | | | | | x | x | | |
| *Fragaria virginica* | | | | x | | | | x | x | |
| *Fraxinus americana* | white ash | | | x | | | x | | | |
| *Fraxinus pensylvanica* | | | | x | | | x | | | |
| *Galium aparine* | stickywilly | | | x | | | x | x | x | |
| *Galium asprellum* | rough bedstraw | | x | | | | | | | |
| *Galium palustre* | common marsh bedstraw | | x | | | | | | | |
| *Galium triflorum* | fragrant bedstraw | | | | | | x | x | | |
| *Gaura biennis* | biennial beeblossom | | | x | | | | | | |
| *Geranium maculatum* | spotted geranium | | | x | | | x | | | |
| *Geum canadense* | white avens | | | x | | | x | x | | |
| *Glechoma hederacea* | ground ivy | | | x | | | | | x | i |
| *Glyceria striata* | fowl mannagrass | | x | | | | | | | |
| *Hamamelis virginiana* | American witchhazel | | | x | | | x | x | | |
| *Heliopsis helianthoides* | smooth oxeye | | | x | | x | | | | |

| SPECIES | COMMONNAME | COLLECTED? | W | F | R | S | M | D | H | Characteristics |
|---|---|---|---|---|---|---|---|---|---|---|
| *Hemerocallis fulva* | orange daylily | | | x | | | | | x | i |
| *Hepatica nobilis var. ac* | | | | | x | | x | | | |
| *Heracleum lanatum* | | | | x | | | | | x | i |
| *Hesperis matronalis* | dames rocket | | | x | | | x | x | x | i |
| *Hieracium caespitosum* | meadow hawkweed | | | | | | | x | x | i |
| *Holcus lanatus* | common velvetgrass | | | | | | | | x | i |
| *Houstonia caerulea* | azure bluet | | | x | | | | x | x | |
| *Hydrangea arborescens* | wild hydrangea | | | | x | | | x | | |
| *Hydrophyllum appendicula* | | | | x | | | x | | | |
| *Hydrophyllum canadense* | bluntleaf waterleaf | | | x | | | x | | | |
| *Hydrophyllum virginianum* | Shawnee salad | | | x | | | x | | | |
| *Hypericum mutilum* | dwarf St. Johnswort | | x | x | | | | | | |
| *Hypericum perforatum* | common St. Johnswort | | | | | | | | x | i |
| *Hypericum prolificum* | shrubby St. Johnswort | | x | | | | | | | |
| *Impatiens capensis* | jewelweed | | x | | | | | | | |
| *Impatiens pallida* | pale touch-me-not | | x | x | | | | | | |
| *Juglans nigra* | black walnut | | | x | | | x | x | | |
| *Juncus effusus* | common rush | | x | | | | | | | |
| *Justicia americana* | American water-willow | x | | | | x | | | | |
| *Lamium amplexicaule* | henbit deadnettle | | | x | | | | | x | i |
| *Laportea canadensis* | Canadian woodnettle | | | x | | | x | | | |
| *Leersia oryzoides* | rice cutgrass | | x | | | | | | | |
| *Leersia virginica* | whitegrass | | x | x | | | x | | | |
| *Ligustrum vulgare* | European privet | | | x | | | x | x | x | i |
| *Lindera benzoin* | northern spicebush | | x | x | | | x | | | |
| *Liparis liliifolia* | brown widelip orchid | | | x | | | x | | | |
| *Liriodendron tulipifera* | tuliptree | | | x | | | x | x | | |
| *Lobelia inflata* | Indian-tobacco | | | x | | | x | x | x | |
| *Lobelia siphilitica* | great blue lobelia | | | x | | x | x | | | |
| *Lonicera japonica* | Japanese honeysuckle | | | x | | | x | x | x | i |
| *Lonicera morrowii* | Morrow's honeysuckle | | | x | | | x | x | x | i |

| SPECIES | COMMONNAME | COLLECTED? | W | F | R | S | M | D | H | Characteristics |
|---|---|---|---|---|---|---|---|---|---|---|
| *Lonicera tatarica* | Tatarian honeysuckle | | | x | | | x | x | x | i |
| *Ludwigia alternifolia* | seedbox | | x | x | | | | | | |
| *Ludwigia palustris* | marsh seedbox | | x | x | | | | | | |
| *Lycopus americanus* | American water horehound | | x | | | | | | | |
| *Lycopus uniflorus* | northern bugleweed | x | x | | | | | | | |
| *Lycopus virginicus* | Virginia water horehound | | x | | | | | | | |
| *Lysimachia ciliata* | fringed loosestrife | | x | x | | | x | | | |
| *Lysimachia nummularia* | creeping jenny | | x | x | | | | | | i |
| *Lysimachia terrestris* | earth loosestrife | | x | | | | | | | |
| *Magnolia acuminata* | cucumber-tree | | | | | | x | | | |
| *Maianthemum canadense* | Canada mayflower | | x | x | | | x | | | |
| *Medeola virginiana* | Indian cucumber | | | | | | x | x | | |
| *Melilotus officinalis* | yellow sweetclover | | | | | | | | x | i |
| *Menispermum canadense* | common moonseed | | | | | x | | | x | |
| *Mentha arvensis* | wild mint | | x | | | | | | | |
| *Mentha spicata* | spearmint | | x | | | | | | | i |
| *Microstegium vimineum* | Nepalese browntop | x | | x | x | x | x | x | x | i |
| *Mimulus alatus* | sharpwing monkeyflower | | x | | | x | | | | |
| *Mimulus ringens* | Allegheny monkeyflower | | x | | | | | | | |
| *Mitella diphylla* | twoleaf miterwort | | | x | | | x | | | |
| *Monarda fistulosa* | wild bergamot | | | x | | | | | | |
| *Monotropa uniflorus* | | | | | | | | x | | |
| *Myosotis scorpioides* | true forget-me-not | | x | | | | | | | i |
| *Oenothera biennis* | common evening-primrose | | | x | | | | | x | |
| *Onoclea sensibilis* | sensitive fern | | x | x | | | | | | |
| *Osmorhiza claytonii* | Clayton's sweetroot | | x | x | | | x | | | |
| *Osmorhiza longistylis* | longstyle sweetroot | | x | x | | | x | | | |
| *Ostrya virginiana* | hophornbeam | | | x | x | | x | x | | |
| *Oxalis stricta* | common yellow oxalis | | | x | | | | | x | |
| *Panicum clandestinum* | | | x | x | | | | | x | |
| *Parthenocissus quinquefo* | | | | x | | | | | | |

| SPECIES | COMMONNAME | COLLECTED? | W | F | R | S | M | D | H | Characteristics |
|---|---|---|---|---|---|---|---|---|---|---|
| *Penstemon digitalis* | talus slope penstemon | | | | | | | | x | |
| *Phalaris arundinacea* | reed canarygrass | | | x | | | | | | |
| *Phleum pratense* | timothy | | | | | | | | x | |
| *Phlox divaricata* | Lapham's phlox | | | x | | | x | | | |
| *Phlox paniculata* | fall phlox | | | | | | | | x | |
| *Physocarpus opulifolius* | common ninebark | | | x | | x | | | | |
| *Phytolacca americana* | American pokeweed | | | x | | | x | x | x | |
| *Pilea pumila* | Canadian clearweed | | x | x | | | x | | | |
| *Pinus strobus* | eastern white pine | | x | x | | | x | x | | |
| *Plantago lanceolata* | narrowleaf plantain | | | | | | | | x | i |
| *Plantago rugelii* | blackseed plantain | | | x | | | | | x | |
| *Platanus occidentalis* | American sycamore | | | x | | x | | | | |
| *Poa compressa* | Canada bluegrass | | | x | x | | x | x | x | i |
| *Poa trivialis* | rough bluegrass | | x | x | | | x | | x | i |
| *Podophyllum peltatum* | mayapple | | | x | | | x | x | | |
| *Polygonatum biflorum* | smooth Solomon's seal | | | x | x | | x | | | |
| *Polygonatum pubescens* | hairy Solomon's seal | | | x | | | x | | | |
| *Polygonum caespitosum* | oriental ladysthumb | | x | x | | | | | x | i |
| *Polygonum convolvulus* | black bindweed | | | x | | | | | x | i |
| *Polygonum cuspidatum* | Japanese knotweed | x | | x | | x | | | x | i |
| *Polygonum hydropiper* | marshpepper knotweed | | x | | | | | | | i |
| *Polygonum hydropiperoide* | | | x | | | | | | | |
| *Polygonum lapathifolium* | curlytop knotweed | x | x | | | | | | | |
| *Polygonum persicaria* | spotted ladysthumb | | | x | | | | | x | i |
| *Polygonum punctatum* | dotted smartweed | | x | | | | | | | |
| *Polygonum sagittatum* | arrowleaf tearthumb | | x | x | | | | | | |
| *Polygonum virginicum* | | | | x | | | x | | | |
| *Polymnia canadensis* | whiteflower leafcup | x | | x | | | | | | |
| *Polystichum acrostichoid* | | | | x | | | x | x | | |
| *Populus deltoides* | plains cottonwood | | | x | | x | | | | |
| *Populus grandidentata* | bigtooth aspen | | | x | | | x | x | | |

| **SPECIES** | **COMMONNAME** | **COLLECTED?** | **W** | **F** | **R** | **S** | **M** | **D** | **H** | **Characteristics** |
|---|---|---|---|---|---|---|---|---|---|---|
| *Potamogeton pusillus* | small pondweed | x | | | | | | | | reservoir |
| *Potentilla canadensis* | dwarf cinquefoil | | | | | | | x | | |
| *Potentilla simplex* | common cinquefoil | | | | | | x | x | x | |
| *Prenanthes alba* | white rattlesnakeroot | | | x | | | x | x | | |
| *Prenanthes altissima* | tall rattlesnakeroot | | | x | | | | x | | |
| *Prenanthes crepidinea* | nodding rattlesnakeroot | | | x | | | x | | | |
| *Prunella vulgaris* | common selfheal | | | x | | | x | x | x | |
| *Prunus americana* | American plum | | | x | | | x | x | | |
| *Prunus serotina* | black cherry | | | x | | | x | x | | |
| *Prunus virginiana* | chokecherry | | | x | | | x | x | x | |
| *Quercus alba* | white oak | | | | | | x | x | | |
| *Quercus bicolor* | swamp white oak | | x | x | | | | | | |
| *Quercus imbricaria* | shingle oak | | | x | | | | | | |
| *Quercus macrocarpa* | bur oak | | | x | | | | | | Welch Hollo |
| *Quercus montana* | | | | | | | | x | | |
| *Quercus rubra* | northern red oak | | | x | | | x | x | | |
| *Ranunculus abortivus* | littleleaf buttercup | | x | x | | | x | | x | |
| *Ranunculus hispidus* | bristly buttercup | | x | | | | | | | |
| *Ranunculus micranthus* | rock buttercup | | | x | | | x | | | |
| *Ranunculus recurvatus* | blisterwort | | | x | | | x | | | |
| *Ranunculus repens* | creeping buttercup | | x | x | | x | | | x | i |
| *Rhus typhina* | | | | x | | | | | x | |
| *Robinia pseudoacacia* | black locust | | | x | | | x | x | x | |
| *Rosa multiflora* | multiflora rose | | | x | | | x | x | x | i |
| *Rubus allegheniensis* | Graves' blackberry | | | x | | x | x | x | x | |
| *Rubus occidentalis* | black raspberry | | | x | | x | x | | x | |
| *Rubus phoenicolasius* | wine raspberry | | | | | | | | x | i |
| *Rudbeckia laciniata* | cutleaf coneflower | | | x | | x | | | | |
| *Rumex acetosella* | common sheep sorrel | | | x | | | | | | i |
| *Rumex crispus* | curly dock | | x | x | | | | | | i |
| *Rumex obtusifolius* | bitter dock | | x | x | | x | x | | x | i |

| SPECIES | COMMONNAME | COLLECTED? | W | F | R | S | M | D | H | Characteristics |
|---|---|---|---|---|---|---|---|---|---|---|
| *Sagittaria latifolia* | broadleaf arrowhead | | x | | | | | | | |
| *Salix nigra* | black willow | | | x | | x | | | | |
| *Sambucus nigra ssp. cana* | | | x | x | | | x | | | |
| *Sambucus racemosa* | red elderberry | | | x | | | x | | | |
| *Sanguinaria canadensis* | bloodroot | | | x | | | | | | |
| *Sanicula odorata* | clustered blacksnakeroot | | | x | | | x | | | |
| *Sassafras albidum* | sassafras | | | | | | | x | | |
| *Saxifraga virginiensis* | early saxifrage | | | | x | | | | | |
| *Schoenoplectus tabernaem* | | | x | | | | | | | |
| *Scrophularia marilandica* | carpenter's square | | | x | | | | | x | |
| *Scutellaria lateriflora* | blue skullcap | | x | x | | | | | | |
| *Sedum ternatum* | woodland stonecrop | | | x | x | x | x | x | | |
| *Senecio aureus* | | | x | x | | | x | | | |
| *Sicyos angulatus* | oneseed burr cucumber | | | x | | | | | x | |
| *Silene virginiana* | | | | x | x | | x | x | | |
| *Sisyrinchium angustifoli* | | | | x | | | | | x | |
| *Smilacina racemosa* | | | | x | | | x | | | |
| *Smilax hispida* | | | x | x | | | x | | x | |
| *Smilax rotundifolia* | roundleaf greenbrier | | | x | | | x | x | x | |
| *Smilax tamnoides* | bristly greenbrier | | | | | | x | | | |
| *Solanum dulcamara* | climbing nightshade | | x | x | | | | | x | i |
| *Solanum nigrum* | black nightshade | | x | x | | | | | x | i |
| *Solidago caesia* | mountain decumbent goldenrod | | | x | | | x | x | | |
| *Solidago canadensis* | Harger's goldenrod | | | x | | | | | x | |
| *Solidago flexicaulis* | zigzag goldenrod | | | | x | | x | | | |
| *Solidago gigantea* | giant goldenrod | | x | x | | | | | x | |
| *Solidago juncea* | early goldenrod | | | x | | | x | | x | |
| *Stellaria pubera* | star chickweed | | | x | | | x | | | |
| *Symphyotrichum divaricat* | | | | | | | x | x | | |
| *Symphyotrichum prenantho* | | | | x | | | | | | |
| *Symphyotrichum puniceum* | purplestem aster | | x | | | | | | | |

| SPECIES | COMMONNAME | COLLECTED? | W | F | R | S | M | D | H | Characteristics |
|---|---|---|---|---|---|---|---|---|---|---|
| *Symphyotrichum shortii* | Short's aster | | | x | | | x | | | |
| *Symplocarpus foetidus* | skunk cabbage | | x | x | | | x | | | |
| *Taraxacum officinale* | common dandelion | | | x | | | | | x | i |
| *Teucrium canadense* | western germander | | | x | | | | | x | i |
| *Thalictrum dioicum* | early meadow-rue | | | | x | | x | x | | |
| *Thalictrum pubescens* | king of the meadow | | x | x | | x | | | | |
| *Thaspium barbinode* | hairyjoint meadowparsnip | | | x | | | x | x | x | |
| *Thelypteris noveboracens* | | | | x | | | x | x | | |
| *Tiarella cordifolia* | heartleaf foamflower | | | x | x | | x | x | | |
| *Tilia americana* | American basswood | | | x | | | x | | | |
| *Toxicodendron radicans* | eastern poison ivy | | | x | x | x | x | x | x | |
| *Trifolium pratense* | red clover | | | | | | | | x | i |
| *Trillium erectum* | red trillium | | | x | | | x | | | |
| *Trillium grandiflorum* | snow trillium | | | x | | | x | | | |
| *Trillium sessile* | toadshade | | | x | | | | | | |
| *Tsuga canadensis* | eastern hemlock | | x | x | | x | x | | | |
| *Tussilago farfara* | coltsfoot | | | x | | | | | x | i |
| *Ulmus americana* | American elm | | | x | | x | x | | | |
| *Ulmus rubra* | slippery elm | | | x | | | x | x | | |
| *Urtica dioica ssp. dioic* | | | | x | | | x | | x | i |
| *Urtica dioica ssp. graci* | | | | x | | x | x | | x | |
| *Uvularia sessilifolia* | sessileleaf bellwort | | | x | | x | | | | |
| *Valeriana pauciflora* | largeflower valerian | | | x | | | | | | |
| *Valerianella chenopodiif* | | | | x | | | x | | | |
| *Verbascum blattaria* | moth mullein | | | | | | | | x | i |
| *Verbascum thapsus* | common mullein | | | x | | | | | x | i |
| *Verbena hastata* | swamp verbena | | x | | | | | | | |
| *Verbena urticifolia* | white vervain | | | x | | | | | x | |
| *Verbesina alternifolia* | wingstem | | | x | | x | | | | |
| *Vernonia gigantea* | giant ironweed | | x | x | | | | | | |
| *Viburnum acerifolium* | mapleleaf viburnum | | | | | | x | x | | |

| SPECIES | COMMONNAME | COLLECTED? | W | F | R | S | M | D | H | Characteristics |
|---|---|---|---|---|---|---|---|---|---|---|
| *Viburnum prunifolium* | blackhaw | | | | | | x | x | | |
| *Viburnum recognitum* | | | x | | | | | | | |
| *Viola cucullata* | marsh blue violet | | x | x | | | x | | | |
| *Viola pubescens* | downy yellow violet | | | x | | | | | | |
| *Viola sororia* | common blue violet | | | x | | | x | x | x | |
| *Viola striata* | striped cream violet | | | x | | | x | | | |
| *Vitis aestivalis* | summer grape | | | x | | x | | | x | |
| *Zizia aptera* | meadow zizia | | | x | | | x | | | |
| | | | | | | | | | | |
| Conspicuously absent | | | | | | | | | | |
| Phacelia purshii | Miami mist | | | | | | | | | |

# Appendix B. Bird Species of the Buffalo Creek Watershed

Compiled by Larry Helgerman, Three Rivers Birding Club
organized by taxonomic group

B=Breeding; M=migratory;
?=Questionable Information

| Common Name | Scientific Name | Status |
|---|---|---|
| Snow Goose | *Chen caerulescens* | M |
| Canada Goose | *Branta canadensis* | B,M |
| Mute Swan | *Cygnus olor* | ? |
| Tundra Swan | *Cygnus columbianus* | M |
| Wood Duck | *Aix sponsa* | B,M |
| Gadwall | *Anas strepera* | M |
| American Wigeon | *Anas americana* | M |
| American Black Duck | *Anas rubripes* | B?,M |
| Mallard | *Anas platyrhynchos* | B,M |
| Blue-winged Teal | *Anas discors* | M |
| Northern Shoveler | *Anas clypeata* | M |
| Northern Pintail | *Anas acuta* | M |
| Green-winged Teal | *Anas crecca* | M |
| Canvasback | *Aythya valisineria* | M |
| Redhead | *Aythya americana* | M |
| Ring-necked Duck | *Aythya collaris* | M |
| Greater Scaup | *Aythya marila* | M |
| Lesser Scaup | *Aythya affinis* | M |
| Bufflehead | *Bucephala albeola* | M |
| Hooded Merganser | *Lophodytes cucullatus* | M |
| Ruddy Duck | *Oxyura jamaicensis* | M |
| Ring-necked Pheasant | *Phasianus colchicus* | B |
| Ruffed Grouse | *Bonasa umbellus* | B |
| Wild Turkey | *Meleagris gallopavo* | B |
| Northern Bobwhite | *Colinus virginianus* | B? |
| Common Loon | *Gavia immer* | M |
| Pied-billed Grebe | *Podilymbus podiceps* | B?,M |
| Double-crested Cormorant | *Phalacrocorax auritus* | M |
| American Bittern | *Botaurus lentiginosus* | M |
| Great Blue Heron | *Ardea herodias* | B,M |
| Great Egret | *Casmerodius albus* | M |
| Green Heron | *Butorides virescens* | B,M |
| Turkey Vulture | *Cathartes aura* | B,M |
| Osprey | *Pandion haliaetus* | M |
| Bald Eagle | *Haliaeetus leucocephalus* | M |
| Northern Harrier | *Circus cyaneus* | B?,M |
| Sharp-shinned Hawk | *Accipiter striatus* | B,M |
| Cooper's Hawk | *Accipiter cooperii* | B,M |
| Red-shouldered Hawk | *Buteo lineatus* | B?,M |
| Broad-winged Hawk | *Buteo platypterus* | M |
| Red-tailed Hawk | *Buteo jamaaicensis* | B,M |
| Rough-legged Hawk | *Buteo lagopus* | M |
| American Kestrel | *Falco sparverius* | B,M |

| Common Name | Scientific Name | Status |
|---|---|---|
| Merlin | *Falco columbarius* | M |
| Virginia Rail | *Rallus limicola* | B,M |
| Sora | *Porzana carolina* | B,M |
| American Coot | *Fulica americana* | M |
| Killdeer | *Charadrius vociferus* | B?,M |
| Greater Yellowlegs | *Tringa melanoleuca* | M |
| Lesser Yellowlegs | *Tringa flavipes* | M |
| Solitary Sandpiper | *Tringa solitaria* | M |
| Spotted Sandpiper | *Actitis macularia* | B,M |
| Semipalmated Sandpiper | *Calidris pusilla* | M |
| Least Sandpiper | *Calidris minutilla* | M |
| Pectoral Sandpiper | *Calidris melanotos* | M |
| Dunlin | *Calidris alpina* | M |
| Wilson's Snipe | *Gallinago gallinago* | M |
| American Woodcock | *Scolopax minor* | B,M |
| Ring-billed Gull | *Larus delawarensis* | M |
| Rock Pigeon | *Columba livia* | B |
| Mourning Dove | *Zenaida macroura* | B |
| Black-billed Cuckoo | *Coccyzux erthropthalmus* | B,M |
| Yellow-billed Cuckoo | *Coccyzux americanus* | B,M |
| Barn Owl | *Tyto alba* | ? |
| Eastern Screech-Owl | *Otus asio* | B |
| Great Horned Owl | *Bubo virginianus* | B |
| Short-eared Owl | *Asio frammeus* | M |
| Common Nighthawk | *Chordeiles minor* | B,M |
| Whip-poor-will | *Caprimulgus vociferus* | ? |
| Chimney Swift | *Chaetura pelagica* | B |
| Ruby-throated Hummingbird | *Archilochus colubris* | B,M |
| Belted Kingfisher | *Ceryle alcyon* | B |
| Red-headed Woodpecker | *Melanerpes erythrocephalus* | B?,M |
| Red-bellied Woodpecker | *Melanerpes carolinus* | B |
| Yellow-bellied Sapsucker | *Sphyrapicus varius* | M |
| Downy Woodpecker | *Picoides pebescens* | B |
| Hairy Woodpecker | *Colaptes auratus* | B |
| Northern Flicker | *Colaptes auratus* | B |
| Pileated Woodpecker | *Dryocopus pileatus* | B |
| Eastern Wood-Pewee | *Contopus borealis* | B |
| Acadian Flycatcher | *Empidonax virescens* | B |
| Willow Flycatcher | *Empidonax traillii* | B |
| Least Flycatcher | *Empidonax minimus* | M |
| Eastern Phoebe | *Sayornis phoebe* | B |
| Great Crested Flycatcher | *Myiarchus crinitus* | B |
| Eastern Kingbird | *Tyrannus tyrannus* | B |
| White-eyed Vireo | *Vireo griseus* | B |
| Yellow-throated Vireo | *Vireo flavifrons* | B |
| Blue-headed Vireo | *Vireo solitarius* | B?,M |
| Warbling Vireo | *Vireo gilvus* | B |
| Red-eyed Vireo | *Vireo olivaceus* | B |
| Blue Jay | *Cyanocitta cristata* | B |
| American Crow | *Corvus brachyrhynchos* | B |
| Horned Lark | *Eremophila alpestris* | M |

| Common Name | Scientific Name | Status |
|---|---|---|
| Purple Martin | *Progne subis* | B |
| Tree Swallow | *Tachycineata bicolor* | B |
| Northern Rough-winged Swallow | *Stelgidopteryx serripennis* | B |
| Barn Swallow | *Hirundo rustica* | B |
| Carolina Chickadee | *Parus carolinensis* | B |
| Tufted Titmouse | *Parus bicolor* | B |
| Red-breasted Nuthatch | *Sitta canadensis* | B |
| White-breasted Nuthatch | *Sitta carolinensis* | B |
| Brown Creeper | *Certhis americana* | M |
| Carolina Wren | *Thryothorus ludovicianus* | B |
| House Wren | *Troglodytes aedon* | B |
| Winter Wren | *Troglodytes troglodytes* | M |
| Golden-crowned Kinglet | *Regulus satrapa* | M |
| Ruby-crowned Kinglet | *Regulus calendula* | M |
| Blue-gray Gnatcatcher | *Polioptila caerulea* | B,M |
| Eastern Bluebird | *Sialia sialis* | B |
| Veery | *Catharus fuscescens* | M |
| Gray-cheeked Thrush | *Catharus minimus* | M |
| Swainson's Thrush | *Catharus ustulatus* | M |
| Hermit Thrush | *Catharus guttatus* | M |
| Wood Thrush | *Hylocichla mustelina* | B,M |
| American Robin | *Turdus migrantorius* | B,M |
| Gray Catbird | *Dumetella carolinensis* | B |
| Northern Mockingbird | *Mimus plyglottos* | B |
| Brown Thrasher | *Toxostoma rufum* | B |
| European Starling | *Sturnus vulgaris* | B |
| American Pipit | *Anthus pubescens* | M |
| Cedar Waxwing | *Bombycilla cedrorum* | B,M |
| Blue-winged Warbler | *Vermivora pinus* | B,M |
| Tennessee Warbler | *Vermivora peregrina* | M |
| Nashville Warbler | *Vermivora ruficapilla* | M |
| Northern Parula | *Parula americana* | B,M |
| Yellow Warbler | *Dendroicca petechia* | B,M |
| Chestnut-sided Warbler | *Dendroica pensylvanica* | M |
| Magnolia Warbler | *Dendroica magnolia* | B,M |
| Black-throated Blue Warbler | *Dendroica caerulescens* | M |
| Yellow-rumped Warbler | *Dendroica magnolia* | B?,M |
| Black-throated Green Warbler | *Dendroica virens* | B,M |
| Blackburnian Warbler | *Dendroica fusca* | B,M |
| Yellow-throated Warbler | *Dendroica dominica* | B,M |
| Pine Warbler | *Dendroica pinus* | M |
| Prairie Warbler | *Dendroica discolor* | M |
| Palm Warbler | *Dendroica palmarum* | M |
| Blackpoll Warbler | *Dendroica striata* | M |
| Cerulean Warbler | *Dendroica cerulea* | B,M |
| Black-and-white Warbler | *Mniotilta varia* | B,M |
| American Redstart | *Myioborus pictus* | B,M |
| Worm-eating Warbler | *Helmitheros vermivorus* | B?,M |
| Ovenbird | *Seirus aurocapillus* | B,M |
| Louisiana Waterthrush | *Seiurus motacilla* | B,M |
| Kentucky Warbler | *Opornis formosus* | M |

| Common Name | Scientific Name | Status |
|---|---|---|
| Mourning Warbler | *Oporornis philadelphia* | M |
| Common Yellowthroat | *Geothlypis trichas* | B,M |
| Hooded Warbler | *Wilsonia citrina* | B,M |
| Wilson's Warbler | *Wilsonia pusilla* | M |
| Canada Warbler | *Wilsonia canadensis* | M |
| Yellow-breasted Chat | *Icteria virens* | B,M |
| Scarlet Tanager | *Piranga olivacea* | B,M |
| Eastern Towhee | *Pipilo erythrophthalmus* | B,M |
| American Tree Sparrow | *Spizella arborea* | M |
| Chipping Sparrow | *Spizella passerina* | B,M |
| Field Sparrow | *Spizella pusilla* | B,M |
| Vesper Sparrow | *Pooecetes gramineus* | ? |
| Savannah Sparrow | *Passerculus sandwichensis* | ? |
| Grasshopper Sparrow | *Ammodramus savannarum* | ? |
| Henslow's Sparrow | *Ammodramus henslowii* | ? |
| Fox Sparrow | *Passerella iliaca* | M |
| Song Sparrow | *Melospiza melodia* | B,M |
| Lincoln's Sparrow | *Melospiza lincolnii* | M |
| Swamp Sparrow | *Melospiza georgiana* | B,M |
| White-throated Sparrow | *Zonotrichia albicollis* | M |
| White-crowned Sparrow | *Zonotrichia leucophrys* | M |
| Dark-eyed Junco | *Junco hyemalis* | B,M |
| Northern Cardinal | *Cardinalis cardinalis* | B |
| Rose-breasted Grosbeak | *Pheucticus ludovicianus* | B,M |
| Indigo Bunting | *Passerina cyanea* | B,M |
| Bobolink | *Dolichonyx oryzivorus* | B?,M |
| Red-winged Blackbird | *Agelaius phoeniceus* | B,M |
| Eastern Meadowlark | *Sturnella magna* | B |
| Rusty Blackbird | *Euphagus carolinus* | M |
| Common Grackle | *Quiscalus quiscula* | B,M |
| Brown-headed Cowbird | *Molothrus ater* | B |
| Orchard Oriole | *Icterus spurius* | B,M |
| Baltimore Oriole | *Icterus galbula* | B,M |
| Purple Finch | *Carpodacus purpureus* | M |
| House Finch | *Carpodacus mexicanus* | B |
| Common Redpoll | *Carduelis flammea* | M |
| Pine Siskin | *Carduelis pinus* | M |
| American Goldfinch | *Carduelis tristis* | B |
| House Sparrow | *Passer montanus* | B |

