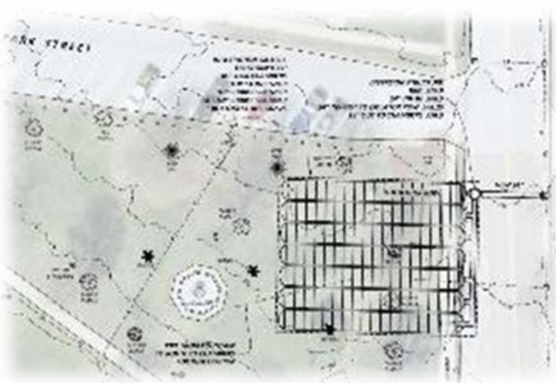

TOWN OF BRISTOL–

STORMWATER MASTER PLAN

BRISTOL,

VERMONT

FINAL REPORT

July 23, 2019

Prepared for:

Town of Bristol

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TABLE OF CONTENTS

LIST OF FIGURES:

LIST OF TABLES:

LIST OF ATTACHMENTS:

Task 1a – Kick Off Minutes
Task 1b – Data Library Summary Memo
1b.1 – GIS Geodatabase of Existing Data (provided as folder)
1b.2 – Relevant Documents (provided as folder)
1b.3 – Stormwater Permits (provided as folder)
Task 2a – Desktop Assessment Summary Memo
2a.1 – Initial Project Locations Maps
2a.2 – Sites List
Task 2b – Field Assessment Summary Memo
2b.1 – Field Assessment Sheets
Task 3 – Site Prioritization Summary Memo
3.1 – Prioritized Sites Map
3.2 – Prioritized Sites Table (provided as Excel document)
3.2a - Prioritized Sites Table (PDF document)
3.3 – Preliminary Ranking Criteria
Preliminary Task 4 – Sketch Concepts Summary Memo
Preliminary Task 4.1 – Sketch Concept Drawings
Task 4 – 30% Design Summary Memo
4.1 – 30% Designs
4.2 – Dry Well Concept Memo
4.3 – Geotechnical Assessment
5.1 – Fitch Avenue – Field Assessment

I. Disclaimer

The intent of this report is to present the data collected, evaluations, analysis, designs, and cost estimates for the Town of Bristol ('Bristol') Stormwater Master Plan under a contract between the Town of Bristol and Watershed Consulting Associates, LLC ('Watershed'). Funding for the project was provided from the Vermont Ecosystem Restoration Program (ERP). The plan presented is intended to provide the watershed's stakeholders a means by which to identify and prioritize future stormwater management efforts. This planning study presents a recommended potential collection of Best Management Practices (BMPs) that would address specific concerns relating to stormwater in Bristol. There are certainly other BMP strategies that could be implemented in the Town – these are the sites and practices that project stakeholders felt would have the greatest impact and the greatest probability of implementation. **This report does not represent a regulatory obligation of any sort.**

1 Project Overview

In May 2013, the State of Vermont Department of Environmental Conservation (VTDEC) issued a document titled Vermont Stormwater Master Planning Guidelines. This document is designed to provide communities in Vermont with a standardized guideline and series of templates to assist them in planning for future stormwater management practices and programs. Vermont has had stormwater regulations in place since 1978, with updates concerning unified sizing criteria in 2002. In 2017 the VT DEC issued a new stormwater management manual and regulations to reflect the current state of Best Management Practices. The State recognizes that managing stormwater can be a costly endeavor – the guidelines are written to help identify the appropriate practices for each watershed, community, and site in order to maximize the use of funds.

The guidelines encourage each stormwater master plan (SWMP) to follow the same procedures. They are:

- Problem Definition
- Collection of Existing Data
- Development of New Data
- Existing and Proposed Program, Procedure, or Practice Evaluation
- Summary and Recommendations

This stormwater master plan follows those guidelines to maximize the cost-benefit ratio associated with developing meaningful stormwater management solutions in Bristol, VT.

2 Background

2.1 Problem Definition

Figure 1: Downtown Bristol showing the drainage area boundaries that demarcate the area of interest for the Town's Stormwater Master Plan project.

The Town of Bristol is a small, mostly rural municipality with a moderately developed downtown area. The town is located on a sandy plateau at the toe of the Green Mountains. Rocky outcrops surround the town and, due to the poor soils and shallow depth to bedrock in these areas, contribute runoff to the Town's streets and drainage infrastructure.

As part of the desktop assessment process, the team attempted to identify all parcels with greater than three acres of impervious cover as those parcels would be included in the new General Stormwater Permit. However, there are no parcels within the area of interest with greater than three acres of impervious cover. Road surfaces are not counted in the three acre tally as those surfaces are covered under the Municipal Roads General Permit (MRGP).

The area of interest within the Town drains directly to the New Haven River which is a tributary of the Otter Creek. The impairments associated with these water bodies are detailed in materials associated with Task 1b – Data Library but generally include:

- Sediment and aquatic habitat alterations in the New Haven River from morphologic instability (which can be caused by stormwater runoff). The Tactical Basin Plan specifically targets stormwater runoff reduction from the Town of Bristol as a goal.
- Floodplain encroachment by development within the riparian area of the New Haven
- Varying degrees of planform stability or change according to Phase 1 & 2 Stream Geomorphic Assessment
- Nutrient and sediment pollution (particularly phosphorus as the Otter Creek is a tributary of Lake Champlain and is subject to the Lake Champlain Total Maximum Daily Load (TMDL) regulations

This study has found potential projects that rely on a mixture of Green Stormwater Infrastructural development whenever possible, and more traditional end-of-pipe stormwater Best Management Practices where applicable in order to use the most effective tools. These practices are designed to eliminate sediment in stormwater runoff to the greatest degree and to help mitigate the effects of channel-changing storms.

2.2 *Data Library*

The master planning project team completed a comprehensive review of existing data related to Bristol and have summarized our review as part of the Task 1b – Data Library Summary Memo. A GIS geodatabase of relevant data was also complied and organized as part of this Attachment (note 1b.1 – GIS Geodatabase of Existing Data – this is in ESRI geodatabase format). Any relevant paper documents and reports have been provided in the folder 1b.2 – Relevant Documents. All stormwater permits are included in Attachment 1b.3 – Stormwater Permits (Excel spreadsheet and permit files - folder).

2.2.1 *Data Review*

The purpose of the data review was to assess the availability and quality of data related to stormwater management within Bristol and to identify any data gaps and/or needs prior to the start of the retrofit assessment. The data library will also serve as a complete compiled source of data that can be easily accessed throughout the project.

2.2.1.1 *Permit Files:*

The State of Vermont's Open Geodata Portal provided by the Vermont Center for Geographic Information (VCGI) and other publishers like the Agency of Natural Resources (ANR) and Vermont Agency of Transportation (VTrans) was used to identify all stormwater issued permits within the town boundary of Bristol. Issued stormwater permits were assessed for ownership, from which the publicly owned permits were identified. In Bristol, there are none. There are only three total stormwater permits in the area of interested in Bristol, one of which is a Multi-sector General Permits (MSGP) while one is a short-duration Construction General Permits (CGP). The remaining permit is the Town's Municipal Roads General Permit (MRGP, 9040).

