

Comprehensive Environmental Inc.

Study of Urban Non-Point Source Pollution PBS, PBH, PBP, WBS & MB Subwatersheds



PENNICHUCK WATER WORKS WINTER - SPRING 2004



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Table of Contents

1 of 7

Section	Title	Page No.
	Executive Summary	i
1.0	Introduction	1-1
	1.1 Project Description	1-1
	1.2 Status and Prioritization of Watershed Recommendations.....	1-2
2.0	Pennichuck Brook to Supply Pond (PBS) Subwatershed	2-1
	2.1 Subwatershed Drainage	2-1
	2.1.1 Area A Drainage Description	2-1
	2.1.2 Area B Drainage Description.....	2-6
	2.2 Site Specific Recommendations	2-12
	2.2.1 Improve Design of Tinker Road Detention Pond	2-14
	2.2.2 Construct Containment Swale for Turnpike Discharge	2-16
	2.2.3 Divert Turnpike Bridge Runoff into Sediment Basin.....	2-19
3.0	Pennichuck Brook to Holts Pond (PBH) Subwatershed	3-1
	3.1 Subwatershed Drainage	3-1
	3.1.1 Area A Drainage Description	3-1
	3.1.2 Area B Drainage Description.....	3-5
	3.1.3 Area C Drainage Description.....	3-17
	3.2 Site Specific Recommendations	3-19
	3.2.1 Evaluate PC Connection Detention Pond	3-19
	3.2.2 Review Future Route 101A Capacity Preservation Plans	3-21
	3.2.3 Create Demonstration Project for Pennichuck Square	3-23

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Table of Contents

2 of 7

Section	Title	Page No.
	3.2.4 Treat Cirus Restaurant Parking Lot Runoff.....	3-25
	3.2.5 Treat ASA Offices Parking Lot Runoff.....	3-26
	3.2.6 Treat Westside Plaza Parking Area Runoff.....	3-27
	3.2.7 Treat Celina Avenue Runoff.....	3-29
	3.2.8 Construct Snow Storage Area at Saturn Dealership	3-30
	3.2.9 Construct Dumpster Storage Area at Greystone Plaza	3-32
	3.2.10 Improve Snow & Dumpster Storage Practices at DJ Square	3-33
4.0	PBP, WBS, & MB Subwatersheds	4-1
	4.1 General Subwatershed Findings	4-1
	4.2 Subwatershed Drainage	4-3
	4.2.1 Witches Brook South	4-3
	4.2.2 Pennichuck Brook to Pennichuck Pond.....	4-5
	4.2.3 Muddy Brook.....	4-7
	4.3 Site Specific Recommendations	4-8
	4.3.1 Construct Containment Swale for Toddy Brook Road.....	4-8
	4.3.2 Construct Containment Swale & Remove Debris Piles from Silver Lake Road	4-12
5.0	General Recommendations.....	5-1
	5.1 General Subwatershed Concerns	5-1
	5.1.1 Fertilizer and Pesticide Application.....	5-1
	5.1.2 Domestic Animals.....	5-2
	5.1.3 Roadways and Transportation	5-3

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Table of Contents

3 of 7

Section	Title	Page No.
	5.2 Recommendations.....	5-4
	5.2.1 Sponsor Homeowner Outreach Program	5-4
	5.2.2 Sponsor Master Gardner Program	5-4
	5.2.3 Educate Stable Owners about Animal & Manure Management ..	5-4
	5.2.4 Erect Watershed Signs	5-5
6.0	Status of Watershed Recommendations.....	6-1
7.0	Subwatershed Improvements Prioritization.....	7-1
	7.1 Ranking Criteria.....	7-1
	7.2 Prioritization Description.....	7-3
	7.3 Implementation Schedule.....	7-4
	7.4 Potential Funding Sources	7-4



Table of Contents

4 of 7

List of Tables

Page No.

Table 2-1	PBS Recommendation Summary	2-12
Table 3-1	PBH Micro-Watersheds Description	3-9
Table 3-2	PBH Recommendation Summary	3-20
Table 5-1	Urbanized Area	5-6
Table 6-1	Pennichuck Watershed 10 Year Action Plan.....	6-4
Table 7-1	Priority Ranking of Recommended Site Specific Improvements from PWW Subwatershed Studies	7-3
Table 7-2	Timeline for Implementing Recommended Improvements	7-5
Table 7-3	Potential Funding Sources	7-6

List of Figures

Figure 1-1	Pennichuck Brook Watershed	End of Section 1
Figure 2-1	PBS Subwatershed Locus Map	2-2
Figure 2-2	Functional Detention Basin for Heron Cove.....	2-4
Figure 2-3	Functional Detention Pond for Heron Cove Office Park	2-4
Figure 2-4	Pumping Station for Gravel Mining Operation.....	2-5
Figure 2-5	Turnpike Bridge Runoff.....	2-5
Figure 2-6	Sediment Filled Vespa Lane Detention Pond	2-8
Figure 2-7	Eroded Bank & Strewn Debris at Tinker Rd. Detention Pd ..	2-8
Figure 2-8	Detention Pond Overflow Pipe Passing Below Tinker Road	2-9
Figure 2-9	Berm & Wetland Basin Designed to Treat Turnpike Runoff	2-9
Figure 2-10	Wetland Basin & Open Sluice Gate Near Turnpike	2-10



Table of Contents

5 of 7

List of Figures

Page No.

Figure 2-11 Unnamed Tributary before Being Channeled Underground..	2-10
Figure 2-12 Unnamed Tributary Emerging into Vegetated Swale	2-11
Figure 2-13 Unnamed Tributary Draining into Pond	2-11
Figure 2-14 PBS Areas of Concern	2-13
Figure 2-15 Overflow Channel Allows Stormwater to Enter Pond.....	2-14
Figure 2-16 Tinker Road Detention Pond Improvement	2-15
Figure 2-17 Turnpike Outflow Pipe Discharges Below Berm	2-16
Figure 2-18 Weed Infested Channel at Harris Pond's Edge	2-17
Figure 2-19 Containment Swale for Turnpike Discharge.....	2-18
Figure 2-20 Channel Erosion Caused by Turnpike Bridge Discharge ..	2-19
Figure 2-21 Sediment Basin for Turnpike Bridge Discharge	2-21
Figure 3-1 PBH Subwatershed Locus Map	3-2
Figure 3-2 Roadside Swales off Eric Street Help Treat Runoff	3-4
Figure 3-3 Older Residential Development without Swales.	3-4
Figure 3-4 Area B Micro-Watersheds	3-8
Figure 3-5 PC Connection Detention Pond Collects Runoff.....	3-10
Figure 3-6 Vegetated Swale Near Home Depot Entrance	3-10
Figure 3-7 Runoff Transports Sediment & Trash down Steep Slope	3-11
Figure 3-8 No On-Site Stormwater Treatment at Pennichuck Plaza.....	3-11
Figure 3-9 Route 101A & Greystone Plaza Discharge.....	3-12
Figure 3-10 Direct Stormwater Discharge from Cirus Restaurant	3-12
Figure 3-11 Functional Infiltration Basin Behind Saturn Dealership....	3-13
Figure 3-12 Detention Basin Effectively Capturing Runoff.....	3-13



Table of Contents

6 of 7

List of Figures

Page No.

Figure 3-13 High Velocity Discharge from Celina Avenue	3-14
Figure 3-14 Marginally Effective Infiltration Swale	3-14
Figure 3-15 U.S. Postal Facility's Detention Pond	3-15
Figure 3-16 Westside Plaza Expansive Parking Area	3-15
Figure 3-17 Trash and Debris Transported in and near Catch Basin.....	3-16
Figure 3-18 Aboveground Drainage Channels in Place of Catch Basins .	3-16
Figure 3-19 Large Detention Basin Captures Commercial Site Runoff ...	3-18
Figure 3-20 Small Pond Near Meadow Drive	3-18
Figure 3-21 PC Connection Detention Pond Outlet	3-21
Figure 3-22 Channel Scouring from Route 101A and Greystone Plaza ...	3-22
Figure 3-23 Untreated Stormwater Discharged East of Continental Blvd	3-23
Figure 3-24 Clogged Catch Basin & Bank Erosion.....	3-24
Figure 3-25 Trash Blown into Wetland Area	3-24
Figure 3-26 Clogged Outfall Pipe and Sediment Trail	3-25
Figure 3-27 Sediment Delta from Discharge of ASA Parking Area	3-26
Figure 3-28 Accumulated Sediment in Channel from Westside Plaza..	3-27
Figure 3-29 Westside Plaza Treatment System	3-30
Figure 3-30 Bank Erosion in Drainage Channel from Celina Avenue ..	3-31
Figure 3-31 Sediment Accumulation on Shoreline from Snow Storage...	3-32
Figure 3-32 Saturn Snow Storage Area Improvement.....	3-33
Figure 3-33 Trash in Wetland Area from Greystone Plaza Dumpsters	3-34
Figure 3-34 Trash in Wetland Area from RJ Square Plaza Dumpsters	3-35
Figure 4-1 WBS, PBP, and MB Subwatersheds Locus Map	4-2



Table of Contents

7 of 7

List of Figures

Page No.

Figure 4-2 WBS, PBP, & MB Watersheds Drainage Map	4-4
Figure 4-3 Working Sediment Trap on Federal Hill Road	4-5
Figure 4-4 Working Sediment Trap with Ponded Stormwater	4-5
Figure 4-5 Site Specific Water Quality Impacts	4-9
Figure 4-6 Sediment from Exposed Road Shoulder	4-10
Figure 4-7 Channel Formed in Toddy Brook Road Shoulder.	4-10
Figure 4-8 Sediment & Debris Collected in Inlet Side of Culvert.....	4-11
Figure 4-9 Exposed Dirt Shoulder Contributes to Sediment in Brook..	4-13
Figure 4-10 Sediment Trail and Paved Channel Leading into Culvert..	4-13
Figure 4-11 Garbage Dumped Adjacent to Witches Brook.....	4-14
Figure 4-12 Construction Debris Dumped Adjacent to Witches Brook ...	4-14
Figure 6-1 Watershed Recommendation Overview.....	6-2

Appendices

Appendix A.....	PC Connection Detention Pond Feasibility Study Grant
Appendix B	Pennichuck Square Demonstration Project Grant
Appendix C	Infiltration Divider
Appendix D.....	Celina Avenue Grant
Appendix E	Containment Swale

References



EXECUTIVE SUMMARY

There are a total of ten subwatersheds within the Pennichuck Watershed as identified in the 1998 Pennichuck Water Works Watershed Management Plan. Five of these ten subwatersheds have been studied in previous reports. This report assessed the five remaining subwatersheds within the watershed.

Previously Studied

- Boire Field Brook (BFB)
- Pennichuck Brook to Bowers Pond (PBB)
- Witches Brook East (WBE)
- Witches Brook North (WBN)
- Stump Pond Brook (STB)

Studied in this Report

- Pennichuck Brook to Supply Pond (PBS)
- Pennichuck Brook to Holts Pond (PBH)
- Pennichuck Brook to Pennichuck Pond (PBP)
- Witches Brook South (WBS)
- Muddy Brook (MB)

Report Findings

Ten major water quality threats were discovered in the PBH subwatershed where Route 101A crosses and commercial areas abut Pennichuck Brook. Most of the threats from this subwatershed involve untreated stormwater discharges from commercial sites near or directly into the brook.

In the PBS subwatershed, three potential water quality threats were found. Two of the threats are caused by untreated stormwater discharges from the F.E. Everett Turnpike into the Harris and Bowers Ponds. The third threat involves the overflow channel in a detention pond near Tinker Road. The low elevation of the channel allows captured stormwater runoff to enter Harris Pond untreated.

Not surprisingly, only two site specific areas of concern were discovered in the three more rural subwatersheds, PBP, WBS and MB. These involved pollutant loadings entering Witches Brook from street runoff.

In all, fifteen new recommendations were made specifically to address these issues and threats. These were then prioritized using the following three criteria; 1) size of drainage area, 2) distance of discharge to the brook or pond, and 3) discharge distance to the water supply intake. Based on the criteria, the ten recommendations listed in the following table ranked the highest.



Top Ten Recommendations			
	Name	Sub-watershed	Estimated Cost
1	Improve Tinker Road Detention Pond	PBS	\$5,900
2	Evaluate PC Connection Detention Pond	PBH	\$23,300
3	Construct Containment Swale for Turnpike Discharge	PBS	\$6,450
4	Divert Turnpike Bridge Discharge into Sediment Basin	PBS	\$8,950
5	Create Demonstration Project for Pennichuck Square Plaza	PBH	\$42,400
6	Treat Ciro's Restaurant Parking Lot Runoff	PBH	\$10,700
7	Treat ASA Offices Parking Lot Runoff	PBH	\$10,700
8	Treat Westside Plaza Parking Area Runoff	PBH	\$46,850
9	Treat Celina Avenue Runoff	PBH	\$13,500
10	Construct Snow Storage Area at Saturn Dealership	PBH	\$2,350



1.0 INTRODUCTION

In 1998, Pennichuck Water Works published a comprehensive Watershed Management Plan (Comprehensive Environmental Inc., 1998) that outlined remedial measures to improve and maintain the water quality of the chain pond system. One primary recommendation was to perform a detailed review of each of the subwatersheds, starting with the most impervious subwatershed, to identify best management practices that could be applied to minimize pollutant loadings from existing impervious surfaces and to prevent pollutant impacts from future development. Five of the ten subwatersheds have been studied as a result of this recommendation. This report focuses on the remaining five subwatersheds listed below and shown in Figure 1-1 at the end of this section.

1. Pennichuck Brook to Supply Pond (PBS)
2. Pennichuck Brook to Holts Pond (PBH)
3. Pennichuck Brook to Pennichuck Pond (PBP)
4. Witches Brook South (WBS)
5. Muddy Brook (MB)

The project was funded jointly by Pennichuck Water Works and the New Hampshire Department of Environmental Services (NHDES).

1.1 Project Description

This project involved a detailed assessment of the remaining subwatersheds to identify drainage patterns, drainage areas, and water quality threats to receiving waters. This information was the basis for developing recommendations to minimize negative impacts to receiving waters. The overall approach to the study included detailed subdrainage reviews followed by recommendations to address water quality threats discovered during field visits.

Subwatershed Drainage

Detailed field reviews were conducted of the subwatersheds during dry and wet weather conditions to identify the key water bodies in the subwatershed and to identify areas and activities contributing to contaminant loadings. A description of the receiving waters and drainage areas is provided for each subwatershed (Sections 2.0, 3.0, & 4.0).

Recommendations

Based on the results of the field investigations, recommendations were then developed for each subwatershed to minimize threats to receiving waters in the subwatershed. The recommendations are divided into two categories: 1) site specific recommendations to address issues identified at specific sites during field

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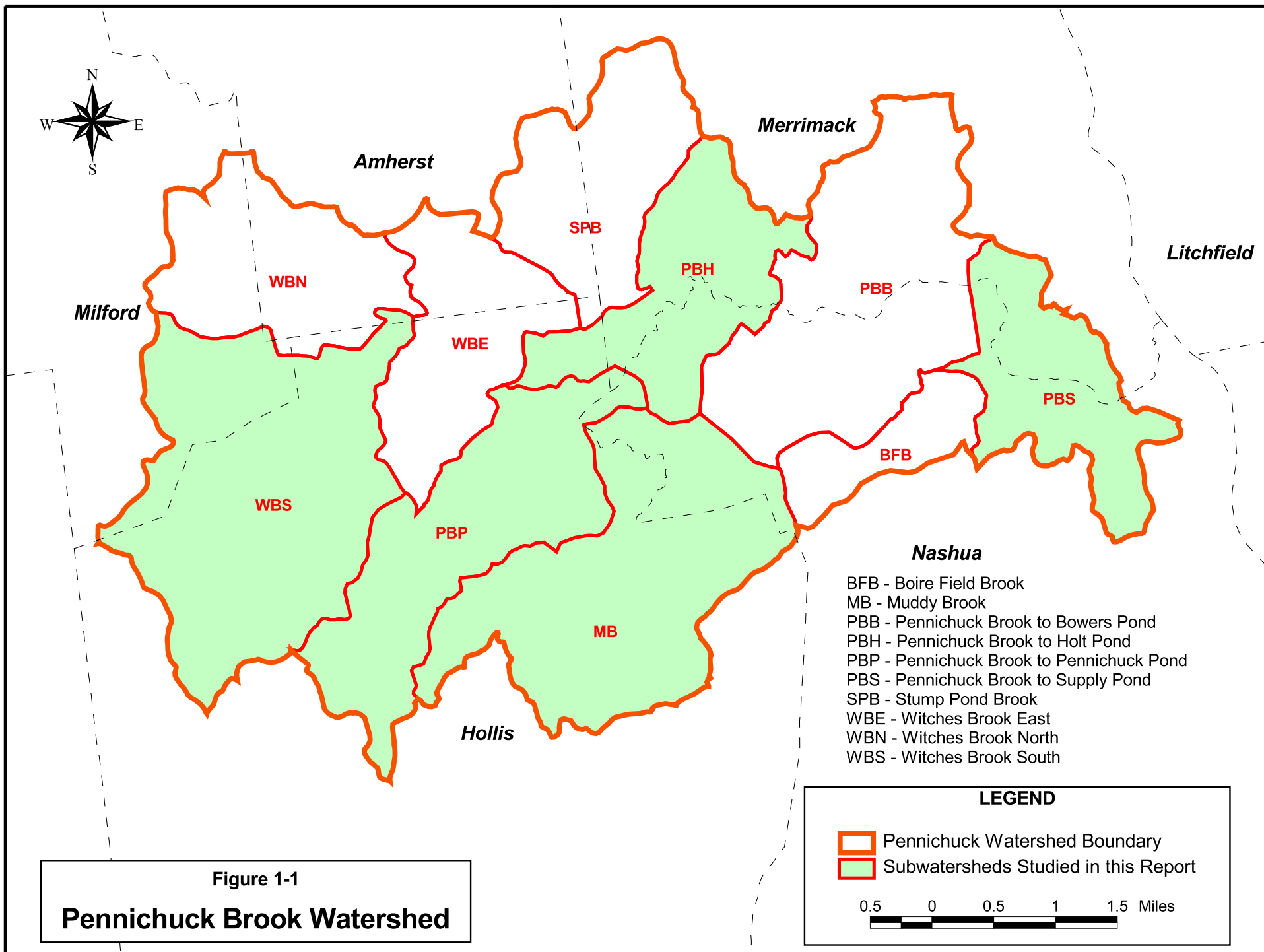


investigations (Sections 2.0, 3.0, & 4.0); and 2) general recommendations to address common problems found throughout the subwatersheds (Section 5.0).

1.2 Status and Prioritization of Watershed Recommendations

This report includes a summary of the recommendations made in previous watershed reports relating to the Pennichuck Subwatershed and the latest status. This information is provided in Section 6.0. Additionally, water quality improvements from the ten subwatersheds are prioritized in Section 7.0 to assist Pennichuck in focusing on the highest areas of concern first. The higher ranked proposed projects have a greater potential to adversely affect the water quality of Pennichuck Brook. The ranking is based on three criteria, size of drainage area, distance of discharge to the brook or pond, and discharge distance to the water supply intake.





2.0 Pennichuck Brook to Supply Pond (PBS) Subwatershed

2.1 SUBWATERSHED DRAINAGE

The Pennichuck Brook to Supply Pond (PBS) Subwatershed comprises 1,508 acres, located in Nashua and Merrimack, and primarily consists of residential development. CEI conducted a detailed review of the subwatershed in 2003 to obtain a better understanding of drainage patterns and to identify water quality threats.

The PBS Subwatershed is divided into two drainage areas, A and B (Figure 2-1), which represent the northern and southern parts of the subwatershed respectively. Drainage Area A is defined by the northern drainage entering into Pennichuck Brook and Drainage Area B is defined by the southern drainage entering into Pennichuck Brook. A description of the drainage areas is provided below.

2.1.1 Area A Drainage Description

Drainage area A represents the northern portion of the subwatershed and lies entirely in the Town of Merrimack, as shown on Figure 2-1. Undeveloped forested land constitutes a significant portion of the drainage area with some residential and commercial development. Stormwater flows through many small tributaries in this drainage area before entering Pennichuck Brook. Described below are descriptions of structured drainage systems and other findings affecting drainage in the subwatershed.

West of Manchester Street

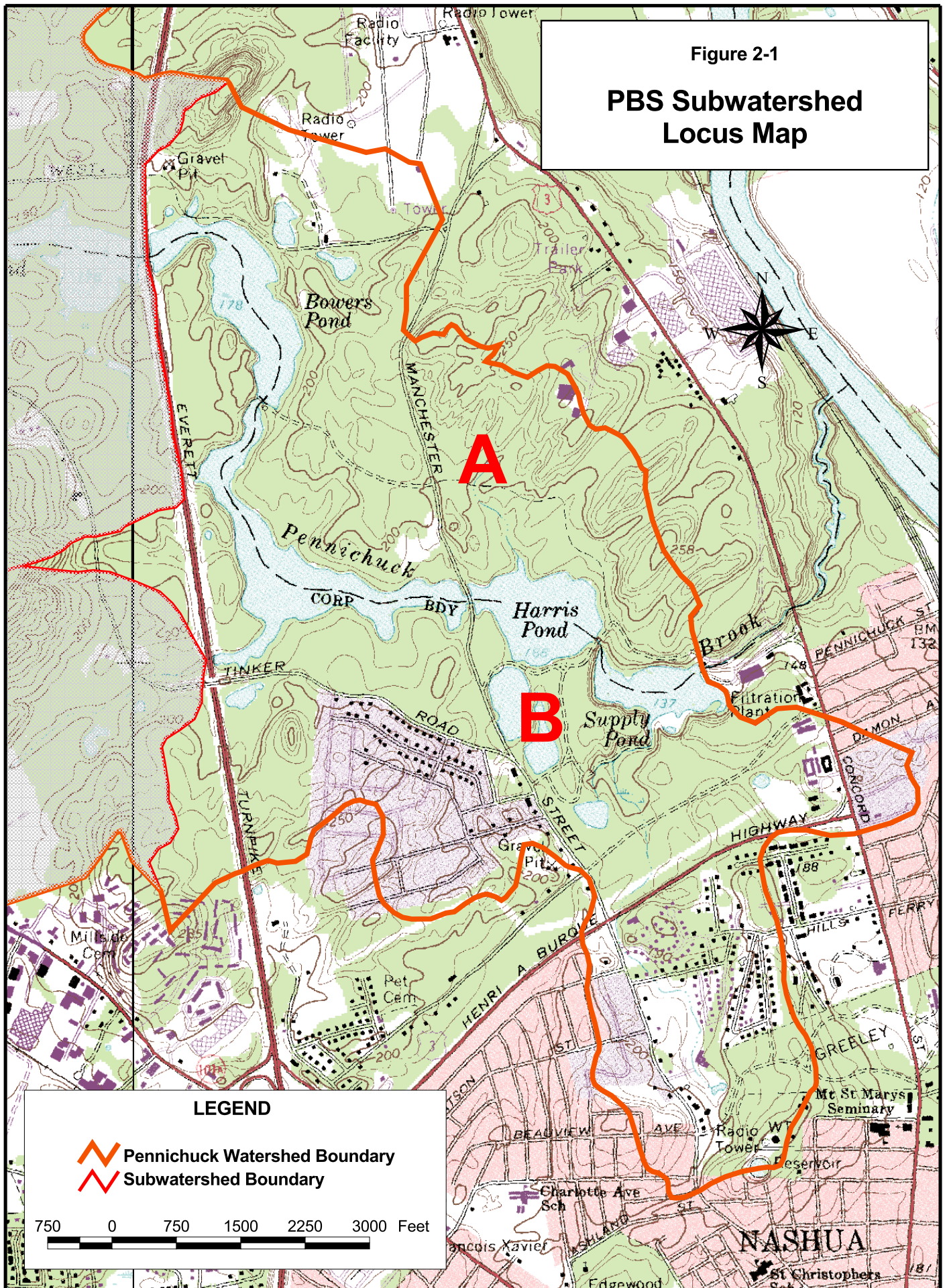
West of Manchester Street is the Heron Cove Housing Development and the Heron Cove Office Buildings I-III. The runoff from the Heron Cove housing development is captured in a series of catch basins and grassy swales that discharge into two large detention basins (Figure 2-2). There are walking paths used by the residents of the Heron Cove development that follow the shoreline of Harris Pond.

Stormwater from the Heron Cove Office Buildings, located at the corner of Al Paul Lane and Manchester Street, is collected in a series of catch basins and grassy/riprap swales before discharging into a large detention pond (Figure 2-3). The detention pond is located east of a small pond adjacent to Al Paul Lane. A constructed channel provides overflow from the detention pond into this small pond.



Figure 2-1

PBS Subwatershed Locus Map



West of Manchester Street (continued)

Gravel Mining Operation

A large gravel mining operation located in the far northern portion of the subwatershed at the end of Al Paul Lane (adjacent to the F.E. Everett Turnpike), lies within a few hundred feet of Bowers Pond. A narrow forested boundary provides a good buffer area for any sediment-laden runoff that may occur at this site. A dirt access road comes very close to Bowers Pond however, no serious erosion or pond sedimentation (from road) was observed. The road leads to a very small pond (on private property) located a few feet from Bowers Pond. It appears that water is pumped from this pond and used for dust suppression at the mining site (Figure 2-4). CEI observed what looked like a slick of oil across a small portion of the pond's surface that may have come from the aged pumping equipment located on the shoreline or from the pump truck(s). However, no direct connection was found between the two bodies of water.

F.E. Everett Turnpike Bridge

The F.E. Turnpike (Route 3) crosses Pennichuck Brook (Bowers Pond). Drainage from the highway flows down steep banks on either side of the bridge causing the erosion of a few small channels. A single 12" pipe a few feet from the shoreline of Bowers Pond was also found just north of the bridge on the east side (Figure 2-5). It appears that stormwater collected from 12 catch basins located within the median strip north of the bridge discharges from this pipe. In addition, there are about fourteen more catch basins located within the median strip south of the bridge. However, no discharge pipe was found near the pond's shoreline. CEI reviewed bridge design maps on file at the NH Department of Transportation, however they did not show any drainage details.

East of Manchester Street

An unnamed tributary east of Manchester Street lies within the undeveloped, forested land area. Future development of the Heron Cove Office Building IV may affect the water quality of this tributary because of the close proximity of the proposed building site.





Figure 2-2 Functional Detention Basin for Heron Cove Housing Development



Figure 2-3 Functional Detention Pond at Heron Cove Office Park



Figure 2-4 Pumping Station for Gravel Mining Operation is Very Close to Bowers Pond

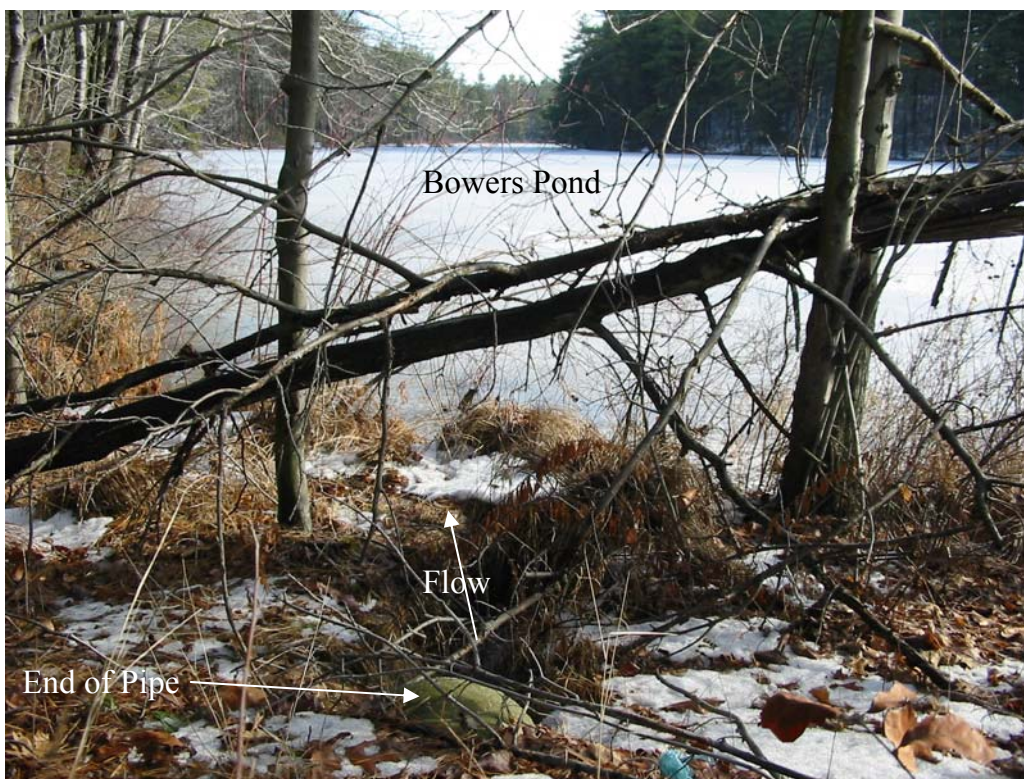


Figure 2-5 Turnpike Bridge Runoff Discharges within a Few Feet of Bowers Pond

2.1.2 Area B Drainage Description

The southern portion of the subwatershed has been identified as Drainage Area B (Figure 2-1 on page 2-2) and lies entirely in the City of Nashua. Many residential homes and subdivisions lie throughout this drainage area. Lawns make up a large portion of the residential properties potentially contributing a significant amount of fertilizer and pesticide runoff into nearby waterways. Drainage from Area B is primarily collected by catch basins and conveyed through drainage piping into three large detention ponds. The only significant tributary flows intermittently parallel to Manchester Street before crossing under the Henri A. Burque Highway. Much of this tributary is piped underground before entering a pond.

Area South of Tinker Road

Stormwater runoff from the network of streets south of Tinker Road and west of Manchester Street is primarily collected in catch basins that discharge into two large constructed detention ponds.

Vespa Lane Detention Pond

The first detention pond, located near the eastern end of Vespa Lane, collects runoff from sections of Todd Road, Dearhaven Drive, Biscayne Parkway, Catalina Lane, Valiant Lane and Vespa Lane. Large sediment deltas are visible downgrade of the outfall pipes. Small trees and bushes have become established in the nutrient rich sediment (Figure 2-6). The storage capacity of this older detention pond has likely diminished over the years because of the sediment influx. The overflow outlet is still elevated above the standing water level and discharges into a forested area east of the fenced in detention pond.

Tinker Road Detention Pond

The second detention pond, located southeast of the Tinker Road bridge crossing over F. E. Everett Turnpike, collects runoff from sections of Monza Road, Monterey Avenue, Vespa Lane, Tuckerwood Court and Tinker Road (Figure 2-7). Overland flow from the turnpike (near the pond) also enters the detention pond in two places. A small access road from Tinker Road provides easy access to the detention pond. CEI observed lots of strewn debris such as wooden shipping pallets, stumps and trash in and around the pond near this access road. In addition, the channel bank downgrade of the 24" inlet pipe (leading into the pond) has been eroding, likely caused by high velocity flow. A 48" outflow pipe passes beneath Tinker Road and terminates at a short vegetated ditch, approximately 50 feet in length, that drains into Harris Pond (Figure 2-8). The elevation of this outfall pipe appears too low in elevation, potentially allowing floating pollutants and debris to enter Harris Pond. This was evident during a visit in May 2003, when the water from the pond was observed flowing through the pipe.



Bennington Road Area

Stormwater runoff in this newer residential neighborhood is collected in a few catch basins located on Bennington Road and an adjacent section of Monza Road. Overflow is discharged (at two locations) into a naturally wooded swale just east of the adjacent F.E. Everett Turnpike on/off ramp.

Preserve Drive

Stormwater runoff along the Preserve Drive housing subdivision, just north of Tinker Road, is collected by a series of catch basins and discharged in four different areas. Four of the outfalls discharge into a forested area several hundred feet from Pennichuck Brook (Harris Pond). The fifth outfall discharges into a vegetated swale that flows into a very small pond located south of the Tinker Road and Manchester Street intersection.

