Inter-Fluve, Inc.

Summary Report

TO:	Town of Bolton Conservation Commission
FROM:	Nick Nelson, Inter-Fluve, Inc.
DATE:	November 1, 2010
REGARDING:	Fyfeshire Dam Removal Feasibility Assessment

1. Introduction

Fyfeshire Dam is a small dam impounding a 10.3 acre pond in Bolton, MA (Figure 1). The dam is in disrepair and was rated as a significant hazard in an unsafe condition (Fuss & O'Neill, 2009). A Phase II Investigation was completed in 2009 that provided cost estimates for dam repair or dam removal. The Conservation Commission determined that the following additional information was necessary before they could make a decision to repair or remove the dam: impounded sediment volume, contamination analysis of impounded sediment, analysis of potential post-dam removal fish habitat, and cost estimates for the design and construction for dam removal.

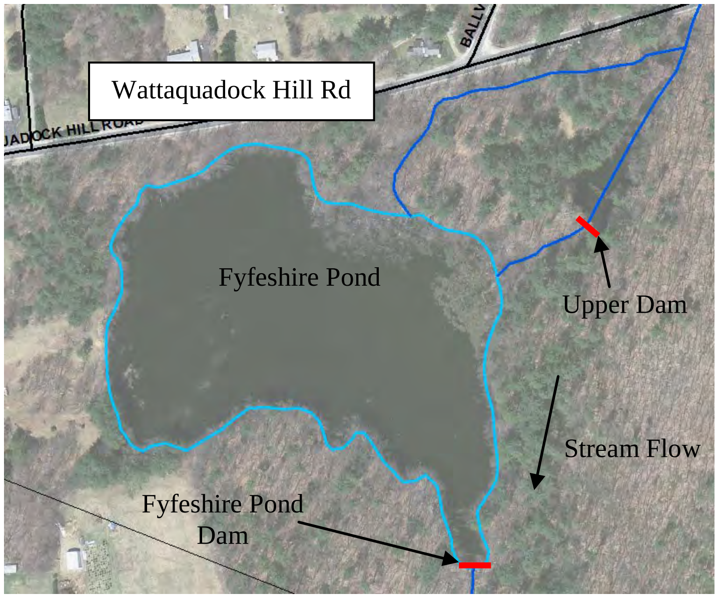


Figure 1: Fyfeshire Pond, just south of Wattaquadock Hill Rd in Bolton, MA.

To accomplish the goals of this project, Inter-Fluve conducted a site assessment to evaluate the habitat of the stream channel upstream and downstream of the pond. This assessment included walking the channel and evaluating the habitat from about 1300 ft upstream of Wattaquadock Hill Rd to the railroad bridge downstream of Lancaster Rd. We conducted a depth of refusal survey in the pond to determine the depth and texture of impounded sediment and the texture of the surface beneath the impounded sediment. We collected sediment samples and delivered them to a laboratory to be analyzed for contaminants. Following these studies, we created a conceptual rendering and Photoshop renderings to visually depict what the area now occupied by the pond may look like following dam removal and river restoration.

This report summarizes the results and analyses of these studies and provides cost estimates for the future phases of dam removal.

2. <u>Impounded Sediment</u>

   2.1. Sediment Volume

Inter-Fluve conducted a depth of refusal survey throughout Fyfeshire Pond. This survey consisted of pushing a calibrated rod into the soft sediment until it reached a hard surface. We collected GPS readings at each probing site to identify our location. We probed the sediment 52 times along eight transects through the impoundment (Appendix A). The middle of the western half of the pond is filled with approximately 16 ft of fine sediment and organic material. It is unknown if this deep hole was excavated by early residents or if it is a natural feature such as a vernal pool. Similar vernal pools were not found nearby, suggesting that this hole may have been excavated possibly during the construction of the dam or earlier.

The total amount of sediment that has been trapped by the dam is approximately 77,593 cubic yards. During dam removal projects, we typically recommend that the dam owner draw down the water levels to allow the sediments to compress and dry, which makes excavation easier. Consolidation of the sediments may reduce its volume 10-15%. For this dam removal project, we do not foresee a need to excavate all of the impounded sediment. We recommend the removal of the sediment that is only within the proposed channel and on top of the floodplain immediately adjacent to this channel. The volume of sediment that will need to be excavated is approximately **1250 cubic yards**. We recommend actively removing this sediment because downstream release does not appear practicable for this project, as will be described in more detail below.

2.2. Sediment Quality

2.2.1. Due Diligence Review

Two historical reports provide limited information regarding the two dams at the Fyfeshire Pond site (Whitcomb, 1988; Forbes, 1998). The land that is currently conservation land was likely William Fyfe's farmland when he built a house in 1740. A dam at or near the current Fyfeshire Pond Dam may have been built around 1770 for use as a sawmill. The current Fyfeshire Pond Dam was likely rebuilt on top of, or including, this earlier structure, but the date of this construction is unknown. In 1830, William Fyfe Jr (or III) built the upper dam and smaller pond to provide power for comb-making machinery. In 1878, William Fyfe IV built a button factory in the same location as the comb shop, but this burnt down in 1890. These activities on the ponds, likely produced little (if any) pollutants or contaminants that would have impacted river sediments.

Inter-Fluve searched public records for information on potential contamination within the Fyfeshire Pond watershed (Figure 2). Sources of information included the MA Department of Environmental Protection (MA DEP), MA Environmental Protection Act (MEPA), the Resource

Conservation and Recovery Act (RCRA), and the US EPA. A search of these resources revealed no potential sources of contamination:

- MA DEP - No waste site reportable releases
    - No Underground Storage Tanks (USTs), leaking or otherwise
- MEPA - No sites listed in the solid and hazardous waste, wastewater, or water thresholds environmental review database
- RCRA - No waste generators and no corrective action sites
- US EPA - No Superfund sites on the National Priorities List or the short-term removal list
    - No sites in the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS)