2.2.1.2 *GIS Data Files:*

GIS data files related to the project were drawn from a variety of public resources including the VCGI Open Data Portal, United States Geological Survey (USGS), and United States Department of Agriculture (USDA). Watershed performed select processing of the data to ensure that it was relevant and responsive to the needs of this particular SWMP. Individual ArcGIS shapefiles were then combined into a geodatabase file structure for ease of use and data migration from platform to platform. These files represent the most current available data, however GIS data within the State of Vermont is very dynamic – these files should not be regarded as the 'final' version. The geodatabase was provided as part of Task 1b (1b.1 – GIS Geodatabase of Existing Data).

2.2.1.3 *Past Watershed Studies:*

The Relevant Documents (1b.2 – Relevant Documents folder) contain all available reports pertaining to the Otter Creek, New Haven River, and the Town of Bristol that the master planning project team was able to find after speaking with various contacts, Town officials, and searching reports on the Internet. These reports include

- Otter Creek Water Quality Management Plan (2012)
- Bristol Zoning Proposed Master Draft
- Phase 2 Geomorphic Assessment – New Haven River
- VT DEC Stormwater Mapping Report

Two additional documents were also included in this deliverable. They are:

- VT League of Cities and Towns LID GSI Bylaw Template

A more complete summary of the materials related to stormwater management can be seen in the Task 1b Data Library Summary Memo.

2.2.1.4 *Data Needs:*

Our review of the currently available data and reports highlighted needs within the Town of Bristol.

One is the need to develop a polygon layer showing approximate public roads rights-of-way in which street-related stormwater management features could be installed on public land. Watershed developed this layer during the course of the desktop assessment phase.

The presence or absence of land use regulations and zoning bylaws concerning stormwater management are also of interest in this project. The Town of Bristol does not currently have a specific stormwater ordinance. It is important to note that the Vermont League of Cities and Towns has a model draft stormwater ordinance which is available here (http://vlct.org/assets/MAC/2015-LID-GSI-model-bylaw.docx). This may be an ordinance which the Town could adopt for future stormwater management efforts.

3 Existing Conditions Analysis (Tasks 2a & 2b)

3.1 Desktop Assessment (Task 2a)

Watershed worked with the Town of Bristol, project stakeholders, and the Addison County Regional Planning Commission to identify locations with existing drainage problems or concerns during the kickoff meeting. This information was utilized during the project scoping process.

Watershed conducted a desktop assessment of stormwater-related issues and opportunities for retrofits in the Town, which involved a thorough review of existing GIS resources and associated attribute data. This included, but was not limited to, storm sewer infrastructure, soils classifications, parcel data, wetlands, and river corridors. This data was used to identify and map stormwater subwatersheds with particularly high impervious cover, stormwater subwatersheds that are more directly connected to water bodies (direct pipes to streams or via overland flow), and parcels with ≥3 acres of impervious cover without a current stormwater permit (of which there were none in the area of interest).

A ‘green streets’ assessment was also conducted to identify any road segments throughout the drainage area appropriate for green stormwater infrastructure (GSI) retrofit opportunities. Streets were evaluated and scored according to width, slope, and soil permeability utilizing a methodology adapted from the “Promoting Green Streets” report published by the River Network. Preference was given to those highest-scoring road segments in more urban areas.
The methodology was modified to better fit specific conditions found in the study area. The analysis utilized two prerequisites and one secondary consideration.

Prerequisites:
Road Slope

- 1-5% Slope = Ideal (Score: 2 points)
- 5-7.5% Slope = Potential (Score: 1 point)
- >7.5% Slope = Unsuitable (Score: 0 points; discarded from further analysis)

Road Right-of-Way Width

- ≥ 50 ft = Ideal (Score: 2 points)
- 46-50 ft = Potential (Score: 1 point)
- < 46 ft = Unsuitable (Score: 0 points; discarded from further analysis)

Secondary Consideration:
Hydrologic Soil Group (indication of infiltration potential)

- A/B (highest infiltration potential) = Ideal (Score: 2 points)
- B/C (moderate infiltration potential) = Potential (Score: 1 point)
- C/D (lowest infiltration potential) = Unsuitable (Score: 0 points; **not** discarded from further analysis)

The scores from each of the three criteria were added, and a score was assigned for each road segment with higher scores indicating a greater potential for GSI suitability. Those sites with greater potential were noted for assessment in the field.

Using this data, 55 potential locations for stormwater BMPs were identified in the Town. Point locations were generated for each site and an overview map was created displaying these points, their ID numbers, site names, and approximate locations. Watershed generated a spreadsheet including a more complete site description including general site notes and preliminary BMP thoughts. The ID numbers are included in both the table and map so that projects can be easily located.

Results of this effort can be seen in Attachment 2a.1 – Initial Project Locations Map and 2a.2 – Sites List.

The Task 2a Desktop Assessment Summary Memo describes this work.

3.2 *Field Assessment (Task 2b)*

Watershed used the results of Task 2a – Desktop Assessment to target field assessment sites. Each of these sites was visited and the feasibility of implementing stormwater management practices at each site was evaluated in the context of the site. Factors considered include probable or known ownership, location of utilities (if applicable and where evident), soil conditions observed including the potential for season high groundwater, parking or traffic use patterns (particularly for streetscape features), feasibility for construction (particularly with respect to steep slopes or other constraints), ease of hydrologic connections, or other potential factors.

The potential management practice type(s), based on field assessment, was also noted for future consideration.

All information was recorded in the field using the custom developed app prepared during Task 2a. Additional information was derived or inferred from baselayers customized during that same Task.

Of particular note is the field assessment for the Bristol Co-housing site. The field team briefly surveyed the property and spoke with property owners regarding stormwater management of the site. According to the owners, a series of dry wells will be installed on the property to further mitigate stormwater runoff during storms. Given the relatively hydrologically disconnected nature of the site (no catch basins draining directly into municipal infrastructure were noted nor are any mapped), along with the dry wells to be installed, this site was not further assessed as it was deemed to be of lower priority than other sites given the proactive nature and relative completeness of the management features already installed as well as those to be installed.

Results of this effort can be seen in Attachment 2b.1 – Field Assessment Sheets.

4 Prioritization (Task 3)

Each field assessed site was assigned a characteristic based on either observations made in the field or assessments based on review of desktop data. Each characteristic has a related score. It is important to note that we chose to use two different ranking matrices for these sites. There are generally two types of projects that are desirable for municipalities. There are the large and impactful projects that manage a significant area, dramatically improving water quality and mitigating stormwater volumes, and the small and inexpensive projects that are easy to implement. These larger projects are critically important, but they are also often complex to design and implementation is usually more expensive. However, our project team also appreciates the importance of smaller scale distributed GSI projects as these fairly minor and inexpensive improvements can have a large cumulative impact. Additionally, these smaller projects often serve as educational showpieces for a municipality, informing the public about the importance of stormwater management and hopefully encouraging residents to take action on their own properties. These small projects can be as simple as installing a rain garden and a rain barrel, or planting a filter strip along a streambank.

Table 1: Preliminary ranking criteria to prioritize larger, potentially more impactful projects.

