

# Kettle Creek Watershed

Center for Watershed Stewardship Keystone Project, Spring 2001

The Pennsylvania State University  
Prepared for the Kettle Creek Watershed Association



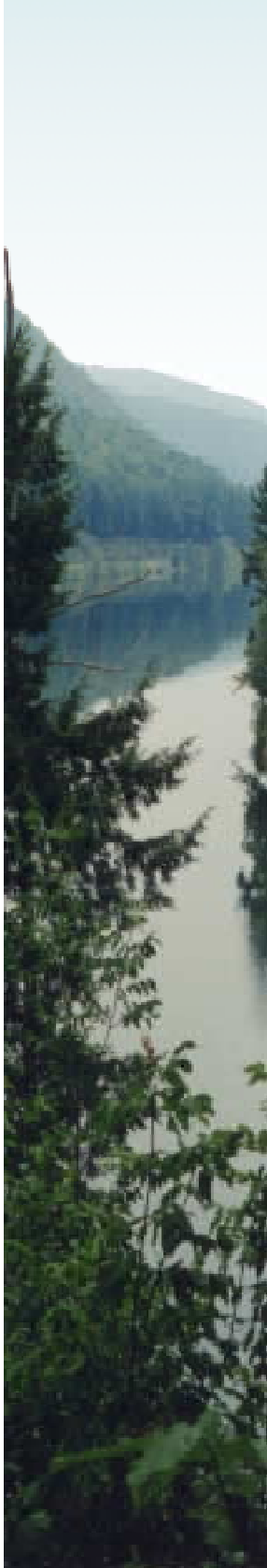
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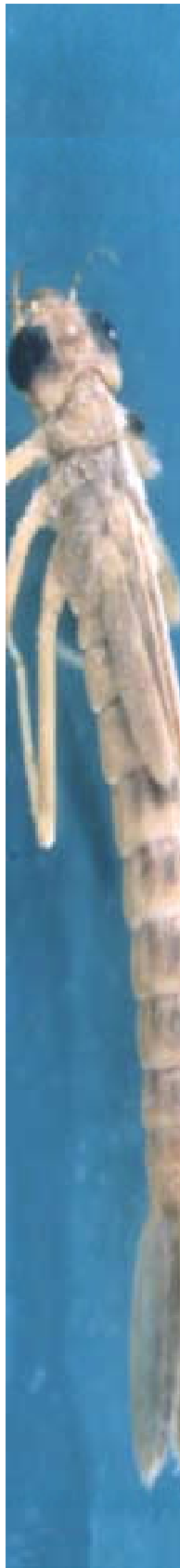
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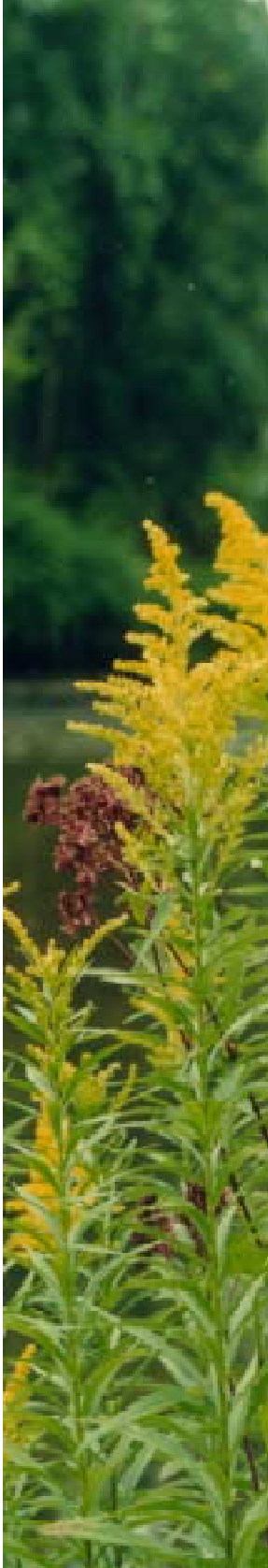
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# INTRODUCTION

The Kettle Creek Watershed Stewardship document which follows is a product of a two-semester "Keystone Project" practicum carried out by a team of graduate students enrolled in the Watershed Stewardship Option offered within five degree-granting programs at The Pennsylvania State University, University Park Campus. Keystone Projects are designed to provide an enhanced educational experience for students focused on water resources by engaging them in a case problem analysis of a Pennsylvania watershed. Most importantly, Keystone Projects are conducted in close collaboration with a community-based sponsor and its network of cooperating agencies, individuals, and organizations concerned with the long-term environmental protection, socio-economic vitality, and quality of life of the study watershed.

