Dam Removal Feasibility Study for Mensch Mill Dam and Impoundment

November 2004

Prepared by:

F. X. Browne, Inc.

Prepared for:

Perkiomen Valley Chapter of
Trout Unlimited

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Executive Summary

The Perkiomen Valley Chapter of Trout Unlimited retained F. X. Browne, Inc. to conduct dam removal feasibility for Mensch Mill dam, a low-head dam located on the West Branch Perkiomen Creek. The purpose of the study was to determine the existing costs and benefits associated with the dam and impoundment, and to evaluate the costs and benefits associated with various design options ranging from dam rehabilitation to dam removal.

I. Introduction

Located approximately 50 miles northwest of Philadelphia, the Upper Perkiomen Watershed encompasses 144 square miles of land in Montgomery, Berks, Lehigh and Bucks Counties and includes six major tributary systems: the West Branch of the Perkiomen (also known as Northwest Branch), Indian Creek, Hosensack Creek, Macoby Creek, Unami Creek, Ridge Valley Creek, and Deep Creek. The Upper Perkiomen Creek watershed is located in the northern portion of the Perkiomen Creek Watershed, which is the largest single subwatershed within the Schuylkill River Basin.

The Perkiomen Valley Chapter of Trout Unlimited (PVTU) conducts stewardship and restoration activities throughout the Upper Perkiomen Creek Watershed including streambank fencing and riparian buffer planting, pond and dam studies, and streambank restoration. In recent years, PVTU has focused many of its stewardship efforts on the West Branch Perkiomen Creek, an exceptional value stream and naturally reproducing brown trout fishing that drains the western portion of the Upper Perkiomen Creek Watershed.

Anecdotal evidence collected by PVTU suggests that a series of three low-head dams located on the West Branch may be significantly impacting the stream's cold water fishery by creating thermal stress, impeding adult trout in the lower reaches of the creek from accessing potential spawning areas, promoting the siltation of natural habitats, and restricting the ability of fish to escape thermal stresses and access food sources. PVTU is interested in evaluating the feasibility of completely or partially removing the structures as a way to significantly expand and improve the existing fishery.

Decisions to remove dams must reflect an understanding of the ecological, economic, and cultural costs and benefits associated with the existing structures as well as the ecological, economic, and cultural costs and benefits associated with the removal of the structure. Design options that allow for the partial removal of the structure or the reduction of ecological impacts through means other than removal (e.g., modifications to the dam structure, installation of fish passage, etc.) must also be considered in terms of their costs and benefits. 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.

In 2002, PVTU and F. X. Browne, Inc. initiated dialogue with the owners of the three dams on the West Branch Perkiomen Creek as part of a grant application to the PA-DEP Growing Greener Program. While PA-DEP did not fund this grant, the landowner contact work proved useful in establishing a dialogue with several of the dam owners.

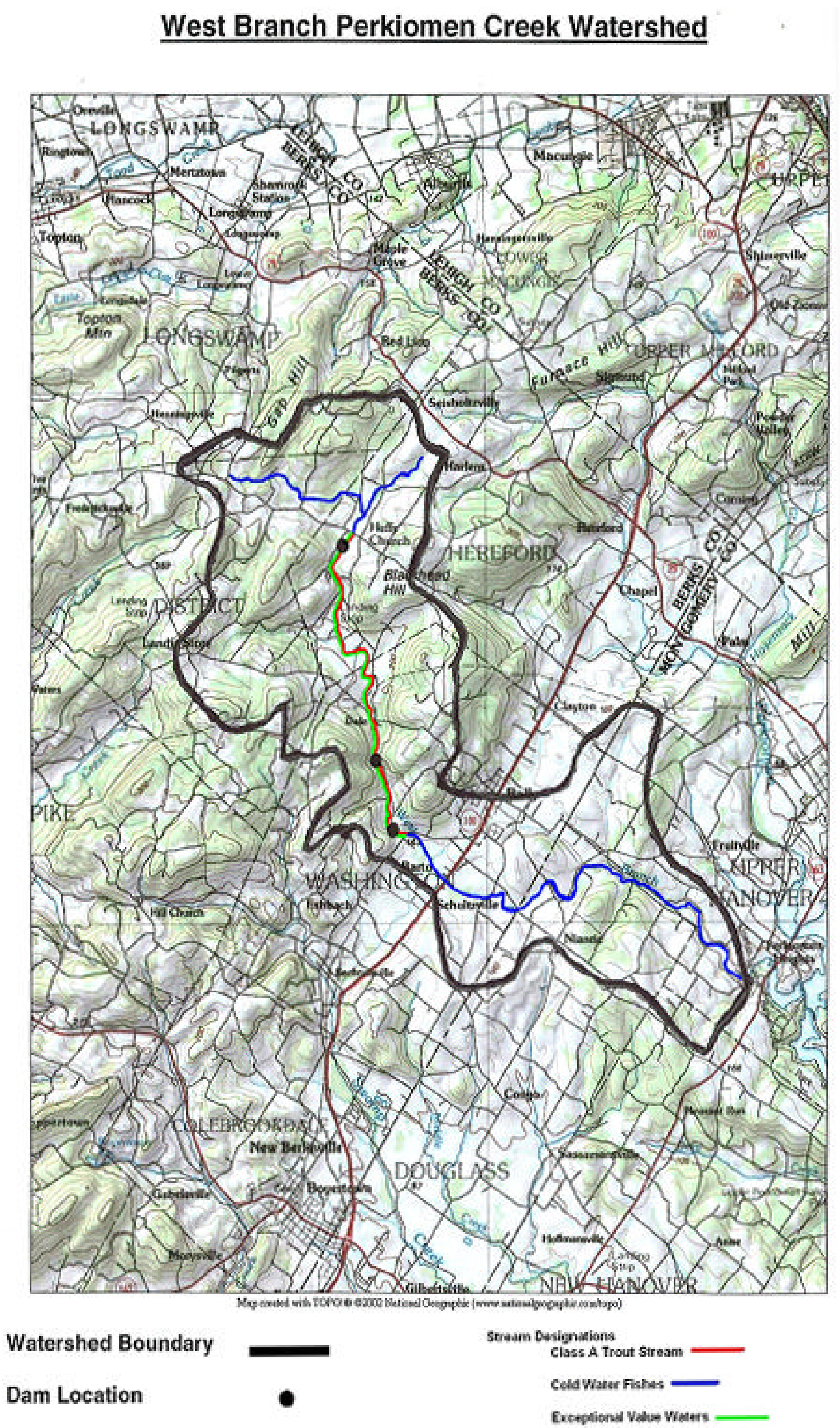


Figure 1. The West Branch Perkiomen Creek Watershed

In particular, we found that the owners of the upstream-most dam, Camp Mensch Mill, were receptive to discussions concerning potential dam modification or removal. Through these discussions, it became clear that the Camp was receptive to the idea of dam removal, but also was interested in exploring alternatives that would allow them to retain some type of pond at the site. PVTU decided that to pursue a feasibility study that would allow PVTU and Camp Mensch Mill to more clearly understand the costs and benefits associated with various design alternatives including dam rehabilitation, partial removal, and full removal.

This report summarizes the results of feasibility studies conducted on the Mensch Mill dam and impoundment by F. X. Browne, Inc. The study was completed by F. X. Browne, Inc. for Perkiomen Valley Trout Unlimited and was partially funded through a grant from the Coldwater Heritage Partnership.

The primary purpose of this report is to:

1. Describe the cultural, historical, and recreational benefits of the dam at Camp Mensch Mill.
2. Evaluate the impacts of the dam at Camp Mensch Mill on the stream ecology and water quality.
3. Provide recommendations for mitigation and minimization of impacts to stream ecology and water quality.

