Berry Brook Watershed Management Plan –Implementation Projects Phase I

Final Report to
The New Hampshire Department of Environmental Services
Submitted by

The City of Dover and the UNH Stormwater Center

Funding for this project was provided in part by a Watershed Assistance Grant from the NH Department of Environmental Services with Clean Water Act Section 319 funds from the

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EXECUTIVE SUMMARY

Berry Brook, a tributary to the Cocheco River, is a 0.9 mile long stream in a 185 acre watershed in downtown Dover that is nearly completely built-out with 30.1% impervious cover (IC). The brook is listed as impaired for aquatic habitat and primary contact recreation. Phase I of the Berry Brook Watershed Plan implementation included several key projects identified in the Berry Brook Watershed Management Plan (WMP)[1]. Key recommendations of the WMP were to implement stormwater Best Management Practices (BMPs) to: 1) reduce bacteria and nutrients, 2) improve natural resources within the watershed, and 3) to educate property owners within the watershed about low impact development (LID) methods for treatment of stormwater runoff.

This project is the first phase of WMP implementation projects. As part of this phase, five stormwater BMP installations were implemented. These included two bioretention systems/raingardens and a tree filter at the Horne Street School; one bioretention at the corner of Snow Avenue and Horne Street; and one bioretention system at the residence of 15A Hillcrest Avenue. Combined these installations provide treatment for approximately 1.17 acres of impervious area and reduced pollutant loading of suspended sediment, phosphorous and nitrogen (total) by 327, 1.11 and 9.75 pounds per year respectively[2] and decreasing impervious cover to about 29.5%. In addition, community outreach was initiated including watershed and stormwater education activities at the Horne Street School; a Community Meeting; homeowner workshops and stormwater audits; a residential rain garden installation; and a watershed clean-up.

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[1] Berry Brook Watershed Management Plan, Dover NH, September 2, 2008, prepared by The Louis Berger Group Inc.

[2] These reductions are based on that the Simple Method which does not account for volume or flow reductions and therefore may underestimate the pollutant load reductions achieved by each BMP.

INTRODUCTION

Berry Brook, a tributary to the Cocheco River, is a 0.9 mile long stream in a 186 acre watershed in downtown Dover that is nearly completely built-out at with 30.1% impervious cover (IC). The brook is listed as impaired for aquatic habitat and primary contact recreation. This project is the first phase of a series of grants[3] and began the implementation of stormwater management retrofit treatment practices in the Berry Brook watershed, one of the major recommendations of the Berry Brook Watershed Management Plan (WMP) (2008). In addition, community outreach and education activities were initiated as part of this grant and will evolve and continue as part of the larger Berry Brook Restoration Project.

The City of Dover was assisted in this Grant by the University of New Hampshire Stormwater Center (UNHSC) and the Cocheco River Watershed Coalition (CRWC). The UNHSC provided recommendations on low impact development (LID), provided survey work, retrofit designs and engineering oversight of the stormwater treatment systems. The CRWC coordinated outreach activities including community meetings and watershed cleanups. The City of Dover generously provided matching funds for this work in the form of time, equipment and materials in the construction of BMPs from the Department of Public Works (DPW). All treatment practices were designed by the UNHSC and installed by the DPW, with engineering oversight provided by UNHSC.

The design of BMPs for this project utilized the concept of LID, an innovative approach to stormwater management that is based upon the principle of managing rainfall at the source. The goal of LID is to mimic the predevelopment hydrology of a site using a combination of site planning and structural design strategies to control runoff rate and volumes. LID is widely recognized as a highly effective strategy for the protection of water quality and watershed health.

Historically, our wetlands, rivers, lakes, and estuaries have provided the work of cleaning and protecting our water resources, referred to as ecosystem services. Intense development can

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[3] A second phase of implementation projects is currently underway as part of a 2011 Watershed Assistance Grant and other wetland and stream restoration activities are being completed as part of an Aquatic Resources Mitigation Grant.

significantly impair water quality and change how surface and groundwater interact. With increases in impervious surfaces, the landscape's ability to absorb rainwater runoff decreases thus reducing the amount of groundwater recharge.

Where human impacts have occurred, LID can restore, to a degree, nature's approach to stormwater runoff management by dealing with rainfall as close to the source as possible using decentralized controls. A site's predevelopment hydrology is reestablished by using design techniques based on the premise that water is a resource that should be preserved and maintained on site as much as possible. Instead of centralizing runoff from impervious surfaces into traditional pipe and pond management controls located at the bottom of drainage areas, LID addresses stormwater through smaller, cost-effective landscape features. These features include vegetated swales, tree filters and bioretention systems (i.e. "raingardens").

PROJECT PERFORMANCE: OBJECTIVES AND DELIVERABLES

The objectives and deliverables of this final report are outlined below.

Objective 1: Installation of Stormwater Treatment Practices at Horne Street School & Calculate Pollutant Load Reductions

Photograph 1: Tree Filter Installed on South Side of Horne Street School

Summary of Objective 1 Activities

Stormwater treatment practices were installed at the Horne Street School to infiltrate and treat stormwater run-off from the building rooftop and parking areas. A figure depicting the location of the BMPs and their associated drainage areas is provided as Figure 1.

Deliverable 1A: Design and Installation Oversight of Tree Filters.

A tree filter was designed to treat the drainage from an approximate 0.33 acre parking area to the south of the school. The tree filter was constructed as a closed open bottom system

with a stone reservoir and underdrain, a high flow bypass and an engineered soil mix with a two-inch-caliper Ash tree. Details of the installation are provided in the photo documentation and design drawing in Appendix A-1.

Deliverable 1B: Design and Construction of Bioretention System

Two bioretention systems were designed and installed in the front of Horne Street School. Bioretention systems, also known as "raingardens," are common LID stormwater BMPs. In general, stormwater runoff flows into landscaped depressions, where it ponds, filters through an engineered soil mix, and infiltrates into the ground, and may be connected to storm drains or surface discharge. An engineered soil mix and the planting/inclusion of native vegetation mimic the water quality treatment and natural flow patterns of undeveloped areas.

Photograph 2 (Left): Bioretention I Installed Near the Main Entrance of Horne Street School.

Photograph 3 (Below): Bioretention II Installed Near Southeast Corner of Horne Street School.

BioBioretention I was installed to the north of the main entrance of the school. This bioretention was designed to treat the run-off from approximately 3,200 square feet (0.07 acres) of rooftop run-off. Internal drain piping of the school's rooftop prevented additional rooftop drainage from being diverted to the Bioretention system. The placement of this bioretention system in front of this main entrance of the school provides for high visibility and creates additional outreach and education opportunities due to high community foot

traffic. Details of the installation are provided in the photo documentation and design drawing in Appendix A-2.

Photograph 4: Erosion Observed in Front of Horne Street School.

The second system, Bioretention II, was completed on the southeast corner of the building, in another highly visible location where poor drainage created numerous problems. The system treats and manages run-off from the roof, and prevents "back splash" from the roof run-off onto the main building and prevents erosion problems. In the winter and during large storm events, run-off from the roof would wash existing mulch and sediment in front of the school which would accumulate on the sidewalk and roadway and eventually run-off to the storm sewer and to Berry Brook. Details of the installation are provided in the photo documentation and design drawing in Appendix A-2.

A third bioretention was completed at the corner of Horne Street and Snow Avenue as part of these activities but will be discussed in more detail in future reports as the project was combined with a BMP installed as part of the larger Berry Brook restoration project to achieve maximum impact. This bioretention evolved from stormwater audits completed as discussed below. This bioretention was completed with an infiltration reservoir and underdrain piping in combination with a downstream vegetated

Photograph 5: Bioretention Installed at Snow Avenue

swale. This system treats approximately 4.16 acres of residential and roadway run-off, of which about 1.56 acres is impervious.

Deliverable 1C: Calculate Pollutant Load Reductions and Impervious Cover Disconnected.

As outlined in the Site Specific Project Plan, UNHSC used the Simple Method to estimate load reduction for this project. The Simple Method is recommended by NHDES for use on Section 319 grant projects. The model was used to estimate pre- and post-BMP implementation pollutant loads. We note that the Simple Method does not account for volume or flow reductions and therefore may underestimate the pollutant load reductions achieved by each BMP. As such, UNHSC will refine the model and may adjust the pollutant load reduction calculation in future phases of the project. Below is a summary of the impervious area (IA) disconnected and the pollutant load reduction for each BMP. A detailed worksheet is included in Appendix C.

TABLE 1: IMPERVIOUS COVER DISCONNECTED AND POLLUTANT LOAD REDUCTIONS

BMP Description	Drainage Area (Acre)	IA %	IA Disconnected (Acre)	IA Disconnected %	Load Reduction lbs/ Year		
					Total Suspended Solids	Total Phosphorus	Total Nitrogen
Horne Street School Bioretention I	0.15	100	0.15	100	49.8	0.18	1.49
Horne Street School Bioretention II	0.11	64	0.07	100	49.1	0.18	1.47
Horne Street School Tree Filter	0.33	100	0.950	100	228.4	0.75	6.79
Project Total**			**1.17**		**327.3**	**1.11**	**9.75**

**Note that an additional bioretention was installed as part of this grant but was part of a larger system installed at Snow Avenue with the on-going Phase II implementation project and will be accounted for in future reporting for that grant.

Objective 2: Develop and Conduct Neighborhood Outreach Programs in the Berry Brook Watershed

The Cocheco River Watershed Coalition (CRWC) led by Loretta B. Chase, developed and implemented neighborhood outreach programs assisted by The City of Dover, NHDES and the UNHSC. These outreach activities included: facilitating two stormwater information workshops for neighborhood residents; coordinating and participating in one neighborhood

meeting regarding the larger Berry Brook Restoration Project; coordinating installation of a project sign and developing a curriculum for the Horne Street School.

Community Meeting

Residents of the Berry Brook watershed were invited to a community meeting to introduce the Restoration activities of the Berry Brook Project. Invitations were mailed to all residents of the Berry Brook Watershed and the meeting was held at the Horne Street School Cafeteria on June 7, 2011 from 6:30 to 8:00 p.m. Approximately forty residents attended the presentation by the project team followed by questions and discussion. The project team prepared poster boards for several aspects of the project. Copies of the posters are provided in Appendix D. Meeting evaluation forms completed by 12 participants all expressed support for the project. Others also expressed interest in volunteering as appropriate. A database of contacts with watershed residents has been created to facilitate their participation in on-going efforts.

At the community meeting the Project Team presented information regarding opportunities to participate in the rain barrel program, to have a residential stormwater audit and to install residential rain gardens. Participants filled out forms and submitted them for review and selection by the project team.

Curriculum Implementation at Horne Street School

Initial outreach activities took place at the Horne Street School in the Berry Brook watershed where students, faculty, parents, and community have been "greening the grounds" in conjunction with a grant from the Timberland Company. Much of the school's work was completed during the April 21 Earth Day activities when the Timberland Company volunteers performed major landscaping tasks around the school. Chase attended this event as an opportunity to meet teachers, view the grounds, and plan stormwater activities to build on their success.

In an introductory meeting on April 26, with Malcolm Forsman, Ph.D., Principal of the Horne Street School, Chase and Forsman agreed that student learning activities related to the installation of the bioretention systems at the school could introduce students to the concepts of the water cycle, function of a watershed, and infiltration of stormwater. This included a visit to Berry Brook, and an exploration of the aquatic biota that live in Berry Brook. Chase

and fourth grade teachers, Mrs. Liz Tong, ESOL and Mrs.Teresa Nicolella, in cooperation with the other third and fourth grade teachers, developed a curriculum around these concepts.

The curriculum was delivered on May 25th (third grade) and May 27th (fourth grade). On each day, participants rotated through activities conducted by trained volunteers from the local natural resource education community. Third graders played the "Water Cycle Game", participated in a demonstration of watershed function with the Enviroscape©, and were introduced to stormwater infiltration concepts through a lesson and hands on activity. Fourth graders sorted macro-invertebrates and read *Trout Are Made of Trees*, made fish prints, participated in the stormwater infiltration demonstrations, and walked to Berry Brook. Approximately 150 students participated in the activities.

Rain Barrel and Rain Garden Workshop

On June 21st from 5:00 to 6:00 p.m. at the Horne Street School, UNHSC staff member, James Houle conducted a rain barrel and rain garden workshop at the Horne Street School. The ten all attendees received a free rain barrel and an overview of rain barrel installation and maintenance guidelines. Attendees also toured the newly installed rain garden and tree filter at the school. Fifty rain barrels were available to the residents of the Berry Brook watershed at a reduced cost of $30 per barrel. These rain barrels were available at the Dover Department of Public Works and information is posted on the City and SkyJuice® websites.

Watershed Clean-Up

Berry Brook clean-up days were scheduled from June 22 through 25, 2011. Streamside residents received a letter from the City informing them that people would be working along the stream on or near their property unless the landowner objected. On June 22 a Strafford County Community Service work crew worked with UNH Professor David Burdick to remove invasive species at the Dover Waterworks property on Lowell Avenue, the location of the upper watershed restoration activities.

Photograph 6: Trash Collected in the Vicinity of Sixth Street Station During Clean-Up Activities

On June 25, a crew worked in the rain from the Cocheco River confluence upstream to Roosevelt Avenue. At Sixth Street they piled a truckload of trash and debris, including construction materials and tires from the area downstream of Dover Crossing condos. Upstream of Sixth Street, impeded by the heavy rain and thick stands of invasive multi-flora rose, minimal trash and debris was removed. Trash removed during the clean-up was piled at Ash Street and Roosevelt Avenue for pick up and disposal by the City personnel. A second clean-up will be organized in the fall which will allow for better access to the stream.

Stormwater Audits and Residential Rain Garden Installation

During the community meeting, information was presented about stormwater audits and residential rain garden opportunities for homeowners. Information was also posted on the project website. Watershed residents who expressed interest in these programs were contacted to coordinate a time for a UNHSC member to meet with them and visit their property to discuss stormwater management at their residence. Audits were conducted with four homeowners.

A representative from the UNHSC completed a three page form documenting the stormwater audit[4] which examined potential stormwater pollutants and pathways around the residence. These "risks" included the presence of storm drains, pet, animal and automotive waste. A detailed list and associated description is provided on the audit sheets provided in Appendix

[4] http://www.stlmsd.com/portal/pls/portal/!PORTAL.wwpob_page.show?_docname=342343.PDF

C. Copies of the completed sheets were also provided to the homeowner. Two of the four properties were selected for stormwater management improvements. A third property was identified as benefiting from upstream runoff disconnections associated with the Snow Avenue drainage improvements.

Results from the audits indicate that one of the major issues in the watershed is the general lack of drainage infrastructure. Most homeowners already responsibly dispose of yard and other residential wastes and have landscaping or wooded buffers sufficient to stabilize soils. All stormwater audit participants (except one) purchased and installed rainbarrels. At 15A Hillcrest, roof drains were discovered that directly connected to the municipal sanitary sewer. The connection to the municipal sewer was disconnected and directed to a raingarden. Results of risk factors as identified in the audit process are presented in Table 2.