Kettle Creek was selected from 22 candidate projects as the 2000/2001 Keystone Project based on a joint proposal of the Kettle Creek Watershed Association (KCWA) and Trout Unlimited (TU) through the "Home Rivers Initiative". The Home Rivers Initiative is a national program designed to promote scientifically-grounded, watershed scale conservation on important coldwater rivers and to serve as a catalyst for the establishment of sustainable, locally-led watershed organizations.

The KCWA/TU proposal set forth several primary elements and objectives of a Keystone Project, summarized below.

- \* Perform a comprehensive watershed assessment and analysis with emphasis on: fisheries resources, aquatic ecology, and stream habitat conditions; cultural and historical attributes of the watershed and; non-point source impacts on water quality focused on thermal regimes, sedimentation problems, and impairment by abandoned mine drainage.

- \* Create a Geographic Information System (GIS) database of assessment information and analyses performed by the student team on selected topics such as riparian canopy coverage of major tributaries, and sediment production potential from dirt and gravel roads in critical subwatersheds.

- \* Produce a Watershed Stewardship Plan of management strategies and actions recommended for implementation by KCWA and its partners to achieve environmental quality and resource conservation goals and to build a strong foundation of community support and participation.

- \* Provide graphic images and text on a variety of topics addressed in the Watershed Stewardship Plan to facilitate KCWA's Education and Outreach activities via web-based and printed documents, workshops, and other media.

On August 22, 2000, a Student Technical Experience in Problem Solving (STEPS) Memorandum of Agreement was executed between KCWA and the Center for Watershed Stewardship (CWS) at Penn State. The STEPS agreement acknowledged that the academic goal to "...support the education and training of students" was paramount in the conduct of the Keystone Project. Consistent with the University's service mission to citizens and communities of the Commonwealth, the project was to be accomplished pro bono through pre-professional services of students and the commitment of CWS faculty time, University equipment, facilities, and other resources in furtherance of KCWA's efforts in the public interest. The STEPS agreement specified the working arrangement between KCWA and CWS and details of the project scope, sponsor support and reimbursement of certain direct costs, timetable, benchmarks of progress, and project outcomes.

The overarching objective of the Kettle Creek Keystone Project was to provide KCWA with a framework to enable the organization to advance integrated, sustainable initiatives to achieve its mission to "enhance, preserve, monitor, and protect the Kettle Creek watershed." The report submitted herein is offered as a vehicle to fulfill that objective.

Authorship of the document's component parts was assigned to individual team members according to their disciplinary background, prior experience, and relevance of a particular topic or area of inquiry to their graduate research interests and professional career goals. The document is a team product, completed through the collaboration of individuals. Latitude is given by the course instructors to accommodate differences in writing style, syntax, and modes of communication appropriate to the diverse subject matter. Narrative, anecdotal de-



scription enlivens Kettle Creek's rich cultural history while quantitative, scientific terminology better suits the presentation of water quality assessment data, for instance. We are mindful, too, of the intended audience and purpose to communicate material of a technical nature in the most straightforward and understandable way possible.

The Kettle Creek Keystone Project team was comprised of the graduate students and CWS faculty listed below (principal areas of responsibility are noted for each):

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# ACKNOWLEDGEMENTS

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David Flack at Quiet Oaks Campground hosted our initial overnight field trip that included "first ever" black bear and elk close encounters for many members of the team. From the onset, Pennsylvania Bureau of Forestry staff provided a wealth of GIS and other data: thanks to Dr. James Grace, Butch Davy, Tom Wallace, Greg McPherson and Mac Waskiewicz. Mary Herrold, Bureau of State Parks, shared considerable information on the region's cultural history and recreational resources. Arlene Hoffmann, Clinton County History Society, and Bob Currin, Potter County Historical Society, provided much of the historical documentation.

Water resources expertise on a wide range of subjects and information in many forms came from these sources: Bruce Hollender and Rick Spear, PA Fish and Boat Commission; David Putnam, U.S. Fish and Wildlife Service; Tony Shaw and Mike Klimkos, PA Department of Environmental Protection; John Nance, U.S. Geologic Service; Mike Moore, PA Geological Survey; and Stan Brua, U.S. Army Corps of Engineers. Kevin Abbey, Steve Blosser, and Woody Colbert, PA Dirt and Gravel Road Program, and Sandy Thompson, Potter County Conservation District, assisted greatly on the important issue of road-generated sediment impacts to Kettle tributaries.

Personal discussions with township supervisors were most helpful to understand their perspectives on how rural municipalities relate to watershed stewardship goals. From Potter County, Robert Fowler, West Branch Township chairman, Martin Godra, Stewardson Township chairman, and James Weaver, Wharton Township, were interviewed as was Ed Berry from Leidy Township, Clinton County.