F. E. Everett Turnpike

The F.E. Everett Turnpike crosses over a tributary of Harris Pond just north of Tinker Road. Two pipes convey the tributary water and pass underneath the turnpike terminating at the shoreline of Harris pond. A vegetated earthen berm was constructed upgradient of these outlets and the pond's shoreline to divert piped runoff from the turnpike from directly entering the pond (see Figure 2-9). A small wetland area with a sluice gate collects the diverted runoff (Figure 2-10). The gate was open, allowing overflow water from the wetland to enter into the pond. The short channel downgradient of the open sluice gate is lined with stone riprap. If an accident were to occur in the vicinity, the gate could be closed to contain any vehicle spills. However, a 12" outlet pipe was found downgradient of the earthen berm, effectively bypassing the detention area and terminating a few feet from the pond's edge.

Area South of the Henri A. Burque Highway

The area south of the Henri A Burque Highway consists mainly of older residential homes on small parcels. Stormwater runoff is captured in a series of catch basins located in the surrounding streets and discharged into an unnamed tributary. The tributary waters flow into a large pipe at the intersection of Royal Oak Drive and Somerville Place and emerge about 1/3 mile away into an open constructed channel north of the Pennichuck Junior High School (see Figure 2-11 and 2-12). Numerous sediment bars lie throughout the channel bed just downgrade of the outflow pipe. The channel runs parallel to the school athletic fields and a road used to access the community athletic field before eventually discharging into a small pond about a 1/4 mile to the west, visible from the Henri A. Burque Highway (Figure 2-13). In addition, drainage from the school parking area and athletic fields discharge into this channel. A dry open channel (overflow) on the northwest shoreline of the pond leads into a forested depression area adjacent to Concord Street.





Figure 2-6 Sediment Filled Vespa Lane Detention Pond



Figure 2-7 Eroded Bank and Strewn Debris at Tinker Road Detention Pond

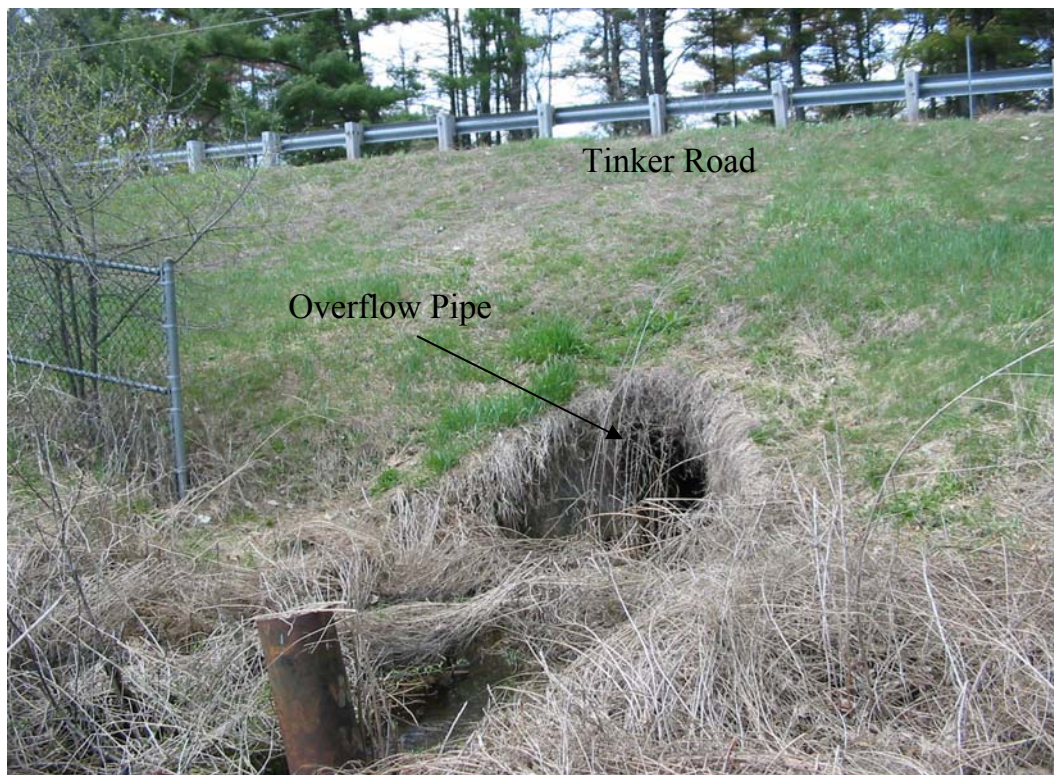


Figure 2-8 Detention Pond Overflow Pipe Passing Below Tinker Road

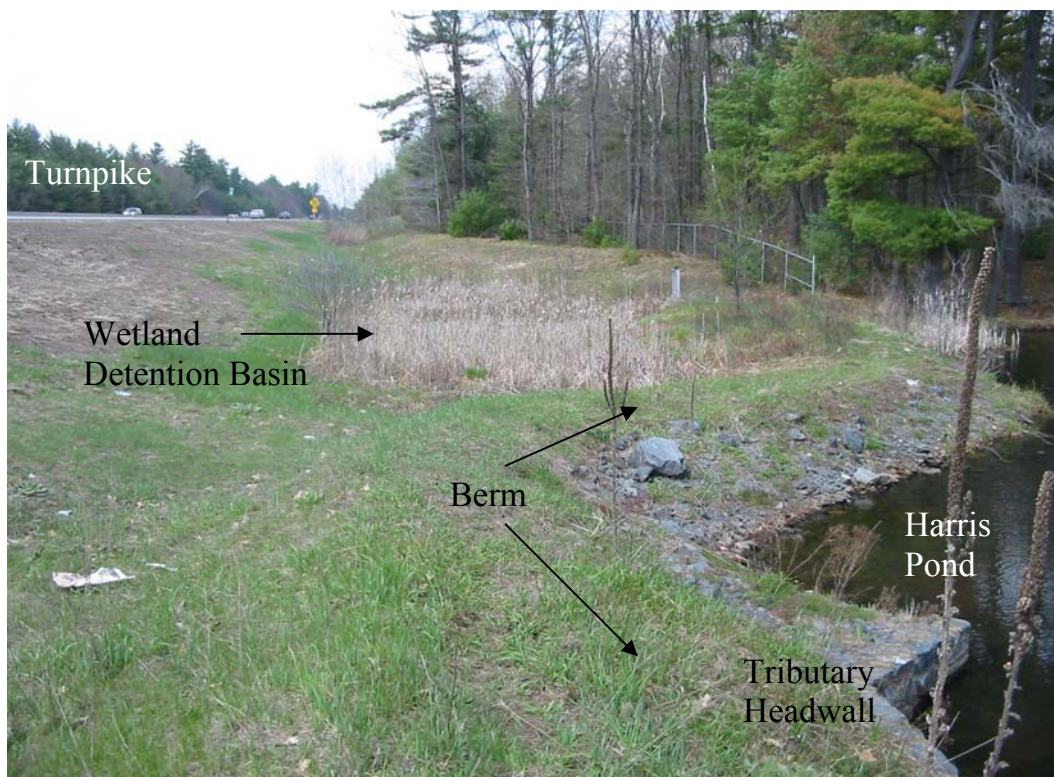


Figure 2-9 Berm and Wetland Basin Designed to Treat Turnpike Runoff Near Tinker Road

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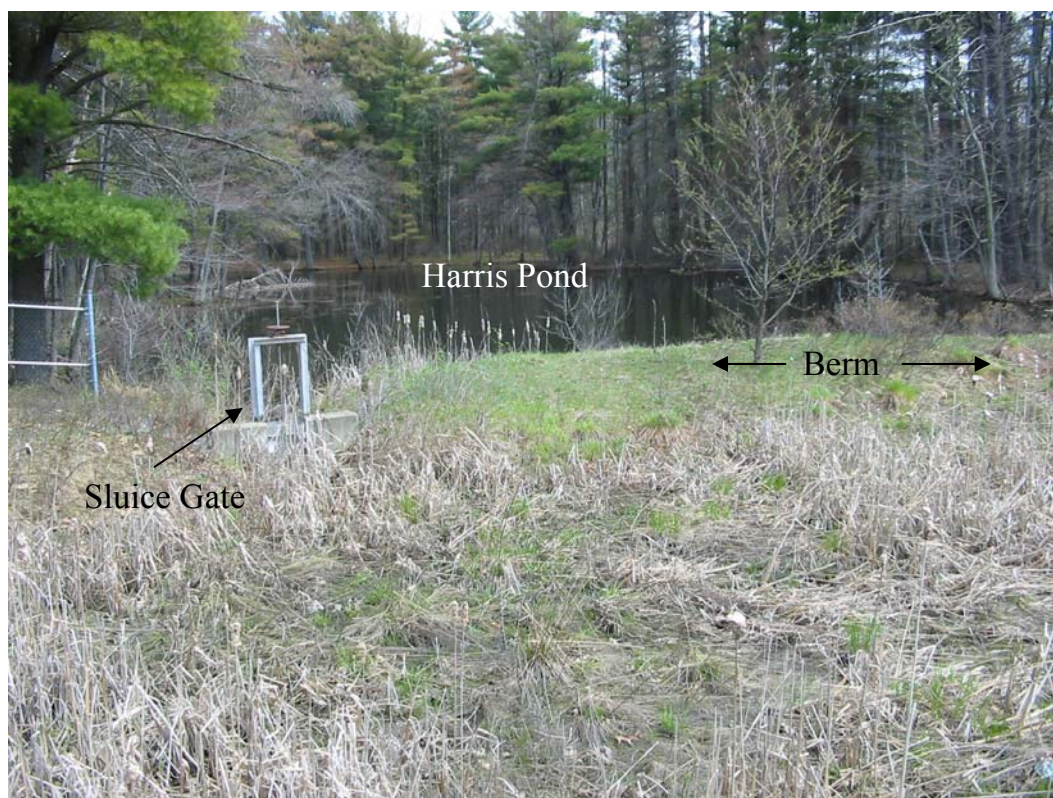


Figure 2-10 Wetland Basin & Open Sluice Gate Near Turnpike & Tinker Road



Figure 2-11 Unnamed Tributary before Being Channeled Underground for $\frac{1}{3}$ Mile
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Figure 2-12 Unnamed Tributary Emerging into a Long Vegetated Swale Adjacent to Pennichuck Jr. High School

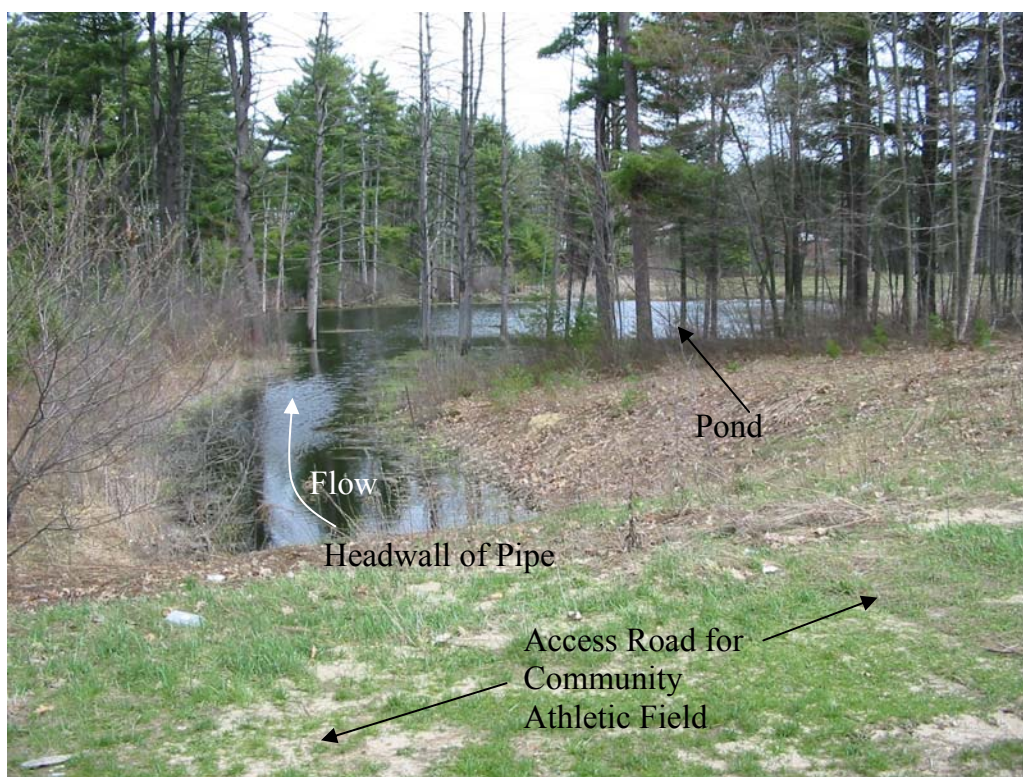


Figure 2-13 Unnamed Tributary Draining into Pond near Henry A. Burque Highway

2.2 SITE SPECIFIC RECOMMENDATIONS

The recommendations made in this section address the significant water quality threats that were uncovered during field investigations for specific sites located within the PBS subwatershed. Figure 2-14 shows the approximate locations of these sites. Table 2-1 summarizes the recommendations for the PBS subwatershed. The recommendations are ranked in order of priority based on three criteria, which are described in Section 6. General recommendations for water quality improvements within this subwatershed are provided in Section 5.

The proposed stormwater systems recommended for each site should be designed to contain a year's worth of sediment loading, if site constraints allow. Systems designed to be cleaned more than once a year are less practical because of higher maintenance costs due to more frequent visits by cleaning crews.

Table 2-1 PBS Recommendation Summary				
Rank¹	Recommendation	Drainage Area (acres)	Proposed Improvement	Estimated Cost
1	Improve Tinker Road Detention Pond	27	• Install gabion check dams and trash/debris fence across upstream channel in front of overflow pipe • Reduce angle of channel bank downgradient of inlet pipe and stabilize with riprap and vegetation	\$5,900
2	Construct Containment Swale for Turnpike Discharge	4.5	• Construct containment swale downgradient of discharge	\$6,450
3	Divert Turnpike Bridge Discharge into Sediment Basin	2.3	• Divert outflow into a small basin with sediment traps	\$8,950
¹ Rank based on distance to water supply intake, size of watershed, and distance of piped discharge to brook or pond.				



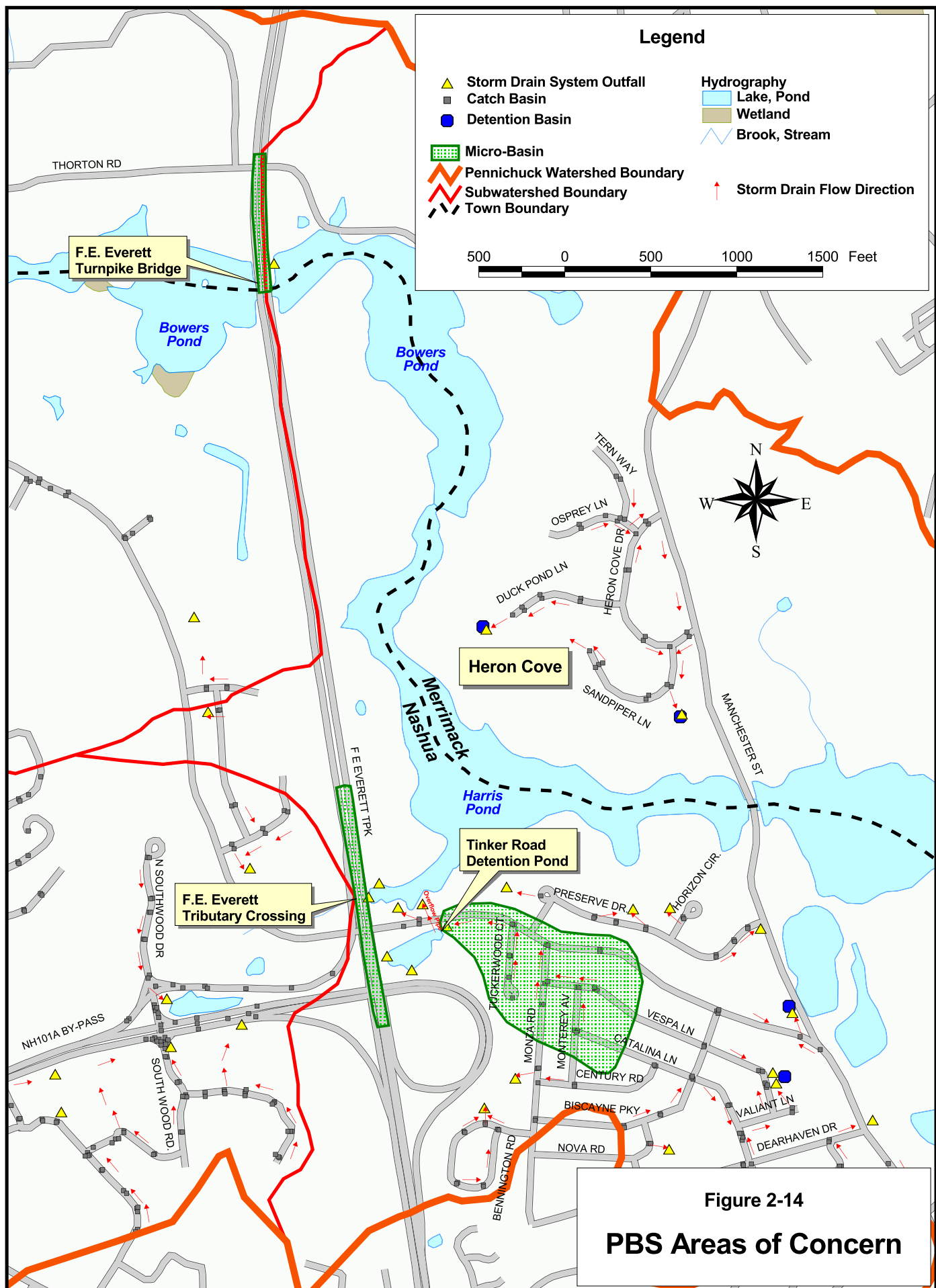


Figure 2-14
PBS Areas of Concern

2.2.1 Improve Tinker Road Detention Pond

Problem:

The 48" outflow pipe of the detention pond appears too low in elevation, allowing floating debris, suspended sediment and pollutants to enter Harris Pond untreated (Figure 2-15). Tires, shipping pallets, and other unidentified trash were observed on the shoreline or floating in the pond. In addition, a section of the channel bank downgradient of the 24" inlet pipe (discharging stormwater from upstream catch basins) is eroding, transporting sediment into the pond.

Recommendation:

Install gabion check dams and a finely woven fence across the channel upstream of the overflow pipe to capture sediment and floating debris. In addition, reduce the steep angle of the channel bank and stabilize with riprap and vegetation (refer to Figure 2-16).

Cost Estimate: \$5,900

Property Owner:

Parcel: Map G-486

Owner: Pennichuck Water Works

4 Water Street, Nashua, NH 03061



Figure 2-15 Overflow Channel Allows Untreated Stormwater to Enter Harris Pond

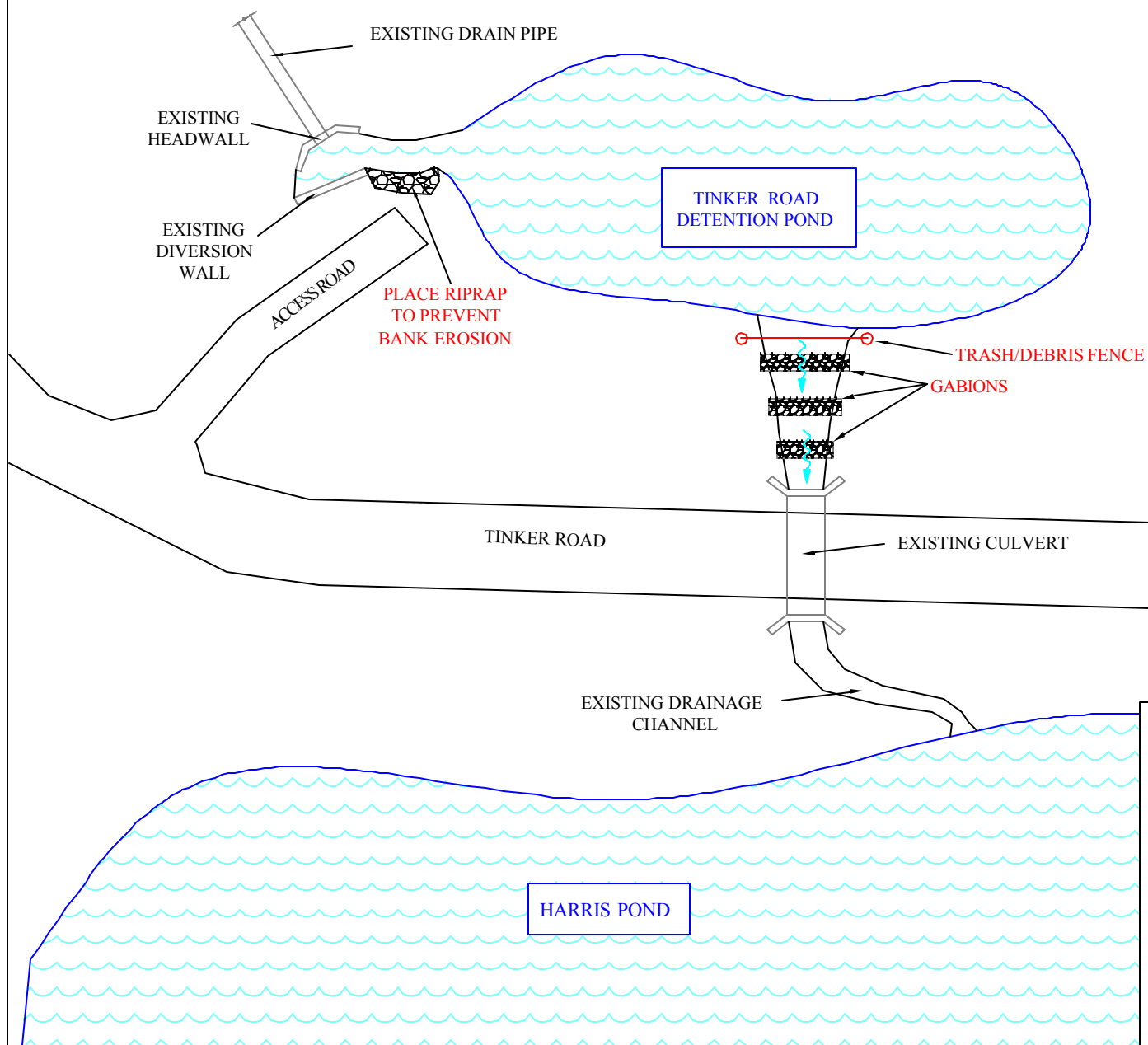


Figure 2-16
Tinker Road Detention Pond
Improvement



**COMPREHENSIVE
ENVIRONMENTAL
INCORPORATED**

21 Depot Street
Merrimack, NH 03054

2.2.2 Construct Containment Swale for Turnpike Discharge

Problem:

It appears that some or all of the catch basins (14 found) located in the median of the F.E. Everett Turnpike discharge stormwater from a 12" outlet pipe a few feet from the pond's edge (see Figure 2-17). The pipe may have been too low in elevation to incorporate into an existing upgradient swale and wetland basin. Weed growth, algae and trash were observed in a shallow channel downgradient of the pipe leading into Harris Pond (see Figure 2-18). Leaking oil and/or hazardous material from an accident occurring along this stretch of the highway could enter into the pond.

Recommendation:

Construct a treatment swale downgradient of the outfall pipe to treat the stormwater runoff (refer to Figure 2-19).

Cost Estimate: \$6,450

Property Owners:

Parcel: Turnpike Right-of-Way

Owner: NH Department of Transportation
7 Hazen Drive, Concord, NH 03302-0483

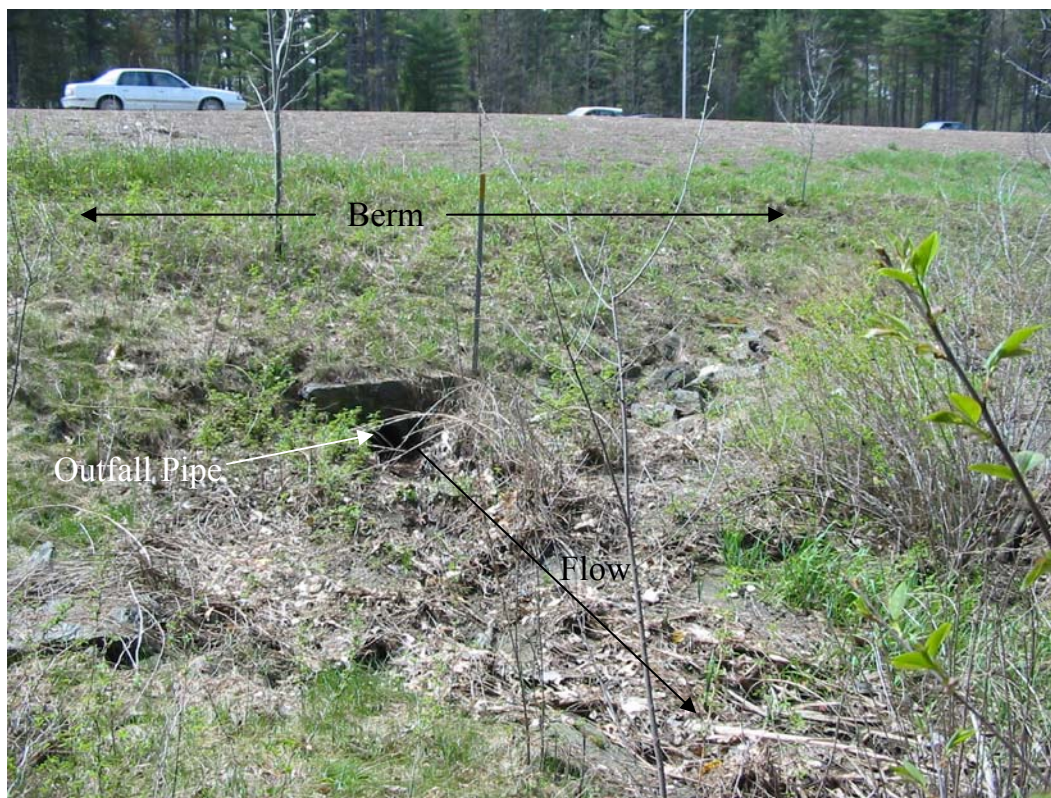
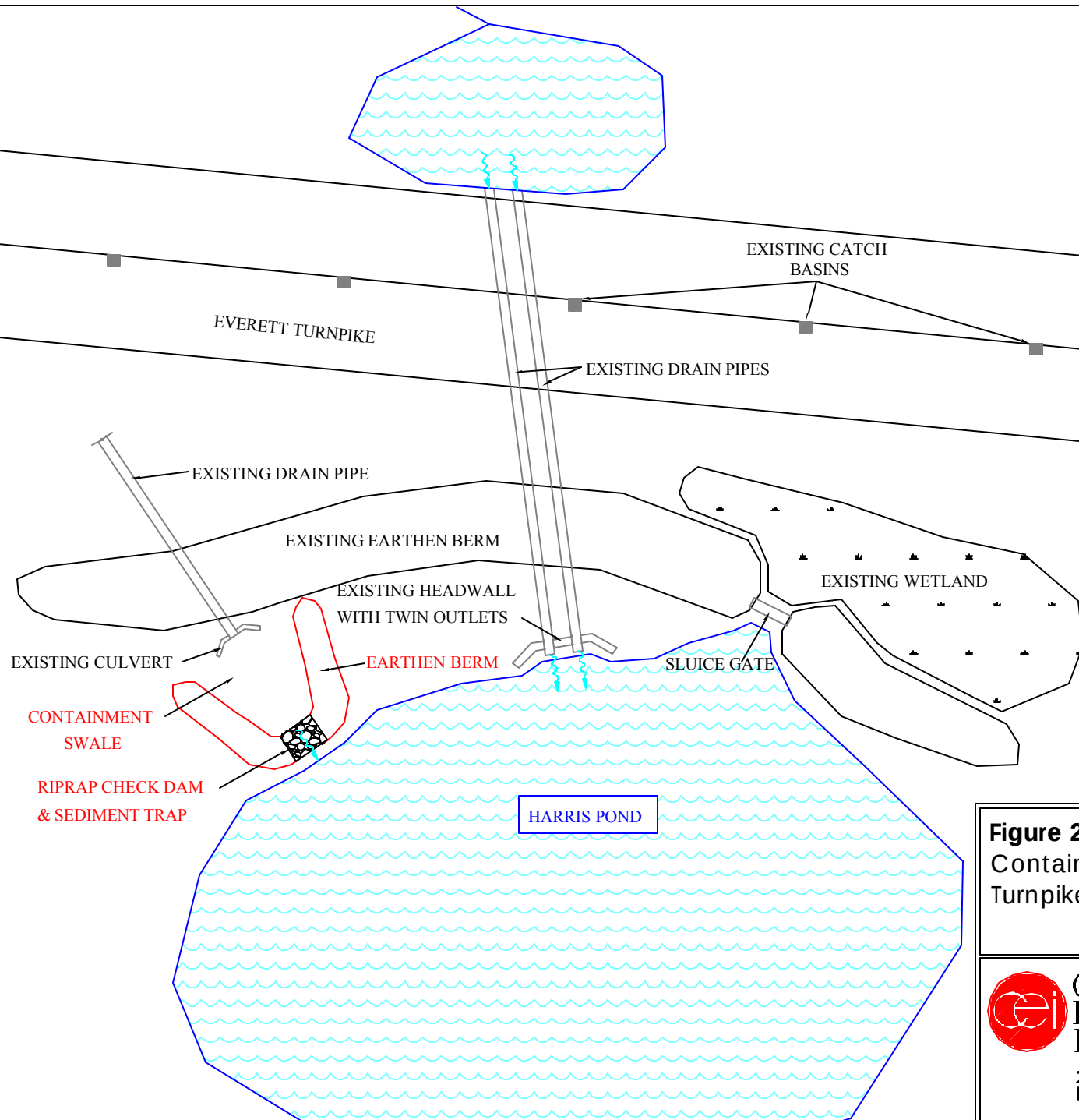


Figure 2-17 Turnpike Outflow Pipe Discharges Below Berm, Bypassing Treatment Area



Figure 2-18 Weed Infested Channel at Harris Pond's Edge from Turnpike Discharge



NOT TO SCALE

Figure 2-19
Containment Swale for
Turnpike Discharge



**COMPREHENSIVE
ENVIRONMENTAL
INCORPORATED**

21 Depot Street
Merrimack, NH 03054

2.2.3 Divert Turnpike Bridge Runoff into Sediment Basin

Problem:

Runoff collected from catch basins located within the median strip of the turnpike appears to discharge stormwater from a 12" outlet pipe located within a few feet of the Bowers Pond shoreline (Figure 2-20). An eroded channel leading into the pond was evident at the pipe discharge. Leaking oil and/or hazardous material from a vehicular accident occurring north of the bridge could enter into the pond.

Recommendation:

Construct a shallow sediment trap basin adjacent to the turnpike and divert drainage from the pipe into the system (refer to Figure 2-21). Design basin to handle at least a 300-gallon spill, if possible, from a potential accident.