TABLE 2: RESIDENTIAL STORMWATER AUDIT RESULTS

Risk Factor Description	Risk Level		
	Low	Medium	High
Storm Drains	0%	0%	100%*
Handling of wastes: oil, pet, automotive	100%	0%	0%
Organic Litter/yard waste	100%	0%	0%
Impervious Surface	0%	75%	25%
Roof Drainage	75%	0%	25%**
Soil Stability and landscape coverage	100%	0%	0%

***High risk is due to the general lack of adequate storm drain infrastructure in the watershed.**
****Represents increased threat due to stormwater connections to the municipal sanitary sewer.**

The stormwater audits identified two locations for residential rain gardens. The first location consisted of a step series rain garden installed at 15A Hillcrest Drive. This rain garden treats and infiltrates approximately 0.2 acres of residential roof-top run-off which previously drained to the municipal sewer system.

Photograph 7: Residential Rain Garden Installed at 15A Hillcrest Drive.

The second rain garden located at 55 Horne Street (referred to as the Snow Avenue Bioretention). Based on the site visit, discussions with the homeowner and observations during rain events, the UNHSC concluded that flooding issues at the residential property were largely related to stormwater run-off from Horne Street. The lack of municipal stormwater infrastructure was causing the drainage problems at this residence. A "typical" residential raingarden would not effectively address these associated issues due to the large volume of water draining the roadway. To maximize the effectiveness of this treatment system, the UNHSC worked with the City to upgrade the residential raingarden to a larger full-scale bioretention with underdrain piping in combination with a downstream vegetated swale. Detailed design specifications and pollutant load reductions will be provided in the Berry Brook Phase II reporting.

On-Going Partnership with City Organizations

On May 12, 2011 Dean Peschel and Lorie Chase attended the Dover Open Lands Committee (OLC) meeting to present the Berry Brook Project The Project Team will continue to work with the OLC on common initiatives as the larger watershed restoration project progresses.

Several representatives from The Dover Community Trails Committee also attended community meeting to express interest in creating linkages from Berry Brook to the Cocheco River and the Community trail. Chase attended their meeting on July 5th at City Hall to provide project updates and will continue to attend at their request.

Objective 3: Provide Grant and Project management

The UNHSC worked with the City of Dover to administer all deliverables and tasks, coordinate subaward agreements, report progress in meeting performance targets to NHDES and preparing the final project report to NHDES.

PROJECT OUTCOMES AND MEASURABLE RESULTS

This project resulted in the following watershed improvements:

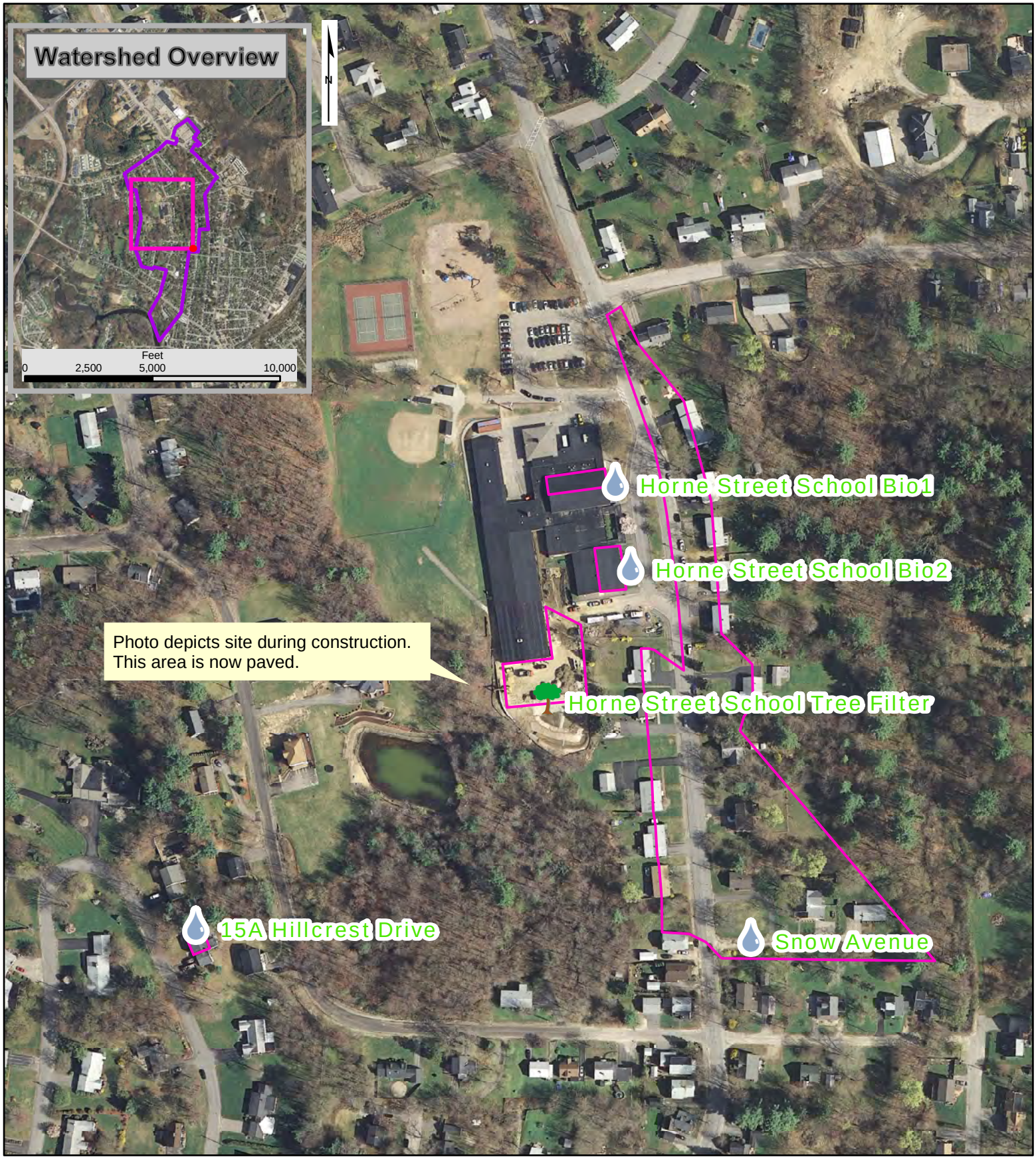
- Reduced Pollutant Loading: Installation of four BMPs which disconnected approximately 0.39 acres of impervious area and reduced pollutant loading of suspended sediment, phosphorous and nitrogen (total) by 327, 1.11 and 9.75 pounds per year respectively.
- Education: Connected students in the 3rd and 4th grades to their local water resource, and involved and educated students in ways they can make a difference in improving their local watershed through classroom and field activities.
- Public Awareness: Residents are aware of the on-going improvements and will be involved in on-going restoration activities.
- Invasive plant species control and debris removal from the watershed.

CONCLUSIONS AND RECOMMENDATIONS

Phase I of the WMP implementation projects has shown that great opportunity exists for LID implementation in the Berry Brook Watershed. Pollutant load estimates indicate removal of suspended solids, phosphorus and nitrogen due to the BMPs installed. In addition, the public participation and awareness generated by these installations will be built upon in future phases of the project. In order to fully achieve success, outreach and education activities should continue to occur with future implementation phases.

Quantitative monitoring of the project's impact on pollutant loading and stream flow will be documented as part of the Phase II implementation. Additional monitoring opportunities will be sought to more fully understand the impacts these implementations will have on the watershed.

FIGURE



Drawn By: M. Bubier/A Scholz
Date: January 2012
Notes:
1. The 2010 1-foot color aerial photograph and the roads was provided by the New Hampshire Department of Transportation and downloaded from the UNH Complex Systems Research Center through NH GRANIT at www.granit.unh.edu.

Feet
0 50 100 200

Figure 1
Horne Street School BMPs and Associated Drainage Areas
Berry Brook Restoration Project
Dover, NH

UNIVERSITY OF NEW HAMPSHIRE
STORMWATER CENTER

Path: Z:\ArcGIS\BerryBrook\Figures\20120118_BBI_Report_Fig.mxd

APPENDICES

APPENDIX A-1
TREE BOX FILTER

UNIVERSITY OF NEW HAMPSHIRE
STORMWATER CENTER

Tree Filter Installation

University of New Hampshire

Stormwater Center

Horne St. Dover, NH

Berry Brook Restoration Project

Tree Filter Installation

- Pipe and structure installed by Dover public works in spring of 2011.
- June 13th 2011– Pea stone, 3" caliper Ash tree, dome grate, and soil mix installed.
- Soil mixture:
  - 80% Sand
  - 15% Compost
  - 5% Water treatment residual

Existing Condition

4/13/11

Tree and Mix installed

7/13/11

Soil mix brought to design elevation and Stone splash pad installed .

7/13/11

Tree installed with root ball centered in the structure. The over flow is connected to an existing drain pipe that was draining the parking lot.

Finished Product

6/23/11

7/3/11

Tree Filter Punch List

Project Name: Horne St. School
78 Horne St, Dover, NH, 03820

Date: 5/16/2011

Item ID	Description	Notes	Scheduled to complete	Date Completed	Responsible Party(s)	Reviewed By
1.0	Remove geotextile from filter box bed					
2.0	Add approx 1 C.Y of 3/8" Pea Gravel					
3.0	Cut Down HDPE Stand Pipe	Top of dome to be at curb inlet elevation				
4.0	Install in-line drain and dome grate	Maintain Total Freeboard of 10"				
5.0	Add approx 3 C.Y of BSM in 8-12" hand compacted lifts	Ponding depth max 6"(distance between bottom of dome grate and top of BSM)				
5.1	Insert Red Maple Tree in conjunction w/ BSM	Tree is to be placed in center of basin				
6.0	Add 2-3" of Crushed Stone at inlet (splash pad)	For erosion control - spread accordinly				
7.0	Replace existing manhole grate w/ blank	Blank cover is on-site				

Tree Filter
Materials List

Project Name: Horne St. School
78 Horne St, Dover, NH, 03820

Date: 5/16/2011

Item ID	Description	Unit	Quantity	Unit Price	Cost	Order Date	Date Completed	Supplier	Notes
1.0	BSM MIX: 80% Sand/15% Compost/5% WTR	C.Y	3.0						
1.1	Sand	C.Y	2.0	$20.50	$41.00			LandCare	Delivery not incl.
1.2	Compost	C.Y	1.0	$34.00	$34.00			LandCare	Delivery not incl.
1.3	WTR	5-gal bucket	5.0	NA	NA			Durham WTF	
2.0	3/8" Pea Gravel	C.Y	1	$44.00	$44.00			LandCare	Price quote is for 1/2" PG
3.0	2-3" dia Crushed Stone for Splash Pad	5-gal bucket	1	NA	NA			NA	
4.0	18" Inline Drain	each	1	$451.00	$451.00			EJP	part# 2718AG12X
4.1	8" Dome Grate	each	1	$112.00	$112.00			EJP	part# 1899CGD
5.0	Red Maple Filter Plant	Each	1	NA				Laurie Chase	

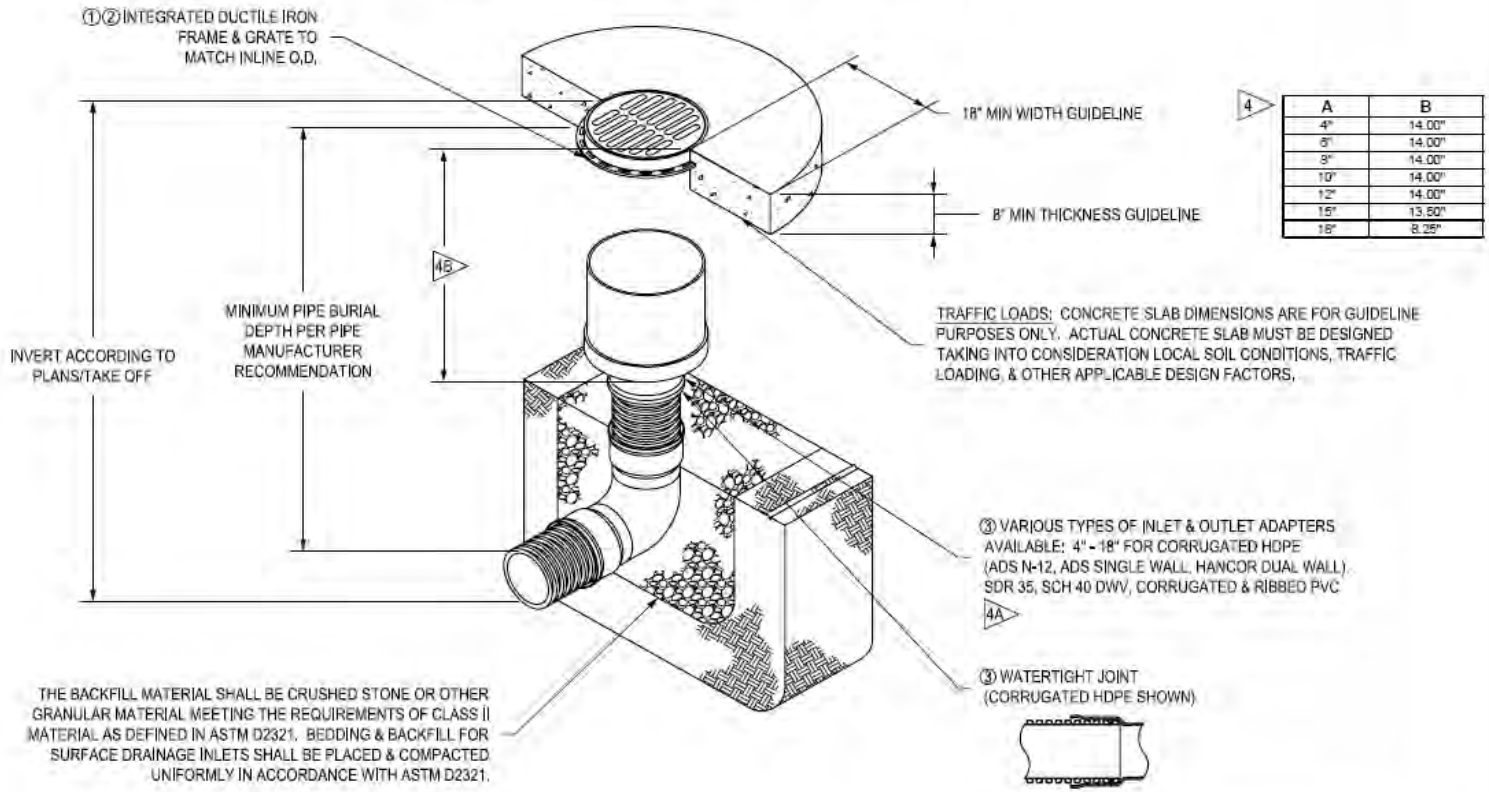
Cost Summary	**$682.00**

18" Inline Drain Detail

Project Name: Horne St. School
78 Horne St, Dover, NH, 03820

Date: 5/16/2011

NYLOPLAST 18" INLINE DRAIN: 2718AG __ X



4

A	B
4"	14.00"
6"	14.00"
8"	14.00"
10"	14.00"
12"	14.00"
15"	13.50"
18"	8.25"