Criteria	Description	Score
Drainage Area Size	Large	25
	Medium	10
	Small	5
Pollutant Load Reduction Potential	High	25
	Medium	10
	Low	5
Impervious Area %	Very High (75%-100%)	25
	High (50%-75%)	20
	Medium (25%-50%)	10
	Low (0%-25%)	5
Hydrologic Connectivity	Connected (directly connected to surface waters)	25
	Semi-Connected	10
	Disconnected (disconnected from surface waters)	5
Hydrologic Soil Group	A - High infiltration potential	25
	B - Moderate infiltration potential	10
	C/D - Low or no infiltration potential	0
Land Owner	Municipality Owned (Parcels or Road ROW)	25
	Participatory Private / VTrans	10
	Unknown Private	0
	Non-Participatory Private	-25
Parcel with ≥3 acres of impervious cover, no permit or expired permit	Yes	15
	No	0
Retrofit Priority	Very High	25
	High	20
	Medium	10
	Low	5
	Very Low	0

The small and inexpensive projects are often superseded in rankings by large projects. As such, we have developed two separate preliminary rankings that will be applied to each of the assessed projects. The first (Table 1) is meant to highlight the "large and impactful" projects while the second (Table 2) is meant to capture the "inexpensive and easy" projects. Each project was scored according to each of the criteria listed on both Table 1 and Table 2, and the scores totaled separately for each set of criteria. The projects were then assigned a rank with those scoring higher ranked as more important. The final ranking for the combined "Top 20" list of both types of projects was determined by the relative score for each project. This was determined by calculating the percent of the total points available that the project scored for each ranking.

Table 3: Preliminary ranking criteria to identify smaller, less complicated or less expensive projects.

Criteria	Description	Score
Cost Projection	High (>$50K)	5
	Medium ($10-50K)	15
	Low (<$10K)	35
Design Complexity	Minimal	25
	Medium	10
	Complex	5
Land Owner	Municipality Owned (Parcels or Road ROW)	25
	Participatory Private / VTrans	10
	Unknown Private	0
	Non-Participatory Private	-25
Pollutant Load Reduction Potential	High	25
	Medium	10
	Low	5
Hydrologic Soil Group	A - High infiltration potential	25
	B - Moderate infiltration potential	10
	C/D - Low or no infiltration potential	0
Hydrologic Connectivity	Connected (directly connected to surface waters)	25
	Semi-Connected	10
	Disconnected (disconnected from surface waters)	5
Impervious Area %	Very High (75%-100%)	25
	High (50%-75%)	20
	Medium (25%-50%)	10
	Low (0%-25%)	5
Retrofit Priority	Very High	25
	High	20
	Medium	10
	Low	5
	Very Low	0

4.1 *Results:*

Rows in blue represent projects associated with road rights-of-way. Rows in orange rows represent project associated with drainage infrastructure or have larger drainage areas.

Based on these criteria, the Top 10 sites in Bristol are:

Table 5: Top 10 proposed best management practice sites in Bristol.

Site ID	Rank	Total Percent Score
West_St_002	1	88.1
School_St_001	2	84.21
North_St_001	2	84.21
Shaws	2	84.21
Mountain_St_004	3	83.33
North_St_005	3	83.33
Outfall_4	4	76.32
Church_St_001	5	76.19
Church_St_002	5	76.19
West_St_001	6	73.81

The Top 20 sites in Bristol are:

Table 6: Top 20 proposed best management sites in Bristol.

Site ID	Rank	Total Percent Score
Mountain_St_005	6	73.81
Outfall_3	6	73.81
Liberty_St_001	7	71.43
Kountry_Trailer_001	7	71.43
West_St_003	7	71.43
Munsill_Ave_002	8	69.05
School_St_002	8	69.05
Pleasant_St_004	9	66.67
Munsill_Ave_001	9	66.67
Maple_St_001	9	66.67

A map of these sites can be seen in 3.1 – Prioritized Sites Map. All ranking results can be seen in 3.2 – Prioritized Sites Table. These are provided as Excel spreadsheets. A PDF of all ranked results can be seen in 3.2a – Prioritized Sites Table. Please note that no effort was made to 'break' ties.

5 Proposed Best Management Practices – 30% Concept Designs (Task 4)

Watershed developed four 30% Concept Designs. These can be seen in 4.1 - 30% Concept Designs. Of note – Watershed provided a Preliminary Task deliverable in the form of 'Sketch Concepts' to illustrate possible options. These were meant to illustrate possible options for discussions with project stakeholders. These can be seen in Preliminary Task 4.1 – Sketch Concept Drawings (and are summarized in Preliminary Task 4 – Sketch Concepts Summary Memo).

5.1 *30% Concept Designs*

The four projects selected for 30% Concept Design are:

- School St 001 – Sub-surface Infiltration Chambers
- North St 001 - Sub-surface Infiltration Chambers
- School 1 & 2 - Sub-surface Infiltration Chambers
- West St 002 & 003 – Infiltration Dry Wells

Each section below describes each project in more detail.

5.1.1 *School St 001*

5.1.1.1 *Description:*

A system of sub-surface chambers is envisioned for the School St 001 site. These chambers would sit under the road and parking spaces adjacent to the park and essentially be invisible, other than a manhole structure that would be used for operation and maintenance access. This structure would be flush with the ground.

Figure 2: School St 001 – the system of chambers would go under the parking spaces in the foreground, as well as part of the open space in the park.

We propose to use ADS StormTech MC-4500 chambers at this location as they will maximize storage and infiltration potential. There will be 3 rows of chambers laid out so that the total number of chambers equals 68 for a total storage volume of 12,466 cubic feet. This asymmetric configuration was chosen to minimize disturbance to the park and its associated features such as trees, play structures, and gardens.

Table 7: School St 001 – summary of drainage area characteristics, phosphorus removed (modeled from WinSLAMM and VT DEC's Stormwater Treatment Practice (STP) calculator), and cost per pound P removed.

Impervious Treated (ac)	Total Drainage Area (ac)	Total Phosphorus Removed Annually (WinSLAMM) (lbs.)	Total Phosphorus Removed Annually (VT DEC STP) (lbs.)	Total Solids Removed (WinSLAMM) (lbs.)	Total Cost Per Pound P Removed (VT DEC)	Total Cost Per Pound P Removed (WinSLAMM)
10.2	32.12	9.86	33.99	14,117	$4,560	$15,720

