Colchester
VERMONT

781 Blakely Road • Colchester, Vermont • 05446 • 802.264.5500

www.colchestervt.gov

March 18, 2022

Christy Witters
Vt. Department of Environmental Conservation
Watershed Management Division
1 National Life Drive, Main 2
Montpelier, Vermont 05620-3522

Dear Ms. Witters:

Attached is the Town of Colchester's 2021 MS4 Annual Report. Included in this report are the following documents:

- 2021 Annual Report Form
- Annual Report Workbook
- BMP Tracking Table
- Attachments supporting our Annual Reporting Workbook

These will all be submitted via the ANR Online Portal.

Please give me a call at 264-5620 if you require any additional information or have any questions.

Sincerely,

Bryan K. Osborne
Director of Public Works
E: bosborne@colchestervt.gov
P: 802.264.5620 | F: 802.264.5503

VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WATERSHED MANAGEMENT DIVISION
STORMWATER PROGRAM

Municipal Separate Storm Sewer System (MS4) 2021 Annual Report

A. Permittee Information

1. Name of MS4: Town of Colchester

2. Permit Number: 7023 - 9014

B. Attached Documents

The following documents have been prepared and submitted with this Annual Report:

- ✔ Annual Report Workbook (.xlsx)
- ✔ BMP Tracking Table (.xlsx)

C. Certification of STPs constructed to comply with the FRP or PCP

The following BMPs were built or implemented within the past calendar year and were constructed in compliance with the approved Flow Restoration Plan (FRP) or Phosphorus Control Plan (PCP).

Name of System	Location
Police Station Outfall Improvements	Colchester Police Station, 835 Blakely Road

Kirstin DiPietro Worden
Name of Qualified Designer

Sr. Environmental Engineer, Hoyle Tanner Associates
Title

Kirstin DiPietro Worden
Signature

March 8, 2022
Date

D. MS4 Operator Certification

This Annual Report shall be signed by a principal executive officer, ranking elected official or other duly authorized employee consistent with 40 CFR §122.22(b) and certified as follows:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Aaron Frank
Print Name

Town Manager
Title

Signature

3/16/2022
Date

Appendix A - List of Attachments to 2021 MS4 Annual Report – Town of Colchester

Regional Stormwater Education Program
110 West Canal Street, Ste 202
Winooski, VT 05404

Invoice

Date	Invoice #
9/13/2021	153

Bill To
Karen Adams Technical Services Manager Town of Colchester PO Box 55 Colchester, VT 05468

Terms
Due on receipt

Quantity	Description	Rate	Amount
1	FY22 Annual Dues ReThink Runoff (formerly RSEP & CCST)	6,000.00	6,000.00

Thank you!

Total $6,000.00

KAA 9·13·21
210434 - 480015

Minimum Control Measure #1:

Public Education & Outreach

REGIONAL STORMWATER EDUCATION PROGRAM

RETHINK RUNOFF

JANUARY–DECEMBER 2021

ANNUAL REPORT

Prepared by:

Pluck

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Introduction

Since 2003, Chittenden County's twelve MS4s have worked to pool resources to professionally engage the public in a one message, one outreach effort known as the Regional Stormwater Education Program. Through regular spring and summer advertisements to drive people to the program's website, www.smartwaterways.org, this cooperative approach to fulfilling its NPDES Permit Minimum Control Measure #1 (Public Education & Outreach) requirements has built a regional awareness among the public of the need for individual action to assist in fighting stormwater problems.

In the summer of 2016, the MS4s contracted with Tally Ho through their Lead Agency, the Chittenden County Regional Planning Commission, to rebrand the Smart Waterways campaign into a combined effort with the MS4's Minimum Measure #2 regional effort known as the Chittenden County Stream Team. The goal was to create one cohesive organization and outreach effort to both educate the public about stormwater and boost public participation in implementation of projects to combat the negative impacts of stormwater. In spring of 2017, Rethink Runoff was publicly launched, including a new website and revised creative by Pluck (previously Tally Ho Design).