Cost Estimate: \$8,950

Maintenance Cost: Completed by the NH Department of Transportation

Property Owners:

Parcel: Turnpike Right-of-Way

Owner: NH Department of Transportation

7 Hazen Drive, Concord, NH 03302-0483



Figure 2-20 Channel Erosion Caused by Turnpike Bridge Discharge before Flowing into Bowers Pond

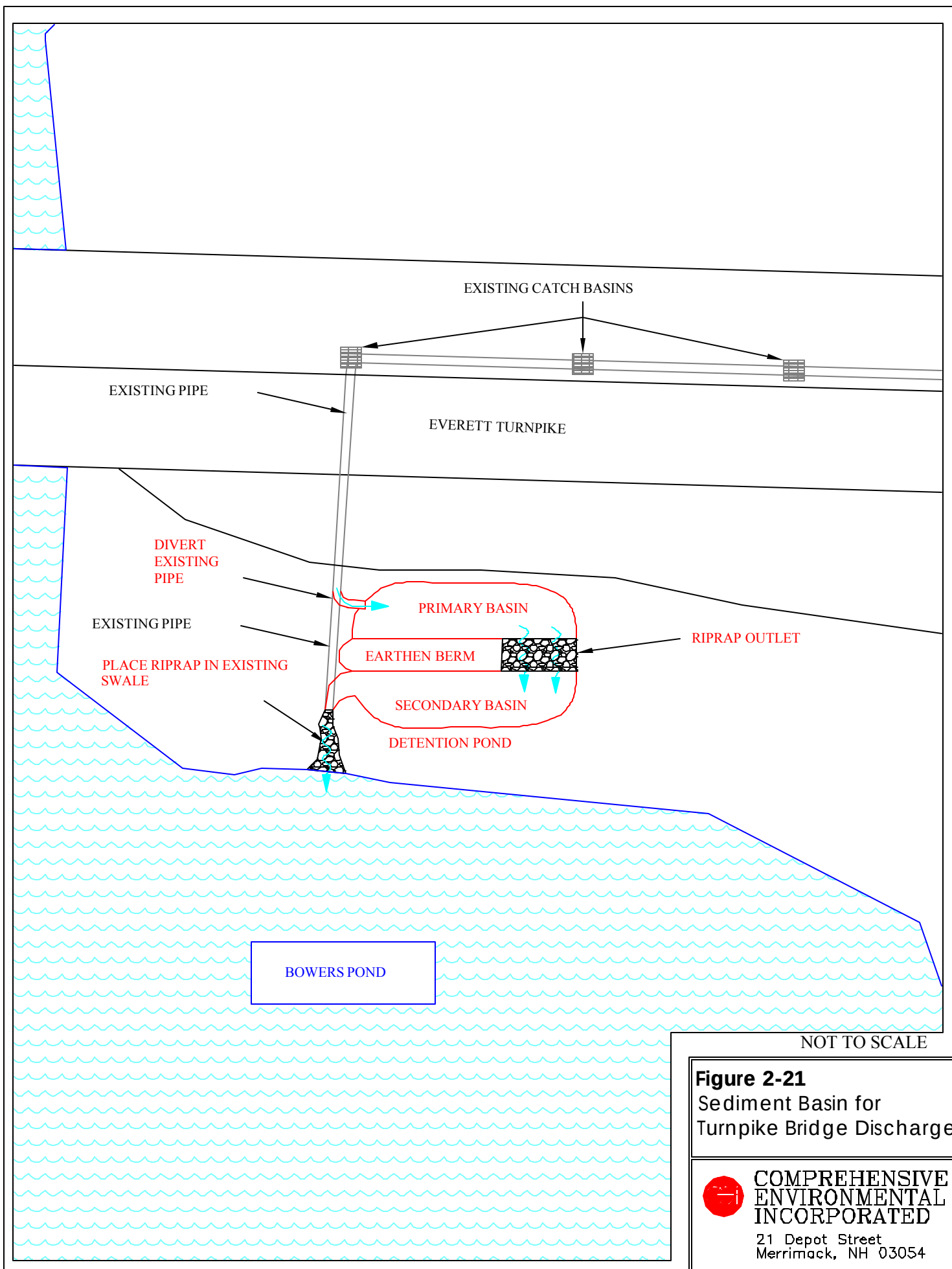


Figure 2-21
Sediment Basin for
Turnpike Bridge Discharge



**COMPREHENSIVE
ENVIRONMENTAL
INCORPORATED**

21 Depot Street
Merrimack, NH 03054

3.0 Pennichuck Brook to Holts Pond (PBH) Subwatershed

3.1 SUBWATERSHED DRAINAGE

The PBH Subwatershed comprises 1,508 acres and is located in Merrimack and Nashua. The subwatershed primarily consists of residential development. CEI conducted a detailed review of the subwatershed in 2003 to obtain a better understanding of drainage patterns and to identify water quality threats. Figures referred to in the text are provided at the end of each section.

The PBH Subwatershed was divided into three drainage areas, A, B and C (Figure 3-1). The drainage area primarily north of Pennichuck Brook consists of drainage Area A. The drainage area south of the brook and north of the railroad tracks is drainage Area B. Drainage Area C consists of the drainage south of the railroad tracks. Drainage areas B and C are partially defined by the constructed railroad bed that created an artificial drainage boundary. Within these three drainage areas are many minor unnamed tributaries (most of which flow intermittently and flow into wetlands) that feed Pennichuck Brook. A detailed description of each drainage area is provided below.

3.1.1 Area A Drainage Description

Drainage area A represents the northern portion of the subwatershed as shown in Figure 3-1 and lies entirely in the Town of Merrimack. This portion of the PBH Subwatershed is hilly compared with the rest of the subwatershed. The primary land use in this drainage area is single-family homes situated along a maze of roads accessed from Naticook Road and Tinker Road. A newer development, accessed off Erik Street, is located on the ridge that divides the PBH subwatershed and the Stump Pond Brook Subwatershed. Catch basins and piped drainage systems have been installed in these residential areas, transporting a higher level of stormwater to “downstream” areas than previously existed.

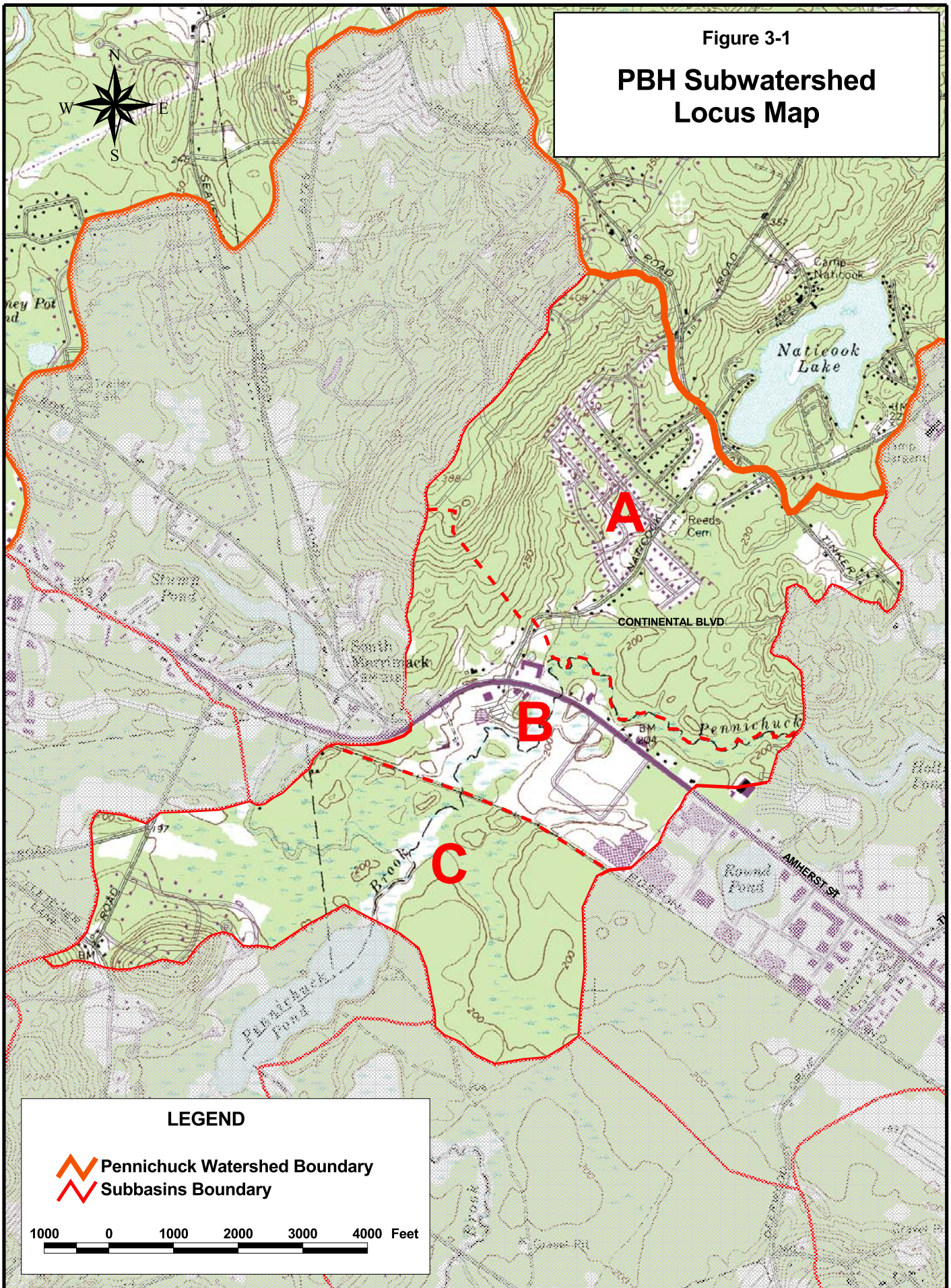
Western Drainage Area

Drainage from the land west of Naticook Road flows into a large unnamed wetland north of the Continental Boulevard and Naticook Road intersection. Water then flows through large culverts underneath Continental Boulevard into a constructed wetland basin adjacent to the Pennichuck Square Plaza before entering Pennichuck Brook.



Figure 3-1

PBH Subwatershed Locus Map



Western Drainage Area (continued)

Runoff from residential lots in the newer subdivision on Erik Street flows through grassy swales (located at the road edges) before discharging into street edge catch basins (Figure 3-2). These roadside swales provide some infiltration and groundwater recharge potential that are often reduced by development. However, street runoff still flows directly into catch basins, bypassing the swales. Runoff collected from catch basins within Erik Street is discharged from a single 48" outfall pipe about 2,000 feet upstream of the unnamed wetland mentioned above.

Runoff from older residential development, located on the maze of streets west of Naticook Road and East of Erik Street, is collected by many catch basins that discharge from two outfalls (Figure 3-3). These outfalls discharge stormwater into the northern portion of the unnamed wetland approximately 1,500-2,000 feet from Pennichuck Brook. Precipitation that would normally have recharged the groundwater and fed intermittent tributary streams has been reduced in this area, due in part to the piped drainage system and impervious land cover. CEI observed (during a visit in April) that many of the catch basins appeared full of sediment. More frequent maintenance may be needed to prevent sediment and pollutants from bypassing the catch basin sump area and entering nearby waterways.

Eastern Drainage Area

There is much less residential development within the eastern segment of Drainage Area A east of Naticook Road. Drainage from the residential development located on Lorraine, Christina and Cynthia Roads is primarily collected in a few catch basins and discharged several hundred feet upstream from the large unnamed wetland previously mentioned. Nearly all of the land east of this development is undeveloped. Stormwater not readily infiltrating into the ground flows into many small wetlands scattered throughout this part of the subwatershed or is conveyed through many small unnamed intermittent streams into Pennichuck Brook. CEI did not find any serious threats at the time of their visit in this part of the subwatershed.



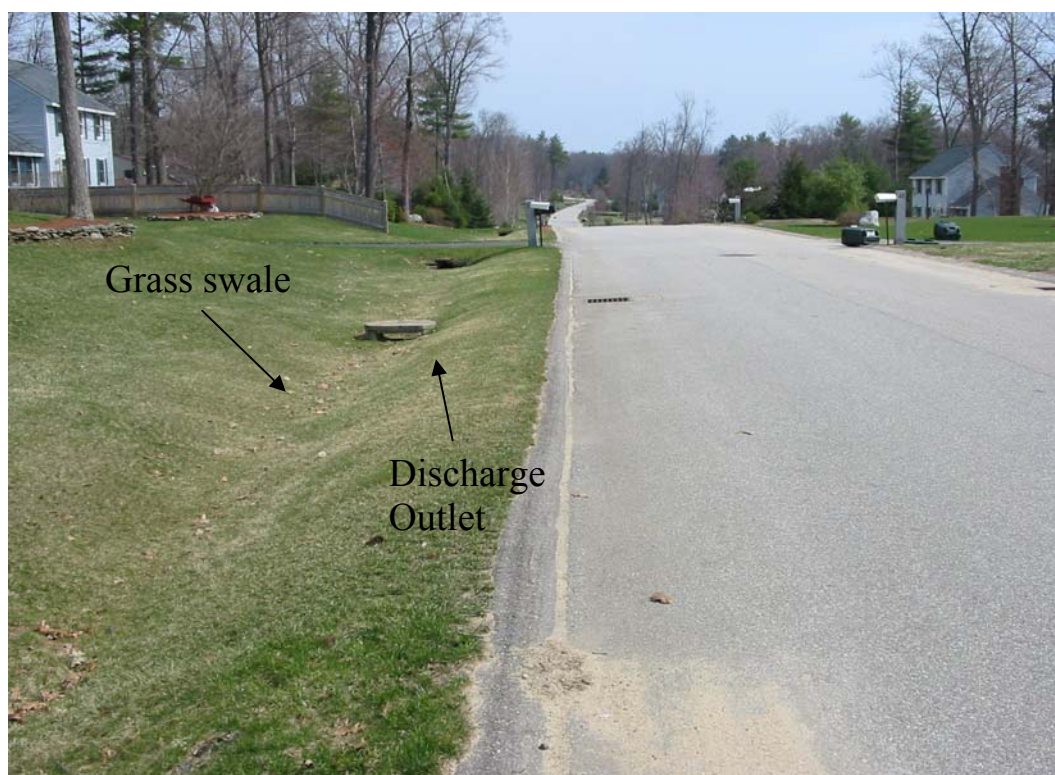


Figure 3-2 Roadside Swales off Erik Street Help Treat Runoff



Figure 3-3 Older Residential Development without Swales, West of Naticook Road

3.1.2 Area B Drainage Description

Drainage Area B, shown in Figure 3-1 (page 3-2), represents the middle portion of the PBH Subwatershed. This area is very flat and heavily developed with most of the area lying in Nashua and a smaller portion in Merrimack. There is very little permeable landscape left, resulting in high amounts of stormwater runoff. Trash, sediment and leaked vehicle fluids, commonly found in highly developed areas such as this one, are easily transported by high velocity runoff. The heavier, denser materials, such as sediment and trash, quickly fill the catch basins, reducing their effectiveness. Drainage Area B has the greatest potential impact to water quality due largely to land use and proximity to Pennichuck Brook.

Drainage Area B is described in two sections, east and west of Pennichuck Brook, for ease of understanding. Figure 3-4 and Table 3-1, provided on pages 3-8 & 3-9, present and describe in more detail the small “micro-watersheds” that exist in the drainage areas described below. Figures referred to in the text are included at the end of this section.

West of Pennichuck Brook

The drainage area described in this section lies west of Pennichuck Brook and north of the railroad tracks in the Town of Merrimack.

West of Continental Boulevard Intersection

Stormwater from a small stretch of Route 101A west of the Continental Boulevard intersection, discharge into a small pond area adjacent to the PC Connection building (Figure 3-5). Four additional outfall pipes also discharge into this small pond that originates from the adjacent businesses and sites such as PC Connection and the VIP auto parts store. Sediment deltas downgradient of the outfalls with weed growth were observed.

The recently built Home Depot business north of Route 101A also ties into the aforementioned system. However, stormwater is treated in a series of stormwater systems including a detention basin, riprap drainage channels, and a vegetated swale, before entering the Route 101A system (Figure 3-6).

East of Continental Boulevard Intersection

A series of catch basins and piping collect stormwater on Route 101A, starting at the Continental Boulevard intersection. Drainage from adjacent lots also ties into this system, including the Talarico Auto Dealership, Government Connection Business and the DJ Square Plaza. The half buried 24” outfall pipe is located about 200 feet west from the Pennichuck Brook bridge crossing and discharges into a wetland area. In addition, stormwater runoff from the access roads located behind DJ Plaza and the St. John Neumann Church also flow into the same wetland area (Figure 3-7).



Runoff from the Pennichuck Square Plaza on the corner of Route 101A and Continental Boulevard appears to drain directly into the brook in two locations, however outfall pipes could not be located to verify the discharge locations (Figure 3-8). A 1982 site plan map, completed by Thomas F. Moran Inc., shows the discharge locations.

East of Pennichuck Brook

The drainage area described in this section lies east of Pennichuck Brook and north of the railroad tracks in the City of Nashua.

Route 101A

Stormwater runoff from a portion of Route 101A (Amherst Street) east of the bridge crossing is collected in a series of catch basins and piping. Many businesses also tie into this system including (from farthest “upstream”) Chili’s Restaurant, Texaco, Bank of America, and the Greystone Plaza on the corner of Northwest Boulevard and Route 101A. Two outfall pipes (36” and 24”) a few feet apart discharge into a wetland area located about 140 feet from the bridge crossing (Figure 3-9). Scouring was observed immediately downgradient of this outlet, caused by high velocity flows.

CEI observed that stormwater runoff from some of the businesses located north of Route 101A (not tied into the aforementioned Route 101A system) in this area is being channeled via piping in or near Pennichuck Brook. These businesses include the Ciro’s Restaurant (Figure 3-10), Saturn Dealership (Figure 3-11), ASA International Offices, PK’s Nursery and the Best Ford Dealership (Figure 3-12). In addition, according to the recent site plans from Nashua and Pennichuck, runoff from the Wendy’s and CVS businesses in this area is channeled into an underground stormwater treatment infiltration system beneath the CVS parking area.

Celina Avenue

Stormwater runoff from Celina Avenue and adjacent businesses including the backside of Westside Plaza, Deerpoint Offices and Amphenol is collected in a series of catch basins and discharged into a vegetated stream channel about 600 feet from Pennichuck Brook (adjacent to the Southern NH Medical Center) (Figure 3-13). Two small detention “swales” located adjacent to the Mill Store (unfinished furniture outlet in the Westside Plaza) across from the U.S. Postal Service Facility, and along Celina Avenue behind the Marshall’s delivery entrance (rear of Westside Plaza), were found. However, the drains for both these detention swales (discharging into Celina Avenue drainage system) are located at ground level, reducing stormwater collection capacity and infiltration potential (Figure 3-14). In addition, the overflow from the large detention basin on the U.S. Postal Service site is tied into the Celina Avenue drainage system (Figure 3-15).



The Celina Avenue drainage area consists of mostly impervious surfaces. Scouring and sediment “bars” was observed down gradient of the 48” outfall pipe.

Northwest Boulevard

Stormwater from the portion of Northwest Boulevard across from the Nashua Self Storage and U-Haul businesses is collected in a series of catch basins and discharged into a straight vegetated stream channel. The adjacent shopping plaza, Westside Plaza, also ties into this drainage system (Figure 3-16). Businesses located in this plaza include Market Basket, Marshall’s, Mill Store, Decathlon, and Home Goods. This shopping plaza area encompasses a large drainage area of nearly 100% impervious surface. Small mulch islands were the only impermeable surfaces remaining. Most of this area consists of the large expansive parking lot for the plaza businesses. Roof drainage is suspected to tie into this system. Lots of sediment and debris was observed near and in many of the catch basins (3-17). Scouring was observed down gradient of the 36” outfall pipe that is likely occurring from high velocity storm flow. Sediment “bars” within the channel was also evident.

Stormwater overland flow from Northwest Boulevard near the railroad crossing enters a vegetated channel (parallel to the railroad tracks) after passing through riprap swales. In addition, a portion of the parking areas from the Amphenol Company and the Southern NH Medical Center also discharges into the same channel.



Figure 3-4
Area B
Micro-Watersheds

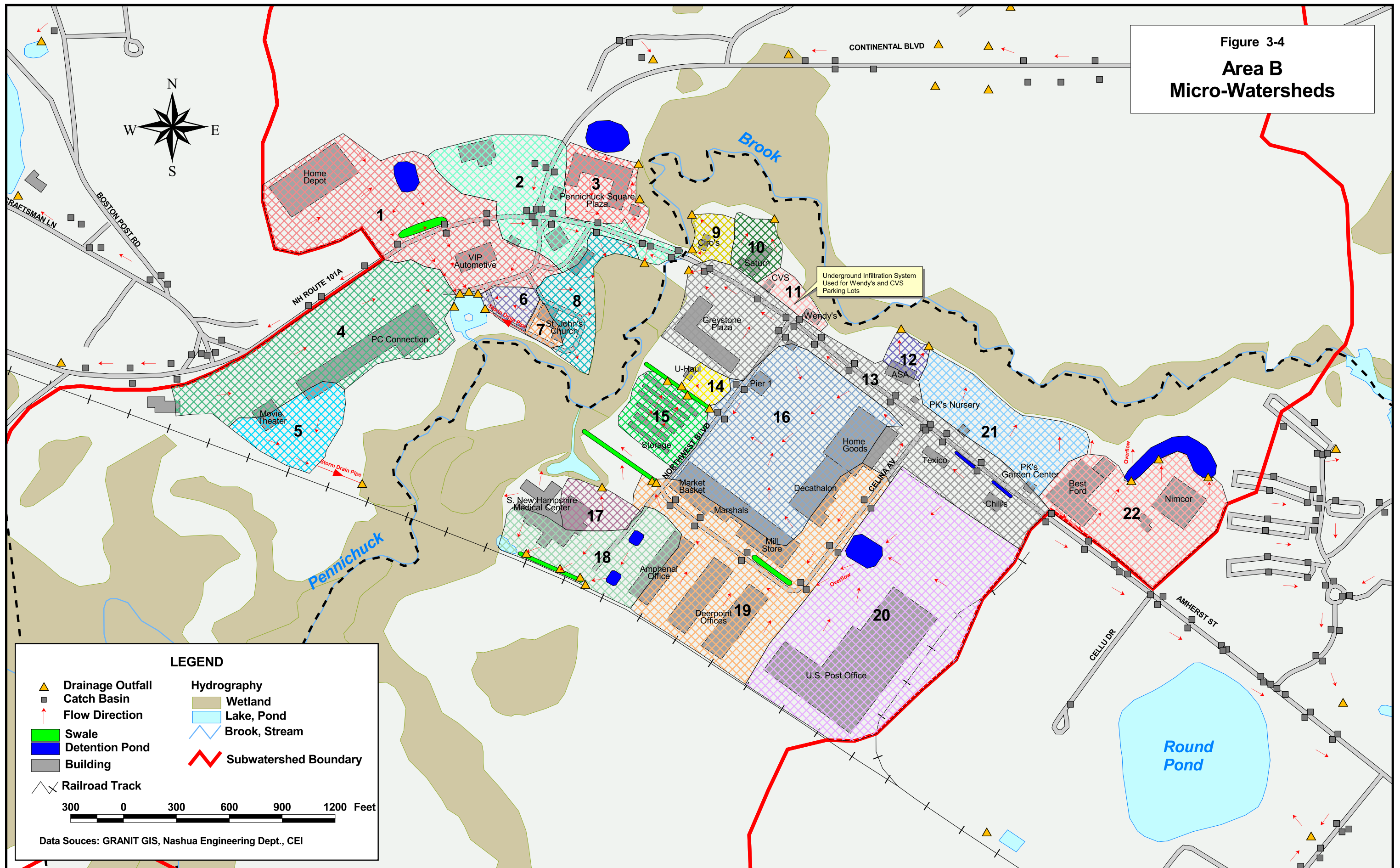


Table 3-1 PBH Micro-Watersheds Description						
Micro-Watershed No.	Size (acres)	Road/Businesses/Plaza Located in Watershed	No. of Catch Basins Found	Outfall Pipe(s) (approximate)		Drainage Description
				Size (inches)	Distance (feet)	
West of Pennichuck Brook						
1	18	Home Depot, Route 101A, VIP, and Access Road Behind VIP Building	41	42"	100ft	A large detention basin with sediment forebay handles the runoff from the Home Depot parking lot. Runoff from the access road discharges into a vegetated swale parallel to Route 101A before draining into a large pipe set beneath the road. Street edge catch basins from a portion of Route 101A also drain into this large pipe, which discharges into a small pond adjacent to PC Connection. In addition, stormwater collected in two catch basins located in the VIP parking area and four basins in the access road behind VIP also discharge into the same pond.
				24"	100ft	
				24"	100ft	
2	12.3	Route 101A, Talarico, Granite Bank, Gov Connection, DJ Square Plaza	13	24"	215ft	A series of catch basins collect stormwater from Route 101A and adjacent lots starting at the Continental Boulevard intersection discharging about 200 feet west from the Pennichuck Brook bridge crossing. CEI was unable to observe the condition of the discharge area immediately down gradient of the pipe’s outlet because it was submerged under water.
3	4	Pennichuck Square Plaza	5	Buried outlets?	Less than 5ft	Runoff collected in four catch basins located in the parking area appear to discharge a few feet from the brook. Another catch basin, located behind the plaza, appears to discharge into the bordering brook as well. No outfall pipes could be found for these drainage systems and are likely submerged below the waterline. In addition, two uncovered dumpsters just south of the catch basin are located on pavement near the bank of the brook.
4	15.4	PC Connection	16	36"	100ft	Catch basins located throughout the parking area collect stormwater and channel it to an outfall pipe in a small pond adjacent to the office building. According to recent site plans, four leaching catch basins are located just "upstream" of the outfall.
5	4.3	Premier 8 Theatres	6	30"	100ft	A series of catch basins in the large parking area of the movie theatre collect stormwater runoff and discharge it into the wetland area adjacent to Pennichuck Brook. The 30" outfall, located just north of the railroad tracks is about 100 feet from Pennichuck Brook.
6	1.3	Parking Area Adjacent to Saint Johns Church	None	-	-	Stormwater runoff is channeled into a short rip-raped swale before entering the pond.
7	0.75	Saint John’s Church	1	18"	100ft	A portion of the property including part of the parking are drains into a single catch basin that discharges into a small pond adjacent to PC Connection.
8	3.9	Access road area behind RJ Square Plaza and Saint John’s Church	None	-	-	Drainage from the access roads located behind the plaza and the church flows over a very steep bank and into a wetland area adjacent to Pennichuck Brook. Evidence of snow storage on the bank was also observed. In addition, there was lots of trash strewn along the bank and in the wetland.
East of Pennichuck Brook						
9	1.38	Ciro's Restaurant	2	Two 12"	Less than 10ft	Two catch basins located in the parking area collect stormwater and discharge just a few feet from the brook. The catch basins were filled with sediment.
10	2	Saturn Car Dealership	14	18"	250ft	Many catch basins in the large vehicle storage area of the Saturn Dealership discharge into an infiltration basin area located about thirty feet from Pennichuck Brook. The infiltration basin appears to be used for snow storage during the winter as evident by observed snow piles. In addition, a sloping lawn area bordering the brook behind the Saturn and CVS businesses (behind dumpsters) also appears to be used for snow storage.
11	1.3	CVS and Wendy’s Restaurant	6	N/A	N/A	Stormwater runoff from the parking areas of the Wendy's and CVS businesses is collected in a series of catch basins that discharge into a large underground stormwater treatment infiltration system. According to site plans from the City of Nashua and Pennichuck, this underground treatment device, located beneath the CVS parking area, has no overflow or bypass outlet. Significant storms may overwhelm the unit causing stormwater to puddle in low-lying areas of the parking lot and eventually flowing downgradient into the brook.
12	1.1	ASA Office Building	3	12"	75ft	Catch basins collect runoff from the parking area behind the building and discharge from two outfalls into a wetland area near Pennichuck Brook.
				12"	75ft	
13	19	Route 101A, Greystone Plaza, Bank of America, Brusters Ice Cream, Texaco, Chili’s Rest.	48	36"	140ft	Many catch basins collect stormwater from this area of Route 101A and adjacent business. Two small detention basins were observed along the street in front of Chili’s Restaurant and Texaco. Stormwater runoff is discharged near Pennichuck Brook from two outfall pipes.
				24"	140ft	
14	1	Uhaul	None	-	-	Stormwater runoff is channeled into a serpentine designed swale that was sparsely vegetated. The overflow outlet discharges into the adjacent vegetated swale.
15	4	Nashua Self-Storage	6	12"	215ft	Drainage of the self-storage lot is collected in a number of catch basins before discharging in two locations into the adjacent vegetated swale.
				12"	360ft	
16	18	Northwest Boulevard, Westside Plaza, Pier 1, Bank of America	23	36"	500ft	A series of catch basins collect stormwater runoff from the large impervious parking area of the Westside Plaza and a section of Northwest Boulevard and discharge into a long and straight vegetated swale. Lots of sediment and debris was observed in and around the storm drains of the plaza's parking area. Snow storage was also observed in two areas of the parking area.
17	2.2	Southern NH Medical Center	1	18"	430ft	A portion of the medical center parking area drains into a single catch basin that discharges into a large adjacent wetland/detention area.
18	7.5	Northwest Boulevard, Southern NH Medical Center, Amphenol Company	3	8"	540ft	A portion of the parking area of the medical center is collected in a few catch basins before discharging from two outlets into an adjacent vegetated drainage channel . Runoff from a portion of the Northwest Boulevard also enters by overland flow into the same channel. In addition, stormwater from the adjacent Amphenol Companies site also discharges into the aforementioned channel. However, runoff from this site is first collected in two on-site small detention basins (one deep narrow basin and one shallow one).
				8"	650ft	
				12"	860ft	
				12"	930ft	
				12"	1000ft	
19	19	Celina Avenue, Westside Plaza, Deerpoint Offices, Southern NH Medical Center	25	48"	600ft	Stormwater runoff from Celina Avenue and adjacent businesses is collected in a series of catch basins and discharged into a vegetated stream channel about 600 feet from Pennichuck Brook. This drainage area consists of mostly impervious surfaces. Scouring and sediment “bars” was observed down gradient of the 48” outfall pipe. In addition, two small detention “swales” were found. One was located adjacent to the Mill Store (unfinished furniture outlet in the Westside Plaza) across from the U.S. Postal Service Facility, and the other is located along Celina Avenue behind the Marshall’s delivery entrance (rear of Westside Plaza).
				12"	600ft	
20	28.3	US Postal Service Office Distribution Facility	18	-	-	A large detention basin located on the Postal Services property is designed to handle all stormwater runoff from the site. The overflow pipe is tied into the Celina Avenue drainage system.
21	7.2	PK’s Garden Center	None	-	-	Nearly all of the PK’s Garden Center land is still pervious (dirt paths and roads among nursery stock) reducing the amount of stormwater runoff. A vegetated buffer exists between Pennichuck Brook and the property boundary. Some of this buffer area appears to have been cut recently presumably to increase space for a compost storage area. An earthen berm appears to have been constructed to help prevent runoff from entering the brook.
22	11.1	NimCor Company, Ford Dealership	13	18"	360ft	A large detention basin behind the NimCor and Ford Dealership businesses captures and infiltrates the stormwater runoff from these sites. The discharge for the overflow pipe is located several hundred feet from Pennichuck Brook. No visible sediment forebay was observed within the basin area.