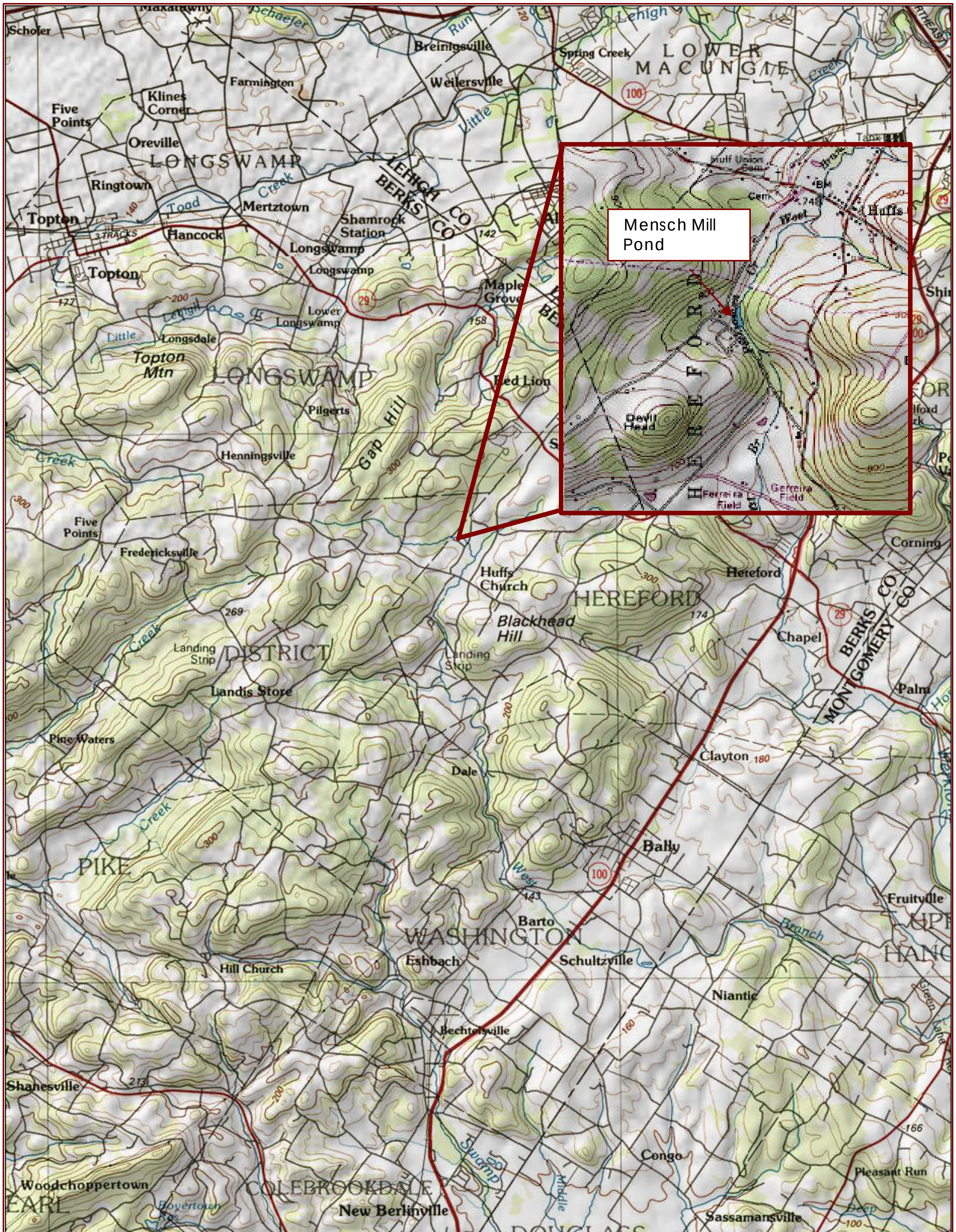
II. Site Description

Location

The study area consists of a small dam and associated impoundment located at Camp Mensch Mill (see Figure 2.), a 140-acre camping and retreat facility owned and operated by the United Church of Christ in Southeastern Pennsylvania. Camp Mensch Mill is located on Camp Mensch Mill Road approximately one mile south of Huff's Reformed and Lutheran Church in Hereford Township, Berks County, Pennsylvania and approximately 14 miles southwest of Allentown, Pennsylvania (Figure 3.) The site is located at an elevation of 769 ft. above sea level.

The dam was originally associated with an old gristmill that dates from 1810. Currently, the dam creates a small impoundment that is used by the camp primarily for boating and environmental programming. The dam, located on the West Branch Perkiomen Creek approximately 10.5 miles upstream of the confluence with Green Lane Reservoir, is the upstream most of three so-called "run of the river" dams located on the West Branch Perkiomen Creek.

Figure 2. View of Mensch Mill Pond



Map created with TOPO!® ©2002 National Geographic (www.nationalgeographic.com/topo)

Figure 3. Location of Camp Mensch Mill Dam and Impoundment

Site History

Camp Mensch Mill has been a site for outdoor ministry for youth, families and adults since 1929. The site was acquired for this purpose in 1928. At the time the site was a farm owned by Adam L. Mensch. At the time, there were three working mills on the site: a gristmill, a cider mill, and a sawmill. The milldam is described as a stone and timber dam in need of repair. The millpond is described as being "almost full of mud and silt". The mills were closed down shortly after the property was converted into a camp.

The site had been first used as a mill by the Lenape Indians, who lived in the area and used a stone located within the upstream end of the current day impoundment to grind Indian corn. First use of the site for milling by European settlers dates to 1733, although the current millpond, dam, and mill buildings date to 1822.

Concurrent with early milling operations, Thomas Maybury operated a wood-burning cook stove on the Mensch Mill site. The furnace, which stood west (upstream) of the present day dam and millpond, was established circa 1753 and employed up to one hundred men. The Berks County Historical Society placed a maker at the site of the Furnace. Today, remnants of the raceway from the old iron works as well as portions of the blast furnace bowl are still visible.

Upon acquiring the property in 1928, the United Church of Christ (then the Reformed Church) made numerous improvements and upgrades to the property including the dismantling of the grist mill, cider mill, and saw mill in 1929 and 1930. In the summer of 1930, the millpond was dredged and widened. The dam was reinforced at the breast. In the early days of the camp, campers frequently used the deepened pond as a swimming hole. The pond and the stream directly upstream from the pond were used for swimming until the 1960s, when high bacteria counts forced the suspension of swimming in the area. The high bacteria counts were most likely a result of upstream farming and livestock operations.

In 1941, the Pennsylvania Department of Forest and Waters issued a permit for reconstruction of the dam. The redesigned dam consisted of a 10-foot wide by 3-foot deep stone and cement foundation and 7-foot tall super structure of stone masonry. We have no evidence of changes to the reconstructed dam or to the pond until 1987, when the pond was dredged, the dam breast was rebuilt, new walking bridge across the dam breast was constructed, and several benches were installed around the pond. The cost of these improvements was reported to be $22,764.

Camp officials report that the pond has not been dredged since 1987. However, as early as 1992, the pond had reportedly filled with sediment, and several quotes were obtained by the camp for dredging the pond. The dredging was never performed, however.

Physical Setting

The Mensch Mill Dam study area is located within the Reading Prong Section of the New England Highlands physiographic province. The Reading Prong is a region of hills and ridges that extends southwest from eastern Connecticut to points west of Reading, Pennsylvania and includes the Highlands Region of Northwestern New Jersey. Locally, this region is considerably higher in elevation than the surrounding areas to the north and west. Many of the hilltops are well forested. Much of the area remains rural with small villages, farms, and livestock operations dominating areas of lower relief.

Like much of the Reading Prong region, Camp Mensch Mill is situated on erosion resistant, igneous and metamorphic rock called granitic gneiss. Weathering of the gneiss materials has produced the well-drained Chester soils that characterize most of camp property. However, most of the impoundment area with the exception the far downstream area is underlain by Atkins soils. These are primary poorly drained alluvial soils deposited in floodplains and differ markedly from the well-drained Chester Soils found in upland regions. Depth to bedrock in Atkins soils is generally 4-6 feet. Atkins soils give way to Chester Soils in the downstream reaches of the impoundment.

Figure 4. Rock outcroppings adjacent to pond

Stream Description

The West Branch Perkiomen Creek originates in District Township and flows in a southeasterly direction for approximately 12 miles until its confluence with the Green Lane Reservoir. Within the project area, the West Branch Perkiomen Creek is classified within Chapter 93 of the Pennsylvania Code as an exceptional value stream and as a Class A wild trout stream by the Pennsylvania Fish and Boat Commission.

Within the study area the creek is a 3^{rd} order stream with an approximate slope of 3% and is strongly confined by steep hills on both sides of the stream channel. The strong confinement of the channel suggests that channel geomorphology within this area (e.g., channel location, sinuosity) is largely dictated by the shape and location of the valley walls, rather than by floodplain processes. Upstream and downstream of the study area, the stream valley widens considerably. Groundwater often moves from the shallow hyporeic zones surrounding the active stream channel into the active stream channel itself during transitions from unconfined to confined valleys. This suggests that groundwater maybe flowing into the stream channel within or immediately upstream of the study area. The drainage area to the study site is approximately 4.5 square miles.

Figure 5. West Branch Perkiomen Creek upstream of Mensch Mill Dam

III. Dam Description

The Mensch Mill dam is rated by PA-DEP as a Hazard Class G-3 dam. The dam is composed of a stone masonry superstructure and a concrete slab foundation. The length of the dam breast is 96 feet. The height of the dam is approximately 7 feet. An elevated wooden footbridge runs across the dam crest leading to a footpath that circumnavigates the pond and leads to boat docks on the far side of the pond. Although the original dam is believed to have been constructed in 1822, the dam currently on site was reconstructed in 1941. The dam breast was again restored in 1987 in conjunction with a dredging project.

Figure 6. Looking upstream at Mensch Mill Dam

Current condition

F. X. Browne, Inc. conducted an informal visual assessment of Mensch Mill Dam on July 30, 2004. The downstream masonry face was in average condition. No major cracks or damage to the masonry were observed. The rock fill behind the dam and the upstream face was in good condition. There was extensive leakage through the dam, mostly in the center and right sections when looking upstream. The concrete foundation was in poor to fair condition. The foundation did not show any signs of settling or movement; however portions of the foundation were cracked. Pieces of the foundation were broken off and lying in the stream channel. Erosion was occurring within the stream channel at the base of the foundation and resulted in the stream channel downcutting by 2-3 feet in the area immediately downstream of the dam. The concrete outlet pipe, which is located on the left side of the dam, appeared to be badly damaged. Extensive erosion and gully formation was observed along the left flank, when looking downstream, endangering the footpath on that side of the dam.

Figure 7. Scour downstream of the concrete footing.

According to Mr. Gary Halstread, Camp Mensch Mill Director, the damage sustained to the flank of the dam occurred after a heavy storm in fall, 2003. The camp plans to install a temporary repair of this area in the fall with a concrete barrier of some kind.

Figure 8. Recent scour and gully formation along the eastern flank of the dam structure

Figure 9. Close-up of downstream masonry face

IV. Impoundment Description

Physical description. The Mensch Mill dam forms a 478 foot-long, shallow impoundment (see Figure 10). The impoundment widens from upstream to downstream and is 180 feet wide at its widest point. The mean depth of the impoundment is 1.7 feet. The maximum depth of the impoundment is 4.5 feet. The area of the impoundment is approximately 1.2 acres. Additional physical characteristics of the Mensch Mill impoundment are presented in Table 1.