# Appendix C. Recorded Butterflies of the Buffalo Creek Watershed

*Identified from 2 volunteer outings

| Common Name | Scientific Name | Family | Subfamily |
|---|---|---|---|
| dun skipper | *Euphyes vestris* | Hesperiidae | Hesperiinae |
| European skipper | *Thymelicus lineola* | Hesperiidae | Hesperiinae |
| firey skipper | *Hylephila phyleus* | Hesperiidae | Hesperiinae |
| least skipper | *Ancyloxpha numitor* | Hesperiidae | Hesperiinae |
| Peck's skipper | *Polites peckius* | Hesperiidae | Hesperiinae |
| tawny-edged skipper | *Polites themistocles* | Hesperiidae | Hesperiinae |
| zabulon skipper | *Poanes zabulon* | Hesperiidae | Hesperiinae |
| common sootywing | *Pholisora catullus* | Hesperiidae | Pyrginae |
| duskywing sp. | *Erynnis sp.* | Hesperiidae | Pyrginae |
| silver-spotted skipper | *Epargyreus clarus* | Hesperiidae | Pyrginae |
| wild indigo duskywing | *Erynnis baptisiae* | Hesperiidae | Pyrginae |
| american copper | *Lycaena phlaeas* | Lycaenidae | Lycaeninae |
| bronze copper | *Cycaena hyllus* | Lycaenidae | Lycaeninae |
| pearl crescent | *Phyciodes tharos* | Lycaenidae | Nymphalinae |
| question mark | *Polygonia interrogationis* | Lycaenidae | Nymphalinae |
| eastern tailed blue | *Everes comyntas* | Lycaenidae | Polyommatinae |
| summer azure | *Celastrina neglecta* | Lycaenidae | Polyommatinae |
| banded hairstreak | *Satyrium calanus* | Lycaenidae | Theclinae |
| gray hairstreak | *Strymon melinus* | Lycaenidae | Theclinae |
| monarch | *Danaus plexippus* | Nymphalidae | Danainae |
| aphrodite fritillary | *Speyeria aphrodite* | Nymphalidae | Heliconiinae |
| great spangled fritillary | *Speyeria cybele* | Nymphalidae | Heliconiinae |
| meadow fritillary | *Boloria bellona* | Nymphalidae | Heliconiinae |
| American snout | *Libytheana carinenta* | Nymphalidae | Libytheinae |
| red-spotted purple | *Limenitis arthemis* | Nymphalidae | Limenitidinae |
| viceroy | *Limenitis archippus* | Nymphalidae | Limenitidinae |
| eastern comma | *Polygonia comma* | Nymphalidae | Nymphalinae |
| Milbert's tortoiseshell | *Mymphalis milberti* | Nymphalidae | Nymphalinae |
| red admiral | *Vanessa atalanta* | Nymphalidae | Nymphalinae |
| little wood satyr | *Megisto cymela* | Nymphalidae | Satyrinae |
| northern pearly eye | *Enondia anthedon* | Nymphalidae | Satyrinae |
| common wood nymph | *Cercyonis pegala* | Nymphalidae | Satyrinae |
| black swallowtail | *Papilio polyzenes* | Papilionidae | Papilioninae |
| eastern tiger swallowtail | *Papilio glaucus* | Papilionidae | Papilioninae |
| pipevine swallowtail | *Battus philenor* | Papilionidae | Papilioninae |
| spicebush swallowtail | *Papilio troilus* | Papilionidae | Papilioninae |
| clouded sulfur | *Colias philodice* | Pieridae | Coliadinae |
| orange sulphur | *Colias eurytheme* | Pieridae | Coliadinae |
| cabbage white | *Pieris rapae* | Pieridae | Pierinae |

# Appendix D. Washington and Jefferson University Salamander Lab Results

March 2004

**Monday Lab**

| | Number of Individuals Collected | | |
|---|---|---|---|
| **Species** | **Seep** | **Hillside** | **Riparian** |
| northern dusky | 8 | 1 | 7 |
| two-lined | | | |
| red back | | 1 | |
| spring | | | |
| total | **8** | **2** | **7** |
| total/m2 | 0.08 | 0.02 | 0.07 |

**Wednesday Lab**

| | Number of Individuals Collected | | |
|---|---|---|---|
| **Species** | **Seep** | **Hillside** | **Riparian** |
| northern dusky | 6 | 2 | 16 |
| two-lined | 2 | | 0 |
| red back | 10 | 16 | 4 |
| spring | 1 | | |
| total | **19** | **18** | **20** |
| total/m2 | 0.19 | 0.18 | 0.2 |

October 20, 2004

**Wednesday Lab***

| | Number of Individuals Collected | | |
|---|---|---|---|
| **Species** | **Seep** | **Hillside** | **Riparian** |
| northern dusky | 9 | 0 | 2 |
| two-lined | 2 | 2 | 5 |
| redback | 2 | 23 | |
| total | **13** | **25** | **7** |
| total/m2 | 0.13 | 0.25 | 0.07 |

*Additionally, two spring salamanders were found in the seep on Monday's lab. Full results for Monday's lab are not listed; the lab was not completed due to weather conditions.

# Appendix E. Fish Species and Tolerance Levels

| Common Name | Scientific Name | Tolerance | Trophic Group | Study |
|---|---|---|---|---|
| banded darter | *Etheostoma zonale* | intermediate | invertivore | 1 |
| black crappie | *Pomoxis nigromaculatus* | intermediate | piscivore | 3,5 |
| blacknose dace | *Rhinichthys atratulus* | tolerant | generalist | 2,3,4,5,7,8 |
| blackside darter | *Percina maculata* | intermediate | invertivore | 1,5,7,8 |
| bluegill | *Lepomis macrochirus* | intermediate | invertivore | 1,3,4,5,6,7 |
| bluntnose minnow | *Pimephales notatus* | tolerant | generalist | 1,2,3,4,5 |
| bigeye shiner | *Notropis boops* | | | 8 |
| brown bulhead | *Ictalurus nebulosis* | tolerant | invertivore | 3,5,6 |
| brown trout | *Salmo trutta* | intermediate | invert/piscivore | 4,6 |
| central stoneroller | *Campostoma anomalum* | intermediate | herbivore | 1,2,4,5,7,8 |
| channel catfish | *Ictalurus punctatus* | intermediate | piscivore | 6 |
| common carp | *Cyprinus carpio* | tolerant | generalist | 1,4,5,7 |
| common shiner | *Notropis cornutus* | intermediate | invertivore | 3,4,5,7,8 |
| creek chub | *Semotilus atromaculatus* | tolerant | generalist | 1,2,3,4,5,7,8 |
| emerald shiner | *Notropis atherinoides* | intermediate | invertivore | 1,2,8 |
| fantail darter | *Etheostoma flabellare* | intermediate | invertivore | 1,3,4,5,7,8 |
| gizzard shad | *Dorosoma cepedianum* | no type | filter feeder | 4 |
| golden redhorse | *Moxostoma erythrurum* | intermediate | invertivore | 1,3,5,7,8 |
| golden shiner | *Notemigonus crysoleucas* | tolerant | generalist | 3,5 |
| goldfish | *Carassius auratus* | intermediate | omnivore | 3,5,7 |
| green sunfish | *Lepomis cyanellus* | tolerant | invertivore | 1,3,4,5,7 |
| greenside darter | *Etheostoma blennioides* | intermediate | invertivore | 1,2,3,5,7,8 |
| Johnny darter | *Etheostoma nigrum* | intermediate | invertivore | 1,2,3,4,5,7,8 |
| largemouth bass | *Micropterus salmoides* | intermediate | piscivore | 6,1 |
| logperch | *Percina caprodes* | intermediate | invertivore | 1,5,7 |
| muskellunge | *Esox masquinongy* | | | 6 |
| northern hog sucker | *Hypentelium nigricans* | intermediate | invertivore | 1,5,7,8 |
| northern pike | *Esox lucieus* | intermediate | piscivore | 6 |
| pumkinseed sunfish | *Lepomis gibbosus* | intermediate | invertivore | 3,4,5,7 |
| rainbow darter | *Etheostoma caeruleum* | intolerant | invertivore | 1,5,7,8 |
| rainbow trout | *Oncorhynchus mykiss* | intermediate | insect/piscivore | 4,6 |
| redside dace | *Clinostomus elongatus* | intolerant | insectivore | 8 |
| redear sunfish | *Lepomis microlophus* | | | 6 |
| rock bass | *Ambloplites rupestris* | Intermediate | Piscivore | 1,3,5,7 |
| rosyface shiner | *Notropis rubellus* | Intolerant | Invertivore | 1,3,5,7 |
| sand shiner | *Notropis stramineus* | intermediate | invertivore | 1,5,7,8 |
| saugeye | *Walleye x Sauger* | intermediate | invertivore | 6 |
| silver shiner | *Notropis Photogenis* | intermediate | Invertivore | 2 |
| silverjaw minnow | *Ericymba buccata* | intermediate | omnivore | 3,8 |
| smallmouth bass | *Micropterus dolomieui* | Intermediate | piscivore | 1,3,5,7,8 |

| Common Name | Scientific Name | Tolerance | Trophic Group | Study |
|---|---|---|---|---|
| spotfin shiner | *Cyprinella spilopterus* | intolerant | invertivore | 1,5,7 |
| stonecat | *Noturus flavus* | Intolerant | invertivore | 1,5,7 |
| striped shiner | *Luxilus chrysocephalus* | intermediate | Invertivore | 1,8 |
| tiger muskie | *Esox lucius x masquinongy* | | | 3,5,6 |
| variegate darter | *Etheostoma variatum* | intolerant | invertivore | 1,5 |
| walleye | *Stizostedion vitreum* | Intermediate | piscivore | 6 |
| white crappie | *Pomoxis annularis* | tolerant | piscivore | 3,5 |
| white sucker | *Catostomus commersoni* | tolerant | generalist | 1,2,3,4,5,7,8 |
| yellow bullhead | *Ameriurus natalis* | tolerant | invertivore | 4,8 |

[1]McCone, R. L., D. G. Argent. 2001

[2]Romanchak, S. S. , D. G. Argent. 2001.

[3] PA Fish and Boat Comm. 1983.

[4] PA Fish and Boat Comm. 1996

[5] PA Fish and Boat Comm. 1997.

[6] PA Fish and Boat Comm. 1999.

[7] Allegheny Energy. 2002.

[8] Western Pennsylvania Conservancy. 2003.

# Appendix F. Example Riparian Buffer Ordinance (courtesy Montgomery County, PA Planning Office)

**MODEL ORDINANCE**
**RIPARIAN CORRIDOR CONSERVATION DISTRICT**

**Section 1. Legislative Intent**.
In expansion of the Declaration of Legislative Intent and Statement of Community Development Objectives found in Sections 101 and 102 of Article I of this ordinance, it is the intent of this article to provide reasonable controls governing the conservation, management, disturbance, and restoration, of riparian corridors under authority of Article I, Section 27 of the Pennsylvania Constitution, Act 247 the Municipalities Planning Code as amended, and other Commonwealth and federal statutes, in conformance with the goals of the Comprehensive Plan, Open Space and Environmental Resource Protection Plan, and the following objectives:

*The legislative intent section provides the rationale for the regulation, including the applicable power to do so. This will demonstrate that the regulation is reasonable and related to a defensible public purpose. The authority to protect riparian corridors is contained within the Pennsylvania Constitution and the MPC (Secs 301b, 603b5, 603d, 604(1), and 605(2)).*

*The intent section also recognizes the scientifically-proven and published benefits of riparian corridors.*

1.1 Improve surface water quality by reducing the amount of nutrients, sediment, organic matter, pesticides, and other harmful substances that reach watercourses, wetlands, subsurface, and surface water bodies by using scientifically-proven processes including filtration, deposition, absorption, adsorption, plant uptake, and denitrification, and by improving infiltration, encouraging sheet flow, and stabilizing concentrated flows.

1.2 Improve and maintain the safety, reliability, and adequacy of the water supply for domestic, agricultural, commercial, industrial, and recreational uses along with sustaining diverse populations of aquatic flora and fauna.

*The Commonwealth of Pennsylvania has invested over a billion dollars in water quality protection over the last two decades. Protection of riparian corridors helps to advance this large public investment.*

1.3 Preserve and protect areas that intercept surface water runoff, wastewater, subsurface flow, and/or deep groundwater flows from upland sources and function to remove or buffer the effects of associated nutrients, sediment, organic matter, pesticides, or other pollutants prior to entry into surface waters, as well as provide wildlife habitat, moderate water temperature in surface waters, attenuate flood flow, and provide opportunities for passive recreation.

1.4 Regulate the land use, siting, and engineering of all development to be consistent with the intent and objectives of this ordinance and the best-accepted conservation practices, and to work within the carrying capacity of existing natural resources.

*The majority of land within a watershed is drained by the smaller 1st and 2nd order streams. Therefore, regulation of riparian corridors must focus upon all streams within a watershed and not just the larger more apparent creeks and rivers.*

1.5 Assist in the implementation of pertinent state laws concerning erosion and sediment control practices, specifically Erosion Control, of the Pennsylvania Clean Streams Law, Act 394, P.L. 1987, Chapter 102 of the Administrative Code (as amended October 10, 1980 Act 157 P.L.), Title 25, and any subsequent amendments thereto, as administered by the Pennsylvania Department of Environmental Protection and the Montgomery County Conservation District.

*There are other laws of the Commonwealth that this ordinance complements which should be referenced.*

1.6 Conserve natural features important to land or water resources such as headwater areas, groundwater recharge zones, floodway, floodplain, springs, streams, wetlands, woodlands, prime wildlife habitats, and other features that provide recreational value or contain natural amenities whether on developed or undeveloped land.

*Depending on a municipality's goals for corridor preservation, recreational opportunities may exist and should be mentioned as part of the regulations intent.*

1.7 Work with floodplain, steep slope, and other requirements that regulate environmentally sensitive areas to minimize hazards to life, property, and riparian features.

*The ordinance should reference other existing municipal regulations regarding natural resource preservation.*

1.8 Recognize that natural features contribute to the welfare and quality of life of the [Municipal] residents.

1.9 Conserve natural, scenic, and recreation areas within and adjacent to riparian areas for the community's benefit.

**Section 2. Application an Width Determination of the District**

*Scientific research has demonstrated that the benefits of riparian corridors are maximized when they extend at least 75 feet from the streambank.*

2.1 Application. The Riparian Corridor Conservation District is an overlay district that applies to the streams, wetlands, and waterbodies, and the land adjacent to them, as specified in the following table:

| Surface Water Feature | Minimum Corridor Width |
|---|---|
| **A. Perennial Streams:** All perennial streams identified in the Soil Survey[1]. (Perennial streams are shown as solid lines on the Soil Survey maps.) | **Zone 1:** Minimum width of 25 feet from each defined edge of the watercourse at bank full flow, measured perpendicular to the edge of the watercourse. |

*Zone one should be a minimum of 25 feet from the streambank and consist of undisturbed forest and vegetation in order to stabilize the streambank, shade the stream, and provide food for aquatic organisms.*

| Surface Water Feature | Minimum Corridor Width |
|---|---|
| | **Zone 2:** Minimum width of 50 feet from the outer edge of Zone 1, measured perpendicular to the edge of Zone 1, or equal to the extent of the 100-year floodplain[3], or 25 feet beyond the outer edge of a wetland along the stream, whichever is greater. (Total minimum width of Zones 1 & 2 = 150 feet plus the width of the stream.) |
| **B. Intermittent Streams:** Intermittent streams identified in the Soil Survey[1] or any stream otherwise identified on the applicant's plan that have an upstream drainage area of 75 acres or more[2]. (Intermittent streams are shown as dotted and dashed lines on the Soil Survey maps.) | **Zone 1:** Minimum width of 25 feet from each defined edge of the watercourse at bank full flow, measured perpendicular to the edge of the watercourse. **Zone 2:** Minimum width of 50 feet from the outer edge of Zone 1, measured perpendicular to the edge of Zone 1, or equal to the extent of the 100-year floodplain[3], or 25 feet beyond the outer edge of a wetland along the stream, whichever is greater. (Total minimum width of Zones 1 & 2 = 150 feet plus the width of the stream.) |
| **C. Other Streams:** All other streams with an upstream drainage area of less than 75 acres[2], including intermittent streams identified in the Soil Survey[1]. | **Zone 1:** Minimum width of 25 feet from the centerline of the watercourse, measured perpendicular to the centerline of the watercourse, or equal to the extent of the 100-year floodplain[3], or 25 feet beyond the outer edge of a wetland along the stream, whichever is greater. (Total minimum width of 50 feet). **Zone 2:** Does not apply. |
| D**. Wetlands and Waterbodies** Wetlands not located along a stream, and waterbodies, where the wetland and/or waterbody is greater than 10,000 square feet in area. | **Zone 1:** Minimum width of 25 feet from the outer edge of the wetland or waterbody, measured perpendicular to the edge. For wetlands located at the edge of a waterbody, the measurement shall be made from the outer edge of the wetland. **Zone 2:** Does not apply. |

*Zone Two is the Aouter edge≅ of the corridor and allows for infiltration of runoff, filtration of sediment and nutrients, and nutrient uptake by plants.*

*The following notes should accompany the chart:*

[1]Soil Survey shall mean the most recent edition of he Soil Survey of Montgomery County.

[2]Upstream drainage area shall be measured from the where the stream exits the applicant's site.

[3]100-year floodplain is identified on the Flood Insurance rate Map (FIRM) prepared by FEMA, or as calculated by the applicant where FEMA data does not apply.

*Steep slopes are often found adjacent to waterways and may*

2.2 Zone Designation Adjustments for Steep Slopes. Where steep slopes in excess of 25 percent are located within 75 feet of a stream identified in 2.1, A or B, above, the area of steep slopes shall be designated as Zone One consistent with the following:

A. If the extent of the steeply sloped area is more than 75 feet, the Zone 1 designation shall extend to 75-feet or to the full extent of the steeply sloped area within the corridor if Zone 1 extends greater than 75 feet as may be required in Section 2.1.C. Zone 2 shall not be required except as may be required in 2.1, A or B for floodplains.

B. If the extent of the steeply sloped area is less than 75 feet, the Zone 1 designation shall extend to the limit of the steeply sloped area, and the width of Zone Two shall be adjusted so that the total corridor width (Zone 1 plus Zone 2) will be that required in 2.1 A, B, or C.

2.3 Identification and Width Determination. The applicant shall be responsible for the following:

A. Identifying the watercourses, wetlands, and/or waterbodies on and abutting the applicant's site, and locating these features accurately on the applicant's plans.

B. Initial width determination of the riparian corridor(s) in compliance with Section 2.1, herein, and for identifying these areas on any plan that is submitted for subdivision, land development, or other improvements that require plan submissions or permits. The initial determination(s) shall be subject to review and approval by the [Municipal] Planning Commission, with the advice of the [Municipal] Engineer.

**Section 3. Uses Permitted in the Riparian Corridor Conservation District**

The following uses are permitted by right in the Riparian Corridor Conservation District in compliance with the requirements of this Article:

3.1 Zones One and Two: At least half of any required yard setback area, for any individual lot, must be entirely outside of the Riparian Corridor Conservation District.

*reduce the infiltration and filtering benefits of the buffer.*

*Providing a Zone 1 designation to the steeply sloped areas will afford greater protection for existing vegetation. Maintaining vegetation on steep slopes is especially critical for reducing erosion and sedimentation.*

*This ordinance requires the applicant to designate the riparian corridor on the subdivision or land development plan. This requirement is similar to the way wetlands and floodplains are designated.*

*The uses permitted within each zone are directly related to the specific benefits the zone provides and should be tailored to the community's goals.*

*To ensure usable yard area is provided, at least half of all yard setbacks shall be outside the riparian corridor.*
*For Zone One to function properly it should remain*

*relatively undisturbed. Therefore, the by-right uses are generally passive and allow for the implementation of streambank stabilization techniques to minimize erosion.*

3.2 Zone One:

A. Open space uses that are primarily passive in character shall be permitted to extend into the area defined as Zone One, including:

1. Wildlife sanctuaries, nature preserves, forest preserves, fishing areas, passive areas of public and private parklands, and reforestation.

2. Streambank stabilization.

*To sustain and encourage agricultural operations, crossings for farm vehicles and livestock are permitted by-right.*

B. Forestry operations approved by the Montgomery County Conservation District.

C. Corridor crossings:

*Invariably, driveways, roads, and other types of corridor crossings will be required and are permitted by-right provided specific mitigation and design standards are satisfied.*

1. Agricultural crossings by farm vehicles and livestock.

2. Driveways serving one or two single-family detached dwelling units, provided the mitigation requirements of Section 7.2 are satisfied. The corridor crossing standards of Section 8 should be considered during design of the driveway.

3. Driveways serving more than two single-family detached dwelling units, or roadways, recreational trails, railroads, and utilities, provided the mitigation requirements of Section 7.2 and the corridor crossing design standards of Section 8 are satisfied.

*The main purpose of Zone Two is to impede the flow of runoff, allowing increased infiltration to filter out nutrients for uptake by plants.*

3.2 Zone Two

A. Open space uses including wildlife sanctuaries, nature preserves, forest preserves, passive areas of public and private parklands, recreational trails, and reforestation.

*Existing agricultural uses should be allowed to continue, as long as best-management practices are implemented.*

B. Agricultural uses conducted in compliance with methods prescribed in the Department of Environmental Protection's Erosion and Sediment Pollution Control Manual, March 2000, as amended.

C. Corridor crossings:

1. Agricultural crossings by farm vehicles and livestock.

2. Driveways serving one or two single-family detached dwelling units, provided the mitigation requirements of Section 7.2 are satisfied. The corridor crossing standards of Section 8 should be considered during design of the driveway.

3. Driveways serving more than two single-family detached dwelling units, or roadways, recreational trails, railroads, and utilities, provided the mitigation requirements of Section 7.2 and the corridor crossing design standards of Section 8 are satisfied.

*The standards for accessory structures should be tailored to be consistent with existing municipal regulation.*

E. Residential accessory structures having an area equal to or less than 225 square feet.

F. Forestry operations approved by the Montgomery County Conservation District.

*The main purpose of Zone Two is to slow runoff. Therefore, concentrated runoff flow should be prevented. This may be particularly important if impervious surface is introduced into Zone Two.*

G. Passive use areas such as camps, campgrounds, picnic areas, and golf courses. Active recreation areas such as ballfields, playgrounds, and courts provided these uses are designed in a manner that will not permit concentrated flow of stormwater runoff.

H. Centralized sewer and/or water lines and public utility transmission lines running along the corridor. When proposed as part of a subdivision or land development, the mitigation requirements of Section 8.2 shall be satisfied. In all cases**,** these lines shall be located as far from Zone One as practical.

**Section 4. Uses Specifically Prohibited in the Riparian Corridor District**

Any use or activity not authorized within Section 3, herein, shall be prohibited within the Riparian Corridor Conservation District and the following activities and facilities are specifically prohibited:

*Denudation of the buffer area is prohibited unless it is done to allow for construction of a permitted use, such as a utility crossing, provided the uses are constructed and revegetated*

4.1 Clearing of all existing vegetation, except where such clearing is necessary to prepare land for a use permitted under Section 3.1, herein, and where the effects of these actions are mitigated by re-establishment of vegetation, as specified under Section 8.1, herein.

*according to ordinance specifications.*

4.2 Storage of any hazardous or noxious materials.

4.3 Use of fertilizers, pesticides, herbicides, and/or other chemicals in excess of prescribed industry standards or the recommendations of the Montgomery County Conservation District.

4.4 Roads or driveways, except where permitted as corridor crossings in compliance with Section 3, herein.

4.5 Motor or wheeled vehicle traffic in any area not designed to accommodate adequately the type and volume.

4.6 Parking lots.

4.7 Any type of permanent structure, including fences, except structures needed for a use permitted in Section 3, herein.

4.8 Subsurface sewage disposal areas.

4.9 Sod farming.

4.10 Stormwater basins, including necessary berms and outfall facilities.

*The ordinance should specifically prohibit uses that may inevitably lead to erosion, sedimentation, pollution, and general disturbance of the corridor, which may not be reasonably mitigated. Once again, this section should be modified to meet the goals of the municipality.*

**Section 5. Nonconforming Structures and Uses in the Riparian Forest Corridor District**

Nonconforming structures and uses of land within the Riparian Corridor Conservation Overlay District shall be regulated under the provisions of Article VII, Nonconforming Status, herein**,** except that the one-year time frame for discontinuance shall not apply to agricultural uses which are following prescribed Best Management Practices for crop rotation.

*Structures and uses that legally exist prior to adoption of this ordinance, which will no longer be permitted, are considered nonconforming. It is important to recognize these instances, regulate their expansion, and determine abandonment.*

**Section 6. Boundary Interpretation and Appeals Procedure**

6.1 When an applicant disputes the Zone 1 and/or 2 boundaries of the Riparian Corridor or the defined edge of a watercourse, surface water body, or wetland, the applicant shall submit evidence to the [Municipality] that shows the applicant's proposed boundary, and provides justification for the proposed boundary change.

*There may be disputes about the extent of the corridor on specific properties. This section provides the applicant with the opportunity to justify a change in the boundary location.*

boundary change.

6.2 The [Municipal] Engineer, and/or other advisors selected by the [Governing Body] shall evaluate all material submitted and provide a written determination within 45 days to the [Governing Body], [Municipal] Planning Commission, and landowner or applicant.

*Similar to other zoning appeals, further disputes should be handled by the zoning hearing board.*

6.3 Any party aggrieved by any such determination or other decision or determination under this section may appeal to the Zoning Hearing Board under the provisions of [existing Zoning Hearing Board Article] of this ordinance. The party contesting the location of the district boundary shall have the burden of proof in case of any such appeal.