①- GRATES/SOLID COVERS SHALL BE DUCTILE IRON PER ASTM A536 GRADE 70-50-05
②- FRAMES SHALL BE DUCTILE IRON PER ASTM A536 GRADE 70-50-05
③- DRAINAGE CONNECTION STUB JOINT TIGHTNESS SHALL CONFORM TO ASTM D3212 FOR CORRUGATED HDPE (ADS & HANCOR DUAL WALL) & SDR 35 PVC

GRATE OPTIONS	LOAD RATING	PART #	DRAWING #
PEDESTRIAN	MEETS H-10	1899CGP	7001-110-212
STANDARD	MEETS H-20	1899CGS	7001-110-213
SOLID COVER	MEETS H-20	1899CGC	7001-110-214
DOME	N/A	1899CGD	7001-110-215
DROP IN GRATE	LIGHT DUTY	1801DI	7001-110-074

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DRAWN BY EBC	MATERIAL	Nyloplast	3130 VERONA AVE BUFORD, GA 30518 PHN (770) 932-2443 FAX (770) 932-2490 www.nyloplast-us.com
DATE 4-3-06			
APPD BY CJA	PROJECT NO./NAME	TITLE 18 IN INLINE DRAIN QUICK SPEC INSTALLATION DETAIL	
DATE 4-3-06			
DWG SIZE A	SCALE 1:30 SHEET 1 OF 1	DWG NO. 7003-110-027	REV B

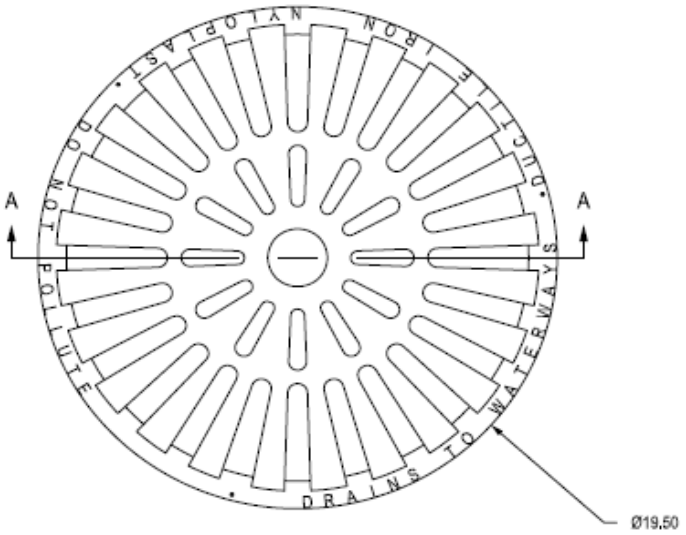
18" Dome Grate Detail

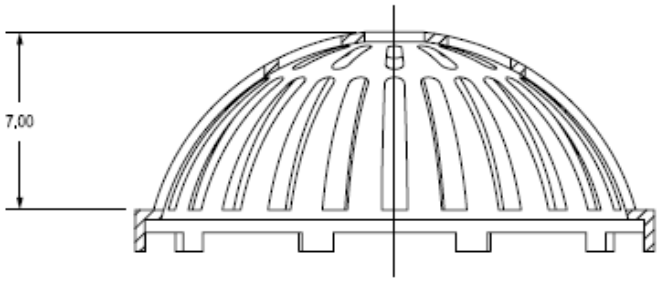
Project Name: Horne St. School
78 Horne St, Dover, NH, 03820

Date: 5/16/2011

1899CGD

APPROX. DRAIN AREA = 175.59 SQ IN
APPROX. WEIGHT = 32.00 LBS





SECTION A-A

DIMENSIONS ARE FOR REFERENCE ONLY
ACTUAL DIMENSIONS MAY VARY
DIMENSIONS ARE IN INCHES
QUALITY: MATERIALS SHALL CONFORM TO ASTM A536 GRADE 70-50-05
PAINT: CASTINGS ARE FURNISHED WITH A BLACK PAINT
LOCKING DEVICE AVAILABLE UPON REQUEST

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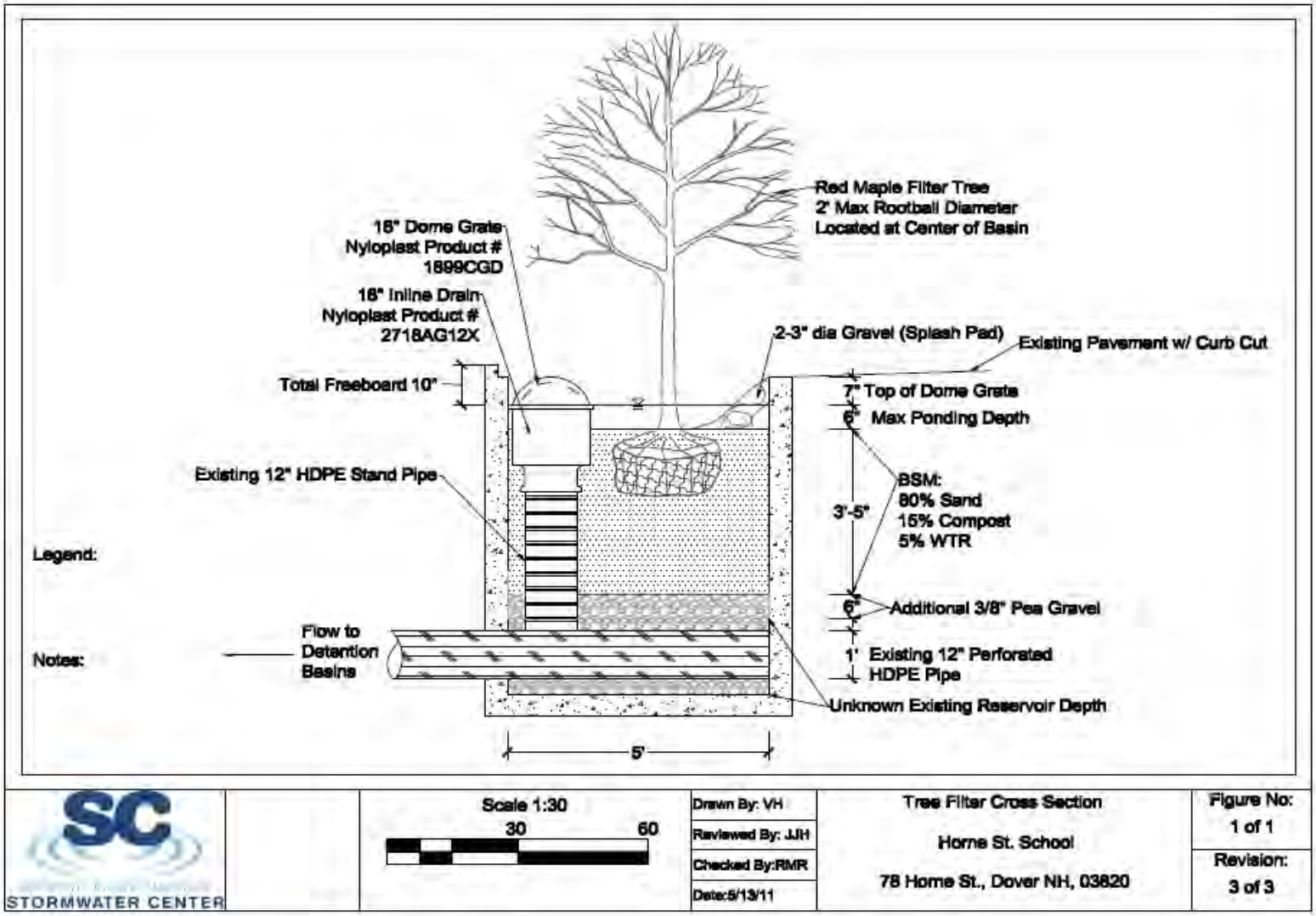
	REVISED BY EBC DATE 3-24-11	PROJECT NO./NAME	TITLE 18 IN DOME GRATE	
	DWG SIZE A	SCALE 1:6 SHEET 1 OF 1	DWG NO. 7001-110-215	REV D

Tree Filter
Cross Sectional Drawing

Project Name: Horne St. School
78 Horne St, Dover, NH, 03820

Date: 5/16/2011



Tree Filter
Material Calculations

Project Name: Horne St. School
78 Horne St, Dover, NH, 03820

Date: 5/16/2011

Input Values

		BSM Mix Breakdown			Additional Material		
Basin Diameter (ft)	BSM Depth (ft)	Sand	Compost	WTR	3/8" Pea Gravel (ft)		
5.0	3.42	0.80	0.15	0.05	0.50		

Output

Material	Units	Total	Rounded Total
BSM Total	C.Y	2.49	3.0
Sand	C.Y	1.99	2.0
Compost	C.Y	0.4	1.0
Pea Gravel	C.Y	0.36	1.0

Required Total Matl	C.Y	2.85	
Actual Total Matl.	C.Y	4.12	
Percentage Over		45	OK

Note: UNHSC

WTR	5-gal Bucket	5.02	5.0

Tree Filter Refererences

Project Name: Horne St. School
78 Horne St, Dover, NH, 03820

Date: 5/16/2011

Name	Company	Title	Contact Info.	Notes
Joe Cherry	BPS	Construction Manager	c. 603-455-2473	Joe has access to school drawings and is familiar with site
Rick Verrier	Nyloplast	Distributor (NH)	c. 603-505-7287	NH Pricing
Drew Lane	Nyloplast	Product sales and support	o. 770-932-2443 ext:245	Drew has been providing detail specs of domes and inline drains
		email	Drew.Lane@ads-pipe.com	
Leo Levin	EJP	Sales (Concord)	o. 603-224-9545	Leo is a contact for pricing and product ordering
		email	leo.lavin@ejprecott.com	
Rob Dowling	UNHSC		c. 603-370-7072	
		email	rje7@unh.edu	
Robert Roseen	UNHSC		o. 603-862-4024	
			c. 603-686-2488	
		email	robert.roseen@unh.edu	
Mindy Bubier	UNHSC	Project Manager	o. 603-862-2818	
			c. 603-502-4607	
		email	mindy.bubier@unh.edu	
Jamie Houle	UNHSC		c. 603-767-7091	Onsite oversight
		email	james.houle@unh.edu	
Viktor Hlas	UNHSC		c. 603-841-0653	Design work
		email	vir3@unh.edu	

Tree Filter Refererences

Project Name: Horne St. School
78 Horne St, Dover, NH, 03820

Date: 5/16/2011

Name	Company	Title	Contact Info.	Notes
Malcom Forsman	Horne St. School	Principal		
		email	m.forsman@dover.k12.nh.us	
Dean Peschel	DPW		o.603-781-5931	
		email	d.peschel@dover.nh.gov	
Lorie Chase	Cocheco Watershed Coalition		o. 603-516-8113	
		email	lorie.chase@unh.edu	
John Crooks	John's Lanscaping		c. 603-817-7788	Landscape work for Bioretention system

APPENDIX A-2
HORNE STREET SCHOOL BIORETENTION I

UNIVERSITY OF NEW HAMPSHIRE
STORMWATER CENTER

Horne St. School Bioretention I

University of New Hampshire

Stormwater Center

Horne St. Dover, NH

Berry Brook Restoration Project

Bioretention Installation

- June 9th 2011 – Excavation.
- June 10th 2011 – Pipe and stone added.
- June 13th 2011 – Bioretention soil mix added.
- Bioretention soil mixture:
  - 50% Sand
  - 20% Compost
  - 20% Woodchips
  - 10% Top soil
- June 15th 2011 – Planting complete, down spout added.

Existing Condition

7/12/11

Bioretention Stone and Pipe Added

6/12/11

View looking north from southern end of raingarden.

6/12/11

View looking southwest from center of walkway.

HDPE liner installed prior to stone addition and under drain pipe connected to existing catch basin..

BSM Added & Brought to Design Elevation

6/12/11

View looking south from northern end of raingarden.

6/12/11

View looking south from northern end of raingarden.

BSM brought to design elevation.

Planting Completed & Down Spout Installed

7/13/11

View looking west from walkway near gym entrance.

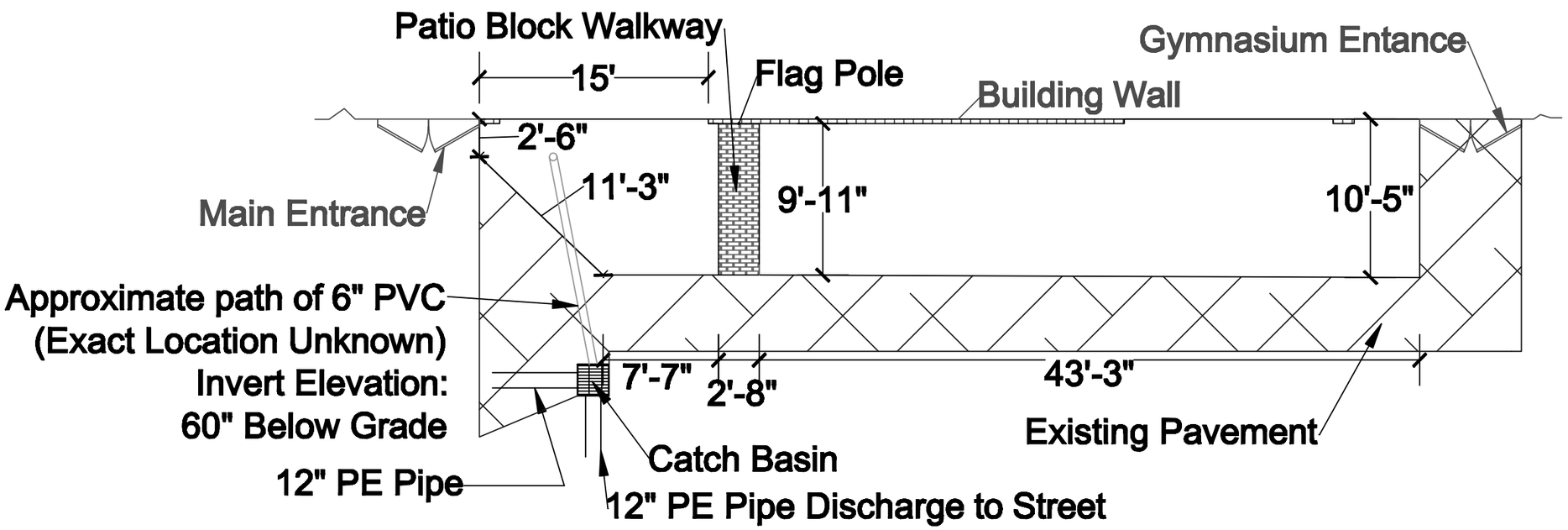
7/13/11

View looking south from northern end of raingarden.