Figure 3-5 PC Connection Detention Pond Collects Runoff from Nearby Sites



Figure 3-6 Vegetated Swale Near Home Depot Entrance Treats Site Runoff

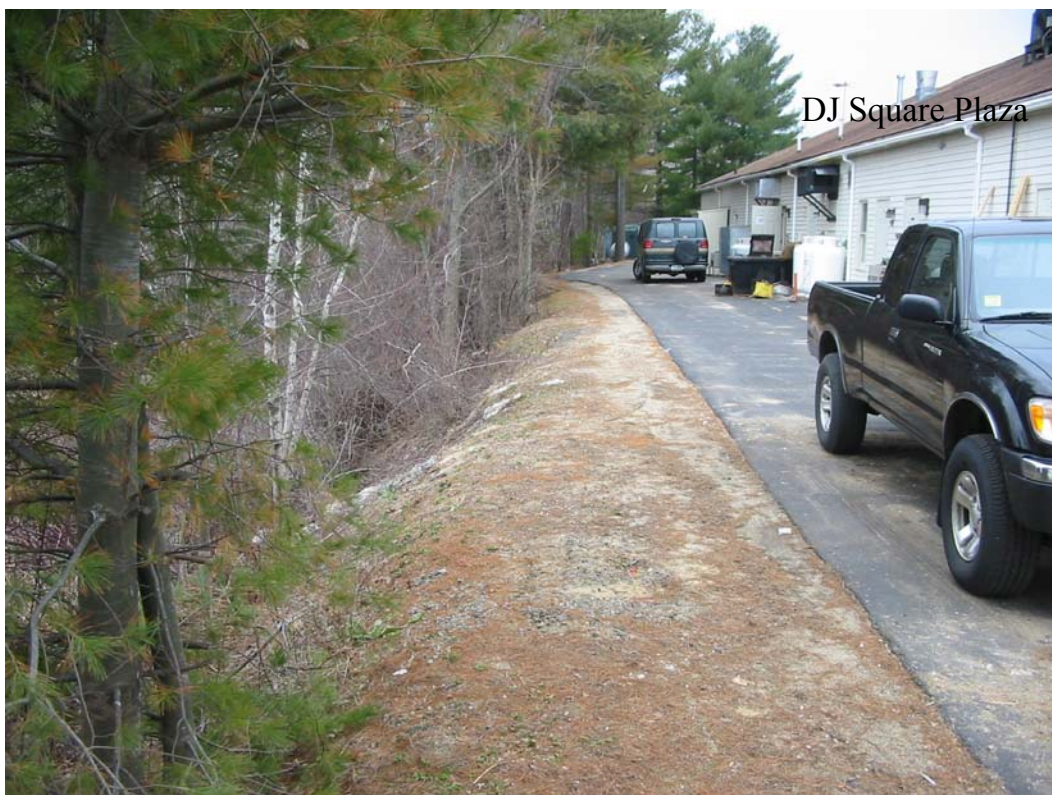


Figure 3-7 Runoff Transports Sediment & Trash down Steep Slope into Wetland Adjacent to Brook



Figure 3-8 No On-Site Stormwater Treatment at Pennichuck Square Plaza

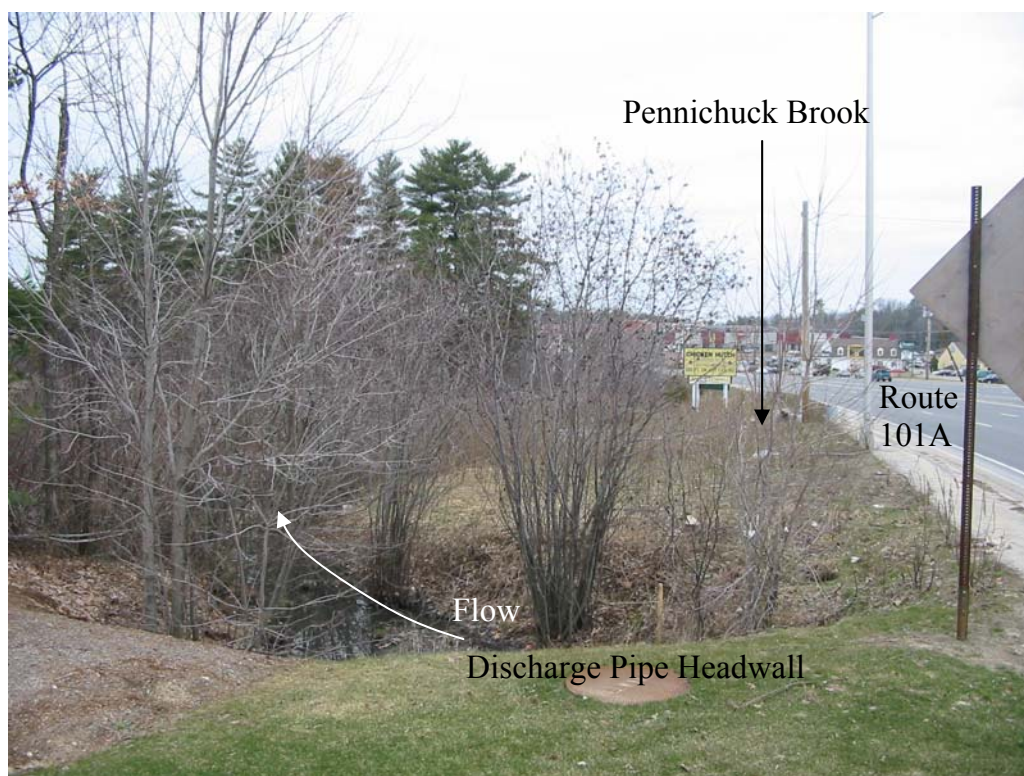


Figure 3-9 Route 101A & Greystone Plaza Discharge Near Pennichuck Brook

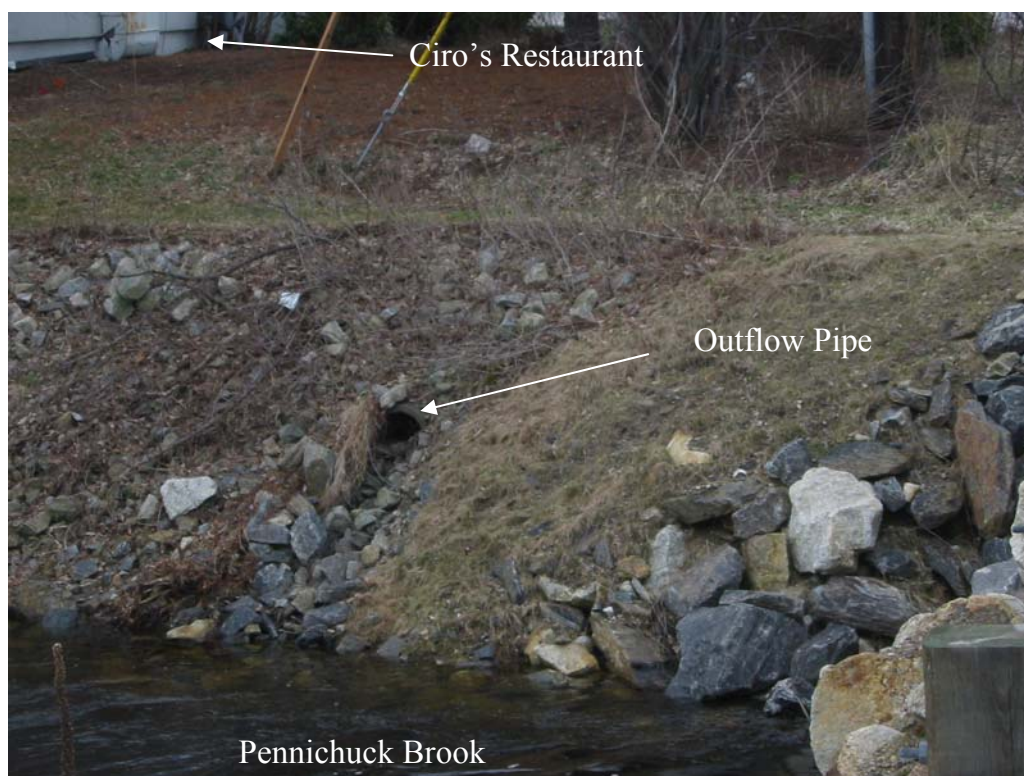


Figure 3-10 Direct Stormwater Discharge from Ciro's Restaurant into Brook



Figure 3-11 Functional Infiltration Basin Behind Saturn Dealership



Figure 3-12 Detention Basin Effectively Capturing Runoff from NimCor & Best Ford



Figure 3-13 High Velocity Discharge from Celina Avenue Causes Scouring and Downstream Sedimentation



Figure 3-14 Marginally Effective Infiltration Swale behind The Mill Store



Figure 3-15 U.S. Postal Facility's Detention Pond Capturing Runoff from Site



Figure 3-16 Westside Plaza Expansive Parking Area Increases Off-Site Runoff Volume



Figure 3-17 Trash and Debris Transported in and near Catch Basin from the Westside Plaza Parking Lot can Degrade Water Quality of Downstream Waterways



Figure 3-18 Aboveground Drainage Channels in Place of Catch Basins Provide Pretreatment for a Portion of Northwest Boulevard Runoff

3.1.3 Area C Drainage Description

Drainage Area C, shown in Figure 3-1 (page 3-2), represents the portion of the PBH Subwatershed that lies south of the railroad tracks. This drainage area lies within Hollis, Merrimack and Nashua. The land is very flat and consists mainly of wetlands bordering the brook.

Northwest Boulevard

Three recently constructed industrial businesses are located off Northwest Boulevard south of the railroad tracks in Nashua. Drainage from these very large buildings and expansive parking areas discharge into massive storm detention basins with sediment forebays (Figure 3-19). Overflow from these basins discharges into wetlands several thousand feet east of the brook.

South Merrimack Road

A few residential homes sparsely located on South Merrimack Road, Buttonwood Drive and Meadow Drive in the Town of Hollis are the only other development within this drainage area. Stormwater runoff from these lots flows overland into roadside ditches. A portion of the drainage of Meadow Drive flows into a small pond (Figure 3-20).





Figure 3-19 Large Detention Basin Captures Commercial Site Runoff for Recent Northwest Boulevard Development



Figure 3-20 Small Pond Near Meadow Drive Captures Street Runoff

3.2 Site Specific Recommendations

The recommendations made in this section address the significant water quality threats that were uncovered during field investigations for specific sites located within the PBH subwatershed. The number in parenthesis following each recommendation refers to the “microwatershed” shown in Figure 3-4. Table 3-2 summarizes the proposed recommendations. The recommendations are ranked in order of priority based on three criteria, which are described in Section 6. General recommendations for water quality improvements are provided in Section 5.

The proposed stormwater systems recommended for each site should be designed to contain a year’s worth of sediment loading if site constraints allow. Systems designed to be cleaned more than once a year are less practical because of higher maintenance costs due to more frequent visits by cleaning crews.

3.2.1 Evaluate PC Connection Detention Pond (1, 4, 6, 7)

Problem: Runoff from surrounding businesses and a portion of Route 101A is discharged from five different points into what appears to be a poorly functioning detention pond near PC Connection. A channel in the southeastern portion of the detention pond allows water to flow directly into Pennichuck Brook (Figure 3-21). The channel is allowing floating debris, pollutants and sediment to reach the brook with little or no treatment.

Recommendation: Conduct a feasibility study to evaluate the dynamics of the detention pond and design effective BMPs to treat pollutants.

Implementation Details: A proposal for a state funded grant was written and submitted in November 2003. However, the landowner decided not to offer support of the project, effectively nullifying the proposal at this time. However, possible future sale of St. John’s property by PC Connection may offer opportunity for the Town of Merrimack to formalize a drainage easement that includes the pond. The grant proposal is included in Appendix A.

Cost Estimate:

Estimated cost of study: \$23,300

Property Owners:

Parcel: Map 2B, Lot 6
 Owner: G&H Post, LLC C/O PC Connections
 730 Milford Road
 Merrimack, NH 03054-4631



Table 3-2
PBH Recommendation Summary

Ranking¹	Micro-watershed	Recommendation	Drainage Area (acres)	Proposed Improvement	Estimated Cost
1	1,4,6,7	Evaluate PC Connection Detention Pond	35.4	• Conduct a feasibility study to evaluate the dynamics of detention pond.	\$23,300
2	13,2	Review Future 101A Preservation Capacity Plans	19.8 & 12.3	• Review future Route 101A Capacity Preservation Program Plans.	N/A
3	3	Create Demonstration Project for Pennichuck Square	4	• Redirect stormwater into on-site constructed infiltration island and swales. • Erect perimeter fence around dumpsters, design to capture fly away trash.	\$42,400
4	9	Treat Ciro's Restaurant Parking Lot Runoff	1.4	• Install infiltration dividers around catch basins	\$10,700
5	12	Treat ASA Offices Parking Lot Runoff	1.1	• Install infiltration dividers around catch basins	\$10,700
6	16	Treat Westside Plaza Parking Lot Runoff	18.2	• Install infiltration dividers in parking area and snow storage area • Construct a series of gabion check dams along the drainage channel	\$46,850
7	19	Treat Celina Avenue Runoff	19	• Construct a series of gabion check dams along the drainage channel • Work with landowner to improve effectiveness of infiltration swales	\$13,500
8	10	Construct Snow Storage Area at Saturn Dealership	Snow storage area	• Construct designated snow storage area with earthen berm	\$2,350
9	13	Construct Dumpster Storage Area at Greystone Plaza	Dumpster area	• Construct a dumpster storage area with cement pad and perimeter fence	\$6,900
10	8	Improve Snow & Dumpster Storage Area Practices at DJ Square Plaza	Dumpster and snow area	• Request snow be stored in adjacent lot away from steep slope • Construct a dumpster storage area with cement pad and perimeter fence	\$6,900

¹ Rank based on distance to water supply intake, size of watershed and distance of piped discharge to brook or pond.





Figure 3-21 PC Connection Detention Pond Outlet Flowing Directly into Pennichuck Brook

3.2.2 Review Future Route 101A Capacity Preservation Plans (13, 2)

The Problem

1. Route 101A and Greystone Plaza

Stormwater from the Greystone Plaza parking area and a Portion of 101A (Amherst Street) is discharged at high velocities from two outfall pipes within a few hundred feet of Pennichuck Brook, causing downstream scouring and sedimentation (Figure 3-22). Transported pollutants and sediment captured and conveyed by stormwater from the drainage area is likely affecting the water quality of the bordering wetland area and the brook.

2. East of Continental Boulevard Intersection

Stormwater from Route 101A east of the Continental Boulevard intersection and adjacent business sites (Talarico Dealership business, Granite State Bank) is discharged into a wetland area a few hundred feet east of the brook (Figure 3-23). Many of the catch basins in this drainage area appear to be partially filled with sediment and debris. Pollutants carried by the stormwater can potentially degrade the water quality of the brook.

Recommendation: Review and comment on the future Route 101A Capacity Preservation design plans for treating the stormwater discharge. Possible effective treatment options for the discharges include:

- Install infiltration dividers or islands around upstream catch basins and/or replace basins with deep sump/leaching units.
- Construct an easily accessible shallow sediment forebay at base of outfall pipe(s).

Property Owner of Land Downgradient of Outfalls:

Parcel: Map 2B, Lot 4

Owner: Roman Catholic Bishop of Manchester
St. John Neumann's Church
708 Milford Road, Merrimack NH 03054

Parcel: Lot I-3

Owner: City of Nashua
229 Main Street, Nashua, NH 03054-4631



Figure 3-22 Channel Scouring from Route 101A and Greystone Plaza Stormwater Discharge Near Pennichuck Brook

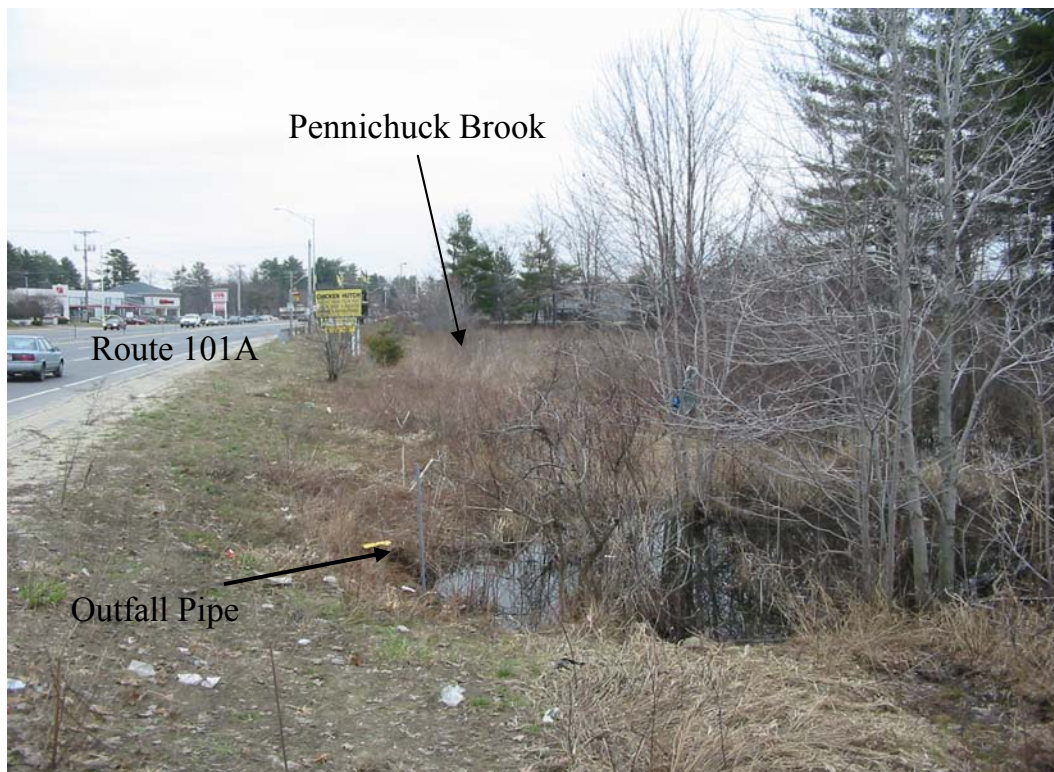


Figure 3-23 Untreated Stormwater Discharged East of Continental Boulevard Intersection Near Pennichuck Brook

3.2.3 Create Demonstration Project for Pennichuck Square (3)

The Problem: Catch basins, partially filled with sediment and debris, collect stormwater from the plaza's parking area before being discharged from two submerged outfall pipes into Pennichuck Brook, degrading water quality (Figure 3-24). In addition, trash from uncovered dumpsters behind the plaza is being blown into the bordering wetland area of brook (Figure 3-25).

Recommendation: Construct a demonstration project for innovative stormwater infiltration techniques that includes a parking lot infiltration island and two treatment swales. Work with landowner to erect a perimeter fence around dumpsters designed to capture blow away trash.

Implementation Details: The state has recently awarded a grant funding the demonstration project which is expected to cost \$42,400 to complete. The grant proposal is included in Appendix B. Provided there are no unforeseen delays, this project is planned to be completed in 2005.

Property Owner:

Parcel: Map 2B, Lots 359 & 360

Owner: Pennichuck Square LTD.

1 Newbury Street, 2nd Floor, Peabody, MA 01960

*PBS, PBH, PBP, WBS, and MB Subwatershed Study
Pennichuck Water Works*





Figure 3-24 Clogged Catch Basin & Bank Erosion behind Pennichuck Square Plaza



Figure 3-25 Trash Blown into Wetland Area from Uncovered Dumpsters behind Pennichuck Plaza

*PBS, PBH, PBP, WBS, and MB Subwatershed Study
Pennichuck Water Works*



3.2.4 Treat Ciro's Restaurant Parking Lot Runoff (9)

The Problem: Two sediment choked catch basins, located within the restaurant's parking area, discharge untreated stormwater from separate outfall pipes only a few feet from the edge of Pennichuck Brook (Figure 3-26). Captured sediment and pollutants are bypassing the sump area of the catch basin and are being transported near and into the water.

Recommendation: Work with landowner to install infiltration dividers around each catch basin (as the preferred option) or replace basins with deep sump/leaching units that have hooded outlets designed to trap floating debris. Please refer to Appendix C for an infiltration divider design.

Cost Estimate for Infiltration Dividers: \$10,700

Property Owner:

Parcel: I-26

Owner: Iiium Mass I, LLC

50 Rowes Wharf, Boston MA 02101



Figure 3-26 Clogged Outfall Pipe and Sediment Trail a Few Feet from the Brook from Ciro's Restaurant Parking Area Discharge

3.2.5 Treat ASA Offices Parking Lot Runoff (12)

The Problem: The parking area of this office building is elevated several feet above Pennichuck Brook, resulting in a very steep slope at the northeastern end of the lot. Catch basins in the parking lot discharge stormwater in two locations at the base of the steep slope into a narrow wetland area bordering Pennichuck Brook. Sediment deposits were observed downgradient of both outfall pipes (Figure 3-27).

Recommendation: Work with landowner to install an infiltration divider around each catch basin (as the preferred option) or replace basins with deep sump/leaching units that have hooded outlets designed to trap floating debris. Please refer to Appendix C for an infiltration divider design.

Cost Estimate for Infiltration Dividers: \$10,700

Property Owners:

Parcel: I-2

Owner: ASA Properties Inc.

10 Speen Street, Framingham, MA 01701-4661

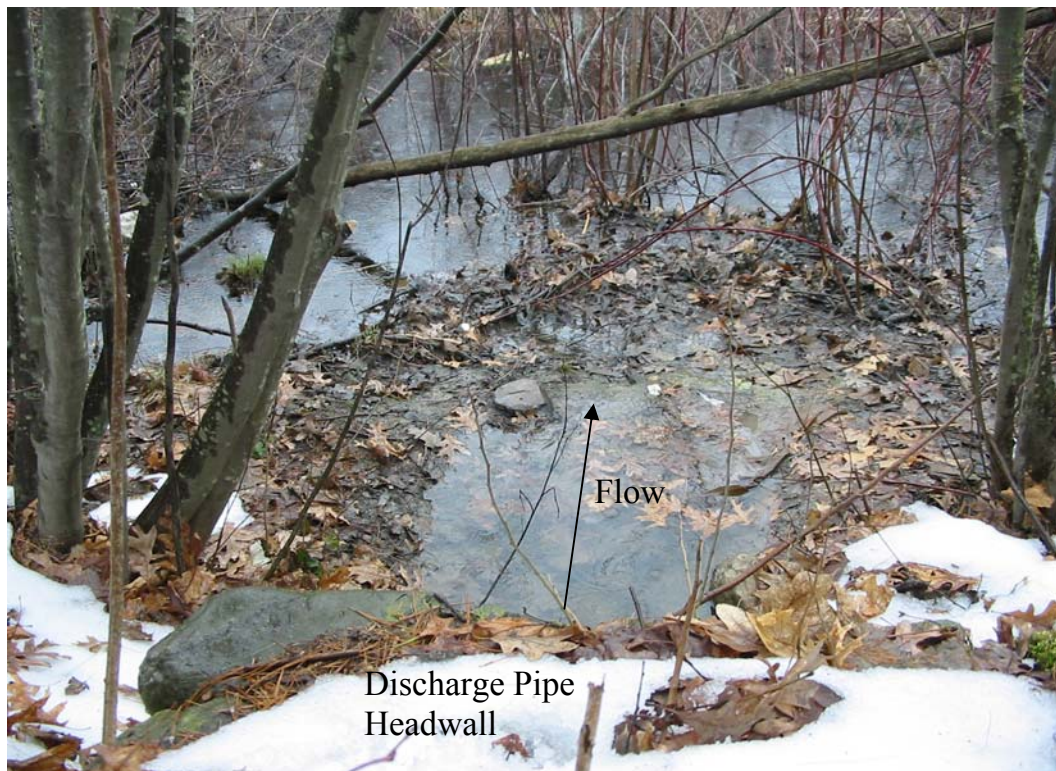


Figure 3-27 Sediment Delta from Discharge of ASA Parking Area

3.2.6 Treat Westside Plaza Parking Area Runoff (16)

The Problem: Stormwater running off the very large impervious parking area of the Westside Plaza (Demoulas Market Basket, Marshall's, Home Goods, Decathlon, The Mill Store) is likely transporting non-point source pollutants such as salt, sand and vehicle fluids from the large impervious parking area into a drainage channel a few hundred feet from Pennichuck Brook (Figure 3-28). High runoff velocities and pollutants are degrading the bordering wetland habitat and the water quality of Pennichuck Brook.

Recommendation: Work with the landowner to install narrow infiltration dividers near many of the existing catch basins to treat and infiltrate the stormwater onsite (Figure 3-29). Dividers may require some parking aisles to be reconfigured and lines repainted because of the current catch basin locations. A larger version of the infiltration divider using stones in place of pavers could also be constructed in the portion of the parking lot that is used for snow storage. Vehicles could still park on the infiltration bed when needed during busy shopping times of year. Please refer to Appendix C for an infiltration divider design.

In addition, a series of gabion check dams could be installed along the entire length of the drainage channel downgradient of the outfall pipe to reduce scouring and to collect sediment. Please refer to the Celina Avenue grant project in Appendix D for a project description of similar design.

Cost Estimate: \$46,850

Property Owner:

Parcel: Lot I-32 and I-33

Owner: Demoulas Supermarket Inc., 875 East Street, Tewksbury, MA 01876



Figure 3-28 Accumulated Sediment in Channel from Westside Plaza Parking Area

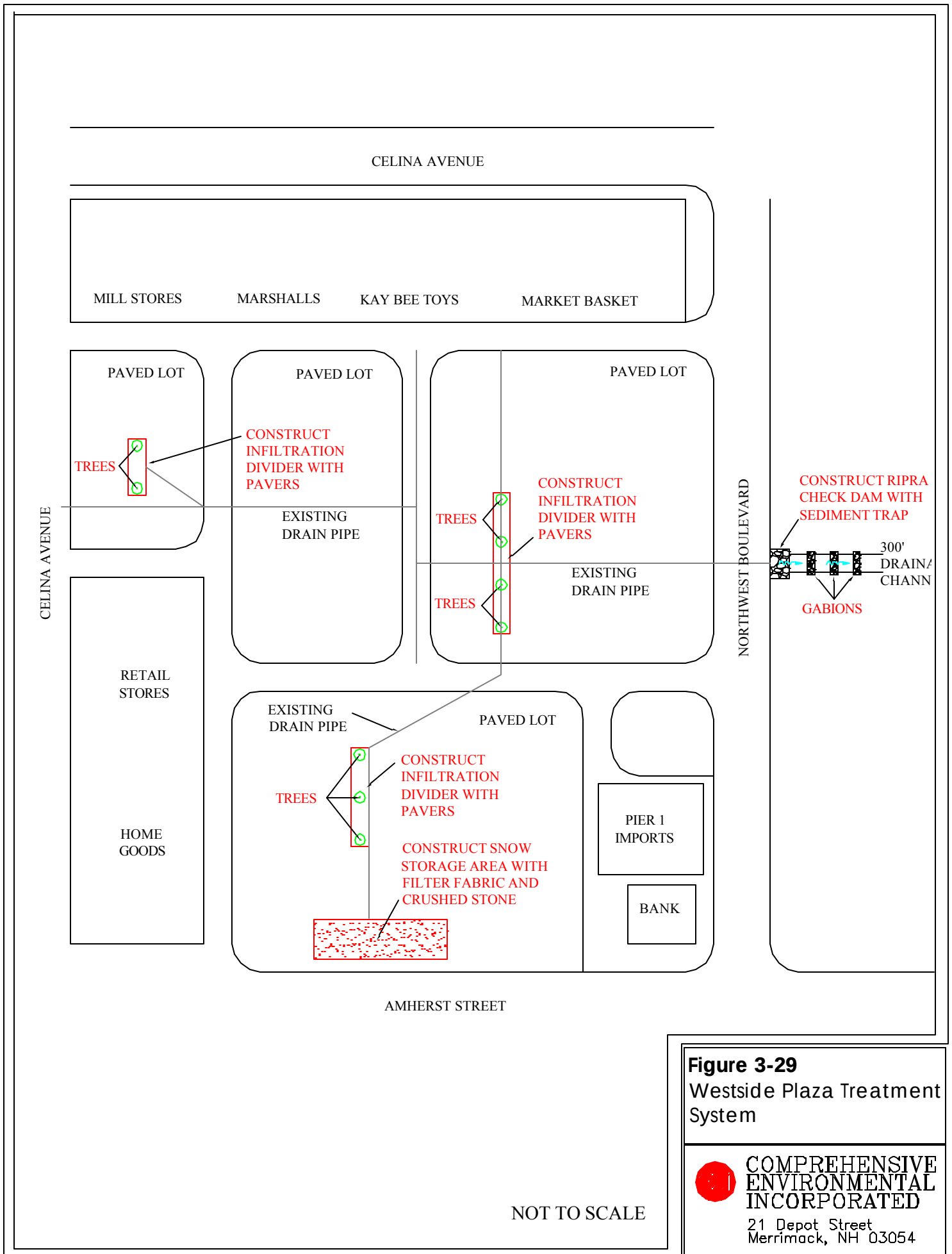


Figure 3-29
Westside Plaza Treatment System



**COMPREHENSIVE
ENVIRONMENTAL
INCORPORATED**

21 Depot Street
Merrimack, NH 03054

3.2.7 Treat Celina Avenue Runoff (19)

The Problem: Stormwater is transporting sediment and other collected pollutants from Celina Avenue into a vegetated drainage channel leading into a wetland bordering Pennichuck Brook. High discharge velocities are causing channel scouring and bank erosion (Figure 3-30). In addition, the drains of two small detention areas along Celina Avenue are not elevated, reducing the stormwater treatment potential of the basin.

Recommendation: Install a series of gabion check dams along the entire length of the drainage channel to reduce scouring, improve infiltration and trap sediment. Work with landowner of infiltration swales to elevate the existing drain pipes to improve treatment and infiltration capacity.

Implementation Details: The State has recently awarded a grant funding the Celina Avenue drainage channel project. The grant proposal is included in Appendix D. Provided there are no unforeseen delays, this project is planned to be completed by the end of 2004.

Property Owner of Drainage Channel:

Parcel: I-42, I53

Owner: Southern NH Medical Center, 8 Prospect Street, Nashua, NH 03060

Property Owner of Treatment Swales:

Parcel: Lot I-32 and I-33

Owner: Demoulas Supermarket Inc. 875 East Street, Tewksbury, MA 01876-1469

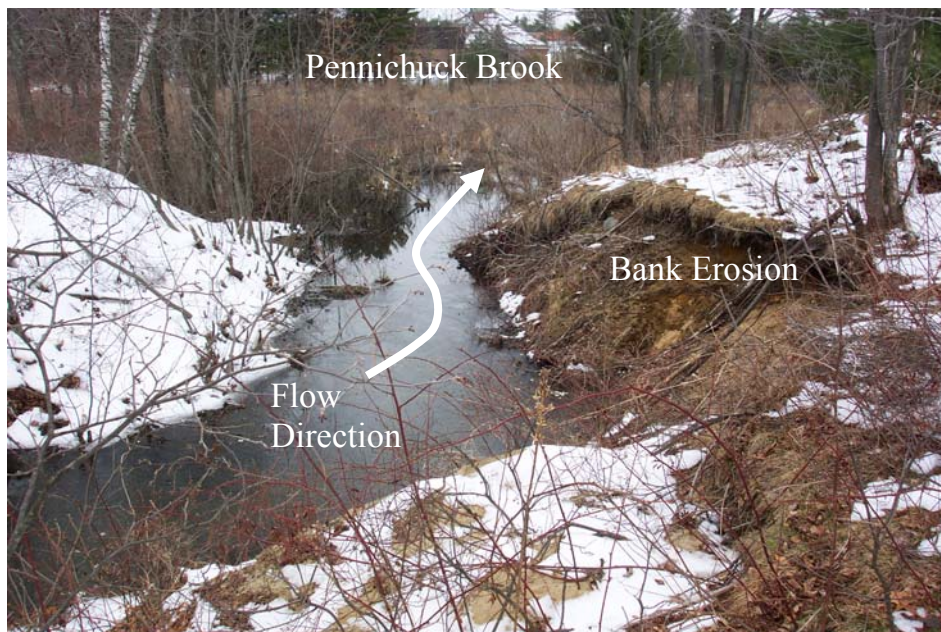


Figure 3-30 Bank Erosion in Drainage Channel from Celina Avenue Discharge
 PBS, PBH, PBP, WBS, and MB Subwatershed Study
 Pennichuck Water Works



3.2.8 Construct Snow Storage Area at Saturn Dealership (10)

The Problem: Snow is stored on a lawn area that borders Pennichuck Brook behind the dumpster storage area (Figure 3-31). Sediment and debris left after the snow melt was observed all over the lawn area. During storm events the sediment and debris are likely being washed into the brook.

Recommendation: Construct a shallow sloped earthen berm between lawn area and the shoreline to prevent sediment and debris from entering the brook. A “snowline storage limit” sign should be erected at the berm’s edge in a conspicuous place to alert payload operator of the snow storage limit (Figure 3-32). In addition, seed the berm with grass or shrubs and plant native shoreline vegetation in-between the berm and the brook.

