Aquetong Creek
Coldwater Heritage Plan

January 2007

Prepared For:

Bucks County Chapter of Trout Unlimited

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Executive Summary

The Aquetong Creek Coldwater Heritage Plan (CHP) addresses the feasibility of reestablishing a sustainable coldwater fishery within the Aquetong Creek Watershed, located in central Bucks County, Pennsylvania. The plan provides a description of the watershed; reviews existing and historical studies and water resources-related initiatives; discusses the outstanding values of the watershed and some of the challenges and constraints associated with protecting and enhancing Aquetong Creek; and provides recommendations for enhancing cold water resources within the watershed.

The Aquetong Creek watershed drains a 7.5 square mile area located in central Bucks County, Pennsylvania within Solebury Township and New Hope Borough. The watershed is characterized by a mix of woodlands, agricultural areas, and residential and commercial developments. Underlying bedrock geology includes significant limestone and dolomite formations that traverse the central portions of the watershed. One of the most significant springs in Southeastern Pennsylvania, Ingham Spring, gives rise to Aquetong Creek's most significant tributary.

Historical studies by the Pennsylvania Fish and Boat Commission (PAFBC) and the Pennsylvania Department of Environmental Protection (PADEP) suggest that habitat quality and macroinvertebrate diversity would be supportive of a cold water fishery, but found an absence of coldwater fish. Studies conducted by F. X. Browne, Inc. characterized summertime thermal conditions above and below Aquetong Lake, a 15-acre impoundment located just downstream of Ingham Spring. These studies suggest that thermal impacts from the impoundment are significantly impairing thermal conditions in downstream waters and that mitigation of these thermal impacts will be critical to reestablishing a coldwater fishery within Aquetong Creek. Plans by Solebury Township to install a coldwater bypass channel around the lake will significantly improve downstream thermal conditions.

Other potential current and future impacts to Aquetong Creek include the effects of additional development. Solebury Township is currently implementing several watershed management initiatives including the adoption of progressive water-resources protection ordinances, an aggressive and highly successful land preservation program, and groundwater management planning which will significantly reduce the impacts of development on in-stream conditions.

The restoration of a cold water fishery within the Aquetong Creek is feasible considering the generally favorable in-stream habitat and biotic resources, the commitment of Solebury Township to implementing sustainable watershed management and land preservation programs, and the on-going stewardship of Bucks County Trout Unlimited (BCTU) and other local conservation groups. The plan outlines the following five broad recommendations in support of restoring a highly-functioning cold water fishery within the Aquetong Creek watershed.

1. Mitigate thermal impacts from impoundments
2. Provide a sustainable approach to managing development and associated infrastructure that protects stream habitats, in-stream flows, and prevents increases to stream temperatures
3. Protect and enhance the existing stream corridor
4. Establish a long term watershed monitoring program
5. Establish/enhance sense of place

The plan also strongly recommends petitioning and obtaining EV status for the entire watershed. EV status will provide additional statutory protection and funding opportunities and is a primary recommendation of this plan.

Introduction and Description of Watershed

Introduction

The Aquetong Creek Coldwater Heritage Plan (CHP) addresses the feasibility of reestablishing a sustainable coldwater fishery within the Aquetong Creek Watershed, located in central Bucks County, Pennsylvania. Funding for the CHP has been provided through a grant from the Coldwater Heritage Partnership Program, to the Bucks County Chapter of Trout Unlimited (BCTU). BCTU's mission is to conserve, protect, and restore the wild trout populations of Bucks County's coldwater streams. Solebury Township, which encompasses the large majority of the watershed and has been very active in implementing a range of on-going watershed-related initiatives within the Aquetong Creek watershed, has been a key partner in the preparation of this plan.

The CHP provides a description of the watershed; reviews existing and historical studies and water resources-related initiatives; discusses the outstanding values of the watershed and some of the challenges and constraints associated with protecting and enhancing Aquetong Creek; and provides recommendations for enhancing coldwater resources within the watershed.