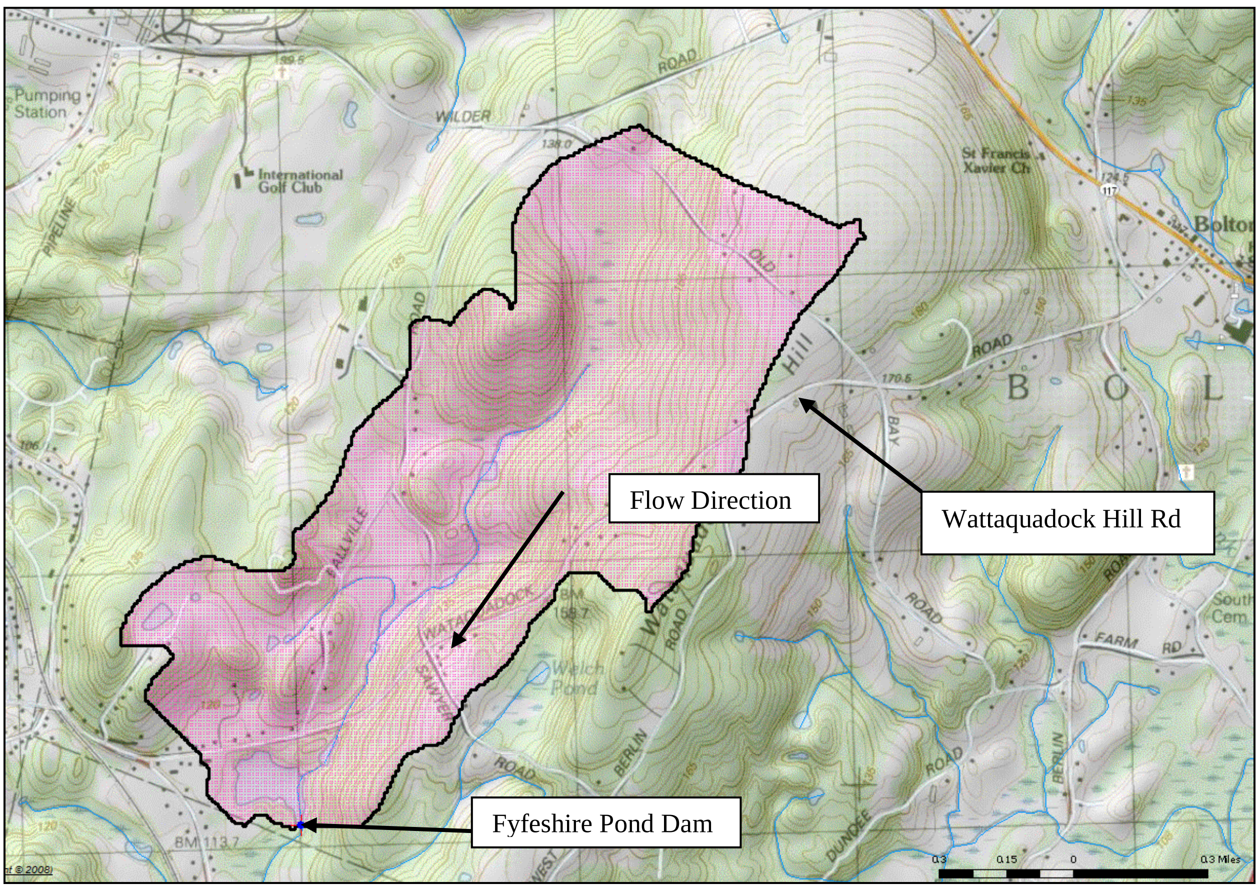


Figure 2: Watershed upstream of Fyfeshire Pond Dam.

An analysis of watershed land use revealed current and historic farming. We analyzed for insecticides in the event that these chemicals were used on some of the farms. The following is the list of parameters for which the sediments were analyzed:

- EPA priority pollutant metals: arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc, silver
- Polychlorinated Biphenyls (PCBs)
- Polycyclic Aromatic Hydrocarbons (PAHs)
- Extractable Petroleum Hydrocarbons (EPHs)
- Volatile Organic Compounds (VOCs)
- Organochlorine insecticides
- Total organic carbon
- Percent water
- Grain size distribution

2.2.2. Sediment Collection and Analysis

Inter-Fluve collected nine sediment cores: three upstream of Fyfeshire Pond, three within the pond, and three downstream of the dam (Figure 3). The nine cores were composited into three sediment samples to be analyzed by the laboratory: one upstream of the pond, one within the pond, and one downstream of the dam. By compositing cores of similar material in similar areas, a larger area is able to sampled with limited funds. The sediment cores were collected with custom-made hand-coring devices and the sediment was placed into containers and delivered to Alpha Labs, a MA certified laboratory.

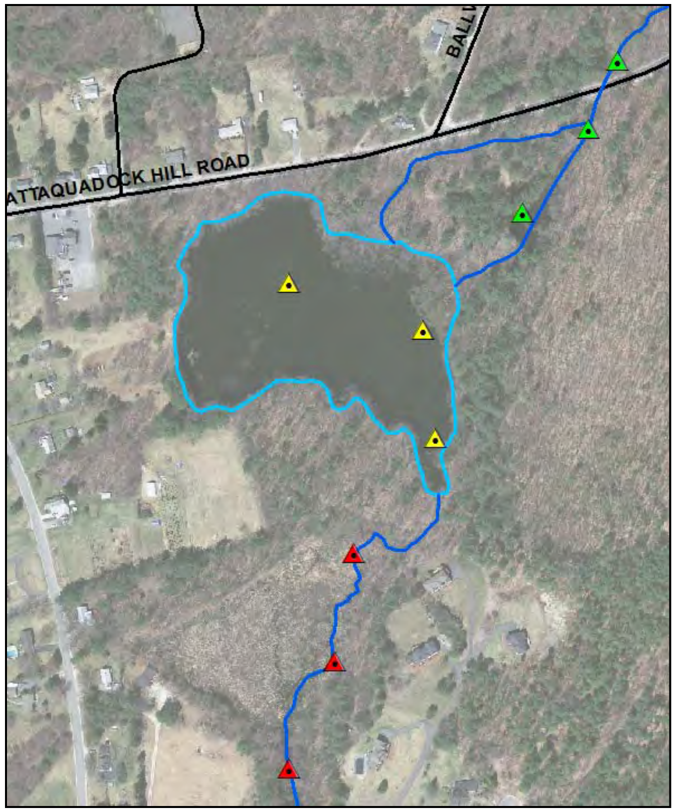


Figure 3: Sediment core locations within Fyfeshire Pond (yellow), in the stream upstream of the pond (green), and in the stream downstream from the pond (red). Cores of the same color were composited into single samples to be analyzed.

The sediment samples were analyzed for the parameters listed in the previous section. The sediment analyses revealed little to no contamination within the pond. Contaminant concentrations in all samples for all contaminants were below the Reportable Concentration Standard (RCS) S-1 and the MA Contingency Plan (MCP) S-1, except 1,4-Dioxane, a volatile organic compound (VOC):

Table 1: Concentration of parameters exceeding MCP S-1 standards.

	MCP S1 (mg/kg)	Upstream Sample	Pond Sample	Downstream Sample
1,4-Dioxane	0.2	1.3	0.53	0.96

Although the concentration of 1,4-Dioxane within the pond exceeds the MCP S-1 standard, the concentration is less than the sediment found upstream and downstream. Because of this lack of contamination within the pond sediments, we do not anticipate having to remove the sediments to an off-site location for treatment during dam removal. For a complete list of the results of the sediment analysis, see Appendix B.

3. Habitat Analysis

Figure 4: Sand deposition upstream of the Wattaquadock Hill Rd culvert.

The stream that flows into and out of Fyfeshire Pond is a small stream about 5-6 ft wide and 1-2 ft deep. The channel bed consists primarily of gravel and cobbles. The culverts through which the stream passes (Wattaquadock Hill Rd, Collins Rd, and Lancaster Rd) are undersized and result in backing water up during high flow conditions. These backwaters cause sediment to fall out of suspension resulting in the sand deposits found upstream of the culverts (Figure 4). Floodplains adjacent to the stream extend upstream of Wattaquadock Hill Rd for about 1000 ft. These floodplains consist of mature red maple trees, skunk cabbage, and other vegetation commonly found in red maple wetlands (Figure 5). The floodplains are typically 15-30 ft wide ending at a low-angle slope leading to upland habitat. The upland habitat is characterized by a pine tree canopy with ferns on the forest floor (Figure 6). Upstream of this forested habitat, the stream becomes less sinuous as it flows through agriculture fields. The lack of canopy cover in these fields results in decreased shade and likely increased water temperatures.

Figure 5: Channel and red maple floodplain upstream of Wattaquadock Hill Rd.

Figure 6: Pine tree and fern upland upstream of Wattaquadock Hill Rd.

The natural riparian corridor from the fields to Fyfeshire Pond is productive and healthy for both aquatic and terrestrial species. The canopy trees provide shade that keeps water temperatures low; the trees also provide a source of woody debris recruitment that is important for in-stream habitat. The gravel and cobble substrate in the channel provides additional habitat complexity and diversity. All of this habitat and geomorphic complexity increases the diversity of macroinvertebrates and subsequently the diversity in fish, bird, and mammal species.

Figure 7: Perched culvert under Lancaster Rd.

Although small fish were observed during the fieldwork, there are a few concerns regarding fish passage and habitat following dam removal. Removal of Fyfeshire Dam will eliminate one fish passage barrier. However, other passage barriers remain in the form of undersized and perched culverts. Undersized culverts often reduce the ability of fish to pass through the culvert during high flows because the water velocity is too great. The Lancaster Rd culvert is perched about 1.5 ft above the channel bed on the downstream end, thus preventing fish from getting into the culvert during low to moderate flows (Figure 7). Finally, the dam just upstream of Fyfeshire Pond within the conservation area presents another fish passage barrier. During high water flow, the pond behind this dam is filled to capacity and with the help of some flash boards at a path crossing (Figure 8) water flows through a secondary channel that flows close to Wattaquadock Hill Rd before flowing into Fyfeshire Pond (Figure 9). At such higher water flows, fish are able to swim up this channel, pass through a perched culvert under the walking path near the parking area, and continue upstream through the Wattaquadock Hill Rd culvert. This was the case during our first site visit on April 24, 2010. By July 20, however, water flows were so low that no water was flowing into that secondary channel and only small amounts of water were seeping through the boards in the dam. So little water flowed, in fact, that the water collected in Fyfeshire Pond soaked into the ground quicker than it could be replenished, resulting in a dry stream bed downstream of Fyfeshire Pond Dam.