Pluck has been responsible for the creative, administration, and management of Rethink Runoff since late 2017.

This 2021 calendar year report recaps the work done primarily related to Minimum Control Measure #1. As in prior years, this work us developed through coordination with CCRPC and its MS4 subcommittee of the Clean Water Advisory Committee.

2021 Initiatives

In 2021, Pluck maintained existing creative for advertising, while introducing certain web initiatives and introducing social media in the 2021-2022 fiscal year, all for the purpose of continuing to drive residents to visit the program website, www.rethinkrunoff.org. We continued our Ms. Drop's Tip of the Month promoted animation as a way of providing monthly and seasonal topics related to stormwater runoff *(A on page 3.)*

We introduced HTML5 animations onto our What You Can Do interior pages on the website *(F on page 4)*. These short, repeatable animations are based on our existing visual language and provide on-screen movement to web visitors.

We set up tracking onto the websites for conversions (or actions our visitors take while visiting the website). Our first conversion to be tracked was a downloadable pdf with instructions on How to Build a Rain Barrel. Rain Barrel workshops often book to capacity and are also restricted to residents by the host city or town, so including a downloadable pdf on the site allows us to measure of interest in visitors doing DIY stormwater-related projects.

During 2020–2021, we discussed our approach to rain gardens with the subcommittee. Rain gardens are inherently expensive to install, when compared with other initiatives, like installing rain barrels. With that in mind, we created a new downloadable pdf *(B on page 3)* identifying plants used in rain gardens that homeowners could use in their gardens, to help alleviate stormwater runoff. The overall strategy was to identify and include a low-cost options for homeowners, allowing them to take action to reduce stormwater runoff, thereby raising awareness.

In Fall 2021, we introduced Google Search ads to complement our Google Display ads and YouTube ads *(E on page 4)*. Whereas Google Display ads are graphic-based ads served on websites based on content (i.e. fertilizer-related ads on a site about lawn care), Google Search are text-based ads shown in response to users' searches. In this way, we're able to provide a presence and a direct call to action. For example, we created a series of Search ads offering non-fertilizer-based lawn care ads designed to be seen when users searched for "fall lawn care tips" or related topics.

Starting in the fall of 2021, we also began to strengthen social media development as well as implementation of social media content. Our social media strategy focuses on Facebook and Instagram, our existing social media channels. Our work here complements the outreach efforts of MCM #2 effort, the Rethink Runoff Stream Team, administered by the Winooski Natural Resources Conservation District. Our overall strategy includes posting brand-related content, Lake Champlain news, general water pollution/clean water news *(C on page 3)*, and Instagram-based engagement from Vermont residents (i.e. reposting Lake Champlain and Vermont waterways photography). In some cases, social media posts are promoted via ads, based on target MS4 audiences *(D on page 3)*.