*Once lands start being preserved, and a contiguous system of lands begin to form, some degree of regular inspection will be necessary. The inspection will determine landowner compliance with the ordinance provisions.*

**Section 7. Inspection of Riparian Corridor Conservation District**

7.1 Lands within or adjacent to an identified Riparian Corridor Conservation Overlay District will be inspected by the [Municipal] Code Enforcement Officer when:

A. A subdivision or land development plan is submitted.

B. A building permit is requested.

C. A change or resumption of nonconforming use is proposed.

7.2 The district may also be inspected periodically by the Code Enforcement Officer and/or other representatives designated by the [Governing Body] for compliance with an approved restoration plan, excessive or potentially problematic erosion, hazardous trees, or at any time when the presence of, or possibility of, an unauthorized activity or structure is brought to the attention of [Municipal] officials.

*Vegetation is one of the key ingredients to a healthy and useful corridor. Therefore, to encourage and aid in the establishment of the riparian corridor, specific riparian plantings should be required as part of the site's general landscaping.*
*When development encroaches upon the riparian corridor, the function of the corridor is compromised and mitigation will be required.*

**Section 8. Management of the Riparian Corridor District**

8.1 Riparian Corridor Planting. Re-establishment of forest cover and woodland habitat shall be required consistent with the requirements of the landscape regulation within the [Municipal] Subdivision and Land Development Ordinance.

8.2 Mitigation Measures. Uses permitted in Section 3 involving corridor crossings or other encroachment within the riparian corridor shall be mitigated by increasing the width of the corridor as replacement for the area lost due to the encroachment or disturbance, so that the total corridor area (land area within Zone One and Zone Two) for each applicable side of the stream or watercourse is equal to that required by Section 2.1.

*A "buffer averaging" approach adds width to portions of the buffer to offset reductions in width due to corridor crossings or other types of disturbance.*

Corridor area is the product of the corridor width required by Section 2.1 and the total length for each applicable side of the stream or watercourse for which a riparian corridor is being established. Perimeter shall be used in place of length for determining wetland buffer area. The increased width shall be spread throughout the corridor to the maximum extent possible. For stream and watercourses, the increased width shall be applied along the length of the stream in blocks of 1,000 feet or more, or the full length of the corridor on the affected property, whichever is less.

*While the need for corridor crossings is inevitable, the number and design of these crossings should be controlled in order to protect the integrity and functionality of the riparian corridor to the greatest extent possible.*

**Section 9. Corridor Crossings Standards**

9.1. Corridor Crossing Criteria. All corridor crossings permitted under Sections 3.1 or 3.2, herein, shall incorporate, as required, the following design standards.

A. The width of the right-of way should not be greater than the minimum right-of-way width required by the [Municipal] Subdivision and Land Development Ordinance.

B. Crossings should be designed to cross the riparian corridor at direct right angles to the greatest extent possible in order to minimize disturbance of the corridor.

C. Corridor crossings should be separated by a minimum of 1,000 feet of buffer length.

D. Bridges should be used in place of culverts when crossings would require a 72-inch or greater diameter pipe. When culverts are installed they should consist of slab, arch, or box culverts and not corrugated metal pipe. Culverts should also be designed to retain the natural channel bottom to ensure the passage of water during low flow or dry weather periods.

**Section 10. Use of Technical Terminology**
Technical terminology used in this article shall be interpreted to have the meanings used by recognized sources and experts in the fields of forestry, woodland or meadow management, streambank protection, wetlands management, erosion and sedimentation control, or other relevant fields.

*Integration of the Riparian Corridor Conservation Overlay District into the municipal zoning ordinance should be complemented by the adoption of specific landscape standards within the municipal subdivision and land development ordinance.*

**Model Landscape Standards for Subdivision and Land Development Ordinance**:

**A. Purpose & Application**

In areas within the Riparian Corridor Conservation District as defined in Section ### of the [*Municipal*] Zoning Ordinance, the edge of water features and stream corridors should be in forest cover to further the ecological and environmental benefits, as stated in the Riparian Corridor Conservation Overlay District (RCC). To promote re-establishment of forest cover and woodland habitat, new tree plantings shall be implemented in Zone One wherever existing trees do not meet the minimum tree planting requirements.

*The required plantings will help to enhance or re-establish a vegetated riparian buffer, maximizing water quality benefits.*

**B. Planting Requirements**

1. New trees shall be planted at a minimum rate of 15 feet on center or one tree per 225 square feet in staggered rows or an equivalent informal arrangement within the area defined as Zone One by the RCC.

2. New trees shall be a variety of sizes ranging from a minimum 4 to 5 foot branched whip to an approximate 1 1/2 " balled and burlapped planting stock.

3. New tree plantings shall be composed of native tree species.

4. Tree plantings shall be located along the streambank to provide shade for the stream, soil erosion control and stormwater benefits, according to accepted streambank restoration practices.

5. Existing trees within Zone One shall be preserved and retained. Existing tree cover should be surveyed and inventoried to assess the need for any new plantings. Existing tree species included on the noxious/invasive plant species list, Appendix C, may be removed where conditions warrant.

*Plantings installed as part of the subdivision and land development process will provide visual cues to future property owners by providing a distinction between the riparian corridor and the remaining lot area.*

*If the riparian corridor is to be ultimately managed by numerous private owners, the municipality should provide or arrange for continued education of property owners regarding the benefits of riparian corridors and proper management and stewardship.*

## Appendix G.  NPDES Permits, West Virginia Portion of Watershed

| Permit Holder | Location | Type | Dates | Waterbody | Latitude | Longitude |
|---|---|---|---|---|---|---|
| Adm Milling Co. | Wellsburg, WV | paper mills | 10/03/99 to 02/10/04 | City Storm System | 40.2822 | -80.6088 |
| Banner Fibreboard Company | Wellsburg, WV | paperboard mills | 03/06/2000 to 06/30/2005 | Ohio River | 40.2844 | -80.60699 |
| Beech Bottom | Wellsburg, WV | paperboard mills | 04/08/1997 to 04/07/2002 | Ohio River | 40.21667 | -80.65 |
| Town of Bethany | Bethany, WV | sewage system | 01/31/2001 to 01/30/2005 | Buffalo Creek | 40.2017 | -80.551 |
| Blue Ridge Manor | Wellsburg, WV | sewer systems | 07/23/1999 to 12/03/03 | Painters/ Buffalo Ck/ Ohio River | 40.26583 | -80.59361 |
| Brooke High School | Wellsburg, WV | sewer systems | 06/02/2000 to 12/03/2003 | Buffalo Creek/Ohio River | 40.26778 | -80.61528 |
| Brooke Hills Park | Wellsburg, WV | sewer systems | 03/09/99 to 12/032003 | UT of Pierce Run | 40.258 | -80.542 |
| Brooke Mobile Park | Wellsburg, WV | mobile homes operator | 05/14/99 to 12/03/2003 | information missing… | 40.29111 | -80.614 |
| City of Wellsburg | Wellsburg, WV | general government | 04/11/2003 to 03/06/2008 | Ohio River | 40.265 | -80.614 |
| Franklin Primary School | Wellsburg, WV | sewage systems | 06/02/2000 to 12/03/03 | ground runoff Cross Ck/ Ohio R | 40.273 | -80.539 |
| Genteel Woods Rental Property | Wellsburg, WV | general medical hospital | 06/30/1999 to 12/03/2003 | TITT Run/ Buffalo Ck/ Ohio | 40.2672 | -80.568 |
| Hammonel PSD | Wellsburg, WV | water supply | 03/25/1993 to 03/24/1998 | Buffalo Creek | 40.255 | -80.6244 |
| Kennels at Beech Bottom | Beech Bottom | racing track operation | 08/16/2004 to 02/10/2004 | UT/ Ohio River | 40.2375 | -80.653 |
| Main Drive Subdivision | Wellsburg, WV | water supply | 08/20/1999 to 12/03/2003 | Coal Hollow Run/ Cross Ck/ Ohio R | 40.25 | -80.625 |
| Mason, Raleigh | Wellsburg, WV | nursing/person al care | 04/12/2002 to 12/03/2003 | UT/Pierce Run/ Buffalo Creek | 40.2719 | -80.534 |
| Peach Pt. | Bethany, WV | sewer systems | 07/26/2001 to 12/03/2003 | Castleman Run/ Buffalo Ck/ Ohio | 40.197 | -80.601 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Stone Container Corp. | Wellsburg, WV | uncoated paper & multiwall bags | 04/21/1999 to 02/10/2004 | Ohio River | -40.286 | -80.601 |
| Trailer Court Apts. | Wellsburg, WV | mobile homes sites | 06/30/1999 to 12/03/2003 | Hukill Run/ Elk River/ Ohio River | -40.202 | -80.632 |
| City of Wellsburg | Wellsburg, WV | sewage | 06/23/2000 to 06/22/2005 | Ohio River | 40.265 | -80615 |
| Wheeling-Pitt Steel Corp. Beech Bottom Plant | Beech Bottom, WV | coating, engraving allied services | 06/30/2000 to 06/29/2005 | UT of Ohio River | 40.3444 | -80.614 |
| Windsor Pur House Coal Company | Power, WV | bituminous coal/ lignite surface mining | 04/24/1984 to 04/24/1989 | Ohio River | 40.1606 | -80.614 |
| Zatta, Edward | Wellsburg, WV | scrap & waste materials | 12/24/1999 to 02/10/2004 | UT/ Green Run/ Buffalo Ck/ Ohio | 40.2477 | -80.628 |

# Appendix H. Water Quality Database

P=primary sites S=secondary sites TSS=total suspended solids
Cl=chlorides FC=fecal coliforms TPN=total phosphorous and nitrogen

| Subwatershed | Site Type | Date | Latitude (N) | Longitude (W) | Site Desc. | Attaining WQ standards? | Probable impairment non WQ standard? | Parameter of impairment, if applicable | DO (mg/L) | pH | Total Disolved Solids (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BC EAST | P | 8/1/03 | 40.152 | 80.371 | upper BC East, S Bridge | yes | no | | 7.2 | 7.7 | 280 |
| BC SOUTH | P | 8/1/03 | 40.152 | 80.371 | upper BC South, 3009 | yes | no | | | 7.6 | 280 |
| BC MIDDLE | P | 8/1/03 | 40.161 | 80.374 | BC gazeebo | yes | yes | conductivity | 7.29 | 8.1 | 370 |
| BRUSH | S | 8/1/03 | 40.209 | 80.351 | Brush Run UNT Ag strea | yes | no | | 8.6 | 8.4 | 280 |
| BUCK | P | 8/1/03 | 40.191 | 80.449 | Mouth Buck Run | yes | no | | 7.56 | 8.2 | 220 |
| LOWER BUFFALO | P | 8/1/03 | 40.198 | 80.516 | BC at WV border | yes | no | | 7.79 | 8.5 | 260 |
| LOWER DUTCH | P | 8/1/03 | 40.184 | 80.486 | Mouth Dutch Fork | yes | yes | pH | 8.75 | 8.6 | 230 |
| FORK | P | 8/1/03 | 40.123 | 80.473 | Dutch Fork Into Lake | yes | yes | conductivity | 6.64 | 7.3 | 300 |
| UPPER DUTCH FORK | S | 8/1/03 | 40.15 | 80.476 | Dutch Fork Exit Lake | yes | no | | | 8.3 | 230 |
| UPPER DUTCH FORK | P | 8/1/03 | 40.184 | 80.486 | Mouth Dutch Fork | no | yes | pH | 8.75 | 8.6 | 230 |
| BRUSH | P | Summer 2003 | 40.196 | 80.448 | Mouth Brush Run | yes | no | | 7.07 | 8.3 | 280 |
| DUNKLE | P | Summer 2003 | 40.201 | 80.44 | Mouth Dunkle Run | yes | no | | 8.02 | 8.3 | 290 |
| BC EAST | P | 10/22/03 | 40.152 | 80.371 | Upper BC East, S Bridge | yes | no | | 9.84 | 7.7 | 280 |
| BC EAST | TSS | 10/22/03 | 40.152 | 80.371 | Upper BC East, S Bridge | yes | no | | | | |

| Subwatershed | Site Type | Date | Latitude (N) | Longitude (W) | Site Desc. | Attaining WQ standards? | Probable impairment non WQ standard? | Parameter of impairment, if applicable | DO (mg/L) | pH | Total Disolved Solids (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BC SOUTH | P | 10/22/03 | 40.152 | 80.371 | upper BC South, 3009 | yes | no | | 9.27 | 7.57 | 210 |
| BC SOUTH | TSS | 10/22/03 | 40.152 | 80.371 | upper BC South, 3009 | yes | no | | | | |
| BC SOUTH | Cl | 10/22/03 | 40.152 | 80.371 | upper BC South, 3009 | yes | no | | | | |
| BC MIDDLE | S | 10/22/03 | 40.161 | 80.379 | Wolf Mouth | yes | no | | 8.95 | 7.94 | 220 |
| BC MIDDLE | TSS | 10/22/03 | 40.161 | 80.379 | Wolf Mouth | yes | no | | | | |
| BC MIDDLE | Cl | 10/22/03 | 40.161 | 80.379 | Wolf Mouth | yes | no | | | | |
| BC MIDDLE | S | 10/22/03 | 40.18 | 40.416 | BC Covered Bridge | yes | no | | 9.49 | 8.09 | 260 |
| BC MIDDLE | P | 10/22/03 | 40.192 | 80.448 | Middle Buffalo Creek Mouth | yes | no | | 10.14 | 8.24 | 260 |
| BC MIDDLE | TSS | 10/22/03 | 40.192 | 80.448 | Middle Buffalo Creek Mouth | yes | no | | | | |
| BRUSH | S | 10/22/03 | 40.207 | 80.36 | Maple Road | yes | yes | conductivity | 9.65 | 7.9 | 290 |
| BRUSH | Cl | 10/22/03 | 40.207 | 80.36 | Maple Road | yes | no | | | | |
| BRUSH | P | 10/22/03 | 40.196 | 80.448 | Mouth Brush Run | yes | no | | 10.33 | 8.28 | 270 |
| BRUSH | TSS | 10/22/03 | 40.196 | 80.448 | Mouth Brush Run | yes | no | | | | |
| BUCK | P | 10/22/03 | 40.191 | 80.449 | Mouth Buck Run | yes | no | | 9.74 | 8.07 | 220 |
| BUCK | TSS | 10/22/03 | 40.191 | 80.449 | Mouth Buck Run | yes | no | | | | |
| BUCK | Cl | 10/22/03 | 40.191 | 80.449 | Mouth Buck Run | yes | no | | | | |
| DUNKLE | P | 10/22/03 | 40.201 | 80.44 | Mouth Dunkle Run | yes | yes | conductivity | 10.24 | 8.2 | 290 |

| Subwatershed | Site Type | Date | Latitude (N) | Longitude (W) | Site Desc. | Attaining WQ standards? | Probable impairment non WQ standard? | Parameter of impairment, if applicable | DO (mg/L) | pH | Total Disolved Solids (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DUNKLE | TSS | 10/22/03 | 40.201 | 80.44 | Mouth Dunkle Run | yes | no | | | | |
| SUGARCAMP | S | 10/22/03 | 40.208 | 80.506 | Sugarcamp at Frogtown | yes | no | | 10.68 | 8.2 | 200 |
| CASTLEMAN | S | 10/22/03 | 40.139 | 80.513 | Castleman Mouth | yes | no | | | 7.9 | 200 |
| CASTLEMAN | TSS | 10/22/03 | 40.139 | 80.513 | Castleman Mouth | yes | no | | | | |
| LOWER BUFFALO | P | 10/22/03 | 40.198 | 80.516 | BC at WV border | yes | no | | 12.94 | 8.4 | 240 |
| LOWER DUTCH | P | 10/22/03 | 40.184 | 80.486 | Mouth Dutch Fork | yes | no | | 9.98 | 7.8 | 240 |
| UPPER DUTCH FORK | P | 10/22/03 | 40.123 | 80.473 | Dutch Fork Into Lake | yes | no | | 9.92 | 7.9 | 240 |
| UPPER DUTCH FORK | Cl | 10/22/03 | 40.123 | 80.473 | Dutch Fork Into Lake | yes | no | | | | |
| UPPER DUTCH FORK | S | 10/22/03 | 40.118 | 80.451 | Cunningham | yes | no | | 9.1 | 7.9 | 200 |
| UPPER DUTCH FORK | Cl | 10/22/03 | 40.118 | 80.451 | Cunningham | yes | no | | | | |
| UPPER DUTCH FORK | Cl | 10/22/03 | 40.17 | 80.387 | Reed Run Mouth | yes | no | | | | |
| UPPER DUTCH FORK | TSS | 10/22/03 | 40.15 | 80.476 | Dutch Fork Exit Lake | yes | no | | | | |
| UPPER DUTCH FORK | P | 10/22/03 | 40.184 | 80.486 | Mouth Dutch Fork | yes | no | | 9.98 | 7.8 | 240 |
| BC EAST | P | 3/24/04 | 40.152 | 80.371 | Upper BC East, S Bridge | yes | yes | conductivity | 12.83 | 8.4 | 370 |
| BC EAST | S | 3/24/04 | 40.129 | 80.323 | Mount Valey/Jolly School Rd. | yes | no | | n/a | 8.2 | 260 |
| BC SOUTH | P | 3/24/04 | 40.152 | 80.371 | upper BC South, 3009 | yes | no | | n/a | 8.2 | 250 |
| BC MIDDLE | P | 3/24/04 | 40.161 | 80.374 | BC gazeebo | yes | no | | 13.03 | 8.4 | 290 |

| Subwatershed | Site Type | Date | Latitude (N) | Longitude (W) | Site Desc. | Attaining WQ standards? | Probable impairment non WQ standard? | Parameter of impairment, if applicable | DO (mg/L) | pH | Total Disolved Solids (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BC MIDDLE | P | 3/24/04 | 40.192 | 80.448 | Middle Buffalo Creek Mouth | yes | no | | 13.26 | 8.4 | 270 |
| BRUSH | P | 3/24/04 | 40.196 | 80.448 | Mouth Brush Run | yes | yes | nitrate | 12.56 | 8.5 | 300 |
| BUCK | P | 3/24/04 | 40.191 | 80.449 | Mouth Buck Run | yes | no | | 12.38 | 8.3 | 220 |
| LOWER BUFFALO | S | 3/24/04 | 40.199 | 80.445 | Hickory Nut Road | yes | yes | nitrate | 11.83 | 8.4 | 290 |
| LOWER BUFFALO | S | 3/24/04 | 40.19 | 80.476 | Narigan Run | no | yes | pH | 11.18 | 8.6 | 230 |
| LOWER BUFFALO | P | 3/24/04 | 40.198 | 80.516 | BC at WV border | yes | no | | n/a | 8.4 | 270 |
| LOWER BUFFALO | S | 3/24/04 | 40.187 | 80.501 | Dog Run | yes | no | | n/a | 8.4 | 230 |
| LOWER DUTCH | P | 3/24/04 | 40.184 | 80.486 | Mouth Dutch Fork | yes | no | | n/a | 8.4 | 290 |
| UPPER DUTCH FORK | P | 3/24/04 | 40.123 | 80.473 | Dutch Fork Into Lake | yes | no | | n/a | 8.3 | 240 |
| UPPER DUTCH FORK | S | 3/24/04 | 40.112 | 80.465 | Below Truck Stop | no | yes | pH | n/a | 8.8 | 340 |
| UPPER DUTCH FORK | P | 3/24/04 | 40.184 | 80.486 | Mouth Dutch Fork | yes | no | | n/a | 8.4 | 290 |
| BC EAST | S | 9/16/04 | 40.128 | 80.336 | BC East, Upper Culvert | no | yes | iron | 7.5 | 7.1 | |
| BC EAST | S | 9/16/04 | 40.141 | 80.352 | S Bridge, small Trib | yes | yes | conductivity | 7.95 | 7.8 | |
| BC EAST | S | 9/16/04 | 40.149 | 80.362 | Buffalo East, Overpass area | yes | no | | 8.98 | 8.1 | |
| BC MIDDLE | P | 9/16/04 | 40.161 | 80.374 | BC Gazebo | yes | no | | 8.01 | 8 | |
| BUCK | S | 9/16/04 | 40.15 | 80.429 | Buck Run Headwaters | yes | no | | 7.3 | 7.9 | |
| SUGARCAMP | S | 9/16/04 | 40.217 | 80.484 | Sugarcamp upstream | yes | no | | 8.67 | 8.2 | |

| Subwatershed | Site Type | Date | Latitude (N) | Longitude (W) | Site Desc. | Attaining WQ standards? | Probable impairment non WQ standard? | Parameter of impairment, if applicable | DO (mg/L) | pH | Total Disolved Solids (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| INDIANCAMP | S | 9/16/04 | 40.206 | 80.454 | Indiancamp Upper | yes | no | | 7.68 | 8 | |
| LOWER BUFFALO | S | 9/16/04 | 40.206 | 80.454 | Lower BC Trib # 1 | yes | no | | 7.85 | 7.9 | |
| DUNKLE | S | 9/1/04 | 40.229 | 80.44 | Dunkle Run Trib | yes | no | | | | |
| BC EAST | P | 9/1/04 | 40.152 | 80.371 | S-Bridge BC | yes | yes | nitrate | | | |
| BRUSH | S | 9/1/04 | 40.207 | 80.36 | Brush Run Trib Maple RD | yes | yes | conductivity | | | |
| BC EAST | FC | 8/18/04 | 40.152 | 80.371 | Buffalo Creek East, S Bridge | no | yes | fecals | | | |
| BC MIDDLE | FC | 8/18/04 | 40.161 | 80.374 | Buffalo Creek, Taylorstown | no | yes | fecals | | | |
| LOWER BUFFALO | FC | 8/18/04 | 40.19 | 80.497 | Buffalo Creek, rt. 3003 Bridge | no | yes | fecals | | | |
| DUNKLE | FC | 8/18/04 | 40.201 | 80.44 | Dunkle Run, mouth | no | yes | fecals | | | |
| BUCK | FC | 8/18/04 | 40.191 | 80.449 | Buck Run, near mouth | no | yes | fecals | | | |
| BC SOUTH | FC | 8/18/04 | 40.205 | 78.485 | UNT, Newman Rd. | no | yes | fecals | | | |
| UPPER DUTCH FORK | FC | 8/18/04 | 40.123 | 80.473 | Upper D. Fork, before reservoir | no | yes | fecals | | | |
| BRUSH | FC | 8/18/04 | 40.2 | 80.445 | UNT, Hickory Nut Rd. | no | yes | fecals | | | |
| BC EAST | FC | 10/19/04 | 40.152 | 80.371 | Buffalo Creek East, S Bridge | | | | | | |
| BC EAST | FC | 10/19/04 | 40.161 | 80.374 | Buffalo Creek, Taylorstown | n/a | n/a | fecals | | | |
| BC MIDDLE | FC | 10/19/04 | 40.19 | 80.497 | Buffalo Creek, rt. 3003 Bridge | n/a | n/a | fecals | | | |
| BUFFALO | FC | 10/19/04 | 40.201 | 80.44 | Dunkle Run, mouth | n/a | n/a | fecals | | | |
| DUNKLE | FC | 10/19/04 | 40.191 | 80.449 | Buck Run, near mouth | n/a | n/a | fecals | | | |

| Subwatershed | Site Type | Date | Latitude (N) | Longitude (W) | Site Desc. | Attaining WQ standards? | Probable impairment non WQ standard? | Parameter of impairment, if applicable | DO (mg/L) | pH | Total Disolved Solids (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BUCK | FC | 10/19/04 | 40.205 | 78.485 | UNT, Newman Rd. | n/a | n/a | fecals | | | |
| BC SOUTH | FC | 10/19/04 | 40.123 | 80.473 | Upper D. Fork, before reservoir | n/a | n/a | fecals | | | |
| UPPER DUTCH FORK | FC | 10/19/04 | 40.137 | 80.374 | Upper Buffalo Creek, softball fields | n/a | n/a | fecals | | | |
| BC EAST | TPN | 5/1/04 | 40.152 | 80.371 | Buffalo East | yes | no | | | | |
| BC MIDDLE | TPN | 5/1/04 | 40.192 | 80.448 | Middle Buff Creek | yes | no | | | | |
| BRUSH | TPN | 5/1/04 | 40.196 | 80.448 | Brush Run | yes | no | | | | |
| BC SOUTH | TPN | 5/1/04 | 40.152 | 80.371 | BC South | yes | no | | | | |
| LOWER DUTCH | TPN | 5/1/04 | 40.184 | 80.486 | DF mouth | yes | no | | | | |
| BUCK | TPN | 5/1/04 | 40.191 | 80.449 | Buck Run | yes | no | | | | |
| DUNKLE | TPN | 5/1/04 | 40.201 | 80.44 | Dunkle Run | yes | no | | | | |
| UPPER DUTCH FORK | TPN | 5/1/04 | 40.123 | 80.473 | DF upper | yes | no | | | | |
| LOWER BUFFALO | TPN | 5/1/04 | 40.198 | 80.516 | WV border | yes | no | | | | |
| UPPER DUTCH FORK | TPN | 5/1/04 | 40.137 | 80.474 | Lake | yes | no | | | | |
| BC EAST | TSS2 | 5/1/04 | 40.152 | 80.371 | Buffalo East | yes | no | | | | |
| BC MIDDLE | TSS2 | 5/1/04 | 40.192 | 80.448 | Middle Buff Creek | yes | no | | | | |
| BRUSH | TSS2 | 5/1/04 | 40.196 | 80.448 | Brush Run | yes | no | | | | |
| BC SOUTH | TSS2 | 5/1/04 | 40.152 | 80.371 | BC South | yes | no | | | | |
| LOWER DUTCH | TSS2 | 5/1/04 | 40.184 | 80.486 | DF mouth | yes | no | | | | |
| BUCK | TSS2 | 5/1/04 | 40.191 | 80.449 | Buck Run | yes | no | | | | |
| DUNKLE | TSS2 | 5/1/04 | 40.201 | 80.44 | Dunkle Run | yes | no | | | | |
| UPPER DUTCH FORK | TSS2 | 5/1/04 | 40.123 | 80.473 | DF upper | yes | no | | | | |
| LOWER BUFFALO | TSS2 | 5/1/04 | 40.198 | 80.516 | WV border | yes | no | | | | |

| Subwatershed | Site Type | Date | Latitude (N) | Longitude (W) | Site Desc. | Attaining WQ standards? | Probable impairment non WQ standard? | Parameter of impairment, if applicable | DO (mg/L) | pH | Total Disolved Solids (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| UPPER DUTCH FORK | TSS2 | 5/1/04 | 40.137 | 80.474 | Lake | yes | no | | | | |
| LOWER BUFFALO | TN | 5/1/04 | 40.198 | 80.516 | WV border | yes | no | | | | |
| BC EAST | alkalinity | 6/1/04 | 40.152 | 80.371 | Buffalo Creek-S-Bridge | yes | yes | fecals | | | |
| BC EAST | alkalinity | 6/1/04 | 40.152 | 80.371 | Buffalo Creek-E Branch (mouth) | yes | no | | | | |
| BC SOUTH | alkalinity | 6/1/04 | 40.152 | 80.371 | Buffalo Creek -South Branch (mouth) | yes | no | | | | |
| BC MIDDLE | alkalinity | 6/1/04 | 40.18 | 80.416 | Buffalo Creek-Covered Brdge. | yes | no | | | | |
| BRUSH | alkalinity | 6/1/04 | 40.196 | 80.448 | Brush Run (hump bridge) | yes | yes | fecals | | | |
| BUCK | alkalinity | 6/1/04 | 40.191 | 80.449 | Buck Run (near 231) | yes | no | | | | |
| LOWER DUTCH | alkalinity | 6/1/04 | 40.184 | 80.486 | Lower D.Fork Creek (mouth) | yes | no | | | | |