Tim Holladay and James Watson of Clinton County Planning gave us planning documents, GIS data and personal interviews; Karl Lang, Potter County planner, did likewise for the upper watershed. Kierstin Carlson, Western Penn-

sylvania Conservancy, conducted a Pennsylvania Natural Diversity Inventory (PNDI) search and Dennis Dusza, PA Game Commission, supplied information on wildlife resources and management.

We are especially grateful to the KCWA members and residents of the watershed who participated in the "Tell Us About Your Watershed" conversations with the team in November and our April 26 presentation to the community, both held at Kettle Creek Hose Company in Cross Fork. Participants at one or both events (not including people already mentioned) were Dennis Barner, Lisa Wertz, Dale Van Sickle, Jack Bruro, William Duynam, Ray Gyurina, Dave and Sharon McIntyre, Carol Camm, Edie Sodergren, Garland Gingerich, and Al Lyons.

The Kettle Creek Keystone Project also received assistance from faculty, colleagues, and other graduate students at Penn State. Landscape Architecture (LARCH) faculty Dan Jones and Tom Yahner advised on the visual corridor analysis. LARCH faculty Sam Dennis, Dan Nadenicek, Madis Philak, Ken Tamminga, and Tom Yahner served on committees for independent research by four students related to Kettle Creek. Neil Kelley, computer network support specialist, aided in the production of large format posters for the community presentation and KCWA's educational programming.

School of Forest Resources (SFR) faculty Dr. Robert Carline, Dr. David DeWalle, and Dr. William Sharpe and Bryan Swistock, extension associate, advised team members in the HOBO thermal assessment work, acidic deposition, and biotic indices as did SFR graduate students Anthony Buda and Susan LeFevre. Dr. Wayne Myers, Joseph Bishop and Jeff Grimm at SFR provided GAP analysis, acid deposition and habitat data. Barry Evans, Environmental Resources Research Institute, provided training to the team on the AVGWLF watershed model he

helped developed, as well as the Kettle Creek information.

It is our sincere hope that the end result of this collaboration will serve to protect and improve Kettle Creek for present and future generations who are fortunate to live, work, and recreate in an extraordinary watershed.

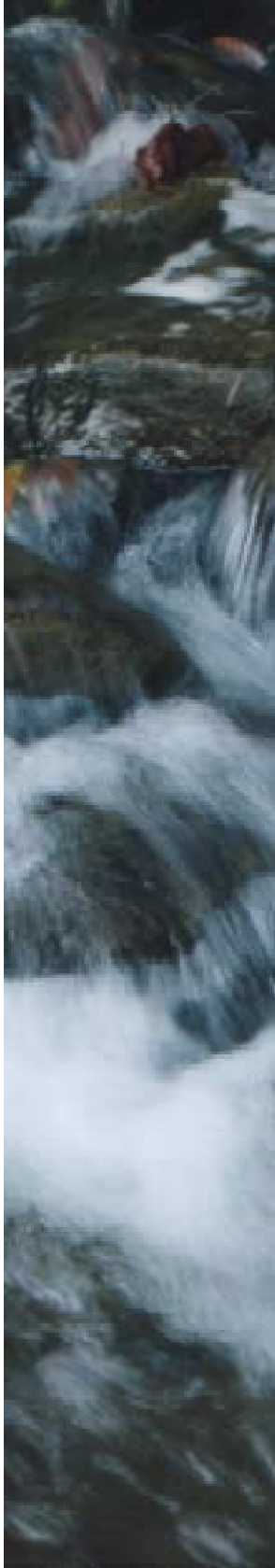
Kettle Creek Keystone Project Team

University Park, Pennsylvania

May 4, 2001

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# EXECUTIVE SUMMARY

## A. Project Background

This document is the result of a two-semester graduate student "Keystone Project" carried out through the Center for Watershed Stewardship at the Pennsylvania State University. Keystone Projects are experiential learning opportunities that allow graduate students to work in close collaboration with community-based sponsors, agencies, and individuals concerned with the environmental and socio-economic issues of a particular Pennsylvania watershed. Eleven graduate students, from five academic programs at Penn State, participated in this effort.

The Kettle Creek Watershed Association (KCWA), in conjunction with Trout Unlimited, sponsored this year-long assessment of the Kettle Creek watershed. The objectives were to perform a comprehensive watershed assessment, create a GIS database of the assessment information, produce a watershed management plan, and provide materials to assist the KCWA in its education and outreach activities. What follows is a summary of the assessment and the management recommendations for the Kettle Creek watershed.