Table No. 1 Physical Characteristics of Mensch Mill Dam and Impoundment	
Maximum length (ft.)	478
Maximum width (ft.)	179
Area (sq. ft.)	52,075.
Perimeter (ft.)	1,226
Mean depth (ft.)	1.72
Maximum depth (ft.)	4.5.
Unconsolidated sediment volume (cu. yd.)	3,881
Water volume (million gallon)	0.78

Steep, forested slopes surround the majority of the impoundment. The southwestern portion of the impoundment is bordered by grassy area, which lies between the pond and Camp Mensch Mill Road. The primary source of surface water to the impoundment is the West Branch Perkiomen Creek, which flows into the northern end of the impoundment. The impoundment is also fed by a smaller tributary that crosses Camp Mensch Mill Road just before entering the southwestern edge of the pond. A wooden walking bridge that traverses the dam breast provides access to the eastern side of the pond. A small footpath traverses the eastern side of the pond, providing access to a concrete dock located about mid way along the eastern side of the pond. Several canoes and paddleboats are stored near the dock.

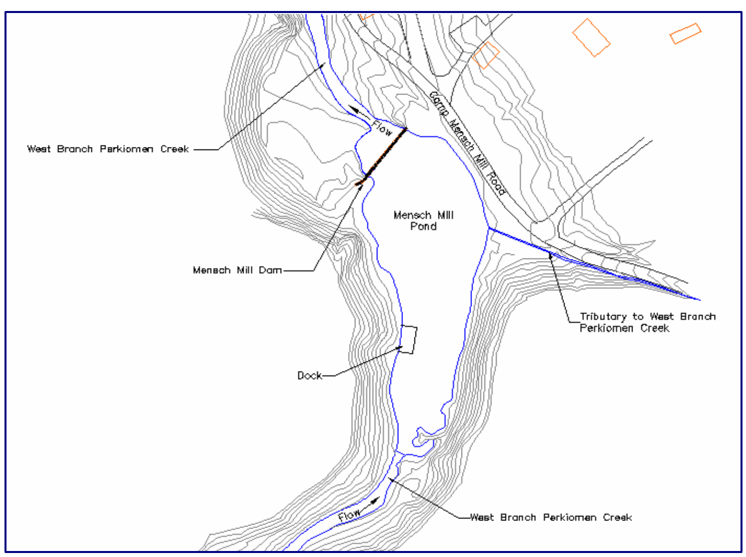


Figure 10. Plan view of Mensch Mill Dam and Impoundment

Current uses. Although originally created as a source of water for milling operations in 1822, Mensch Mill Pond is now a focal point for passive and active recreation at Camp Mensch Mill. The impoundment is used by summer camp groups for boating; there are several canoes and paddleboats along with a small concrete dock on the eastern shore of the impoundment. Camp staff also use the pond and stream for conducting environmental education lessons. Visiting groups and locals passing through the area occasionally fish in the pond. Campers and staff often visit the pond to sit and talk, and meditate. The pond provides a setting for various camp ceremonies and is an integral part of some of camp's ceremonial activities. Many of the camp attendees and camp staff also enjoy the sound of falling water over the dam as it echoes through the night air. The pond and stream were used for swimming until the 1960s, when high bacteria levels were found.

Figure 11. Recreational facilities at Mensch Mill Pond

Condition. Visual and historical evidence suggests that Mensch Mill pond is severely impacted by sedimentation. The impoundment has been dredged at least three times, in 1930, 1955, and 1987. Two silting basins were installed at the inlets to the pond in 1987. A newspaper article describing the project commented, "In the future, these silting basins will greatly retard the accumulation (of silt) so that a project like this…will hopefully not be necessary for at least 50 years." Unfortunately, the silting basins proved ineffective and by 1993, the Camp was again soliciting estimates for silt removal.

On June 30, 2004, F. X. Browne, Inc. performed a bathymetric survey of Mensch Mill Pond to determine the depth and volume of accumulated sediments present in the lake. Results of the survey show that the pond contains 3,881 cubic yards of accumulated sediment. The mean depth of accumulated sediments is 2 ft. Figure 12 and 13 show water depth and sediment depth within Mensch Mill Pond, respectively.