5.1.1.2 *Cost:*

Table 8: Cost projection for School St 001.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
N/A	MOBILIZATION	LS	1	$ 1,500.00	$ 1,500.00
653.55	PROJECT DEMARCATION FENCE	LF	500	$ 1.17	$ 585.00
653.20	TEMPORARY EROSION MATTING	SY	200	$ 2.20	$ 440.00
652.10	EPSC PLAN	LS	1	$ 500.00	$ 500.00
652.20	MONITORING EPSC PLAN	HR	8	$ 37.22	$ 297.76
N/A	CONSTRUCTION STAKING	HR	6	$ 125.00	$ 750.00
				Subtotal:	$ 4,072.76
Chambers - Excavation and Materials					
	EXCAVATION				
203.15	COMMON EXCAVATION	CY	1000	$ 9.86	$ 9,860.00
203.28	EXCAVATION OF SURFACES AND PAVEMENTS	CY	100	$ 21.94	$ 3,291.00
204.20	TRENCH EXCAVATION OF EARTH	CY	150	$ 14.05	$ 2,107.50
	MATERIALS				
	BASE / COVER / SURROUNDING STONE				
629.54	CRUSHED STONE BEDDING (3/4" - 1 1/2" STONE)	TON	650	$ 34.04	$ 22,126.00
	PIPING				
601.0915	18" CPEP	LF	30	$ 64.04	$ 1,921.20
601.0920	24" CPEP	LF	100	$ 61.37	$ 6,137.00
	STRUCTURES AND APPURTENANCES				
604.18	PRECAST REINFORCED CONCRETE DROP INLET WITH CAST IRON GRATE	EACH	2	$ 4,009.29	$ 8,018.58
	GRASS REPLACEMENT				
656.41	PERENNIALS	EACH		$ 8.77	$ -
651.15	SEED	LB	25	$ 7.66	$ 191.50
653.20	TEMPORARY EROSION MATTING	SY	225	$ 2.20	$ 495.00
	PAVEMENT REPLACEMENT (ABOVE CHAMBERS IN PAVED AREAS)				
401.10	AGGREGATE SURFACE COURSE	CY	40	$ 43.60	$ 1,744.00
406.25	BITUMINOUS CONCRETE PAVEMENT	TON	160	$ 127.86	$ 20,457.60
616.26	PRECAST REINFORCED CONCRETE CURB, TYPE B	LF	85	$36.50	$ 3,102.50
	CHAMBERS - ALL COSTS (FROM ADS STORMTECH)				
N/A	MC4500	EACH	60	$ 483.00	$ 28,980.00
N/A	MC4500 PLAIN END CAP	EACH	4	$ 494.50	$ 1,978.00
N/A	MC4500 24B END CAP	EACH	1	$ 682.81	$ 682.81
N/A	MC4500 18T END CAP	EACH	3	$ 682.81	$ 2,048.44
N/A	18" TEE	EACH	4	$ 230.01	$ 920.05
N/A	18" 90 BEND	EACH	1	$ 144.80	$ 144.80
N/A	18" COUPLERS	EACH	8	$ 23.54	$ 188.32
N/A	18" N12 FOR MANIFOLD (AASHTO)	LF	60	$ 15.28	$ 917.01
N/A	24" N12 for Isolater Row (AASHTO)	LF	5	$ 23.06	$ 115.29
N/A	601TG to wrap system (SY)	SY	1000	$ 0.67	$ 667.00
N/A	315WTM for scour protection (SY)	SY	100	$ 0.69	$ 69.00
N/A	6" INSERTA TEE	EACH	1	$ 86.32	$ 86.32
N/A	6" RED HOLE SAW	EACH	1	$ 132.43	$ 132.43
N/A	12" INLINE DRAIN	EACH	1	$ 310.50	$ 310.50
				Subtotal:	$ 116,691.85
Subtotal:					$ 120,764.61
	Construction Oversight**	HR	16	$ 125.00	$ 2,000.00
	Construction Contingency - 10%**				$ 12,076.46
	Incidentals to Construction - 5%**				$ 6,038.23
	Minor Additional Design Items - 5%**				$ 6,038.23
	Final Design	HR	55	$ 125.00	$ 6,875.00
	Permit Review and Applications (exclusive of permit fees)	HR	10	$ 125.00	$ 1,250.00
				Total (Rounded to nearest $1,000)	**$ 155,000.00**

5.1.2 North St 001

5.1.2.1 *Description:*

A system of sub-surface chambers is envisioned for the North St 001 site. These chambers would sit under the park and a portion of the road and essentially be invisible, other than a manhole structure that would be used for operation and maintenance access. This structure would be flush with the ground.

Figure 3: North St 001 – the system of chambers would occupy the open space (underground) to the left of the fire hydrant in this photo and extend down to the fountain in the park (not shown here).

We propose to use ADS StormTech MC-4500 chambers at this location as they will maximize storage and infiltration potential. There will be 7 rows of approximately 18 chambers each for a total storage volume of 22,279 cubic feet. Note that these chambers were shifted slightly out on to North Street in order to minimize impact on the adjacent water fountain and were shifted slightly south to avoid impacts to the fire hydrant on the northeast corner of the park.

Table 9: North St 001 - summary of drainage area characteristics, phosphorus removed (modeled from WinSLAMM and VT DEC's Stormwater Treatment Practice (STP) calculator), and cost per pound P removed.

Impervious Treated (ac)	Total Drainage Area (ac)	Total Phosphorus Removed Annually (WinSLAMM) (lbs.)	Total Phosphorus Removed Annually (VT DEC STP) (lbs.)	Total Solids Removed (WinSLAMM) (lbs.)	Cost per Pound P removed (WinSLAMM) ($)	Cost per Pound P removed (VT DEC STP) ($)
16.09	190.26	29.9	118.36	537,622	$7,325	$1,850

5.1.2.2 *Cost:*

Table 10: Cost projection for North St 001.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
N/A	MOBILIZATION	LS	1	$ 1,500.00	$ 1,500.00
653.55	PROJECT DEMARCATION FENCE	LF	500	$ 1.17	$ 585.00
653.20	TEMPORARY EROSION MATTING	SY	250	$ 2.20	$ 550.00
649.51	GEOTEXTILE FOR SILT FENCE	SY	250	$ 4.13	$ 1,032.50
653.35	VEHICLE TRACKING PAD	CY	30	$ 50.48	$ 1,514.40
652.10	EPSC PLAN	LS	1	$ 500.00	$ 500.00
652.20	MONITORING EPSC PLAN	HR	8	$ 37.22	$ 297.76
N/A	CONSTRUCTION STAKING	HR	6	$ 125.00	$ 750.00
				Subtotal:	$ 6,729.66
Chambers - Excavation and Materials					
	EXCAVATION				
203.15	COMMON EXCAVATION	CY	1625	$ 9.86	$ 16,022.50
203.28	EXCAVATION OF SURFACES AND PAVEMENTS	CY	25	$ 21.94	$ 548.50
204.20	TRENCH EXCAVATION OF EARTH	CY	100	$ 14.05	$ 1,405.00
	MATERIALS				
	BASE / COVER / SURROUNDING STONE				
629.54	CRUSHED STONE BEDDING (3/4" - 1 1/2" STONE)	TON	1050	$ 34.04	$ 35,742.00
	PIPING				
601.0915	18" CPEP	LF	100	$ 64.04	$ 6,404.00
601.0920	24" CPEP	LF	80	$ 61.37	$ 4,909.60
	STRUCTURES AND APPURTENANCES				
604.18	PRECAST REINFORCED CONCRETE DROP INLET WITH CAST IRON GRATE	EACH	3	$ 4,009.29	$ 12,027.87
	PLANTING (ABOVE CHAMBERS IN GREENSPACE)				
651.15	SEED	LB	50	$ 7.66	$ 383.00
653.20	TEMPORARY EROSION MATTING	SY	500	$ 2.20	$ 1,100.00
	PAVEMENT REPLACEMENT (ABOVE CHAMBERS IN PAVED AREAS)				
401.10	AGGREGATE SURFACE COURSE	CY	25	$ 43.60	$ 1,090.00
406.25	BITUMINOUS CONCRETE PAVEMENT	TON	115	$ 127.86	$ 14,703.90
616.26	PRECAST REINFORCED CONCRETE CURB, TYPE B	LF	100	$36.50	$ 3,650.00
	CHAMBERS - ALL COSTS (FROM ADS STORMTECH)				
N/A	MC4500	EACH	112	$ 483.00	$ 54,096.00
N/A	MC4500 PLAIN END CAP	EACH	7	$ 494.50	$ 3,461.50
N/A	MC4500 24B END CAP	EACH	1	$ 682.81	$ 682.81
N/A	MC4500 18T END CAP	EACH	6	$ 682.81	$ 4,096.88
N/A	18" TEE	EACH	7	$ 230.01	$ 1,610.08
N/A	18" 90 BEND	EACH	1	$ 144.80	$ 144.80
N/A	18" COUPLERS	EACH	7	$ 23.54	$ 164.78
N/A	18" N12 FOR MANIFOLD (AASHTO)	LF	100	$ 15.28	$ 1,528.35
N/A	24" N12 for Isolater Row (AASHTO)	LF	20	$ 23.06	$ 461.15
N/A	601TG to wrap system (SY)	SY	2000	$ 0.67	$ 1,334.00
N/A	315WTM for scour protection (SY)	SY	400	$ 0.69	$ 276.00
N/A	6" INSERTA TEE	EACH	1	$ 86.32	$ 86.32
N/A	6" RED HOLE SAW	EACH	1	$ 132.43	$ 132.43
N/A	12" INLINE DRAIN	EACH	1	$ 310.50	$ 310.50
				Subtotal:	$ 166,371.97
Subtotal:					$ 173,101.63
	Construction Oversight**	HR	24	$ 125.00	$ 3,000.00
	Construction Contingency - 10%**				$ 17,310.16
	Incidentals to Construction - 5%**				$ 8,655.08
	Minor Additional Design Items - 5%**				$ 8,655.08
	Final Design	HR	55	$ 125.00	$ 6,875.00
	Permit Review and Applications (exclusive of permit fees)	HR	12	$ 125.00	$ 1,500.00
				Total (Rounded to nearest $1,000)	**$ 219,000.00**