## **B. Assessment**

### **Physical Setting**

Kettle Creek is located in the mountainous, north central region of Pennsylvania. The watershed terrain varies from rolling to extremely rugged in the deep, dissected tributary valleys. The geology of the region has led to coal and gas extraction activities over the past century. There are more than 400 miles of streams in the watershed, from several tributaries that are sizable in their own right, including Cross Fork Creek and Hammersley Fork, to very small tributaries, such as Walters Run. On occasion, flooding of Kettle Creek's main stem has been a problem for floodplain residents. While the construction of the Alvin Bush Dam in the late 1950s, in the lower watershed, alleviated much of the flooding issues, its construction inundated the town of Leidy.

### **Cultural Setting**

**History.** The Kettle Creek watershed was occupied by Native Americans for centuries prior to the arrival of European settlers. The Iroquois and Delaware tribes both claimed portions of the watershed. The watershed was blanketed in forests, dominated by hemlock, pine, oak, and chestnut and typical of what would become Pennsylvania. Wildlife was abundant, including elk and wolves. Europeans explored the region

in the mid-1700s and early settlers periodically met resistance from the Native Americans. Several treaties "settled" the disputes and allowed Pennsylvania to sell large tracts of lands to settlers and resource speculators. The first known settler to make a claim on lands within the watershed did so in 1794. Others followed slowly, as access to and within the watershed was difficult at best. Early settlers were primarily farmers, but as they cleared timber off the land, sawmills began processing the wood commercially. This was the beginning of the first major extractive industry within the watershed. By the mid-1850s, lumbering was common throughout the Kettle Creek watershed.

Along with the increasing numbers of settlers came the development of villages and towns. One of the more famous attempts at planned settlement was the Norwegian colony backed by the world-famous violinist, Ole Bull. The lands he had purchased for the new colony were difficult to farm, and in fact, many of the sites colonists developed were located on reservations outlined in the deed. Though his effort failed, Bull was and is commemorated in the establishment of the Ole Bull State Park. In the northern parts of the watershed, German immigrants settled the area now known as Germania, an area still dominated by agriculture. Growth of towns in the lower watershed (e.g., Cross Fork) was spurred by timbering, some forming from what were supposed to be temporary logging camps (e.g., Hammersley Fork). Toward the end of the 1800s, timbering activity increased greatly as railroads made their way into the watershed, facilitating the transport of logs to mills and lumber to markets. By about 1910, most of the timber had been cut and timber companies moved on to other North American forests. What had been a booming industry collapsed quickly, leading to the mass exodus of residents from the watershed.

In the late 1800s, mining for coal began another large extractive industry within the watershed, particularly in the lower reaches. By the beginning of the 1900s, coal mining was leading the formation of new towns, such as Bitumen (just west of the watershed's western boundary). Ethnic groups, such as Slovaks, moved into the watershed, in search of readily available jobs in the mines. By the late 1920s as market prices fell, much of the deep mining was abandoned, leaving only surface mining operations. These, too, ceased in the 1970s, leaving only the legacy of unreclaimed lands and acid mine drainage to reveal mining story.

As the timber companies removed the valuable timber and left the watershed, they abandoned their lands to the state. The Commonwealth claimed the lands and set about trying to restore the forests and to protect and preserve the rivers and streams. As a result, the Commonwealth now owns about 92% of the watershed as state forests and state parks. The forest, while not pristine, has recovered considerably over the past century. The Civilian Conservation Corps (CCC) played a large role in restoration and protection efforts during the 1930s. State forests include the Susquehannock, Sproul, Tioga, and a small portion of the Elk. The Kettle Creek State Park and the Ole Bull State Park are located within the watershed.

Today the watershed is sparsely populated and predominantly under state management. The primary industries are forestry (through the state forests), recreation and limited agriculture. Kettle Creek is a renowned trout stream, and the landscape is a popular destination for hunting as well. Small businesses have grown to support those activities.

**Demography.** There are ten townships and four counties that cover the Kettle Creek watershed. Population numbers in the watershed peaked at the turn of the 20th century, concurrent with

logging and mining industries. Populations levels within the watershed have remained relatively stable since the 1930s.

The watershed population is generally older, as younger age groups decline in numbers. Few of the landowners within the watershed are actually permanent residents (< 20%). Most seasonal residents live within Pennsylvania, generally near Lancaster and Philadelphia.

**Economy.** The historical industries of agriculture and forestry still maintain a presence within the watershed, although mining is past. There have been some manufacturing industries within the watershed, but these have generally left the region over the past decade. The region has, on occasion, suffered some of the highest unemployment rates in the Commonwealth. Most watershed residents are not employed within the watershed itself, traveling as much as 25 minutes to work sites. The Kettle Creek Watershed Association is mostly nonresident.