Description of Watershed

The Aquetong Creek watershed encompasses 7.5 square miles in Solebury Township and New Hope Borough, Bucks County (Figure 1). Most of the watershed is located in Solebury Township, with only a small portion of the downstream-most section of the watershed located within New Hope Borough. The drainage network consists of the mainstem of Aquetong Creek, as well as a principle tributary flowing from Aquetong Lake, a 15-acre impoundment currently owned and operated by the Pennsylvania Fish and Boat Commission (PAFBC). Downstream of the confluence with the Aquetong Lake tributary, the mainstem flows due east for approximately 2 miles before entering the Delaware River at New Hope Borough. Aquetong Lake is formed by a 500-foot long earthen dam, which is fed by Aquetong Spring, known locally as Ingham Spring. This limestone spring produces approximately 2,000 gallons of water per minute, and is thought to be one of the most productive springs in Southeastern Pennsylvania. Several other small impoundments, including Honey Hollow pond, are found on the mainstem as well as minor tributary branches upstream of the confluence with the Aquetong Lake tributary.

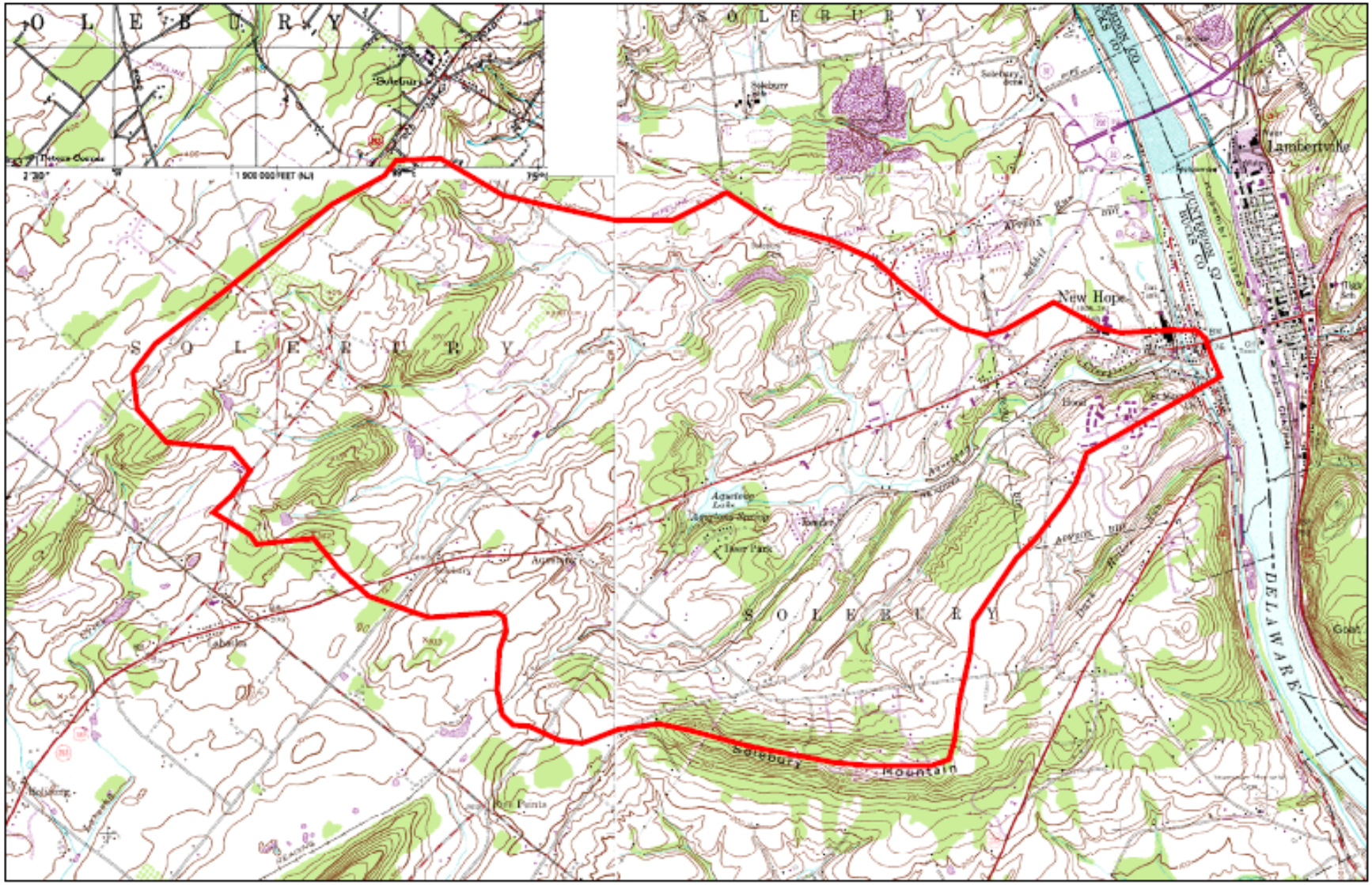
Although the property containing Ingham Spring and Aquetong Lake is currently owned by PAFBC, Solebury Township is in final negotiations with PAFBC to acquire the property. Solebury Township plans to rehabilitate the existing dam and develop the property as a multi-use recreational facility. BCTU has been working with PAFBC and Solebury Township to ensure that a coldwater bypass (or similar thermal mitigation) will be included as an essential part of Solebury's redevelopment plans for the property. To date, these negotiations have been productive, with the parties continuing to work on specific language in the agreement of sale for the property that will mandate the bypass. Continued cooperation between Solebury Township, BCTU, PAFBC and other stakeholders will be required to implement a fair, flexible, adaptive approach to managing the allocation of the Ingham Spring flow to satisfy both downstream flow and thermal requirements and provide