# Appendix H. Water Quality Database

| Subwatershed | Site Type | Date | Latitude (N) | Longitude (W) | Site Desc. | Conductivity (uS) | Temp C | Nitrate (mg/L) | Phosphate(mg/L) | Turbidity (NTU) | Sulfate (mg/L) | Iron (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BC EAST | P | 8/1/03 | 40.152 | 80.371 | upper BC East, S Bridge | 520 | 67.3 | 0.25 | 0 | 10 | 50 | 0.5 |
| BC SOUTH | P | 8/1/03 | 40.152 | 80.371 | upper BC South, 3009 | 540 | 67.3 | 0.25 | 0 | 10 | 50 | 0.5 |
| BC MIDDLE | P | 8/1/03 | 40.161 | 80.374 | BC gazeebo | 710 | 68.4 | 0.25 | 0 | | 50 | 0.75 |
| BRUSH | S | 8/1/03 | 40.209 | 80.351 | Brush Run UNT Ag strea | 510 | 71.5 | 0.5 | 0 | | 20 | 1 |
| BUCK | P | 8/1/03 | 40.191 | 80.449 | Mouth Buck Run | 420 | 68.1 | 0 | 0 | | 20 | 0 |
| LOWER BUFFALO | P | 8/1/03 | 40.198 | 80.516 | BC at WV border | 510 | 73.5 | 0 | 0 | | | 0.5 |
| LOWER DUTCH | P | 8/1/03 | 40.184 | 80.486 | Mouth Dutch Fork | 540 | 73.3 | 0 | 0 | | | 0+ |
| FORK | P | 8/1/03 | 40.123 | 80.473 | Dutch Fork Into Lake | 580 | 70.9 | 0.25 | 0 | | | 0+ |
| UPPER DUTCH FORK | S | 8/1/03 | 40.15 | 80.476 | Dutch Fork Exit Lake | 440 | 74.2 | 0.5 | 0 | | 50 | 0.5 |
| UPPER DUTCH FORK | P | 8/1/03 | 40.184 | 80.486 | Mouth Dutch Fork | 540 | 73.3 | 0 | 0 | | | 0+ |
| BRUSH | P | Summer 2003 | 40.196 | 80.448 | Mouth Brush Run | 530 | 68.7 | 0.25 | 0 | | 20 | 0 |
| DUNKLE | P | Summer 2003 | 40.201 | 80.44 | Mouth Dunkle Run | 550 | 69.1 | 0.25 | 0 | | | 0 |
| BC EAST | P | 10/22/03 | 40.152 | 80.371 | Upper BC East, S Bridge | 544 | 51.9 | 0.25 | 0 | 0 | 60 | 0 |
| BC EAST | TSS | 10/22/03 | 40.152 | 80.371 | Upper BC East, S Bridge | | | | | | | |

| Subwatershed | Site Type | Date | Latitude (N) | Longitude (W) | Site Desc. | Conductivity (uS) | Temp C | Nitrate (mg/L) | Phosphate(mg/L) | Turbidity (NTU) | Sulfate (mg/L) | Iron (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BC SOUTH | P | 10/22/03 | 40.152 | 80.371 | upper BC South, 3009 | 460 | 52.7 | 0 | 0 | 0 | 10 | 0 |
| BC SOUTH | TSS | 10/22/03 | 40.152 | 80.371 | upper BC South, 3009 | | | | | | | |
| BC SOUTH | Cl | 10/22/03 | 40.152 | 80.371 | upper BC South, 3009 | | | | | | | |
| BC MIDDLE | S | 10/22/03 | 40.161 | 80.379 | Wolf Mouth | 423 | 52 | 0.25 | 0 | <5 | 20 | 0 |
| BC MIDDLE | TSS | 10/22/03 | 40.161 | 80.379 | Wolf Mouth | | | | | | | |
| BC MIDDLE | Cl | 10/22/03 | 40.161 | 80.379 | Wolf Mouth | | | | | | | |
| BC MIDDLE | S | 10/22/03 | 40.18 | 40.416 | BC Covered Bridge | 484 | 53.1 | 0 | 0 | <10 | 20-50 | 0 |
| BC MIDDLE | P | 10/22/03 | 40.192 | 80.448 | Middle Buffalo Creek Mouth | 500 | 52.7 | 0 | 0 | <10 | 20 | 0 |
| BC MIDDLE | TSS | 10/22/03 | 40.192 | 80.448 | Middle Buffalo Creek Mouth | | | | | | | |
| BRUSH | S | 10/22/03 | 40.207 | 80.36 | Maple Road | 560 | 51.3 | 0 | 0 | 10 | 40 | 0 |
| BRUSH | Cl | 10/22/03 | 40.207 | 80.36 | Maple Road | | | | | | | |
| BRUSH | P | 10/22/03 | 40.196 | 80.448 | Mouth Brush Run | 523 | 51.9 | 0 | 0 | <10 | 50 | 0 |
| BRUSH | TSS | 10/22/03 | 40.196 | 80.448 | Mouth Brush Run | | | | | | | |
| BUCK | P | 10/22/03 | 40.191 | 80.449 | Mouth Buck Run | 402 | 52.3 | 0 | 0 | <10 | | |
| BUCK | TSS | 10/22/03 | 40.191 | 80.449 | Mouth Buck Run | | | | | | | |
| BUCK | Cl | 10/22/03 | 40.191 | 80.449 | Mouth Buck Run | | | | | | | |
| DUNKLE | P | 10/22/03 | 40.201 | 80.44 | Mouth Dunkle Run | 552 | 51.8 | 0.25 | 0 | <10 | <50 | 0 |

| Subwatershed | Site Type | Date | Latitude (N) | Longitude (W) | Site Desc. | Conductivity (uS) | Temp C | Nitrate (mg/L) | Phosphate(mg/L) | Turbidity (NTU) | Sulfate (mg/L) | Iron (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DUNKLE | TSS | 10/22/03 | 40.201 | 80.44 | Mouth Dunkle Run | | | | | | | |
| SUGARCAMP | S | 10/22/03 | 40.208 | 80.506 | Sugarcamp at Frogtown | 424 | 52.2 | 0.25 | 0 | <10 | 50 | 0 |
| CASTLEMAN | S | 10/22/03 | 40.139 | 80.513 | Castleman Mouth | 387 | | 0 | 0 | | 20-50 | 0 |
| CASTLEMAN | TSS | 10/22/03 | 40.139 | 80.513 | Castleman Mouth | | | | | | | |
| LOWER BUFFALO | P | 10/22/03 | 40.198 | 80.516 | BC at WV border | 460 | 55 | 0 | 0 | <10 | 50 | 0 |
| LOWER DUTCH | P | 10/22/03 | 40.184 | 80.486 | Mouth Dutch Fork | 452 | 52 | 0 | 0 | <10 | 50 | 0 |
| UPPER DUTCH FORK | P | 10/22/03 | 40.123 | 80.473 | Dutch Fork Into Lake | 466 | 52.4 | 0 | <.05 | | 0 | 0 |
| UPPER DUTCH FORK | Cl | 10/22/03 | 40.123 | 80.473 | Dutch Fork Into Lake | | | | | | | |
| UPPER DUTCH FORK | S | 10/22/03 | 40.118 | 80.451 | Cunningham | 388 | 52.5 | 0 | 0 | | 20 | 0 |
| UPPER DUTCH FORK | Cl | 10/22/03 | 40.118 | 80.451 | Cunningham | | | | | | | |
| UPPER DUTCH FORK | Cl | 10/22/03 | 40.17 | 80.387 | Reed Run Mouth | | | | | | | |
| UPPER DUTCH FORK | TSS | 10/22/03 | 40.15 | 80.476 | Dutch Fork Exit Lake | | | | | | | |
| UPPER DUTCH FORK | P | 10/22/03 | 40.184 | 80.486 | Mouth Dutch Fork | 452 | 52 | 0 | 0 | <10 | 50 | 0 |
| BC EAST | P | 3/24/04 | 40.152 | 80.371 | Upper BC East, S Bridge | 580 | 40.1 | 1 | 0 | n/a | n/a | 0 |
| BC EAST | S | 3/24/04 | 40.129 | 80.323 | Mount Valey/Jolly School Rd. | 380 | n/a | 0.5 | 0 | n/a | <20 | 0 |
| BC SOUTH | P | 3/24/04 | 40.152 | 80.371 | upper BC South, 3009 | 400 | n/a | 0.5 | 0 | n/a | 50 | 0 |
| BC MIDDLE | P | 3/24/04 | 40.161 | 80.374 | BC gazeebo | 470 | 40.03 | ~1.0 | 0 | | 50 | .5-1.0 |

| Subwatershed | Site Type | Date | Latitude (N) | Longitude (W) | Site Desc. | Conductivity (uS) | Temp C | Nitrate (mg/L) | Phosphate(mg/L) | Turbidity (NTU) | Sulfate (mg/L) | Iron (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BC MIDDLE | P | 3/24/04 | 40.192 | 80.448 | Middle Buffalo Creek Mouth | 440 | 41.9 | 0.5 | 0 | n/a | n/a | 0 |
| BRUSH | P | 3/24/04 | 40.196 | 80.448 | Mouth Brush Run | 470 | n/a | 1.0-2.0 | 0 | n/a | n/a | 0 |
| BUCK | P | 3/24/04 | 40.191 | 80.449 | Mouth Buck Run | 330 | 40.6 | 0.25-0.5 | 0 | n/a | 50 | 0 |
| LOWER BUFFALO | S | 3/24/04 | 40.199 | 80.445 | Hickory Nut Road | 440 | n/a | 1.0-2.0 | 0 | n/a | 50-80 | 0.5 |
| LOWER BUFFALO | S | 3/24/04 | 40.19 | 80.476 | Narigan Run | 370 | 44.2 | 0.5 | 0 | n/a | 50-80 | 0 |
| LOWER BUFFALO | P | 3/24/04 | 40.198 | 80.516 | BC at WV border | 440 | n/a | 0.5 | 0 | n/a | n/a | 0 |
| LOWER BUFFALO | S | 3/24/04 | 40.187 | 80.501 | Dog Run | 360 | n/a | 0.25 | 0 | n/a | n/a | 0 |
| LOWER DUTCH | P | 3/24/04 | 40.184 | 80.486 | Mouth Dutch Fork | 460 | n/s | 0.5 | 0 | n/a | n/a | 0 |
| UPPER DUTCH FORK | P | 3/24/04 | 40.123 | 80.473 | Dutch Fork Into Lake | 380 | n/a | 0.25 | 0 | n/s | n/s | 0 |
| UPPER DUTCH FORK | S | 3/24/04 | 40.112 | 80.465 | Below Truck Stop | 530 | n/a | unk | 0 | n/a | | |
| UPPER DUTCH FORK | P | 3/24/04 | 40.184 | 80.486 | Mouth Dutch Fork | 460 | n/s | 0.5 | 0 | n/a | n/a | 0 |
| BC EAST | S | 9/16/04 | 40.128 | 80.336 | BC East, Upper Culvert | 440 | 61.7 | <.25 | <.05 | | ~20 | ~3 |
| BC EAST | S | 9/16/04 | 40.141 | 80.352 | S Bridge, small Trib | 730 | 62.7 | <.25 | n/a | | 20-50 | 0 |
| BC EAST | S | 9/16/04 | 40.149 | 80.362 | Buffalo East, Overpass area | 530 | 64.7 | ~.25 | | | 20-50 | <.5 |
| BC MIDDLE | P | 9/16/04 | 40.161 | 80.374 | BC Gazebo | 479 | 64.7 | <.25 | | | 20-50 | <.5 |
| BUCK | S | 9/16/04 | 40.15 | 80.429 | Buck Run Headwaters | 360 | 64.7 | 0 | n/a | | ~50 | ~.5 |
| SUGARCAMP | S | 9/16/04 | 40.217 | 80.484 | Sugarcamp upstream | 520 | 67.9 | .25-.5 | n/a | | | |

| Subwatershed | Site Type | Date | Latitude (N) | Longitude (W) | Site Desc. | Conductivity (uS) | Temp C | Nitrate (mg/L) | Phosphate(mg/L) | Turbidity (NTU) | Sulfate (mg/L) | Iron (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INDIANCAMP | S | 9/16/04 | 40.206 | 80.454 | Indiancamp Upper | 320 | 68.3 | ~.25 | | | ~60 | ~.5 |
| LOWER BUFFALO | S | 9/16/04 | 40.206 | 80.454 | Lower BC Trib # 1 | 400 | 65.6 | 0 | | | 50-80 | 0 |
| DUNKLE | S | 9/1/04 | 40.229 | 80.44 | Dunkle Run Trib | | | .5-1.0 | | | | |
| BC EAST | P | 9/1/04 | 40.152 | 80.371 | S-Bridge BC | | | 1.0-2.0 | | | | |
| BRUSH | S | 9/1/04 | 40.207 | 80.36 | Brush Run Trib Maple RD | | | 4 | | | | |
| BC EAST | FC | 8/18/04 | 40.152 | 80.371 | Buffalo Creek East, S Bridge | | | | | | | |
| BC MIDDLE | FC | 8/18/04 | 40.161 | 80.374 | Buffalo Creek, Taylorstown | | | | | | | |
| LOWER BUFFALO | FC | 8/18/04 | 40.19 | 80.497 | Buffalo Creek, rt. 3003 Bridge | | | | | | | |
| DUNKLE | FC | 8/18/04 | 40.201 | 80.44 | Dunkle Run, mouth | | | | | | | |
| BUCK | FC | 8/18/04 | 40.191 | 80.449 | Buck Run, near mouth | | | | | | | |
| BC SOUTH | FC | 8/18/04 | 40.205 | 78.485 | UNT, Newman Rd. | | | | | | | |
| UPPER DUTCH FORK | FC | 8/18/04 | 40.123 | 80.473 | Upper D. Fork, before reservoir | | | | | | | |
| BRUSH | FC | 8/18/04 | 40.2 | 80.445 | UNT, Hickory Nut Rd. | | | | | | | |
| BC EAST | FC | 10/19/04 | 40.152 | 80.371 | Buffalo Creek East, S Bridge | | | | | | | |
| BC EAST | FC | 10/19/04 | 40.161 | 80.374 | Buffalo Creek, Taylorstown | | | | | | | |
| BC MIDDLE | FC | 10/19/04 | 40.19 | 80.497 | Buffalo Creek, rt. 3003 Bridge | | | | | | | |
| BUFFALO | FC | 10/19/04 | 40.201 | 80.44 | Dunkle Run, mouth | | | | | | | |
| DUNKLE | FC | 10/19/04 | 40.191 | 80.449 | Buck Run, near mouth | | | | | | | |

| Subwatershed | Site Type | Date | Latitude (N) | Longitude (W) | Site Desc. | Conductivity (uS) | Temp C | Nitrate (mg/L) | Phosphate(mg/L) | Turbidity (NTU) | Sulfate (mg/L) | Iron (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BUCK | FC | 10/19/04 | 40.205 | 78.485 | UNT, Newman Rd. | | | | | | | |
| BC SOUTH | FC | 10/19/04 | 40.123 | 80.473 | Upper D. Fork, before reservoir | | | | | | | |
| UPPER DUTCH FORK | FC | 10/19/04 | 40.137 | 80.374 | Upper Buffalo Creek, softball fields | | | | | | | |
| BC EAST | TPN | 5/1/04 | 40.152 | 80.371 | Buffalo East | | | | | | | |
| BC MIDDLE | TPN | 5/1/04 | 40.192 | 80.448 | Middle Buff Creek | | | | | | | |
| BRUSH | TPN | 5/1/04 | 40.196 | 80.448 | Brush Run | | | | | | | |
| BC SOUTH | TPN | 5/1/04 | 40.152 | 80.371 | BC South | | | | | | | |
| LOWER DUTCH | TPN | 5/1/04 | 40.184 | 80.486 | DF mouth | | | | | | | |
| BUCK | TPN | 5/1/04 | 40.191 | 80.449 | Buck Run | | | | | | | |
| DUNKLE | TPN | 5/1/04 | 40.201 | 80.44 | Dunkle Run | | | | | | | |
| UPPER DUTCH FORK | TPN | 5/1/04 | 40.123 | 80.473 | DF upper | | | | | | | |
| LOWER BUFFALO | TPN | 5/1/04 | 40.198 | 80.516 | WV border | | | | | | | |
| UPPER DUTCH FORK | TPN | 5/1/04 | 40.137 | 80.474 | Lake | | | | | | | |
| BC EAST | TSS2 | 5/1/04 | 40.152 | 80.371 | Buffalo East | | | | | | | |
| BC MIDDLE | TSS2 | 5/1/04 | 40.192 | 80.448 | Middle Buff Creek | | | | | | | |
| BRUSH | TSS2 | 5/1/04 | 40.196 | 80.448 | Brush Run | | | | | | | |
| BC SOUTH | TSS2 | 5/1/04 | 40.152 | 80.371 | BC South | | | | | | | |
| LOWER DUTCH | TSS2 | 5/1/04 | 40.184 | 80.486 | DF mouth | | | | | | | |
| BUCK | TSS2 | 5/1/04 | 40.191 | 80.449 | Buck Run | | | | | | | |
| DUNKLE | TSS2 | 5/1/04 | 40.201 | 80.44 | Dunkle Run | | | | | | | |
| UPPER DUTCH FORK | TSS2 | 5/1/04 | 40.123 | 80.473 | DF upper | | | | | | | |
| LOWER BUFFALO | TSS2 | 5/1/04 | 40.198 | 80.516 | WV border | | | | | | | |

| Subwatershed | Site Type | Date | Latitude (N) | Longitude (W) | Site Desc. | Conductivity (uS) | Temp C | Nitrate (mg/L) | Phosphate(mg/L) | Turbidity (NTU) | Sulfate (mg/L) | Iron (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UPPER DUTCH FORK | TSS2 | 5/1/04 | 40.137 | 80.474 | Lake | | | | | | | |
| LOWER BUFFALO | TN | 5/1/04 | 40.198 | 80.516 | WV border | | | | | | | |
| BC EAST | alkalinity | 6/1/04 | 40.152 | 80.371 | Buffalo Creek-S-Bridge | | | | | | | |
| BC EAST | alkalinity | 6/1/04 | 40.152 | 80.371 | Buffalo Creek-E Branch (mouth) | | | | | | | |
| BC SOUTH | alkalinity | 6/1/04 | 40.152 | 80.371 | Buffalo Creek -South Branch (mouth) | | | | | | | |
| BC MIDDLE | alkalinity | 6/1/04 | 40.18 | 80.416 | Buffalo Creek-Covered Brdge. | | | | | | | |
| BRUSH | alkalinity | 6/1/04 | 40.196 | 80.448 | Brush Run (hump bridge) | | | | | | | |
| BUCK | alkalinity | 6/1/04 | 40.191 | 80.449 | Buck Run (near 231) | | | | | | | |
| LOWER DUTCH | alkalinity | 6/1/04 | 40.184 | 80.486 | Lower D.Fork Creek (mouth) | | | | | | | |

# Appendix H. Water Quality Database

| Subwatershed | Site Type | Date | Latitude (N) | Longitude (W) | Site Desc. | TSS (mg/L) | Cl (mg/L) | Total P (mg/L) | Total N (mg/L) | Fecal Coliform (units/100 mL) | Alkalinity (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BC EAST | P | 8/1/03 | 40.152 | 80.371 | upper BC East, S Bridge | | | | | | |
| BC SOUTH | P | 8/1/03 | 40.152 | 80.371 | upper BC South, 3009 | | | | | | |
| BC MIDDLE | P | 8/1/03 | 40.161 | 80.374 | BC gazeebo | | | | | | |
| BRUSH | S | 8/1/03 | 40.209 | 80.351 | Brush Run UNT Ag strea | | | | | | |
| BUCK | P | 8/1/03 | 40.191 | 80.449 | Mouth Buck Run | | | | | | |
| LOWER BUFFALO | P | 8/1/03 | 40.198 | 80.516 | BC at WV border | | | | | | |
| LOWER DUTCH | P | 8/1/03 | 40.184 | 80.486 | Mouth Dutch Fork | | | | | | |
| FORK | P | 8/1/03 | 40.123 | 80.473 | Dutch Fork Into Lake | | | | | | |
| UPPER DUTCH FORK | S | 8/1/03 | 40.15 | 80.476 | Dutch Fork Exit Lake | | | | | | |
| UPPER DUTCH FORK | P | 8/1/03 | 40.184 | 80.486 | Mouth Dutch Fork | | | | | | |
| BRUSH | P | Summer 2003 | 40.196 | 80.448 | Mouth Brush Run | | | | | | |
| DUNKLE | P | Summer 2003 | 40.201 | 80.44 | Mouth Dunkle Run | | | | | | |
| BC EAST | P | 10/22/03 | 40.152 | 80.371 | Upper BC East, S Bridge | | | | | | |
| BC EAST | TSS | 10/22/03 | 40.152 | 80.371 | Upper BC East, S Bridge | <3 | | | | | |

| Subwatershed | Site Type | Date | Latitude (N) | Longitude (W) | Site Desc. | TSS (mg/L) | Cl (mg/L) | Total P (mg/L) | Total N (mg/L) | Fecal Coliform (units/100 mL) | Alkalinity (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BC SOUTH | P | 10/22/03 | 40.152 | 80.371 | upper BC South, 3009 | | | | | | |
| BC SOUTH | TSS | 10/22/03 | 40.152 | 80.371 | upper BC South, 3009 | <3 | | | | | |
| BC SOUTH | Cl | 10/22/03 | 40.152 | 80.371 | upper BC South, 3009 | | 26.2 | | | | |
| BC MIDDLE | S | 10/22/03 | 40.161 | 80.379 | Wolf Mouth | | | | | | |
| BC MIDDLE | TSS | 10/22/03 | 40.161 | 80.379 | Wolf Mouth | <3 | | | | | |
| BC MIDDLE | Cl | 10/22/03 | 40.161 | 80.379 | Wolf Mouth | | 35.3 | | | | |
| BC MIDDLE | S | 10/22/03 | 40.18 | 40.416 | BC Covered Bridge | | | | | | |
| BC MIDDLE | P | 10/22/03 | 40.192 | 80.448 | Middle Buffalo Creek Mouth | | | | | | |
| BC MIDDLE | TSS | 10/22/03 | 40.192 | 80.448 | Middle Buffalo Creek Mouth | <3 | | | | | |
| BRUSH | S | 10/22/03 | 40.207 | 80.36 | Maple Road | | | | | | |
| BRUSH | Cl | 10/22/03 | 40.207 | 80.36 | Maple Road | | 28.8 | | | | |
| BRUSH | P | 10/22/03 | 40.196 | 80.448 | Mouth Brush Run | | | | | | |
| BRUSH | TSS | 10/22/03 | 40.196 | 80.448 | Mouth Brush Run | <3 | | | | | |
| BUCK | P | 10/22/03 | 40.191 | 80.449 | Mouth Buck Run | | | | | | |
| BUCK | TSS | 10/22/03 | 40.191 | 80.449 | Mouth Buck Run | <3 | | | | | |
| BUCK | Cl | 10/22/03 | 40.191 | 80.449 | Mouth Buck Run | | 6.7 | | | | |
| DUNKLE | P | 10/22/03 | 40.201 | 80.44 | Mouth Dunkle Run | | | | | | |

| Subwatershed | Site Type | Date | Latitude (N) | Longitude (W) | Site Desc. | TSS (mg/L) | Cl (mg/L) | Total P (mg/L) | Total N (mg/L) | Fecal Coliform (units/100 mL) | Alkalinity (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DUNKLE | TSS | 10/22/03 | 40.201 | 80.44 | Mouth Dunkle Run | <3 | | | | | |
| SUGARCAMP | S | 10/22/03 | 40.208 | 80.506 | Sugarcamp at Frogtown | | | | | | |
| CASTLEMAN | S | 10/22/03 | 40.139 | 80.513 | Castleman Mouth | | | | | | |
| CASTLEMAN | TSS | 10/22/03 | 40.139 | 80.513 | Castleman Mouth | <3 | | | | | |
| LOWER BUFFALO | P | 10/22/03 | 40.198 | 80.516 | BC at WV border | | | | | | |
| LOWER DUTCH | P | 10/22/03 | 40.184 | 80.486 | Mouth Dutch Fork | | | | | | |
| UPPER DUTCH FORK | P | 10/22/03 | 40.123 | 80.473 | Dutch Fork Into Lake | | | | | | |
| UPPER DUTCH FORK | Cl | 10/22/03 | 40.123 | 80.473 | Dutch Fork Into Lake | | 66.5 | | | | |
| UPPER DUTCH FORK | S | 10/22/03 | 40.118 | 80.451 | Cunningham | | | | | | |
| UPPER DUTCH FORK | Cl | 10/22/03 | 40.118 | 80.451 | Cunningham | | 3.8 | | | | |
| UPPER DUTCH FORK | Cl | 10/22/03 | 40.17 | 80.387 | Reed Run Mouth | | 28.4 | | | | |
| UPPER DUTCH FORK | TSS | 10/22/03 | 40.15 | 80.476 | Dutch Fork Exit Lake | 4 | | | | | |
| UPPER DUTCH FORK | P | 10/22/03 | 40.184 | 80.486 | Mouth Dutch Fork | | | | | | |
| BC EAST | P | 3/24/04 | 40.152 | 80.371 | Upper BC East, S Bridge | | | | | | |
| BC EAST | S | 3/24/04 | 40.129 | 80.323 | Mount Valey/Jolly School Rd. | | | | | | |
| BC SOUTH | P | 3/24/04 | 40.152 | 80.371 | upper BC South, 3009 | | | | | | |
| BC MIDDLE | P | 3/24/04 | 40.161 | 80.374 | BC gazeebo | | | | | | |

| Subwatershed | Site Type | Date | Latitude (N) | Longitude (W) | Site Desc. | TSS (mg/L) | Cl (mg/L) | Total P (mg/L) | Total N (mg/L) | Fecal Coliform (units/100 mL) | Alkalinity (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BC MIDDLE | P | 3/24/04 | 40.192 | 80.448 | Middle Buffalo Creek Mouth | | | | | | |
| BRUSH | P | 3/24/04 | 40.196 | 80.448 | Mouth Brush Run | | | | | | |
| BUCK | P | 3/24/04 | 40.191 | 80.449 | Mouth Buck Run | | | | | | |
| LOWER BUFFALO | S | 3/24/04 | 40.199 | 80.445 | Hickory Nut Road | | | | | | |
| LOWER BUFFALO | S | 3/24/04 | 40.19 | 80.476 | Narigan Run | | | | | | |
| LOWER BUFFALO | P | 3/24/04 | 40.198 | 80.516 | BC at WV border | | | | | | |
| LOWER BUFFALO | S | 3/24/04 | 40.187 | 80.501 | Dog Run | | | | | | |
| LOWER DUTCH | P | 3/24/04 | 40.184 | 80.486 | Mouth Dutch Fork | | | | | | |
| UPPER DUTCH FORK | P | 3/24/04 | 40.123 | 80.473 | Dutch Fork Into Lake | | | | | | |
| UPPER DUTCH FORK | S | 3/24/04 | 40.112 | 80.465 | Below Truck Stop | | | | | | |
| UPPER DUTCH FORK | P | 3/24/04 | 40.184 | 80.486 | Mouth Dutch Fork | | | | | | |
| BC EAST | S | 9/16/04 | 40.128 | 80.336 | BC East, Upper Culvert | | | | | | |
| BC EAST | S | 9/16/04 | 40.141 | 80.352 | S Bridge, small Trib | | | | | | |
| BC EAST | S | 9/16/04 | 40.149 | 80.362 | Buffalo East, Overpass area | | | | | | |
| BC MIDDLE | P | 9/16/04 | 40.161 | 80.374 | BC Gazebo | | | | | | |
| BUCK | S | 9/16/04 | 40.15 | 80.429 | Buck Run Headwaters | | | | | | |
| SUGARCAMP | S | 9/16/04 | 40.217 | 80.484 | Sugarcamp upstream | | | | | | |