Cost Estimate: \$2,350

Property Owners:

Parcel: I-28

Owner: International Cars LTD INC

635 Amherst Street, Nashua, NH 03063



Figure 3-31 Sediment Accumulation on Shoreline from Snow Storage behind Saturn Dealership is Entering Brook

*PBS, PBH, PBP, WBS, and MB Subwatershed Study
Pennichuck Water Works*



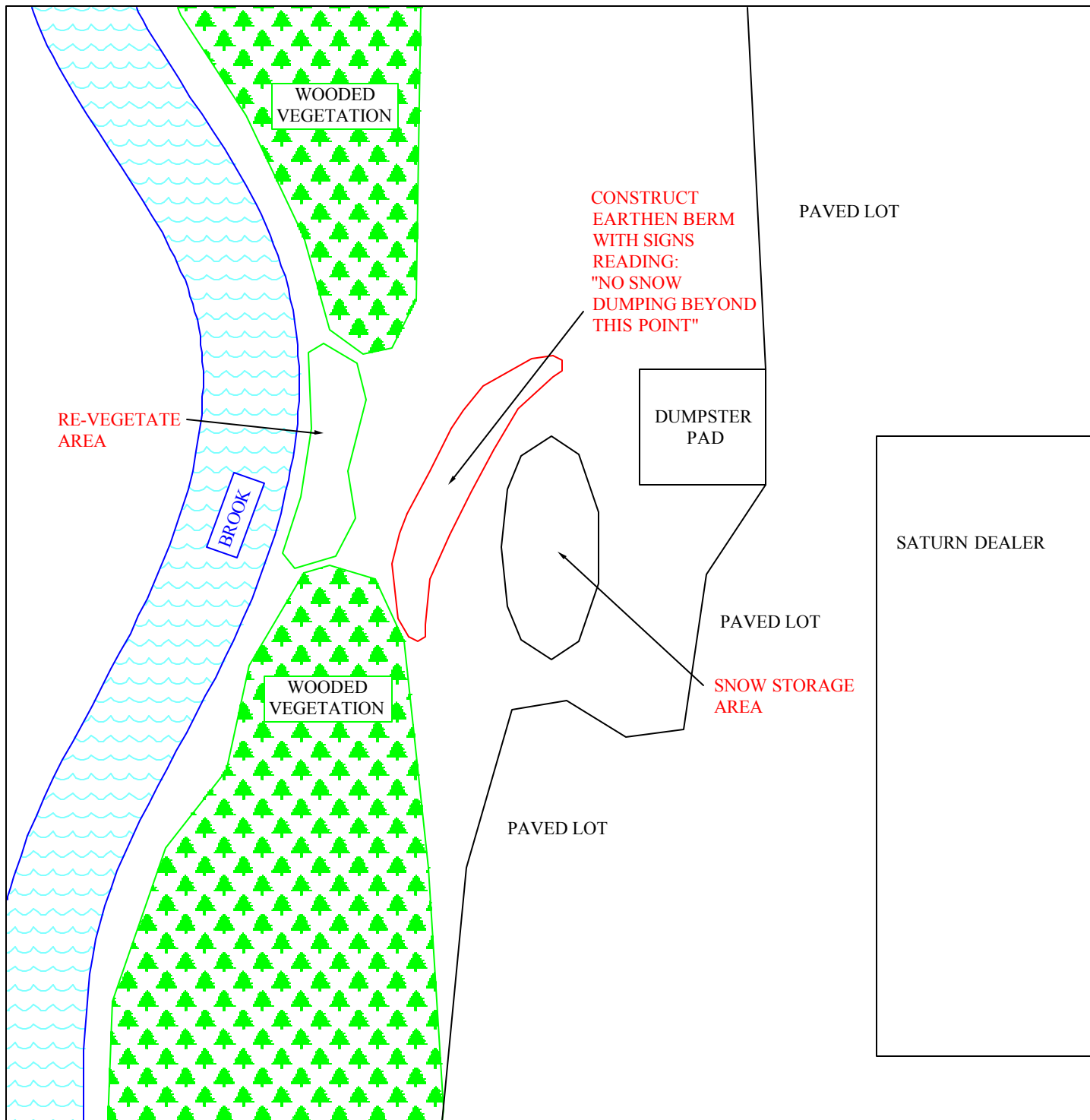


Figure 3-32
Saturn Snow Storage
Area Improvement



**COMPREHENSIVE
ENVIRONMENTAL
INCORPORATED**

21 Depot Street
Merrimack, NH 03054

NOT TO SCALE

3.2.9 Construct Dumpster Storage Area at Greystone Plaza (13)

Problem: Trash blown by the wind and leakage from the dumpsters located behind the Greystone Plaza are entering the wetland area adjacent to Pennichuck Brook (Figure 3-33).

Recommendation: Work with landowner to construct a dumpster storage area consisting of a concrete pad with perimeter lip to prevent leakage into the wetland. Additionally, install a fence around the structure to capture fly-away trash and, if possible, locate away from wetland area to the south of the building.

Cost Estimate for dumpster structure: \$6,900

Property Owner of Plaza:

Parcel: Lot I-39

Owner: Nash Family Investment Properties
730 Milford Road, Nashua, NH 03054-4631



Figure 3-33 Trash in Wetland Area from Greystone Plaza Dumpsters

3.2.10 Improve Snow & Dumpster Storage Practices at DJ Square Plaza (8)

The Problem: A trail of sediment and debris from snow storage was observed on a steep, partially vegetated embankment behind the plaza. A wetland bordering Pennichuck Brook lies at the bottom of this embankment. In addition, dumpsters behind the plaza are uncovered and are not located on an impervious surface (Figure 3-34). Leaking material from the dumpsters can infiltrate into the surrounding soils and/or enter into the wetland area bordering the brook, degrading water quality.

Recommendation: Work with landowner to construct a dumpster storage area consisting of a concrete pad with perimeter lip to prevent leakage and a fence to capture fly-away trash. In addition, request that snow from behind plaza be stored in adjacent parking area.

Cost Estimate: \$6,900

Property Owners:

Parcel: Map 2B, Lot 1

Owner: DJ Associates, LLC

74 Stony Brook Lane, Contoocook, NH 03329



Figure 3-34 Trash in Wetland Area from DJ Square Plaza Dumpsters

4.0 Witches Brook South (WBS), Pennichuck Brook to Pennichuck Pond (PBP), and Muddy Brook (MB) Subwatersheds

The WBS, PBP and MB subwatersheds were studied in 2003 as a group because of the similarities in geographic location and land use. Concerns for impacts to the Pennichuck water supply are limited in this rural area that covers the southwest portion of the watershed.

4.1 General Subwatershed Findings

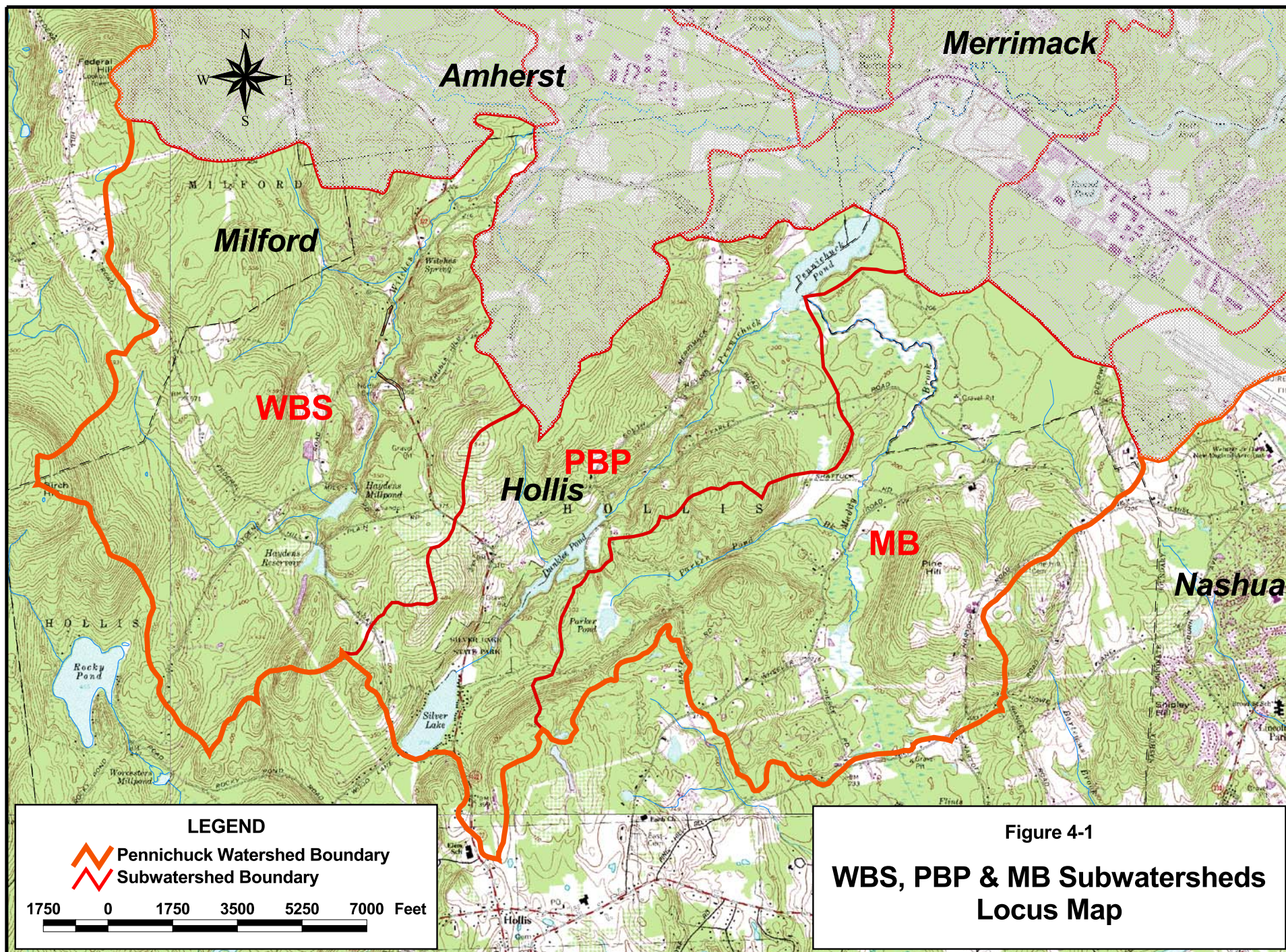
The WBS, PBP and MB subwatersheds, illustrated in Figure 4-1, include land within the Towns of Hollis, Milford, Nashua and a small portion of Amherst. The land in this region is mostly forested with natural drainage patterns that do not require extensive closed drainage systems to manage stormwater runoff. The general character of the developed land throughout these subwatersheds does not appear to pose a major threat to water quality.

Stormwater runoff within the subwatersheds is typically directed to nearby wooded areas or grass swales by road grading or small closed drainage systems, which provides the runoff a chance to infiltrate and allow sediments and other contaminants to settle out prior to reaching a water body. However, soil erosion and large sediment deposits that are impacting water quality are occurring at locations where the runoff is being directed toward or discharged directly into waterbodies without any pretreatment. In addition to sand and sediment deposits, automotive chemicals and heavy metals on road surfaces are being discharged to the waterbodies at these locations.

Existing land use conditions provide an opportunity for the small communities in these subwatersheds to focus on the prevention of environmental impacts that address water quality concerns. Public education and land management practices are effective methods to manage water quality in this area.

Specific drainage and land use descriptions for the three subwatersheds are provided in this section.





4.2 SUBWATERSHED DRAINAGE

The WBS, PBP and MB subwatersheds include approximately 43 percent (7,828 acres) of the Pennichuck water supply tributary area. With the exception of some road crossings, Pennichuck Brook, Witches Brook and Muddy Brook flow through wooded land and wetlands before they meet near Pennichuck Pond and continue as Pennichuck Brook to Supply Pond and the Merrimack River. Added protection is provided by conservation land that abuts Pennichuck Brook and Muddy Brook. Descriptions of land features and stormwater drainage for each subwatershed are discussed below. Figure 4-2 identifies the conservation land and drainage systems that are found in the WBS, PBP and MB subwatersheds.

Witches Brook South

The Witches Brook South is the single largest subwatershed tributary to Pennichuck water supply. It is comprised of 3,120 acres, with land uses primarily made up of single family residential, with a small portion agricultural land which includes a couple of small horse stables. The majority of the subwatershed is located in Hollis (2,380 acres), with 720 acres in Milford and 20 acres in Amherst. Approximately 340 acres of forest and conservation land are located in the WBS subwatershed.

Terrain of WBS subwatershed is steep, creating several small, seasonal tributaries that feed Witches Brook before flowing into Hayden Mill Pond. There the brook receives additional flow from Haydens Reservoir and a small pond north of Haydens Road. Witches Brook then continues in a northern direction along Silver Lake Road (Route 122) toward Amherst. As the brook approaches the Amherst/Hollis town line, it begins to head in an eastern direction and flows through a series of wetlands before discharging into Pennichuck Brook, just north of Pennichuck Pond. The total length of the brook is approximately 7 miles from headwater to the point where it meets Pennichuck Brook.

Stormwater drainage in the WBS subwatershed is primarily overland flow with a few collection systems in the newer developments, such as those found on Colburn Lane, Arbor Lane and Shedd Lane. Runoff from these subdivisions is managed with a variety of stormwater treatment methods such as grassy swales and detention systems. Federal Hill Road has a simple but effective drainage system that controls sediment deposits along the steep dirt road. Runoff from the road is diverted into a series of sediment traps that collect stormwater before discharging into the woods and nearby tributaries to Witches Brook. The traps create temporary ponding that allow sediment to settle out and stormwater to infiltrate. Sediment deposits are periodically removed by the Hollis DPW to maintain the traps' capacities. Examples of the sediment traps on Federal Hill Road are pictured in Figures 4-3 and 4-4.

*PBS, PBH, PBP, WBS, and MB Subwatershed Study
Pennichuck Water Works*



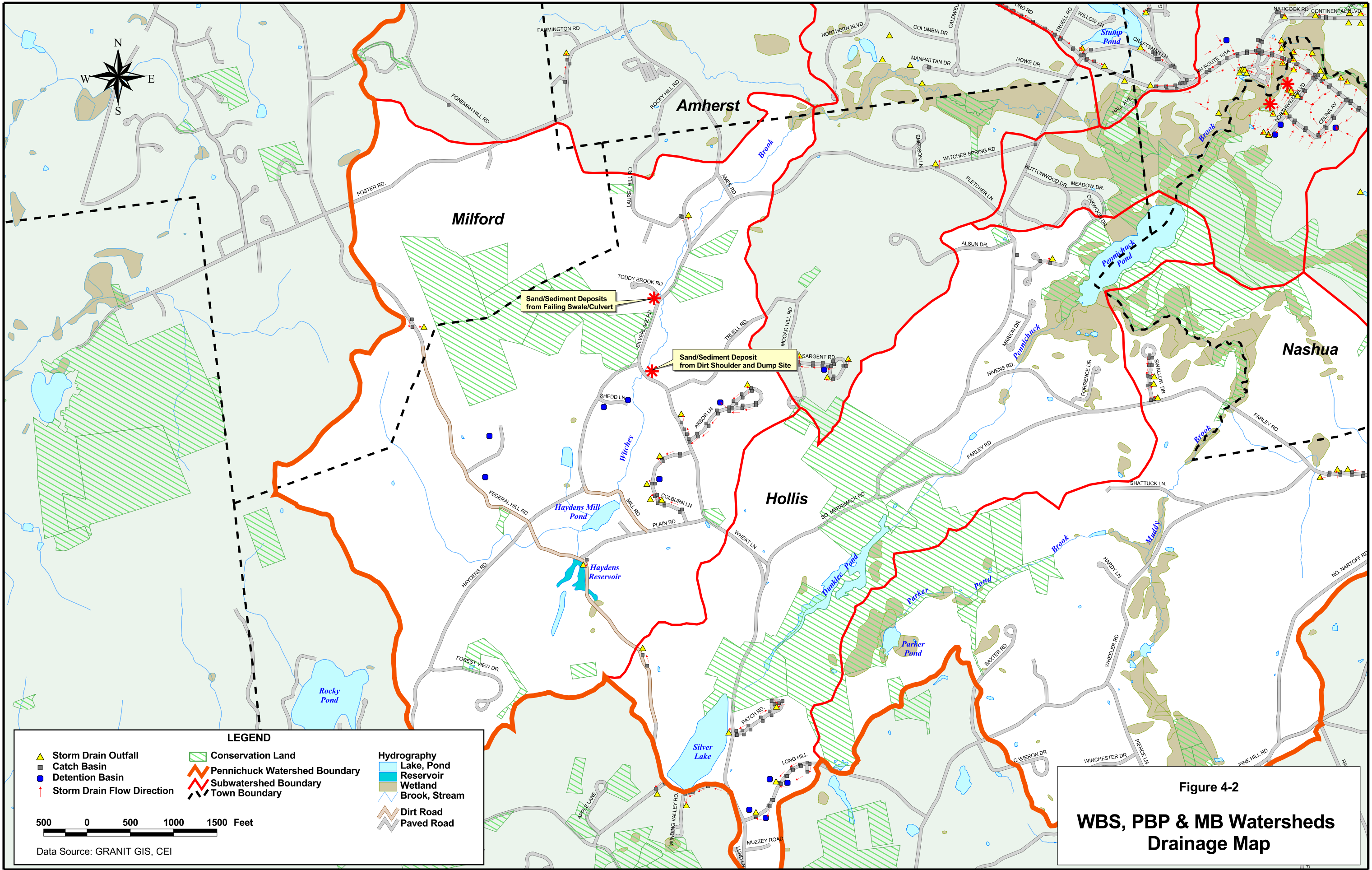




Figure 4-3 Working Sediment Trap on Federal Hill Road



Figure 4-4 Working Sediment Trap with Ponded Stormwater

*PBS, PBH, PBP, WBS, and MB Subwatershed Study
Pennichuck Water Works*



Pennichuck Brook to Pennichuck Pond (PBP)

This subwatershed includes the tributary area for Pennichuck Brook and Pennichuck Pond. The 2,000 acre subwatershed is primarily made up of single family residential with some agricultural land use that included horse stables. Approximately 1,930 acres are located in Hollis, 65 acres in Nashua and 5 acres in Merrimack. Conservation and forested land uses cover approximately 470 acres.

Pennichuck Brook begins at Silver Lake where it flows in a northeast direction through a narrow valley into Silver Lake State Park and through Dunklee Pond. The brook receives protection from the park and conservation land to the point where it crosses under Farley Road. The brook continues through a wooded residential area where the topography levels out and begins to pass through a series of wetlands as it approaches Pennichuck Pond.

A very flat landscape surrounds Pennichuck Pond and is primarily a vegetated wetland. Conservation land includes approximately 75 percent of the property abutting the pond. Additional protection is offered by the Zone II wellhead protection area for Wells 6, 7 and 8 of the Merrimack Village District.

Stormwater drainage in the SBP subwatershed is primarily overland flow with the exception of a couple collection systems on Long Hill and Patch Road. Long Hill is a new single-family residential subdivision along the southern ridge of the Pennichuck Brook watershed. A series of detention ponds are used on Long Hill to control runoff velocity and allow sediments to settle out before ultimately discharging at two points along the southern slope of the road. The eastern half of Patch Road directs stormwater from a residential area through a closed system where it is piped under Route 122 and into Silver Lake.

Muddy Brook

The Muddy Brook subwatershed is located along the southern boundary of the Pennichuck Brook watershed. It includes 2,700 acres of land that is primarily single-family residential with agricultural land uses that include a large nursery, farming practices and a Hollis Horse Ranch. Many individual homes were also observed boarding horses. The majority of the subwatershed is located in Hollis (2,205 acres), with 495 acres in Nashua. Approximately 380 acres of conservation land are included in the subwatershed.

The terrain of the MB subwatershed is made up of a series of ridges and hills, with the largest being Pine Hill. This regular change in elevation effectively channels stormwater into three tributaries. The main tributary is Muddy Brook, which has a general drainage direction from the south to the north. The land



quickly begins to flatten out as the tributaries begin to converge and enter a large wetland that leads to Pennichuck Pond.

Muddy Brook begins at a wetland located at the southern end of the subwatershed, just north of Pine Hill Road. Property adjacent to this wetland is used as agricultural cropland. The brook follows a wide, forested valley through a relatively flat corridor, and receives runoff from Pine Hill and adjacent slopes along Pierce Lane and Wheeler Road. Wetlands that are found throughout this valley provide the brook with protection and an opportunity to treat stormwater by trapping sediments and taking up nutrients. Muddy Brook flows through a small pond before crossing Wheeler Road, where it meets a large tributary from the west called Parker Pond Brook.

Parker Pond Brook's headwaters begin at Parker Pond and flow in a west to east direction, following a narrow valley with steep slopes to the south and Silver Lake State Park to the north. The brook receives protection from conservation land and the park at its higher reaches and remains isolated at the lower reaches, primarily due to wetlands preventing any new development.

As Muddy Brook receives flow from Parker Pond Brook it continues toward Farley Road where it collects additional flow from a second, unnamed tributary prior to entering the large wetland leading up to Pennichuck Pond.



4.3 Site Specific Recommendations

Site specific recommendations made in this section address the significant water quality threats discovered during field investigations within the WBS, PBP and MB subwatersheds. The location of each site is indicated in Figure 4-5. General recommendations, based on field observations and land use characteristics, are discussed in Section 5.0. These recommendations are made to address potential sources of pollution that commonly occur from each type of land use within the Pennichuck watershed.

4.3.1 Construct Containment Swale for Toddy Brook Road Discharge

The Problem: Stormwater runoff from Toddy Brook Road and Silver Lake Road flows to an eroded swale along Silver Lake Road. Eroded soil is carried by stormwater runoff through a small culvert under Toddy Brook Road and discharges into Witches Brook. The intake of the culvert is located in what looks like a sinkhole, without a headwall or riprap to stabilize the surrounding soil.

The roadway shoulder is also impacted from vehicles making right turns onto Silver Lake Road (Figure 4-6). The extent of the vehicle traffic has prevented any vegetative growth on the corner of the intersection. Figures 4-7 and 4-8 show the channelized shoulder, sediment deposits and impacts to vegetation at Toddy Brook Road.

Recommendation

Construct a containment swale (within the existing aforementioned swale area) to trap sand and sediment that is washed off the roadway surface. Construct a small headwall at the culvert intake to help stabilize the shoulder and prevent soil from eroding. Refer to Appendix E for a containment swale design.

The swale should reduce the velocity of runoff entering the Toddy Brook Road culvert and provide some infiltration. This would reduce the impact to the bank of Witches Brook where the culvert discharges.

In addition, a barrier could be constructed at the corner of Toddy Brook Road and Silver Lake Road to prevent vehicles from cutting the corner and driving on the shoulder.

Cost Estimate: \$6,450

Property Owners:

Parcel: State and Town of Hollis Right-of-Way

Owners: Town of Hollis and NH Department of Transportation
7 Hazen Drive, Concord, NH 03302-0483

*PBS, PBH, PBP, WBS, and MB Subwatershed Study
Pennichuck Water Works*



Figure 4-5
Site Specific
Water Quality Impacts

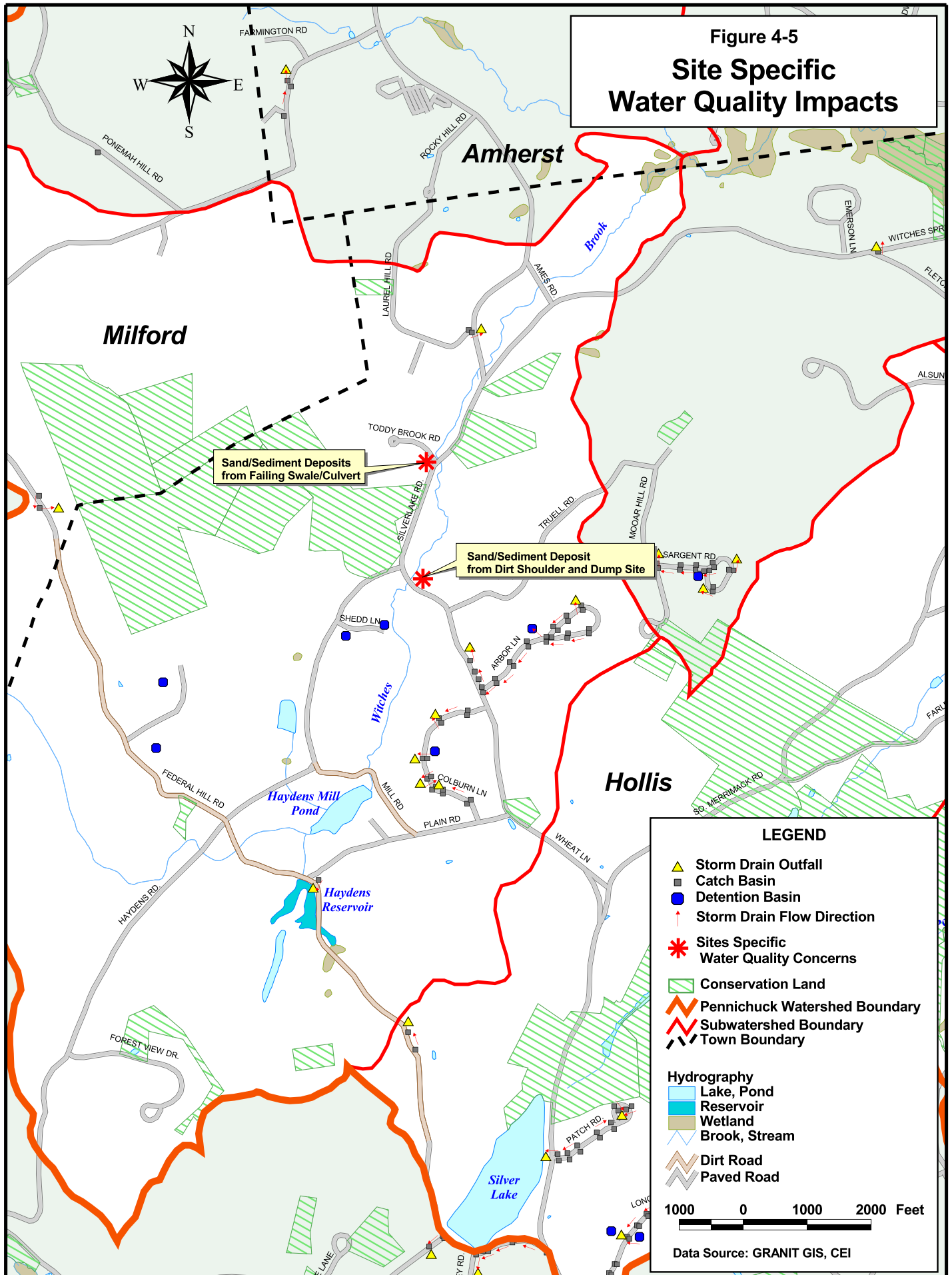




Figure 4-6 Sediment from Exposed Road Shoulder is Being Transported into Brook through Culvert

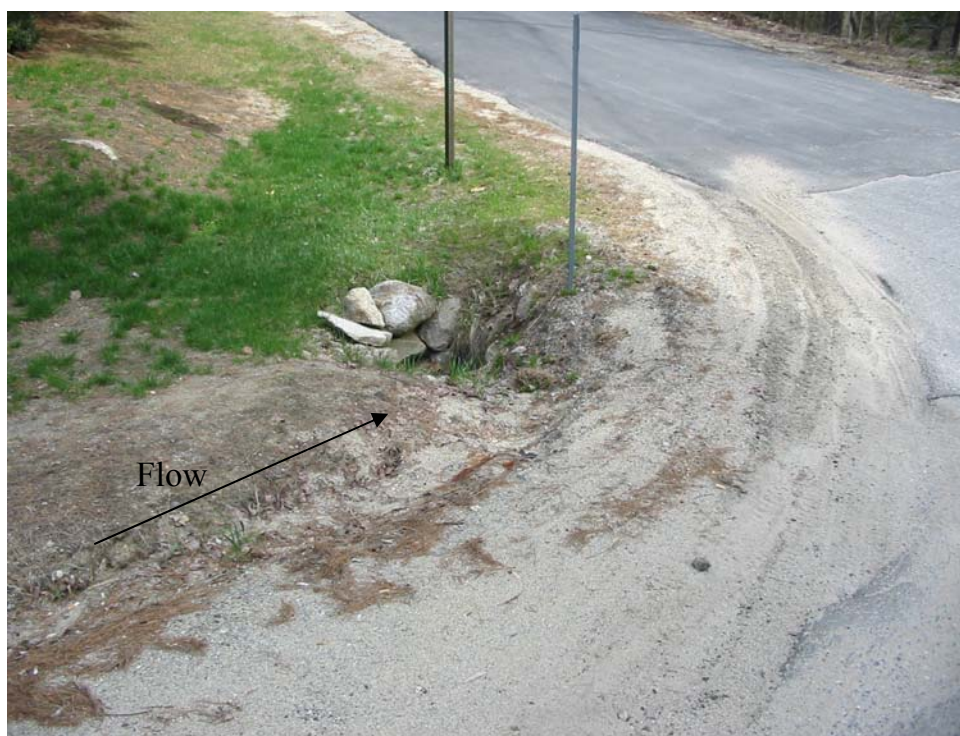


Figure 4-7 Channel Formed in Toddy Brook Road Shoulder from Street Runoff

*PBS, PBH, PBP, WBS, and MB Subwatershed Study
Pennichuck Water Works*





Figure 4-8 Sediment & Debris Collected in Inlet Side of Culvert

4.3.2 Construct Containment Swale & Remove Debris Piles Near Silver Lake Road

The Problem: Stormwater runoff from Silver Lake Road flows across a large dirt shoulder before discharging into Witches Brook. A small paved channel also directs runoff from the bridge and road surfaces to the inside of the culvert's wing wall, discharging directly to the brook. There is no form of grass swale or detention basin to treat or slow the runoff before reaching the brook. Runoff during the spring deposited enough sediment to cause a delta to form immediately downstream from the bridge.

Piles of garbage and debris were also dumped near this site in the woods adjacent to Witches Brook. Stormwater runoff from these piles could be contributing pollutants directly into the brook.

Figures 4-9 and 4-10 are photographs of the exposed shoulder and sediment buildup at the brook crossing on Silver Lake Road. Figures 4-11 and 4-12 show the garbage and construction materials that have been dumped at this location.

Recommendation:

Construct a containment swale to treat runoff from the paved channel on the edge of Silver Lake Road, similar to those used on Federal Hill Road in Hollis. Remove the piles of debris along the edge of the brook and re-vegetate the Silver Lake Road shoulder. Refer to Appendix E for a containment swale design.

The containment swale would allow sand and sediment to settle out of stormwater before discharging into the brook and provide a convenient way to remove sediment deposits.

Cost Estimate: \$7,350

Maintenance Cost: Completed by the NH Department of Transportation

Property Owner:

Parcel: Turnpike Right-of-Way

Owner: NH Department of Transportation

7 Hazen Drive, Concord, NH 03302-0483





Figure 4-9 Exposed Dirt Shoulder Contributes to Sediment in Brook



Figure 4-10 Sediment Trail and Paved Channel Leading into Culvert from Street Runoff



Figure 4-11 Garbage Dumped Adjacent to Witches Brook



Figure 4-12 Construction Debris Dumped Adjacent to Witches Brook

5.0 General Recommendations

General watershed concerns and recommendations included in this section address common water quality impacts to the Pennichuck water supply that are currently found throughout the subwatersheds. Site specific recommendations for the subwatersheds studied in this report can be found in the Sections 2.0, 3.0 and 4.0.

5.1 General Subwatershed Concerns

Many of the general concerns for the water supply come from residential, agricultural and nursery properties that are located near to the water supply tributaries. This section discusses the threats that these land uses pose on water quality and other sources of contaminants found in the Pennichuck watershed.

5.1.1 Fertilizer and Pesticide Application

Residential Landscape Practices

Many residential lots drain directly to tributaries to the surface water supply or indirectly through catch basins that empty into tributaries to the water supply. Nutrient loads from suburban lawns can contribute significant amounts of phosphorus to nearby surface waters through stormwater runoff. It is estimated that there are 25-30 million acres of turf and lawn in the U.S. (Schueler, 2000). Nutrients are applied to lawns at about the same rate as row crops in terms of fertilizer inputs, (Schueler, 2000), a very high rate.