**Recreation.** Recreation plays a large role in the watershed, especially as 92% of the watershed is state-owned and offers public access to forest and park environments. Numerous forest and water-based recreational activities occur year round. Popular activities include fishing, camping, hunting, boating, snowmobiling, and ice fishing. The state forests and parks are well-connected with a large network of hiking trails. Many small businesses have arisen to support recreational activities, thus providing a significant part of the economic base for the watershed residents.

**Visual Assessment.** The Kettle Creek watershed is a beautiful landscape. It maintains the rural character so typical of the central portion of Pennsylvania. Vast expanses of forests intertwined with the various streams provide an aesthetic found in few other locations throughout the state. Historic buildings still abound and help to remind us of the history of the water-

shed. Winding roads lead through the variety of landscapes contained along Kettle Creek and its tributaries. The roads also help to remind us of the history of the watershed, as we move from Westport north to Germania.

### **Natural Setting**

**Landuse.** Landuse reflects the interaction of people and the landscape within the watershed. Broad uses have been reflected in the cultural development of the Kettle Creek watershed through agriculture, forestry, and mining. The current rural nature of the watershed lends itself largely to forest cover, a mix of industry, recreation, and preservation. Most of the land (92%) is under public ownership, though much is available for forestry activities. There are areas of the state forest, such as the Hammersley Wild Area, that are considered to be noncommercial forests, with values other than the timber. The Ole Bull and Kettle Creek state parks, though relatively small in size, contribute to the protected and recreational nature of landuse in the watershed. There are a variety of significant and sensitive natural areas within the region. There are a number of ecologically important sites as classified by the Pennsylvania Natural Diversity Inventory (PNDI). These areas may be geologically unique features, rare habitats, or home for rare and endangered species of plants and animals.

Private lands contribute a small percentage (8%) of the area of the watershed, but are located in some of the more ecologically sensitive regions, such as floodplains. Any future development of private lands into resorts, for example, has the potential to negatively impact ecologically sensitive areas.

Agriculture occupies a small proportion of the watershed (0.3%), but a significant 15% of private land use. These areas are primarily in the

upper watershed; thus any impacts from sediment or chemicals could potentially be distributed through the entire watershed. In addition, if these areas are developed for other uses, such as resorts, then potential water quality impacts could also be noticed far downstream.

Wetlands occupy a small percentage of the area of the watershed (<1%), but their loss could have serious negative impacts for the quality of the stream network. Small wetlands, scattered throughout the watershed, serve a variety of roles, from water quality purification to flood storage. Though small in area, their impact on the overall quality of the Kettle Creek watershed is large. A larger proportion of the wetlands (37%) are on private lands.

The watershed is criss-crossed with many dirt and gravel roads. These roads, if not designed and maintained properly, have the potential to deliver excess loads of sediment into the tributaries and main stem of Kettle Creek. Sediment deposition can seriously impair wild trout production as well as impact upon stocked fishes.

**Fisheries.** Trout fishing holds a special place in the history of the Kettle Creek watershed, as well as the lives of its current residents. Kettle Creek has long been known as a special place for trout fishing, as far back as President Grant. There has been a documented decline in the brook trout fishery over decades, probably due to the introduction of brown trout. There has been a general decline in the fishing for both species as a result of thermal problems within Kettle Creek and its tributaries. Trout need clear and cold water to thrive yet many regions within the watershed indicate warming of the streams due to such things as siltation or a loss of riparian cover. Kettle Creek is one of the more heavily stocked streams in Pennsylvania, both by the Commonwealth itself as well as by private groups. Thus, it is considered very important to residents and seasonal visitors alike



to maintain and improve the conditions for native and stocked trout within the watershed.

**Habitat Assessment.** Many groups have assessed stream habitat in the watershed over the years, using several different approaches. Most of the stream parameters measured are considered to be good, with the exception of areas where there were problems with substrate, sediment deposition, channel flow, bank cover, and the width of the riparian zone. It is important to have all tributaries assessed using a standard protocol such that regions can be compared.

**Terrestrial Wildlife.** Most of Pennsylvania's native wildlife species can be found throughout the Kettle Creek watershed. Notable species include restored populations of elk, river otter, and fisher. Almost 300 species of wildlife could be found within the watershed based on habitat opportunities. Highest species diversity appears to be along the riparian corridors. There are no State Games Lands within the watershed, although hunting is allowed in most of the state forest lands.

**Water Quality.** Water quality within the watershed is quite good, with the exception of areas in the lower watershed affected by acid mine drainage. All waters above the Alvin Bush dam are classified as Exceptional Value (EV) by the Pennsylvania's Department of Environmental Protection. This is reflected in the lack of problems noted by numerous water quality studies conducted over the years. Occasional problems have been found, but the water quality is good. Where AMD impacts are found, there are obvious problems with acidity and pH, aluminum, iron, and manganese.