| Subwatershed | Site Type | Date | Latitude (N) | Longitude (W) | Site Desc. | TSS (mg/L) | Cl (mg/L) | Total P (mg/L) | Total N (mg/L) | Fecal Coliform (units/100 mL) | Alkalinity (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| INDIANCAMP | S | 9/16/04 | 40.206 | 80.454 | Indiancamp Upper | | | | | | |
| LOWER BUFFALO | S | 9/16/04 | 40.206 | 80.454 | Lower BC Trib # 1 | | | | | | |
| DUNKLE | S | 9/1/04 | 40.229 | 80.44 | Dunkle Run Trib | | | | | | |
| BC EAST | P | 9/1/04 | 40.152 | 80.371 | S-Bridge BC | | | | | | |
| BRUSH | S | 9/1/04 | 40.207 | 80.36 | Brush Run Trib Maple RD | | | | | | |
| BC EAST | FC | 8/18/04 | 40.152 | 80.371 | Buffalo Creek East, S Bridge | | | | | >200 | |
| BC MIDDLE | FC | 8/18/04 | 40.161 | 80.374 | Buffalo Creek, Taylorstown | | | | | >200 | |
| LOWER BUFFALO | FC | 8/18/04 | 40.19 | 80.497 | Buffalo Creek, rt. 3003 Bridge | | | | | >200 | |
| DUNKLE | FC | 8/18/04 | 40.201 | 80.44 | Dunkle Run, mouth | | | | | 0 | |
| BUCK | FC | 8/18/04 | 40.191 | 80.449 | Buck Run, near mouth | | | | | >200 | |
| BC SOUTH | FC | 8/18/04 | 40.205 | 78.485 | UNT, Newman Rd. | | | | | >200 | |
| UPPER DUTCH FORK | FC | 8/18/04 | 40.123 | 80.473 | Upper D. Fork, before reservoir | | | | | >200 | |
| BRUSH | FC | 8/18/04 | 40.2 | 80.445 | UNT, Hickory Nut Rd. | | | | | >200 | |
| BC EAST | FC | 10/19/04 | 40.152 | 80.371 | Buffalo Creek East, S Bridge | | | | | 2540 | |
| BC EAST | FC | 10/19/04 | 40.161 | 80.374 | Buffalo Creek, Taylorstown | | | | | 3600 | |
| BC MIDDLE | FC | 10/19/04 | 40.19 | 80.497 | Buffalo Creek, rt. 3003 Bridge | | | | | 3100 | |
| LOWER BUFFALO | FC | 10/19/04 | 40.201 | 80.44 | Dunkle Run, mouth | | | | | 3760 | |
| DUNKLE | FC | 10/19/04 | 40.191 | 80.449 | Buck Run, near mouth | | | | | 1430 | |

| Subwatershed | Site Type | Date | Latitude (N) | Longitude (W) | Site Desc. | TSS (mg/L) | Cl (mg/L) | Total P (mg/L) | Total N (mg/L) | Fecal Coliform (units/100 mL) | Alkalinity (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BUCK | FC | 10/19/04 | 40.205 | 78.485 | UNT, Newman Rd. | | | | | 2460 | |
| BC SOUTH | FC | 10/19/04 | 40.123 | 80.473 | Upper D. Fork, before reservoir | | | | | 2340 | |
| UPPER DUTCH FORK | FC | 10/19/04 | 40.137 | 80.374 | Upper Buffalo Creek, softball fields | | | | | 1560 | |
| BC EAST | TPN | 5/1/04 | 40.152 | 80.371 | Buffalo East | | | 0.08 | | | |
| BC MIDDLE | TPN | 5/1/04 | 40.192 | 80.448 | Middle Buff Creek | | | 0.09 | | | |
| BRUSH | TPN | 5/1/04 | 40.196 | 80.448 | Brush Run | | | 0.24 | | | |
| BC SOUTH | TPN | 5/1/04 | 40.152 | 80.371 | BC South | | | 0.11 | | | |
| LOWER DUTCH | TPN | 5/1/04 | 40.184 | 80.486 | DF mouth | | | 0.05 | | | |
| BUCK | TPN | 5/1/04 | 40.191 | 80.449 | Buck Run | | | 0.18 | | | |
| DUNKLE | TPN | 5/1/04 | 40.201 | 80.44 | Dunkle Run | | | 0.1 | | | |
| UPPER DUTCH FORK | TPN | 5/1/04 | 40.123 | 80.473 | DF upper | | | 0.13 | | | |
| LOWER BUFFALO | TPN | 5/1/04 | 40.198 | 80.516 | WV border | | | 0.05 | | | |
| UPPER DUTCH FORK | TPN | 5/1/04 | 40.137 | 80.474 | Lake | | | 0.02 | | | |
| BC EAST | TSS2 | 5/1/04 | 40.152 | 80.371 | Buffalo East | 55.7 | | | | | |
| BC MIDDLE | TSS2 | 5/1/04 | 40.192 | 80.448 | Middle Buff Creek | 94.3 | | | | | |
| BRUSH | TSS2 | 5/1/04 | 40.196 | 80.448 | Brush Run | 65.7 | | | | | |
| BC SOUTH | TSS2 | 5/1/04 | 40.152 | 80.371 | BC South | 67.1 | | | | | |
| LOWER DUTCH | TSS2 | 5/1/04 | 40.184 | 80.486 | DF mouth | 28.6 | | | | | |
| BUCK | TSS2 | 5/1/04 | 40.191 | 80.449 | Buck Run | 24.3 | | | | | |
| DUNKLE | TSS2 | 5/1/04 | 40.201 | 80.44 | Dunkle Run | 48.6 | | | | | |
| UPPER DUTCH FORK | TSS2 | 5/1/04 | 40.123 | 80.473 | DF upper | 38.6 | | | | | |
| LOWER BUFFALO | TSS2 | 5/1/04 | 40.198 | 80.516 | WV border | 94.3 | | | | | |

| Subwatershed | Site Type | Date | Latitude (N) | Longitude (W) | Site Desc. | TSS (mg/L) | Cl (mg/L) | Total P (mg/L) | Total N (mg/L) | Fecal Coliform (units/100 mL) | Alkalinity (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| UPPER DUTCH FORK | TSS2 | 5/1/04 | 40.137 | 80.474 | Lake | 12.9 | | | | | |
| LOWER BUFFALO | TN | 5/1/04 | 40.198 | 80.516 | WV border | | | | 0.84 | | |
| BC EAST | alkalinity | 6/1/04 | 40.152 | 80.371 | Buffalo Creek-S-Bridge | | | | | | 240 |
| BC EAST | alkalinity | 6/1/04 | 40.152 | 80.371 | Buffalo Creek-E Branch (mouth) | | | | | | 220 |
| BC SOUTH | alkalinity | 6/1/04 | 40.152 | 80.371 | Buffalo Creek -South Branch (mouth) | | | | | | 220 |
| BC MIDDLE | alkalinity | 6/1/04 | 40.18 | 80.416 | Buffalo Creek-Covered Brdge. | | | | | | 220 |
| BRUSH | alkalinity | 6/1/04 | 40.196 | 80.448 | Brush Run (hump bridge) | | | | | | 240 |
| BUCK | alkalinity | 6/1/04 | 40.191 | 80.449 | Buck Run (near 231) | | | | | | 200 |
| LOWER DUTCH | alkalinity | 6/1/04 | 40.184 | 80.486 | Lower D.Fork Creek (mouth) | | | | | | 200 |

# Appendix I. WPC Macroinvertebrate Field Protocol

**Field Sampling Procedure Section**

## 1.0 Scope and Applicability

The purpose of the SOP is to describe the procedure by which macroinvertebrate organisms are collected in the most applicable way in order to integrate the data to existing statewide data sets. The goals of the macroinvertebrate field sampling are to: 1) determine a list of taxa identified to the genus level, and 2) determine relative abundance of each taxa per site.

## 2.0 Summary of Method

This SOP describes the methodology by which macroinvertebrates are collected in the field based on several existing methods. It also describes the method by which samples are preserved in the field and potential cautions about field sampling precision.

## 3.0 Definitions

| | |
|---|---|
| Reach: | The reach is the length of the sample area, 100 meters, based on RPB methods (Barbour et al.1999). EMAP data is based on 40x the stream width for the habitat assessment. |
| RPB: | Rapid Bioassessment Protocol (Barbour et al. 1999) |
| Sample: | The sample includes the collected macroinvertebrates and the substrate removed during collection. |

## 4.0 Health and Safety Warnings

Biologists for each organization should follow the regulations set forth by their respective organization.

## 5.0 Cautions

The sampling should be standardized according to the procedure described below. Best professional judgment should be used in a situation in which modifications to this protocol need to be made. All equipment should be properly maintained and cleaned after each sampling site.

Consider the gradient and substrate of the stream reach before proceeding with kick-net sampling. In some cases of low gradient, marsh-like systems, jabs may be more sufficient for certain habitats. If the methods are modified, please note this on the field sheet for the site.

## 6.0 Personnel Qualifications

Each field crew should be trained in these methods by a biologist in either organization. In most cases, the presence of the trained biologist will aid in quality of field collection.

## 7.0 Apparatus and Materials

- D-frame aquatic net, 500 µm mesh, 0.5 meter width
- Sieve bucket, 500 µm mesh
- 95 percent ethanol
- Sample containers
- Forceps
- Field Sheets/IPAQ/Field notebook
- Labels for samples
- Sharpie pens/pencils
- Neoprene gloves
- First Aid Kit

## 8.0 Instrument or Method Calibration

Not applicable.

## 9.0 Sample Collection

Samples should be taken and stored in whirl-pak sterilized bags or plastic containers with lids. This SOP slightly modifies the RBP multi-habitat approach (Barbour et al. 1999).

1. The sample reach (considered the sampling site) should extend 100 meters in a stream habitat in which there are no major tributaries entering the sampling area. The sample reach should be located a significant distance from road crossings or bridges. When bridges are in the immediate area, the sample reach should extend upstream of the bridge or road crossing. The reach length (100 meters) should be recorded on the sampling sheet.
2. The reach should be evaluated before conducting the collection in order to assess habitat and substrate of the reach.
3. The relative proportion of each type of habitat should be assessed. This will dictate the number of kick samples to be taken in each habitat throughout the entire reach, with a total number of kicks equal to 20.
4. Collection using the d-frame net is conducted downstream to upstream in all habitats, however, sampling of the riffle habitats should be conducted first, then individually cleaned and stored before other habitats have been sampled. All other habitats may be pooled into the sieve bucket during collection.
5. Place the d-frame net securely on the streambed and perpendicular to the downstream flow.
6. Kick vigorously 0.5-meters upstream of the d-frame net until the substrate is adequately disturbed (usually around 5 vigorous kicks).
7. Any large debris in the d-frame net should be removed and searched for clinging organisms. If present, these organisms should be removed from the debris and placed in the net. Remove any large rocks, branches, or other debris from the net before transferring it to the sieve bucket.
8. Rinse any remaining debris from the d-frame net into the sieve bucket. Rinse several times to ensure removal of all organisms. Inspect the d-frame net for any remaining organisms and rinse well with stream water.

9. Continue sampling throughout the habitats until 20 kick samples have been taken from the entire reach.
10. Once the debris has been collected in the sieve bucket, the debris should be transferred to whirl-paks or sampling bottles for storage until the samples can be picked.

**10.0 Labeling of Samples**

Each sample should be labeled with the sampling site code, date, and number of the sample taken from the site (i.e. 1 of 5).

**11.0 Sample Handling and Preservation**

The samples in the field should be preserved with 95% ethanol. The samples should be transferred to the laboratory facilities for each organization to wait to be processed.

**12.0 Data Management and Records Management**

All samples should be tracked from collection to processing by their site code. The biologist will track the samples collected from each organization internally.

**<QUALITY CONTROL PROTOCOLS?>**

**References**

Standard Operating Procedure (SOP) for Macroinvertebrate Single Habitat Sampling using a 0.5 Meter Dip Net. USEPA Wheeling, WV. July 2001.

Barbour, M.T., Gerritsen, J., Snyder, B.D., and J.B. Stribling. 1999. Rapid bioassessment protocols for use in wadeable streams and rivers: periphyton, benthic macroinvertebrates, and fish. Second edition. EPA 841-B-99-002

# Appendix J. Pennsylvania DEP Wadeable Streams Field Form

## Unassessed Waters Field Form: Wadeable Streams

**Date (YYMMDD), Start Time (military), and your three Initials uniquely identify the station.**

| Date-Time-Initials Example 970212-0312-XYZ | Date - Time - Initials | State Water Plan | Stream Code |
|---|---|---|---|
| Secondary Station ID | | Surveyed by: | |
| Survey Type: (9)Unassessed Screening. Use the generic field form for all other survey types. | | | 9 |

**Location Description:**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Residential: | % | Commercial: | % | Industrial: | % | Cropland: | % | Pasture: | % |
| Abd. Mining: | % | Old Fields: | % | Forest: | % | Other: | % | | |

**Land Use Comments:**

1. Abundance obviously low
2. Seven or fewer Families in the collection
3. Three or fewer mayfly individuals; excluding Baetidae, Caenidae, and Siphlonuridae
4. Stoneflies collectively present
5. Mayflies and caddisflies are collectively abundant; excluding Baetidae, Caenidae, Siphlonuridae, Hydropsychidae, and Polycentropodidae
6. *July thru September:* at least four EPT Families with a Hilsenhoff of 4 or less *November thru May* : at least six
7. Four or more Families with a Hilsenhoff of 3 or less
8. Six or more Families with a Hilsenhoff of 4 or less
9. Dominant Family with a Hilsenhoff of 4 or less
10. Dominant Family with a Hilsenhoff greater than 5 (Criteria 7 and 8 negate this criterion)
11. Seven or more Families with a Hilsenhoff of 6 or more (Criteria 7 and 8 negate this criterion)
12. Sample dominated by Families with a mean Hilsenhoff of 5 or less
13. Sample dominated by Families with a mean Hilsenhoff of 6 or more
14. [#3 Riff/Run: embeddedness *or* #3 Glide/Pool: substrate character] + #6 Sediment Deposition twenty-four or less *(twenty or less for warm water, low gradient streams)*
15. #9 Condition of Banks + #10 Bank Vegetation twenty-four or less *(twenty or less for warm water, low gradient streams)*
16. Total habitat score 140 or less for forested, cold water, high gradient streams *(120 or less for warm water, low gradient streams)*
17. Special conditions. Left box OK right box impaired. Describe in comments.

| Not Impaired: | | Impaired Biology: | | Impaired Habitat: | | Rock Picks Influenced Assessment? | | Impact is Localized | | Reevaluate Designated Use? | |
|---|---|---|---|---|---|---|---|---|---|---|---|

**Describe Impairment and/or Locate Reaches for Use Designation Reevaluation:**

# Appendix K. Macroinvertebrate Tolerances for Pennsylvania Streams

| TAXA | Hils | Rel. Abundance | | |
|---|---|---|---|---|
| SCREEN# | | 1 | 2 | 3 |
| MISCELLANEOUS | | | | |
| 1. Annelida | 9 | | | |
| 2. Bryozoa | 4 | | | |
| 3. Hirudinea | 8 | | | |
| 4. Hydracarina | 7 | | | |
| 5. Oligochaeta | 10 | | | |
| 6. Tubificidae | 10 | | | |
| 7. Turbellaria | 9 | | | |
| 8. Other Worms | 9 | | | |
| Gastropoda - Snails | | | | |
| 9. Ancylidae | 7 | | | |
| 10. Hydrobiidae | 8 | | | |
| 11. Lymnaeidae | 7 | | | |
| 12. Physidae | 8 | | | |
| 13. Planorbidae | 6 | | | |
| 14. Pleuroceridae | 7 | | | |
| 15. Valvatidae | 2 | | | |
| 16. Viviparidae | 8 | | | |
| Bivalvia - Clams | | | | |
| 17. Corbiculidae | 4 | | | |
| 18. Sphaeriidae | 8 | | | |
| 19. Unionidae | 4 | | | |
| Isopoda - Sow Bugs | | | | |
| 20. Asellidae | 8 | | | |
| Amphipoda - Scuds | | | | |
| 21. Amphipoda | 6 | | | |
| 22. Crangonyctidae | 4 | | | |
| 23. Gammaridae | 4 | | | |
| 24. Talitridae | 8 | | | |
| Decopoda - Crayfish | | | | |
| 25. Cambaridae | 6 | | | |
| INSECTA | | | | |
| MAYFLIES - Ephemeroptera | | | | |
| 26. Ameletidae | 0 | | | |
| 27. Baetidae | 6 | | | |
| 28. Baetiscidae | 3 | | | |
| 29. Caenidae | 7 | | | |
| 30. Ephemerellidae | 2 | | | |
| 31. Ephemeridae | 4 | | | |

| | | | | |
|---|---|---|---|---|
| 32. Heptageniidae | 3 | | | |
| 33. Isonychiidae | 3 | | | |
| 34. Leptophlebiidae | 4 | | | |
| 35. Neoephemeridae | 3 | | | |
| 36. Polymitarcyidae | 2 | | | |
| 37. Potamanthidae | 4 | | | |
| 38. Siphlonuridae | 7 | | | |
| 39. Tricorythidae | 4 | | | |
| DRAGONFLIES - Odonata | | | | |
| 40. Aeshnidae | 3 | | | |
| 41. Cordulegastridae | 3 | | | |
| 42. Corduliidae | 5 | | | |
| 43. Macromiinae | 3 | | | |
| 44. Gomphidae | 4 | | | |
| 45. Libellulidae | 9 | | | |
| DAMSELFLIES - Odonata | | | | |
| 46. Calopterygidae | 5 | | | |
| 47. Coenagrionidae | 8 | | | |
| 48. Lestidae | 9 | | | |
| STONEFLIES - Plecoptera | | | | |
| 49. Capniidae | 3 | | | |
| 50. Chloroperlidae | 0 | | | |
| 51. Leuctridae | 0 | | | |
| 52. Nemouridae | 2 | | | |
| 53. Peltoperlidae | 2 | | | |
| 54. Perlidae | 3 | | | |
| 55. Perlodidae | 2 | | | |
| 56. Pteronarcyidae | 0 | | | |
| 57. Taeniopterygidae | 2 | | | |
| BEETLES - Coleoptera | | | | |
| 58. Dryopidae | 5 | | | |
| 59. Dytiscidae | 5 | | | |
| 60. Elmidae | 5 | | | |
| 61. Gyrinidae | 4 | | | |
| 62. Hydrophilidae | 5 | | | |
| 63. Psephenidae | 4 | | | |
| 64. Ptilodactylidae | 5 | | | |
| DOBSONFLIES & ALDERFLIES - Megaloptera | | | | |
| 65. Corydalidae | 3 | | | |
| 66. Corydalus | 4 | | | |
| 67. Nigronia | 2 | | | |

| | | | | |
|---|---|---|---|---|
| 68. Sialidae | 6 | | | |
| SPONGILLAFLIES - Neuroptera | | | | |
| 69. Sisyridae | 1 | | | |
| CADDISFLIES - Trichoptera | | | | |
| 70. Brachycentridae | 1 | | | |
| 71. Glossosomatidae | 0 | | | |
| 72. Helicopsychidae | 3 | | | |
| 73. Hydropsychidae | 5 | | | |
| 74. Hydroptilidae | 4 | | | |
| 75. Lepidostomatidae | 1 | | | |
| 76. Leptoceridae | 4 | | | |
| 77. Limnephilidae | 4 | | | |
| 78. Molannidae | 6 | | | |
| 79. Odontoceridae | 0 | | | |
| 80. Philopotamidae | 3 | | | |
| 81. Phryganeidae | 4 | | | |
| 82. Polycentropodidae | 6 | | | |
| 83. Psychomyiidae | 2 | | | |
| 84. Rhyacophilidae | 1 | | | |
| 85. Uenoidae | 3 | | | |
| 86. Moths - Lepidoptera | 5 | | | |
| TRUE FLIES - Diptera | | | | |
| 87. Athericidae | 2 | | | |
| 88. Blephariceridae | 0 | | | |
| 89. Ceratopogonidae | 6 | | | |
| 90. Chironomidae (red) | 10 | | | |
| 91. Chironomidae(other) | 6 | | | |
| 92. Dixidae | 1 | | | |
| 93. Dolichopodidae | 4 | | | |
| 94. Empididae | 6 | | | |
| 95. Psychodidae | 10 | | | |
| 96. Simuliidae | 6 | | | |
| 97. Tabanidae | 6 | | | |
| 98. Tipulidae | 4 | | | |
| 99. Other Diptera | 6+ | | | |
| Total "Other" Taxa | | | | |
| SAMPLE Total # Taxa | | | | |
| Code of Dominant Taxa | | | | |

**Relative Abundance: (R)are < 3 (P)resent 3-9 (C)ommon 10-24 (A)bundant 25-100 (VA)Very Abundant > 100**

**Comments:**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| C/E Sample Numbers: | Macroinvertebrates: | | | Water: | | | |
| Field Chem: | pH: | Temp: | °C | Conductivity: | Uohms | D.O. | mg/l |

# Appendix L. Basic Macroinvertebrate Protocol for Watershed Groups

## MACROINVERTEBRATE SURVEY

Page 64

Type of Sampling (check one)

Rocky bottom _______ Muddy bottom _______

Page 68

Muddy Bottom Sampling Only: Record the number of jabs taken in each habitat type.

| | |
|---|---|
| Vegetated bank margin | ____ |
| Snags and logs | ____ |
| Aquatic vegetation beds | ____ |
| Silt/sand/gravel substrate | ____ |

## MACROINVERTEBRATE COUNT

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1. Identify the macroinvertebrates in your sample and assign them letter codes based on their abundance: R (rare) = 1-9 organisms; C (common) = 10-99 organisms; and D (dominant) = 100 plus organisms.

| Group I Sensitive | Group II Somewhat-Sensitive | Group III Tolerant |
|---|---|---|
| ____ Water penny larvae | ____ Beetle larvae | ____ Aquatic worms |
| ____ Hellgrammites | ____ Clams | ____ Blackfly larvae |
| ____ Mayfly nymphs | ____ Crane fly larvae | ____ Leeches |
| ____ Gilled snails | ____ Crayfish | ____ Midge larvae |
| ____ Riffle beetle adult | ____ Damselfly nymphs | ____ Snails |
| ____ Stonefly nymphs | ____ Scuds | |
| ____ Non net-spinning caddisfly larvae | ____ Sowbugs | |
| | ____ Fishfly larvae | |
| | ____ Alderfly larvae | |
| | ____ Net-spinning caddisfly larvae | |

## WATER QUALITY RATING

Page 70

2. To calculate the index value, add the number of letters found in the three Groups above and multiply by the indicated weighting factor.

| Group I | Group II | Group III |
|---|---|---|
| ____ (*# of R's*) x 5.0 | ____ (*# of R's*) x 3.2 | ____ (*# of R's*) x 1.2 |
| = ______ | = ______ | = ______ |
| ____ (*# of C's*) x 5.6 | ____ (*# of C's*) x 3.4 | ____ (*# of C's*) x 1.1 |
| = ______ | = ______ | = ______ |
| ____ (*# of D's*) x 5.3 | ____ (*# of D's*) x 3.0 | ____ (*# of D's*) x 1.0 |
| = ______ | = ______ | = ______ |
| **Sum of the Index value for Group I =** ______ | **Sum of the Index value for Group II =** ______ | **Sum of the Index value for Group III =** ______ |

To calculate the water quality score for the stream site, add together the index values for each group. The sum of these values equals the water quality score.

Water quality score = ______

Compare this score to the following number ranges to determine the quality of your stream site.

- ❑ Good >40
- ❑ Fair 20 - 40
- ❑ Poor <20

**NOTE:** The tolerance groupings (Group I, II, and III) and the water quality rating categories were developed for streams in the Mid-Atlantic states. A trained biologist familiar with local stream fauna should help determine if these tolerance and water quality rating categories should be modified for your geographic region and program.

# Appendix M. Visual Assessment Protocol

## Buffalo Creek Visual Assessment

Sampler(s) name______________________________________________________ Date___________

Stream name_________________________ Reach location: Latitude__________ Longitude__________

Reach location description ______________________________________________________________

Land use (%): row crop______ grazing/pasture ______ forest ______ residential______ hayland_______

industrial______ Conservation Reserve______ other:___________________

Weather conditions-today_______________________ Past 2-5 days____________________________

Active channel width______ Dominant substrate: boulder____ cobble____ gravel____ sand____

silt____ mud____

Photos taken? Y/N if yes, please describe: ___________________________________________________

Topographic Map of Reach Location

***Scoring Descriptions***

Each assessment element is rated with a value of 1 to 10. Rate only those elements appropriate to the stream reach. Record the score that best fits the observations you make based on the narrative description provided.

Channel Condition

| | | | |
|---|---|---|---|
| Natural channel; no structures, dikes. No evidence of down-Cutting or excessive lateral cutting. | Evidence of past channel alteration, but with significant recovery of channel and banks. Any dikes or levies are set back to provide access to an adequate flood plain. | Altered channel; <50% of the reach with riprap and/or channelization. Excess ***aggradation***; braided channel. Dikes or levees restrict flood plain width. | Channel is actively downcutting or widening. >50% of the reach with riprap or channelization. Dikes or levees prevent access to the flood plain. |
| 10 9 8 | 7 6 5 4 | 3 2 | 1 |

***aggradation****: The process by which a stream's gradient steepens due to increased deposition of sediment.*

Riparian Zone

| | | | | |
|---|---|---|---|---|
| Natural Vegetation extends at least two active channel widths on each side. | Natural vegetation extends one active channel width on each side.<br>Or<br>If less than one width, covers entire flood plain. | Natural vegetation extends half of the active channel width on each side. | Natural vegetation extends a third of the active channel width on each side.<br>Or<br>Filtering function moderately compromised. | Natural vegetation less than a third of the active channel width on each side.<br>Or<br>Lack of regeneration.<br>Or<br>Filtering function severely compromised. |
| 10 9 | 8 7 6 | 5 4 | 3 2 | 1 |

Bank Stability

| | | | |
|---|---|---|---|
| Banks are stable; 33% or more of eroding surface area of banks in outside bends is protected by roots that extend to the base-flow elevation. | Moderately stable; less than 33% of eroding surface area of banks in outside bends is protected by roots that extend to the base-flow elevation. | Moderately unstable; banks may be low, but typically are high; outside bends are actively eroding (overhanging vegetation at top of bank, some mature trees falling into stream annually, some slope failures apparent). | Unstable; banks may be low, but typically are high; some straight reaches and inside edges of bends are actively eroding as well as outside bends (overhanging vegetation at top of bare bank, numerous mature trees falling into stream annually, numerous slope failures apparent). |
| 10 9 8 | 7 6 5 4 | 3 2 | 1 |

Note: when looking at bank stability, look at the slope of the bank. A steep or vertical slope indicates an unstable bank. Vegetation is also an important factor when looking at stability. A steep bank that has a good amount of vegetation or dense root cover would be more stable than a steep bank with little or no vegetation or root cover. A gradual sloping bank with a good amount of vegetation would indicate good bank stability.