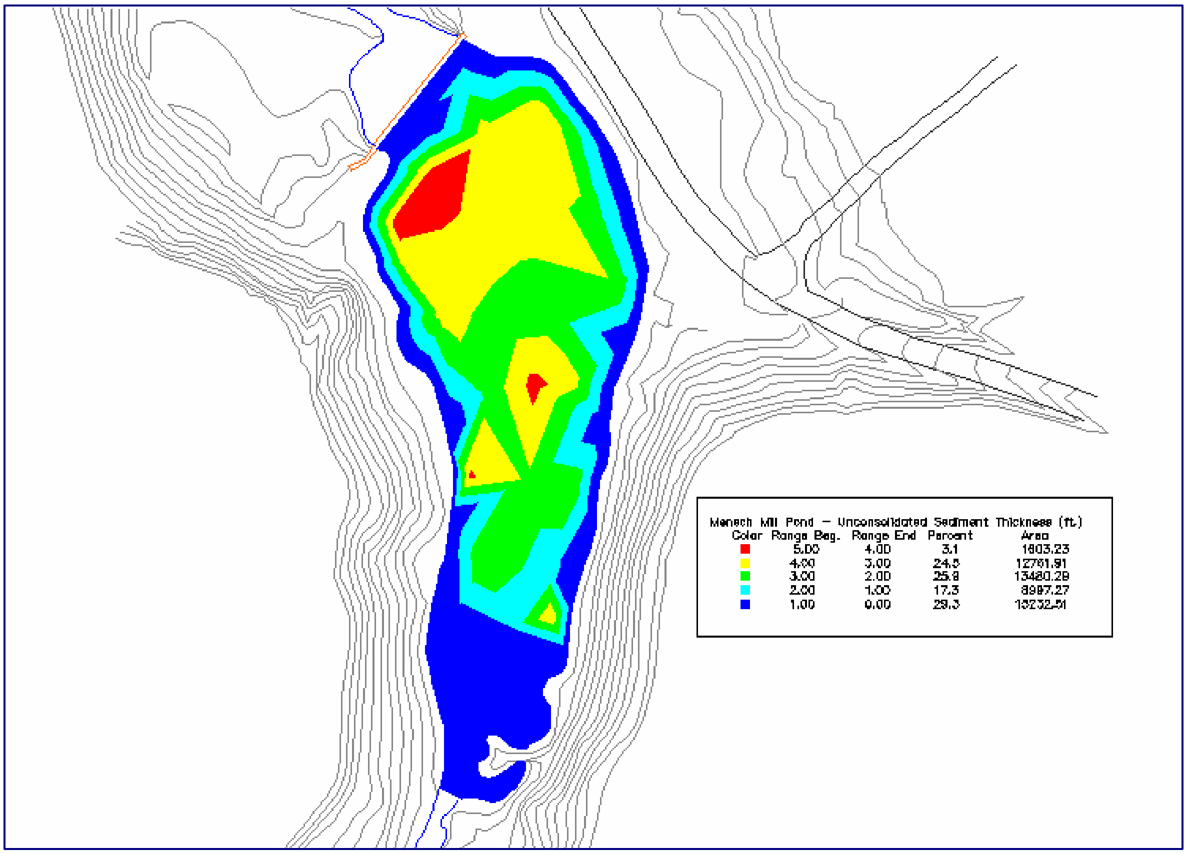


Figure 12. Unconsolidated sediment thickness within Mensch Mill Pond

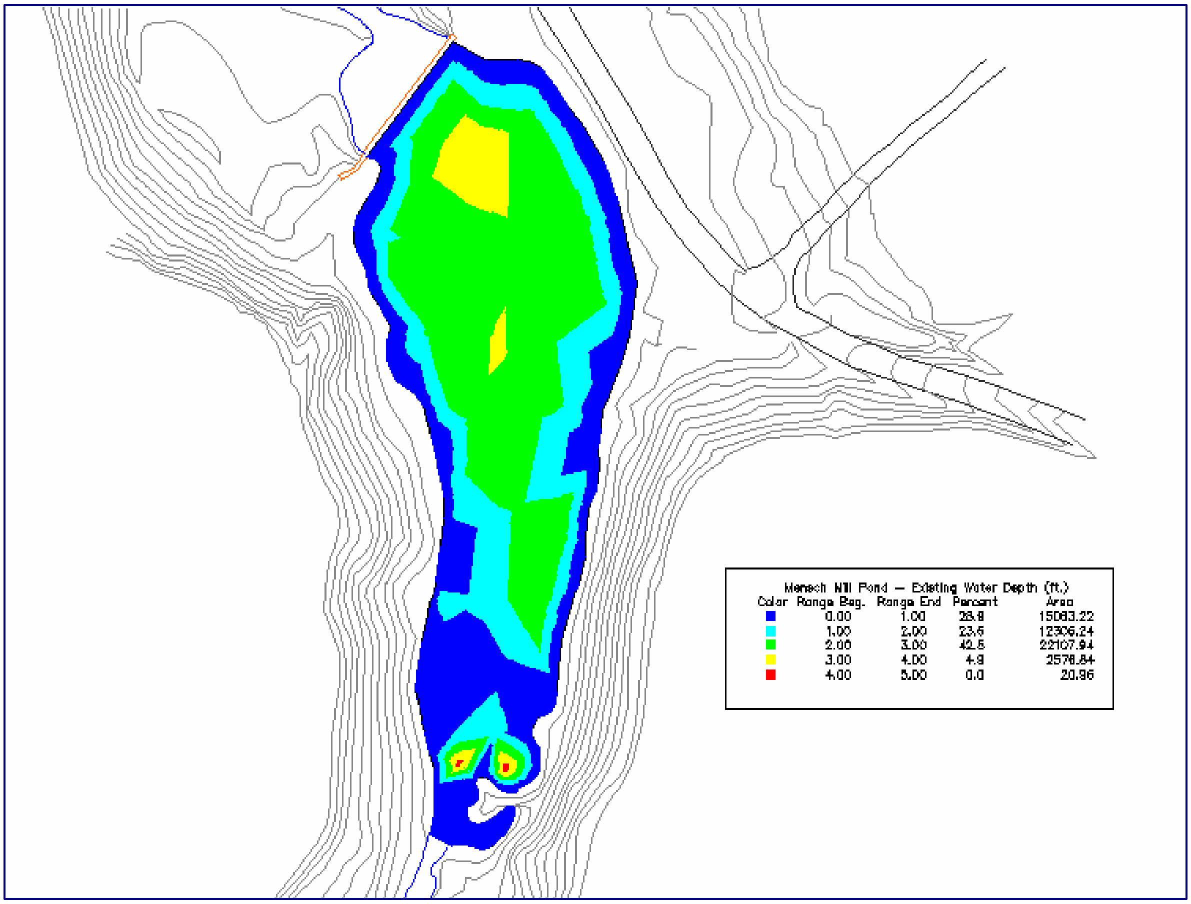


Figure 13. Water depth within Mensch Mill Pond

The rapid sedimentation in the pond not only creates a perpetual economic burden for the Camp, but also undermines the uses for which the pond is intended. Accumulated sediments are rich in nutrients, which in turn stimulate growth of nuisance and invasive aquatic plants, such as Eurasian Water Milfoil. Sedimentation also decreases water depth, which increases light transmission throughout the water column. Increased light levels, in turn further stimulate plant growth. Excessive plant growth throughout the pond was observed during our site visit on June 30, 2004. Nuisance plant growth undermines the aesthetic qualities of the pond and renders the pond unusable for activities such as boating. Further, the decomposition of plant material within the pond during the fall and winter can reduce the dissolved oxygen concentrations to levels that are harmful to other forms of aquatic life including fish.

Figure 14. Sediment loading to Mensch Mill Pond

Figure 15. Nuisance aquatic weed growth in Mensch Mill Pond

V. Upstream and Downstream Ecological and Water Quality Impacts

The Mensch Mill dam creates an impoundment area that is prone to sedimentation and thus requires continual upkeep, management, and maintenance. In addition to conditions within the impoundment, we also wanted to understand the influence of the dam on the ecological health of upstream and downstream stream segments, particularly with regard to the ability of the stream to support an active and sustainable coldwater fishery.

As part of this study, we measured stream temperature upstream and downstream of the Mensch Mill impoundment using HOBO® Water Temp Pro automated temperature sensors. We evaluated the influence of the impoundment on upstream/downstream water chemistry, habitat quality, and biological communities by reviewing and summarizing data collected by the Academy of Natural Sciences in 2002. These data were collected by the Academy as part of a study characterizing the ecological impacts of low head dams throughout Southeastern Pennsylvania.

Temperature. The effect of Mensch Mill Dam on stream temperature was studied by placing HOBO® Water Temp Pro automated temperature sensors upstream and downstream of the impoundment. Temperature data was recorded in 15-minute intervals. from July 5 to August 9, 2004. Our results show that average daily temperature were higher at the downstream site (65.27 ° F) than at the upstream site (66.34° F) by 1.06° F. However, average daily maximum temperature was virtually identical at upstream and downstream stations (Upstream = 69.58° F; Downstream =69.49° F). Several site characteristics help

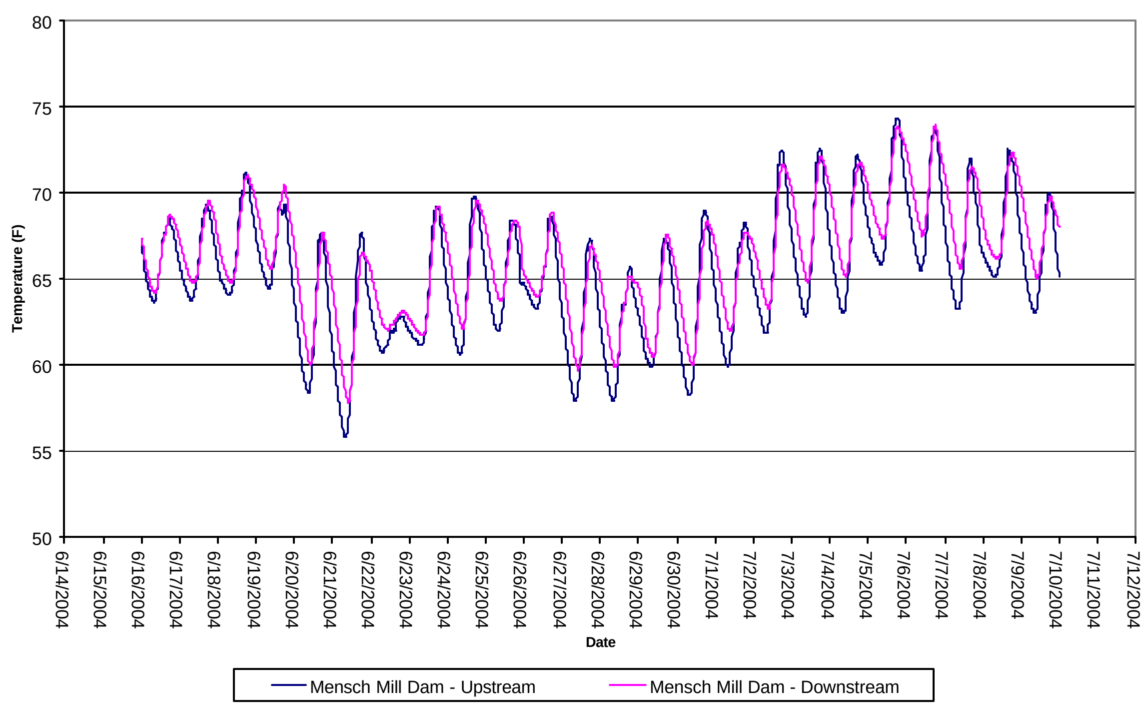


Figure 16. Stream Temperature
Upstream and Downstream of Mensch Mill Dam, June-July 2004

explain the absence of large temperature variations. First, the size of the impoundment is small compared with the volume of water entering the impoundment. Thus, water does not remain in the impoundment for extended periods of time, limiting the amount of time during which direct warming can occur. Secondly, the impoundment is narrow and, for the most part, surrounded by dense forested vegetation. Therefore, it is likely that the impoundment does not receive ample sunlight to permit substantial heating of the stream water. Finally, and perhaps most importantly, a small tributary that enters the northwest corner of the impoundment provides a source of cool spring water that may help to offset any heating that does occur within the impoundment.

While the individual impact of Mensch Mill dam on stream temperature is small, temperature data collected above and below two dams located downstream of Mensch Mill dam indicate that the combined effect of all three dams may be significantly impairing trout populations in the lower reaches of the West Branch. Specifically, we found that each dam produced an increase in average temperature over the three-week study period. Over the study period, average temperature above the Forgedale Road Dam was 1.24° F cooler than temperatures downstream of the dam. Average temperature above the Paper Mill Road Dam was 0.69° F cooler than the corresponding temperature below the dam. Maximum temperature below the most downstream dam exceeded the lethal temperature for brook trout and approached the lethal temperature for brown trout.

What is also of note is that significant warming also occurred between the downstream Forgedale Road Dam station and the upstream Paper Mill Road Dam station. Clearly the influence of the dams is only one factor causing thermal pollution in the system. Heating may also be occurring as water flows through long, slow-moving, un-shaded pools and as a result of warmer water entering the stream from stormwater runoff.

Figure 17. Maximum Daily Stream Temperature Upstream and Downstream of Three Dams on the West Branch Perkiomen Creek, June-July 2004