5.1.3 *School 1 & 2*

5.1.3.1 *Description:*

A system of sub-surface chambers is envisioned for the School 1 (northern) and School 2 (southern) sites. These chambers would sit under the playground and essentially be invisible, other than a manhole structure that would be used for operation and maintenance access. This structure would be flush with the ground. Both of these systems may require additional drainage infrastructure (catch basins and pipes) to adequately convey runoff to them. This may complicate construction and increase cost, but not to a prohibitive degree. The system described for School 1 would also be able to treat runoff from the large area above Mountain Street. This could alleviate strain on the existing drainage infrastructure along that road. Note that additional 24” pipe will be need to convey safely overflow from the new splitter structure on Mountain Street down to an existing catch basin. This splitter structure and pipe is necessary to ensure that not all runoff from the large drainage area above Mountain Street is routed to the chamber system on the School property. That could result in more nuisance flooding or groundwater mounding, both conditions that the splitter and pipe will help avoid.

5.1.3.2 *School 1 (northern) Site:*

We propose to use ADS StormTech MC-4500 chambers at this lo cation as they will maximize storage and infiltration potential. There will be 1 row of approximately 11 chambers each for a total storage volume of 2,200 cubic feet. The table below shows the potential drainage area, impervious cover, and total amount of phosphorus washoff in pounds, annually.

Figure 4: School 001 (northern) site. The inlet to the existing dry well is shown in the foreground. The system of chambers would be installed underground directly off the edge of the parking lot's paved area.

Table 11: School 1 (northern) Site - summary of drainage area characteristics, phosphorus removed (modeled from WinSLAMM and VT DEC's Stormwater Treatment Practice (STP) calculator), and cost per pound P removed.

Impervious Treated (ac)	Total Drainage Area (ac)	Total Phosphorus Removed Annually (WinSLAMM) (lbs.)	Total Phosphorus Removed Annually (VT DEC STP) (lbs.)	Total Solids Removed (WinSLAMM) (lbs.)	Cost per Pound P removed (WinSLAMM) ($)	Cost per Pound P removed (VT DEC STP) ($)
2.00	59.59	5.11	24.64	94,720	$20,547	$4,261

5.1.3.3 *Cost:*

Table 12: Cost projection for School 1 (northern) site

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
N/A	MOBILIZATION	LS	1	$ 1,000.00	$ 1,000.00
653.55	PROJECT DEMARCATION FENCE	LF	300	$ 1.17	$ 351.00
653.20	TEMPORARY EROSION MATTING	SY	250	$ 2.20	$ 550.00
649.51	GEOTEXTILE FOR SILT FENCE	SY	200	$ 4.13	$ 826.00
653.35	VEHICLE TRACKING PAD	CY	30	$ 50.48	$ 1,514.40
652.10	EPSC PLAN	LS	1	$ 500.00	$ 500.00
652.20	MONITORING EPSC PLAN	HR	8	$ 37.22	$ 297.76
N/A	CONSTRUCTION STAKING	HR	6	$ 125.00	$ 750.00
				Subtotal:	$ 5,789.16
Chambers - Excavation and Materials					
	EXCAVATION				
203.15	COMMON EXCAVATION	CY	195	$ 9.86	$ 1,922.70
203.28	EXCAVATION OF SURFACES AND PAVEMENTS	CY	10	$ 21.94	$ 219.40
204.20	TRENCH EXCAVATION OF EARTH	CY	20	$ 14.05	$ 281.00
	MATERIALS				
	BASE / COVER / SURROUNDING STONE				
629.54	CRUSHED STONE BEDDING (3/4" - 1 1/2" STONE)	TON	125	$ 34.04	$ 4,255.00
	PIPING				
601.0915	18" CPEP	LF	200	$ 64.04	$ 12,808.00
601.0920	24" CPEP	LF	430	$ 61.37	$ 26,389.10
	STRUCTURES AND APPURTENANCES				
604.18	PRECAST REINFORCED CONCRETE DROP INLET WITH CAST IRON GRATE	EACH	3	$ 4,009.29	$ 12,027.87
	PLANTING (ABOVE CHAMBERS IN GREENSPACE)				
651.15	SEED	LB	10	$ 7.66	$ 76.60
653.20	TEMPORARY EROSION MATTING	SY	100	$ 2.20	$ 220.00
	PAVEMENT REPLACEMENT				
401.10	AGGREGATE SURFACE COURSE	CY	50	$ 43.60	$ 2,180.00
406.25	BITUMINOUS CONCRETE PAVEMENT	TON	50	$ 127.86	$ 6,393.00
	CHAMBERS - ALL COSTS (FROM ADS STORMTECH)				
N/A	MC4500	EACH	11	$ 483.00	$ 5,313.00
N/A	MC4500 PLAIN END CAP	EACH	1	$ 494.50	$ 494.50
N/A	MC4500 18T END CAP	EACH	1	$ 682.81	$ 682.81
N/A	18" TEE	EACH	1	$ 230.01	$ 230.01
N/A	18" COUPLERS	EACH	1	$ 23.54	$ 23.54
N/A	18" N12 FOR MANIFOLD (AASHTO)	LF	15	$ 15.28	$ 229.25
N/A	601TG to wrap system (SY)	SY	250	$ 0.67	$ 166.75
N/A	315WTM for scour protection (SY)	SY	100	$ 0.69	$ 69.00
N/A	6" INSERTA TEE	EACH	1	$ 86.32	$ 86.32
N/A	6" RED HOLE SAW	EACH	1	$ 132.43	$ 132.43
N/A	12" INLINE DRAIN	EACH	1	$ 310.50	$ 310.50
				Subtotal:	$ 74,510.79
Subtotal:					$ 80,299.95
	Construction Oversight**	HR	16	$ 125.00	$ 2,000.00
	Construction Contingency - 10%**				$ 8,030.00
	Incidentals to Construction - 5%**				$ 4,015.00
	Minor Additional Design Items - 5%**				$ 4,015.00
	Final Design	HR	40	$ 125.00	$ 5,000.00
	Permit Review and Applications (exclusive of permit fees)	HR	10	$ 125.00	$ 1,250.00
				Total (Rounded to nearest $1,000)	**$ 105,000.00**