sufficient flow to maintain water quality and level conditions in Aquetong Creek supportive of intended recreational uses.

Geologically, the far upper reaches of the watershed are underlain by Stockton sandstones. Much of the center portions of the watershed, encompassing the vicinity of Ingham Spring, flow over Cambrian and Ordovician limestone and dolomite formations (Allentown, Beekmantown Group, and Leithsville formations), while the lower portions of the watershed are situated in Brunswick siltstones and mudstones. The limestone and dolomite formations that extend into the Aquetong Creek watershed are unique within central Bucks County and are relatively rare in Southeastern Pennsylvania. Streams draining these geological formations are commonly characterized by coldwater thermal conditions due to substantial year-round groundwater contributions to baseflow. The importance of limestone aquifers is highlighted by the special protection status afforded to coldwater streams under Pennsylvania's Water Quality Standards.

Land use in the watershed is a mix of agriculture, developed areas, and woodlands. Despite significant development in the region in recent years, growth within Solebury Township has been limited due to an aggressive land preservation program. The wooded and agricultural lands therefore remain present in the watershed.

The Pennsylvania Department of Environmental Protection (PADEP) lists the entire Aquetong Creek drainage network as a High Quality, Coldwater Fishery (HQ-CWF). This Chapter 93 water quality designation offers special protection during proposed development and infrastructure projects, requiring plans that meet anti-degradation criteria. Special protection status is also helpful in leveraging state and federal funding for open space protection, watershed management, and stream protection projects.



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Projection: UTM Zone 18 NAD 1927

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Drawn By: JMD
Checked By: SJS
Plot Date: 01/10/07

Figure 1: Map of Aquetong Creek Watershed
Aquetong Creek
Coldwater Heritage Plan

Notes:

1. Data accuracy is limited to the accuracy and scale of the original data sources.
2. This map is part of the Aquetong Creek Coldwater Heritage Plan and should be used in conjunction with the compiled text.

Sources:

1. USGS topographic digital raster graphic layers were obtained from PA Spatial Data Access (PASDA)
2. Aquetong Creek watershed layer created by F. X. Browne Inc.

Historical and On-going Studies and Initiatives

Water resources planning

Over the last several years, Solebury Township has initiated several important water resource management activities that will significantly influence environmental conditions within Aquetong Creek. These management activities include township ordinance revisions, groundwater protection, water quality and habitat studies, and a highly successful land preservation program.

Baseline aquatic characterization

The Township is funding on-going baseline studies to better characterize existing aquatic resources throughout the township. These studies include extensive assessments of physical, biological and chemical parameters including:

- Stream geomorphology
- Stream flow
- In-stream habitat
- Water chemistry (including pH, conductivity, dissolved oxygen, and fecal coliform),
- Macroinvertebrates
- Fish communities

The Township is also funding a study of ponds to determine their impacts on the township's streams.