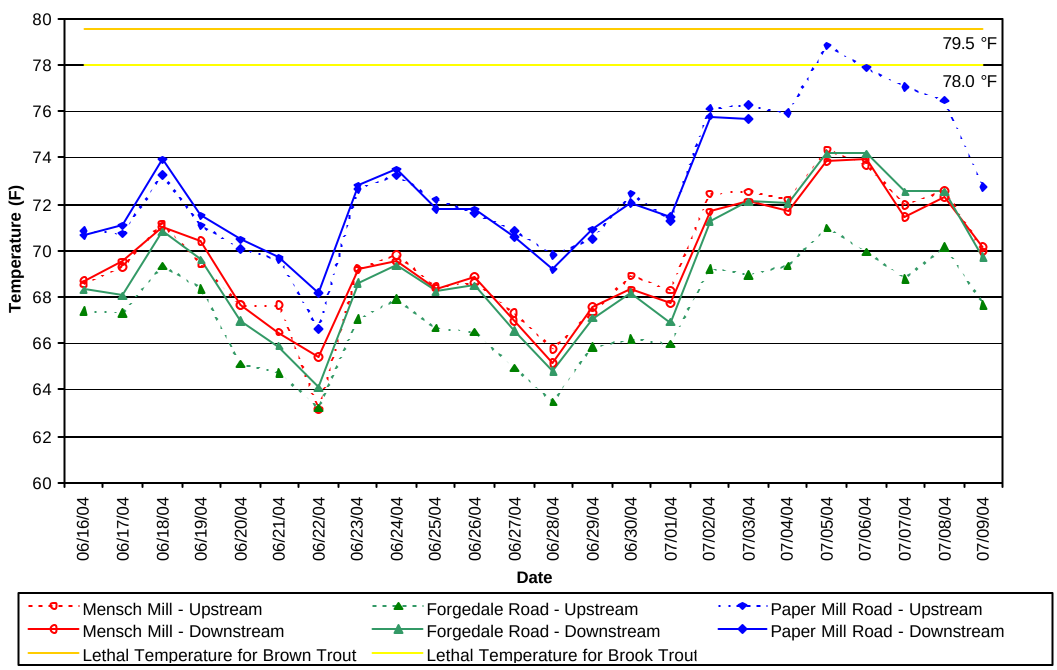
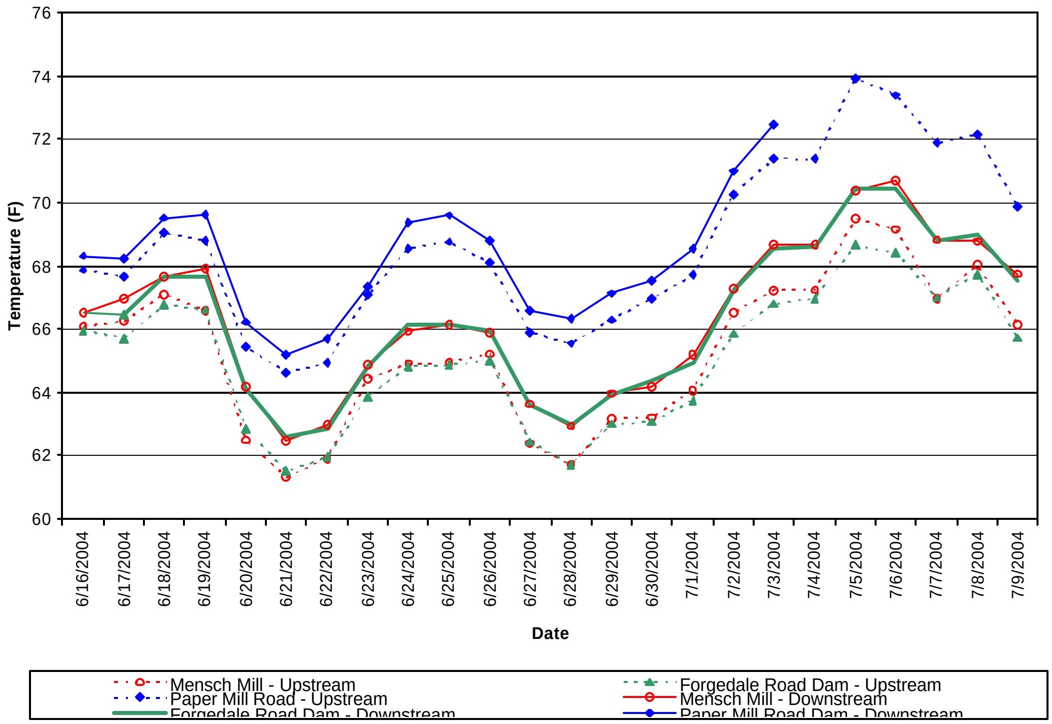


Figure 18. Average Daily Stream Temperature Upstream and Downstream of Three Dams on the West Branch Perkiomen Creek, June-July 2004



Macroinvertebrate communities. In 2002, the Academy of Natural Sciences characterized macroinvertebrate communities upstream and downstream of the Mensch Mill Impoundment. Upstream of the impoundment, macroinvertebrates populations were somewhat more dense. Total taxa and number of EPA taxa were similar in upstream and downstream samples as was total macroinvertebrate community quality as measured by the Hilsenhoff's Biotic Index, Bode's New York Biotic Index, and the North Carolina Biotic Index.

Table 2 Comparison of macroinvertebrate community data from samples obtained upstream and downstream of Mensch Mill Dam			
	Upstream	Downstream	Percent different
Estimated number of individuals per sq. meter	11,456.67	9,807.78	14%
Total number of taxa	36.00	38.00	-6%
Total number of Ephemeroptera, Plecoptera, Trichoptera taxa	15.00	17.00	-13%
Diversity, Shannon-Weiner	2.85	2.75	4%
Evenness, Pielou's J	0.80	0.75	5%
% of total abundance that were Chironomidae	0.09	0.10	-11%
% of total abundance that were Non-insect taxa	0.15	0.08	43%
Ratio of EPT abundance to Chironomidae abundance	5.81	5.50	5%
Hilsenhoff's Biotic Index (Hilsenhoff 1987, 1988, and Barbour 1999)	3.89	3.65	6%
North Carolina Biotic Index, based on 2001 SOP	3.58	3.36	6%
NY Biotic Index by Bode, from Mandaville 2002.	4.03	4.04	0%
Percent Abundance of Collector-Gatherers	0.33	0.25	27%
Percent Abundance of Collector-Filterers	0.27	0.33	-21%
Percent Abundance of Shredders	0.04	0.06	-37%
Percent Abundance of Scrapers	0.22	0.27	-23%
Percent Abundance of Predators	0.13	0.10	26%

Water quality. In 2002, the Academy of Natural Sciences collected and analyzed stream water samples from above and below the Mensch Mill Impoundment. Three chemistry samples were obtained at one location downstream of the impoundment and at one location upstream of the impoundment. Parameters measured included total suspended solids (mg/L), alkalinity (mg/L), and several species of nitrogen and phosphorus. The effect of the impoundment on stream chemistry appears to be mixed. Several parameters showed significant increases from downstream to upstream; several parameters showing reductions from downstream to upstream; and several parameters showing no significant changes in either direction.

Table 3
Comparison of Stream Chemistry Data from samples obtained upstream and downstream of Mensch Mill Dam *

Parameter	*Downstream* Mean	*Downstream* standard deviation	*Upstream* Mean	*Upstream* standard deviation	Percent difference	T-test result
Total suspended solids (mg/L)	2.20	0.40	1.48	0.20	-48%	0.04**
Total alkalinity (mg/L)	42.00	0.80	42.13	0.61	0%	0.42
Total hardness (mg/L)	67.33	1.01	65.33	0.46	-3%	0.03**
Chloride (mg/L)	12.92	0.13	12.23	0.12	-6%	.001**
Chlorophyll a (ug/L)	1.21	0.11	1.26	0.04	4%	0.25
Dissolved organic carbon (mg/L)	2.46	0.31	2.67	0.04	8%	0.18
Silicate (ug/L)	24,074.00	57.16	25,598.00	42.00	6%	0.000004**
Nitrate + Nitrite (ug/L)	1,555.00	13.45	1,714.33	15.01	9%	0.0001**
Ammonia + ammonium (ug/L)	21.67	1.53	17.67	7.23	-23%	0.22
Soluble kieldahl nitrogen (ug/L)	183.67	6.81	153.67	15.50	-20%	0.03**
Dissolved organic nitrogen (ug/L)	162.00	8.19	136.00	12.77	-19%	0.03**
Total dissolved phosphorus (ug/L)	15.67	0.58	18.33	0.58	15%	.002**
Soluble reactive phosphorus (ug/L)	11.33	1.15	15.67	0.58	28%	0.01**
Dissolved organic phosphorus (ug/L)	4.33	0.58	2.67	1.15	-63%	0.06
Total phosphorus) (ug/L)	28.53	1.00	26.90	4.77	-6%	0.31
Particulate phosphorus (ug/L)	12.87	0.45	8.57	5.34	-50%	0.15
Particulate nitrogen (ug/L)	38.00	3.46	28.00	5.57	-36%	0.03**
Particulate organic carbon (ug/L)	397.70	8.80	367.32	35.15	-8%	0.14

* Data collected by the Academy of Natural Sciences, 2002, three samples were collected from one upstream site and one downstream site.

** Indicates the difference between the upstream and downstream measurements show significance to a = 0.05

Habitat quality. In 2002, the Academy of Natural Sciences evaluated physical habitat quality and geomorphic characteristics upstream and downstream of the impoundment. Physical habitat and geomorphological characteristics were similar, but not identical between upstream and downstream reaches. Overall habitat quality as measured by the EPA Habitat Index was virtually identical between the two reaches.

Channel particle sizes were consistently smaller upstream of the impoundment than downstream of the impoundment. Stream slope was dramatically higher downstream of the dam, which could account for the larger particle sizes downstream of the dam.

Upstream areas had fewer pools and more runs than downstream areas. Maximum pool depth was somewhat lower in the upstream reach, while riffles were somewhat shallower downstream. Large woody debris was more plentiful in the upstream reach, possibly due to lower stream slope. In general stream velocity was lower in the upstream reach than in the downstream reach, again probably reflecting the difference in slope between the two reaches. Discharge was somewhat higher in the downstream site, which is explained by the entrance of a small tributary within the impoundment area.

Table 4
Comparison of geomorphic and habitat data upstream and downstream of Mensch Mill Dam *

Parameter	Upstream	Downstream	Percent difference
% Pool	35.23	24.30	-45%
% Riffle	35.92	34.81	-3%
% Run	28.84	40.89	29%
% Scour bar area/reach area	21.59	19.86	-9%
% of reach with undercut bank	-	-	0%
Maximum pool depth (m)	0.45	0.43	-5%
Average riffle depth (m)	0.07	0.07	11%
Max pool / avg riffle depth	6.77	5.79	-17%
Large woody debris volume (mw/m)	0.02	0.03	46%
Avg. pool velocity (ft/s)	0.17	0.06	-182%
Max pool velocity (ft/s)	0.85	0.22	-286%
Avg. riffle velocity (ft/s)	0.69	0.71	2%
Max riffle velocity (ft/s)	3.93	3.05	-29%
Discharge (ft^3/s)	1.32	2.09	37%
EPA Habitat Score	169.00	172.00	2%
d_{50}	27.22	80.61	196.14
d_{16}	0.39	20.73	5193.73
d_{84}	243.96	397.91	63.11
Width (m)	8.86	9.02	0.64
Slope	(0.02)	(0.06)	189.57

Fish passage. The seven-foot high Mensch Mill Dam effectively prevents the upstream or downstream movement of fish. In particular, downstream populations of brown trout are restricted from accessing nearly five miles of the headwater reaches of the West Branch Perkiomen Creek, which likely contain significant high quality spawning habitats. Mensch Mill dam also inhibits the ability of downstream fish to move upstream in response to thermal stress, feeding needs, or to escape other environmental stressors. Dams can sometimes provide an environmental benefit by blocking the spread of invasive or exotic fish species. However, given the relatively small drainage area upstream of the dam, and the significant environmental benefits associated with providing access to headwater spawning areas, the net effect of Mensch Mill Dam on the cold water fishery of the West Branch Perkiomen Creek is most likely negative.