Lawn fertilization is often a widespread watershed activity. Recent surveys indicate that at least 50% of homeowners apply lawn fertilizer every year. Surveys that have reviewed fertilization frequency indicate that homeowners fertilize an average of 2.3 times per year. Some statistics indicate that 52%, 65% and 70% of people who use fertilizer apply too much and that only 10-20% of lawn owners perform soil tests to determine what nutrients, if any, their lawn requires (Schueler, 2000).

Over-fertilized lawns are susceptible to stormwater runoff of nutrients, as well as weakness and susceptibility to pests and diseases. Yards directly abutting tributaries provide direct conduits for phosphorus to enter the water. However, all of the yards within the watershed can contribute through overland runoff and directly connected storm drains. Those who over-irrigate their lawns may also contribute phosphorus during dry weather conditions.

In addition, many people dispose of yard wastes by throwing them in the woods or ditch behind their house instead of composting them. CEI has observed several



piles of yard waste along tributaries in the water supply watershed. This can further add nutrients into the stormwater and eventually the water supply.

Agriculture/ Nursery/Landscape Businesses

Orchards, small farms, nurseries, garden centers and landscape businesses located within the watershed pose a risk to the surface water supply. Agricultural and nursery practices such as excessive application of fertilizer and pesticides, as well as soil erosion and sedimentation, can result in water supply impacts.

Inappropriate storage of fertilizer and pesticide can result in a spill of materials that can mix with stormwater and enter nearby tributaries. Educational brochures were distributed to farms, nurseries and landscaping supply businesses and follow up visits performed as part of the 2002 Hot Spots project to help address these concerns.

CEI has observed the presence of chemical lawn trucks within the water supply watershed. Since landscapers typically travel to their clients' property to provide lawn and garden services, they are sometimes unaware of their proximity to surrounding water resources. This can result in the use of inappropriate products close to drinking water supplies. Since homeowners and business owners typically expect immediate growth with lush, green results, landscapers may use high nitrogen and phosphorus and/or "weed and feed" products that can result in severe water quality impacts.

The transport of nutrients from residential and commercial sites in close proximity to tributaries of the Pennichuck water supply could significantly encourage the rate of algae and aquatic plant growth. As a result, these water bodies may lose their ability to adequately treat stormwater runoff. Elevated nutrient inputs, in combination with sediment runoff, can cause surface water bodies to become increasingly shallow and choked with weeds. Algae growth can contribute to greater turbidity and lower dissolved oxygen concentrations.

Impacts of nutrient runoff and sedimentation to the water supply can limit the recreational values and wildlife habitat. Additionally, degraded raw water quality can increase treatment costs.

5.1.2 Domestic Animals

Domesticated animals may be a significant source of bacteria and nutrient input to the surface water supply, particularly near waterways and tributaries.

Horses

An average size horse produces about 50 pounds of manure daily and approximately eight tons per year (DEP, 2000). Lack of manure management, such as failure to clean yards/pens and uncovered manure storage, can result in



bacterial contamination of adjacent tributaries and water supplies. Several homes with horses were observed within the watershed and in close proximity to water supply tributaries. However, the condition of all paddock areas and manure management were not directly inspected.

CEI also notes that the stable located at the intersection of Silver Lake Road and South Merrimack Road has fenced horses in a paddock with a seasonal tributary running through it. The tributary was observed during a visit to the stable when significant bank damage and erosion was occurring with no vegetated buffer.

Pets

With the majority of the watershed used as residential single-family housing, it is safe to assume that many of these residences contain pets, including dogs. Studies indicate that an average size dog on an average diet produces 100 pounds of fecal waste per year. Shoreline residences with pets may contribute large quantities of bacteria if pet wastes are left near the shore.

Past U.S. surveys have indicated that people agree that dog waste can be a water quality problem, however, they generally rank it as the least important local water quality problem (Schueler, 1995). This implies that watershed education may be necessary to increase public awareness about the water quality and health consequences of dog waste.

5.1.3 Roadways and Transportation

Roadways throughout the water supply watershed are potential sources of contamination, especially during the winter season. Application of sand and salt during winter storms elevate levels of sodium in stormwater runoff from roadways. Stormwater from precipitation and snowmelt is often directed to the closest surface water body. As a result, roadway contaminants are carried into the water supply without any form of treatment.



5.2 RECOMMENDATIONS

EPA Phase II Regulation require towns within the U.S. Census defined urbanized areas (refer to Figure 5-1) to develop Stormwater Management Plans and Best Management Practices to reduce the impacts of stormwater discharges. As part of these regulations, the watershed towns (Amherst, Hollis, Merrimack, Milford and Nashua) are planning to implement educational programs addressing many of the watershed concerns previously mentioned. To enhance the Phase II programs, Pennichuck could offer additional assistance to towns in the following areas.

5.2.1 Sponsor Homeowner Outreach Program

Sponsor homeowners who are willing to modify their properties in a manner that benefits Pennichuck Water Works water resources, such as improving stream buffers. Town Conservation Commissions could manage the program. They could screen the applications for problem areas and determine to what extent individual projects merit funding. The top proposals that offer the greatest water resource improvement for the money would then be implemented each year. Sponsored Master Gardener applicants discussed below could assist in this process.

5.2.2 Sponsor Master Gardener Program

Sponsor a Master Gardener applicant each year. The Master Gardener Program is a state program that provides an opportunity for selected individuals to get training and attend seminars related to horticulture. A participant needs to give back to the community by providing 45 hours of volunteer work to complete the program. The individual could then host a workshop or be a speaker in a series of workshops for the communities within the Pennichuck Watersheds. Having a Master Gardener in one's neighborhood would be a welcome resource to many, and since the program is geared towards low impact gardening and landscaping, it will help protect water resources.

5.2.3 Educate Stable Owners about Animal and Manure Management

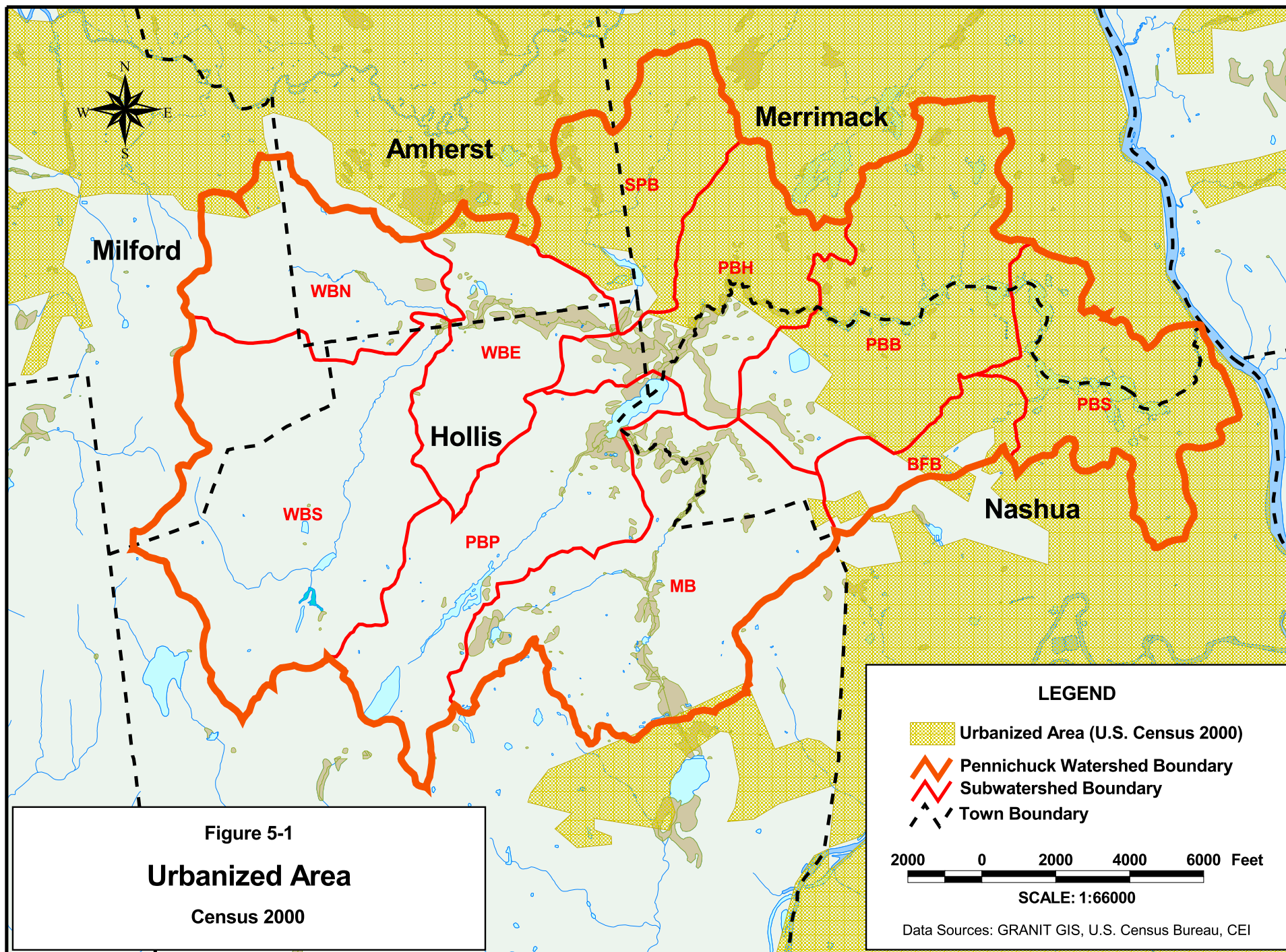
Encourage the more rural towns of Hollis, Milford and Amherst (Board of Health Departments), to send out material to stable owners including fact sheets on BMPs and available grant funding for improvement projects. A brochure was created and mailed as part of the 2002 Hot Spots project to agricultural business with follow-up visits performed. However, homeowners who own horses and livestock were not part of this program. Information on available grants is provided in Section 7.0.



5.2.4 Erect Watershed Signs

Encourage towns to erect “You are Entering a Public Water Supply Watershed” signs throughout the watershed. Signs can be used to inform travelers when they are entering the Pennichuck water supply watershed. This is a simple method to make the public aware of their surroundings and to pay special attention to their activities. Signs should be installed in high traffic locations where roads first enter the watershed and at each point where a tributary is crossed.





6.0 STATUS OF WATERSHED RECOMMENDATIONS

This section briefly describes the recommendations that were made in each of the completed Pennichuck Watershed reports and studies listed below.

1. Pennichuck Water Works Watershed Management Plan, August 1998
2. Study of Urban Non-Point Source Pollution – Boire Field Brook Subwatershed, Spring 2000
3. Sediment Study of Pennichuck Ponds, July 2000
4. Study of Urban Non-Point Source Pollution – Pennichuck Brook to Bowers Pond, Spring 2001
5. Hot Spot Visitations – Pennichuck Watershed, May 2002
6. Study of Urban Non-Point Source Pollution – Witches Brook East Subwatershed, Summer 2002
7. Study of Urban Non-Point Source Pollution – Witches Brook North Subwatershed, Summer 2002
8. Study of Urban Non-Point Source Pollution – Stump Pond Brook Subwatershed, Summer/Fall 2002

Figure 6-1 on the following pages provides a summary of the recommendations and follow-up actions taken or are planned to be taken by Pennichuck. Table 6-1 provides a ten-year action plan. For full descriptions of drainage areas and recommendations, the watershed reports should be referenced. Pennichuck is planning to hire interns during the summer months to assist in completing recommendations.

Many of the recommendations require town and/or landowner support that may not be immediately forthcoming. However, future efforts should be made in such cases as community awareness and circumstances constantly change.



Figure 6-1 Watershed Recommendation Overview

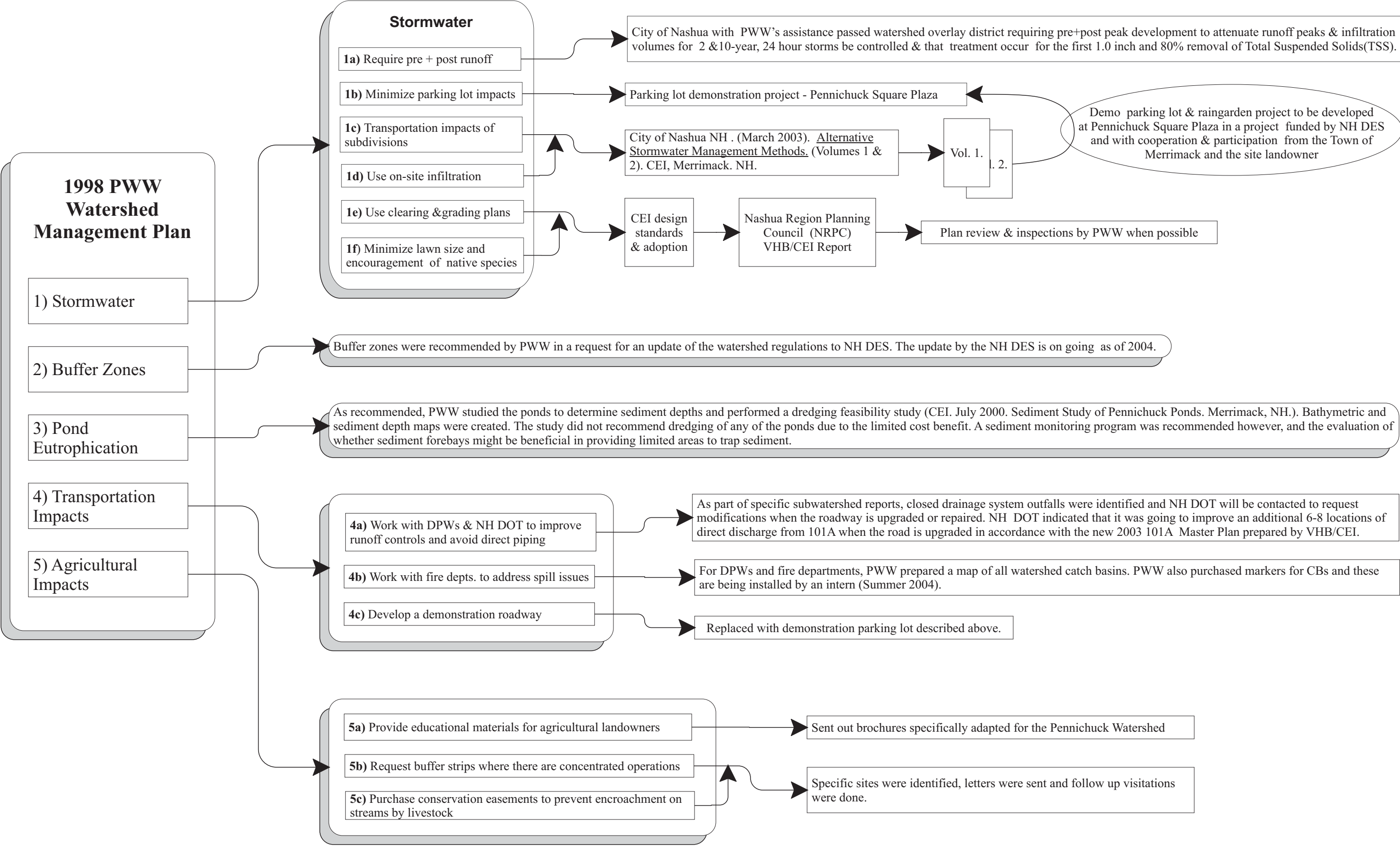
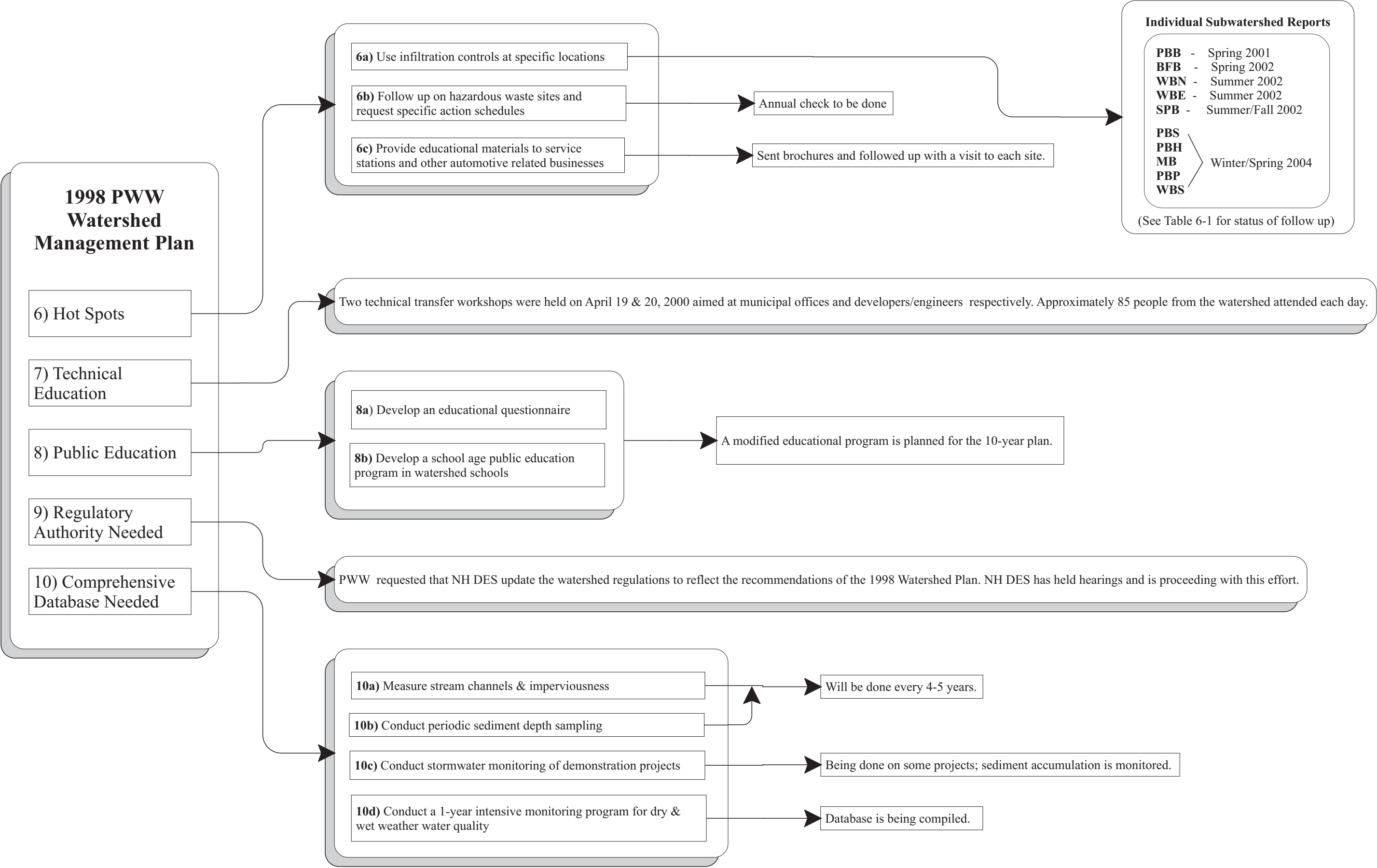


Figure 6-1 Watershed Recommendation Overview



**Table 6-1 Pennichuck Watershed 10 Year Action Plan
Items To Be Completed**

Report Reference	Description	Specifics and Schedule
1. A. Require pre and post development stormwater runoff controls ^a	Encourage watershed towns to adopt similar runoff controls to that adopted by Nashua (equal pre and post-development peaks and infiltration for 2 and 10-year, 24 hour storms.	Send letters to the remaining watershed towns encouraging them to use the Nashua model regulation or to adopt CEI's design standards for runoff controls. Emphasize that this could be part of the communities' Phase II Stormwater compliance.
1. B. Minimize parking lot impacts ^a	Construct a demonstration project in an existing parking lot in one of the watershed communities at the site of a cooperating landowner. Include raingarden as a demonstration if possible.	Construction to begin summer and fall of 2004, Pennichuck Square, Merrimack. Design by CEI is now ongoing and a kickoff needs to be scheduled to gain participation of the stakeholders (landowner, Town of Merrimack, tenants, Pennichuck).
1.D. Use onsite infiltration of roof leader and other recharge; 1.E. Use clearing and grading pans; 1.F. Minimize lawn sizes, encourage use of native plantings	Continue plan reviews for all watershed projects as they arise. Encourage adoption of CEI's design standards for stormwater controls by all communities in the watershed as these standards address these issues.	Set up a design review checklist and distribute to the watershed communities to encourage its use. Send to DPWs, Conservation Commissions and Planning Boards of all watershed communities.
3. Pond Eutrophication ^b	Monitor sediment depths over time and evaluate whether sediment forebays might benefit the ponds.	Replicating the original locations to the extent possible, sediment depth monitoring needs to be done every 4 or 5 years during the summer. Original depths acquired late summer 1999, so depths should be acquired in 2004.
5. Agricultural Impacts ^c	Farms and nurseries visited in 2001 and 2002 should be revisited in 2004 and every two years afterwards.	Use the checklist in the Hot Spot Visitations report during visits, distribute the brochures again. Check whether the Natural Resource Conservation Service (NRCS) has completed their work with watershed farms identified in the report.

^a Pennichuck Water Works Watershed Management Plan, Recommendation #1 Stormwater, CEI, August, 1998.

^b Sediment Study of Pennichuck Ponds. CEI, July 2000.

^c Hot Spot Visitations Pennichuck Watershed. CEI, May 2002.



Table 6-1 Pennichuck Watershed 10 Year Action Plan
Items To Be Completed

6.A. Use infiltration controls at specific locations	See followon recommendations from Subwatershed Reports at the end of this table on page 6-3.	– Inspect all constructed BMPs annually and send letters to applicable authorities if maintenance has not been completed
6.B. Follow up on hazardous waste sites	– Update the sites list generated in the 1998 Watershed Plan. – Contact NH DES and request information on specific action schedules for each site.	– Update the record search of sites done for the 1998 plan (Appendix F HAZWASTE sites) – Send a letter to John Regan at NH DES asking if he could give you an update on the status of these sites, listing those identified above
7. Technical Education	Apply for another grant for 2005/6 to repeat the highly successful 2000 workshops with updated information and model regulations.	Submit grant application November 2004.
8. Public Education	Provide a map of the demonstration sites and plan a tour to be combined with the 2005 workshops. Invite cable channels from each of the watershed towns to the tour. Invite public through press releases beforehand. Build on current Low Impact Development (LID) movement by including techniques that could be used in new development in ongoing construction sites.	Map should include selected existing BMPs that work well, the Pennichuck Square BMP, the Celina Avenue BMP and Cornerstone properties BMP. It should show watershed areas and provide plans and specifications. Add to above grant application.
10.A. Measure stream channels and imperviousness; 10B. Conduct periodic sediment depth sampling; 10.C. Conduct stormwater monitoring of demonstration projects.	A-B should be done on a 4-5 year basis. C. is being done by NRPC under grant to DES. D. is being completed 2004.	Analyze after completion of 8-10 years of data and update the watershed recommendations to reflect the results. Substitute sediment depth monitoring (for stormwater monitoring) for infiltration based demonstration projects to gauge effectiveness.



Table 6-1 Pennichuck Watershed 10 Year Action Plan
Items To Be Completed

10.D. One year intensive monitoring program for dry and wet weather water quality.	(See above)	(See above)
Boire Field Brook Subwatershed	- <u>O&M Plans</u>. Encourage the use of O&M plans by watershed towns by sending them a “model” plan under a cover letter that highlights why it is important for their Phase II compliance and for water quality in Pennichuck Brook. - Request that EPA or NHDES Phase II program provide guidance on disposal of street sweepings. - Evaluate whether the Crowne Plaza waterfowl situation warrants further actions	- Other specific Phase II bylaws that must be adopted will also improve the maintenance situation on new BMPs. Provide model bylaws from NHDES if needed. - Hand out DES prepared guidance on street sweepings to the involved businesses and their contractors if this is noted as a problem. - Inspect sites specifically mentioned in the BFB report and send new letters if needed to encourage maintenance. Copy in Nashua DPW as the City is now responsible for making sure that maintenance is accomplished (Phase II regulations). - Take samples for E. coli upstream and downstream of the site and if significantly higher downstream in summer, take further actions.
Pennichuck Brook to Bowers Pond Subwatershed	- The Amherst Planning Board could request that the detention structures at Amherst Park be rebuilt if the site ever needs approval for expansion or substantial modification Send a letter to Nashua DPW, the Nashua Planning Board and the Nashua Conservation Commission, with copies to NH DOT regarding the Blackstone pond and its need for maintenance.	- If this site comes up for review by Amherst municipal agencies, Pennichuck should request that the drainage detention structures be modified to be more effective. - Remind Nashua agencies that the Blackstone detention pond needs cleaning out and request action. If this is not done before the 101A upgrades, request from NH DOT when they go to make the improvements on 101A near that site. - Reinspect these sites and send a letter to Nashua DPW with



Table 6-1 Pennichuck Watershed 10 Year Action Plan
Items To Be Completed

Pennichuck Brook to Bowers Pond Subwatershed (continued)	- Similar to the above, request that Nashua require owners to maintain the sites listed in the report (pages 8-9)	copies of the notes above.
Witches Brook North Subwatershed	- Sponsor a Master Gardener from the local area who would then provide public education on how homeowners can reduce fertilizer and pesticide use in yards - Encourage watershed towns to include recharge requirements and steep slope controls in their Phase II regulatory updates. - Inspect other small sites identified in the WBN report to obtain a status and need for further actions	- Contact UNH Master Gardener program to see how they might be able to assist Pennichuck in this education effort - Send a letter to watershed Planning Boards encouraging them to consider steep slope and recharge requirements in their regulatory updates required under Phase II.
Witches Brook East Subwatershed	- Inspect drainage structures listed in the WBE report and update status. - Send letters to Amherst regarding these sites and maintenance actions needed or modifications requested when site changes are approved.	- These are all private developments with drainage issues. They may be contacted during the visits to see if they might want to participate in modifications such as are occurring at Pennichuck Square in 2004. Each site will need updating if further actions need to be taken so that the latest designs can be used.
Stump Pond Brook Subwatershed	- Submit sediment forebay (pg 4-1) to NH DOT for consideration in 101A upgrades in future. Alternatively, a grant application could be submitted for this BMP. - Submit other roadway BMPs to the town of Amherst for consideration and similarly possibly grant applications if involved parties agree to participate.	- These BMPs are in right-of-ways for the state and for Amherst. They will need to participate for any construction to occur. Some landowners are also peripherally involved as well.



7.0 SUBWATERSHED IMPROVEMENT PRIORITIZATION

This section ranks the twenty-five recommended site specific improvements that are described in studies for the ten subwatersheds listed below. Recommended improvements that have been implemented from previous studies are considered complete and are not included in this section.

1. Pennichuck Brook to Supply Pond (PBS)
2. Pennichuck Brook to Bowers Pond (PBB)
3. Boire Field Brook (BFB)
4. Pennichuck Brook to Holts Pond (PBH)
5. Stump Pond Brook (SPB)
6. Pennichuck Brook to Pennichuck Pond (PBP)
7. Witches Brook East (WBE)
8. Witches Brook North (WBN)
9. Witches Brook South (WBS)
10. Muddy Brook (MB)

7.1 Ranking Criteria

This subsection describes how the recommended improvements toward areas of concern found in the studied subwatersheds were made. Points were assigned to each recommended improvement based on the perceived threat from three criteria. For example, a recommended improvement addressing an area of concern with a large drainage area that discharges within 25 feet of the brook near the water supply intake, will rank higher than a recommended improvement addressing a small drainage area discharging more than 100 feet from the brook far upstream of the water supply intake. The following three criteria used are as follows:

1. Distance to Water Supply Intake

Untreated runoff discharged closer to the water supply intake has a greater potential of affecting the quality of the raw water supply. Discharges occurring farther upstream need to travel farther before reaching the intake and are therefore subject to greater amounts of dilution, reducing the impact of the threat.



2. Discharge Proximity to Pennichuck Brook or Tributary

Stormwater discharged within a few feet or directly in Pennichuck Brook (or tributary) is likely to have a greater negative impact on the water quality than from stormwater discharged several hundred feet away from a waterway. Any type of treatment or buffer area upstream or downstream of the discharge can help reduce water quality threats from non-point source pollutants transported by stormwater runoff.

3. Size of Drainage Area

Drainage area size can affect the quantity of stormwater runoff entering the brook. Stormwater runoff is more likely to transport higher quantities of non-point source pollutants from a larger drainage area than a smaller one. However, land use in a drainage area can affect the quantity and types of pollutants transported by stormwater runoff. For example, heavily developed areas with impervious parking areas and buildings are more likely to contribute higher quantities of non-point source pollutants than rural residential areas.

7.2 Prioritization Description

Twenty five recommended improvements are ranked in Table 7-1 (on the following page) to help guide Pennichuck toward focusing on the highest areas of concern. The higher ranked proposed projects have a greater potential to adversely affect the water quality of Pennichuck Brook and should therefore be targeted first. However, all the areas of concern pose a water quality threat to Pennichuck's water supply and should be addressed. This threat is primarily from untreated stormwater discharged in or near the brook (or tributary), which can transport non-point source pollutants such as sediment, road salt, oil, vehicle coolant, lawn fertilizers and pesticides that can degrade water quality and wildlife habitats.