5.1.3.4 *School 2 (southern) Site:*

We propose to use ADS StormTech MC-4500 chambers at this location as they will maximize storage and infiltration potential. There will be 1 row of approximately 12 chambers each for a total storage volume of 2,356 cubic feet. The table below shows the potential drainage area, impervious cover, and total amount of phosphorus washoff in pounds, annually.

Figure 5: School 002 (southern) site. The system of chambers would be installed underneath the open area of the playground. New drainage infrastructure would need to be installed to convey runoff to this practice.

Table 13: School 2 (southern site - summary of drainage area characteristics, phosphorus removed (modeled from WinSLAMM and VT DEC's Stormwater Treatment Practice (STP) calculator), and cost per pound P removed.

Impervious Treated (ac)	Total Drainage Area (ac)	Total Phosphorus Removed Annually (WinSLAMM) (lbs.)	Total Phosphorus Removed Annually (VT DEC STP) (lbs.)	Total Solids Removed (WinSLAMM) (lbs.)	Cost per Pound P removed (WinSLAMM) ($)	Cost per Pound P removed (VT DEC STP) ($)
1.25	2.54	0.35	3.92	335.5	$217,142	$19,387

5.1.3.5 *Cost:*

Table 14: Cost projection for School 2 (southern) site.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
N/A	MOBILIZATION	LS	1	$ 1,000.00	$ 1,000.00
653.55	PROJECT DEMARCATION FENCE	LF	300	$ 1.17	$ 351.00
653.20	TEMPORARY EROSION MATTING	SY	250	$ 2.20	$ 550.00
649.51	GEOTEXTILE FOR SILT FENCE	SY	200	$ 4.13	$ 826.00
653.35	VEHICLE TRACKING PAD	CY	30	$ 50.48	$ 1,514.40
652.10	EPSC PLAN	LS	1	$ 500.00	$ 500.00
652.20	MONITORING EPSC PLAN	HR	8	$ 37.22	$ 297.76
N/A	CONSTRUCTION STAKING	HR	6	$ 125.00	$ 750.00
				Subtotal:	$ 5,789.16
Chambers - Excavation and Materials					
	EXCAVATION				
203.15	COMMON EXCAVATION	CY	205	$ 9.86	$ 2,021.30
203.28	EXCAVATION OF SURFACES AND PAVEMENTS	CY	12	$ 21.94	$ 263.28
204.20	TRENCH EXCAVATION OF EARTH	CY	22	$ 14.05	$ 309.10
	MATERIALS				
	BASE / COVER / SURROUNDING STONE				
629.54	CRUSHED STONE BEDDING (3/4" - 1 1/2" STONE)	TON	135	$ 34.04	$ 4,595.40
	PIPING				
601.0915	18" CPEP	LF	225	$ 64.04	$ 14,409.00
	STRUCTURES AND APPURTENANCES				
604.18	PRECAST REINFORCED CONCRETE DROP INLET WITH CAST IRON GRATE	EACH	3	$ 4,009.29	$ 12,027.87
	PLANTING (ABOVE CHAMBERS IN GREENSPACE)				
651.15	SEED	LB	10	$ 7.66	$ 76.60
653.20	TEMPORARY EROSION MATTING	SY	100	$ 2.20	$ 220.00
	PAVEMENT REPLACEMENT				
401.10	AGGREGATE SURFACE COURSE	CY	50	$ 43.60	$ 2,180.00
406.25	BITUMINOUS CONCRETE PAVEMENT	TON	50	$ 127.86	$ 6,393.00
	CHAMBERS - ALL COSTS (FROM ADS STORMTECH)				
N/A	MC4500	EACH	12	$ 483.00	$ 5,796.00
N/A	MC4500 PLAIN END CAP	EACH	1	$ 494.50	$ 494.50
N/A	MC4500 18T END CAP	EACH	1	$ 682.81	$ 682.81
N/A	18" TEE	EACH	1	$ 230.01	$ 230.01
N/A	18" COUPLERS	EACH	1	$ 23.54	$ 23.54
N/A	18" N12 FOR MANIFOLD (AASHTO)	LF	15	$ 15.28	$ 229.25
N/A	601TG to wrap system (SY)	SY	275	$ 0.67	$ 183.43
N/A	315WTM for scour protection (SY)	SY	120	$ 0.69	$ 82.80
N/A	6" INSERTA TEE	EACH	1	$ 86.32	$ 86.32
N/A	6" RED HOLE SAW	EACH	1	$ 132.43	$ 132.43
N/A	12" INLINE DRAIN	EACH	1	$ 310.50	$ 310.50
				Subtotal:	$ 50,747.15
Subtotal:					$ 56,536.31
	Construction Oversight**	HR	16	$ 125.00	$ 2,000.00
	Construction Contingency - 10%**				$ 5,653.63
	Incidentals to Construction - 5%**				$ 2,826.82
	Minor Additional Design Items - 5%**				$ 2,826.82
	Final Design	HR	40	$ 125.00	$ 5,000.00
	Permit Review and Applications (exclusive of permit fees)	HR	10	$ 125.00	$ 1,250.00
				Total (Rounded to nearest $1,000)	**$ 76,000.00**

5.1.4 *West St 002 and 003 (Dry Wells)*

5.1.4.1 *Description*

Figure 6: This photo shows the area in which dry wells are to be installed during the summer of 2019.

A series of dry wells of different sizes could be used in this are to replace existing catch basins. The dry wells would capture runoff and slowly bleed it off through the perforations in the bottom and sides, with a grate and overflow pipe that would function similarly to a normal catch basin. Each of these structures would be sized to treat the WQv to the maximum extent possible (DW-1 and DW-2 can only treat up to 50% of the WQv). The table below summarizes the cumulative benefits of all five dry wells if installed.

We previously submitted the 30% concept for the West St 002 and 003 dry wells to the Town of Bristol as a 'design/build' concept plan that they plan on constructing prior to paving, which is set to occur this summer. That memo is included as Attachment 4.2 – Dry Well Concept Memo.

Also note that the Town of Bristol elected to modify the concept design the Watershed provided in order to conform with their knowledge of their infrastructure and project goals. Watershed can make no verifications as to the applicability of these changes as the plan was provided as a concept only for 'design/build' by the Town or the Town's chosen contractor. In modifying the concept, the Town also included additional piping that was not part of Watershed's concept design. This affected the overall cost of the project. The cost provided here is the cost for the modifications proposed by Watershed only – not any additional piping between them.