Ordinance revisions

In recent years, Solebury Township has adopted progressive zoning, subdivision, and stormwater ordinances that will help to protect water quality, improve groundwater recharge, and maintain in-stream flows. For instance, one of the provisions of Solebury Township's stormwater ordinance requires no net increase in discharge, which is more restrictive than the NPDES Phase 2 stormwater regulations in Pennsylvania. Recent revisions to the township's grading and soil erosion control ordinance require erosion and sediment control plans for all developments greater than 1,000 s.f. rather than the 5,000 s.f. required by state regulations. The Township is also discussing ordinances that would require bridge designs with stream-friendly provisions, such as crossings that do not constrict the flow of water, and adequate floodplain retention. To support this effort, the Township has obtained grant funding to develop criteria for better bridge design.

Groundwater protection

Solebury Township is actively working to protect groundwater resources in the Aquetong Creek watershed through a variety of regulatory and non-regulatory approaches. A summary of these activities is included below:

1. The Township is currently mapping the extents of the groundwater aquifer that feeds Ingham Spring. The Township will then map groundwater recharge areas to the aquifer and eventually plans to manage development in recharge areas through the creation of a zoning overlay district.

2. Solebury Township is working with neighboring Buckingham Township to identify the region as a state Critical Water Planning Area under Act 220. If established, a Critical Area Resource Plan would be developed for the area. This plan would include a water availability evaluation, assessment of water quality/quantity issues, and will identify existing and potential impacts to water resources uses.

3. Solebury Township is conducting on-going groundwater studies to determine the effects of current and projected water withdrawals (primarily from two wells owned and operated by Bucks County Water and Sewer Authority) on aquifer yields and has conducted preliminary discussions with Bucks County Water and Sewer Authority concerning collaborative approaches to sustainable aquifer management.

4. The Township is also encouraging recharge, recycling, and reuse of water and wastewater in existing and new developments including the use of grey-water systems. The Township's Environmental Advisory Committee (EAC) is conducting educational programs to encourage watershed-friendly practices among homeowners. Through funding from the Delaware River Joint Toll Bridge Commission, the Township is also working on a project to assess groundwater recharge and stormwater treatment opportunities associated with proposed improvements to SR202 from the Delaware River toll bridge to SR179.

Land preservation program

Solebury Township has implemented an aggressive and successful land preservation program. Solebury Township's Land Preservation Program was the 2006 winner of the Pennsylvania Planning Association's Outstanding Planning Award for Implementation. Since 1998, Solebury Township has eased almost 2,300 acres of land on 40 properties, using agricultural and conservation easements. Almost 2,000 acres have been protected by Heritage Conservancy and Natural Lands Trust, and over 700 acres have been protected in parks and open space by the township, state, and county. Close to 5,000 acres of the 17,900 acres in Solebury Township has so far been protected in some way from further development.

PA Fish and Boat Commission Studies

Macroinvertebrate and fish electroshocking surveys were completed on the Aquetong Creek on April 23, 1985. Approximately 350 feet of stream was surveyed, beginning at the base of the dam below the lake, to the edge of the wooded section downstream.

The results of the qualitative macroinvertebrate study showed an abundance of mayflies and scuds. Other identified insects were stoneflies, beetles, caddisflies, dragonflies, damselflies, midges, crane flies, water striders, crayfish, wood lice, planarians, and snails. Different species vary in their tolerance towards water pollutants, with caddisflies, mayflies, stoneflies, and certain types of snails and beetles being the most sensitive. These species will not be found in abundance, if at all, in polluted water.

The qualitative electrofishing survey, completed on the same date, showed an abundance of bluegill, especially at the base of the dam, and a moderate abundance of carp. Other species,

noted in low abundance were American eel, smallmouth bass, redbreast sunfish, largemouth bass, white crappie, creek chub, comely shiner, hybrid sunfish, golden shiner, pumpkinseed, white sucker, and bullhead. The fish noted in the survey are either warm water species or species that are transitional between cold and warm water. Some species probably entered Aquetong Creek from the lake above, and others most likely traveled upstream from the Delaware River. No coldwater species, such as trout, were found downstream of Aquetong Lake, in the area of the survey.

Aquatic Biology Investigation for Aquetong Creek
This investigation, performed to determine existing water quality associated with a proposed sewage treatment facility, was completed by the PA Department of Environmental Resources (now PADEP) on July 6, 1993, and published in a report dated November 21, 1994. Two representative locations were selected for testing, one at river mile 2.65, Sugan Lane, Solebury Township, and another at river mile 2.18, 150 meters downstream from Aquetong Lake tributary. The investigation concluded that Aquetong Creek exhibited good to excellent water quality and a well-established, diverse benthic community at both stations surveyed. No evidence of trout reproduction was observed, although the study found that suitable habitat exists. The study indicated that the fish community was somewhat less diverse and contained fewer individuals than would have been expected based on water quality and available habitat.