## Water Appearance

| | | | |
|---|---|---|---|
| Very clear, or clear but tea-colored; objects visible at depth 3 to 6 ft (less if slightly colored); no oil sheen on surface; no noticeable film on submerged objects or rocks. | Occasionally cloudy; objects visible at depth 1.5 to 3 ft; may have slightly green color; no oil sheen on water surface. | Considerable cloudiness most of time; objects visible to depth 0.5 to 1.5 ft; slow sections may appear pea-green; bottom rocks or submerged objects covered with heavy green or olive-green film.<br>Or<br>Moderate odor of ammonia or rotten eggs. | Very turbid or muddy appearance most of the time; objects visible to depth <0.5 ft; slow moving water may be bright-green; other obvious water pollutants; floating algal mats, surface scum, sheen or heavy coat of foam on surface.<br>Or<br>Strong odor of chemicals, oil, sewage, other pollutants. |
| 10 9 8 | 7 6 5 4 | 3 2 | 1 |

## Nutrient Enrichment

| | | | |
|---|---|---|---|
| Clear water along entire reach; little algal growth present. | Fairly clear or slightly greenish water along entire reach; moderate algal growth on stream substrates. | Greenish water along entire reach; overabundance of lush green macrophytes; abundant algal growth, especially during warmer months. | Pea green, gray or brown water along entire reach; dense stands of macrophytes clog stream; severe algal blooms create thick algal mats in stream. |
| 10 9 8 | 7 6 5 4 | 3 2 | 1 |

## Fish Barriers

| | | | | |
|---|---|---|---|---|
| No barriers. | Seasonal water withdrawals inhibit movement within the reach. | Drop structures, culverts, dams or diversions (<1ft drop) within the reach. | Drop structures, culverts, dams or diversions (>1ft drop) within 3 miles of reach. | Drop structures, culverts, dams or diversions (>1ft drop) within the reach. |
| 10 9 | 8 7 6 | 5 4 | 3 2 | 1 |

## Instream Fish Cover

| | | | | |
|---|---|---|---|---|
| >7 cover types available | 6 to 7 cover types available | 4 to 5 cover types available | 2 to 3 cover types available | None to 1 cover type available |
| 10 9 | 8 7 6 | 5 4 | 3 2 | 1 |

Cover types: Logs/large woody debris, deep pools, overhanging vegetation, boulders/cobble, riffles, undercut banks, thick root mats, dense macrophyte beds, isolated/backwater pools, other:_____________

## Embeddedness

| | | | | |
|---|---|---|---|---|
| Gravel or cobble particles are <20% embedded. | Gravel or cobble particles are 20 to 30% embedded. | Gravel or cobble particles are 30 to 40% embedded. | Gravel or cobble particles are >40% embedded. | Completely embedded. |
| 10 9 | 8 7 6 | 5 4 | 3 2 | 1 |

Note: embeddedness is defined as the degree to which objects in the stream bottom are surrounded by fine sediment. Only evaluate this item in riffles & runs. Measure the depth to which objects are buried by sediment.

## Insect/invertebrate Habitat

| | | | |
|---|---|---|---|
| At least 5 types of habitat available. Habitat is at a stage to allow full insect colonization (woody debris and logs not freshly fallen). | 3 to 4 types of habitat. Some potential habitat exists, such as overhanging trees, which will provide habitat, but have not yet entered the stream. | 1 to 2 types of habitat. The substrate is often disturbed, covered, or removed by high stream velocities and scour or by sediment deposition. | None to 1 type of habitat. |
| 10 9 8 | 7 6 5 4 | 3 2 | 1 |

Cover types: Fine woody debris, submerged logs, leaf packs, undercut banks, cobble, boulders, coarse gravel, other: ___________

## Canopy Cover

*Coldwater fishery*

| | | | |
|---|---|---|---|
| >75% of water surface shaded and upstream 2 to 3 miles generally well shaded. | > 50% shaded in reach. Or >75% in reach, but upstream 2 to 3 miles poorly shaded. | 20 to 50% shaded. | <20% of water surface in reach shaded. |
| 10 9 8 | 7 6 5 4 | 3 2 | 1 |

*Warmwater fishery*

| | | | |
|---|---|---|---|
| 25 to 90% of water surface shaded; mixture of conditions. | >90% shaded; full canopy; same shading condition throughout reach. | (Intentionally blank) | <25% water surface shaded in reach. |
| 10 9 8 | 7 6 5 4 | | 1 |

## Sewage (if applicable)

| | | | |
|---|---|---|---|
| (Intentionally blank) | Noticeable odor, excess plant growth and siltation. | Noticeable odor, excess plant growth. And Questionable pipe and black stream substrate. | Visible pipe with effluent, heavy odor. |
| | 5 4 | 3 2 | 1 |

## Manure Presence (if applicable)

| | | | |
|---|---|---|---|
| (Intentionally blank) | Evidence of livestock access to riparian zone. | Occasional manure in stream or waste storage structure located on the flood plain. | Extensive amount of manure on banks or in stream. Or Untreated human waste discharge pipes present. |
| | 5 4 | 3 2 | 1 |

**Assessment Scores**

Channel condition ☐

Riparian zone ☐

Bank stability ☐

Water appearance ☐

Nutrient enrichment ☐

Fish barriers ☐

Instream fish cover ☐

Embeddedness ☐

Invertebrate habitat ☐

Canopy Cover ☐

*Score only if applicable*

Sewage ☐

Manure presence ☐

Overall score
(Total divided by number scored) __________

| | |
|---|---|
| <6.0 | **Poor** |
| 6.1-7.4 | **Fair** |
| 7.5-8.9 | **Good** |
| >9.0 | **Excellent** |

# Appendix N.  Visual Assessment Database

| ID | SUBSHED | STREAM DESCRIPTION | DATE | SAMPLED BY | CHANNEL CONDITION | RIPARIAN ZONE | BANK STABILITY | WATER APPEAR. | NUTRIENT ENRICH. | FISH BARRIERS | INSTREAM FISH COVER | EMBEDDEDNESS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MIDDLE BC | BUFFALO CRK, PROPOSED SEWAGE TREATMT TO COV BRDG | 6/24/2003 | AL,SB,CM | 8 | 8 | 6 | 6 | 7 | 9 | 7 | 7 |
| 2 | MIDDLE BC | UNT ENTERING BC SECTION 4, SR 4057 | 6/24/2003 | AL,SB,CM | 7 | 5 | 7 | 8 | 8 | 5 | 4 | 8 |
| 3 | MIDDLE BC | WOLF RUN AT CLARK RD AND RURAL VALLEY RD | 6/24/2003 | AL,SB,CM | 7 | 4 | 6 | 3 | 5 | 4 | 4 | 4 |
| 4 | MIDDLE BC | BUFFALO CRK, WOLF RUN TIL PROPOSED POWER PLNT | 6/24/2003 | AL,SB,CM | 7 | 6 | 5 | 5 | 8 | 9 | 7 | 8 |
| 5 | MIDDLE BC | BUFFALO CRK, COVERED BRIDGE TO INTERS. BUCK RUN | 6/24/2003 | AL,SB,CM | 9 | 9 | 7 | 6 | 7 | 9 | 7 | 7 |
| 6 | MIDDLE BC | BUFFALO CRK, KRANE PROPERTY TO WOLF RUN | 6/24/2003 | AL,SB,CM | 7 | 6 | 6 | 5 | 8 | 8 | 8 | 8 |
| 7 | BC EAST | BUFFALO CRK, BC S BRIDGE TO KRANE PROPERTY | 6/24/2003 | AL,SB,CM | 7 | 6 | 8 | 7 | 8 | 8 | 7 | 5 |
| 8 | MIDDLE BC | UNT AT GAZEEBO AT TAYLOR AT TAYLORSTOWN | 6/24/2003 | AL,SB,CM | 6 | 7 | 3 | 3 | 6 | 7 | 5 | 1 |
| 9 | MIDDLE BC | POLECAT HOLLOW | 6/24/2003 | AL,SB,CM | 9 | 8 | 9 | 9 | 9 | 9 | 5 | 7 |
| 10 | MIDDLE BC | UNT AT COVERED BRIDGE | 6/24/2003 | AL,SB,CM | 9 | 9 | 9 | 5 | 4 | 7 | 8 | 7 |
| 11 | MIDDLE BC | UNT AT INTERSECTION SR221, SR 4059 | 6/24/2003 | AL,SB,CM | 9 | 9 | 8 | 8 | 9 | 5 | 7 | 8 |
| 12 | BRUSH | BRUSH RUN UNT 1 | 7/15/2003 | AL,CM,JB | 7 | 7 | 6 | 8 | 7 | 7 | 5 | 6 |
| 13 | BRUSH | BRUSH RUN UNT 2 FARRAR SCHOOL RD | 7/15/2003 | AL,CM,JB | 7 | 8 | 8 | 9 | 7 |  | 8 | 9 |
| 14 | BRUSH | BRUSH RUN UNT 3 | 7/15/2003 | AL,CM,JB | 5 | 7 | 8 | 6 | 8 | 7 | 7 | 7 |
| 15 | BRUSH | BRUSH RUN UNT 4 CHERRY RD | 7/15/2003 | AL,CM,JB | 7 | 6 | 7 | 6 | 6 | 7 | 8 | 6 |

| ID | SUBSHED | STREAM DESCRIPTION | DATE | SAMPLED BY | CHANNEL CONDITION | RIPARIAN ZONE | BANK STABILITY | WATER APPEAR. | NUTRIENT ENRICH. | FISH BARRIERS | INSTREAM FISH COVER | EMBEDDEDNESS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | BRUSH | BRUSH RUN UNT 5 UP STREAM | 7/15/2003 | AL,CM,JB | 7 | 5 | 5 | 5 | 6 | 5 | 5 | 5 |
| 17 | BRUSH | BRUSH RUN UNT 5 MOUTH | 7/15/2003 | AL,CM,JB | 8 | 8 | 7 | 8 | 7 | 6 | 7 | 7 |
| 18 | BRUSH | BRUSH RUN UNT 6 ELM RD | 7/15/2003 | AL,CM,JB | 8 | 8 | 8 | 6 | 7 | 7 | 6 | 6 |
| 19 | BRUSH | BRUSH RUN UNT 7 RIDGE RD | 7/15/2003 | AL,CM,JB | 6 | 7 | 5 | 6 | 7 | 6 | 6 | 5 |
| 20 | BRUSH | BRUSH RUN UNT 8 BUFFALO RD | 7/15/2003 | AL,CM,JB | 7 | 8 | 8 | 5 | 6 | 7 | 5 | 7 |
| 21 | BRUSH | BRUSH RUN UNT 9 REED RD | 7/15/2003 | AL,CM,JB | 7 | 6 | 7 | 8 | 8 | 5 | 7 | 7 |
| 22 | BRUSH | BRUSH RUN UNT 10 MAPLE RD | 7/15/2003 | AL,CM,JB | 8 | 8 | 8 | 7 | 7 | 7 | 6 | 7 |
| 23 | BRUSH | BRUSH RUN UNT 11 | 7/15/2003 | AL,CM,JB | 6 | 8 | 8 | 7 | 8 | 6 | 3 | 5 |
| 24 | BRUSH | BRUSH RUN UNT 12 | 7/15/2003 | AL,CM,JB | 6 | 7 | 7 | 5 | 6 | 7 | 7 | 4 |
| 25 | BRUSH | BRUSH RUN UNT13, LYNWOOD RD | 7/15/2003 | AL,CM,JB | 8 | 7 | 7 | 8 | 7 | 7 | 7 | 6 |
| 26 | BRUSH | BRUSH RUN 1, UP TO ELM RD | 7/15/2003 | AL,CM,JB | 4 | 6 | 6 | 7 | 8 | 5 | 8 | 7 |
| 27 | BRUSH | BRUSH RUN 2, FROM ELM RD TO HEADWATERS | 7/15/2003 | AL,CM,JB | 6 | 7 | 7 | 6 | 8 | 7 | 6 | 5 |
| 29 | BUCK | BUCK RUN UNT 1 | 7/14/2003 | AL,CM | | | | | | | | |
| 30 | BUCK | BUCK RUN UNT 2 YOUNG RD | 7/14/2003 | AL,CM | 9 | 8 | 8 | 7 | 7 | 6 | 9 | 4 |
| 31 | BUCK | BUCK RUN UNT 3, RAMAGE RD | 7/14/2003 | AL,CM | 8 | 9 | 8 | 7 | 6 | 9 | 9 | 9 |
| 32 | BUCK | BUCK RUN UNT 4, SCHOOLHOUSE RD | 7/14/2003 | AL,CM | 8 | 8 | 8 | 7 | 8 | 7 | 9 | 9 |
| 33 | BUCK | BUCK RUN UNT 5 WEST 1 | 7/14/2003 | AL,CM | 8 | | | 7 | 8 | | 9 | |
| 34 | BUCK | BUCK RUN UNT 5 WEST 2 | 7/14/2003 | AL,CM | 7 | 8 | 3 | 5 | 4 | 8 | 9 | 5 |

| ID | SUBSHED | STREAM DESCRIPTION | DATE | SAMPLED BY | CHANNEL CONDITION | RIPARIAN ZONE | BANK STABILITY | WATER APPEAR. | NUTRIENT ENRICH. | FISH BARRIERS | INSTREAM FISH COVER | EMBEDDEDNESS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35 | BUCK | BUCK RUN UNT 5 EAST 1, DONLEY | 7/14/2003 | AL,CM | 7 | 6 | 6 | 6 | 6 | 7 | 7 | 6 |
| 36 | BUCK | BUCK RUN UNT 5 EAST 2 | 7/14/2003 | AL,CM | | | | | | | | |
| 37 | BUCK | BUCK RUN | 7/14/2003 | AL, CM | 9 | 8 | 7 | 7 | 6 | 9 | 9 | 8 |
| 39 | DUNKLE | HANEN RUN UNT 2, OPPOSSUM HOLLOW RD | 7/23/2003 | AL,CM | 2 | 7 | 6 | 7 | 6 | 6 | 4 | 4 |
| 40 | DUNKLE | HANEN RUN SECTION 01 | 7/23/2003 | AL,CM | 7 | 8 | 8 | 8 | 8 | 8 | 7 | 3 |
| 41 | DUNKLE | HANEN RUN SECTION 02 | 7/23/2003 | AL,CM | 6 | 1 | 5 | | | 7 | 2 | |
| 42 | DUNKLE | RACOON RUN | 7/23/2003 | AL,CM | | | | | | | | |
| 43 | DUNKLE | HANEN RUN UNT 1 SEC 1, END AT FOX RD | 7/23/2003 | AL,CM | | | | | | | | |
| 44 | DUNKLE | HANNEN RUN UNT 1 SECTION | 7/23/2003 | AL,CM | 8 | 8 | 8 | | 8 | 8 | 7 | 7 |
| 45 | DUNKLE | HANEN RUN UNT 1, 2 EAST TRIB | 7/23/2003 | AL,CM | 8 | 2 | 8 | | | 9 | 7 | 5 |
| 46 | DUNKLE | DUNKLE RUN UNT 1, FOX RD | 7/23/2003 | AL,CM | 8 | 9 | 9 | | | 5 | 5 | |
| 47 | DUNKLE | DUNKLE RUN UNT 2 | 7/23/2003 | AL,CM | 8 | 8 | 9 | 8 | 9 | 8 | 9 | 9 |
| 48 | DUNKLE | DUNKLE RUN SECTION 1, EN | 7/23/2003 | AL,CM | 9 | 9 | 8 | 8 | 9 | 9 | 8 | 7 |
| 49 | DUNKLE | DUNKLE RUN SECTION 02, BEGINS AT FOX RD | | AL,CM | 7 | 2 | 3 | 3 | 4 | 8 | 3 | 3 |
| 50 | DUTCH FORK | UPPER DUTCH FORK EAST | 7/29/2003 | CM, AL | | | | | | | | |
| 51 | DUTCH FORK | BONAR RUN | 7/29/2003 | CM, AL | 6 | 6 | 4 | 4 | 4 | 7 | 5 | 3 |
| 52 | UPPER DUTCH FORK | UPPER DUTCH FORK UNT2, HICKS RD | 7/29/2003 | CM, AL | 9 | 9 | 6 | 8 | 7 | 9 | 9 | 7 |
| 53 | DUTCH FORK | UPPER DUTCH FORK WEST UNT 5 TUNNEL ST | 7/29/2003 | CM, AL | 4 | 7 | 7 | 8 | 8 | 5 | 6 | 7 |
| 54 | DUTCH FORK | DUTCH FORK LAKE UNT 2 | 7/29/2003 | CM, AL | 9 | 9 | 7 | 7 | 9 | 5 | 4 | 5 |

| ID | SUBSHED | STREAM DESCRIPTION | DATE | SAMPLED BY | CHANNEL CONDITION | RIPARIAN ZONE | BANK STABILITY | WATER APPEAR. | NUTRIENT ENRICH. | FISH BARRIERS | INSTREAM FISH COVER | EMBEDDEDNESS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 55 | BC SOUTH | BC SOUTH UNT 1, NEWMAN RD | 9/29/2003 | CM | 8 | 4 | 2 | 4 | 4 | 8 | 4 | 2 |
| 56 | BC SOUTH | UNT 1,3 NEWMAN RD | 9/29/2003 | CM | 8 | 4 | 2 | 4 | 4 | 8 | 4 | 2 |
| 57 | BC SOUTH | BC SOUTH UNT 1,1 | 9/29/2003 | CM | 7 | 6 | 7 | 7 | 6 | 5 | 4 | 7 |
| 58 | BC SOUTH | BC SOUTH 1, 2 | 9/29/2003 | CM | 6 | 6 | 7 | 8 | 8 | 4 | 6 | 7 |
| 59 | BC SOUTH | BC SOUTH UNT 2 | 9/29/2003 | CM | 7 | 3 | 3 | 6 | 5 | 8 | 5 | 4 |
| 60 | BC SOUTH | BC SOUTH LOWER | 9/29/2003 | CM | 8 | 6 | 6 | 7 | 6 | 7 | 8 | 6 |
| 61 | BC SOUTH | BC SOUTH UPPER | 9/29/2003 | CM | 7 | 6 | 4 | 6 | 5 | 7 | 6 | 5 |
| 62 | BC SOUTH | BC SOUTH UNT 11 W DOWNSTREAM | 9/29/2003 | CM | 6 | 4 | 3 | 5 | 4 | 5 | 5 | 5 |
| 63 | BC SOUTH | BC SOUTH UNT 11 W UPSTREAM | 9/29/2003 | CM | 7 | 6 | 6 | 6 | 5 | 6 | 6 | 4 |
| 64 | MIDDLE BC | UNT 9, POWER PLANT PROPERTY | 11/16/2003 | CM | 9 | 9 | 8 | 7 | 4 | 9 | 3 | 6 |
| 65 | LOWER BC | UNT 1, LOWER SECTION | 11/16/2003 | CM | 8 | 9 | 9 | 6 | 4 | 8 | 6 | 3 |
| 66 | LOWER BC | UNT 1, UPPER SECTION | 11/16/2003 | CM | 3 | 2 | 3 | 6 | 4 | 8 | 3 | 5 |
| 67 | LOWER BC | CARMICHAEL'S, BCREEK LOWER UNT 3 | 11/16/2003 | CM | 9 | 9 | 9 | 6 | 6 | 7 | 7 | 6 |
| 68 | MIDDLE BC | WIGGONTON, UNT 1 | 11/13/2003 | CM, MS | 8 | 8 | 8 | 9 | 7 | 4 | 4 | 7 |
| 69 | UPPER BUFF E | ALONG MT. VALLEY RD., UNT 7 | 12/2/2003 | CM | 5 | 2 | 2 | 4 | | 3 | 2 | 2 |
| 70 | UPPER BUFF E | ALONG JOLLEY SCHOOL RD., UNT 6 | 12/2/2003 | CM | 6 | 1 | 2 | 6 | 5 | 4 | 6 | 5 |
| 71 | UPPER BUFF E | ALONG RT. 40 | 12/2/2003 | CM | 6 | 5 | 6 | 7 | 5 | 5 | 6 | 6 |
| 72 | INDIANCAMP | INDIAN CAMP UNT 1 E, INDIANCAMP RD | 6/2/2004 | CM, JB, | 8 | 8 | 7 | 8 | 8 | 7 | 9 | 8 |

| ID | SUBSHED | STREAM DESCRIPTION | DATE | SAMPLED BY | CHANNEL CONDITION | RIPARIAN ZONE | BANK STABILITY | WATER APPEAR. | NUTRIENT ENRICH. | FISH BARRIERS | INSTREAM FISH COVER | EMBEDDEDNESS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 73 | LOWER BC | TRIB TO BUFFALO CREEK, 2S | 6/1/2004 | CM, JB, | | | | | | | | |
| 74 | LOWER DUTCH FORK | DOG RUN | 6/1/2004 | CM, JB, | 5 | 8 | 7 | 8 | 7 | 6 | 9 | 7 |
| 75 | DUTCH FORK | DOG RUN UNT A, NEAREST TO MOUTH | 6/2/2004 | CM, JB, | 8 | 8 | 7 | 8 | 8 | 8 | 8 | 8 |
| 76 | LOWER BC | WELSCH RUN UNT 2 N, NEAR HEADWATERS | 6/1/2004 | CM, JB, | 9 | 9 | 8 | 9 | 8 | 7 | 10 | 8 |
| 77 | LOWER BC | WELSCH RUN MAIN TRIB | 6/1/2004 | CM, JB, | 9 | 9 | 8 | 9 | 9 | 8 | 10 | 9 |
| 78 | LOWER BC | WELCH RUN UNT 2N | 6/1/2004 | CM, JB, | 9 | 9 | 8 | 9 | 9 | 8 | 10 | 8 |
| 79 | LOWER BC | NEAR WV BORDER, UNT 1N | 6/1/2004 | CM, JB, | 9 | 9 | 9 | 8 | 8 | 6 | 10 | 9 |
| 80 | LOWER BC | NARIGAN UNT B | 6/2/2004 | CM, JB, | 8 | 8 | 7 | 7 | 7 | 4 | 9 | 7 |
| 81 | LOWER BC | NARIGAN  UNT C | 6/2/2004 | CM, JB, | 8 | 6 | 8 | 7 | 7 | 6 | 9 | 6 |
| 82 | LOWER BC | NARIGAN RUN | 6/1/2004 | CM, JB, | 6 | 8 | 8 | 7 | 7 | 6 | 8 | 7 |
| 83 | LOWER BC | NARIGAN UNT 1 (A) | 6/1/2004 | CM, JB, | 8 | 9 | 8 | 8 | 8 | 8 | 8 | 7 |
| 84 | LOWER BC | MAINSTEM, BY WV BORDER GOING UPSTREAM | 6/1/2004 | CM, JB, | 7 | 7 | 5 | 7 | 6 | 8 | 8 | 6 |
| 85 | SUGARCAMP | INDIAN CAMP MAIN STEM | 6/2/2004 | CM, JB, | 7 | 7 | 6 | 7 | 5 | 8 | 8 | 6 |
| 86 | SUGARCAMP | INDIAN CAMP HEADWATERS | 6/2/2004 | CM, JB, | | | | | | | | |
| 87 | SUGARCAMP | OFF SUGARCAMP RD., UNT 1 E | 6/2/2004 | CM, JB, | 5 | 2 | 2 | 4 | 3 | 6 | 1 | 2 |
| 88 | SUGARCAMP | OFF SUGARCAMP RD., UNT 2 E | 6/2/2004 | CM, JB, | 8 | 6 | 6 | 7 | 5 | 7 | 6 | 5 |

| ID | SUBSHED | STREAM DESCRIPTION | DATE | SAMPLED BY | CHANNEL CONDITION | RIPARIAN ZONE | BANK STABILITY | WATER APPEAR. | NUTRIENT ENRICH. | FISH BARRIERS | INSTREAM FISH COVER | EMBEDDEDNESS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 89 | SUGARCAMP | CHESTNUT RD. | 6/2/2004 | CM, JB, | 8 | 7 | 6 | 7 | 6 | 7 | 7 | 5 |
| 90 | SUGARCAMP | UPSTREAM, SECTION B | 6/2/2004 | CM, JB, | 7 | 3 | 3 | 6 | 4 | 7 | 5 | 4 |
| 91 | SUGARCAMP | OFF INDIAN CAMP RD. , UNT 3 E | 6/2/2004 | CM, JB, | | | | | | | | |
| 92 | SUGARCAMP | OFF SUGARCAMP RD.,UNT 2N | 6/2/2004 | CM, JB, | 9 | 9 | 8 | 8 | 9 | 7 | 9 | 8 |
| 93 | SUGARCAMP | OFF SUGARCAMP RD., UNT 1N | 6/2/2004 | CM, JB, | 9 | 9 | 8 | 9 | 9 | 7 | 9 | 9 |
| 94 | SUGARCAMP | NEAR WV LINE, SUGARCAMP RD, SECTION A | 6/2/2004 | CM, JB, | 7 | 8 | 8 | 7 | 7 | 8 | 9 | 7 |
| 95 | SUGARCAMP | BRASHEARS RD. NEAR MOUTH, SECTION A | 6/2/2004 | CM, JB, | 3 | 7 | 3 | 8 | 7 | 9 | 8 | 9 |
| 96 | SUGARCAMP | BRASHEARS RD, UPPER, SEC B | 6/2/2004 | CM, AT, | 3 | 5 | 3 | 6 | 6 | 7 | 7 | 5 |
| 97 | SUGARCAMP | INDIANA CAMP UNT 3W | 6/2/2004 | CM, AT, | 3 | 5 | 7 | 5 | 7 | 5 | 7 | 5 |
| 98 | BUFFALO SOUTH | OFF OF 3009, BY HOUSE, UNT 3E | 6/29/2004 | JB, CM, | 7 | 7 | 6 | 7 | 3 | 7 | 7 | 7 |
| 99 | O SOUTH | BY SUNSET BEACH, UNT 1 W | 6/29/2004 | JB, CM, | | | | | | | | |
| 100 | O SOUTH | GOES THROUGH YARD, UNT 2E | 6/29/2004 | JB, CM, | | | | | | | | |
| 101 | O SOUTH | MCCREREY RD. | 6/29/2004 | JB, CM, | | 9 | | 9 | 9 | 9 | 7 | 5 |
| 102 | O SOUTH | MRS. PATTERSON'S, UNT Ie | 6/29/2004 | JB, CM, | 7 | 8 | 8 | 9 | 7 | 9 | 6 | 9 |
| 103 | O SOUTH | HAWTHORNE RD. TRIB | 6/29/2004 | JB, CM, | 8 | 8 | 5 | 6 | 8 | 9 | 7 | 5 |
| 104 | O SOUTH | PARALLEL TO MCLELLAND | 6/29/2004 | JB, CM, | 7 | 8 | 5 | 7 | 7 | 9 | 9 | 8 |
| 105 | O SOUTH | LOWER DUSTY TR RD., SECT A | 7/6/2004 | JB,CM | 8 | 7 | 7 | 6 | 6 | 8 | | 7 |