Planting and down spout installed by John's Landscaping of Madbury, N.H.

Finished Product

7/12/11



UNIVERSITY OF NEW HAMPSHIRE
STORMWATER CENTER

N

Legend:

Notes:
1-800-DIGSAFE

Scale 1:100

0 100 200

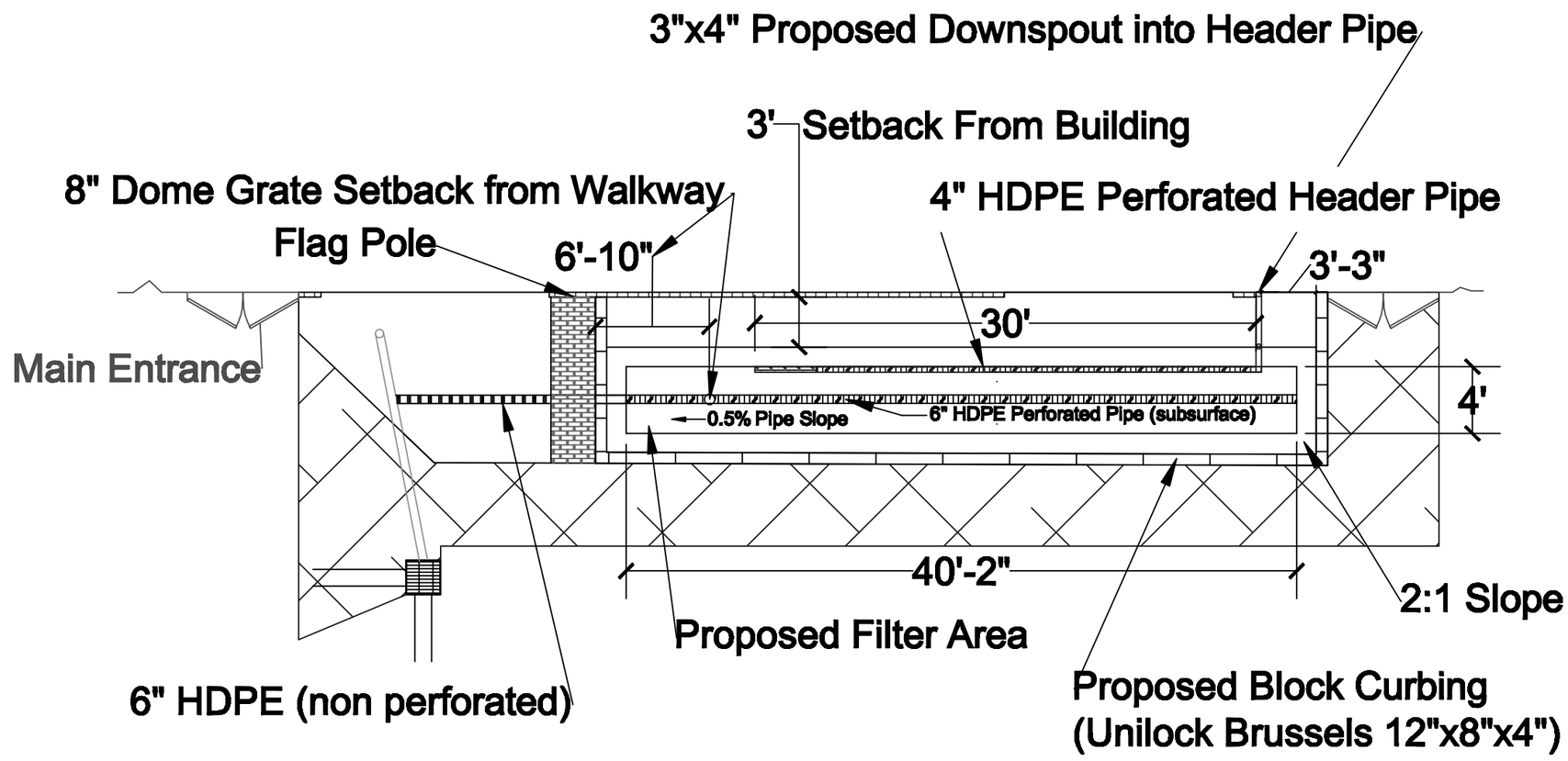
Drawn By: VH
Reviewed By: JJH
Checked By: RMR
Date: 5/16/2011

Existing Conditions of Proposed Bioretention Area
Horne St. School

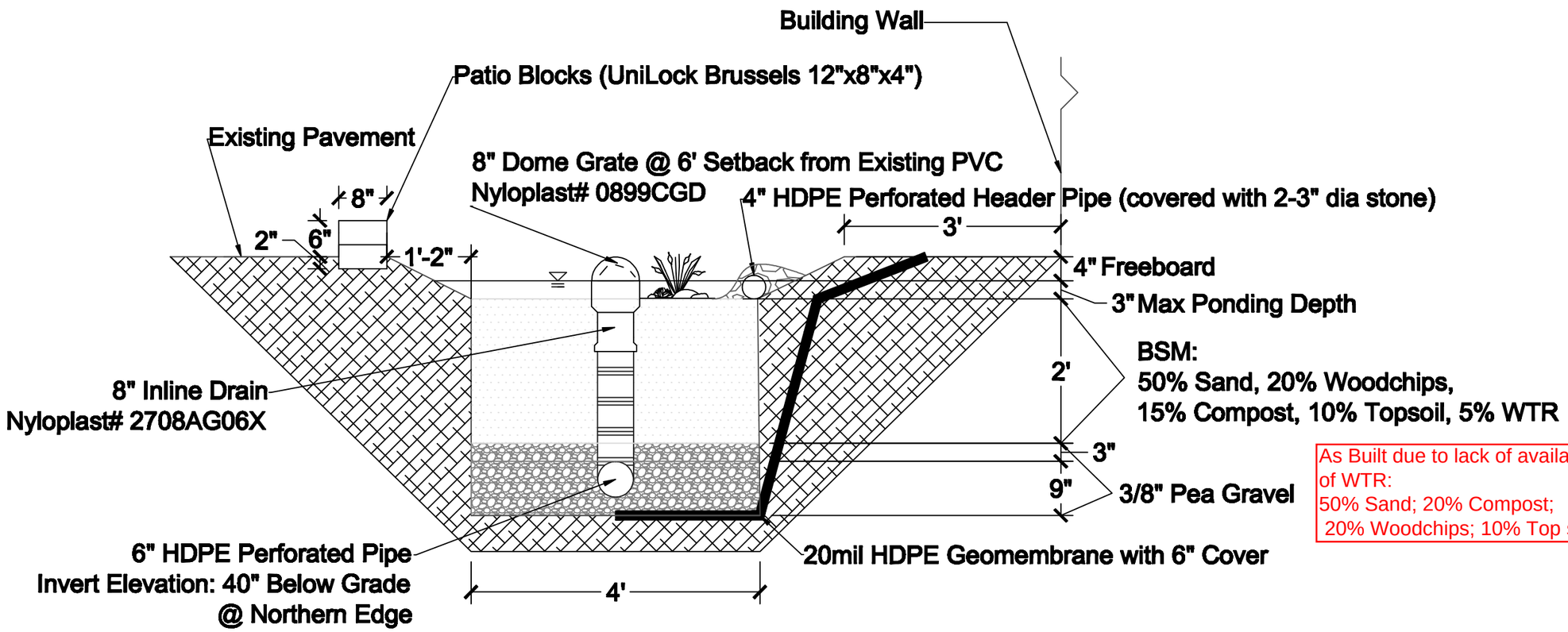
78 Horne St. Dover NH, 03820

Figure No:
1 of 4

Revision:
4 of 4

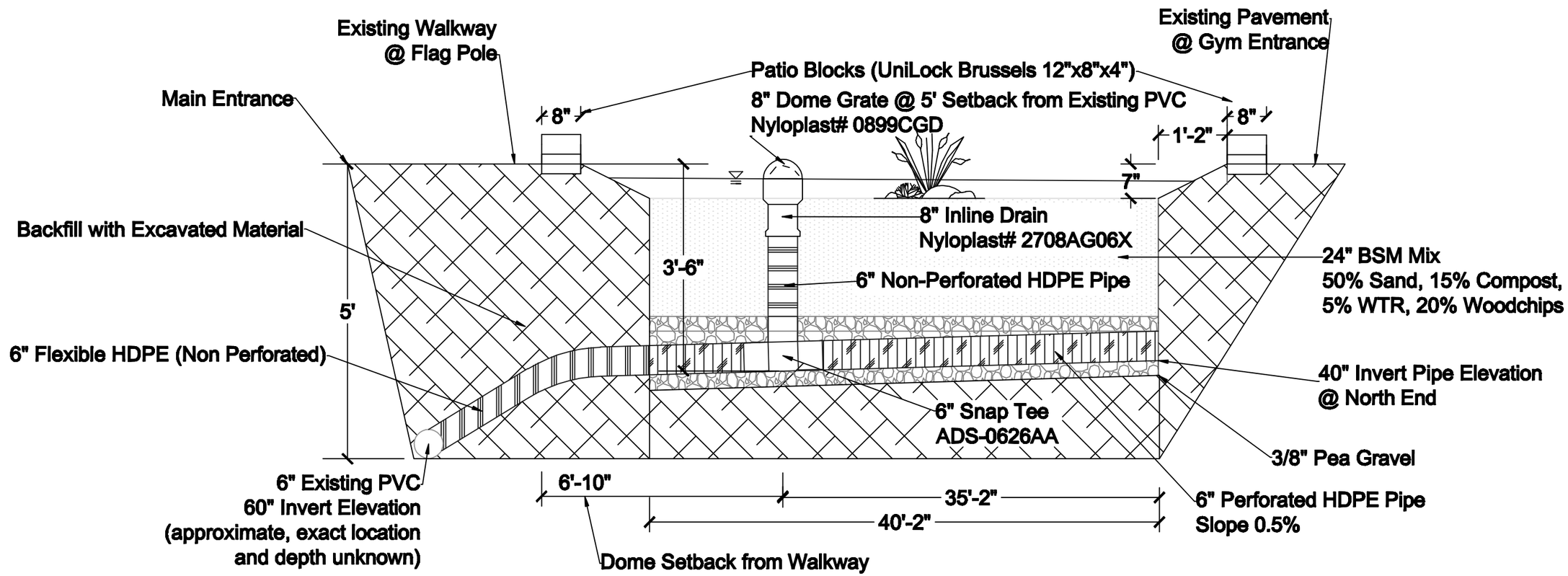


SC UNIVERSITY OF NEW HAMPSHIRE STORMWATER CENTER	N	Legend:	Notes: 1-800-DIGSAFE	Scale 1:100 0 100 200	Drawn By: VH Reviewed By: JJH Checked By: RMR Date: 5/17/2011	Bioretention Layout View Horne St. School 78 Horne St. Dover NH, 03820	Figure No: 2 of 4 Revision: 5 of 5



As Built due to lack of availability of WTR:
50% Sand; 20% Compost;
20% Woodchips; 10% Top soil

SC UNIVERSITY OF NEW HAMPSHIRE STORMWATER CENTER		Legend:	Notes: 1-800-DIGSAFE	Scale 1:20 0 20 40	Drawn By: VH Reviewed By: JJH Checked By: RMR Date: 5/16/2011	Bioretention Cross Section Horne St. School 78 Horne St. Dover NH, 03820	Figure No: 3 of 4 Revision: 4 of 4



NTS

SC UNIVERSITY OF NEW HAMPSHIRE STORMWATER CENTER		Legend:	Notes: 1-800-DIGSAFE	Scale NTS	Drawn By: VH Reviewed By: JJH Checked By: RMR Date: 5/17/2011	Bioretention Pipe Detail Horne St. School 78 Horne St. Dover NH, 03820	Figure No: 4 of 4 Revision: 5 of 5

APPENDIX A-3
HORNE STREET SCHOOL BIORETENTION II

UNIVERSITY OF NEW HAMPSHIRE
STORMWATER CENTER

Horne St. School Bioretention II

University of New Hampshire

Stormwater Center

Horne St. Dover, NH

Berry Brook Restoration Project

Swale Installation

- October 24th 2011 – Raingarden & stone trench excavated, perforated pipe installed, BSM added.
- Bioretention soil mixture:
  - 50% Sand
  - 20% Compost
  - 20% Woodchips
  - 10% Top soil
- October 25th 2011 – Connecting pipe installed.
- October 26th 2011 – Planting and stone addition

Existing Condition

7/12/11

Trench & Bioretention Excavation

10/21/11

View looking northwest from rain garden area.

10/21/11

View looking south from northern end of stone trench

Stone trench will catch roof runoff and direct it into the Rain garden. Designed at a 1% slope.

Pea Stone & Perf. Pipe Added

10/21/11

View looking southeast from front of school building.

10/21/11

View looking east from front of school building.

Perforated pipe (left) set on 6" of pea stone to act as an under drain. HDPE pipe (right) to be connected to existing catch basin on 10/22/11.

Overflow Riser Added & Pea Stone Brought to Design Elevation

10/21/11

View looking northwest from front of school building.

10/21/11

View looking east from front of school building.

Pipe covered in 8” of pea stone. Beehive overflow to be added during planting process.

Soil Mix & Fabric Added

10/21/11

View looking west from bus drop off area.

10/21/11

View looking northwest from southern end of stone trench.

BSM added and brought to design elevation (left). Fabric laid against the wall and along the trench (right).