Table 7-1 Priority Ranking of Recommended Site Specific Improvements from PWW Subwatershed Studies										
Priority Ranking ¹		Subwatershed Name/Report	Name of Recommendation	Type of Improvement	Estimated Implementation Cost (2004 Costs ²)	Approximate Size of Drainage Area (Acres)	Land Use in Drainage Area	Approximate Outfall Distances ³		Existing BMPs or Natural Retention Features "downstream" of Discharge
								Distance of Discharge to Brook/Pond (feet)	Distance to Water Supply Intake (Miles)	
1	2397	Pennichuck Brook to Supply Pond (2004)	Improve Tinker Road Detention Pond	Gabion check dams and stream bank protection	\$5,900	27	Residential & Highway	50	0.9	None
2	2132	Pennichuck Brook to Holts Pond (2004)	Evaluate PC Connection Detention Pond	Feasibility study and design	\$23,300	35.4	Commercial & State Road	0	5.8	None
3	1989	Pennichuck Brook to Supply Pond (2004)	Construct Containment Swale for Turnpike Discharge	Containment swale	\$6,450	4.5	Highway	5	1.0	None
4	1880	Boire Field Brook (2000)	Crowne Plaza Waterfowl	Educational leaflet, feeding deterrents, signage, wire gridding	\$34,500	1.5	Commercial	Direct discharge into tributary	1.5	Two "Please Do Not Feed Waterfowl" signs around ponds
5	1864	Pennichuck Brook to Supply Pond (2004)	Divert Turnpike Bridge Discharge into Sediment Basin	Sediment trap/basin	\$8,950	2.3	Highway	5	1.8	None
6	1661	Pennichuck Brook to Bowers Pond (2001)	Sediment Removal in Blackstone Detention Pond	Dredging of pond by 2020	\$44,000	46	Residential & Commercial	No direct discharge (overflow)	4.6	Sediment filled detention pond offers limited treatment
7	1609	Pennichuck Brook to Bowers Pond (2001)	Baffle Tank at Amherst Park	Baffle tank installation	\$13,200	3.4	Residential & Commercial	Direct discharge into tributary	4.6	None
8	1563	Pennichuck Brook to Holts Pond (2004)	Create Demonstration Project for Pennichuck Square	Infiltration islands/dividers	\$42,400	4	Commercial	0	5.2	None
9	1494	Pennichuck Brook to Holts Pond (2004)	Treat Ciro's Restaurant Parking Lot Runoff	Infiltration dividers	\$10,700	1.4	Commercial	10	5.2	None
10	1484	Pennichuck Brook to Holts Pond (2004)	Treat ASA Offices Parking Lot Runoff	Infiltration dividers	\$10,700	1.1	Commercial	75	4.6	Wetland buffer
11	1308	Pennichuck Brook to Holts Pond (2004)	Treat Westside Plaza Parking Area Runoff	Install infiltration dividers and gabion check dams	\$46,850	18.2	Commercial	500	5.6	Long drainage channel & wetland buffer
12	1292	Witches Brook East (2002)	Columbia Brook Discharge	Infiltration Basin	\$94,500	14	Commercial	50	9.4	Natural small wetland area
13	1213	Pennichuck Brook to Holts Pond (2004)	Treat Celina Avenue Runoff	Gabion check dams	\$13,500	19	Commercial & City Road	600	5.7	Long drainage channel and wetland buffer
14	1196	Stump Pond Brook (2003)	Reduce erosion at Craftsman Lane Bridge	Install containment swales, and filter berm	\$6,000	0.7	Town Road & Residential	Direct discharge into brook	8.2	None
15	1176	Stump Pond Brook (2003)	Reduce Sediment Loading to Stump Pond	Small sediment forebay and vegetated swale with check dams	\$20,000	3.2	Commercial & State Road	30	8.6	None
16	1116	Witches Brook East (2002)	Poly-Ject Inc. Brook Discharge	Retrofit catch basin with hooded outlet	\$800	0.2	Commercial	100	7.9	Natural woodland buffer
17	1072	Witches Brook North (2002)	Ponemah Hill Road	Roadside stabilization with riprap and filter fabric	\$26,250	31	Residential & Town Road	450	11.0	Limited riprap and vegetation
18	1072	Witches Brook North (2002)	Rocky Hill Road/Route 122	Leaching catch basin	\$2,650	29.5	State Road	500	10.2	Small detention pond
19	952	Witches Brook East (2002)	Norwich Building Discharge	Infiltration Strip	\$8,950	8	Commercial	300	9.1	Natural woodland buffer
20	714	Pennichuck Brook to Holts Pond (2004)	Construct Snow Storage Area at Saturn Dealership	Designated snow storage area with berm & signs	\$2,350	Snow Storage Area	Commercial	No direct discharge	4.9	None
21	662	Pennichuck Brook to Holts Pond (2004)	Construct Dumpster Storage Area at Greystone Plaza	Constructed pad and fence for dumpster storage	\$6,900	Dumpster Area	Commercial	No direct discharge	5.4	Wetland buffer
22	656	Pennichuck Brook to Holts Pond (2004)	Improve Snow & Dumpster Storage Practices at DJ Square Plaza	Constructed pad and fence for dumpsters and designated snow storage area	\$6,900	Dumpster/ Snow Area	Commercial	No direct discharge	5.4	Wetland buffer
23	623	Stump Pond Brook (2003)	Reduce Sediment Loading into Wetland Near Boston Post Road	Constructed pond/wetland with forebay	\$20,000	4.6	State Road	800	6.7	Wetland buffer
24	102	Muddy Brook (2004)	Construct Containment Swale for Toddy Brook Road Discharge	Containment swale	\$6,450	1.4	State Road	No direct discharge	11.3	None
25	76	Muddy Brook (2004)	Construct Containment Swale and Remove Debris Piles Near Silver Lake Rd.	Containment swale and debris removal	\$7,350	2.2	State & Town Road	No direct discharge	11.7	None
Total Cost					\$469,550					
¹ Ranking was determined by 1) drainage size, 2) distance of discharge to water supply intake, and 3) distance of piped discharge to pond, brook or tributary										
² Based on cost of inflation, living, and service increases.										
³ Distances as measured along center line of brook.										



7.3 Implementation Schedule

This section discusses the strategy toward implementing the twenty six structural improvements listed in Table 7-1. Because of the high total cost (\$480,250), a ten year timeline was seen as a feasible target for implementing these projects. This would entail seeking around \$50,000 annually to implement these proposed improvements. To achieve this annual target amount and to balance the project load, some lower ranked projects will have to be completed before higher ranked ones. Table 7-2 on the following page provides a timeline describing projects to fund over the ten-year period. Section 7.4 provides information for available funding to assist in implementing these projects.

Many of the projects are located on private land requiring support from the landowner. Some landowners may not be willing to provide support for a project. Unexpected delays may require some shuffling of projects to achieve the ten year project completion goal. The timeline in Table 7-2 shows a best case scenario, assuming all landowners are willing to cooperate. The table does not include the proposed PC Connection Pond Feasibility Study (Rank No. 2) because the landowner, for liability reasons, did not support the project. (However, future adjacent land purchases by PC Connection may lead to the establishment of a drainage easement that includes the pond, potentially allowing the project to proceed.) Additionally, the table does not include the Baffle Tank at Amherst Park Project (Rank No. 7). After further review by CEI and Pennichuck, it was decided that a baffle tank was not the best approach to the sedimentation problem.

7.4 Potential Funding Sources

This section provides information on currently available funding sources that Pennichuck can apply for to assist in implementing the recommended improvements. Pennichuck has applied for and received funding in the past from some of the listed sources. Table 7-3 on page 7-6 provides a listing of the sources. Annual award amounts from these sources may vary from year to year depending on available funding.



Table 7-2 Timeline for Implementing Recommended Improvements				
Year	Project Name	Rank No.	Annual Cost	
2004	Create Demonstration Project for Pennichuck Square	8		\$42,400
	Treat Celina Avenue Runoff	14		\$13,500
			Total:	\$60,900
2005	Improve Design of Tinker Road Detention Pond	1		\$5,900
	Construct Containment Swale for Turnpike Discharge	3		\$6,450
	Crowne Plaza Waterfowl	4		\$34,500
			Total:	\$46,850
2006	Treat Westside Plaza Parking Area Runoff	12		\$46,850
			Total:	\$46,850
2007	Divert Turnpike Bridge Discharge into Sediment Basin	5		\$8,950
	Treat Ciro's Restaurant Parking Lot Runoff	10		\$10,700
	Treat ASA Offices Parking Lot Runoff	11		\$10,700
	Reduce Erosion at Craftsman Lane Bridge	15		\$6,000
			Total:	\$36,350
2008 - 2009	Columbia Brook Discharge - Infiltration Basin	13		\$94,500
			Total:	\$94,500
2010	Reduce Sediment Loading to Stump Pond	16		\$20,000
	Ponemah Hill Road	18		\$26,250
			Total:	\$46,250
2011	Poly-Ject Inc. Brook Discharge	17		\$800
	Rocky Hill Road/Route 122	19		\$2,650
	Norwich Building Discharge	20		\$8,950
	Reduce Sediment Loading into Wetland Near Boston Post Rd	24		\$20,000
			Total:	\$32,400
2012	Construct Snow Storage Area at Saturn Dealership	21		\$2,350
	Construct Dumpster Storage Area at Greystone Plaza	22		\$6,900
	Improve Snow & Dumpster Storage Practices at DJ Sq. Plaza	23		\$6,900
	Construct Containment Swale for Toddy Brook Road Discharge	25		\$6,450
	Construct Containment Swale and Remove Debris Piles Near Silver Lake Rd.	26		\$7,350
			Total:	\$29,950
2013	Sediment Removal in Blackstone Detention Pond	6		\$44,000
			Total:	\$44,000
				Total: \$433,050



**Table 7-3
Potential Funding Sources**

Funding Organization	Contact	Eligibility	Amount Funded Annually	Areas Funded	Application Deadlines	Match Required
319 Watershed Assistance Grants	Eric Williams, NH DES 271-2358	• Non-profits • Public water suppliers • Planning commissions • Watershed associations	\$600,000	• Watershed planning • BMP implementation • Monitoring & Assessment	November	40%
Small Outreach & Education Grants	Barbara McMillan, NH DES 271-7889	Same as above including schools	Up to \$2,000 per project	• Publications & Mailings • Web sites and displays • Public events	None – open schedule	40%
Drinking Water Source Protection Grants	Paul Susca or Johnna McKenna, NH DES 271-7061	Public water supplier (or endorsement from a public supplier)	Up to \$15,000 per project	• Protection projects implementation • Water supply threat inventory • Assessment/planning	November	None required
Agricultural Nutrient Management Grant Program	Richard Uncles, NH Dept. of Agriculture 271-3685	• Farms • Livestock operations • Watershed associations	Up to \$2,500 per project	• Controlled wetland crossings • Buffer reestablishment • Manure/compost storage structures • Alternative livestock water systems	June 1 st & December 1 st	None required
National Resource Conservation Service – Environmental Quality Incentives Program	Jim Spielman (603) 868-7581	• Livestock operations • Agricultural operations	\$1,000,000 in 2003	• Manure/compost storage • Barnyard runoff control • Erosion control – buffers, filter strips • Nutrient Management, IPM	Annual announced cutoff date	%25
U.S. EPA – Targeted Watershed Grants Program	William Walsh-Rogalski or Lynne Hamjian 617-918-1035 and 617-918-1601	The governor must submit nomination to EPA	Up to \$1,300,000 per watershed	Watershed protection and restoration program – EPA plans to select 20 watersheds in the country in 2004	January – Need nomination from Governor	25%



Appendices

Appendix A.....	PC Connection Detention Pond Feasibility Study Grant
Appendix B	Pennichuck Square Demonstration Project Grant
Appendix C	Infiltration Divider
Appendix D	Celina Avenue Grant
Appendix E	Containment Swale

**New Hampshire Department of Environmental Services
2004 Local Source Water Protection Grant
Grant Application Form**

Project

Title: Feasibility Study to Evaluate the Effectiveness of PC Connection Detention Pond

Applicant/Organization: Pennichuck Water Works

Contact

Person: Don Ware

Address: PO Box 448, 4 Water Street

Nashua, NH 03061

Telephone: (day) (603) 882-5191 (evening) (603) 424-4125

(fax) (603) 882-4125

(E-mail address) donald.ware@pennichuck.com

Project Location

Town(s): Merrimack

Water System(s) for which source(s) are to be protected: Pennichuck Water Works

EPA ID# for source(s) to be protected: 1621010

Grant Amount Requested: \$ \$15,000

Local Match to be Provided: \$ 8,300

Total Project Cost: \$ \$23,300

Please provide a brief description of your project (no more than one or two paragraphs) that could be used for publicity purposes if your proposal is selected for funding.

The purpose of this study is to create an effective stormwater treatment design that will address non-point source contaminants directly entering Pennichuck Brook (greater Nashua's drinking water supply) from an existing detention pond near PC Connection. This will be accomplished in two phases. The first phase of this project will be to evaluate the dynamics of the pond system and to design plans for an effective BMP treating the pollutants. The evaluation will consist of water quality sampling, sediment analysis, and survey work. The second phase will be to implement the design. This proposal for the 2004 grant round is only for the first phase of this project. A proposal will be written for the second phase of this project during next years grant round.

Please attach the three or four page project narrative answering the questions posed in the application packet, and attach any maps, photos, designs, and/or graphics as appropriate.

DUE BY NOVEMBER 21, 2003

Continued on Reverse Side >>>

Budget Format

BUDGET ITEM	<u>A</u> QUANTITY	<u>B</u> RATE	<u>C</u> TOTAL (AXB)	<u>D</u> GRANT (C-E)	<u>E</u> MATCH (Identify source)
EQUIPMENT					
LABOR					
MATERIALS					
SALARY					
<i>Position 1</i>					
<i>Position 2</i>					
BENEFITS					
CONTRACTED SERVICES - provide budget detail			\$23,300	\$15,000	\$8,300 PWW Cash match
SUPPLIES					
OVERHEAD - specify					
OTHER - explain					
TOTALS			\$23,300	\$15,000	\$8,300

The budget should also be broken down by Task. Please use the table below to list the general project tasks and the cost breakdown for each task. For example, a project task may involve creating education materials where the grant supports \$2,000 in materials and the applicant provides \$1,000 in labor costs as match. The total cost of this task is \$3,000.

Task (provide description)	Funds provided by Grant	Matching Contribution	Total cost of task
Task 1: Data Collection	\$700	\$0	\$700
Task 2: Sediment Analysis	\$2,500	\$1,500	\$4,000
Task 3: Water Quality Analysis	\$2,000	\$1000	\$3,000
Task 4: Site Survey	\$2,500	\$1,000	\$3,500

Task 5: Project Design	\$7,300	\$4,800	\$12,100
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Total:	\$15,000	\$8,300	\$23,300
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Project Narrative

Feasibility Study to Evaluate the Effectiveness of PC Connection Detention Pond

Introduction

Pennichuck Watershed is a 17,984 acre watershed serving recreational and water supply needs for five towns in southern New Hampshire. Located in a rapidly developing area of New Hampshire, Pennichuck Watershed has been seriously impacted by development over the last 20 years. Some portions of the watershed are intensely developed with high levels of imperviousness. Other more upper watershed portions are mostly undeveloped and contain some pristine trout stream segments with undisturbed habitat.

Water quality impacts in this area are well known. Sediment washing or eroding into the ponds and reduced base flow due to imperviousness have reduced the capacity of the Pennichuck Brook water supply system by an estimated 70% over the years.

There are many ongoing and completed watershed protection efforts in the Pennichuck Watershed. The basis for this proposal is from an ongoing subwatershed study that is being funded by a 2003 Source Water Protection Grant. In this study, many areas of concern have been discovered in the Pennichuck Brook to Holts Pond Subwatershed. This study focuses on addressing one of the major concerns discovered.

The Purpose of this Project

The goal of this project is to reduce the amount of non-point source pollutants entering Pennichuck Brook, the drinking water supply of the greater Nashua area, from what appears to be a rapidly filling detention pond owned by PC Connection. It will also provide as much pretreatment as possible to reduce the rate of sediment filling in the pond. This will be accomplished in two phases. The first phase of the project is to conduct a feasibility study that would evaluate the dynamics of the pond system including the water being discharged into the pond and to create a more effective design or designs to pre-treat the stormwater runoff and to enhance the pond's effectiveness. The second phase would be to implement the design(s) recommended in the study. This proposal for the 2004 grant round is only for the first phase of this project. A proposal for the second phase of this project would be written in time for next years grant round providing the study is completed in time.

Project Description

Five piped outfalls, ranging from 18" to 42", discharge stormwater from the surrounding commercial/business sites (including PC Connection, VIP, and St. Johns Church) and a portion of Route 101A into a small detention pond near PC Connection. An outlet in the southeastern portion of the pond flowing directly into Pennichuck Brook appears to limit the usefulness of the pond from retaining and treating the stormwater from the 35-acre drainage area.

The feasibility study includes an evaluation of the water being discharged into the pond and brook and an effective design plan addressing any potential water quality threats found. The evaluation would consist of taking water quality samples of the stormwater runoff being discharged into the pond, sampling the water entering the brook from the pond, sediment analysis of the pond, and survey work of the site. The following tasks are included to complete the feasibility study. Please refer to the map and photos in Attachments A and B for visual displays of the study site.

Task 1. Data Collection

Existing information will be collected to assist in the design of a BMP(s), including existing site maps and drainage maps of the project site and surrounding land parcels and drainage calculations.

Task 2. Sediment Analysis

A transect map of the pond will be prepared identifying areas for sediment depth measurement. Sediment depths in the field will be measured using a depth probe. A bathymetric map of the pond will be created from the collected data. Based on the mapping produced, the quantity of sediment within the pond will be estimated.

Task 3. Water Quality Analysis

During the measurement of sediment depths, three rounds of water quality samples will be collected during the first flush condition of storm events at the five piped discharges into the pond (or upstream if pipes are submerged), and at the discharge outlet of the pond. The water will be sampled for total suspended solids (TSS), phosphorus, nitrogen (TKN), total coliform, and oil/grease concentrations. The collected data will be used to analyze the water quality that is flowing into the pond and into the brook.

Task 4. Site Survey

This task involves survey work to define property boundaries and to identify contour measurements including shoreline features, discharge pipe inverts (entering pond), and the discharge outlet flowing into the brook from the pond.

Task 5. Project Design

An engineering design of maintainable pretreatment units on the storm drains and any modifications needed to improve the effectiveness of the pond will be created based on the data collected from the evaluation. The performance of BMPs and other structures will be evaluated to come up with the most effective design. The design will include the preparation of plans and technical specifications, a construction cost estimate, a scheduled timeline for completion, and an operation and maintenance (O&M) plan for cleaning the BMP structure(s). The plan will outline the frequency of cleaning and the method to be used.

Consistency with Source Water Protection Program

The study is directly related to source water protection because it addresses non-point source pollutants that are potentially degrading the water quality of Pennichuck Brook, the drinking water supply for the greater Nashua area.

Local Support

The pond's owner, G&H Post, LLC, C/O PC Connection, supports this project with the understanding that they are not committed to any funding or specific work. However due to the timing of preparing this proposal, G&H Post was not able to provide a support letter in time before the application deadline. A letter will be forthcoming from the landowner and sent to DES's attention soon thereafter.

Schedule and Costs

This study will begin in May/June 2004 and is expected to require 6 months to complete. The first phase of the project, the feasibility study, is estimated to cost \$23,300. The goal is to finish the study in time to prepare a submittal for the implementation of a structural BMP project (Phase II) in time for next year's grant round.

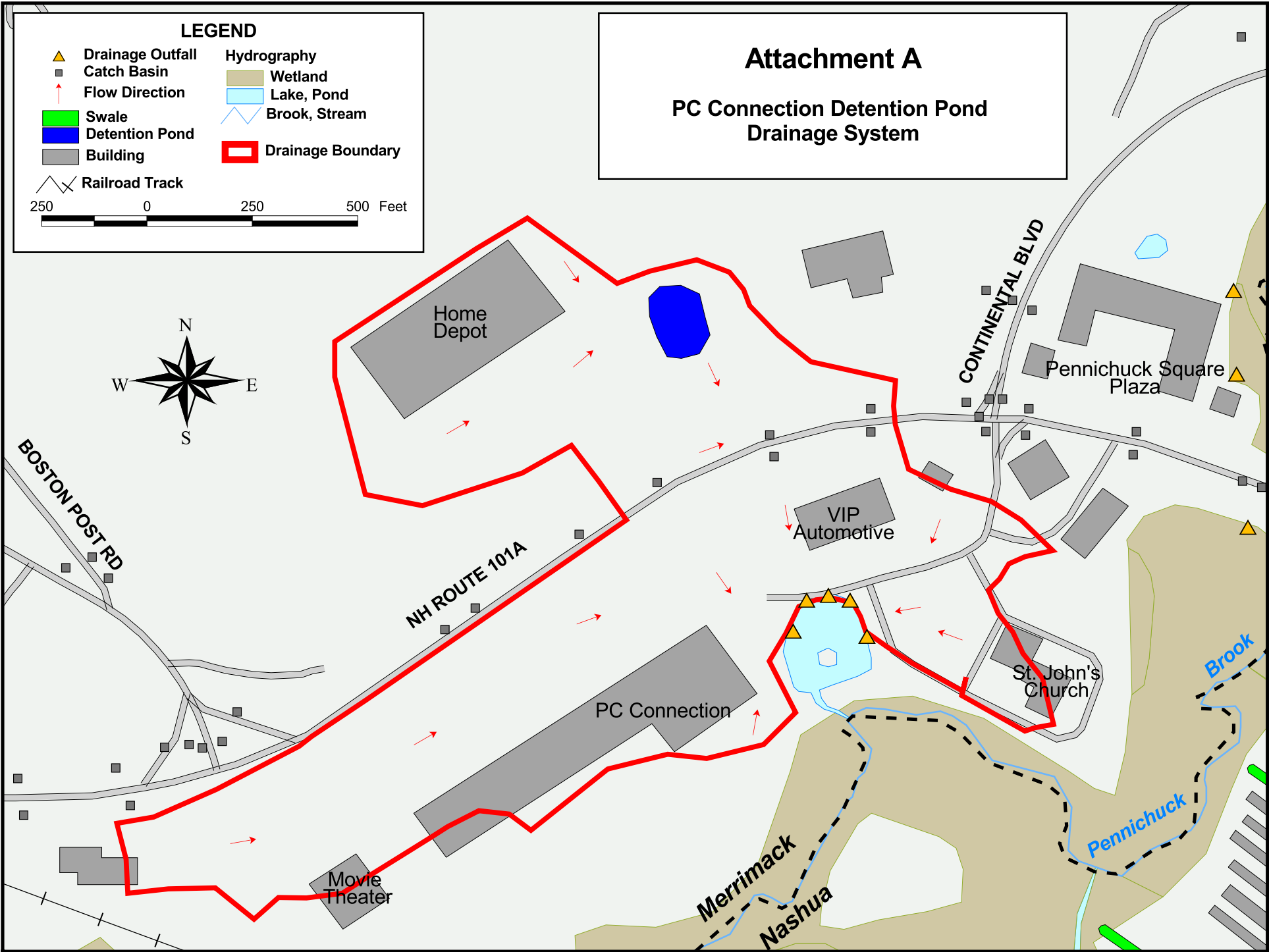
Attachment A

PC Connection Detention Pond Drainage System

LEGEND

 Drainage Outfall	Hydrography
 Catch Basin	 Wetland
 Flow Direction	 Lake, Pond
 Swale	 Brook, Stream
 Detention Pond	 Drainage Boundary
 Building	
 Railroad Track	

250 0 250 500 Feet



Attachment B – Photos



View of Detention Pond with the PC Connection Building in Background



View of Detention Pond Facing South Toward Pennichuck Brook

Attachment B – Photos



Close-up View of Detention Pond Outlet Flowing into Pennichuck Brook



View of Three Partially Submerged Discharge Outlet Pipes (Outlets hidden behind vegetation) Flowing into the Detention Pond

Project Narrative

Pennichuck Square Plaza Stormwater Treatment

Introduction

Pennichuck Watershed is a 17,984 acre watershed serving recreational and water supply needs for five towns in southern New Hampshire. Located in a rapidly developing area of New Hampshire, Pennichuck Watershed has been seriously impacted by development over the last 20 years. Some portions of the watershed are intensely developed with high levels of imperviousness. Other more upper watershed portions are mostly undeveloped and contain some pristine trout stream segments with undisturbed habitat.

Water quality impacts in this area are well known. Sediment washing or eroding into the ponds and reduced base flow due to imperviousness have reduced the capacity of the Pennichuck Brook water supply system by an estimated 70% over the years.

There are many ongoing and completed watershed protection efforts in the Pennichuck Watershed. The basis for this proposal is from an ongoing subwatershed study that is being funded by a 2003 Source Water Protection Grant. In this study, many areas of concern have been discovered in the Pennichuck Brook to Holts Pond Subwatershed. This study focuses on addressing one of the major concerns discovered.

The Purpose of this Project

The goal of this project is to prevent non-point source pollutants from entering Pennichuck Brook (the source of drinking water to the greater Nashua region) from the parking area of the Pennichuck Square Plaza, and provide a demonstration project for innovative stormwater infiltration techniques that will improve water quality and groundwater recharge wherever used. This will be accomplished by 1) constructing a demonstration infiltration island in the parking lot of the square; 2) redirecting stormwater runoff that is currently discharged directly into the brook into one existing swale (to be enlarged) and to another new treatment swales. The landowner is interested in participating in the project, which will include a public education component as well as news releases and fact sheets on the project. The Town of Merrimack is submitting the project in cooperation with Pennichuck Water Works, who is providing the match for the project.

Project Description

The proposed grant project is designed to improve the water quality of Pennichuck Brook by treating stormwater runoff from the 1.5-acre parking area of the plaza onsite before it reaches the waterway. The first step consists of designing and constructing several low maintenance stormwater controls and a developing/implementing a public education component. Please refer to the map and photos in Attachments A and B for visual displays of the study site.

Task 1. Preliminary Design

The first task involves the design of treatment swales/islands on existing grassy areas or within the plaza's parking area with the requirement that no parking spaces be lost. Hooded outlets would also be specified on two of the existing catch basin outlet pipes to trap floating debris and petroleum products. This design will also include plans for redirecting drainage into an existing swale located behind the plaza and removing or capping an existing catch basin that discharge directly into the brook. In order to increase infiltration and reduce erosion of the treatment swales, vegetation and a series of check dams will be incorporated into the design. In addition, public education will be aimed at describing the need to treat stormwater and demonstrating how it can be done with an attractive and easily maintained system.

Task 2. Coordination Meetings

Meetings will be held to coordinate between the Town of Merrimack, Pennichuck Water Works, the landowner, NH DES and the consultant. Tenants could also be invited if desired by the landowner. The preliminary design will be presented for comment and modifications will be made to address concerns if needed. However, the project will not have significant impacts on the site other than to provide a more environmentally sound stormwater handling method in this site that sits so close to a major water supply. There will be some minor disruption during the construction phase, but this will be limited as much as possible and press releases will emphasize the positive environmental nature of the project.

Task 3. Construction

The second phase of this project consists of implementing the approved design created in the second phase. The stormwater treatment system constructed at the Pennichuck Square Plaza site would be used as a demonstration project for people to see and for Merrimack and Pennichuck to use in referring developer's to an operating and innovative BMP.

Consistency with Source Water Protection Program

The study is directly related to source water protection because it addresses non-point source pollutants that are potentially degrading the water quality of Pennichuck Brook, the drinking water supply for the greater Nashua area.

Local Support

Pennichuck Square LTD, the owner of the plaza, is fully supportive of this proposal with the understanding that they are not committed to any finding or specific work. However due to the timing of preparing this proposal Pennichuck Square LTD was not able to provide a support letter in time before the application deadline. A letter will be forthcoming from the landowner and sent to DES's attention when available.

Schedule and Costs

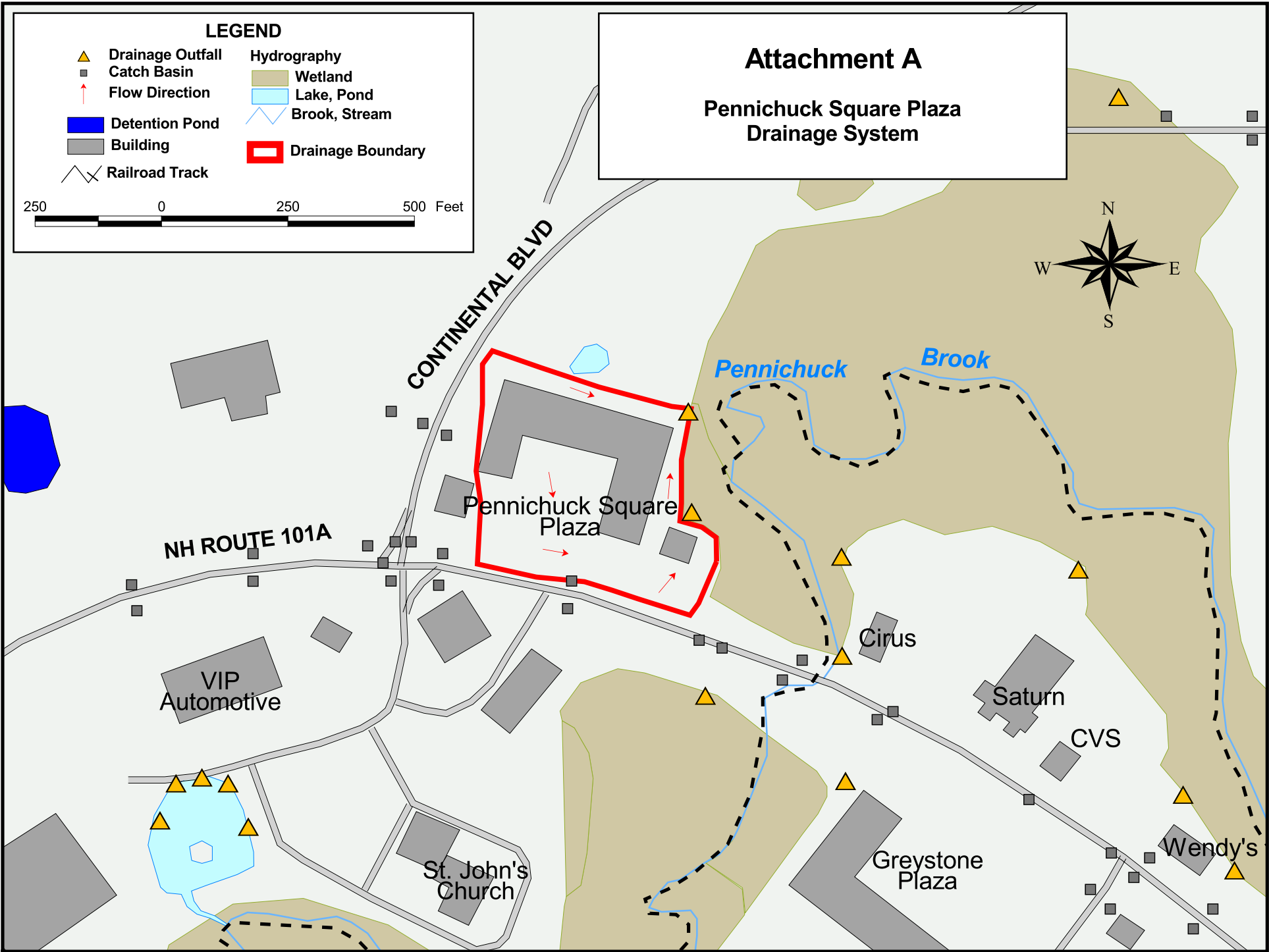
This project would begin in May/June 2004 and is expected to require 12 months to complete. The project is estimated to cost \$42,400 to complete.