Threat Assessment for Smart Conservation
This report, completed in January 2003 for the Natural Lands Trust, examines the most important indicators of the likelihood of development, scores them, and determines the relative threat of development in 239 municipalities across the 5-county Southeastern Pennsylvania (SEPA) area. The information is being used to establish a prioritization of lands for future conservation funding decisions. The 239 municipalities were scored based on five categories:

- Trend Friction
- Employment Center Travel Times
- Building Activity – Proposed Housing Units Relative to Municipal Size and Available Land
- Vulnerability Index
- Sewer Service Areas

A final composite threat map was developed by using weighted scores for the five categories above. It displays relative threat of development in SEPA for the 239 municipalities. The results indicate that Solebury Township is situated in a threat "hotspot".

Ingham Spring Dam Removal Study
The study, prepared in November 2004 for BCTU, measured summer stream temperatures above and below Aquetong Lake and found that the lake has a significant warming effect on stream temperature. Mean daily stream temperatures upstream of the lake were ~15° F cooler than downstream temperatures over the course of the study. The study found that the difference in temperature is sufficient to shift the thermal regime in Aquetong Creek

from one amenable to the year-round sustenance of cold water fishes to one where the successful reproduction of cold-water fishes would be unlikely.

Follow-up studies conducted by BCTU in 2005 found significant thermal impairment at three additional stream stations. These studies suggest that thermal stress is widespread within the Aquetong Creek watershed.

Unique and Outstanding Values of the Watershed and Stream

Aquetong Creek has a number of unique and outstanding values:

Ingham Spring: Ingham Spring is a rare and special resource. Several sources indicate that it is one of the most productive springs in Southeastern Pennsylvania, while other publications note the spring pool's mysterious beauty as well as the sacredness of the spring site for native Leni Lenape Indians.

Intact stream habitats and riparian buffers: A review of past studies and aerial photographs of the watershed suggest that riparian corridors and in-stream habitats are relatively intact. The high quality of existing habitats creates the potential for successful reintroduction of wild trout if thermal conditions can be addressed.

Proactive municipal involvement: Solebury Township is proactively dealing with development pressures by adopting strong ordinances, and encouraging the preservation of land. Solebury has a strong commitment to implementing an integrated water resources management plan and is conducting new studies that will help to further characterize existing surface and groundwater resources and provide a baseline for their sustainable management. The township's commitment to sustainable, long term water resource management suggests that restoration efforts will not be undermined by future impacts to water resources.

Historical significance: The history connected to Aquetong Creek and the surrounding watershed makes it an important resource to restore and preserve. The historic period ranges from the Native Americans, through the early industrial age, and the Victorian era. The name Aquetong originated from a local Indian word meaning "place of the pine trees", which referred to the pine forest that the creek ran through at the beginning of its route. Towards its end, the creek forms a scenic waterfall near a former water-powered mill, now known as the Bucks County Playhouse. The historical significance of the watershed creates an opportunity to engage and interest local watershed residents in actively restoring and protecting the area.

Areas of Concern and Potential Conflicts

There are several major areas of concern for the Aquetong Creek watershed that must be addressed if a viable, sustainable coldwater fishery can be established within the Aquetong Creek watershed.

Residential and commercial development: The watershed is considered a developmental threat hotspot according to the Threat Assessment for Smart Conservation study. Despite best efforts, development can lead to potential increases in stormwater runoff that may degrade the stream channel and negatively impact in-stream habitat as well as reduce groundwater recharge. The discharge of stormwater runoff and wastewater into the stream may also affect water quality. Future development in the watershed will need to be carefully managed if existing water and habitat quality is to be maintained.

Groundwater withdrawal: The ability of Aquetong Creek to support a coldwater fishery is strongly tied to groundwater flows. Currently, water is being pumped from the aquifer feeding Aquetong Creek via two wells owned and operated by Bucks County Water and Sewer Authority. A portion of wastewater generated within the watershed is also being pumped to Lambertville for treatment, reducing groundwater recharge. It should be noted that Solebury Township is aggressively managing new wastewater discharges within the watershed through several programs including regulations that require on-site systems. In the long term, the maintenance of thermal and in-stream flow conditions supportive of a coldwater fishery will depend strongly on the maintenance of the regional aquifer that feeds Ingham Spring.