Finished Product

10/26/11

Bioretention System for Berry Brook
Horne St. School, Dover NH

September 20, 2011

Project Partners

UNH Stormwater Center, Town of Dover, NH, Berry Brook Restoration Project

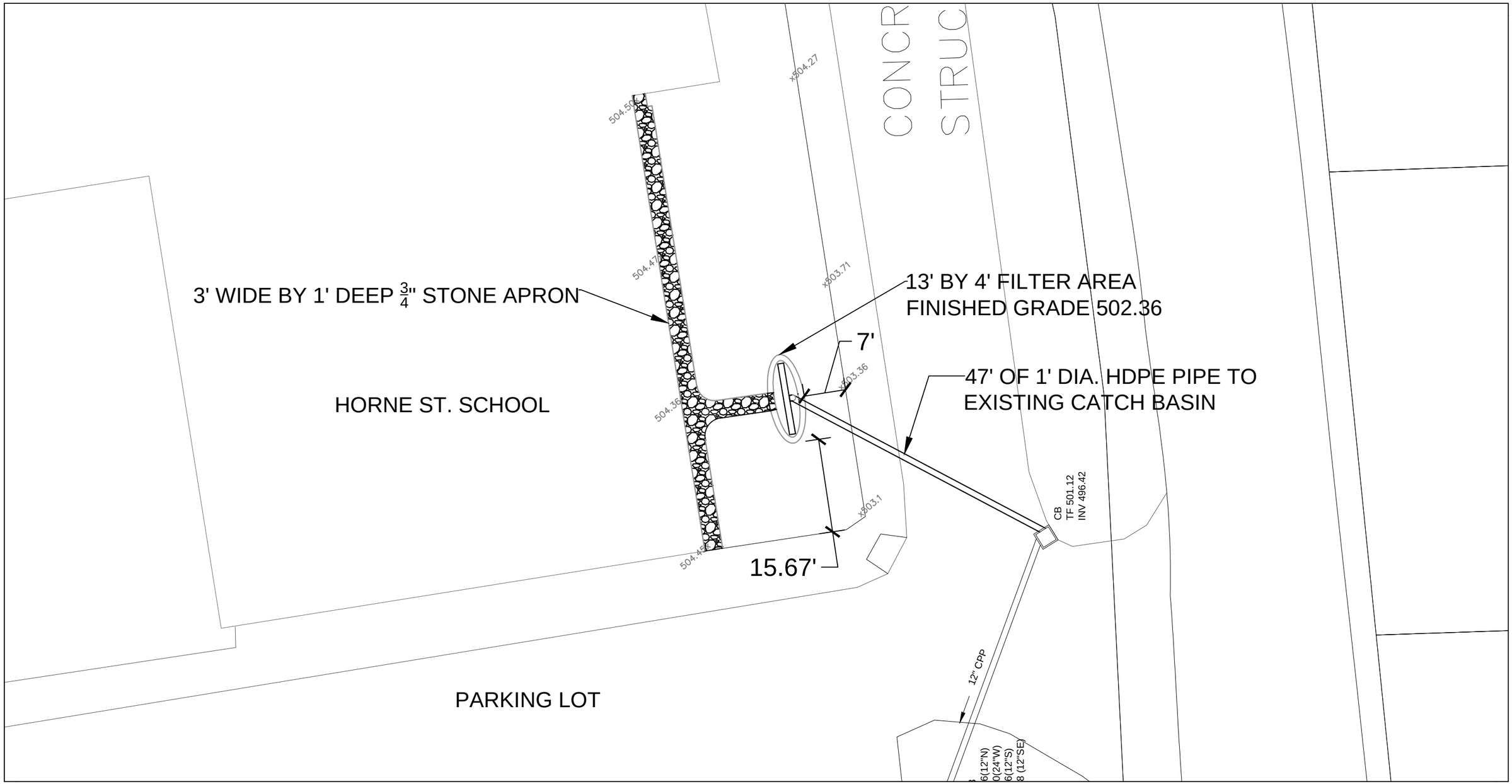
ESTIMATED CONSTRUCTION SCHEDULE

TBD	Mobilization
TBD	Excavation
TBD	Cell Construction
TBD	Swale Construction
TBD	Landscaping

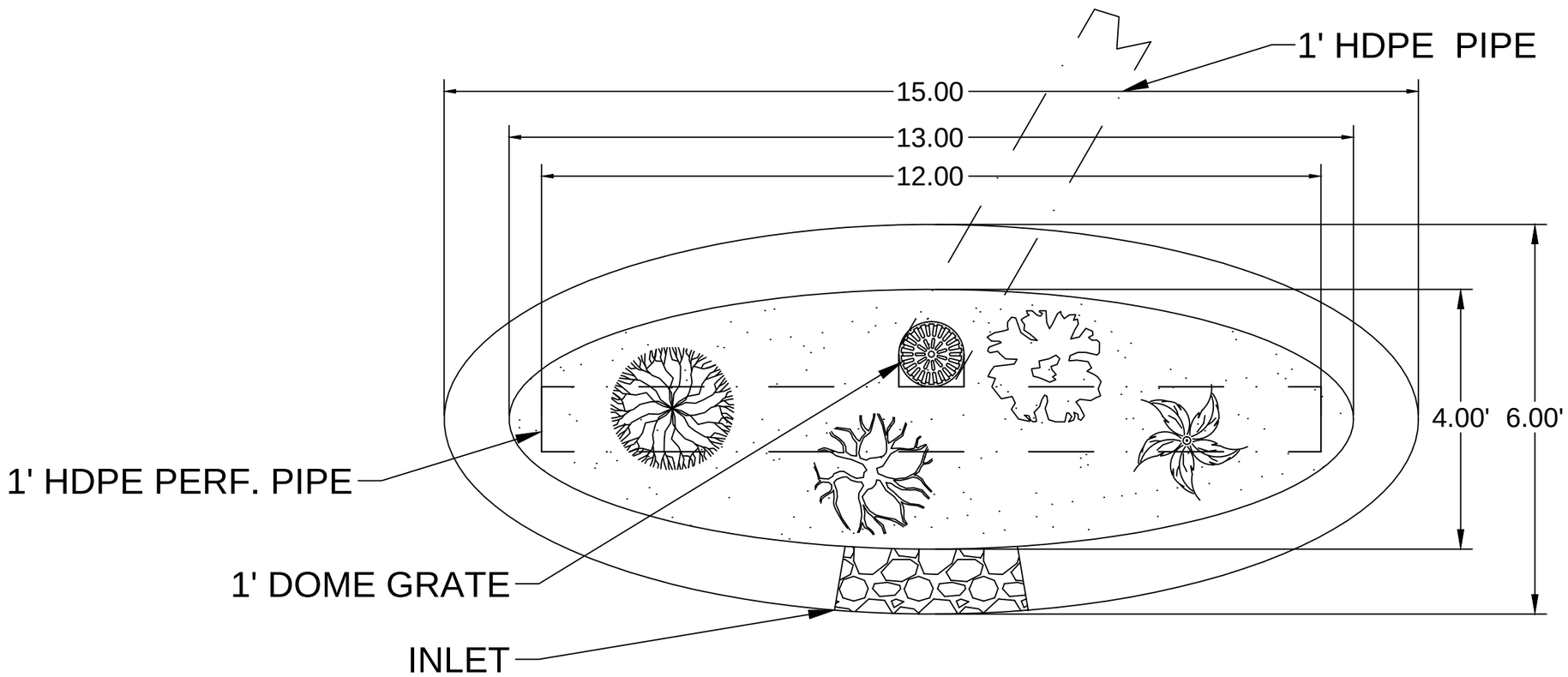
Drawn By: RJD,AS
Reviewed By: JJH,AS
Checked By: RMR
Date: 9/19/11

INDEX

Sheet 1: Title Sheet and Index
Sheet 2: Site Location
Sheet 3: Bioretention Cell Layout
Sheet 4: Bioretention Cell Cross-Section
Sheet 5: Materials List Estimates and Contact Info



SC UNIVERSITY OF NEW HAMPSHIRE STORMWATER CENTER	N	Legend:	Notes: 1-800-DIGSAFE	Scale 1:16 0 16 32	Drawn By: RD,AS Reviewed By: JJH Checked By: RMR Date: 9/20/2011	Existing Conditions of Proposed Bioretention Area Horne St. School 78 Horne St. Dover NH, 03820	Figure No: 2 of 5 Revision: 2 of 2



UNIVERSITY OF NEW HAMPSHIRE
STORMWATER CENTER

N

Legend:

Notes:
1-800-DIGSAFE

EXISTING PLANTINGS IN THE DISTURBANCE AREA SHOULD BE REPLANTED IN THE PROPOSED BIORENTION AREA.

Scale 1:2

0 2 4

Drawn By: RD,AS	
Reviewed By: JJH	
Checked By: RMR	
Date: 9/16/2011	

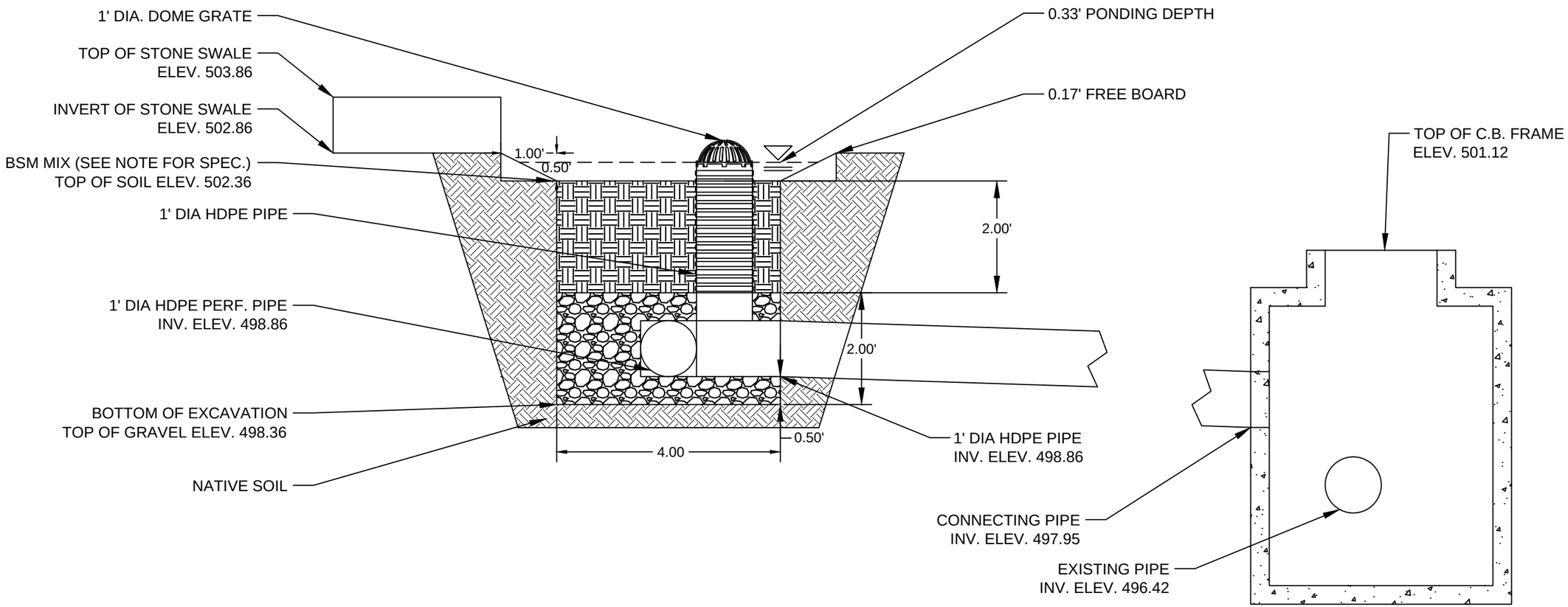
Bioretention Layout View

Horne St. School

78 Horne St. Dover NH, 03820

Sheet No: 3 of 5

Revision: 1 of 1



UNIVERSITY OF NEW HAMPSHIRE
STORMWATER CENTER

Legend:

Notes:
BIORETENTION SOIL MIX
50% SAND
20% COMPOST
20% WOODCHIPS
10% TOP SOIL

Scale 1:2

0 2 4

Drawn By: RD.AS	
Reviewed By: JJH	
Checked By: RMR	
Date: 9/20/2011	

Bioretention Cross Section

Horne St. School

78 Horne St. Dover NH, 03820

Sheet No: 4 of 5

Revision: 2 of 2

Bioretention
Materials List

Project Name: Horne St. School
78 Horne St, Dover, NH, 03820

Date: 9/20/2011

Item ID	Description	Unit	Quantity	Unit Price	Cost	Order Date	Date Completed	Supplier	Notes	
1.0	BSM MIX: 50% Sand/20% Compost/10% Top Soil/20% Woodchips	C.Y	5.0							
1.1	Sand	C.Y	2.5	$20.50	$51.25			LandCare	Delivery not incl.	
1.2	Compost	C.Y	1.0	$34.00	$34.00			LandCare	Delivery not incl.	
1.3	Top Soil	C.Y	0.5	$21.00	$10.50			LandCare	Delivery not incl.	
1.4	Woodchips	C.Y	1.0	$11.00	$11.00			LandCare	Delivery not incl.	
2.0	3/8" Pea Gravel	C.Y	5	$25.00	$125.00			LandCare	Delivery not incl.	
3.0	5"-6"River Stone	C.Y	14	$24.00	$336.00			NA		
4.0	12" Non Perf HDPE	ft	52	$3.32	$172.64			EJP	Shorelock wo/sock	
4.1	12" 90 Snap	each	1	$3.32	$3.32			EJP	Shorelock wo/sock	
4.2	12" Snap Tee	each	2	NA	NA			EJP	Shorelock wo/sock	
4.3	12" Dome Grate	each	1	$31.89	$31.89			EJP	Part # 0626AA	
4.4	Couplers	each	5	NA	NA			EJP		
5.0	Plantations	NA	NA	NA	NA					
				SUM	$775.60					

Name	Company	Title	Contact Info.	Notes
Robert Roseen	UNHSC	Director	o. 603-862-4024	
			c. 603-686-2488	
		email	robert.roseen@unh.edu	
Rob Dowling	UNHSC	Design Engineer	c. 603-370-7072	Design/Drawings
		email	rje7@unh.edu	Onsite/Oversite
Jamie Houle	UNHSC	Program Manager	c. 603-767-7091	Onsite/Oversight
		email	james.houle@unh.edu	
Mindy Bubier	UNHSC	Project Manager	o. 603-862-2818	
		email	mindy.bubier@unh.edu	
Ann Sholz	UNHSC	Project Manager	o. 603-862-3264	Design/Drawings
		email	Ann.Scholz@unh.edu	
Malcom Forsman	Horne St. School	Principal		
		email	m.forsman@dover.k12.nh.us	
Dean Peschel	DPW		o.603-781-5931	
		email	d.peschel@dover.nh.gov	
Lorie Chase	Cocheco Watershed Coalition		o. 603-516-8113	
		email	lorie.chase@unh.edu	
John Crooks	John's Lanscaping		c. 603-817-7788	
		email	johnscaping@yahoo.com	

APPENDIX B
IMPERVIOUS COVER AND
POLLUTANT LOAD CALCULATIONS

UNIVERSITY OF NEW HAMPSHIRE
STORMWATER CENTER

Berry Brook Pollutant Load Reductions
Prepared by UNHSC

Eqn 1: $R = P * P_j * Rv$

Where: R = Annual runoff (inches)
P = Annual rainfall (inches) 48
P_j = Fraction of annual rainfall events that produce runoff 0.9
Rv = Runoff coefficient **Eqn 2: Rv=0.05+0.9Ia**
Ia= % Impervious area

Eqn 3: $L_i = 0.226 * R * C * A$

Where: L_i = Annual load (lbs) to brook
R = Annual runoff (inches)
C = Pollutant concentration (mg/l)
A = Area (acres)
0.226 = Unit conversion factor

Eqn 4: $L_e = L_i * R_e * V_r$

Where: L_e = Total Annual Effluent Load (lbs)
L_i =Total Annual Influent Load (lbs)
R_e = 1 - BMP pollutant removal efficiency[1]
V_r = BMP volume reduction[2]

Table 1: UNHSC Pollutant Removal Efficiencies (%)[1]