VI. Historical and Cultural Values

The Mensch Mill dam and impoundment were created in 1822 to support local milling operations. In this historical context, the millpond and dam are not particularly unique. Hundreds of similar dams were created in the region for similar purposes during that time, many of them older and well preserved. The original dam structure was essentially destroyed during the 1930 reconstruction reducing its historical significance.

Figure 19. Monument of Hereford Furnace located northwest of Mensch Mill Pond

Beyond the area's signficance as a milling site, there are several other historical features of interest in the area. The most prominent of these is Thomas Mayberry's Hereford Furnace. Remnants of the furnace's blast bowl and raceway are found just northwest of the present day impoundment as is a stone monument marking the location of the furnace.

In 2001, the Southeastern Pennsylvania Conference of the United Church of Christ submitted an application to the Commonwealth of Pennsylvania requesting that Camp Mensch Mill be recognized as a state historical site. The application focused on the presence of several original mill buildings as well as the remnants of the Hereford Furnace. The Commonwealth of Pennsylvania responded to the application in 2002 stating that they were more interested in the historical significance of the camping facility itself. Established in 1928, Camp Mensch Mill is one of the oldest continually operated church-run camps in Pennsylvania. Based on this feedback, the application was revised and resubmitted in 2002 and is still pending.

While the millpond and dam are not historically unique, the significance of the millpond to the history of Camp Mensch Mill and to its current operation should not be understated. The dam and pond were central features of the Camp at the time of its founding in 1928 and have been a part of the camp's landscape since that time. The pond sits across the road from the main camp offices and is an integral part of the camp's visual identity.

The pond serves several important programmatic functions as well. During the summer, the pond is used by campers for boating, although the use of the pond for boating is significantly undermined by the ongoing sedimentation problems. The camp also uses the pond as an environmental classroom. Camp groups regularly visit the pond to learn about and explore aquatic habitats.

In addition to its programmatic functions, the pond also plays an important role as a natural place of spiritual significance. Many camp staff and visitors come to the pond to enjoy quiet conversations, meditate, and relax. In particular, many of the campers routinely visit the pond for morning meditation sessions. Staff and visitors also frequently use the paths that circle the pond for hiking, walking, and nature observation. Finally, the pond area is frequently used as a site for camp-wide ceremonies and sometimes plays an active role in ceremonial activities. For instance, during one type of ceremony, small paper boats are released into the pond.

VII. Liability and Cost Concerns

While the impoundment does provide several important benefits to Camp Mensch Mill, it is also a source of financial cost. The financial cost associated with the dam fall within three main areas: operations and maintenance costs, property damage, and financial liability.

Operations and Maintenance

Major operations and maintenance costs associated with the Mensch Mill Dam and Impoundment include removal of accumulated sediments from the pond and upkeep of and repair to the dam structure.

Dredging costs. Mensch Mill pond has been dredged at least three times since the inception of Camp Mensch Mill in 1928 – in 1930, 1955, and 1987. Following the dredging operations in 1987, the pond had accumulated significant quantities of sediment as by 1992. This indicates that the pond should probably be dredged more frequently to maintain acceptable water depth and water quality to support its intended uses. In its present configuration (e.g., a small impoundment located on a perennial stream with a high sediment load), dredging will be an on going and significant O&M cost for the camp.

Dam Structure Rehabilitation and Repair. The Mensch Mill Dam was rebuilt in 1930 following the establishment of the camp in 1928. Since that time, the dam has undergone two major repairs, in 1941 and 1987. At present, the dam is again in serious need of repair. In particular, seepage through the masonry dam face is extensive and needs to be addressed. In addition, recent flooding in 2003 resulted in significant gully formation around the eastern side of the dam. If left unrepaired, this gullying could expand and threaten the integrity of the entire structure. Although the camp plans to install temporary “stop-gap” measures this fall, a major rehabilitation of the dam will be required to bring the dam into compliance with current regulations.

Additional O&M costs include five-year dam inspections, routine maintenance of the dam, upkeep of the boat dock, and additional pond management costs. Additional pond management costs include herbicide treatments or other aquatic plant management technique and yearly water quality testing.

Property Damage

On several occasions in the past several years, flooding from the West Branch Perkiomen Creek has caused significant damage to camp facilities including undercutting and erosion along Camp Mensch Mill Road. Based on our assessment, there is a reasonable likelihood that the current configuration of the dam is exacerbating local flooding. While this cost is difficult to project into the future, it seems likely that the camp will occasionally incur property damage due to flooding so long as the present dam and pond configuration remain in place.

Financial liability

As the owner of the dam and impoundment, Camp Mensch Mill assumes full legal liability for damage to persons or property that would occur as a result of a dam failure. Camp Mensch Mill may also be liable for injuries that occur as a result of unsafe conditions in and around the impoundment and dam structure. A review of USGS topographic quadrangle maps of the area show no significant buildings or structures downstream of the dam for a distance of 0.3 miles and no major downstream settlements or infrastructure for a distance of several miles. Given the small size of the dam and the impoundment and the lack of vulnerable resources downstream, it seems that the financial liability associated with a dam failure would be relatively minor. This conclusion is reinforced by the fact that the dam is rated as a Category 3 dam by PA-DEP, a rating given to dams with low threat levels to life and property.

VIII. Alternatives analysis

Based on existing site characteristics, a review of environmental data, discussions with Camp Mensch Mill staff, and an analysis of short term and long term environmental, financial, historical, and cultural costs and benefits, we developed five design alternatives for the Camp Mensch Mill site. Each alternative is explained in detail below.

Alternative No. 1 – Maintain existing conditions

Alternative No. 1 consists of maintaining the pond and dam in their present condition. The camp would continue to incur operations and maintenance costs associated with the dam and impoundment including periodic dredging, dam repair, dam inspection and maintenance, pond management costs, and facility upkeep costs. The impoundment will most likely continue to experience major impacts from sedimentation. Maintaining water quality and water depth for existing uses including boating, fishing, and aesthetics will require active management on the part of the camp in perpetuity.

Alternative No. 1 would result in no lessening of the impacts of the dam structure on the cold water fishery. At present it appears that the principle impact to the cold water fishery is limitations to fish passage. From our review of the Academy of Natural Sciences data, the dam does not significantly negatively influence stream chemistry, or habitat quality. While impacts to stream temperature are also minor, these impacts contribute to progressive warming of the stream water in the downstream direction.

Alternative No 1. would most likely not require a dam permit from PA-DEP provided the repair does not alter the water elevation of the impoundment.

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Figure 20. Alternative No. 1 – Maintain Existing Conditions

Alternative No. 2 – Bypass Channel with Off-line Pond A

Description

Alternative No. 2 would involve partially removing the existing dam and impoundment. A free flowing stream channel would be reestablished along the eastern side of the current impoundment. The southwestern portion of the impoundment would be regraded to form a new pond. The new pond would be approximately 50% of the size of the current impoundment, and would be primarily fed by the small tributary that currently flows into the impoundment. The outlet structure of the new impoundment would integrate portions of the former dam structure.

Impacts to Cultural and Recreational Values

The new impoundment would provide similar, though slightly reduced boating and fishing opportunities for campers and visitors. Overflow from the new outlet structure will create a falling water sound similar to that created by the current impoundment. The new pond, while smaller, would offer enhanced aesthetics and fishing opportunities because of lower sedimentation and associated water quality problems. Boating would still be possible, but the experience would be diminished somewhat because of the new pond's smaller size. The new pond would provide similar spiritual and passive recreational opportunities and would quickly become part of the camp's visual identity much as the current pond is today. The establishment of a healthy and diverse native aquatic plant community within the new pond will also enhance learning opportunities for campers. Further, the integration of park of the current dam structure into the new design will help maintain a connection with the past.

In addition to the new pond, campers and visitors would have enhanced access to fishing, walking, and nature exploration within a high quality, free flowing stream habitat. Overall, the new configuration should provide an equal, but somewhat different set of recreational and cultural benefits than does current configuration.

Impacts to Long Term Costs

The new pond would significantly reduce O&M costs for the Camp for several reasons. Because the pond is located off-line from the primary stream channel, less sediment will enter the pond. As a result, long term O&M costs associated with sediment removal will be reduced significantly. Also, the new off-line dam would not be directly exposed to the hydraulic force of the primary stream. This would presumably lessen the long-term repair and upkeep costs associated with the dam.

The new configuration would also lessen flooding potential associated with the current impoundment. The newly created stream channel would provide enhanced conveyance for stormflow through the reach and would prevent extensive overland flooding.

Environmental Benefits

Alternative No. 2 would fully restore fish passage thorough the area, which is the major impact associated with the current structure. Alternative No. 2 would also restore more than 500 feet of stream habitat currently occupied by the impoundment. Any thermal impacts associated with the heating of stream water from the mainstream channel would be ameliorated as well.

Design and Construction Costs

The primary drawback associated with Alternative No. 2 is the design and construction costs associated with the project. An off-line pond and bypass channel system requires extensive design and permitting. In particular, because the drainage area to the small tributary is over 100 acres (163 acres), the construction of a new impoundment would require a dam permit from PA-DEP. The permit would require the development of, among other things, an emergency action plan and an operations and maintenance manual. Removal of the existing dam would most likely require a separate PA-DEP approval.

Construction of this type of system would be significantly more expansive than a full dam removal in which the pond was eliminated completely. Also despite a reduction in sediment loading, the impoundment would require periodic dredging. The frequency and cost of the dredging, however, would be far lower than would be required to maintain the current configuration.