Aquetong Lake: Temperature data collected by the Ingham Spring Dam Removal Study (F. X. Browne, Inc., 2004) suggests that temperatures are much higher below Aquetong Lake than above the lake, by an average of at least 15 ºF. Both the PAFBC and PADEP studies of the watershed suggest that habitat quality and food availability are sufficient to support trout populations. Taken in sum, the body of previous studies in the watershed suggests that thermal impairment, of which Aquetong Lake is likely the major source, is the primary barrier to establishing a coldwater fishery within the Aquetong Creek at present. Along with careful growth and water management, the mitigation of thermal impacts from Aquetong Lake (and to a lesser extent, other impoundments in the watershed) through the installation of a coldwater bypass system will be key to restoring coldwater communities to the watershed.

Recommendations and Next Steps

Aquetong Creek watershed clearly has the potential, through active restoration and stewardship, to be restored to a high quality coldwater fishery. The following sections of the plan outline several of the key steps required to restore and maintain a coldwater fishery within the Aquetong Creek watershed. BCTU and Solebury Township should initially discuss the recommendations and next steps to establish a lead organization and timeline for each.

Central to the implementation of many of the recommendations outlined below will be to apply for and obtain Exceptional Value (EV) status for the Aquetong Creek watershed, the highest water quality designation defined within Pennsylvania's Water Quality Standards. EV status will provide additional measures of protection for the watershed through the Pennsylvania's erosion and sediment control and anti-degradation programs and will enhance the watershed as a priority for state funding.

1. Mitigate thermal impacts from impoundments

a. Incorporate a coldwater bypass into the restoration plan for the Aquetong Creek dam

Solebury Township and Bucks County Chapter of Trout Unlimited have reached an agreement-in-principle that would incorporate a coldwater stream bypass around the impoundment to redirect a percentage of the flow from Ingham Spring into the downstream channel, allowing more favorable conditions for the establishment of a coldwater fishery downstream of Aquetong Lake.

A coldwater bypass system should be included in any plans to restore or rehabilitate Aquetong Creek dam. It is recommended that an initial study be conducted prior to the design of the coldwater bypass system that would establish the initial allocation of water to the bypass. The allocation of water should meet both flow and temperature requirements at multiple downstream stations. Sufficient flow must be maintained to Aquetong Lake to maintain water quality and lake levels supportive of the lake's intended recreational use.

It is recommended that the bypass system be constructed so that the flow allocation can be adjusted on an intra-annual and inter-annual basis based on both downstream thermal and flow conditions and in-lake water quality and lake level conditions. After initial flow allocations are determined, an adaptive management approach is recommended to refine and adjust allocations over time. The adaptive management approach would allow adjustments to flow allocations at fixed internals (e.g., yearly, biennially) to be determined based on regularly collected in-stream and in-lake monitoring data.

A consensus agreement should be developed that outlines the initial flow allocation, the type of allocation (fixed or variable), the frequency and type of proposed in-lake and in-stream monitoring activities, and the decision making process (responsible parties, frequency) for adjusting the flow allocation based on monitoring data.

b. Study other impoundments located in the stream network, such as Honey Hollow and others, to determine thermal impacts, if any, and engage dam owners to determine mitigation and/or removal options

There are several other impoundments in the Aquetong Creek watershed that should be evaluated for impacts to upstream and downstream waters. The feasibility of various mitigation options including fish passage, partial or full removal, or the "no build" alternative should be evaluated in terms of the ecological, economic, and cultural costs and benefits associated with each option. A comprehensive feasibility process helps to inform the decision making process and helps to foster a collaborative design process in which the full range of costs and benefits associated with various stakeholder groups (e.g. landowners and conservation groups, etc.) are considered.