BMP	TSS	TP	TN
Bioretention	87%	34%	NT
Porous Asphalt	99%	60%	NT
Tree filter	93%	NT	3%
Drywell[5]	9%	NT	NT

[5]Deep Sump CB UNHSC 2009 Biannual Report

Table 2: EPA's Volume Reduction[2]

BMP	Installed outlet		No installed outlet	
	% Runoff Reduction	Disconnection Coefficient	% Runoff Reduction	Disconnection Coefficient
Rain garden	75%	0.25	95%	0.05
Tree filter	75%	0.25	95%	0.05
Drywell	85%	0.15	95%	0.05
Porous Asphalt	85%[4]	0.15	95%	0.05

[4]UNHSC 2009 Biannual Report

Upper Subwatershed of Berry Brook Baseline Pollutant Loads

Land Use	Cover Area AC	TSS Concentration mg/l	TSS Annual Load 'L' #/year	TP Concentration mg/l	TP Annual Load 'L' #/year	TN Concentration mg/l	TN Annual Load 'L' #/year
Multi-Family	0.72	100	211	0.4	1	2.2	5
Single Family	65.71	100	16,669	0.4	67	2.2	367
Commercial/ Institutional	18.46	77	8,211	0.33	35	2.97	317
Outdoor Rec/Forest	17.03	51	592	0.11	1	1.74	20
Water/Wetlands	1.23	6	62	0.08	1	1.38	14
Roads and Other IC	7.49	172	11,497	0.55	37	1.4	94
Total	110.64		37,242		142		817

**** Values are from the NHDES Simple Method Guidance.**

Berry Brook Pollutant Load Reductions per BMP

Location (Land Use)	BMP Description	Berry Brook Subwatershed parameters				TSS			TP			TN		
		Drainage Area 'A' Acre	Impervious Area 'Ia' %	Runoff Coefficient 'Rv'	Annual Runoff 'R' inches	Total Influent Annual Pollutant Load Li (lbs/yr)	Total Effluent Annual Pollutant Load Le (lbs/yr)	Total Annual Pollutant Load Removed (lbs/yr)	Total Influent Annual Pollutant Load Li (lbs/yr)	Total Effluent Annual Pollutant Load Le (lbs/yr)	Total Annual Pollutant Load Removed (lbs/yr)	Total Influent Annual Pollutant Load Li (lbs/yr)	Total Effluent Annual Pollutant Load Le (lbs/yr)	Total Annual Pollutant Load Removed (lbs/yr)
Horne Street School Dover, NH (Commercial/ Institutional)	Bio 1	0.073	98%	0.932	40.26	51.5	1.7	49.8	0.22	0.04	0.18	1.99	0.50	1.49
	Bio 2	0.072	98%	0.932	40.26	50.8	1.7	49.1	0.22	0.04	0.18	1.96	0.49	1.47
	Tree Filter	0.332	98%	0.932	40.26	232.5	4.1	228.4	1.00	0.25	0.75	8.97	2.17	6.79
Drainage area total		0.478			**Totals**	**334.7**	**7.4**	**327.3**	**1.43**	**0.3**	**1.11**	**12.91**	**3.16**	**9.75**

Bioretention Design

Project Name: Horne St. School
78 Horne St, Dover, NH, 03820

Date: 1/18/2012

Input Table		
Watershed Area (sf)		3,200
Watershed Area (acres)		0.07
Imperviousness (%)		0.98
dmax (ft)		0.25
df (ft)		2.00
h_ave (ft)		0.13
Kact (ft day)		24.00
Safety Factor		3.00
Kd (ft/day)		8.00
td (days)		2.00
d_underdrain (ft)		1.00
freeboard (ft)		0.33
System width (ft)		4.0
System length (ft)		40.2
Filter Area (sf)		161

Available Area

3200
0.09

Bioretention Storage Capacity				
	Void Space	Depth	Adjust Depth	Storage
		ft	ft	ft3
Pool	1	0.25	0.25	40
BSM	0.22	2	0.44	71
3/8" Pea Gravel	0.4	1	0.4	64
freeboard (ft)	1	0.33	0.33	53
total		3.58		229

$$A_f = \frac{W_{qv} d_f}{k(h_f + d_f)t_f}$$

Required Area

Storm Return Period (yrs)	Rainfall (in)	DRO (in)	Volume RO (ft3)	Peak Flow (cfs)	Filter Area, Af (ft2)	Filter Length (ft)	Filter Area, Af (ft2) @5%WA	Filter Length (ft)
WQV	1.0	1.000	261	1.0	15	3.8	160.00	40.0
1	2.5	1.574	411	1.7	24	6.0		
2	3.0	2.002	523	2.0	31	7.7		
5	3.8	2.742	717	2.6	42	10.5		
10	4.3	3.226	843	2.9	50	12.4		
25	5.1	3.990	1043	3.5	61	15.3		
50	5.6	4.513	1179	3.8	69	17.3		
100	6.3	5.265	1376	4.3	81	20.2		

Bioretention Design

Project Name: Horne St. School
78 Horne St, Dover, NH, 03820

Date: 1/18/2012

Input Table		
Watershed Area (sf)		3,157
Watershed Area (acres)		0.07
Imperviousness (%)		0.98
dmax (ft)		0.25
df (ft)		2.00
h_ave (ft)		0.13
Kact (ft day)		24.00
Safety Factor		4.00
Kd (ft/day)		6.00
td (days)		1.00
d_underdrain (ft)		1.00
freeboard (ft)		0.33
System width (ft)		4.0
System length (ft)		40.2
Filter Area (sf)		161

Available Area

3157
0.091225847

Bioretention Storage Capacity				
	Void Space	Depth	Adjust Depth	Storage
		ft	ft	ft3
Pool	1	0.25	0.25	40
BSM	0.22	2	0.44	71
3/8" Pea Gravel	0.4	1	0.4	64
freeboard (ft)	1	0.33	0.33	53
total		3.58		229

$$A_f = \frac{W_{qv} d_f}{k(h_f + d_f)t_f}$$

available

Required Area

Storm Return Period (yrs)	Rainfall (in)	DRO (in)	Volume RO (ft3)	Peak Flow (cfs)	Filter Area, Af (ft2)	Filter Length (ft)	Filter Area, Af (ft2) @5%WA	Filter Length (ft)
WQV	1.0	1.000	258	1.0	40	10.1	157.85	39.5
1	2.5	1.574	406	1.7	64	15.9		
2	3.0	2.002	516	2.0	81	20.2		
5	3.8	2.742	707	2.6	111	27.7		
10	4.3	3.226	832	2.9	130	32.6		
25	5.1	3.990	1029	3.5	161	40.3		
50	5.6	4.513	1164	3.8	183	45.6		
100	6.3	5.265	1357	4.3	213	53.2		

APPENDIX C
COMPLETED STORMWATER AUDITS

UNIVERSITY OF NEW HAMPSHIRE
STORMWATER CENTER

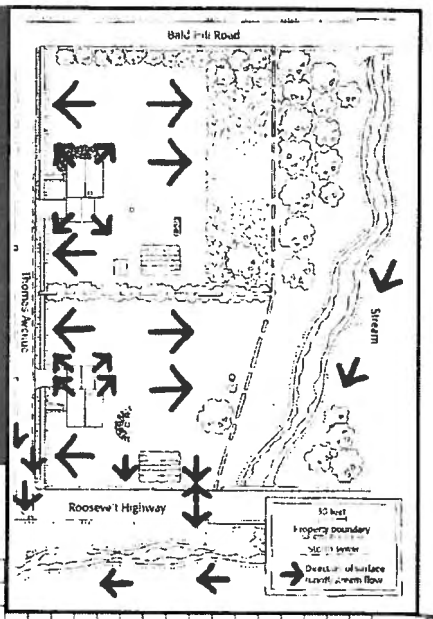
Derek eg 15A Hillcrest dr

Map your runoff

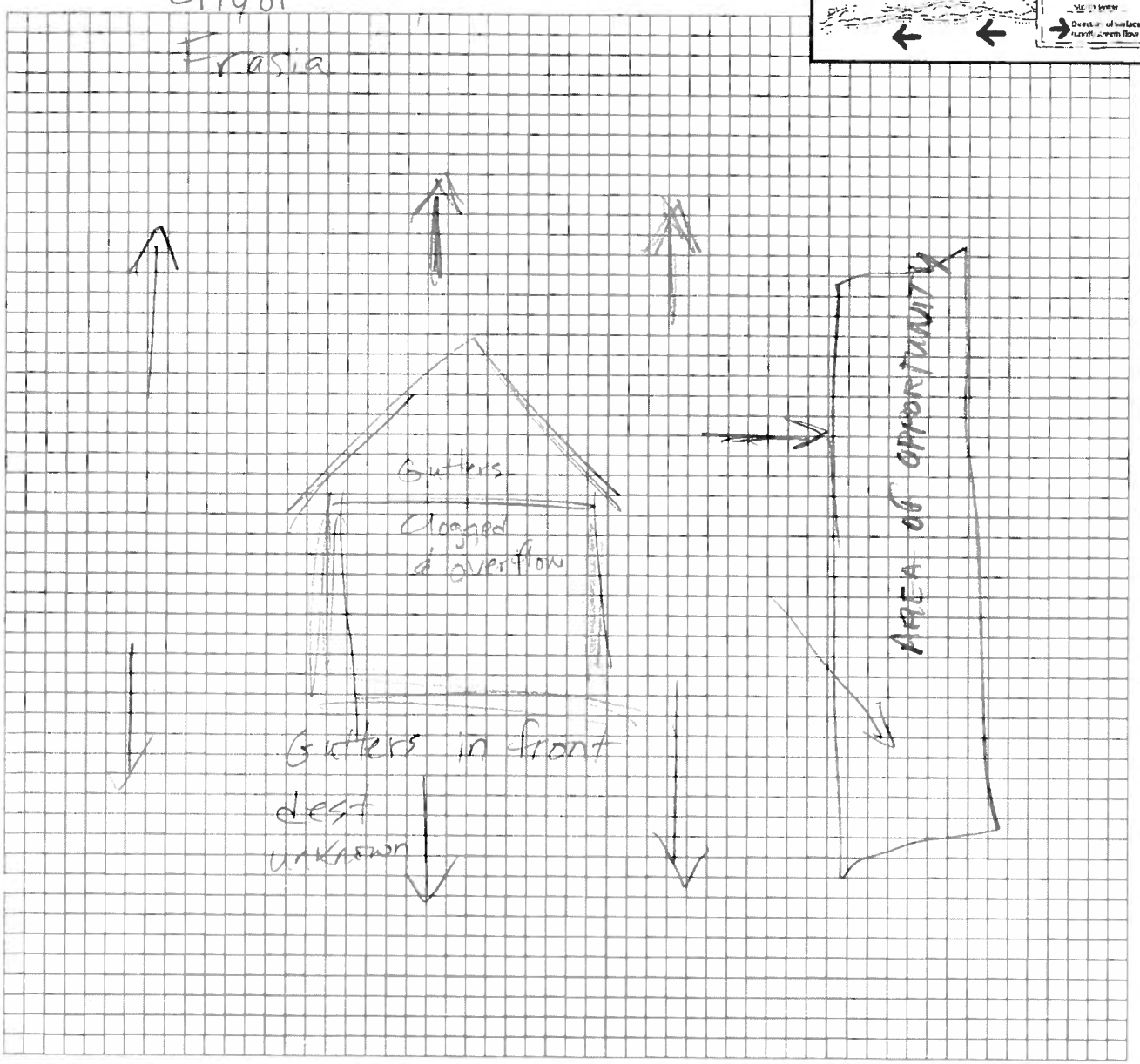
Where does your water go? In the graph below, map your home and yard. Add arrows to indicate the direction water flows (from higher to lower elevation). See sample map at right.

Each square in the graph is equivalent to 10 square feet.

Sample map reproduced with permission from Home*A*Syst: An Environmental Risk-Assessment Guide for the Home *(NRAES-87). Natural Resource, Agriculture, and Engineering Service. http://www.nraes.org*



Lily of Frasia



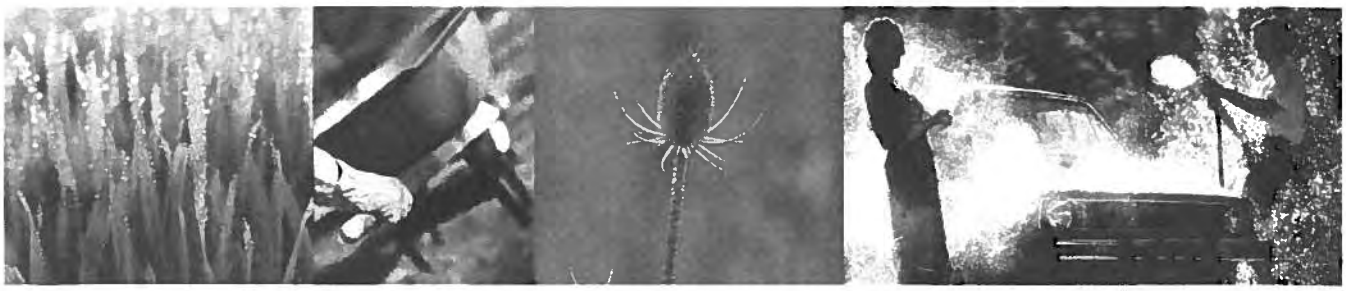
I w se to be Connected I Sewer

Home Stormwater Assessment

Do an assessment of your home to locate higher risk areas.