Figure 8: Flash boards in trail crossing upstream of upper dam.

Figure 9: Secondary channel flowing along Wattaquadock Hill Rd into Fyfeshire Pond.

Under natural low-flow conditions with no dams, fish could likely sustain themselves in pools and move through the shallow portions of flowing water. The removal of Fyfeshire Pond Dam will greatly improve fish passage and fish habitat conditions, but fish will only be able to move upstream to the next dam unless the secondary channel has flowing water. Engineering this channel so that the water flowing under Wattaquadock Hill Rd flows into the secondary channel would not be difficult, but this may result in portions of the year in which water depths in the small pond at the upstream dam are very low.

4. Dam Removal and River Restoration

Based on our analyses of the sediment depth and quality and of the habitat within the watershed, the removal of Fyfeshire Pond Dam and the restoration of the channel would likely not be difficult or costly relative to other dam removal projects in MA. The depth of refusal survey suggests that there is a deep pool in the western part of the pond, and that the historic channel likely flowed at the base of the hillside on the eastern side of the pond (see conceptual rendering, Appendix C). The location of the historic channel was confirmed by topographic maps from 1898 (Figure 10). This 1898 map shows the channel with no ponds even though historical reports suggest the dams were built before 1898. It is possible the maps were not detailed enough to include these small ponds, or they were based on information from prior to the construction of the dams.

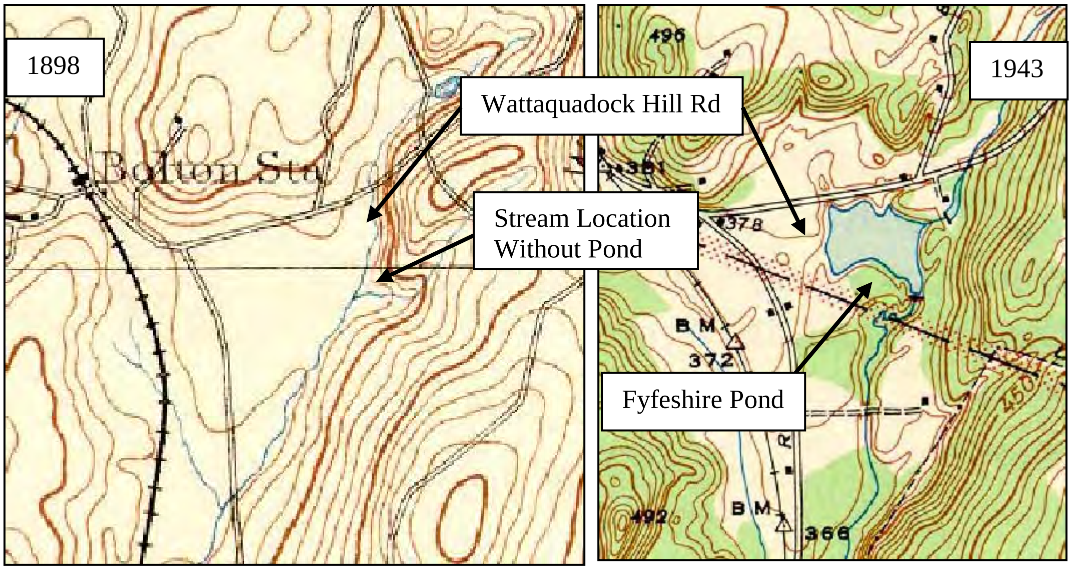


Figure 10: Study area as depicted on USGS topographic maps in 1898 (left) and 1943 right).

The sediment analysis results revealed very low contamination levels within the pond, much lower than in most impoundments in MA. Because only one VOC was slightly above the MCP threshold and all other contaminants were below, there should be no need to remove the sediment off-site for special treatment. This greatly reduces the costs of construction. Typically, with clean impounded sediment, we would suggest the possibility of releasing the impounded sediment downstream naturally. This again reduces construction costs and introduces sediment to a stream system that has been starved of that sediment for many years. In this case, however, we do not recommend passive downstream release for two main reasons: 1) the Town of Berlin boundary lies about 200 ft downstream of Fyfeshire Pond Dam. Downstream release of sediments would necessarily require the involvement of Berlin town officials, increasing the timeline and expense of removal. 2) The stream below Fyfeshire Pond Dam does not flow directly into a larger river system that could easily absorb the released sediment. Instead, a wetland lies about 300 ft downstream of the dam and there is an undersized road culvert about 250 ft downstream of this wetland. The undersized culvert has already resulted in increased stream sedimentation and the wetland is heavily vegetated with cattails, sedges, and other wetland vegetation. Released sediment would become trapped in the wetland, altering the wetland and the hydraulics of the system.

Instead of downstream release, we suggest excavating the approximately 1250 cubic yards of sediment and reusing them onsite to build microtopography that improves the riparian habitat.

The depth of refusal survey suggested that the channel in the eastern part of the pond was separated from the deep pool in the western part of the pond by a low rise that may have historically been floodplain or upland (see planform and cross sections, Appendix A). The excavated sediment could be re-used in the area between the channel and the pool to improve floodplain and upland habitat. The sediment primarily consists of fine to medium sand (combined 73.6%), but also contains 22.1% fine-grained material less than 0.075 mm (Appendix B). The fine to medium sand could be spread onto the ground surface first followed by the silt and organics that would provide good substrate for vegetation re-growth.

Conceptual rendering and Photoshop renderings - We have based our conceptual and Photoshop renderings on the depth of refusal survey and the analysis of upstream and downstream habitats (Appendix C and D). We suggest that the restored channel and land adjacent to the channel will resemble the channel and riparian corridor upstream of Wattaquadock Rd: a 5-6 ft channel with a red maple-dominated floodplain and pine tree upland (Exhibit 1B in Appendix D). Much of the area between the restored channel and the pool ('vernal pool' in the concept rendering) will likely be dominated by a canopy of red maple trees and an understory of shrubs, saplings, skunk cabbage, and ferns (see Exhibit 2B in Appendix D). It is possible that the high points, and thus drier areas, will sustain pine trees as well. As indicated on the conceptual rendering, this new riparian area would be a good location for a trail that would connect the two existing trails on either side of the pond.

The area of the existing pond that maintained the deepest sediment was the western part of the pond. Here, the depth of refusal survey found up to 16 ft of fine-grained sediment and organic material below the water surface. Upon dam removal, the water elevation will decrease a few more feet (the water level during the survey was already very low) and the sediment and organics will likely compress as the edges of this deep pool dry out. We have suggested that this area may become similar to a 'vernal pool,' which is a pool that periodically becomes dry. The pool will maintain the sediment and organic matter that it currently holds and this will provide the substrate and nutrients for wetland vegetation to grow. During rain storms and snow melt, the pool will likely be filled with water and may even have open water, but during drier periods, the pool will likely become partially or completely dry. The wetland vegetation within the vernal pool will likely consist of grasses, sedges, and arrowleaf with the edges of the pool possibly containing cattails and taller grasses (Exhibit 3B in Appendix D). Different vegetation will thrive as the water level varies, producing a succession of colorful flowering plants. Vernal pools rarely maintain fish populations but provide excellent habitat for amphibian and insect species. This pool will likely sustain many frog and toad species and may even provide breeding habitat for salamanders.

Recreational opportunities will continue within the conservation area. The addition of trails between the restored channel and the vernal pool as well as around the western edge of the vernal pool will increase the walking possibilities and will allow visitors to circumnavigate the conservation area without crossing private property. The stream is too small to support boating, but skilled fishermen may be able to catch fish during periods of high water. The water level in the vernal pool will likely not be deep enough to support boats and is generally not conducive to swimming. Although they are beautiful areas with lots of species to observe, it is generally recommended that visitors do not enter vernal pools during high water levels as the fine sediment can be difficult to move through. The birding should be excellent, however, and observing the flora and fauna from the trails would be the suggested recreational option.