| ID | SUBSHED | STREAM DESCRIPTION | DATE | SAMPLED BY | CHANNEL CONDITION | RIPARIAN ZONE | BANK STABILITY | WATER APPEAR. | NUTRIENT ENRICH. | FISH BARRIERS | INSTREAM FISH COVER | EMBEDDEDNESS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 106 | O SOUTH | UPPER DUSTY TRAIL RD., SECT B | 7/6/2004 | JB,CM | 7 | 6 | 5 | 4 | 7 | 5 | 5 | 1 |
| 107 | O SOUTH | WALNUT TRIB | 7/6/2004 | JB,CM | 7 | 6 | 6 | 7 | 6 | 8 | 7 | 2 |
| 108 | O SOUTH | OFF OF SAWHILL RD., UNT 2 N | 7/6/2004 | JB,CM | | | | | | | | |
| 109 | BUFFALO SOUTH | LOWER SAWHILL,NEAR MTH,SECT A | 7/6/2004 | JB,CM | 6 | 8 | 7 | 6 | 7 | 8 | 9 | 6 |
| 110 | BUFFALO SOUTH | UPPER SAWHILL RD., SECT B | 7/6/2004 | JB,CM | 3 | 1 | 2 | | | 8 | 6 | 6 |
| 111 | O SOUTH | SAWHILL UNT 1 N | 7/6/2004 | JB,CM | | | | | | | | |
| 112 | DUTCH FORK | VALLEY VIEW RD. TRIB | 7/6/2004 | JB,CM | 6 | 6 | 5 | 7 | 7 | 2 | 6 | 2 |
| 113 | DUTCH FORK | VALLEY VIEW UNT | 7/6/2004 | JB,CM | 7 | 8 | 8 | 8 | 8 | 8 | 3 | 1 |
| 114 | DUTCH FORK | LOWER DUTCH FORK SECTION A | 7/15/2004 | JB,CM | 6 | 8 | 7 | 7 | 6 | 8 | 7 | 8 |
| 115 | DUTCH FORK | NORTH OF CHAPEL RD, DUTCH FORK SECT B | 7/15/2004 | JB,CM | 8 | 8 | 8 | 8 | 8 | 8 | 9 | 7 |
| 116 | DUTCH FORK | BY GAMELANDS | 7/15/2004 | JB,CM | 9 | 9 | 8 | 6 | | | | 8 |
| 117 | DUTCH FORK | ALONG CHAPEL HILL RD | 7/15/2004 | JB,CM | 7 | 8 | 8 | 9 | 8 | 8 | 8 | 8 |
| 118 | DUTCH FORK | 1ST TRIB FROM CHAPLE HILL, JENSEN RD | 7/15/2004 | JB,CM | 6 | 9 | 8 | 7 | 9 | 8 | 7 | 8 |
| 119 | DUTCH FORK | 2nd TRIB OFF OF DFORK CHURCH RD | 7/15/2004 | JB,CM | 8 | 9 | 8 | 9 | 9 | 9 | 9 | 9 |
| 120 | DUTCH FORK | ALONG SHALER | 7/15/2004 | JB,CM | 9 | 9 | 9 | 7 | 6 | 6 | 7 | 6 |
| 121 | DUTCH FORK | UNT 1 W RALSTON, VALLEY RD | 7/15/2004 | JB,CM | 8 | 9 | 9 | 8 | 9 | 8 | 7 | 8 |
| 122 | DUTCH FORK | BY BALL FIELDS | 7/13/2004 | JB,CM | 6 | 6 | 5 | 7 | 6 | 9 | 7 | 6 |
| 124 | UPPER DUTCH FORK | TRIB TO BONAR CRK, 2 E A | 7/15/2004 | JB,CM | 8 | 1 | 6 | 6 | 6 | 7 | 3 | 4 |

| ID | SUBSHED | STREAM DESCRIPTION | DATE | SAMPLED BY | CHANNEL CONDITION | RIPARIAN ZONE | BANK STABILITY | WATER APPEAR. | NUTRIENT ENRICH. | FISH BARRIERS | INSTREAM FISH COVER | EMBEDDEDNESS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 125 | UPPER DUTCH FORK | TRIB TO BONAR CRK, 1 E | 7/15/2004 | JB,CM | 8 | 8 | 7 | 6 | 8 | 3 | 6 | |
| 126 | DUTCH FORK | HEADWATERS ABOVE RESERVOIR, SCHOOL RD | 7/13/2004 | JB,CM | 7 | 7 | 8 | 7 | 7 | 7 | 7 | 6 |
| 127 | DUTCH FORK | ALONG VALLEY VIEW RD | 7/13/2004 | JB,CM | 7 | 7 | 8 | 7 | 6 | 7 | 6 | 6 |
| 128 | DUTCH FORK | DFORK UPPER UNT 1 S | 7/13/2004 | JB,CM | 7 | 8 | 8 | 7 | 6 | | 7 | 8 |
| 129 | UPPER DUTCH FORK | NEAR GASHEL RD | 7/13/2004 | JB,CM | 5 | 5 | 6 | 6 | 7 | 7 | 3 | 5 |
| 130 | DUTCH FORK | DFORK UPPER UNT 2 N | 7/13/2004 | JB,CM | | | | | | | | |
| 132 | DUTCH FORK | DFORK UPPER 4 N | 7/15/2004 | JB,CM | | | | | | | | |
| 133 | DUTCH FORK | NEAR SUNOCO, UNT | 7/15/2004 | JB,CM | 6 | 8 | 8 | 6 | 6 | 7 | 7 | 6 |
| 134 | DUTCH FORK | TRIB ALONG EALY RD | 7/15/2004 | JB,CM | | | | | | | | |
| 135 | DUTCH FORK | UPPER D FORK TRIB, UNT 6 | 7/15/2004 | JB,CM | 8 | 9 | 8 | 7 | 7 | 9 | 9 | 6 |
| 136 | DUTCH FORK | FROM W ALEXANDER TO MAIN BRNCH | 7/15/2004 | JB,CM | 8 | 8 | 7 | 8 | 5 | 9 | 5 | 4 |
| 137 | DUTCH FORK | BEFORE RESERVOIR | | JB,CM | 8 | 7 | 6 | 7 | 6 | 9 | 8 | 5 |
| 138 | CASTLE MAN | ALONG POGUE ROAD | 10/8/2004 | CM,HB | 8 | 8 | 8 | 9 | 7 | 7 | 8 | 9 |
| 139 | CASTLE MAN | ALONG CRUPES RD | 10/8/2004 | CM,HB | 8 | 4 | 6 | 7 | 4 | 3 | 7 | 6 |
| 140 | CASTLE MAN | ALONG MARROW LN | 10/8/2004 | CM,HB | 8 | 3 | 6 | 7 | 6 | 7 | 5 | 6 |
| 141 | CASTLE MAN | UNT 5 AFTER MARROW LN, SECT A | 10/8/2004 | CM,HB | 7 | 2 | 4 | 6 | 4 | 8 | 6 | 5 |
| 142 | CASTLE MAN | UNT5 AFTER MARROW LN, SE | 10/8/2004 | CM,HB | 8 | 8 | | | | | 8 | |

| ID | SUBSHED | STREAM DESCRIPTION | DATE | SAMPLED BY | CHANNEL CONDITION | RIPARIAN ZONE | BANK STABILITY | WATER APPEAR. | NUTRIENT ENRICH. | FISH BARRIERS | INSTREAM FISH COVER | EMBEDDEDNESS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 143 | CASTLE MAN | CASTLEMAN MAIN/PA SIDE | 10/8/2004 | CM,HB | 7 | 4 | 5 | 6 | 5 | 7 | 5 | 5 |
| 145 | CASTLE MAN | KLAGES RD TRIB | 10/8/2004 | CM,HB | 3 | 6 | 7 | 6 | 4 | 7 | 7 | 5 |
| 146 | SUGARC AMP | UNT 5N OFF OF RT 844 | 10/8/2004 | CM,HB | 7 | 3 | 6 | 7 | 3 | 8 | | 4 |
| 147 | SUGARC AMP | OFF OF 844 | 10/8/2004 | CM,HB | 8 | 2 | 4 | 4 | 6 | 8 | 6 | 3 |
| 148 | SUGARC AMP | SUGARCAMP 2W | 10/8/2004 | CM,HB | 8 | 8 | 7 | 8 | 6 | 9 | 7 | 7 |
| 149 | BUFF EAST | UNT 3N CLARK RD | 10/7/2004 | CM,HB | 7 | 8 | 7 | 9 | 9 | 6 | 6 | 7 |
| 150 | BUFF EAST | UNT 4N KELLY RD | 10/7/2004 | CM,HB | 6 | 8 | 8 | 7 | 7 | 1 | 7 | |
| 151 | UPPER BUFF EAST | UNT 7N GORBY RD | 10/7/2004 | CM,HB | 2 | 4 | 2 | 5 | 5 | 4 | 4 | 4 |
| 152 | BUFF EAST | UNT 6N 4022 HW | 10/7/2004 | CM,HB | 3 | 3 | 3 | 5 | 5 | 7 | 2 | 2 |
| 153 | BUFF EAST | UNT 5N REESE RD | 10/7/2004 | CM,HB | 4 | 6 | 3 | 5 | 5 | 8 | 3 | 3 |
| 154 | BUFF EAST | PLEASANT VALLEY EAST-BOONE RD | 10/7/2004 | CM,HB | 7 | 5 | 4 | 5 | 4 | 5 | 6 | 5 |
| 155 | BUFF EAST | PLEASANT VALLEY RD. SECT 1 | 10/7/2004 | CM,HB | 1 | 6 | 4 | 6 | 5 | | 4 | 3 |
| 156 | UPPER BUFF EAST | PLEASANT VALLEY RD. SECT 2 | 10/7/2004 | CM,HB | 5 | 6 | | 7 | 4 | 8 | | 4 |
| 157 | UPPER BUFF EAST | S-BRIDGE TO JOLLY SCHOOL RD | 10/7/2004 | CM,HB | 7 | 4 | 4 | 7 | 5 | 8 | 5 | 6 |
| 160 | UPPER DUTCH FORK | TRIB TO RESERVOIR | 7/15/2004 | CM | 8 | 8 | | | 6 | 8 | | 5 |

| ID | SUBSHED | INVERT HABITAT | CANOPY COVER | SEWAGE | MANURE PRESENCE | OVERALL SCORE | LAND USE | DOMINANT SUBSTRATE | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| 1 | MIDDLE BC | 7 | 9 | | | 7.4 | 50% FORESTED, 50% OPEN SPACE-FIELD | COBBLE, SILT | START - TAYLORSTOWN PROPOSED PP, END-COV BRDGE |
| 2 | MIDDLE BC | 6 | 8 | | | 6.6 | 75% AG, 25% FOREST | | SEWAGE ALONG ROAD, 25% CANOPY |
| 3 | MIDDLE BC | 4 | 8 | | 5 | 4.9 | 70% PASTURE, 30% RESIDENTIAL, WOODS | MUD | STARTS AT STRIP MINE, JUCT T619 AND SR 4042 |
| 4 | MIDDLE BC | 5 | 8 | | | 6.8 | 75% RESIDENTIAL, 25% FOREST | COBBLE, SILT | |
| 5 | MIDDLE BC | 8 | 9 | | | 7.8 | FOREST | BOULDERS,COBBLE | GAMELANDS |
| 6 | MIDDLE BC | 5 | 8 | | | 6.9 | 75%FIELD, 25% FOREST | SILT/COBBLE | HAS A SMALL TRIB |
| 7 | BC EAST | 8 | 9 | | | 7.3 | 50% RESIDENTIAL, 5O% FOREST | COBBLE, BEDROCK | SMALL 1ST ORDER STREAM 100FT DOWN FROM "S" BRDGE |
| 8 | MIDDLE BC | 3 | 9 | 2 | | 5.0 | RESIDENTIAL AND FOREST | MUD | GOOD CHEM SAMPLE SITE |
| 9 | MIDDLE BC | 9 | 9 | | | 8.3 | FOREST | COBBLE, BEDROCK | DUSKY SALAMANDERS FOUND |
| 10 | MIDDLE BC | 8 | 9 | | 2 | 7.5 | 80% FOREST, 20% AG | COBBLE, MUD | STARTS IN AG FIELD |
| 11 | MIDDLE BC | 8 | 7 | | | 7.8 | SUCCESSIONAL SCRUB, FOREST | COBBLE | GLADE AT TOP POTENTIAL SALAMANDERS |
| 12 | BRUSH | 5 | 7 | | | 6.5 | 80% FORESTED, 20% RES | SILT, SAND, SMALL GRAVEL | LOOKS GOOD, @ MOUTH-ALTERED CHANNEL, SOME SEDIMENT, ORIGINATES IN FIELD |
| 13 | BRUSH | 8 | 8 | | | 8.0 | AG W/GOOD RIPARIAN | | FOUND CADDIS FLIES AND WATER PENNIES; SOME AG; GOOD RIPARIAN |
| 14 | BRUSH | 7 | 8 | | | 7.0 | | | SOME SEDIMENTATION |
| 15 | BRUSH | 8 | 8 | | | 6.9 | 50% AG, 50% FOREST | | AG, COWS CAN GET IN STREAM, STREAM NARROWS, COULD USE FENCE, 30 COWS; CHANGES FROM FOREST TO AG |

| ID | SUBSHED | INVERT HABITAT | CANOPY COVER | SEWAGE | MANURE PRESENCE | OVERALL SCORE | LAND USE | DOMINANT SUBSTRATE | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| 16 | BRUSH | 5 | 8 | | | 5.6 | 70% AG/RESIDENTIAL;30%FOREST | COBBLE, MUD, SILT | OLD SHEEP FARM, COWS W/O FENCE; NARROW STREAM, MUDDY, FORESTED HEADWATERS |
| 17 | BRUSH | 7 | 8 | | | 7.3 | FORESTED | COBBLE | GOOD RIPARIAN, RIFFLES |
| 18 | BRUSH | 7 | 7 | | | 7.0 | 80% FOREST, 20% AG | | AG CONSERVATION FARM (WEST), RUN-OFF FROM FARM (MUDDY, ALGAE, GARBAGE);MOSTLY FORESTED |
| 19 | BRUSH | 7 | 8 | | | 6.3 | AG, RESIDENTIAL | | LOTS OF COWS, FENCED IN PARTS,GOOD RIPARIAN ZONE IN PARTS; SOME CROPS |
| 20 | BRUSH | 7 | 8 | | | 6.8 | 80% AG, 20% FOREST | COBBLE, DEPOSITION | RIPARIAN ZONE GONE, GRASS GROWING IN STREAM |
| 21 | BRUSH | 7 | 8 | | | 7.0 | 70% FOREST, 30% RES | COBBLE | RIPARIAN PART MOWED, PART FOREST |
| 22 | BRUSH | 7 | 8 | | | 7.3 | 30% AG, 65% RES, 5%FOREST | GRAVEL, SOME SEDIMENT | MOUTH-GOOD RIPARIAN, JUNKYARD,COWS FENCED OFF |
| 23 | BRUSH | 3 | 8 | | | 6.2 | 90% AG, 10% FOREST | MUD, SILT | |
| 24 | BRUSH | 6 | 8 | | | 6.3 | 10%RESID, 75% AG,15% FOREST | | NO FENCE; CORN, HAY, EMBEDDED; HEADWATERS-APPLE ORCHARD, FOREST |
| 25 | BRUSH | 6 | 7 | | | 7.0 | 10% RES, 75% OLDFIELD, 10% HAYFIELD | GRAVEL, COBBLE | GOOD RIPARIAN, SOME EMBEDDEDNESS |
| 26 | BRUSH | 8 | 8 | | | 6.7 | 75% RESIDENTIAL, 25% FOREST | GRAVEL, COBBLE,SILT | 1/2 RIPARIAN FOREST &1/2 MOWED |
| 27 | BRUSH | 5 | 8 | | | 6.5 | 50% AG, 50% RESIDENT | GRAVEL, SILT | PIATT - LANDOWNER;COWS IN STREAM, HORSE FARMS |
| 29 | BUCK | | | | | | | | UNABLE TO FIND |
| 30 | BUCK | 9 | 8 | 5 | | 7.5 | FOREST | COBBLE | OPEN/BRUSH, SHRUB, SEWAGE SMELL AT CROSSOVER, PIPE GOING UNDER RD |
| 31 | BUCK | 9 | 9 | | | 8.3 | FOREST | COBBLE | |
| 32 | BUCK | 9 | 9 | | | 8.2 | FOREST | COBBLE | VOIGHT'S, ALGAE, MUDDY, POSSIBLE FARMING UPSTREAM, OK RIPARIAN |
| 33 | BUCK | 8 | | | 5.0 | 8.0 | 50%FOREST, 50% AG | COBBLE, MUD | COW YARD/MANURE AT MOUTH, CHANNELIZATION |
| 34 | BUCK | 7 | 7 | 8 | | 6.3 | 70% FOREST, 30% RES | MUD, COBBLE | SEWAGE, LAWN FERTILIZER, OIL WELL DRILLING |

| ID | SUBSHED | INVERT HABITAT | CANOPY COVER | SEWAGE | MANURE PRESENCE | OVERALL SCORE | LAND USE | DOMINANT SUBSTRATE | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| 35 | BUCK | 7 | | | 8 | 6.4 | 60% FIELDS, 40% FOREST | MUD SILT | COW FIELDS |
| 36 | BUCK | | | | | | | | UNABLE TO ASSESS, LOOKS LIKE AG |
| 37 | BUCK | 9 | 9 | | | 8.1 | FOREST | GRAVEL, COBBLE | ALL GAME LANDS |
| 39 | DUNKLE | 4 | 7 | | | 5.3 | RESIDENTIAL,AG, FOREST | COBBLE, GRAVEL,SILT | STRAIGHTENING OF STREAM BY FARMER TO REMOVE MEANDER, OTHER ALTERATIONS |
| 40 | DUNKLE | 9 | 8 | | | 7.4 | FOREST | COBBLE | MOUTH- GRAVEL FROM RD, DECENT CANOPY, FENCING NEEDED |
| 41 | DUNKLE | 2 | 1 | | | 3.4 | RESIDENTIAL, AG | SAND, MUD | FIELD, COWS IN FIELD/POSSIBLE DONE SBF |
| 42 | DUNKLE | | | | | | AG, RESIDENTIAL ,FOREST | | MOUTH AT AG, FIELD W FOREST BUFFER |
| 43 | DUNKLE | | | | | | | | UNABLE TO ASSESS, NEED MORE INFO |
| 44 | DUNKLE | 8 | 7 | | | 7.7 | 20%RESIDENTIAL, 80% FALLOW | | WEST BRANCH BEGINS IN RESIDENTIAL, MIDDLE SECTION FOREST |
| 45 | DUNKLE | 7 | 8 | | | 6.8 | AG | COBBLE, GRAVEL | NO RIPARAIN, LOTS OF EROSION |
| 46 | DUNKLE | 9 | 9 | | | 7.7 | FOREST | | 50% CANOPY COVER, GOOD RIPARIAN, SBF UNDERWAY, UNABLE TO COMPLETE |
| 47 | DUNKLE | 9 | 8 | | | 8.5 | AG FIELD | COBBLE, GRAVEL | CLEAR ON VERY RAINY DAY, AG FIELD, LANDOWNER CONTI, NO ONE HOME |
| 48 | DUNKLE | 9 | 9 | | | 8.5 | FOREST | COBBLE | DUMP SITE BURNING; J SCOTT OWNS JOLLEY HOLLOW |
| 49 | DUNKLE | 2 | 2 | | 4 | 3.7 | AG, RESIDENTIAL | GRAVEL, SAND, MUD | SBF UNDERWAY, LOTS OF EROSION,NEW RIPARIAN FORMING WITH PLANTINGS |
| 50 | DUTCH FORK | | | | | | RESIDENTIAL, AG | | CHANNELIZED, JUNK YARD, 60%EMBEDDED |
| 51 | DUTCH FORK | 7 | 8 | | | 5.4 | 90% AG | GRAVEL, COBBLE | DAIRY FARM W CROSSING;COWS IN STREAM IN SOME AREAS;HIGH ALGAE |
| 52 | UPPER DUTCH FORK | 8 | 9 | | | 8.1 | FOREST | GRAVEL, SAND | LESS EROSION AT MOUTH, LOW FLOW, INVASIVES (JAP BARBERRY, HONEYSUCKLE) |
| 53 | DUTCH FORK | 7 | 9 | | | 6.8 | RESIDENTIAL | | JUNKYARD, SHRUB, INVASIVE SPECIES |
| 54 | DUTCH FORK | 8 | 9 | | | 7.2 | FOREST | 25%COBBLE, 50% GRAVEL,25%SILT | OILY MUD |

| ID | SUBSHED | INVERT HABITAT | CANOPY COVER | SEWAGE | MANURE PRESENCE | OVERALL SCORE | LAND USE | DOMINANT SUBSTRATE | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| 55 | BC SOUTH | 3 | 7 | | 3 | 4.6 | AG | | COWS IN STREAM,ERODED BANKS,HDWATERS RES, SPARSE RIPARIAN |
| 56 | BC SOUTH | 3 | 7 | | 3 | 4.6 | AG | | VERY SMALL, IMPACTED BY AG |
| 57 | BC SOUTH | 4 | 8 | | | 6.1 | 30%GRAZING,5%FOREST,5%RES,60%SHRUB | 75%MUD,25%COBBLE | SMALL ORDER, SHRUBBY |
| 58 | BC SOUTH | 6 | 8 | | | 6.6 | 25%GRAZING,25%FOREST,25%RES,25%HAYLAND | 75%MUD,25%COBBLE | REVERTING SCRUB/SMALL HORSE FARM |
| 59 | BC SOUTH | 5 | 7 | | | 5.3 | 10%FOREST,15%RES,75%OLDFIELDS | 50%COBBLE/50%MUD | MOSTLY ABANDONED FIELDS |
| 60 | BC SOUTH | 7 | 8 | | | 6.9 | 60% GRAZING, 15% FOREST, 25% RES | 25%COBBLE, 10% GRAVEL, 65% MUD | FOUND NORTHERN DUSKY, SOME GROSS BUBBLES |
| 61 | BC SOUTH | 6 | 8 | | | 6.0 | 10% FOREST, 90% RES | | BANKS ARE ERODING, SOME FENCING NEEDED, RD CLOSE TO STREAM |
| 62 | BC SOUTH | 4 | 7 | | | 4.8 | | | NO RIPARIAN ZONES AND PEOPLE MOWING TO STREAM |
| 63 | BC SOUTH | 6 | 8 | | | 6.0 | | | NOT AS BADLY IMPACTED AS DOWNSTREAM |
| 64 | MIDDLE BC | 7 | 9 | | | 7.1 | 40% FOREST, 10% RES, 50%SCRUB | 20% GRAVEL, 80% SILT | NUTRIENT ENRICHMENT, NOT SURE OF SOURCE |
| 65 | LOWER BC | 5 | 10 | | | 6.8 | 100% FOREST | 20 % COBBLE,10%SILT, 70%GRAVEL | DOWNSTREAM FROM AG, SELECTIVELY LOGGED |
| 66 | LOWER BC | 4 | 7 | | | 4.5 | 10%PASTURE/20%FOREST/20%RES/50%HAYLAND | 10%COBBLE,10%GRAVEL, 30%SILT,50%MUD | COWS IN SMALL SECTION |
| 67 | LOWER BC | 7 | 10 | | | 7.6 | 80% FOREST, 10% RES, 10% HAYLAND | 50% COBBLE, 20%GRAVEL,30%SILT | SOME NUTRIENTS FROM UNKNOWN SOURCE |
| 68 | MIDDLE BC | 7 | 9 | | | 7.1 | 20%GRAZING,60%FOREST,20% RES | 50%COBBLE,25%GRAVEL, 25%MUD | SECTIONS ARE DEGRADED WITH LITTLE RIPARIAN ZONE |
| 69 | UPPER BUFF E | 2 | 7 | | 3 | 3.2 | 70% GRAZING, 10% FOREST,20% RES | 10% COBBLE, 10%SILT,80% MUD | NO RIPARIAN ZONE AND ORIGINATES IN AG W NO FENCING |
| 70 | UPPER BUFF E | 5 | 7 | | | 4.7 | 50% GRAZING, 10% FOREST,40% RES | 40% COBBLE, 20% SILT, 40% MUD | FENCING NEEDED, NOT AS EMBEDDED AS EXPECTED |
| 71 | UPPER BUFF E | 6 | 7 | | | 5.9 | 50% GRAZING, 30% FOREST,20% RES | 60%COBBLE,10%GRAVEL, 20%SILT,10%MUD | NUTRIENT ENRICHMENT, COWS HAVE ACCESS, SMALL STREAM |
| 72 | INDIANCAMP | 9 | 9 | | | 8.1 | 100% FOREST | 10% BOULDER,50%COBBLE,20%GRAVEL,10%SILT | SOME EROSION |

| ID | SUBSHED | INVERT HABITAT | CANOPY COVER | SEWAGE | MANURE PRESENCE | OVERALL SCORE | LAND USE | DOMINANT SUBSTRATE | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| 73 | LOWER BC | | | | | | | | LOOKS GOOD, BUT INACCESSIBLE |
| 74 | LOWER DUTCH FORK | 9 | 9 | | | 7.5 | FOREST AND OLD FIELDS/GAMELANDS | 10% BOULDER, 30% COBBLE, 30% GRAVEL, 20% SILT, 10% BEDROCK | ROAD CROSSES STREAM MANY TIMES |
| 75 | DUTCH FORK | 8 | 8 | | | 7.9 | 50% FOREST/50% OLD PASTURE | 50% COBBLE, 50% GRAVEL | MULTIFLORA ROSE PROBLEM |
| 76 | LOWER BC | 10 | 10 | | | 8.8 | 100% FOREST | 80% BOULDER, 20% COBBLE | NATURAL FISH BARRIERS |
| 77 | LOWER BC | 10 | 9 | | | 9.0 | SUCCESSIONAL SUGAR MAPLE FOREST | | |
| 78 | LOWER BC | 10 | 10 | | | 9.0 | 1% GRAZING, 99% FOREST | BOULDER,40%COBBLE,30%GRAVEL,10%SILT,10%BE | IRONWOOD,BOXELDER,WITCH HAZEL |
| 79 | LOWER BC | 10 | 9 | | | 8.7 | 98% FOREST,2% OLDFIELD | 40% COBBLE,40% GRAVEL, 10% SILT, 10% BOULDER | |
| 80 | LOWER BC | 9 | 8 | | | 7.4 | 100 %FOREST | | MIDDLE-AGED FOREST STAND |
| 81 | LOWER BC | 9 | 8 | | | 7.4 | 50%FOREST,40%HAYLAND, 10% OLDFIELD | 80% GRAVEL, 20% SILT | RECENTLY LOGGED SURROUNDING AREA AND PUT IN LOGGING ROAD |
| 82 | LOWER BC | 9 | 9 | | | 7.5 | 5%FOREST, 75%PASTURE, 5% RES,10% ROAD | 10% BOULDER,40%COBBLE,30%GRAVEL,10%SILT,10%BEDROCK | RIPRAP,SOME CHANNELIZATION,HEADWATERS IN AG |
| 83 | LOWER BC | 8 | 8 | | | 8.0 | 100%FOREST | 30% COBBLE, 50%GRAVEL,20%SILT | |
| 84 | LOWER BC | 8 | 9 | | | 7.1 | RESIDENTIAL/FOREST | | SHEEPSHEAD, TROUT, BASS, MINNOWS |
| 85 | SUGARCAMP | 7 | 8 | | | 6.9 | 20%FOREST, 40% RESID, 40% OLD FIELD | 20% COBBLE, 10% SILT, 70% BEDROCK | RIPRAP, DEEPLY CUT MEANDERS |
| 86 | SUGARCAMP | | | | | | | | GOLF COURSE, KNOTWEED! |
| 87 | SUGARCAMP | 2 | 1 | | 4 | 2.8 | 98% GRAZING, 2% RES | 20%GRAVEL,70%SILT,10% MUD | STREAMBANKFENCINGNEEDED/PASTURE WITH NO TREES |
| 88 | SUGARCAMP | 7 | 9 | | 5 | 6.6 | 5% ROWCROP, 95% GRAZING/PASTURE | 40% COBBLE, 30% GRAVEL, 30% SILT | HORSE PASTURE AND CROPS/ALGAE/FENCING NEEDED |