Assessment 1 – Reducing Pollutants in Runoff

	Low Risk	Medium Risk	High Risk	Risk Level
Storm drains	Storm drains are clear of litter, mud, plants or other debris. Storm drains are labeled to prevent pollution and to teach people that drains lead directly to streams.	Storm drains are clear of litter and other debris, but they are not labeled to prevent dumping.	Storm drains are covered or clogged with leaves, litter, mud, other debris and are not labeled to prevent dumping.	❑ Low ❑ Medium ☒ High go to seller
Litter	Trash is disposed of properly and there is no litter to be seen on the ground. Trash cans and recycling bins have closed lids and are emptied frequently.	There is very little trash and litter present on the ground, however, there are no designated containers for recycling.	There is a lot of trash and litter the ground.	☒ Low ❑ Medium ❑ High
Handling and use of pesticides, fertilizers, road salts or deicing chemicals, and household chemicals	Spills are cleaned up immediately, particularly on paved surfaces. Minimal amounts of these chemicals are used and applied according to label. Applications of fertilizers are delayed to avoid rain.	Applications of pesticides or fertilizers are not delayed to avoid rain.	Spills are not cleaned up. Chemical products are used in higher amounts than what is recommended on the label.	☒ Low ❑ Medium ❑ High
Pet and animal waste	Animal and pet wastes are wrapped in a plastic bag and placed in the trash or wastes are flushed down the toilet (do NOT flush plastic bag or kitty litter).	Animal wastes are left to decompose in tall grass (>4 inches) located away from storm drain inlets.	Animal wastes are left on paved surfaces, concentrated in pen or yard areas, or dumped down a storm drain or in a ditch.	☒ Low ❑ Medium ❑ High
Automotive wastes	Automobile fluid leaks are repaired as soon as possible. Oil drips and fluid spills are cleaned up with an absorbent material such as kitty litter or sand and wastes are properly disposed of. Used auto fluids are disposed of at designated recycling centers.	Drips and spills are not cleaned up. Car parts and other vehicle wastes are left on unpaved areas outside.	Used oil, antifreeze, and other wastes are dumped down the storm sewer, in a ditch, or on the ground.	☒ Low ❑ Medium ❑ High
Car washing	Cars and trucks are taken to a commercial car wash or spray booth.	Cars, trucks, or other items are washed on a lawn or gravel drive.	Cars, trucks, or other items are washed on a driveway, street, or other paved area.	☒ Low ❑ Medium ❑ High



Assessment 2 – Landscaping & Site Management to Control Runoff

	Low Risk	Medium Risk	High Risk	Risk Level
Impervious Surface	Paved surfaces are minimized to less than 10% of the property. Alternatives such as wood chips or pervious pavers are used for walkways.	Only some areas are paved for activities like basketball courts. Paved surfaces account for approximately 10% to 25% of the property.	Paved surfaces are used extensively, accounting for more than 25% of the property.	❑ Low ☑ Medium ❑ High
Roof Drainage	Roof drainage is collected into rain barrels or underground cisterns for water reuse and/or it is directed to a rain garden for detention, where it slowly soaks into the ground.	Downspouts and drip lines direct roof drainage onto a grassy area or patch of rocks where water has a better chance of soaking into the ground.	Most all drainage from the roof discharges onto paved surfaces, or downspouts are connected directly to storm drains.	❑ Low ❑ Medium ☑ High
Bare Soil	There are few places with bare soil. Bare patches in lawns are quickly reseeded and covered with straw; mulch is used to cover bare soil in garden or landscaped areas.	Grass or other ground cover is spotty, particularly on slopes. There is evidence of some erosion.	There are several places with bare soil. Soil has been carried onto sidewalks or driveways. Gullies have started to form on slopes with no vegetation in place.	☑ Low ❑ Medium ❑ High
Landscaping and Vegetation	Many trees, bushes, and deep-rooted, native plants are present on the property. Landscaping is designed to slow the flow of stormwater and provide areas where water soaks into the ground. Unmowed buffer strips of thick vegetation are left near any ditches and waterways.	No areas are landscaped to encourage water to soak in, but there are some trees and bushes that dot the landscape. Mowed grass or spotty vegetation exists adjacent to ditches and waterways.	There are few trees and bushes on the property. Landscaping does little to slow the flow of stormwater.	☑ Low ❑ Medium ❑ High
Leaves, grass clippings, and other yard waste	Grass clippings, leaves, and other yard wastes are swept off paved surfaces and onto lawns away from water flow routes. If possible these yard wastes are composted on site.	Leaves and other yard wastes are piled on the lawn next to the street for collection.	Grass clippings, leaves, and other yard wastes are left on sidewalks, streets, and other paved areas to be carried off by stormwater.	❑ Low ❑ Medium ❑ High

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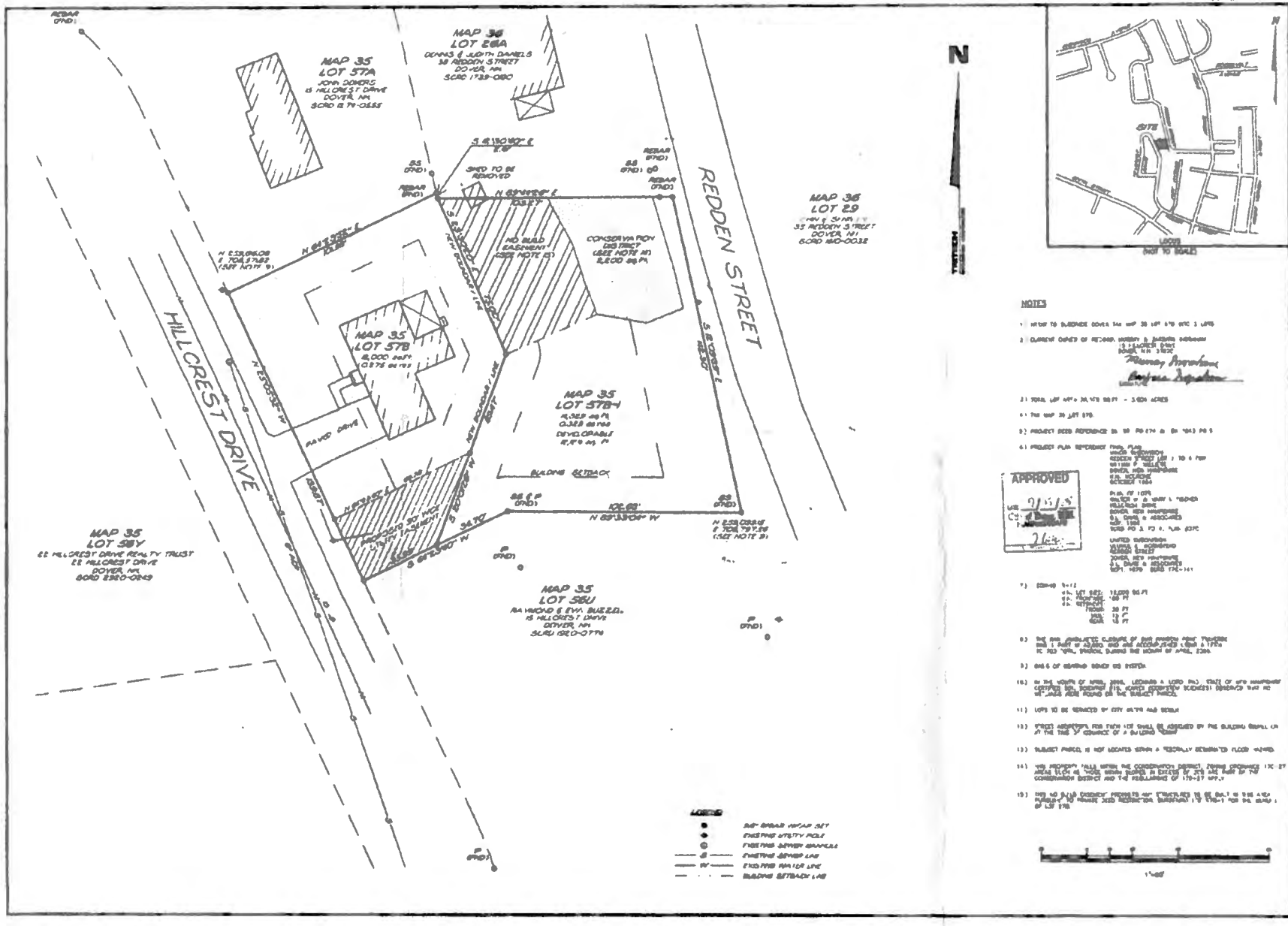
15A Hillcrest

016881



48 Horne st

Map your runoff

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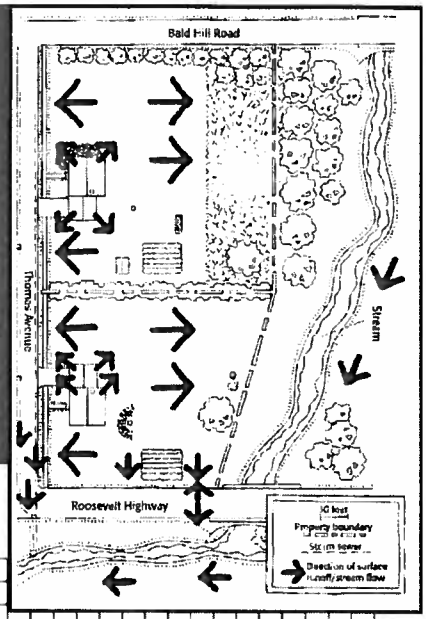

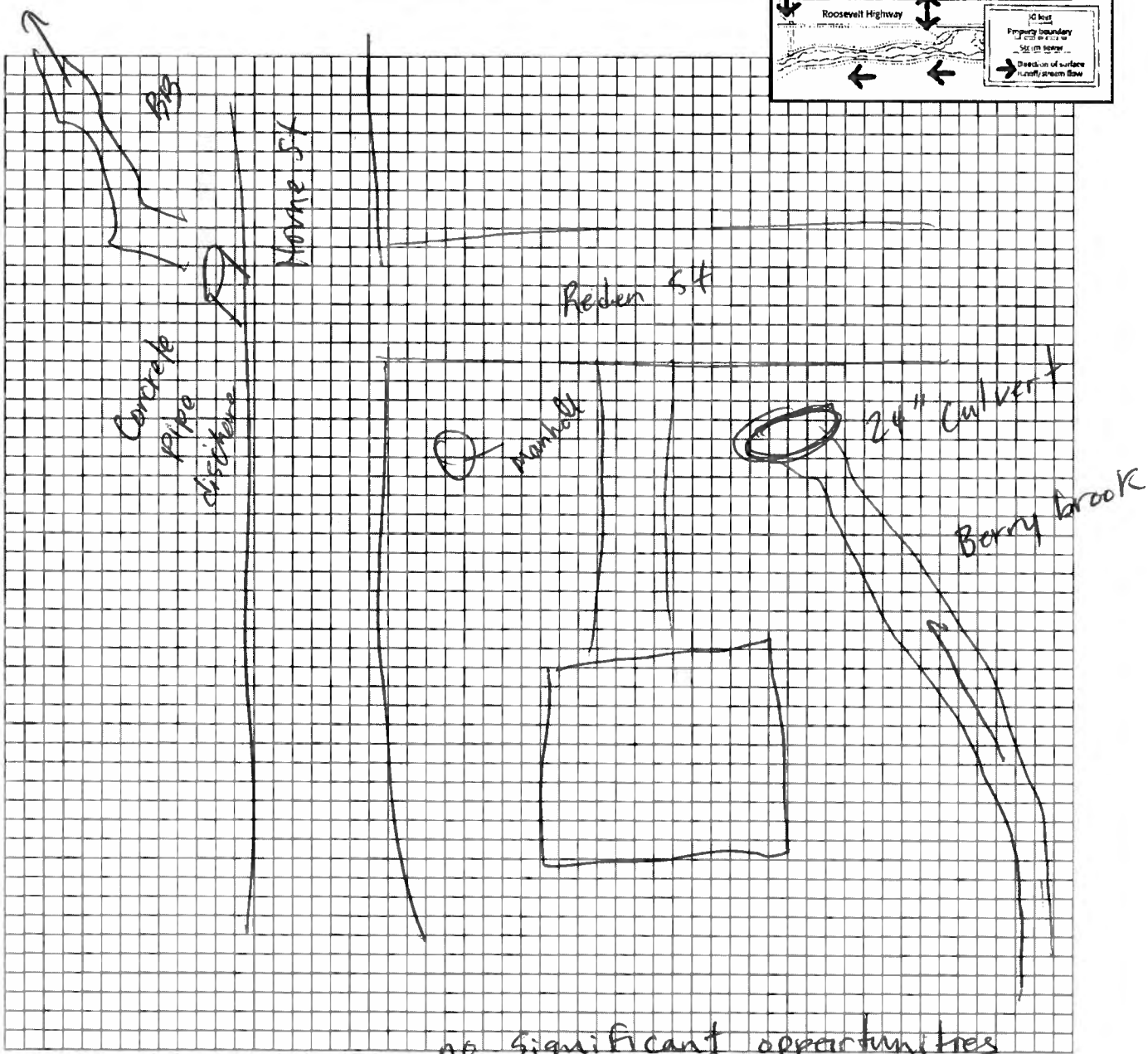

- no significant opportunities
May benefit from upstream discomnections

48 Horne Street

Home Stormwater Assessment

Do an assessment of your home to locate higher risk areas.

Assessment 1 – Reducing Pollutants in Runoff

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Assessment 2 – Landscaping & Site Management to Control Runoff

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55 Horne Street

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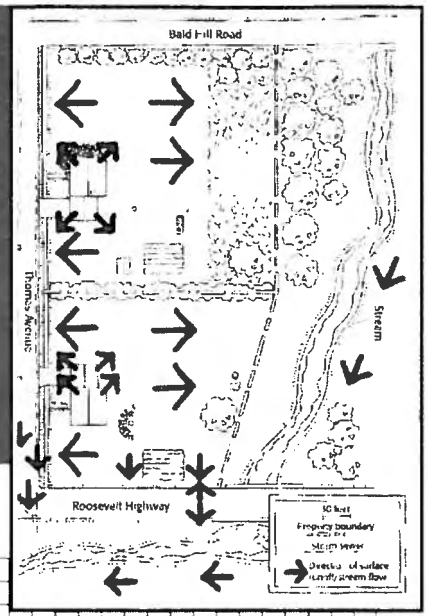

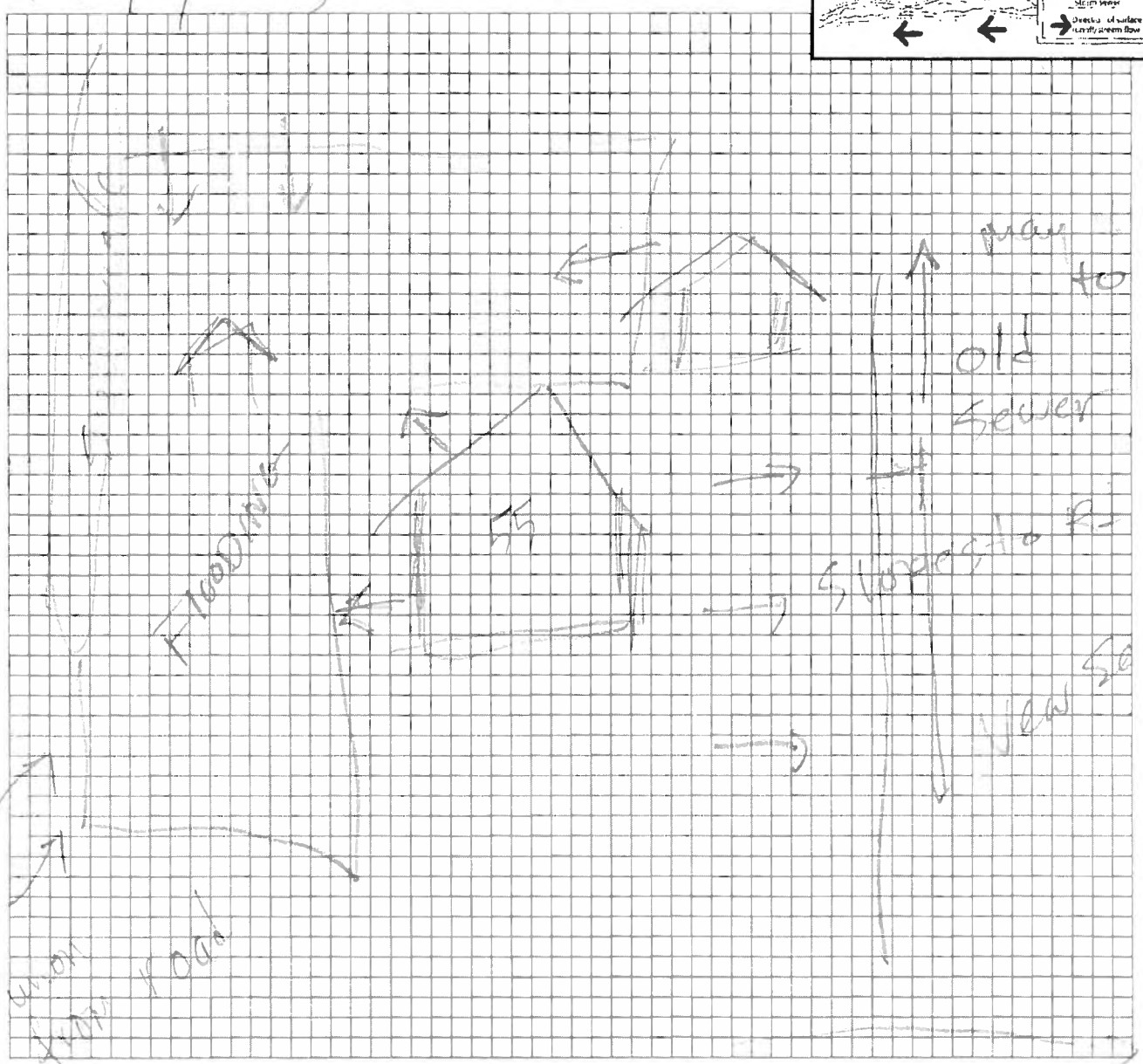

Home Stormwater Assessment

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Assessment 2 – Landscaping & Site Management to Control Runoff