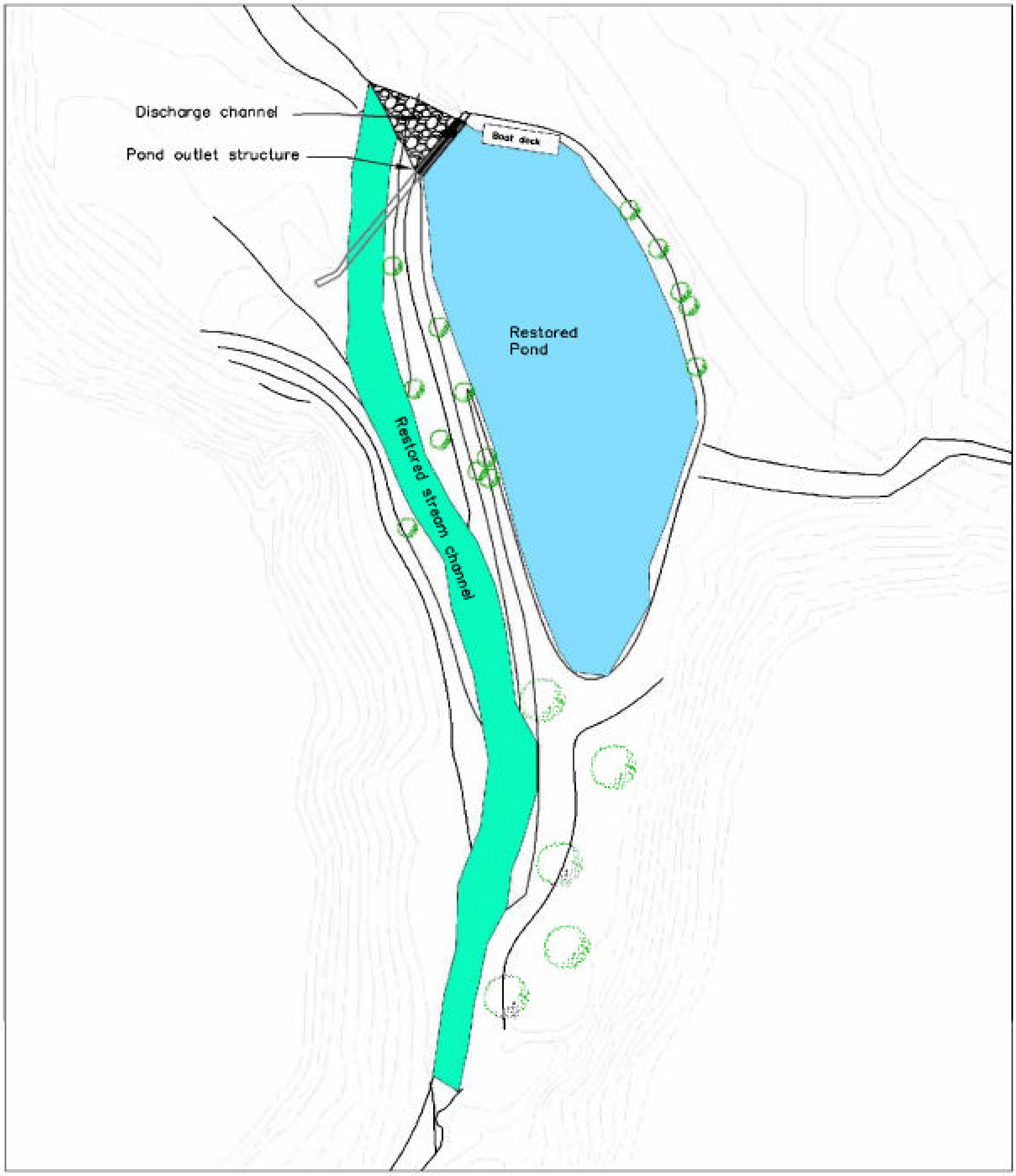

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Figure 21. Alternative No. 2 – Bypass Channel with Off-Line Pond A

Alternative No. 3 – Bypass Channel with Off-line Pond B

Alternative No. 3 is similar to Alternative No. 2. in that it consists of a bypass channel and an off-line pond. However, the location of the bypass channel and off-line pond are reversed. The bypass channel follows the western shore of the current impoundment, while the off-line pond is located in the eastern portion of the current impoundment. Unlike Alternative No. 2, the off-line pond proposed in Alternative No. 3 would not have a direct surface water input. Rather pond levels would be maintained actively, using a pump, or passively, through an adjustable weir, either of which would transfer water from the bypass channel to the off-line pond.

Alternative No. 3 would provide similar recreational and cultural benefits to Alternative No. 2. The proposed impoundment would be approximately 50% of the size of the current impoundment. Alternative No. 3 would provide direct view of the stream from the camp complex located across Camp Mensch Mill Road. However, campers and visitors would have to cross the stream to access the pond. A bridge over the stream would be required to provide this access.

Another potential drawback to Alternative No. 3 is the proximity of the stream to the road and to the camp offices located on the other side of the road. Streambank erosion as a result of large flood events could endanger the structural integrity of the road. As a result, the outer streambank would have to be structurally fortified to prevent erosion. Secondly, the proximity of the stream to the road may increase the likelihood of flooding and associated property damage. Third, because of the proximity of the stream to the road, to the potential for riparian buffer establishment along the stream would be limited. This increases the likelihood of increased light transmission to the stream, reduction in woody debris inputs, and the delivery of pollutants from stormwater runoff from Camp Mensch Mill Road.

One primary advantage that emerges when comparing Alternative No. 3 to Alternative No 2. is that flow associated with both the main stream channel and the smaller tributary is bypassed. With Alternative No. 2, the flow from the small tributary is subject to warming as it passes through the new impoundment. Further, the new dam structure creates a barrier that prevents fish from accessing the small tributary. Alternative No. 3 eliminates these impacts by allowing the small tributary to flow directly into the restored bypass channel.

Permitting associated Alternative No. 3 would be less complicated than that for Alternative No. 2. The off-line pond proposed would not require PA-DEP approval because it does not impound an existing surface water body with a drainage area of over 100 acres, as is the case with Alternative No. 2. An approval for the dam breach would be required from PA-DEP.

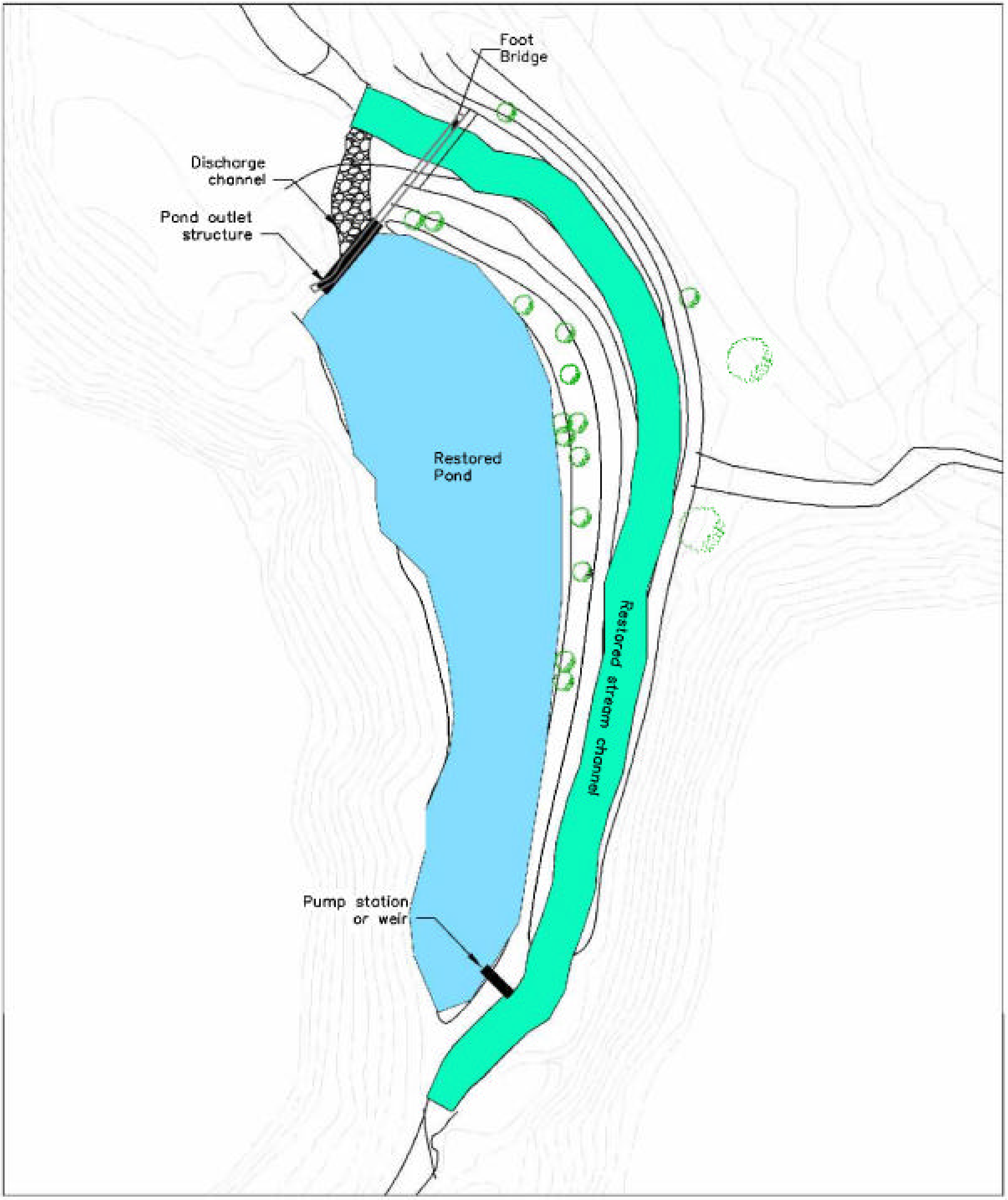

Figure 22. Alternative No. 3 – Bypass Channel with Off-line Pond B

Alternative No. 4– Full Dam Removal

Alternative No. 4 consists of fully removing the existing dam, removing the pond, and restoring a naturally flowing stream channel within the former impoundment area. Alternative No. 4 would result in the loss of some of the benefits associated with the existing pond. However, many of the values associated with the pond would be retained and even enhanced. For example, a free-flowing stream would provide a wonderful location for meditative walks, quiet conversations, and camp ceremonies, and would provide enhanced fishing opportunities. Boating opportunities would be eliminated, however.