One means of assessing water quality is to see what lives in the water. Macroinvertebrates are small organisms that indicate water quality conditions. For example, only certain organisms can live in very polluted water. Concurrent with chemical data, analysis of the macro-inverte-

brates shows the water quality in much of the watershed to be good. There are fair macro populations in some areas throughout the watershed. Populations drastically decline below the Alvin Bush Dam (even before AMD locations).

Non-point source pollution (pollution that enters the streams from diffuse sources) might be an issue to watch within the watershed. Runoff from dirt and gravel roads carries not only the excess sediment from the road, but any chemicals attached to that soil. Given the prevalence of dirt and gravel roads throughout the Kettle Creek watershed, care should be taken to ensure that road crossings of streams are well managed. There is also potential for excess nutrient and pesticide inflow into the streams from agricultural regions.

**Atmospheric Deposition.** Atmospheric deposition (also known as acid rain) has been an identified problem for the northern United States for many years. Pennsylvania lies squarely in the region of highest acidic deposition. With poorly buffered soils and streams in the watershed, it is possible for acidification to occur, damaging both forests and streams alike. If stream pH drops below 5, very little in the way of aquatic life can live in those waters. If forest soils are impacted by excess acids, tree regeneration is slowed and we might begin to lose the forest. There currently is no known data on acid precipitation from the Kettle Creek watershed, although there are measurement stations in nearby watersheds. The region is at high risk for problems.

**Groundwater.** Most of the drinking water in the Kettle Creek watershed comes from relatively shallow wells. It is important that the groundwater quality be maintained if drinking water supplies are to be protected. There was no clearly identified groundwater pollution problem when a model that evaluates groundwater pollution potential was applied. It is important

to locate and protect those areas that serve as recharge points for groundwater. Any development on these sites could lead to introduction of pollutants (by paving) or a reduction in recharge, leading to supply problems.

## **C. Recommendations**

Seven broad topics to be addressed for effective, long-term stewardship of Kettle Creek emerged from the assessment and problem analysis phase of the Keystone Project. Core issues were identified for each topic, goals were formulated to respond to those issues, and many specific actions, approaches, and strategies are offered as a range of alternatives recommended for consideration and implementation by the Kettle Creek Watershed Association and its partners.

### **Topic: Watershed Identity**

The ecological and cultural features that distinguish and give identity unique to Kettle Creek as well as the connectivity of environmental conditions to internal, and external, social/political systems are key concepts imbedded in a successful "watershed approach". The goals defined for the watershed identity topic encompass: (1) a common future vision; (2) exploration and celebration of a rich history; (3) recognition of a strong visual quality derived from the forested mountain - valley landscape that is influenced by past and future land use and resource management; (4) protection of natural features related to residents' lifestyles and visitors' experiences; and (5) cooperative interactions to rally support for conservation initiatives.

Recommendations to broaden awareness and appreciation of identity focused on forming a committee charged with incorporating history components into watershed efforts in partnership with local, county, and state agencies. The intent is to develop and carry out projects por-

traying local history as a common bond among various stakeholders. Historical markers celebrating significant people, places, and events, interpretive modules linked to recreational opportunities such as logging rail beds, oral histories and photo documentation are among the suggested tools.

Conservation of the landscape expressing the Kettle Creek identity may most appropriately be implemented by voluntary, non-regulatory approaches. Mechanisms worthy of exploration include PA Scenic Rivers and/or Greenway designation of the PA Route 144 corridor and greatly expanded historic site interpretive signage. Proactive land use management ideas suggested would involve donated conservation easements or purchased development rights (PDR's) of unprotected critical areas (wetlands, floodplains, heritage attributes, visual amenities) identified and prioritized under the auspices of local planning programs.

The productive cooperative interactions the KCWA has forged with numerous partner agencies and institutions should be expanded and diversified to engage a larger support network. County planning/community development agencies, other watershed organizations in the West Branch, Susquehanna River, and Chesapeake Bay basins, and the Lumber Heritage Region are likely potential allies to leverage resources and support.

### **Topic: Education and Outreach**

Kettle Creek stakeholders must have insights and knowledge of the relationship of sometimes technical, possibly unfamiliar, and seemingly irrelevant watershed stewardship matters to their personal values and interests and those of the community as a whole and to understand KCWA's mission if they are to become involved and supportive of the organization's goals. Since educating current members and reaching out to non-members is particularly im-

portant for the relatively newly formed KCWA to communicate its story, three issues framed the recommendations offered.