The sequence of tasks for dam removal is often important for keeping costs down and the schedule on time. We recommend drawing down the water level as low as possible so there is no ponding of water for a few months. This will allow the sediments to dry out, which makes them much easier and cheaper to move. Once the sediments dry out, it would be preferable to do the bulk of the work during summer or fall when water flow is very low. This will minimize the dewatering and pumping costs. Because we do not recommend releasing the sediment downstream, we suggest restoring the channel and floodplains before removing the dam. This sequence allows the dam to trap any sediment that might be disturbed and prevents it from flowing downstream. The sediment would get excavated from the proposed channel and floodplains and spread on the area between the channel and the vernal pool. If necessary, gravel and cobble substrate will be placed in areas along the channel to build riffles and pools. We suspect, however, that the historic channel will be found and the historic substrate will be used rather than needing to import material. As the channel is being excavated, the banks will be stabilized with fabric and seeding/planting. Following channel construction, the dam can be removed and the channel where the dam was can be built. Once the channels have been built and the dam removed, the paths can be constructed and the revegetation can be completed.

5. <u>Cost Estimates for Design and Construction for Dam Removal/River Restoration</u>

The following cost estimates are based on similar dam removal projects in MA and elsewhere. These cost estimates will likely be within 40% of actual costs; following preliminary designs (75%), these cost estimates can be refined. These cost estimates are also provided with the following assumptions:

- Survey data and hydraulic models previously completed will be available and will not need to be duplicated
- The sediment will not require special treatment; additional sampling will not be necessary
- The pond will be dewatered prior to construction to allow sediments to dry
- Construction will occur during a low-flow period of the year
- The historic channel will be found and little substrate will need to be imported
- Construction of the channel and removal of the dam will last approximately three weeks
- Permitting will be completed by the contractor (if the town or other project partner would like to complete the permitting, this could be a big cost savings)
- Cost estimate does not include monitoring - the extent of monitoring is usually up to the conservation commission, unless mandated by other funding agencies

The tasks included in this cost estimate are:

- Engineering design
    - Project management
    - Topographic survey, data collection, base map construction
    - Hydrology and hydraulics analysis
    - Sediment management plan
    - Preliminary engineering design (75% complete)
    - Final engineering design (100% complete)
- Permitting will likely include
    - MA Environmental Policy Act (MEPA), Environmental Notification Form (ENF)

    - MA Endangered Species Act (MESA)
    - Notice of Intent Application
    - U.S. Army Corps of Engineers - Section 404 Permit
    - MA General Waterways Ch. 91 Permit
    - MA Water Quality Certification (Section 401 Permit)
    - MA Office of Dam Safety Jurisdictional Determination
    - MA Historical Commission Project Notification Form
- Pre-construction preparation
    - Specifications
    - Bid preparation
    - Assistance with bid selection
- Construction
    - Mobilization
    - Traffic control
    - Erosion control
    - Dewatering
    - Channel and channel bank construction
    - Dam removal
    - Revegetation - seeding, plugs, shrubs, trees
- Construction oversight - about three weeks of continuous oversight

COST ESTIMATE FOR DESIGN AND CONSTRUCTION

Task	Cost
Engineering Design (75% preliminary and 100% complete)	$45,000
Permitting	$30,000
Bid Preparation, Specifications, Bid Selection	$10,000
Construction	$225,000
Construction Oversight	$25,000
Total	**$335,000**
Range (+/- 40%)	**$201,000-$469,000**

6. References

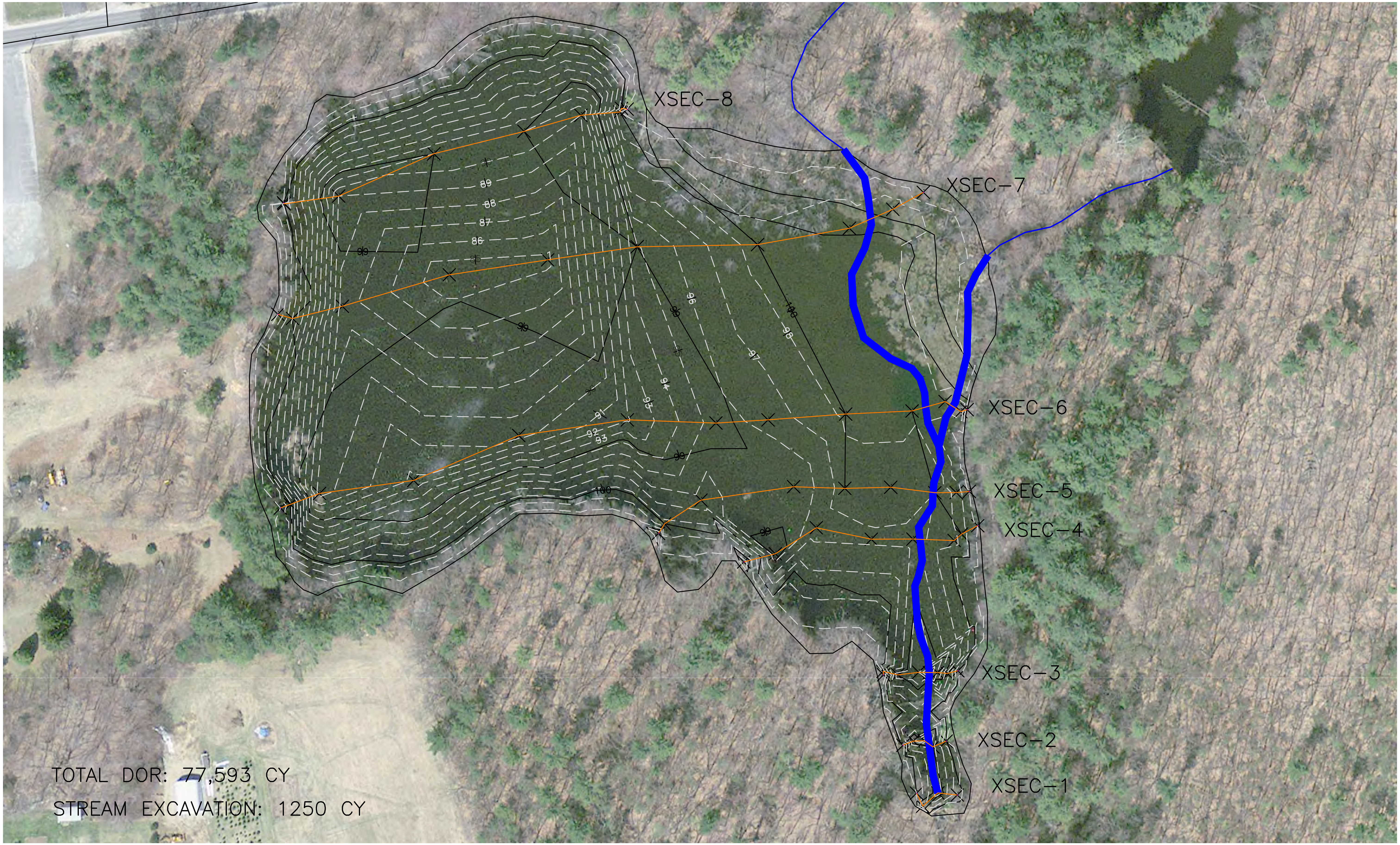
Forbes, A. 1998. Historic Landscape Survey of Fyfeshire Pond Conservation Area. Bolton Historical Commission.

Fuss & O'Neill, 2009. Visual Inspection Update. Prepared for the Department of Conservation and Recreation.

Fuss & O'Neill, 2009. Fyfeshire Pond Dam Phase II Investigations Report. Prepared for the Town of Bolton Conservation Commission.

Whitcomb, E. 1988. About Bolton. Bolton Historical Society.

APPENDIX A
Depth of refusal survey results; sediment volume calculations.