Please note that the table below presents the dry wells cumulatively.

Table 15: West St 002 and 003 Dry Wells - summary of drainage area characteristics, phosphorus removed (modeled from WinSLAMM and VT DEC's Stormwater Treatment Practice (STP) calculator), and cost per pound P removed.

Impervious Treated (ac)	Total Drainage Area (ac)	Total Phosphorus Removed Annually (WinSLAMM) (lbs.)	Total Phosphorus Removed Annually (VT DEC STP) (lbs.)	Total Solids Removed (WinSLAMM) (lbs.)	Cost per Pound P removed (WinSLAMM) ($)	Cost per Pound P removed (VT DEC STP) ($)
3.56	8.93	2.69	8.5	47,675	$11,150	$3,530

5.1.4.2 *Cost:*

Table 16: Cost projection for West St 002 and 003 Dry Wells.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
N/A	MOBILIZATION	LS	1	$ 500.00	$ 500.00
				Subtotal:	$ 500.00
Materials and Excavation					
	EXCAVATION				
203.15	COMMON EXCAVATION	CY	175	$ 9.86	$ 1,725.50
203.28	EXCAVATION OF SURFACES AND PAVEMENTS	CY	80	$ 21.94	$ 1,755.20
204.20	TRENCH EXCAVATION OF EARTH	CY	20	$ 14.05	$ 281.00
	MATERIALS				
	PIPING (CULVERTS)				
601.0905	12" CPEP	LF	20	$ 39.24	$ 784.80
601.0910	15" CPEP	LF	10	$ 34.05	$ 340.50
601.5814	18" CPEP ELBOW	EACH	5	$200.00	$ 1,000.00
601.0915	18" CPEP	LF	20	$ 64.04	$ 1,280.80
	DRY WELLS OR OTHER STRUCTURES				
N/A	DRY WELL STRUCTURE - 8' DIAMETER X 4' HIGH SECTION	EACH	8	$ 800.00	$ 6,400.00
N/A	DRY WELL STRUCTURE - 8' COVER	EACH	5	$ 625.00	$ 3,125.00
613.10	STONE FILL, TYPE I (BACKFILL AROUND STRUCTURE)	CY	100	$ 43.91	$ 4,391.00
604.46	CAST IRON GRATE WITH FRAME, TYPE B	EACH	5	$826.00	$ 4,130.00
649.31	GEOTEXTILE UNDER STONE FILL	SY	150	$ 2.51	$ 376.50
				Subtotal:	$ 25,590.30
Subtotal:					$ 26,090.30
	Construction Contingency - 10%**				$ 2,609.03
	Incidentals to Construction - 5%**				$ 1,304.52
				Total (Rounded to nearest $1,000)	$ 30,000.00

5.2 *Additional Projects to Pursue*

5.2.1 *Other Best Management Practices (Structural):*

There are a number of other sites in the Town of Bristol that could be pursued for additional assessment, design, and potential implementation.

5.2.1.1 *Shaw's Complex*

This site has a landowner (Pomerleau Real Estate) that is willing to implement some type of stormwater management practice. The site is wholly privately owned and will not fall under the State's newly implemented stormwater rule concerning 3-acre impervious coverage sites. At this time, we do not believe that there is any specific action that the Town of Bristol can take with respect to promoting further stormwater management development at this site. The owner may elect, under the State's stormwater rule crediting system, to implement a practice here. However, this remains to be determined.

5.2.1.2 *Fitch Avenue*

The Town of Bristol requested that, due to landowner issues with flooding and runoff entering driveways and basements, that the design team look into the Fitch Avenue to determine the cause of the nuisance flooding as well as to develop suggested solutions. The design team performed this work as part of the field assessment process and discussed their findings with the project stakeholders during a check-in meeting.

The basic summary of the issue is that runoff from the road is claimed to enter the driveway at 11 Fitch Street and then continues on to other properties where it causes nuisance flooding (ponding in yards, basement water intrusion, etc.). Some of this runoff may come from Mountain Street and the large undeveloped area above it – in large storms the shallow depth to bedrock in that undeveloped area may allow water to runoff and on to Mountain Street where it may escape drainage infrastructure there and run on to Fitch Avenue. It is envisioned that the proposed management practice of School 1 (northern) site will alleviate this issue to some degree, though that practice is not, by any means, sized to accept and infiltrate larger (above the 1" water quality volume) storms. This practice may also prevent runoff from the school's parking area and campus from entering some of the properties downstream. Many of these properties are the same ones that are complaining of flooding from Fitch Avenue. In this way, the design team hopes that implementation of the School 1 chamber system will have a positive impact on those properties.

In addition to the School 1 practice, there are a number of other potential options that the Town could implement on Fitch Avenue. They include:

- Installing ditching (potentially paved swales) on both sides of Fitch Avenue, preferably with dry wells to capture and infiltrate runoff, thereby reducing the volume of runoff from all storms. This could potentially eliminate some or all of the nuisance runoff.
- Another option would be to install 'standard' non-perforated catch basins and connecting them to the Town's existing drainage network on North Street. This is not the design team's preferred option as this would increase runoff volume and potential pollutant loading to the outfall from that system.
- The Town could also install a small paved berm at the end of the driveways that are experience nuisance flooding. This would ensure that runoff stays within the road right-of-way. Provisions would be necessary to ensure that that runoff does not then enter another property, effectively transferring the problem downstream. This issue could be alleviated by implementing one of the two solutions suggested above.

In all, this situation seems relatively to resolve in a manner that would eliminate nuisance flooding from private properties as well as reduce runoff volume and pollutant loading to the New Haven River. See the field assessment report in 5.1 – Fitch Avenue – Field Assessment with photos and suggestions underlying each for potential solutions to the issues described above.

5.2.1.3 *Mountain St 004*

Installation of dry wells at this location could reduce runoff volume and pollutant loading to the outfall. This site is also potentially higher priority for solution implementation as Mountain Street receives runoff from the undeveloped but poorly drained area above it. This runoff can result in flooding of the road in larger storms, according to Town staff and project stakeholders. Installation of multiple dry wells in this area may help to alleviate that if sufficient storage volume is created. See 2b.1 – Field Assessment Sheets for additional information.

5.2.1.4 *North St 005*

This site is on North St 005, directly below Fitch Avenue. The road right-of-way is relatively expansive in this location. Installing dry wells in place of standard catch basins would help reduce runoff to the outfall of this system (one of the largest drainage systems in the area of interest). Installation of dry wells could be relatively easy here as the ROW is wide and there appear to be fewer constraints than in other locations along North Street (trees, underground utilities, etc.).

5.2.1.5 *Outfall 4*

This is the outfall associated with the North Street drainage system. The outfall may be within river corridor and floodplain boundaries – mapping is somewhat inconclusive here and needs to be verified with the River Corridor and Floodplain managers for the region. If feasible, an infiltration practice could be installed here. If infeasible due to regulatory and natural resource concerns, this outfall could also be suitable for the installation of a filter system of some sort to be located out of the river corridor and floodplain area. It is important to note that a filter, while potentially effective at removing pollutants from runoff, will have little effect on runoff volume reduction which is important in reducing in-stream erosion which has been noted as an issue in the New Haven River.