The complete removal of the existing pond would create the space for a fully restored natural stream channel and associated floodplain and fringe wetlands, something not possible with Alternatives No 2. and 3, in which the location of the stream channel is determined by the location of the restored pond. The restored area created in Alternative No. 4 could create an appealing new set of visual, recreational, and spiritual experiences for campers and other visitors. The lack of infrastructure associated with the design would permit the creation of an unencumbered natural landscape not possible with Alternative Nos. 2 and 3. The area would provide nature-viewing, interpretive, and environmental teaching opportunities not possible with other alternatives. Further, the newly restored area would demonstrate in unequivocal terms the commitment of the camp and its owners to fostering and advancing environmental stewardship.

Alternative No. 4 would effectively eliminate long term O&M costs associated with maintaining an impoundment and dam structure on the property. Alternative No. 4 also offers the best solution for eliminating flooding of Camp Mensch Mill. Like Alternatives No. 2 and 3, Alternative No. 4 would require a dam removal authorization would be required from PA-DEP. Design and construction costs associated with Alternative No. 4 would also be lower than costs associated with Alternatives No. 2 and 3.

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Figure 23. Alternative No. 4 – Full Dam Removal

Alternative No. 5 - Installation of Fish Passage Device

Alternative No. 5 consists of installing a fish passage device, such as a fish ladder, that would allow fish to bypass the existing dam. The current dam and impoundment configuration would remain essentially unchanged. Under Alternative No. 5, the current benefits and costs of the current configuration would be retained (see Alternative No. 1), with the exception of impacts to fish passage, which would be eliminated. Fish could circumvent the dam by entering and climbing the fish passage structure. The installation of the fish passage structure would require a plan review by PA-DEP Dam Safety.

Figure 24. Picture of a typical fish ladder

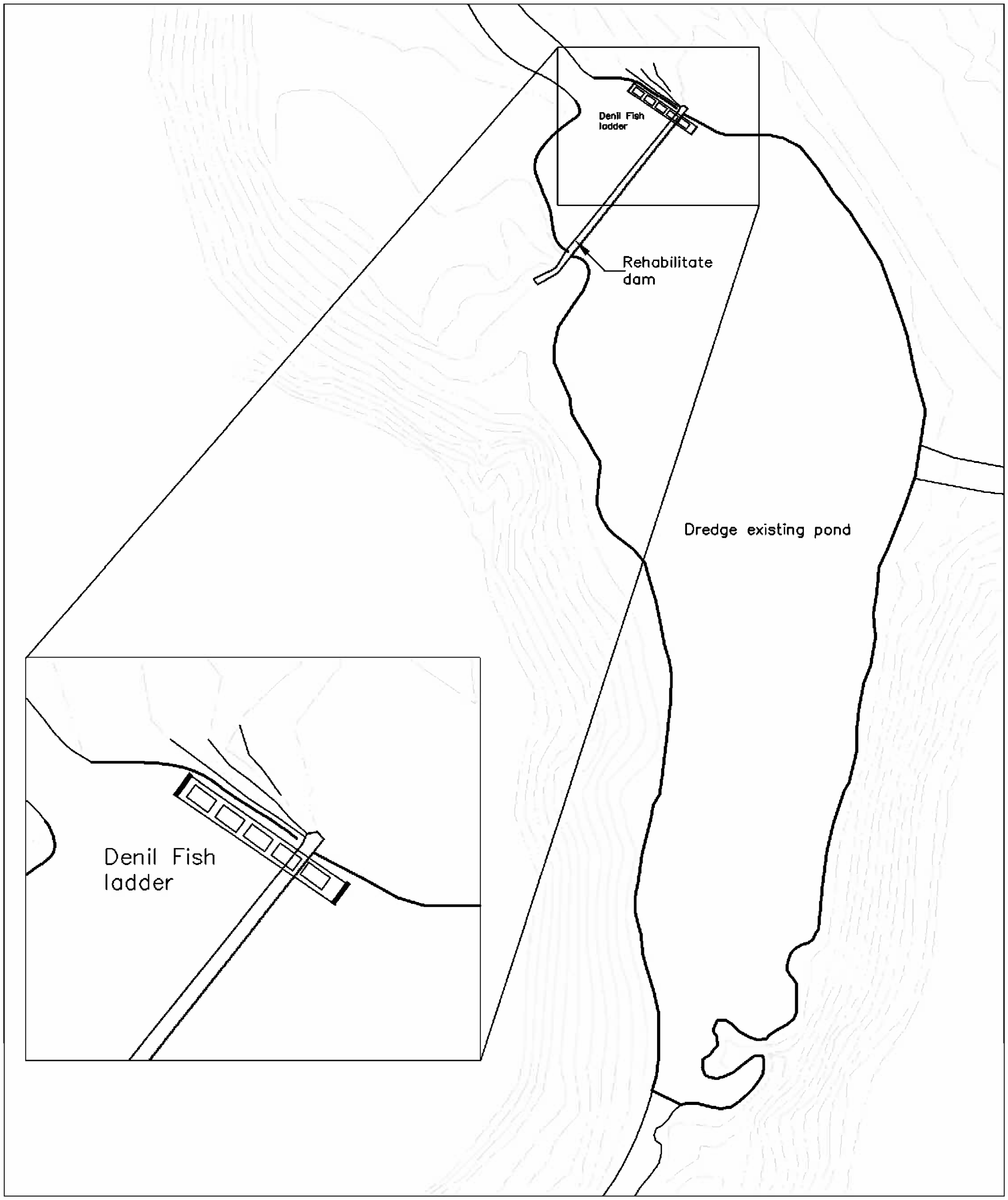

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Figure 25. Alternative No. 5 – Installation of Fish Passage Device

IX. Estimated Costs

Design and construction costs associated with each design alternative are presented in Table 5, below. Please note that these are approximate costs and could change significantly as permitting and design requirements are more fully understood.

Table 5
Comparison of Estimated Initial and Annual O&M Costs for Five Dam Removal and Rehabilitation Scenarios for Mensch Mill Dam and Impoundment

Alternative No.	*Alternative Description*	*Initial Costs*	*Yearly O&M Costs*
1	Dam repair and dredging	$ 75,000	$ 8,000
2	Pond and bypass channel A	$ 175,000	$ 4,300
3	Pond and bypass channel B	$ 165,000	$ 4,600
4	Full dam removal w/ stream and floodplain restoration	$ 75,000	$ 500
5	Fish passage, dam repair, and dredging	$ 120,000	$ 8,000

X. Conclusions

Mensch Mill Dam negatively impacts the West Branch Perkiomen Creek primarily by impeding fish passage, increasing average stream temperature, and promoting sedimentation and associated water quality problems behind the impoundment. Mensch Mill Dam also is a source of on-going maintenance costs for the dam owner, Camp Mensch Mill. Currently the pond is in need of dredging and the dam is in need of significant repair. The dam may also be contributing to periodic flooding problems that impact Camp Mensch Mill. Camp Mensch Mill continues to be financially liable for a dam failure or for accidents occurring as a result of the dam. Despite its costs, however, the dam and impoundment is a lasting and important landscape feature of Camp Mensch Mill. The dam and pond have been a part of the fabric of the Camp Mensch Mill landscape since the Camp's inception in 1928. Many of the campers and staff that enjoy Camp Mensch Mill have an emotional attachment to the dam and pond. The pond is used for both active and passive recreation, most notably boating. The pond is also a common place for meditation, conversation, and quiet walks. The soothing sound of the falling water over the dam breast has punctuated the nighttime air of the Camp for more than 80 years.

Several design options have been identified and evaluated in this report, ranging from dredging of the pond and repair of the dam to full removal of the dam and pond. Two hybrid alternatives, which involve the partial removal of the dam and the creation of a smaller, offline pond have been proposed and evaluated as well. Finally, we explored the option of alleviating the fish passage issue through the installation of a fish ladder. Each alternative is associated with a particular set of environmental, financial, cultural, and functional costs and benefits.

In an overall sense, the full dam removal option is the best option for reducing environmental and financial costs in the long term. The project could most likely be entirely funded through public funding. This option also provides for a number of the existing benefits currently associated with the pond including a place for fishing, nature study, ceremonies, quiet walking, meditation, and conversation. The primary costs associated with the option are the loss of boating and emotional impact of significantly changing one of the Camp's salient landscape features.

Of the remaining options, Alternative No. 2 seems to maximize or improve most of the existing benefits (e.g., provides for a pond and stream area for nature study) while reducing long-term operations and maintenance costs significantly. The primary drawback associated with Alternative No. 2 is the high up-front costs associated with design, permitting, and construction. Also, the smaller tributary that feeds the existing pond would continue to be impounded.

It is the final recommendation of this report that either Alternative No. 2 or Alternative No. 4 be considered for further discussion among Camp Mensch Mill, Perkiomen Creek Valley Chapter of Trout Unlimited, as well as funding and regulatory agencies.

XI. References

Ackerman, Franklins. 1970. Soil Survey of Berks County, Pennsylvania. United States Department of Agriculture.