Plan View

NO.	BY	DATE	REVISION DESCRIPTION

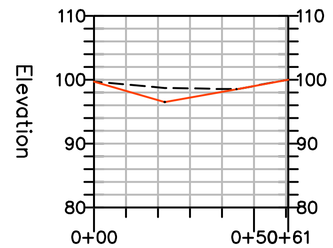
GO	NN	x
DRAWN	DESIGNED	CHECKED
x	09/16/2010	
APPROVED	DATE	PROJECT

Fyfeshire Dam
Massachusetts
Location

inter-fluve
3602 Atwood Avenue Suite 3
Madison, WI 53714
608.441.0342
www.interfluve.com

Plan View

SHEET
1 OF 2



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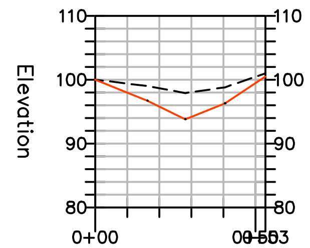

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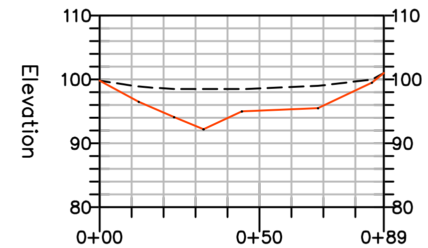

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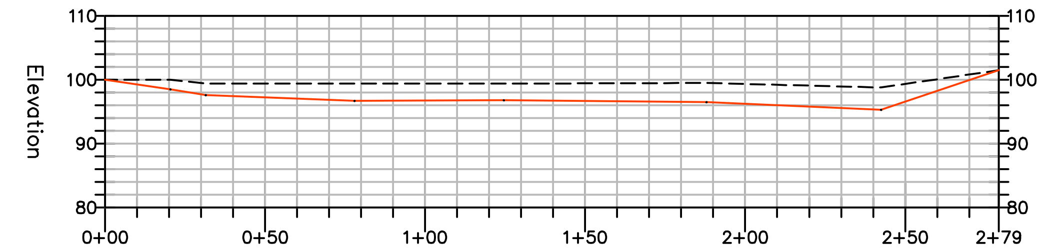

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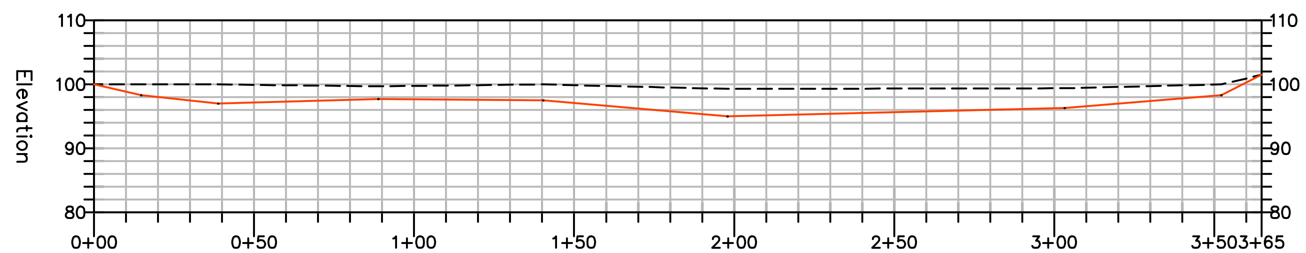

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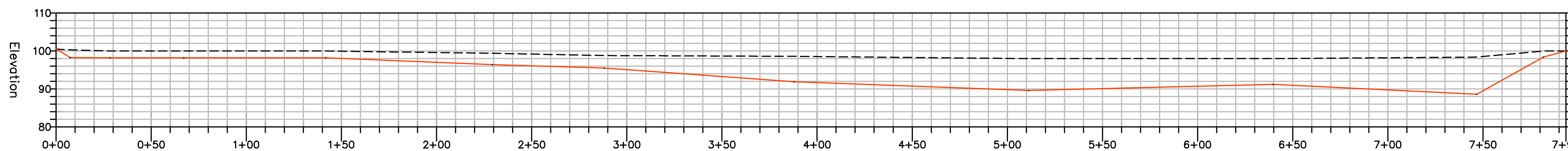

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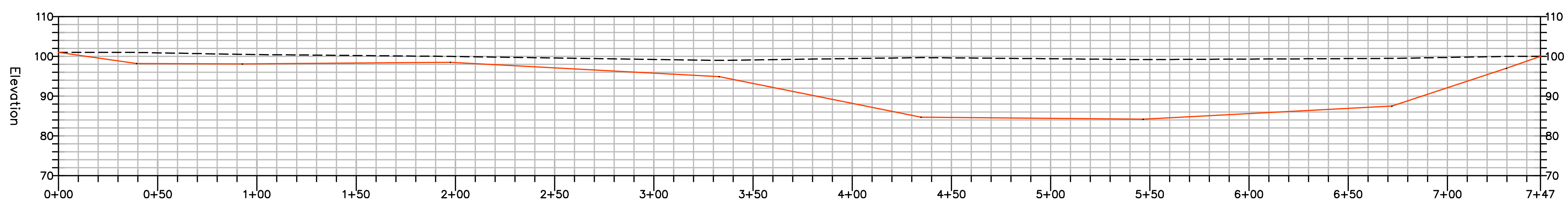

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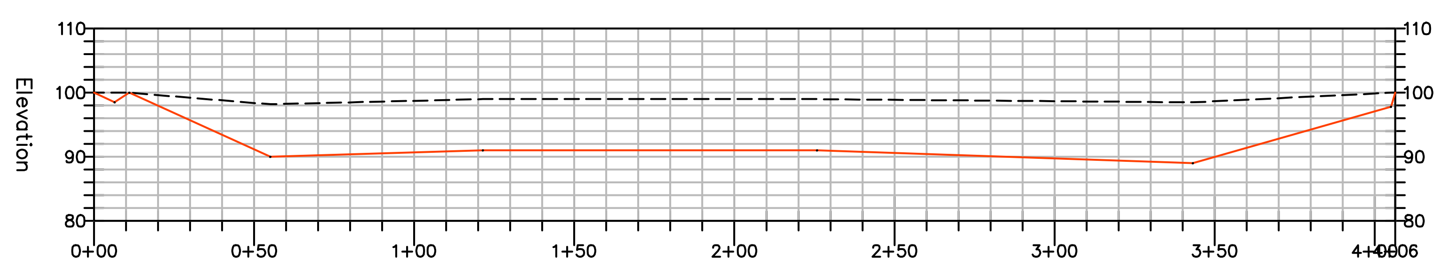

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Plan View

NO.	BY	DATE	REVISION DESCRIPTION

GO	NN	x
DRAWN	DESIGNED	CHECKED
x	09/16/2010	
APPROVED	DATE	PROJECT

Fyfeshire Dam
Massachusetts
Location

inter·fluve
3602 Atwood Avenue Suite 3
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Plan View

SHEET
1 OF 2

APPENDIX B
Sediment Sampling Results

Sample Results Comparison with MCP S1/GW-1 Criteria.
Results in gray shading exceed MCP S1/G1 thresholds