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24 Maple Suzzanne

Map your runoff

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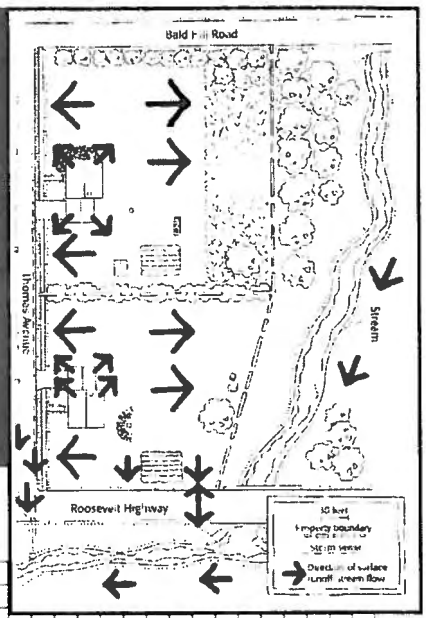
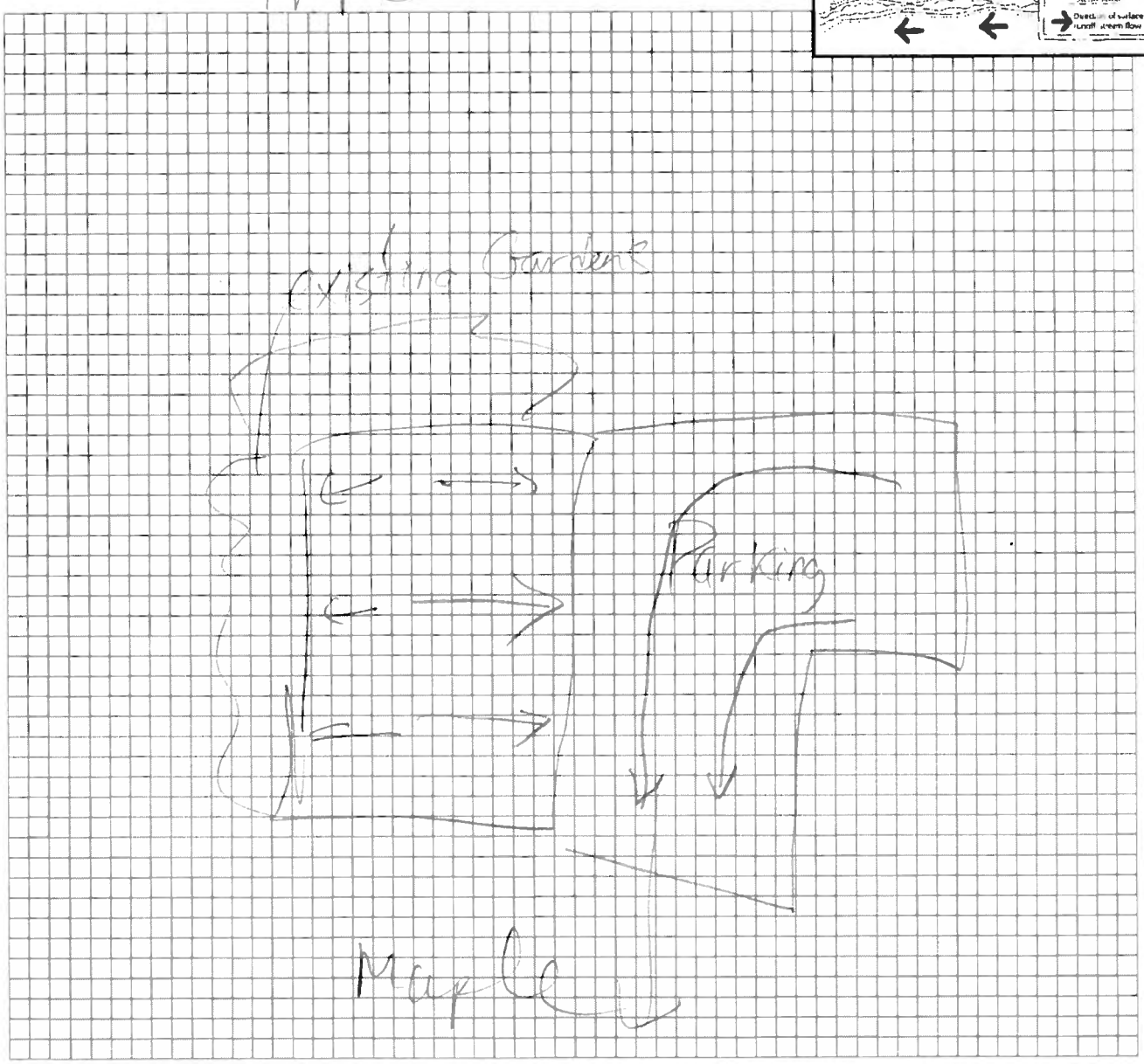


Triple



- no significant opportunities.
- homeowner has raingardens and insufficient space & grade to do more

24 Maple Street

Home Stormwater Assessment

Do an assessment of your home to locate higher risk areas.

Assessment 1 – Reducing Pollutants in Runoff

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APPENDIX D
COMMUNITY MEETING POSTERS

UNIVERSITY OF NEW HAMPSHIRE
STORMWATER CENTER

Berry Brook Watershed Restoration Project

Outcome

Prepared by The University of New Hampshire Stormwater Center

Stream Restoration

- The goal of the Stream Restoration in the watershed is to expand and enhance the existing wetland at the headwaters of the Berry Brook (Water Works facility) and re-establish an open channel, floodplain, and wetland pond system by day lighting portions of the stream which is currently piped underground.

- In the lower watershed where the brook runs into the Cocheco river our goal is to reestablish a direct connection of lower portion of Berry Brook (near Sixth Street Station) to the main stem of the Cocheco River. This would involve restoring approximately 500' of natural stream channel.

Berry Brook Restoration Site

Monitoring

- Monitoring will be conducted in Berry Brook to examine the benefits of the watershed improvements. Fish Monitoring will be performed by the NHFG.
- Potential species of interest include primarily sea lamprey, alewife, blueback herring, American shad, various trout, and American eel.
- Water quality monitoring will be conducted by the UNHSC for dry weather and wet weather events over a 2 year period.
- Locations include an upper watershed location where the degree of treatment and level of impervious cover reduction will be highest in relation to the watershed area, and a lower watershed location where the entire watershed response can be monitored.

Title Picture: Open marsh with intact forested wetland to left, and fill area to right

Proposed fill area to be converted to grassed area

Conservation Elements

- Conservation areas and urban greenways provide an important space where community can gather, converse, recreate, relieve stress, and be proud of.
- As a component of this project The City will establish a protected easement for the areas that are proposed for restoration in headwater wetlands and the stream.

Pre-Restoration Efforts

Newly Restored Stream

Water Quality Improvements through Implementation of Low Impact Development (Best Management Practices)

- Stormwater management improvements will be installed at 8 different locations to improve water quality for Berry Brook. Installations will all be Low impact Development and will include bioretention/raingardens, bioswales, tree filters, and treatment wetlands.
- The systems will help improve stream baseflow, provide pollutant reduction, and slow highly erosive flows. Sites include: Headwaters Gravel Wetland , Easement and Buffer, Crescent Ave Bioswale, Glencrest Ave Bioswale , Lowell Ave Tree Filter, Redden Street Extension Infiltration Basin, Redden Street Bioswale, Corner of Ash and Horne Infiltration Trench, Maple Street Industrial Site Bioswale .

Project Partners

The City of Dover; New Hampshire Department of Environmental Services; Cocheco River Watershed Coalition; the New Hampshire Fish and Game Department; and American Rivers Restoration Program.

Acknowledgements

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James Houle, CPSWQ
James Sherrard Jr., E.I.T

City of Dover Lead
Dean Peschel
603-516-6094
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NHDES Grant Managers
Sally Soule
Lorie Sommer

Funding for this project was provided in part by a Watershed Assistance Grant from the NH Department of Environmental Services with Clean Water Act Section 319 funds from the U.S. Environmental Protection Agency.

Berry Brook Watershed Restoration Project

Watershed Overview

Prepared by The University of New Hampshire Stormwater Center

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Berry Brook Watershed Restoration Project

Rain Gardens and Rain Barrels

Prepared by The University of New Hampshire Stormwater Center

Rain Barrels

- By saving rainwater you can help reduce the amount of water drawn from local reservoirs, streams, and wells.
- Saving rainwater helps control erosion and improve water quality.
- A one inch rain on an average sized roof produces 700 gallons of rainwater runoff.
- Water quality is impacted by stormwater runoff which carries sediment, fertilizers, pesticides, animal waste, oils, gas additives, and other pollutants which can significantly impact water quality.
- Using a Rain Barrel will reduce your water bill. During the summer the average household uses 40% of their water bill for lawn and garden purposes.
- Rainwater is free water. It contains no chlorine, lime or calcium. (http://www.skyjuice.us/html/why_use_a_barrel.html)

School St. School Rain Garden in Rochester, NH
(Treating Runoff from the Schools Roof)

Rain Gardens

- Rain gardens are attractive and functional landscaped areas that are designed to capture and filter stormwater from roofs, driveways, and other hard surfaces.
- They collect water in bowl shaped, vegetated areas, and allow it to slowly soak into the ground.
- This reduces the potential for erosion and minimizes the amount of pollutants flowing from your lawn into streams and lakes (NHDES).

Rain Barrel (http://www.skyjuice.us/index.html)

Rain Barrel Workshop Information

- Through the project the City will offer a collective purchasing program for SkyJuice rain barrels.
- Residents of the watershed will be able to purchase rain barrels at the discounted price of $35 (retail $125), this is a $90 savings to Berry Brook neighborhood residents.
- 40 rain barrels will be delivered to the DPW where they will be available for pick up on June 21, 2011.
- Rainbarrels will be sold on a first come, first served basis.
- In addition we will be hosting a rain barrel and rain garden workshop on the evening of June 21, 2011 at the Horne Street School from 5:00 – 6:00 PM.
- As an incentive we will be offering free rain barrels to the first 10 residents that show up.

School St. School Rain Garden in Rochester, NH (Solved Playground Flooding Issues)

Project Partners

The City of Dover; New Hampshire Department of Environmental Services; Cocheco River Watershed Coalition; the New Hampshire Fish and Game Department; and American Rivers Restoration Program.

Acknowledgements

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Funding for this project was provided in part by a Watershed Assistance Grant from the NH Department of Environmental Services with Clean Water Act Section 319 funds from the U.S. Environmental Protection Agency.

Berry Brook Watershed Restoration Project

Project Summary and History

Prepared by The University of New Hampshire Stormwater Center

Horne St. School (Watershed Assistance Grant)

Grant provided to the City of Dover from NHDES which includes:

- Installation of a Tree Filter, Rain Garden and project sign at the Horne Street School.
- Develop and assist in the delivery of a watershed curriculum for Horne Street School.
- Community Outreach with CRWC through workshops and a neighborhood meeting.

Aquatic Resources Mitigation Grant (ARM)

A Grant provided to the UNH Stormwater Center to:

- Restore and reconnect 2000 ft. of Berry Brook through stream restoration.
- Create and enhance 2+ acres of wetland complexes.
- Evaluate and repair potential fish passage barriers.
- Monitoring of aquatic life (fish) improvements

Berry Brook Restoration (Watershed Assistance Grant)

A Grant provided to the City of Dover to:

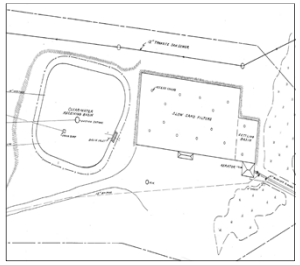
- Design and install stormwater treatment practices to filter, infiltrate, and reduce stormwater runoff from impervious cover.
- Evaluate and monitor water quality improvements.
- Community Outreach and watershed clean-up with CRWC and participating neighborhood volunteers.

Current Activities: Wetlands Permitting, Section 106 –Historic Review, Site Preparation, Stream Restoration and BMP Design.

Upcoming Year 1 Activities: Construction of stream channel, installation of BMPs in Upper Watershed.

Year 2 Activities: Permitting design and construction of the lower stream channel, installation of BMPs in lower Watershed.

Long-Term Activities: For long-term maintenance, this project will rely on the commitment and investment of the City of Dover Open Lands Committee, the community of Berry Brook, and the CRWC. The City, community, and watershed coalition have demonstrated long-term vested interests in maintaining and building upon the proposed improvements



Lowell Avenue Historic Water Treatment Operation

Gravel Wetland

Current Berry Brook crossing below Sixth St

Potential Future Wetland Habitat

Timeline

Site Prep and Permitting

Stream Restoration at Lowell Avenue Site

Installation of BMPs in Upper Watershed

Coordinate with landowners, permitting, design for lower watershed stream channel and BMPs

Complete Lower watershed Improvements

Watershed Stewardship

Improved Water Quality and Habitat

Conservation

Summer 2011

Year 1

Summer 2012

Year 2

Going Forward…

Project Partners

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