Attachment A
**Pennichuck Square Plaza
Drainage System**

LEGEND

 Drainage Outfall	Hydrography
 Catch Basin	 Wetland
 Flow Direction	 Lake, Pond
 Detention Pond	 Brook, Stream
 Building	 Drainage Boundary
 Railroad Track	

250 0 250 500 Feet



Attachment B – Photos

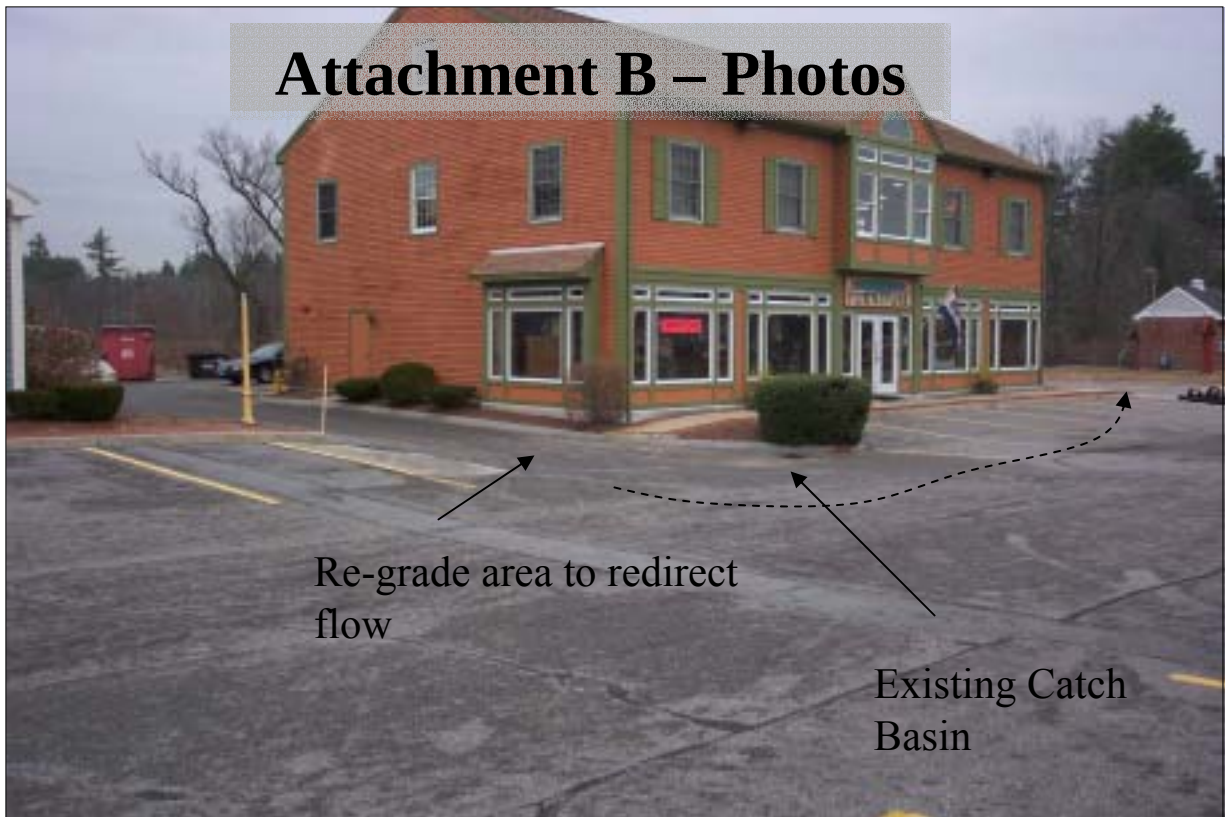


View of Pennichuck Square Main Parking Area – Proposed Infiltration Dividers and Rain Garden Can be Constructed Without the Loss of Parking Isles



View of Pennichuck Square Parking Area in Front of Furniture Building

Attachment B – Photos



Close-up View of Parking Area in Front of Furniture Store



View of Parking Area Next to Furniture Building

Attachment B – Photos

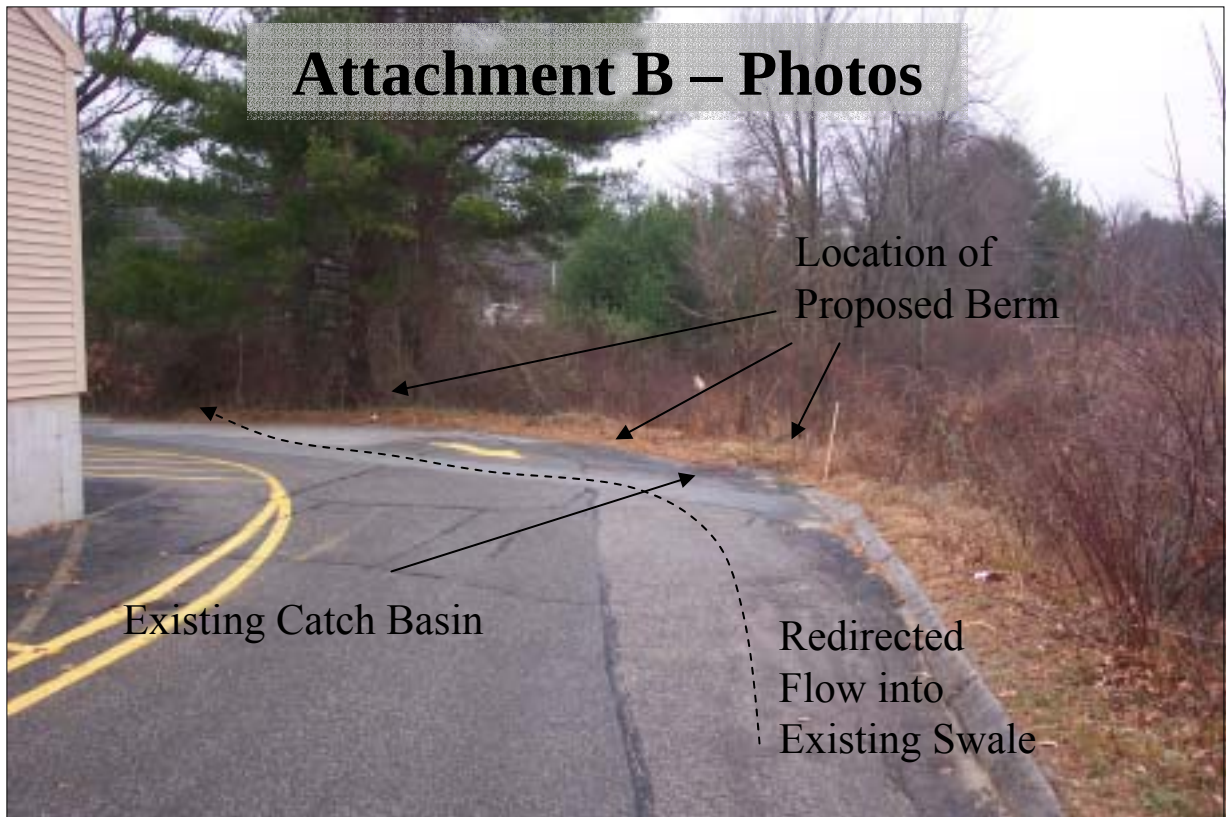


Close-up View of Paved Drainage Swale and Catch Basin Located Behind the Plaza



View of Access Road Behind Plaza – Catch Basin in Foreground

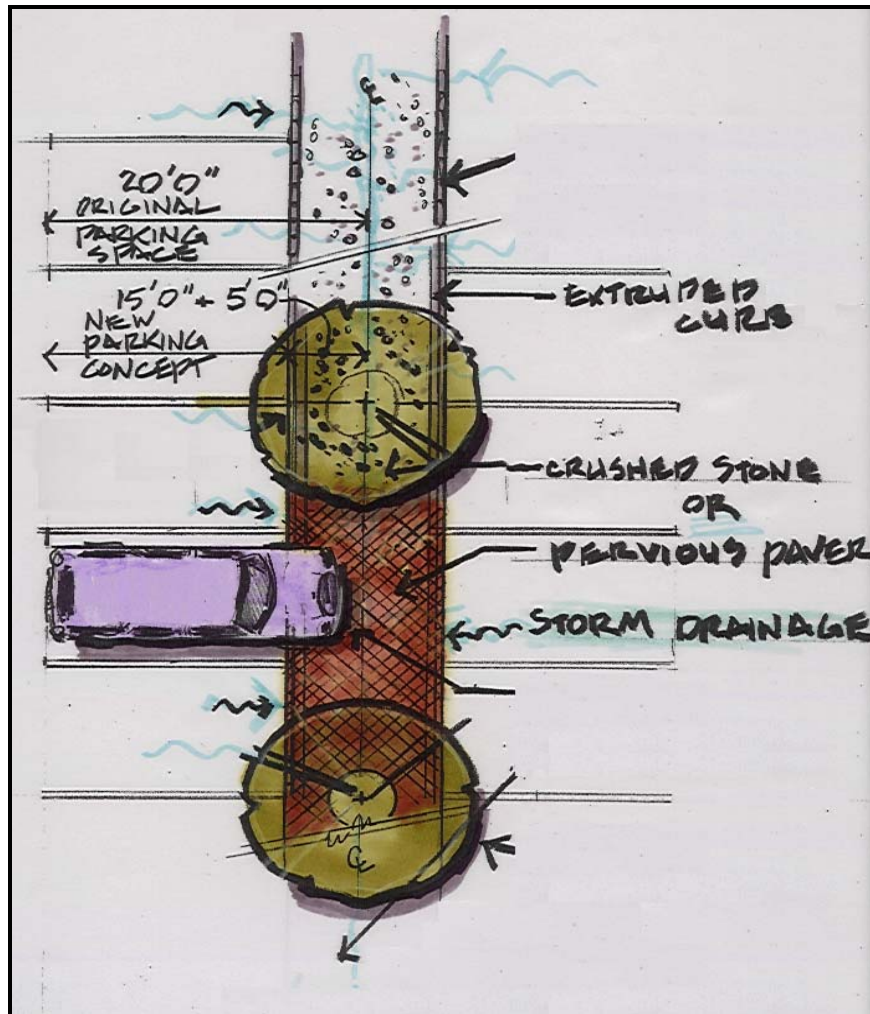
Attachment B – Photos



View of Access Road Behind Plaza – Plaza Building is on the left and the brook is on the right



View of Access Road Behind Plaza



Infiltration Divider

Description

A stone filled depressed infiltration strip accepting sheet flow from adjacent paving. Typically 3-4 feet deep and of variable width and length. Surfacing options include pavers, or $\frac{3}{4}$ inch stone (plain or ornamental). Trees and a strip of grooved pavement are recommended for delineation of the divider and in place of curbing.

Application

This is an infiltration device used to collect runoff from the parking space and travel aisle. It occupies the space usually reserved for vehicular overhang (front wheel to bumper) and is an efficient use of this normally paved and unutilized area. As the name divider implies, it is used to separate two rows of face-in parking and serves to break up the expanse of pavement with moderate sized trees.

Advantages

By using the overhang space in a parking lot the device does not compromise the number of parking spaces attainable at the site. The island can serve the same traffic routing function as raised parking islands. Impacts from foot traffic through the infiltration divider are minimal.

Cost is mainly affected by surface treatment. The plain stone surface treatment is not as costly and performs as well as the more expensive pavers which can be used by those who wish to add more distinction and aesthetic appeal to their parking lot.

Disadvantages

Planting choices may be limited by drought tolerance and width of island (shrubs may be too wide at the car bumper level and become deformed/injured).

The low organic content within the island unit may not provide optimal treatment of organic pollutants if it is located in rapidly draining sandy soils. Some augmentation with coarse peat at the bottom of the stone reservoir (6" thick) area may be warranted in these cases.

Design Considerations

Designs are optimized at 8-10 feet in width which is the normal distance between front axles of vehicles parked nose to nose. The divider handles runoff from the centerline of a typical 20 foot wide travel aisle and the 15 foot parking space. This width also protects trees and cars from butting up to each other. When used as a true divider to separate two rows of parking, widths should not be less than 6 feet.

Depths can vary, but the floor of the structure should be at least two feet from the seasonal high water table. Depths from the inlet surface elevation to the floor of the structure of 2 feet or less are only appropriate if infiltrating the first ½-inch of runoff.

A deeper surface depression can maximize the volume retained within the structure as no stone occupies this space and all of it can be used for retention. Curbing or wheel stops could be used in this application to prevent cars from entering the depression. In some cases, curbing would prevent an even distribution of water to the surface of the structure and the gaps between wheel stops may become blocked and glazed over from snow plowing operations. Alternately, grooves should be cut in the pavement 6" from the edge, around the perimeter of the structure. The grooves will provide a reasonable assurance that cars will come to a stop as they pull forward in the parking space and will provide no restriction for water entering the structure.

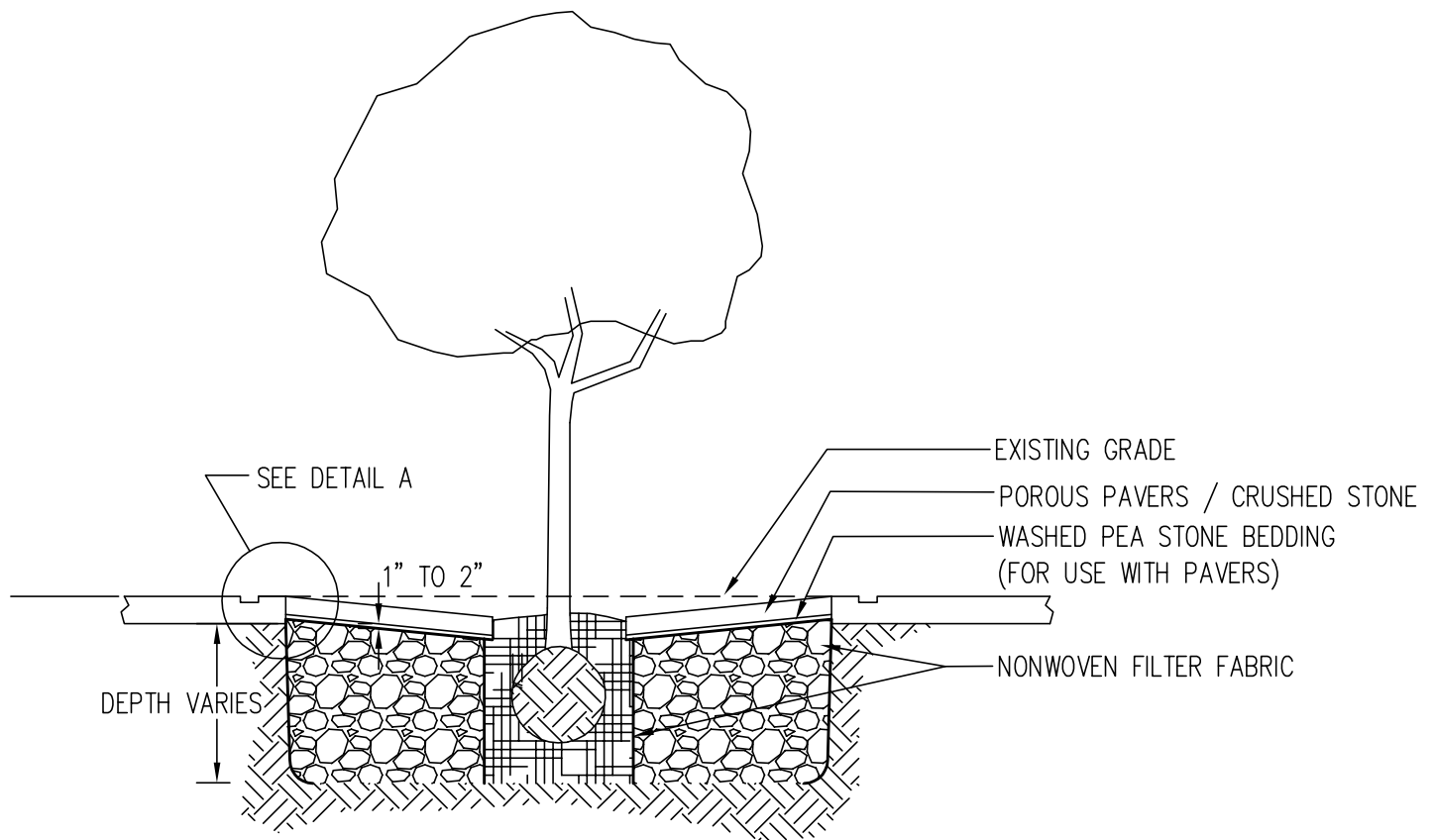
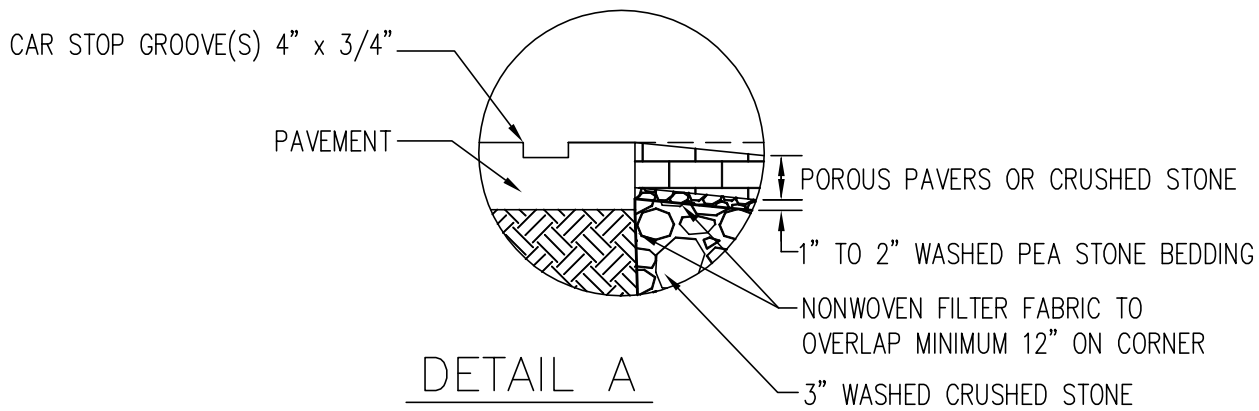
Surface treatment materials must be highly porous and durable. They can range from ¾ inch stone (ornamental or plain) to pervious pavers. Cost will play a large part in the choice of surface materials since pavers are more expensive than stone.

Treatment of stormwater in this device is accomplished by the stormwater passing first through the filter fabric and then through the native soil surrounding the main chamber. The main distinction of the Infiltration Divider is its ability to rapidly accept stormwater below grade. Organic material and the associated decomposition matter can hinder the ability of the surface to accept runoff.

Shade trees are recommended, to assist in delineating the Infiltration Divider from the traveled portions of the parking lot. This RPM offers a balance between rapid infiltration and aesthetic and traffic control objectives.

Maintenance

The frequency of surface rehabilitation can vary from 1-5+ years based on sand application rates and sweeping of the parking lot). Rehabilitation involves use of a vacuum truck or manual labor to remove the top 6 inches of material and replacement of the filter fabric pre-filter zone. Although stone may be screened from the accumulated sand and sediment and reused, it may be more practical and cost effective to send the removed material to a gravel facility for reprocessing and replace it with a new 6 inch stone layer after each cleaning



Note: Not to Scale, For Conceptual Design Purposes Only

Infiltration Divider



**COMPREHENSIVE
ENVIRONMENTAL
INCORPORATED**

21 DEPOT STREET
MERRIMACK, NH 03054
64 DILLA STREET
MILFORD, MA 01757

Project Narrative

Celina Avenue Stormwater Treatment

Introduction

Pennichuck Watershed is a 17,984 acre watershed serving recreational and water supply needs for five towns in southern New Hampshire. Located in a rapidly developing area of New Hampshire, Pennichuck Watershed has been seriously impacted by development over the last 20 years. Some portions of the watershed are intensely developed with high levels of imperviousness. Other more upper watershed portions are mostly undeveloped and contain some pristine trout stream segments with undisturbed habitat.

Water quality impacts in this area are well known. Sediment washing or eroding into the ponds and reduced baseflow due to imperviousness have reduced the capacity of the Pennichuck Brook water supply system by an estimated 70% over the years.

There are many ongoing and completed watershed protection efforts in the Pennichuck Watershed. The basis for this proposal is from an ongoing subwatershed study that is being funded by a 2003 Source Water Protection Grant. In this study, many areas of concern have been discovered in the Pennichuck Brook to Holts Pond Subwatershed. This study focuses on addressing one of the major concerns discovered.

The Purpose of this Project

The goal of this project is to reduce non-point source pollutants from entering Pennichuck Brook from the stormwater discharge of Celina Avenue. This will be accomplished by installing a series of gabion check dams along the entire length of the existing drainage channel to reduce scouring from high velocity flows, improve infiltration rates, and trap sediment. Additionally the project will be used for demonstration purposes for people and developers to see how a relatively inexpensive BMP can effectively treat stormwater runoff.

Project Site Description

Stormwater runoff from Celina Avenue and adjacent businesses (loading dock areas behind the Westside Plaza and Deerpoint office land parcels) is collected in a series of catch basins and discharged from a 48" outfall pipe into a 300-foot long drainage channel located a few hundred feet from Pennichuck Brook. This 19-acre drainage area consists of impervious surfaces including, delivery areas, small parking areas, and throughways that limit on-site treatment options. Please refer to the map and photos in Attachments A and B for visual displays of the study site.

To address the high velocity stormwater flows entering the drainage channel from the impervious drainage site, a series of gabion check dams would be installed. The following tasks would be performed to complete this project.

Task 1. Data Collection

Existing information for this location will be collected to assist in the design and installation of the gabion check dams that includes survey work, existing drainage maps, and drainage calculations.

Task 2. Design

A design will be created indicating the installment locations of the gabion check dams and the installation method based on the collected data in Task 1. The design will include the preparation of plans, technical specifications, and a scheduled timeline for completion. In addition, meetings with the City of Nashua will be held to review the design plans.

Task 3. Project Implementation

The approved design plan will be implemented and the check dams installed. Construction services will be provided including on-site engineering review services during the construction period.

Task 4. Operation and Maintenance Plan

An operation and maintenance plan (O&M) will be prepared for cleaning and maintaining the check dams. The plan will outline the frequency of cleaning and the method to be used.

Consistency with Source Water Protection Program

The study is directly related to source water protection because it addresses non-point source pollutants that are potentially degrading the water quality of Pennichuck Brook, the drinking water supply for the greater Nashua area.

Local Support

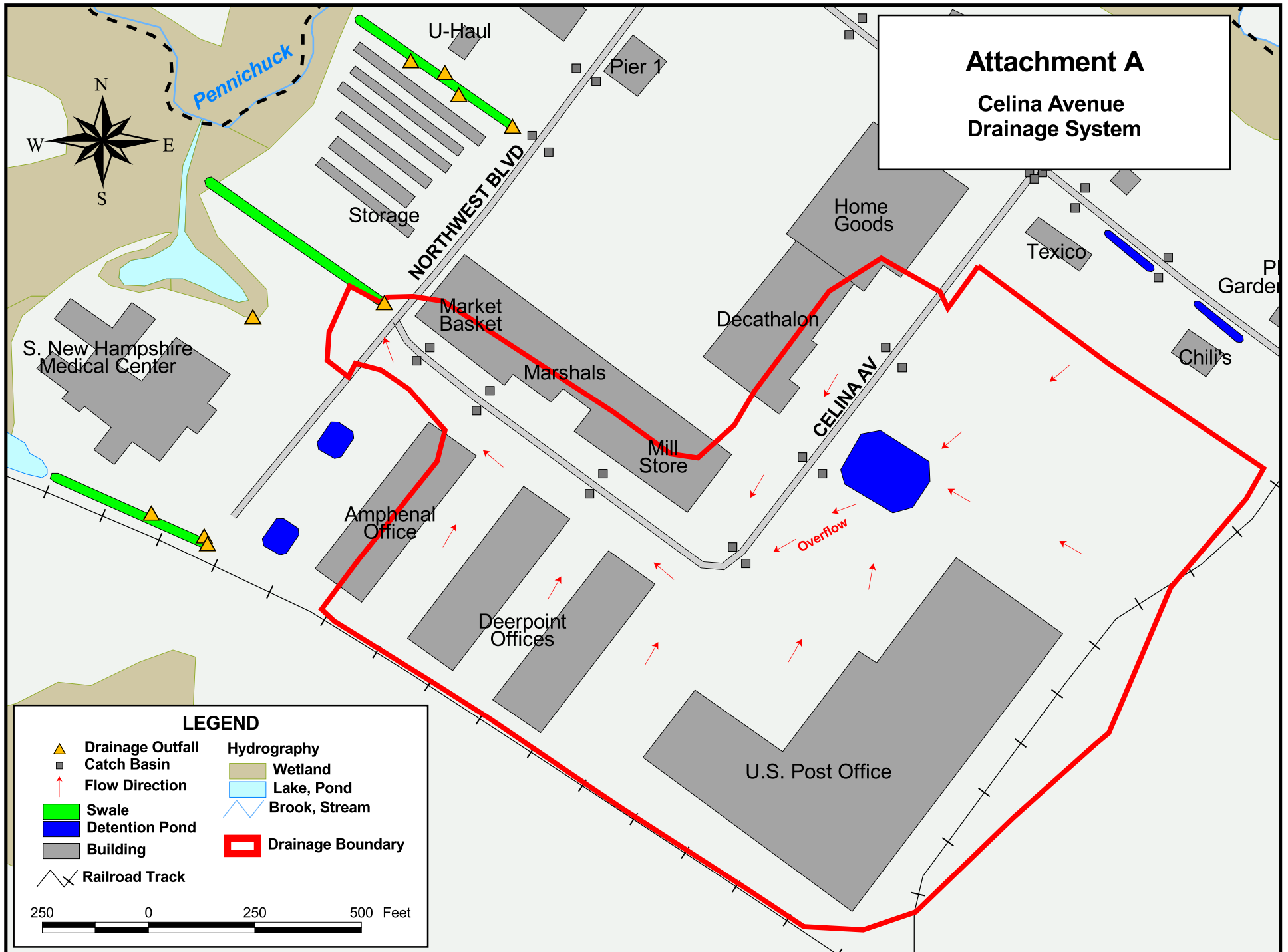
The City of Nashua, drainage easement owner, fully supports this project with the understanding that they are not committed to any funding or specific work. However due to the timing of preparing this proposal, the City of Nashua was not able to provide a support letter in time before the application deadline. A letter will be forthcoming from the City and sent to DES's attention when available.

Schedule and Costs

This study will begin in May/June 2004 and is expected to require 6 months to complete. The project is estimated to cost \$13,500.

Attachment A

Celina Avenue Drainage System



LEGEND

- | | |
|--------------------|--------------------|
| ▲ Drainage Outfall | Hydrography |
| ■ Catch Basin | Wetland |
| ↑ Flow Direction | Lake, Pond |
| — Swale | Brook, Stream |
| ■ Detention Pond | |
| ■ Building | Drainage Boundary |
| ⋈ Railroad Track | |
- 250 0 250 500 Feet

Attachment B – Photos



View of Discharge Outlet into Ditch from Celina Avenue



View of Drainage Outlet – High velocity flows has caused scouring of ditch

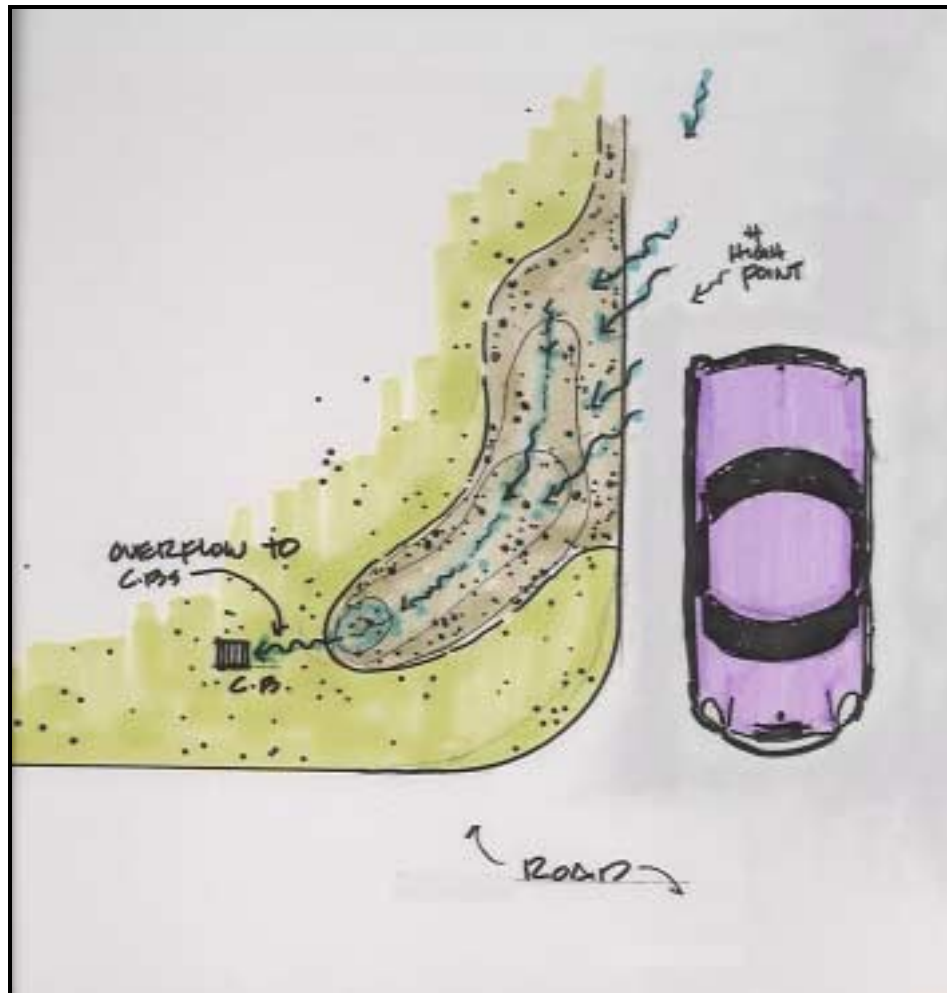
Attachment B – Photos



View of Drainage Ditch Swollen With Spring Melt



View of the End of the Drainage Ditch– Note major bank erosion on right



Containment Swale

Description

A shallow depression located adjacent to a roadways shoulder that is used to capture and infiltrate roadway runoff and/or lawn runoff before it enters a catchbasin. Although similar to a typical swale, this RPM is designed to pond and infiltrate water to the maximum extent possible, rather than as a means of conveyance. Excess water overflows into a nearby catch basin.

Application

There are two applications for this design. The first would be to collect roadway runoff from a street without an existing curb and gutter system. The RPM is constructed along the edge of the street allowing runoff to enter into it before discharging to a downgradient catch basin. The second application is to collect runoff from lawn areas that would

normally flow into the roadway. The RPM could be installed between the lawn area and roadway. When the unit fills with water, it would overflow back into the street drainage system (as if the RPM had not been there).

Advantages

Roadside Stormwater Diverters are relatively inexpensive given the large amount of water that can be captured, treated, and recharged.

Disadvantages

Some road agents may be resistant to infiltrating water adjacent to a road's subgrade for fear of frost damage.

Design Considerations

Shoulder slopes should be maintained particularly in areas where the roadway is narrow and around corners.

Using an impervious barrier to shield a road's subgrade may be necessary to ameliorate concerns of frost heaves damaging pavement.

Maintenance

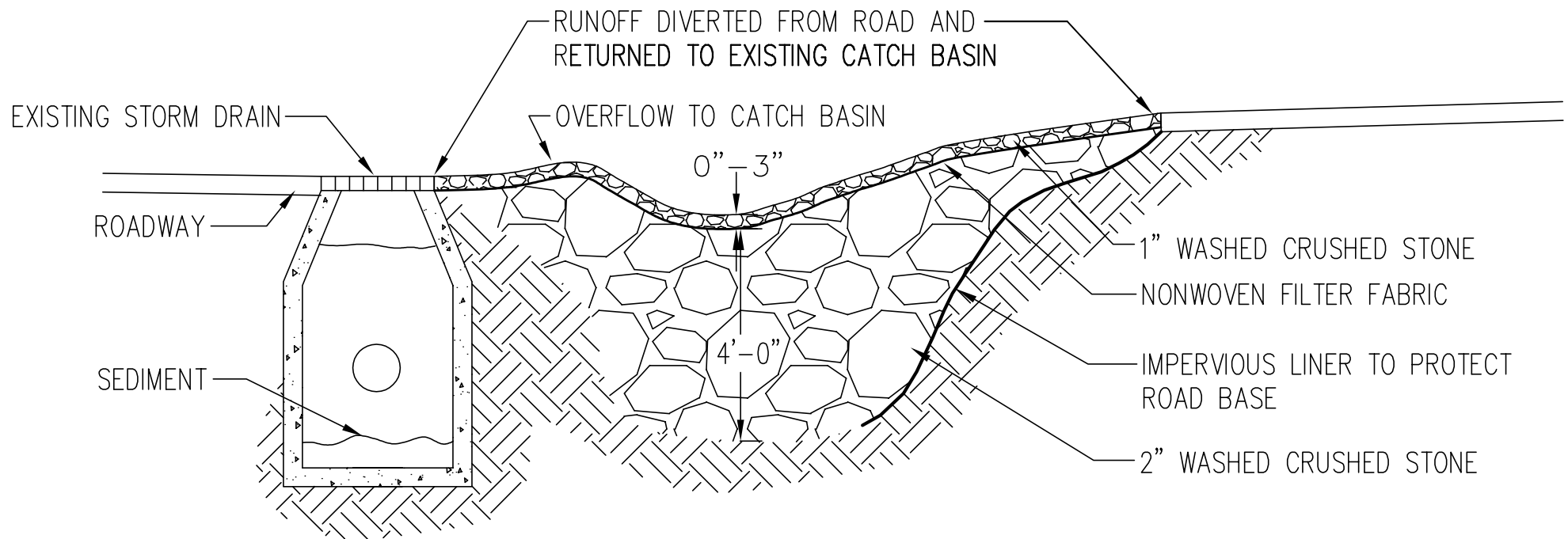
Sediment and accumulated debris should be removed in the Spring and late Fall after the leaves have dropped.

If stormwater ponds on the surface of the structure for longer than 48 hours after the end of a storm³, the filter fabric pre-filter may be clogged. In this case, the filter fabric and material covering the upper most layer of filter fabric should be removed. Owners may then either replace both the filter fabric and the cover material or, alternatively, clean the clogging material from them. This material should not need to be disposed of at a landfill, however it should not be placed on an area that will be subject to runoff which might resuspend it.

The frequency of this rehabilitation will depend on the ratio of filter fabric surface to contributing drainage area, the amount of sand applied to the impervious drainage area, and the frequency with which preventative maintenance has been performed.

The Diverter should be inspected occasionally to make sure erosion is not occurring on any of its surfaces.

³ This is a storm of normal duration during the growing season and would not include prolonged periods of rainfall, or spring thaw conditions for example.



Note: Not to Scale, For Conceptual Design Purposes Only

Containment Swale



**COMPREHENSIVE
ENVIRONMENTAL
INCORPORATED**

21 DEPOT STREET
MERRIMACK, NH 03054
64 DILLA STREET
MILFORD, MA 01757

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