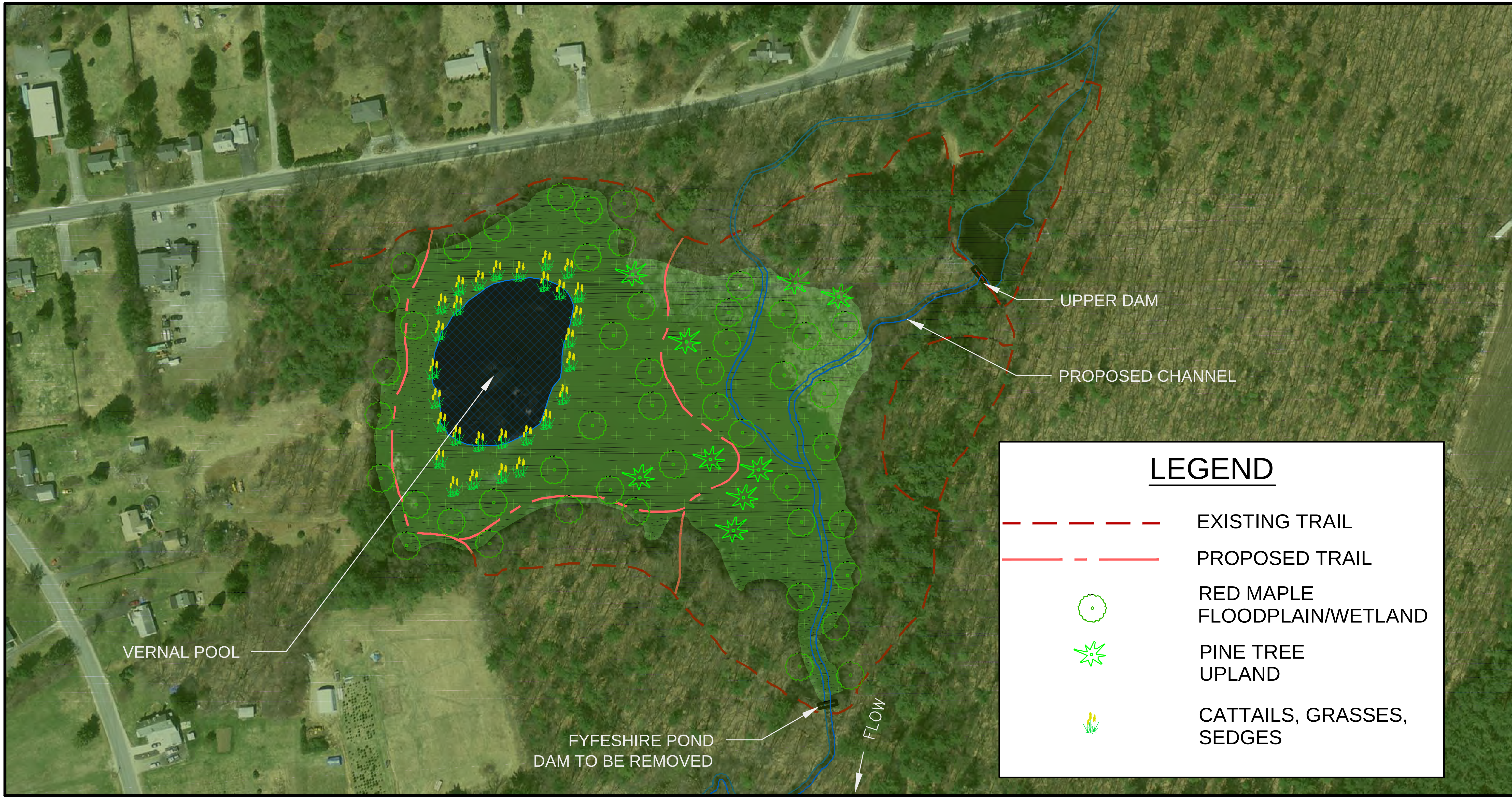
LOCATION			US	POND	DS
SAMPLING DATE			09-AUG-10	09-AUG-10	09-AUG-10
LAB SAMPLE ID			L1012505-04	L1012505-05	L1012505-06
	MCP S1/G1 Threshold	Units			
General Chemistry - Westborough Lab					
Solids, Total		%	29	52	29
General Chemistry - Mansfield Lab					
Solids, Total		%	58.4	42.2	49.7
Total Organic Carbon - Mansfield Lab					
Total Organic Carbon (Rep1)		%	1.62	3.67	4.36
Total Organic Carbon (Rep2)		%	1.85	4.01	4.56
Grain Size Analysis - Mansfield Lab					
% Cobbles		%	0.1	0.1	0.1
% Coarse Gravel		%	0.1	0.1	0.1
% Fine Gravel		%	0.3	0.2	4.4
% Coarse Sand		%	1.2	4.1	8.6
% Medium Sand		%	17.1	24.5	36.8
% Fine Sand		%	69	49.1	43.6
% Total Fines		%	12.4	22.1	6.6
Total Metals - Mansfield Lab					
Arsenic, Total	20	mg/kg	4.54	4.91	4.4
Cadmium, Total	2	mg/kg	0.212	0.196	0.318
Chromium, Total	30	mg/kg	7.24	7.2	7.99
Copper, Total		mg/kg	6.96	4.92	5.82
Lead, Total	300	mg/kg	23.2	20.2	24.5
Mercury, Total	20	mg/kg	0.094	0.074	0.077
Nickel, Total	20	mg/kg	8.81	7.68	10.6
Zinc, Total	2500	mg/kg	32	37.2	42.5
MCP Volatile Organics by 8260B/5035 - Westborough Lab					
1,1,1,2-Tetrachloroethane	0.1	mg/kg	0.0026	0.0011	0.0019
1,1,1,2-Tetrachloroethane	0.1	mg/kg	0.0017	0.0012	0.0023
1,1,1-Trichloroethane	30	mg/kg	0.0026	0.0011	0.0019
1,1,1-Trichloroethane	30	mg/kg	0.0017	0.0012	0.0023
1,1,2,2-Tetrachloroethane	0.005	mg/kg	0.0026	0.0011	0.0019
1,1,2,2-Tetrachloroethane	0.005	mg/kg	0.0017	0.0012	0.0023
1,1,2-Trichloroethane	0.1	mg/kg	0.0039	0.0016	0.0029
1,1,2-Trichloroethane	0.1	mg/kg	0.0025	0.0019	0.0035
1,1-Dichloroethane	0.4	mg/kg	0.0039	0.0016	0.0029
1,1-Dichloroethane	0.4	mg/kg	0.0025	0.0019	0.0035
1,1-Dichloroethene	3	mg/kg	0.0026	0.0011	0.0019
1,1-Dichloroethene	3	mg/kg	0.0017	0.0012	0.0023
1,1-Dichloropropene		mg/kg	0.01	0.0043	0.0077
1,1-Dichloropropene		mg/kg	0.0067	0.005	0.0093
1,2,3-Trichlorobenzene		mg/kg	0.01	0.0043	0.0077
1,2,3-Trichlorobenzene		mg/kg	0.0067	0.005	0.0093
1,2,3-Trichloropropane		mg/kg	0.01	0.0043	0.0077
1,2,3-Trichloropropane		mg/kg	0.0067	0.005	0.0093
1,2,4-Trichlorobenzene	2	mg/kg	0.01	0.0043	0.0077
1,2,4-Trichlorobenzene	2	mg/kg	0.0067	0.005	0.0093
1,2,4-Trimethylbenzene		mg/kg	0.01	0.0043	0.0077
1,2,4-Trimethylbenzene		mg/kg	0.0067	0.005	0.0093
1,2-Dibromo-3-chloropropane		mg/kg	0.01	0.0043	0.0077
1,2-Dibromo-3-chloropropane		mg/kg	0.0067	0.005	0.0093
1,2-Dibromoethane	0.1	mg/kg	0.01	0.0043	0.0077
1,2-Dibromoethane	0.1	mg/kg	0.0067	0.005	0.0093
1,2-Dichlorobenzene	9	mg/kg	0.01	0.0043	0.0077
1,2-Dichlorobenzene	9	mg/kg	0.0067	0.005	0.0093
1,2-Dichloroethane	0.1	mg/kg	0.0026	0.0011	0.0019
1,2-Dichloroethane	0.1	mg/kg	0.0017	0.0012	0.0023
1,2-Dichloropropane	0.1	mg/kg	0.009	0.0037	0.0067
1,2-Dichloropropane	0.1	mg/kg	0.0058	0.0044	0.0082
1,3,5-Trimethylbenzene		mg/kg	0.01	0.0043	0.0077
1,3,5-Trimethylbenzene		mg/kg	0.0067	0.005	0.0093
1,3-Dichlorobenzene	1	mg/kg	0.01	0.0043	0.0077
1,3-Dichlorobenzene	1	mg/kg	0.0067	0.005	0.0093
1,3-Dichloropropane		mg/kg	0.01	0.0043	0.0077