| ID | SUBSHED | INVERT HABITAT | CANOPY COVER | SEWAGE | MANURE PRESENCE | OVERALL SCORE | LAND USE | DOMINANT SUBSTRATE | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| 89 | SUGARCAMP | 7 | 9 | | | 6.9 | 15%ROWCROP,5%GRAZING,25%FOREST,5%RES,50%OLDFIELD | 35% COBBLE, 20% GRAVEL, 40 % SILT, 5 % MUD | MOWED UP TO STREAMS, COW PASTURE UPSTREAM |
| 90 | SUGARCAMP | 6 | 8 | | | 5.3 | 99% GRAZING/PASTURE 1% FIELD | 30% GRAVEL, 50% SILT, 20% MUD | ALGAE, BAD EROSION, FENCING NEEDED |
| 91 | SUGARCAMP | | | | | | | | SOME COWS, UNABLE TO GET SCORE |
| 92 | SUGARCAMP | 9 | 9 | | | 8.5 | 99%FOREST, 1%FIELD | 60% COBBLE, 30% GRAVEL, 10% SILT | |
| 93 | SUGARCAMP | 9 | 9 | | | 8.7 | 100% FOREST | | BOXELDER/SYCAMORE FLOODPLAIN |
| 94 | SUGARCAMP | 9 | 10 | | | 8.0 | 60%FOREST, 38% OLD FIELD, 2 % RES | 35% COBBLE,20% SILT, 45% BEDROCK | FAIRLY GOOD FLOODPLAIN FOREST |
| 95 | SUGARCAMP | 9 | 10 | | | 7.3 | FOREST NEARLY 100% | 30% COBBLE, 40% GRAVEL, 30% BEDROCK | ROAD CAUSING SOME EROSION AND ALTERATIONS; SMALL, NATURAL WATERFALLS |
| 96 | SUGARCAMP | 7 | 7 | | | 5.6 | 100% GRAZING/PASTURE | 10% COBBLE, 50 % GRAVEL, 40% SILT | GOES THROUGH PASTURE, SOME FENCED BUT OTHERS NOT; CHANNELIZED |
| 97 | SUGARCAMP | 8 | 8 | | 5 | 6.0 | 70%PASTURE, 10%FOREST, 20% RES | 60% COBBLE, 10% GRAVEL, 30% SILT | STARTS IN HORSE FARM, CHANNELIZED, STREAMBANK FENCING NEEDED |
| 98 | BUFFALO SOUTH | 9 | 9 | | | 6.9 | FOREST/RESIDENTIAL/OLD FARM | | POSSIBLE SEWAGE OR AG PROBLEM, THOUGH NO VISIBLE FARMING, MOWS TO STREAM |
| 99 | O SOUTH | | | | | | | | NOT ABLE TO GET GOOD LOOK AT; MANY INVASIVES |
| 100 | O SOUTH | | | | | | RESIDENTIAL | GRAVEL | POSSIBLE SEWAGE OR AG PROBLEM; CONDUCTIVITY=680US |
| 101 | O SOUTH | | 9 | | | 8.1 | OLD FIELD/AG | 20% GRAVEL, 80% SILT | GOOD RIPARIAN ZONE |
| 102 | O SOUTH | 6 | 9 | | | 7.8 | OLD PASTURE | | CONDUCTIVITY=650 US, 2 HORSES IN PASTURE |
| 103 | O SOUTH | 6 | 9 | | | 7.1 | FOREST/RESIDENTIAL/OLD FARM | SILT | SILTATION, POSSIBLY FROM UPSTREAM |
| 104 | O SOUTH | 7 | 9 | | | 7.6 | 15% GRAZING, 35% FOREST, 50% OLDFIELD | 85% GRAVEL, 15% SILT | GOOD FISH HABITAT,STREAM HAS RECOVERED FROM PAST DISTURBANCE |
| 105 | O SOUTH | 6 | 8 | | | 7.0 | FOREST /HAY/OLDFIELD | 30%COBBLE, 50%GRAVEL, 20 % SILT | |

| ID | SUBSHED | INVERT HABITAT | CANOPY COVER | SEWAGE | MANURE PRESENCE | OVERALL SCORE | LAND USE | DOMINANT SUBSTRATE | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| 106 | O SOUTH | 3 | 7 | | 5 | 5.0 | GRAZING/FOREST/HAY | SILT AND MUD | COWS HAVE ACCESS, ATV CROSSING, MURKY |
| 107 | O SOUTH | 6 | 7 | | 5 | 6.2 | 78%GRAZING, 2% RES, 20% OLD FIELD | GRAVEL AND SILT | SEVERAL COWS AND HORSES HAVE ACCESS |
| 108 | O SOUTH | | | | | | | | ACCESS DENIED BY LANDOWNER |
| 109 | BUFFAL O SOUTH | 9 | 9 | | | 7.5 | GRAZING/FOREST/HAY | 60% COBBLE, 30% SAND, 10% SILT | WATER LOW, FAIRLY GOOD BUT IS PROBABLY BEING IMPACTED BY UPSTREAM EROSION |
| 110 | BUFFAL O SOUTH | 6 | 7 | | | 4.9 | 70% GRAZING, 30% RES | | FLOODINGPROBLEMS/SBFENCING NEEDED, LANDOWNERS "STRAIGHTENING" STREAM |
| 111 | BUFFAL O SOUTH | | | | | | | | NOT ABLE TO GET GOOD LOOK, LOTS OF SEDIMENT AND CATTLE |
| 112 | DUTCH FORK | 6 | 7 | | | 5.4 | 25 % HAY, 25% SHRUB FIELD | 15% GRAVEL, 85% SILT | OLD COW PASTURE, SOME MOWING UP TO STREAM |
| 113 | DUTCH FORK | 3 | 9 | | | 6.3 | OLDFIELDS/SHRUBS | SILT AND MUD | 2 COWS/ POSSIBLY WERE MORE COWS PREVIOUSLY |
| 114 | DUTCH FORK | 6 | 8 | | | 7.1 | 35%GRAZING, 40% FOREST, 25% RES | COBBLE/GRAVEL/SILT | CHANNELIZATION FROM ROAD; SMALL ANIMAL FARM |
| 115 | DUTCH FORK | 8 | 9 | | | 8.1 | 20%GRAZING, 60% FOREST, 20% RES | COBBLE/GRAVEL/SILT | SMALL COW FARMS/SHADED ALMOST ENTIRE REACH |
| 116 | DUTCH FORK | 8 | 9 | | | 8.1 | FOREST | COBBLE/GRAVEL/SILT | POSTED/NOT ABLE TO SEE MUCH |
| 117 | DUTCH FORK | 8 | 10 | | | 8.2 | FOREST AND RESIDENT | GRAVEL/COBBLE/BEDROC K | SOME DRIVING ACROSS STREAM, NICE FORESTED HILLSIDE |
| 118 | DUTCH FORK | 8 | 9 | | | 7.9 | 20%GRAZING, 60% FOREST, 20% RES | | GABBION WALL, COSE TO ROAD |
| 119 | DUTCH FORK | 9 | 10 | | | 8.9 | 98% FOREST, 2%RES | COBBLE | GOES THROUGH YARD AT MOUTH |
| 120 | DUTCH FORK | 7 | 9 | | | 7.5 | MAINLY FOREST | COBBLE/SILT | SUGAR MAPLE HICKORY FOREST NEAR RD |
| 121 | DUTCH FORK | 8 | 9 | | | 8.3 | 15% PASTURE, 80% FOREST, 5 % RES | GRAVEL | GOOD MACROS, ENDS IN A DRIVEWAY WITH SOME ALTERATIONS |
| 122 | DUTCH FORK | 7 | 7 | | | 6.6 | BALL FIELDS | COBBLE/GRAVEL/SILT | BANK INSTABILITY, LOTS OF DRAGONFLIES AND BUTTERFILES |
| 124 | UPPER DUTCH FORK | 4 | 1 | | 4 | 4.6 | GRAZING/PASTURE | COBBLE/SILT/MUD | SOME FENCING NEEDED/WOODED SOME WAY, REST HAS COWS IN STREAM |

| ID | SUBSHED | INVERT HABITAT | CANOPY COVER | SEWAGE | MANURE PRESENCE | OVERALL SCORE | LAND USE | DOMINANT SUBSTRATE | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| 125 | UPPER DUTCH FORK | 6 | 9 | | | 6.8 | CROPS/FOREST/RES | GRAVEL/SILT | SEDIMENTATION/ POSSIBLE SEWAGE PROBLEM (303D STREAM), WITHDRAWALS |
| 126 | DUTCH FORK | 7 | 9 | | | 7.2 | FOREST/RESIDENTIAL | GRAVEL | RESERVOIR ON LOWER END BY SCH |
| 127 | DUTCH FORK | 6 | 9 | | | 6.9 | GRAZING/RES | COBBLE/GRAVEL/SILT | HIGH CONDUCTIVITY (938 US), POSSIBLY FROM RT 70 |
| 128 | DUTCH FORK | 7 | 8 | | | 7.3 | GRAZING/FOREST/RES | GRAVEL/SILT | DOES HAVE STREAMBANK FENCING |
| 129 | UPPER DUTCH FORK | 4 | 3 | | 5 | 5.1 | 40%GRAZING, 60% RES | GRAVEL/MUD | SLAUGHTERHOUSE; STREAMBANK FENCING NEEDED IN SOME AREAS |
| 130 | DUTCH FORK | | | | | | | | UNABLE TO GET ACCESS, FENCED OFF, SEWAGE PLANT? |
| 132 | DUTCH FORK | | | | | | PASTURE/RESIDENTIAL | COBBLE/SILT | LANDOWNER SAYS HAS FENCING FOR COWS |
| 133 | DUTCH FORK | 6 | 8 | | | 6.8 | FOREST/RESIDENTIAL | GRAVEL/COBBLE | DANGEROUS HOLE NEAR ROAD, LOW WATER |
| 134 | DUTCH FORK | | | | | | GRAZING/FOREST/HAY | COBBLE/GRAVEL/SILT | UNABLE TO SEE B/C MULTIPLE LANDOWNERS |
| 135 | DUTCH FORK | 7 | 9 | | | 7.9 | FOREST | COBBLE/GRAVEL/SILT | ROAD CAVING, POOR NEAR MTH |
| 136 | DUTCH FORK | 4 | 9 | | | 6.7 | 90% FOREST; 10% RES | GRAVEL/SILT | NOT ABLE TO SEE-RT 70 |
| 137 | DUTCH FORK | 8 | | | | 7.1 | 80% FOREST, 20% RES | COBBLE/GRAVEL/SILT/ MUD | |
| 138 | CASTLE MAN | 7 | 9 | | | 8.0 | 10%ROW CROP/40%FOREST;10% RES/40%OLD FIELD | 90%COBBLE/10%GRAVEL | STARTS AS A DITCH, OLD FIELD AND FOREST MOSTLY |
| 139 | CASTLE MAN | 7 | 6 | | 5 | 5.8 | 40%GRAZING/60%FOREST | 90%COBBLE/10%SILT | YOUNG COWS IN BOTTOM SECTION/SOME MILD BANK EROSION/ HIGH CULVERT |
| 140 | CASTLE MAN | 6 | 1 | | 5 | 5.5 | 100 GRAZING/PASTURE | 10%COBBLE/80%GRAVEL/ 10% SILT | SHEEPS HAVE ACCESS TO STREAM/SMALL TRIB |
| 141 | CASTLE MAN | 5 | 2 | | | 4.9 | 100% RESIDENTIAL | 80%COBBLE/10%GRAVEL/ 10% SILT | |
| 142 | CASTLE MAN | 8 | 8 | | | 8.0 | 100% FOREST | 80%COBBLE/10%GRAVEL 10% SILT | |

| ID | SUBSHED | INVERT HABITAT | CANOPY COVER | SEWAGE | MANURE PRESENCE | OVERALL SCORE | LAND USE | DOMINANT SUBSTRATE | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| 143 | CASTLE MAN | 5 | 4 | | 5 | 5.3 | 80% GRAZING (LIGHT)/20% FOREST | 50% GRAVEL/20% SILT/ 30% MUD | HORSES IN STREAM, SOME BANK EROSION/MANY HAYFIELDS/ FOREST ON RT SIDE |
| 145 | CASTLE MAN | 6 | 6 | | | 5.7 | 50%FOREST/30%RES/20% OLDFIELD | 20%COBBLE/30%GRAVEL/ 10%SILT/40%BEDROCK | CHANNELIZATION-NEXT TO ROAD;LOTS OF ALGAE ON ROCKS;RUNS INTO WMA |
| 146 | SUGARCAMP | | 2 | | | 5.0 | 70%GRAZING/30%RES | 90%GRAVEL/10% GRAVEL | SOME THICK ALGAE AND CHANNELIZATION |
| 147 | SUGARCAMP | 4 | 2 | | | 4.7 | 100%FARMING | 50%COBBLE/20%S SILT/30% MUD | PROBABLY NOT AS GOOD DOWNSTREM |
| 148 | SUGARCAMP | 8 | 9 | | | 7.7 | 90%FOREST/10%UNKNOWN | 55%COBBLE/40%GRAVEL/ 5% SILT | DIDN'T WALK WHOLE WAY, BUT APPEARS FOREST ON RT, FISH OBSERVED |
| 149 | BUFF EAST | 8 | 9 | | | 7.6 | 20%FOREST/40%RES/40% OLD FIELD | 20%COBBLE/5%SILT/5%MUD;70%BEDROCK | SAW CADDIS/MAYFLIES;LOTS OF OLD FIELDS AND RES |
| 150 | BUFF EAST | 8 | 9 | 5 | | 6.8 | 30%FOREST/50%RES/2O% OLD FIELD | 20%COBBLE10%SILT/10% MUD/ 60% BEDROCK | NO ACTIVE FARMING/SMELLED SEWAGE |
| 151 | UPPER BUFF EAST | 4 | 3 | | | 3.7 | 5%GRAZING/15%FOREST /80% RES | 10%COBBLE/10%SILT/80% BEDROCK | COWS AND DONKEYS IN STREAM/CHANNELIZED AND BIG CULVERT DROPS/ EARTHMOVING |
| 152 | BUFF EAST | 2 | 2 | | | 3.4 | 60%GRAZING/40% RES | 50%GRAVEL/10%SILT/10% MUD/30% BEDROCK | MOWED TO STREAM/0% CANOPY IN SOME AREAS |
| 153 | BUFF EAST | 4 | 5 | | | 4.6 | NG/10% FOREST/60% RES | 15%COBBLE/15%SILT/ 70% BEDROCK | LOTS OF NEW HOUSES/MOWED UP TO STREAM |
| 154 | BUFF EAST | 6 | 4 | | | 5.1 | 80%GRAZING/20%RES | 65%GRAVEL/5%SILT/ 30% MUD | OLD FIELDS/ALGAE ON ROCKS/SOME FENCING POSSIBLY NEEDED |
| 155 | BUFF EAST | 4 | 5 | | | 4.2 | 30%OLDFILED/30%RES/40% PASTURE | 20%COBBLE/30%GRAVEL/ 50% SILT | |
| 156 | UPPER BUFF EAST | 6 | 7 | | | 5.9 | | 20%COBBLE/30% GRAVEL/50% SILT | |
| 157 | UPPER BUFF EAST | 4 | 4 | | | 5.4 | 20%GRAZING/20%FOREST 60%RES | 10%COBBLE/60%GRAVEL/ 10% SILT/20% MUD | SOME FENCING NEEDED/PIPE GOINT TO STREAM,SBF NEEDED |
| 160 | UPPER DUTCH FORK | 9 | 9 | | | 7.6 | 70%WOODED/30%AG | 90%COBBLE/10%SILT | MORE SILTATION THAN EXPECTED GIVEN LAND USE |

# Appendix P. Funding Sources

| Funding Description | Types of Activities Covered | Average Grant Size | Potential Partners | Contact Info |
|---|---|---|---|---|
| **Greenways/Outdoor Recreation** | | | | |
| Penn Dot Transportation Enhancement Program | Greenway projects with a tie to transportation, historic preservation, bicycling, or environmental transportation | varies | local municipalities and trails groups | Dante Accurti, (783) 2258-DCNR |
| DCNR Community Conservation Partnership Program | Greenways or park projects which have a 50% match from a project sponsor | varies | BCWA, BVA, other municipalities | DCNR Southwest, (412) 880-0486 |
| Rails to Trails Grants Program | Rails to Trails projects such as completion of the National Pike Tail | varies | local municipalities, BCWA, and trail groups; 50% match required | Wilmer Henninger (717) 772-3704 |
| Urban and Community Forest Grants | Planting of trees in local communities (provide 50% of purchase and delivery costs) | varies | municipalities, volunteer groups, nonprofits | Norm Lacasse (717) 783-0385 |
| National Recreation Trails Fund Act, administered by DCNR | Land acquisition and construction of trail leads and facilities; local match required | maximum $150,000 | municipalities, BCWA, BVA, other local gropus | Vanyla Tierney (717) 783-2654 |

| Funding Description | Types of Activities Covered | Average Grant Size | Potential Partners | Contact Info |
|---|---|---|---|---|
| Rivers, Trails and Conservation Assistance Program | Conservation Plans, trail development, and greenway development | varies | municipalities, BCWA,BVA,others | website: http://www.ncrc.nps.gov/programs/rtca |
| **Community Revitalization/Smart Growth** | | | | |
| Department of Community and Economic Development (DCED) Community Revitalization Program | Community projects aimed at improving a community's quality of life and business conditions (street conditions, walkways, etc.) | $5,000 to $50,000 | local municipalities | Oliver Bartlett |
| **Planning** | | | | |
| State Planning Assistance | Preparation and maintenance of community development plans, policies, and measures; requires 50% match and regional participation | varies | local municipalities | Kerry Wilson (717) 783-1402 |
| Small Communities Planning Assistance | Neighborhood revitalization, community conservation, economic development and housing plans; must benefit low to moderate income residents | varies | local municipalities | Kerry Wilson (717) 783-1402 |
| Communities of Opportunity Program | Redevelopment projects, competitive housing | varies | local municipalities | Diana Kerr (717) 787-5327 |

| Funding Description | Types of Activities Covered | Average Grant Size | Potential Partners | Contact Info |
|---|---|---|---|---|
| Community Development Block Grants | Infrastructure improvements, housing rehabilitation, public services, and community facilities that partly benefit low to moderate income people | varies | local municipalities | Scott Dunwoody (717) 787-5327 |
| Main Street Program | Improvements and management of community downtown revitalization activities (partial funding) | varies | local municipalities | Diana Kerr (717) 787-5327 |
| Stormwater Planning and Management Grant Program | Preparation of stormwater management plans and ordinances; requires 25% match | varies | Washington County Planning Office, local municipalities | Durla Lathia (717) 772-4048 |
| **Historic Preservation** | | | | |
| Keystone Historic Preservation Grants | Preservation, rehabilitation, and restoration of historic properties, buildings, structures, and sites (50% match required) | $5,000 to $100,000 | local municipalities and nonprofits | Bryan Van Sweden (717) 772-5071 |
| Certified Local Government Grants | Cultural Resource Surveys, technical and planning assistance, educational interpretive programs, and national register nominations (40% match required) | small grants, varied amounts | local municipalities | Michel Lefevre (717) 787-0771 |
| **Environmental Improvement Projects and Assessments** | | | | |

| Funding Description | Types of Activities Covered | Average Grant Size | Potential Partners | Contact Info |
|---|---|---|---|---|
| Nonpoint Source Management 319 Grants | Watershed Asssessments, restoration projects; requires match | varies | BCWA, BVA, local municipalities | Russ Wagner (717) 787-5642 |
| Environmental Fund for Pennsylvania | Environmental, conservation, and recreation projects that improve local quality of life | varies | multiple | Tim Schlitzer (215) 545-5880 |
| DEP Growing Greener Program | Farmland preservation, open space preservation, watershed planning, recreational trails and parks | varies | BCWA, BVA, local municipalities, and other groups | 1-877-724-7336 |
| Conservation Reserve Program | Protect environmentally sensitive and highly erodible areas by paying farmers to convert these land into less intensive use | varies | individuals, associations, corporations, estates, cities, etc. | Washington County NRCS office |
| Wetland Reserve Progam | Protects sensitive wetlands by paying farmers to put them under permanent easements; can be used to fund protection of open space and greenways within riparian zones | varies | individuals, associations, corporations, estates, cities, etc. | Washington County NRCS office |
| Watershed Protection and Flood Prevention Small Watershed Grants | Maintenance and operation of watershed improvements involving watershed protection, flood prevention, wildlife and fishery enhancements, and recreational planning; match required for some projects | varies | local nonprofits and sate agencies | website http://www.epa.gov/owow/watershed/wacademy/fund/prevent.html |

| Funding Description | Types of Activities Covered | Average Grant Size | Potential Partners | Contact Info |
|---|---|---|---|---|
| DCNR River Conservation Program | Restoration and enhancement of rivers from watershed with an approved river conservation plan | varies | nonprofits and municipalities | Marian Hrubovcak (717) 787-2316 |
| Dominion Mini Grants | Operational and project costs | currently up to $1,000 | BCWA, possibly BVA | Ben Wright (724) 459-0953 |
| Western Pennsylvania Watershed Program | Projects that incorporate local leadership and collaboration into protecting or restoring a watershed area | varies | BCWA | John Dawes or Associate (814) 669-4847 |
| **Environmental Education and Outreach** | | | | |
| Environmental Education Grant Program, DEP | Environmental outreach materials and programs | $1,000 to $20,000 | public and private schools, nonprofit groups, Washington County Conservation District | DEP (717) 772-1828 |
| League of Women Voters | Environmental and outreach projects related to groundwater and watersheds | maximum $5,000 | municipalities, BCWA,BVA, drinking water suppliers, and other public entities | http://pa.lwv.org/wren/grants/local.html. |
| **Sewage and Water Improvements** | | | | |
| Penn Vest Growing Greener Grants | Design and construction of water and wastewater treatment facilities (grants and loans) | varies | municipalities | |

| Funding Description | Types of Activities Covered | Average Grant Size | Potential Partners | Contact Info |
| --- | --- | --- | --- | --- |
| Penn Vest On-lot Funding Program | Improvement and replacement of onlot septic systems (loans) | up to $25,000 | individuals | |

# Appendix Q. Useful Contacts

| Contact Name | Types of Issues | Contact Info |
|---|---|---|
| Washington County Planning Commission | Municipal Planning Code, land ordinance information, and possible funding sources for planning projects | 701 Courthouse Square 100 W. Beau St. Washington, PA 15301 |
| DEP Southwest | Contact to report sewage and other discharges to streams and about potential projects | (412) 442-4184 |
| DEP Office of Longwall Mining | Concerns about problems arising from longwall mining | California District Office 25 Technology Park Coal Center, PA 15423; (412) 442-4184 |
| DEP Oil and Gas | May be contacted if an oil or gas leak is suspected | (412) 442-4024 |
| Partners for Fish and Wildlife/California University | Streambank fencing related inquiries | 302 South Hall Box 31 California, PA 15419; (724) 938-5799 |
| Washington County Conservation District | Information regarding Erosion and Soil Control Permits, water quality issues, Dirt and Gravel Roads Program, and agricultural best management practices | 100 W. Beau St. Suite 602 Washington, PA 15301; (724) 228-6774 |
| Washington County Agland Preservation | Provide information regarding development of agricultural easements | 701 Courthouse Square 100 W. Beau St. Washington, PA 15301 |
| Pennsylvania Game Commission/Southwest | Information regarding Gamelands 232 management plans, hunting regulations, and programs | Bolivar, PA 15923; (1-877-877-7137) |

| Contact Name | Types of Issues | Contact Info |
|---|---|---|
| PA Cleanways | Illegal dump clean ups, bulky waste days, and other inquiries related to reducing illegal dumping | 165 West 4th St. Greensburg, PA 15601; (724)836-4121 |
| Washington County Natural Resource Conservation Service | Agricultural BMP practices, including regulations and grant programs such as Conservation Reserve Enhancement Program and Project Grass | USDA/NRCS 2800 N. Main St. Ext. Meadowlands, PA (724) 222-3960 |
| Washington County Tourism Promotion Agency | Issues related to promoting eco-tourism and other tourism activities in Washington County | 273 S. Main St. Washington, PA 15301; (724) 228-5520 |
| Western Pennsylvania Conservancy Watershed Assistance Center | Information about grant opportunities and watershed education; questions and information about Buffalo Creek Watershed Assessment and Protection Plan | 246 South Walnut Street Blairsville, PA 15717 |
| Citizens for Pennsylvania's Future | Low cost legal representation and advise on laws concerning water quality, air quality, and other environmental issues, and citizens rights | 610 North Third Street Harrisburg, PA 17101 (717) 214-7920 |

# Appendix R

**Buffalo Creek Protection Plan Draft**
**Public**
**Comments**
April 21-May 30, 2005

**History**

- Include mention of the McGuffey Reader.
  *A section was added to include information on McGuffey Reader.*

- Note the KKK meeting site above the general store in Taylorstown.
  *Comment noted.*

- Not that the entire town of Taylorstown is on the National Historic Register.
  *Section changed to make it clear that entire town is Historic Site.*

- Some info on possible origin of name of "Buffalo".
  *Information added that this is possibly because an old Buffalo trace went through the area.*

**Project Area**

- Are there Ag Easements in East Finley Township? —not mentioned in plan.
  *There are no agricultural easements in the township (Table 1-11).*

- Landowner concerned about mining in East Finley Township scheduled to occur 8 or 9 years, the mining company has been there to do studies.
  *'Project Area Characteristics: Coal Mining' addresses rights of landowners in coal mined area and agencies and organizations available to help.*

- In the Executive Summary, 164 "acres" should be "square miles".
  *Correction made.*

- On page 1-19 "potentially" should be taken out. Abandoned and unregistered oil and gas wells do exist.
  *Correction made.*

- Not all agricultural security areas or easement areas in watershed are shown on the map.
  *Mapping information is not available for areas added after 2001. This explanation is added to the map.*

**Water Resources**

- Landowners concerned about amount of brush in creek—needs to be removed.
  *Comment noted.*

- Note that Washington County is in the initial stages of a countywide stormwater management plan. Each watershed will be looked at individually, starting with the Chartiers Creek Watershed
  *This information is added to the Water Resources section.*

- Need a heading on Table 3-6 (USGS sampling results)
  *Correction made.*

- Add a section explaining pH and iron, in addition to the other chemical parameters.
  *Section added.*

- Add "Table 3-12" to Table 3-12.
  *Correction made.*

- Include updated agricultural statistics (2003-2004)
  *Updated statistics added.*

- Do not say that Washington County is the "least forested" county. This is not true. Just say that it is 50% forested.
  *Wording changed to say "50% forested versus 60% for state as a whole."*

- Darken the secondary roads on the Dirt and Gravel Roads map and change color of "applications pending" areas to be more visible.
  *Correction made.*

- It is mentioned on page 3-24 that a photo shows erosion from crop grazing; this is actually slip that is not at all related to grazing. Also, more mention should be made of rotational grazing and other management practices to prevent erosion. A well-managed pasture will greatly reduce soil erosion.
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  *More information added about practices that can prevent erosion on pastureland.*
  *Comment noted.*

- One page 3-13, paragraph 2, line 6, omit the use of "were considered."
  *Correction Made.*

**Natural Resources**

- More distinct mention should be concerning the Natural Heritage Inventories.
  *There is an entire section on the Natural Heritage Inventories, pages 2-20 and 2-31.*

- Note high quality of mammal life in the area.
  *This is noted in the Natural Resources Section.*

- More info on Natural Heritage Report by Wagner.
  *There is a very detailed description of this in the Natural Resources Section, pages 2-30 and 2-31.*

**Outdoor Resources**

- "Rails to Trails" should be mentioned.
  *The Rails to Trails program is mentioned in this section and in Chapter 1, Project Area Characteristics under Open Space and Greenway Protection*

- More emphasis on eco-tourism generally.
  *More detailed information added on eco-tourism.*

- More emphasis on desirability of restoring Dutch Fork Lake and its importance to eco-tourism.
  *The importance of Dutch Fork Lake for eco-tourism is mentioned in Chapter 5 , Issues and Recommendations and in Chapter 3, Water Resources.*

- Buffalo Creek in Pennsylvania is not trout-stocked.
  *Pennsylvania Fish and Boat Commission contacted to verify stocked sections in the watershed. Buffalo Creek is not trout-stocked in Pennsylvania and this segment was removed from the map as a trout-stocked section.*

**Other**

- A list of steering committee members should be included in plan.
  *A list of steering committee members added.*

- One of the pictures in front should be replaced with a photo of streambank fencing.
  *Change made.*

- Note that there is money out there for municipalities to apply for grants for historic preservation.
  *This is mentioned in Chapter 5, Issues and Recommendation and in Funding Sources, Appendix P.*

- List of related funding sources for municipalities.
  *Appendix P. lists funding sources for municipalities and other groups.*

- More examples of relevant generic ordinances.
  *A riparian zone ordinance is included (Appendix F.). Other example ordinances may be obtained by contacting other municipalities in Pennsylvania.*