First, fundamental watershed management concepts, baseline knowledge of problems, and communication of KCWA's mission and achievements should be emphasized at this early stage. Maps of watershed boundaries displayed at public places, wide dissemination of annual reports/newsletters/project announcements to include consistent electronic and print media coverage and name recognition. Graphic thematic posters produced by the keystone team for school, church, club, retail locations or project sites may augment the traveling display.

Second, stakeholders need accurate, reliable information to constructively participate in decision-making discussions affecting resource policy on public lands or their individual actions to promote environmental stewardship. Formation of an Education/Outreach committee and use of an E/O coordinator, knowledgeable volunteers and specialists in various fields to deliver educational programs on current and upcoming topics is recommended. Numerous sources of technical and financial assistance, educational materials, pamphlets, fact sheets, web sites are available and referenced in the report.

Third, establishing a regional watershed education network in partnership with schools, conservation districts, watershed groups and others would stretch limited resources through sharing costs.

### **Topic: Community Capacity**

KCWA's marshalling of external constituencies, such as non-resident anglers and state and federal agencies, to successfully implement ambitious stream habitat improvement and abandoned mine drainage remediation is widely recognized, well-established, and has gained much

credibility for the association. Directing attention now to enhancing local capacity at the "community" level, strengthening ties with people in leadership positions, and investing in organizational development will pay similar dividends.

The issues framed dovetail with the preceding watershed identity and education and outreach functions: (1) increasing dialogue and working relationships between KCWA and local government, business, agricultural landowners, and other interests not currently engaged, including potentially conflicting viewpoints; (2) promoting inter-municipal collaboration; and (3) envisioning KCWA's broader, long-term mission and support base.

To increase dialogue and interaction, it is recommended that KCWA volunteers be appointed to attend municipal, school, county, service organization, clubs, Grange, and other meetings and to extend reciprocal invitations to KCWA meetings and events. Under-represented and nontraditional stakeholders should be systematically identified and non-confrontational forums developed to improve communications.

The need to build a viable organization for long-term stewardship would be addressed through periodic assessment of its mission, development of a five-year financial plan, membership recruitment and retention plan, and other ways and means.

### **Topic: Fisheries & Habitat**

Habitat conditions are the primary determinants influencing the fisheries resources of the Kettle Creek main stem and important coldwater tributaries. The issue of coldwater habitat is a central theme and a driving force behind the Kettle Creek initiative. Warm water fisheries in the lower main stem should also be recognized and

managed as a significant component of the watershed's recreational and biological assets.

Habitat recommendations are offered across a wide range. Bio-assessment techniques should be refined to better monitor conditions in streams of varying gradient following a protocol and data form developed for Kettle Creek. The KCWA habitat advisory committee can provide oversight and facilitation of expanded bio-assessment in the subwatersheds listed in the report.

Numerous stream reaches and subwatersheds are recommended for habitat improvement focused on five categories of habitat condition specific to the streams. The parameters used to evaluate and target habitat improvement needs are: (1) fish and invertebrate living conditions; (2) riffle and velocity-depth combinations; (3) sedimentation; (4) channel condition; and (5) bank condition. Techniques such as bank vegetation plantings, cross vanes and J-hooks, and live cribwalls typically used to address each type of habitat problem are referenced in the recommendations.

Angler surveys (last done in 1984) are recommended tools to monitor wild trout populations and establish management strategies, including hatchery trout stocking policies and potential modification of harvest regulations toward a goal of more self-sustaining wild trout populations.

### **Topic: Thermal Quality**

Degradation of cold water ecosystems by elevated summer water temperatures is a long-standing concern in Kettle Creek. The problem is rooted in landscape scale change from historic logging and the resultant destabilization of stream channel morphology and riparian forest cover from which Kettle Creek has not yet, and may never, fully recover. Mitigation of thermal degradation to the extent possible in critical

tributaries would be maximized utilizing data acquired through a watershed-wide thermal monitoring study and a prototype streamside canopy cover GIS assessment of the Long Run subwatershed initiated by the KCWA and the Keystone Project.

Recommendations are to continue the thermal study as presently installed. After one year, and annually thereafter, evaluation of results would permit relocation of equipment from unimpaired streams to new sites to acquire comprehensive data. The information would serve to prioritize on-going mitigation efforts in the most cost-effective manner and provide the greatest benefits. Thermal assessment is also recommended for the Alvin Bush Dam, small impoundments, headwater agricultural areas, and tributaries such as Hammersley Fork with channel alterations at the confluence of the main stem.

The Long Run streamside canopy assessment model should be extended to other subwatersheds and coordinated with the thermal data acquisition locations and findings to identify and prioritize future treatment sites to establish and improve riparian buffers of native trees, shrubs, and herbaceous plants.