1,3-Dichloropropane		**mg/kg**	**0.0067**	**0.005**	**0.0093**
1,4-Dichlorobenzene	**0.7**	**mg/kg**	**0.01**	**0.0043**	**0.0077**
1,4-Dichlorobenzene	**0.7**	**mg/kg**	**0.0067**	**0.005**	**0.0093**
1,4-Dioxane	**0.2**	**mg/kg**	**1.3**	**0.53**	**0.96**
1,4-Dioxane	**0.2**	**mg/kg**	**0.84**	**0.62**	**1.2**
2,2-Dichloropropane		**mg/kg**	**0.013**	**0.0053**	**0.0096**
2,2-Dichloropropane		**mg/kg**	**0.0084**	**0.0062**	**0.012**
2-Butanone	**4**	**mg/kg**	**0.036**	**0.095**	**0.04**
2-Butanone	**4**	**mg/kg**	**0.024**	**0.26**	**0.09**
2-Hexanone		**mg/kg**	**0.026**	**0.011**	**0.019**
2-Hexanone		**mg/kg**	**0.017**	**0.012**	**0.023**
4-Methyl-2-pentanone	**0.4**	**mg/kg**	**0.026**	**0.011**	**0.019**
4-Methyl-2-pentanone	**0.4**	**mg/kg**	**0.017**	**0.012**	**0.023**
Acetone	**6**	**mg/kg**	**0.11**	**0.058**	**0.14**
Acetone	**6**	**mg/kg**	**0.075**	**0.14**	**0.29**
Benzene	**2**	**mg/kg**	**0.0026**	**0.0011**	**0.0019**
Benzene	**2**	**mg/kg**	**0.0017**	**0.0012**	**0.0023**
Bromobenzene		**mg/kg**	**0.013**	**0.0053**	**0.0096**
Bromobenzene		**mg/kg**	**0.0084**	**0.0062**	**0.012**
Bromochloromethane		**mg/kg**	**0.01**	**0.0043**	**0.0077**
Bromochloromethane		**mg/kg**	**0.0067**	**0.005**	**0.0093**
Bromodichloromethane	**0.1**	**mg/kg**	**0.0026**	**0.0011**	**0.0019**
Bromodichloromethane	**0.1**	**mg/kg**	**0.0017**	**0.0012**	**0.0023**
Bromoform	**0.1**	**mg/kg**	**0.01**	**0.0043**	**0.0077**
Bromoform	**0.1**	**mg/kg**	**0.0067**	**0.005**	**0.0093**
Bromomethane	**0.5**	**mg/kg**	**0.0051**	**0.0021**	**0.0038**
Bromomethane	**0.5**	**mg/kg**	**0.0033**	**0.0025**	**0.0046**
Carbon disulfide		**mg/kg**	**0.01**	**0.0043**	**0.0077**
Carbon disulfide		**mg/kg**	**0.0067**	**0.005**	**0.0093**
Carbon tetrachloride	**10**	**mg/kg**	**0.0026**	**0.0011**	**0.0019**
Carbon tetrachloride	**10**	**mg/kg**	**0.0017**	**0.0012**	**0.0023**
Chlorobenzene	**1**	**mg/kg**	**0.0026**	**0.0011**	**0.0019**
Chlorobenzene	**1**	**mg/kg**	**0.0017**	**0.0012**	**0.0023**
Chloroethane		**mg/kg**	**0.0051**	**0.0021**	**0.0038**
Chloroethane		**mg/kg**	**0.0033**	**0.0025**	**0.0046**
Chloroform	**0.4**	**mg/kg**	**0.0039**	**0.0016**	**0.0029**
Chloroform	**0.4**	**mg/kg**	**0.0025**	**0.0019**	**0.0035**
Chloromethane		**mg/kg**	**0.01**	**0.0043**	**0.0077**
Chloromethane		**mg/kg**	**0.0067**	**0.005**	**0.0093**
cis-1,2-Dichloroethene	**0.3**	**mg/kg**	**0.0026**	**0.0011**	**0.0019**
cis-1,2-Dichloroethene	**0.3**	**mg/kg**	**0.0017**	**0.0012**	**0.0023**
cis-1,3-Dichloropropene	**0.01**	**mg/kg**	**0.0026**	**0.0011**	**0.0019**
cis-1,3-Dichloropropene	**0.01**	**mg/kg**	**0.0017**	**0.0012**	**0.0023**
Dibromochloromethane	**0.005**	**mg/kg**	**0.0026**	**0.0011**	**0.0019**
Dibromochloromethane	**0.005**	**mg/kg**	**0.0017**	**0.0012**	**0.0023**
Dibromomethane		**mg/kg**	**0.01**	**0.0043**	**0.0077**
Dibromomethane		**mg/kg**	**0.0067**	**0.005**	**0.0093**
Dichlorodifluoromethane		**mg/kg**	**0.026**	**0.011**	**0.019**
Dichlorodifluoromethane		**mg/kg**	**0.017**	**0.012**	**0.023**
Ethyl ether		**mg/kg**	**0.013**	**0.0053**	**0.0096**
Ethyl ether		**mg/kg**	**0.0084**	**0.0062**	**0.012**
Ethyl-Tert-Butyl-Ether		**mg/kg**	**0.01**	**0.0043**	**0.0077**
Ethyl-Tert-Butyl-Ether		**mg/kg**	**0.0067**	**0.005**	**0.0093**
Ethylbenzene	**40**	**mg/kg**	**0.0026**	**0.0011**	**0.0019**
Ethylbenzene	**40**	**mg/kg**	**0.0017**	**0.0012**	**0.0023**
Hexachlorobutadiene	**6**	**mg/kg**	**0.01**	**0.0043**	**0.0077**
Hexachlorobutadiene	**6**	**mg/kg**	**0.0067**	**0.005**	**0.0093**
Isopropyl Ether		**mg/kg**	**0.01**	**0.0043**	**0.0077**
Isopropyl Ether		**mg/kg**	**0.0067**	**0.005**	**0.0093**
Isopropylbenzene		**mg/kg**	**0.0026**	**0.0011**	**0.0019**
Isopropylbenzene		**mg/kg**	**0.0017**	**0.0012**	**0.0023**
Methyl tert butyl ether	**0.1**	**mg/kg**	**0.0051**	**0.0021**	**0.0038**
Methyl tert butyl ether	**0.1**	**mg/kg**	**0.0033**	**0.0025**	**0.0046**
Methylene chloride	**0.1**	**mg/kg**	**0.026**	**0.011**	**0.019**
Methylene chloride	**0.1**	**mg/kg**	**0.017**	**0.012**	**0.023**
n-Butylbenzene		**mg/kg**	**0.0026**	**0.0011**	**0.0019**
n-Butylbenzene		**mg/kg**	**0.0017**	**0.0012**	**0.0023**
n-Propylbenzene		**mg/kg**	**0.0026**	**0.0011**	**0.0019**
n-Propylbenzene		**mg/kg**	**0.0017**	**0.0012**	**0.0023**
Naphthalene	**4**	**mg/kg**	**0.01**	**0.0043**	**0.0077**
Naphthalene	**4**	**mg/kg**	**0.0067**	**0.005**	**0.0093**
o-Chlorotoluene		**mg/kg**	**0.01**	**0.0043**	**0.0077**
o-Chlorotoluene		**mg/kg**	**0.0067**	**0.005**	**0.0093**
o-Xylene	**400**	**mg/kg**	**0.0051**	**0.0021**	**0.0038**
o-Xylene	**400**	**mg/kg**	**0.0033**	**0.0025**	**0.0046**
p-Chlorotoluene		**mg/kg**	**0.01**	**0.0043**	**0.0077**