2. Provide a sustainable approach to managing development and associated infrastructure that protects stream habitats, in-stream flows, and prevents increases to stream temperatures

Impervious surfaces, such as driveways, roads, and rooftops, can result in the heating of stormwater runoff, which in turn can result in thermal stress to receiving waters. The DVRPC Threat Assessment and other planning documents clearly recognize the Aquetong Creek watershed as a high growth area.

a. Continue implementation of land conservation programs

Working with county governments, private land conservancies and others, Solebury Township has acquired and protected significant areas of open space. The continued implementation of these programs will be critical to preserving aquatic conditions required for a viable coldwater fishery. Solebury Township should consider the use of a GIS-based approach to prioritize future acquisitions based in part on surface and groundwater protection requirements. Priority should be given to acquiring lands in headwater areas and in groundwater recharge zones. Land conservancies as well as private consultants can conduct these types of analyses.

b. Require infiltration-based stormwater management for all new development

Solebury Township is a small MS4 in a designated urban area and as such is required under its Phase II NPDES permit to implement minimum control measures, including public education and outreach, illicit discharge determination, construction site runoff control, post-construction runoff control, and pollution/prevention and good housekeeping. In compliance with NPDES Phase II regulations, Solebury Township has adopted stormwater management ordinances that require post construction stormwater management. Further, all proposed developments in Solebury Township are required to provide peak flow, volume, and water quality control to comply with Phase II NPDES permitting requirements. Several of the provisions of Solebury Township's stormwater ordinance require more stringent controls than those mandated by NPDES regulations. Given the controls currently in place, hydrologic and water quality stormwater impacts *should* be well controlled from *new* development, particularly if stormwater facilities are well maintained. However, Solebury

Township should implement a long term maintenance program in cooperation with private homeowners associations to ensure that infiltration-based BMPs are maintained over time.

Also, Solebury Township should consider adopting an adaptive management program to assess the efficacy of its stormwater ordinance programs by establishing in-stream monitoring locations downstream of newly developing areas. These monitoring locations can be used to assess changes to in-stream conditions over time that can be used to determine whether existing ordinances are sufficiently minimizing impacts or whether ordinance revisions should be considered.

c. Identify and remediate existing sources of thermal, flow, and water quality pollution.

Working with local non-profits and other partners, Solebury Township should consider conduct inventories of areas developed prior to the adoption of progressive ordinances to identify sources of thermal and water quality pollution and flow modification. Visual assessment protocols, such as those recommended by the Center for Watershed Protection, can be used to identify pollution sources and potential project opportunities. These may include uncontrolled runoff from impervious surfaces and runoff from conventional stormwater detention basins and ponds. Grants are available through the PADEP Growing Greener program and other programs to implement stormwater retrofit projects. County conservation districts, private consultants, and other groups can provide varying levels of assistance to implement such projects.

d. Sustainably manage existing groundwater resources

Groundwater flow is critical to providing year round baseflow to Aquetong Creek. Currently, Solebury Township is working to map the extents of the groundwater aquifer that feeds Aquetong Creek and to assess the impacts of current water withdrawals on aquifer yields. These studies combined with growth projections should allow the Township to develop estimates of future water needs. Based on the outcome of these studies, we would recommend that Solebury Township establish a groundwater recharge zone (zoning overlay), within which the creation of new impervious areas would be restricted to allow maximum aquifer recharge.

Solebury Township should work cooperatively with Bucks County Water and Sewer Authority to establish voluntary groundwater withdrawal limits that will ensure the protection of baseflow in Aquetong Creek. Solebury Township should move forward with its petition to the State and the Delaware River Basin Commission (DRBC) to extend the Southeast PA Groundwater Protected Area into Solebury Township, and with its plans to petition PADEP for the establishment of an Act 220 Critical Water Planning Area in coordination with Buckingham Township.

e. Evaluate best management practices for wastewater treatment

As part of its 537 plan revision, the Plan's recommendation is that Solebury Township consider the feasibility of eliminating or reducing the transfer of wastewater to Lambertville treating this water, instead using best management practices including decentralized wastewater disposal systems such as spray or drip irrigation. This would enhance

groundwater recharge within the Aquetong Creek watershed. With the Township's many acres of conserved lands, a suitable spray or drip irrigation system location may be available. An analysis of potential field locations would be a good first step to explore for converting to spray and/or drip irrigation.