### **Topic: Water Quality**

Water quality, a primary indicator of watershed health, is remarkably good generally in Kettle Creek watershed but there are issues relating to several types of "non-point sources", including sediment from dirt and gravel roads and paved road runoff, acid mine drainage (AMD), acidic deposition, and agricultural runoff. Acquisition of reliable water quality and stream flow data is needed. The role of wetlands in protecting water quality is comparable to the wildlife habitat and biological diversity values of these important resources.

Nutrient reduction recommendations through Best Management Practices are focused on the

upper watershed where agriculture is concentrated. Target watersheds, listed in rank order of priority are Long Run, Sliders Branch, Germania Branch, Cross Fork, and Little Kettle Creek. Educational programs on proper maintenance and installation of private wastewater treatment systems, demonstration systems at State Parks, and Bureau of Forestry upgrade programs at leased camps offer realistic alternatives.

High priority was assigned to the Dirt and Gravel Road program problem sites at Long Run, Cross Fork, upper Kettle Creek main stem, Sliders Branch, Germania Branch, and Little Kettle Creek. Pre- and post-construction monitoring of effectiveness should be done and a "road husbandry" program of community volunteers established to identify and refer candidate locations to municipal, county and state authorities as appropriate.

Training sessions sponsored by the state program would develop knowledge of volunteers.

Major abandoned mine drainage abatement has been initiated; collaboration with other nearby watershed groups (Beech Creek) on expensive sampling and monitoring would have mutual benefits. Establishing educational/research demonstration sites would attract universities and government-funded efforts which would promote construction of additional passive treatment systems.

Recommended data acquisition actions involved: a standard sampling protocol and sites; estimated flow measurement techniques; and relocation of the Water Quality Network (WQN) to the Cross Fork USGS stream gauge above the influence of Alvin Bush Dam.

Staff gauges and flow-rating curves are to be established by the thermal study research team by the end of summer 2001; on-going flow/temperature data collection by volunteers should continue at those locations.

The potential for acidic deposition impacts on water quality, and wild trout populations, in tributaries with poorly buffered bedrock geology of the Pottsville and Allegheny groups should be assessed during spring snowmelt or intense rain events. Sampling by portable pH meter and field kit tests for acidity/alkalinity would suffice to identify problem streams for more in-depth analysis of aluminum concentrations as a critical mortality factor for trout and other fish species.

Wetland occurrence modeling by the Keystone Project identified 472 acres of additional wetlands not previously inventoried by the National Wetlands Inventory (NWI). More precise delineation of the GIS database provided in the Keystone report by a university or DCNR-funded ground inventory should be performed. Management recommendations include a 25-foot buffer between identified wetlands and land development and a 2:1 mitigation ratio of disturbed wetlands, including a functional assessment after mitigation.

Purchased easement programs such as the USDA Wetland Reserve and other funding programs are available.

### **Topic: Landuse**

Land conservation goals to maintain Kettle Creek's agricultural production base and heritage, the rural character and historic sites of the landscape, sensitive natural areas such as wetlands, floodplains, riparian corridors, scenic vistas, steep slopes, and unique biota or habitats are integral to a comprehensive watershed stewardship initiative.

The issue of declining agricultural production and increased economic value of land for even limited residential and commercial development in critical headwaters may be addressed by encouraging landowner participation in the county Farmland Preservation program. Per-

petual agricultural land easements, Environmental Quality Incentives (EQIP), and Clean and Green provide economic incentives for voluntary land conservation. Prime farmland soils and those farming operations implementing Best Management Practices to protect watershed resources should receive preferential ranking and compensation through both private and public land conservation programs.

Baseline inventories and periodic updates of existing structures and potential development areas are needed. Voluntary land conservation techniques may be applied to maintain existing open space, low density villages, rural architectural identity and housing styles; good development that follows sustainable practices, links to existing infrastructure, and protects the watershed's rural character should be encouraged and recognized. Cluster development in environmentally suitable areas, avoiding floodplains, and poor wastewater treatment sites. Establish performance standards such as 50-foot buffers between buildings, utilities, and roads and natural features and zero storm water discharge for 25-year storm events.

A comprehensive inventory of natural areas is needed to promote awareness and to form the basis for proactive efforts to protect these cherished, high value assets. There is great potential for connectivity of large, contiguous natural systems, recreational values, and important watershed functions through collaboration of KCWA, Bureau of Forestry, local and county planners, and many other public agencies and private partners.

A watershed-wide land conservation initiative of this magnitude is clearly a substantial undertaking, exceeding the exemplary collaboration brought to bear on localized problems such as mine drainage abatement. The ability of the Kettle Creek community to meet the challenge will have a profound influence on the long term stewardship of the watershed.