p-Chlorotoluene		mg/kg	0.0067	0.005	0.0093
p-Isopropyltoluene		mg/kg	0.0026	0.0011	0.0019
p-Isopropyltoluene		mg/kg	0.0029	0.0012	0.0038
p/m-Xylene	400	mg/kg	0.0051	0.0021	0.0038
p/m-Xylene	400	mg/kg	0.0033	0.0025	0.0046
sec-Butylbenzene		mg/kg	0.0026	0.0011	0.0019
sec-Butylbenzene		mg/kg	0.0017	0.0012	0.0023
Styrene	3	mg/kg	0.0051	0.0021	0.0038
Styrene	3	mg/kg	0.0033	0.0025	0.0046
tert-Butylbenzene		mg/kg	0.01	0.0043	0.0077
tert-Butylbenzene		mg/kg	0.0067	0.005	0.0093
Tertiary-Amyl Methyl Ether		mg/kg	0.01	0.0043	0.0077
Tertiary-Amyl Methyl Ether		mg/kg	0.0067	0.005	0.0093
Tetrachloroethene	1	mg/kg	0.0026	0.0011	0.0019
Tetrachloroethene	1	mg/kg	0.0017	0.0012	0.0023
Tetrahydrofuran		mg/kg	0.01	0.0043	0.0077
Tetrahydrofuran		mg/kg	0.0067	0.005	0.0093
Toluene	30	mg/kg	0.0039	0.0016	0.0029
Toluene	30	mg/kg	0.0025	0.0019	0.0035
trans-1,2-Dichloroethene	1	mg/kg	0.0039	0.0016	0.0029
trans-1,2-Dichloroethene	1	mg/kg	0.0025	0.0019	0.0035
trans-1,3-Dichloropropene	0.01	mg/kg	0.0026	0.0011	0.0019
trans-1,3-Dichloropropene	0.01	mg/kg	0.0017	0.0012	0.0023
Trichloroethene	0.3	mg/kg	0.0026	0.0011	0.0019
Trichloroethene	0.3	mg/kg	0.0017	0.0012	0.0023
Trichlorofluoromethane		mg/kg	0.01	0.0043	0.0077
Trichlorofluoromethane		mg/kg	0.0067	0.005	0.0093
Vinyl chloride	0.6	mg/kg	0.0051	0.0021	0.0038
Vinyl chloride	0.6	mg/kg	0.0033	0.0025	0.0046
PAHs/PCB Congeners by GC/MS - Mansfield Lab					
Acenaphthene	4	mg/kg	0.0131	0.0173	0.0142
Acenaphthylene	1	mg/kg	0.0667	0.0173	0.0142
Anthracene	1000	mg/kg	0.0305	0.0173	0.0142
Benz(a)anthracene		mg/kg	0.141	0.0292	0.0292
Benzo(a)pyrene	2	mg/kg	0.117	0.0173	0.0269
Benzo(b)fluoranthene	7	mg/kg	0.176	0.0394	0.0408
Benzo(ghi)perylene	1000	mg/kg	0.0962	0.0173	0.0198
Benzo(k)fluoranthene	70	mg/kg	0.066	0.0173	0.0196
Chrysene	70	mg/kg	0.117	0.0257	0.0263
Cl10-BZ#209		mg/kg	0.00131	0.00173	0.00142
Cl2-BZ#8		mg/kg	0.00131	0.00173	0.00142
Cl3-BZ#18		mg/kg	0.00131	0.00173	0.00142
Cl3-BZ#28		mg/kg	0.00131	0.00173	0.00142
Cl4-BZ#44		mg/kg	0.00131	0.00173	0.00142
Cl4-BZ#49		mg/kg	0.00131	0.00173	0.00142
Cl4-BZ#52		mg/kg	0.00131	0.00173	0.00142
Cl4-BZ#66		mg/kg	0.00131	0.00173	0.00142
Cl5-BZ#101		mg/kg	0.00131	0.00173	0.00142
Cl5-BZ#105		mg/kg	0.00131	0.00173	0.00142
Cl5-BZ#118		mg/kg	0.00131	0.00173	0.00142
Cl5-BZ#87		mg/kg	0.00131	0.00173	0.00142
Cl6-BZ#128		mg/kg	0.00131	0.00173	0.00142
Cl6-BZ#138		mg/kg	0.00131	0.00173	0.00142
Cl6-BZ#153		mg/kg	0.00131	0.00173	0.00142
Cl7-BZ#170		mg/kg	0.00131	0.00173	0.00142
Cl7-BZ#180		mg/kg	0.00131	0.00173	0.00142
Cl7-BZ#183		mg/kg	0.00131	0.00173	0.00142
Cl7-BZ#184		mg/kg	0.00131	0.00173	0.00142
Cl7-BZ#187		mg/kg	0.00131	0.00173	0.00142
Cl8-BZ#195		mg/kg	0.00131	0.00173	0.00142
Cl9-BZ#206		mg/kg	0.00131	0.00173	0.00142
Dibenz(a,h)anthracene		mg/kg	0.0243	0.0173	0.0142
Fluoranthene	1000	mg/kg	0.289	0.062	0.0616
Fluorene	1000	mg/kg	0.033	0.0197	0.0183
Indeno(1,2,3-cd)Pyrene	7	mg/kg	0.095	0.0173	0.0211
Naphthalene	4	mg/kg	0.0158	0.0173	0.0142
Phenanthrene	10	mg/kg	0.149	0.0173	0.0222
Pyrene	1000	mg/kg	0.273	0.0596	0.0535
Organochlorine Pesticides by GC - Mansfield Lab					
2,4'-DDD		mg/kg	0.0141	0.00211	0.00381
2,4'-DDE		mg/kg	0.00154	0.00211	0.0019
2,4'-DDT		mg/kg	0.00154	0.00211	0.0019
4,4'-DDD	4	mg/kg	0.0624	0.0047	0.0117
4,4'-DDE	3	mg/kg	0.0455	0.0196	0.0193

4,4'-DDT	3	mg/kg	0.00705	0.00272	0.0019
Aldrin	0.04	mg/kg	0.00154	0.00211	0.0019
Alpha-BHC		mg/kg	0.00154	0.00211	0.0019
Beta-BHC		mg/kg	0.00154	0.00211	0.0019
Chlordane	0.7	mg/kg	0.0773	0.106	0.0951
cis-Chlordane		mg/kg	0.00154	0.00211	0.0019
Delta-BHC		mg/kg	0.00154	0.00211	0.0019
Dieldrin	0.05	mg/kg	0.00154	0.00211	0.0019
Endosulfan I	0.5	mg/kg	0.00154	0.00211	0.0019
Endosulfan II	0.5	mg/kg	0.00154	0.00211	0.0019
Endosulfan sulfate		mg/kg	0.00154	0.00211	0.0019
Endrin	8	mg/kg	0.00154	0.00211	0.0019
Endrin aldehyde		mg/kg	0.00154	0.00211	0.0019
Endrin ketone		mg/kg	0.00154	0.00211	0.0019
gamma-BHC		mg/kg	0.00154	0.00211	0.0019
Heptachlor	0.2	mg/kg	0.00154	0.00211	0.0019
Heptachlor epoxide	0.09	mg/kg	0.00154	0.00211	0.0019
Hexachlorobenzene	0.7	mg/kg	0.00154	0.00211	0.0019
Methoxychlor	200	mg/kg	0.00154	0.00211	0.0019
Mirex		mg/kg	0.00154	0.00211	0.0019
Oxychlordane		mg/kg	0.00154	0.00211	0.0019
Toxaphene		mg/kg	0.0773	0.106	0.0951
trans-Chlordane		mg/kg	0.00154	0.00211	0.0019
trans-Nonachlor		mg/kg	0.00154	0.00211	0.0019
Extractable Petroleum Hydrocarbons - Westborough Lab					
C11-C22 Aromatics, Adjusted	1000	mg/kg	11	23	13.3
C11-C22 Aromatics, Unadjusted		mg/kg	11	23	13.3
C19-C36 Aliphatics	3000	mg/kg	11	15.8	13.3
C9-C18 Aliphatics	1000	mg/kg	11	15.1	13.3

APPENDIX C
Conceptual Rendering



PLAN VIEW

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FYFESHIRE POND
FEASIBILITY STUDY
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APPENDIX D
Photo Rendering

Exhibit 1A. Looking downstream towards Fyfeshire Pond Dam: Existing conditions

Exhibit 1B. Looking downstream towards former Fyfeshire Pond Dam: Proposed conditions

Exhibit 2A. Looking west across Fyfeshire Pond: Existing conditions

Exhibit 2B. Looking west across former Fyfeshire Pond: Proposed conditions with creek in the foreground and vernal pool in background.

Exhibit 3A. Looking east across Fyfeshire Pond from beaver lodge: Existing conditions

Exhibit 3B. Looking east across former Fyfeshire Pond: Proposed conditions with vernal pool in foreground