5.2.1.6 *Church St 001 and 002*

Installation of dry wells in place of standard catch basins in this area is advised as the area is suitable for infiltration practices, possesses a relatively wide ROW, and does not have as many constraints (mature trees, underground utilities, etc.,) as other areas. Additionally, installing dry wells here would reduce runoff to Outfall 7. This outfall experienced mass slope failure following a large storm in or around 2008 (according to project stakeholders). Reducing runoff volume to this area would be advisable to prevent future slope failures. Dry well practices along Church Street, in concert with the potential chamber system at School St 001 and the dry wells to be installed on West Street could have an appreciable impact on runoff even from larger storms.

These recommendations encompass the remainder of the Top 10 sites that were not selected for 30% concept design. Many of these sites could be further designed relatively simply (with the exception of Outfall 4 which would require more regulatory analysis and advanced solution selection).

For potential solutions outside of the Top 10 sites, 2b.1 – Field Assessment Sheets can be consulted for brief synopses of solutions, many of which include the installation of dry wells in the road ROW. If there is one strategy that the Town of Bristol could pursue in general, installation of dry wells throughout the town would greatly improve stormwater management while reducing runoff volume and pollutant loading to the New Haven River.

5.2.2 *Other Best Management Practices (non-structural and/or general recommendations):*

5.2.2.1 *Implementation of Dry Wells in place of standard catch basins*

We would highly recommend that the Town of Bristol adopt a standard practice of replacing 'standard' catch basins (catch basins with no side or bottom perforations) with dry wells similar to the structures being implemented at West St 002 and 003. This will result in a distributed overall runoff reduction strategy. These structures could be sized to specific drainage areas, as was done for the structures at West St 002 and 003 or could be installed as 'standard' sized structures (8' diameter by 4' or 8' tall for example) which would still result in runoff reduction. The Town of Bristol currently has numerous dry wells throughout the downtown area. However, in communication with Road Foreman Eric Cota, the design team learned that these structures are often only 2' in diameter by 3-5' tall with small (4") perforated pipe acting as additional storage and infiltration practices. According to Mr. Cota, these structures don't work. The design team thinks this is because they are undersized with respect to the volume of runoff and sediment they receive, resulting in frequent clogging. Using a larger structure will alleviate this issue. The dry wells can then be connected to the existing pipe network, if desired, to provide defined overflow pathways. They can also be used as standalone practices to manage runoff in certain areas.

5.2.2.2 *Adopt Town-specific Stormwater Bylaws*

Many towns in Vermont are working to adopt Town-specific stormwater bylaws, whether as part of an MS4 permit or as an initiative to preserve water quality and protect infrastructure within their jurisdiction. These bylaws are meant to complement the VT DEC stormwater regulations for 'sub-jurisdictional' development (essentially any development that would not be covered under a State stormwater permit).

In order to encourage the adoption of such practices, the Vermont League of Cities and Towns (VLCT) has created a set of model bylaws addressing site development during all phases of construction: pre-, during, and post-construction stormwater management practices designed to minimize soil disturbance, reduce or eliminate sediment-laden runoff, and manage site-specific stormwater after construction has finished. These bylaws are intended to be modified by each municipality to fit their desired goals.

To support adoption of these bylaws, the VLCT has also prepared a manual and sizing tool titled the Vermont Green Stormwater Infrastructure Simplified Sizing Tool for Small Projects. Debuted in October, 2015, this manual and tool are specifically aimed at small, sub-jurisdictional sites in Vermont.

Adopting bylaws and encouraging the use of the simplified small sites sizing tool in Bristol could have a net benefit for the Town in terms of reduction of load on existing stormwater infrastructure and pollutant removal enhancement - ensuring compliance with the Lake Champlain TMDL. Jurisdictional stormwater regulations may not guarantee that cleanup goals are met – and not meeting those goals could lead to stricter regulations across a broader array of sites. Enacting a Town-specific program now could prevent further regulations in the future. A model for this program and tools for implementation can be found as part of 1b.2 – Relevant Documents (part of the Task 1b Data Library).

5.2.2.3 *Adopt and Promote Usage of the VT DEC's Guide to Stormwater Management for Homeowners and Small Businesses*

This guide is specifically aimed at sub-jurisdictional stormwater management practices that are easy for residents and small businesses to adopt. It contains helpful explanations of each practice, along with illustrations for each, and other resources to use when considering implementing stormwater management on small properties. Encouraging the adoption of the guidelines laid out in this manual could have an appreciable cumulative impact on water quality in the Town of Bristol. That document can be found here: https://dec.vermont.gov/sites/dec/files/wsm/erp/docs/2018-06-14%20VT_Guide_to_Stormwater_for_Homeowners.pdf

5.2.2.4 *Enact Town-wide Illicit Discharge Detection and Elimination (IDDE) Program*

The Town of Bristol was the beneficiary of a grant through the VT DEC that investigated the presence of illicit discharges in and around the Town. Watershed conducted this work and did not find any confirmed illicit discharges, though a connection was found between the high school pool overflow and a stormwater outlet, though this connection does not qualify as an illicit discharge.

Currently, the Town does not have its own IDDE program. As many illicit discharges are the result of broken sanitary or stormwater infrastructure (sagging or broken pipes, leaks in old clay-tile pipe joints, etc.), it is recommended that that Town adopt a town-specific IDDE program that conducts an annual dry weather outfall survey to look for water flowing during periods of no precipitation. This could lead to the regular detection of illicit discharges, dumping, or other issues. Now that the Town possesses updated stormwater system mapping information, as well as sanitary sewer mapping information, this process could be economical.

6 Next Steps and Recommendations:

We have the following recommendations for the Town to pursue with respect this stormwater master plan:

- Seek final design funding for the combined projects of School St 001 and North St 001 (both infiltration chamber systems). This funding could be obtained from the Ecosystem Restoration Program (ERP) or Clean Water Fund (CWF). Once final design has been completed, implementation funding could be sought through the same program. Note – this funding will not pay for design and implementation as part of the same grant.
- Seek design funding for the School 1 and School 2 projects through the same program as above. In general, this program favors working with school campuses. This campus is not part of the VT DEC's initial so-called 'green schools' project. However, as the 'green schools' program (a program envisioned to create a dedicated funding stream for assessment and implementation of stormwater management practices on Vermont school campuses) develops, there is likely to be dedicated for projects of this nature.
- Implement the suggested solutions on Fitch Avenue. Funding for this may be obtained through the ERP/CWF programs, though the Lake Champlain Basin Program (LCBP) may have implementation funding for this type of small project (provided that it specifically addresses stormwater management and pollutant reduction, not just nuisance flooding elimination).
- Conduct further (30% design) for a practice to manage stormwater at Outfall 4 near the outfall. This location could very beneficial for stormwater management practice solution development. However, it is also one of the most constrained outfalls at which to develop a potential solution. Funding could be available through either the VT DEC ERP or LCBP grants programs mentioned above.
- Adopt a general practice of installing dry wells instead of standard catch basins. The first step in this process is documenting the construction process for the dry wells on West Street and developing a 'best practices' method based on experiences with that process. This should be memorialized by Town staff for future reference.
- Review and consider adopting the Vermont League of Cities and Towns stormwater bylaw. This should be incorporated into the Town's planning and zoning process.