3. Protect and enhance the existing stream corridor

Providing forested buffers around all surface water features in the Aquetong Creek watershed is a critical aspect of establishing and maintaining a healthy coldwater fishery. Forest buffers reduce stream temperature, reduce streambank erosion, provide a source woody debris to the stream, and help to filter pollutants from surface runoff. Based on a review of aerial photographs and previous studies, most of the stream miles in the watershed appear to be well buffered. However, there are also several locations where the stream is unbuffered or minimally buffered.

a. Restore riparian buffers along currently unbuffered sections of stream

Bucks County Trout Unlimited, Bucks County Conservation District, Solebury Township, and other partners should implement a program to identify and engage riparian landowners with absent or degrading buffers. Several funding programs exist to assist landowners with voluntary riparian buffer projects.

b. Limit new development in riparian corridors and floodplains

Solebury Township and Buckingham Township should adopt riparian buffer and floodplain protection ordinances that limit new development in these areas.

4. Establish a long term watershed monitoring program

A long term monitoring program including monitoring of stream geomorphology, biological communities, in-stream habitats, temperature, and water chemistry should be established within the Aquetong Creek watershed. Solebury Township, Bucks County Conservation District, BCTU, and private consultants can play important roles in implementing this program. PADEP and PAFBC may be able to provide funding and technical support. Ideally, water quality testing, macro-invertebrate and habitat assessments should be conducted every 2-3 years at 2-3 sites throughout the watershed. Temperature and stream geomorphology should be measured yearly at 5-7 sites. A "watershed report card" that summarizes the results of the monitoring program can be distributed to watershed residents.

5. Establish/enhance sense of place

Critical to the success of any restoration or protection initiative, is the degree to which local residents incorporate the resource in question into their sense of place. Ingham Spring is a special place that is unique in the region. To the extent possible, residents should be exposed the unique nature of this resource and the need for its protection.

a. Provide historical interpretation/access to the Ingham Spring pool and property
b. Work with New Hope Borough to install watershed and historical signage

Summary and Conclusions

Previous studies and information sources indicate that suitable conditions already exist for the establishment of a coldwater fishery upstream of Aquetong Lake. Ingham Spring, with its limestone and dolomite geology, provides the cool temperatures required by trout, with an average temperature of 53 ºF, recorded during one study (F. X. Browne, Inc., 2004). The study also notes the anecdotal reports of wild trout in the reaches above Aquetong Lake. However, the portion of stream upstream of Aquetong Lake constitutes a small fraction of the total surface water drainage network.

Downstream of the lake, the resident fish populations are a reflection of the warmer temperatures found by the Ingham Spring Dam Removal Study, with an average temperature of 68 ºF during the study period. The PA Fish and Boat Commission reported a variety of fish species that are tolerant of warm water, as well as transitional warm/cold water species, just below the dam, in a study from April 1985. No coldwater fish were found to be present in the area at the time of the PAFBC study. There were, however, several pollution-sensitive macroinvertebrate taxa found living downstream of the lake. This is a positive indicator of good water quality below the dam at the time of the PAFBC study. A visual assessment of the downstream conditions conducted by the Ingham Spring Dam Removal Study found that the habitat conditions appear to be "sufficient to support trout development, feeding and reproduction. Pool and riffle habitats are well-developed, the stream channel is well-shaded, banks are generally well-vegetated and stable, and large woody debris is plentiful within the stream channel." The Aquatic Biology Investigation of 1994 concurs, citing good to excellent water quality, a diverse benthic community, and suitable habitat for trout reproduction.

Concluding from the information gathered in previous studies, it appears that, with the exception of temperature, all other conditions required for a coldwater fishery are in place - in-stream habitat for shelter and reproduction; riparian zones for shading, cooling, and the supply of woody debris; and the availability of macroinvertebrates as a main food source. Therefore, it may be plausible to conclude that with the restoration of a cooler temperature regime downstream of the lake, a coldwater fishery may be established. Updated studies should be performed, however, to determine present conditions of the stream and riparian zones.

This plan identifies several important steps required to reestablish and maintain a coldwater fishery within the Aquetong Creek watershed. Mitigation of the existing thermal impacts at Aquetong Lake is fundamentally central to any efforts to restore the fishery. Efforts to explore and remediate other sources of thermal pollution, as well as efforts to improve the riparian corridor will further enhance conditions in the watershed. A sustainable approach to managing future development in the watershed will also be central to preserving the fishery over time. Certainly, Solebury Township's multi-faceted water resources management programs will be a key component to sustaining a restored coldwater fishery within the Aquetong Creek watershed. Long term monitoring of surface and groundwater conditions within the watershed, and the establishment of flexible, adaptive policies which can be adjusted based on monitoring results, will provide the best chances for long term success.

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