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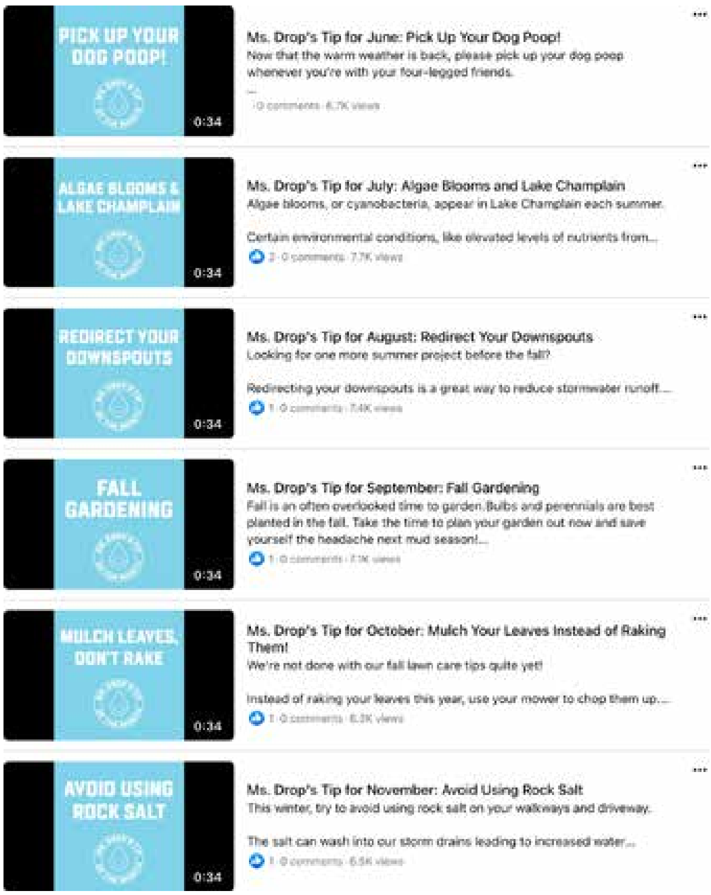
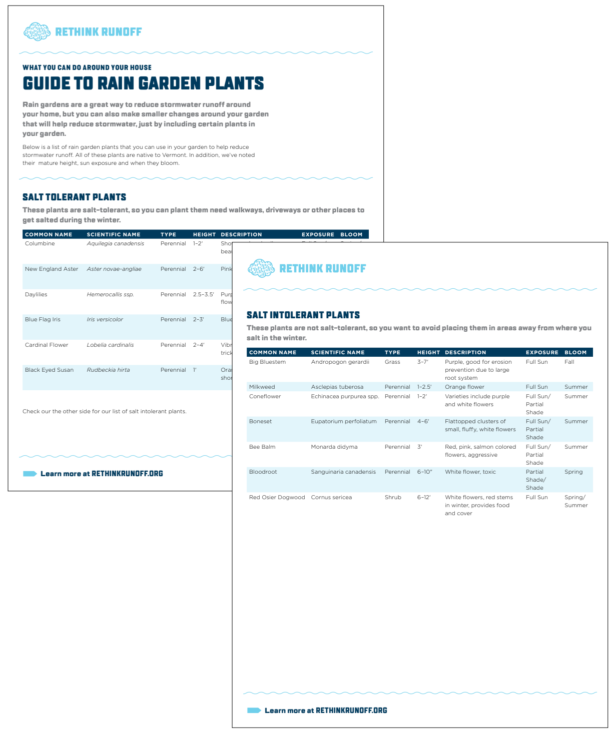
2021 Creative

A. SOCIAL MEDIA ANIMATIONS: SAMPLE VIDEOS



B. RAIN GARDEN PLANTS PDF



RETHINK RUNOFF

WHAT YOU CAN DO AROUND YOUR HOUSE

GUIDE TO RAIN GARDEN PLANTS

Rain gardens are a great way to reduce stormwater runoff around your home, but you can also make smaller changes around your garden that will help reduce stormwater, just by including certain plants in your garden.

Below is a list of rain garden plants that you can use in your garden to help reduce stormwater runoff. All of these plants are native to Vermont. In addition, we've noted their mature height, sun exposure and when they bloom.

SALT TOLERANT PLANTS

These plants are salt-tolerant, so you can plant them need walkways, driveways or other places to get salted during the winter.

COMMON NAME	SCIENTIFIC NAME	TYPE	HEIGHT	DESCRIPTION	EXPOSURE	BLOOM
Columbine	*Aquilegia canadensis*	Perennial	1-2'			
New England Aster	*Aster novae-angliae*	Perennial	2-6'			
Daylilies	*Hemerocallis ssp.*	Perennial	2.5-3.5'			
Blue Flag Iris	*Iris versicolor*	Perennial	2-3'			
Cardinal Flower	*Lobelia cardinalis*	Perennial	2-4'			
Black Eyed Susan	*Rudbeckia hirta*	Perennial	1'			

Check our the other side for our list of salt intolerant plants.

Learn more at RETHINKRUNOFF.ORG

RETHINK RUNOFF

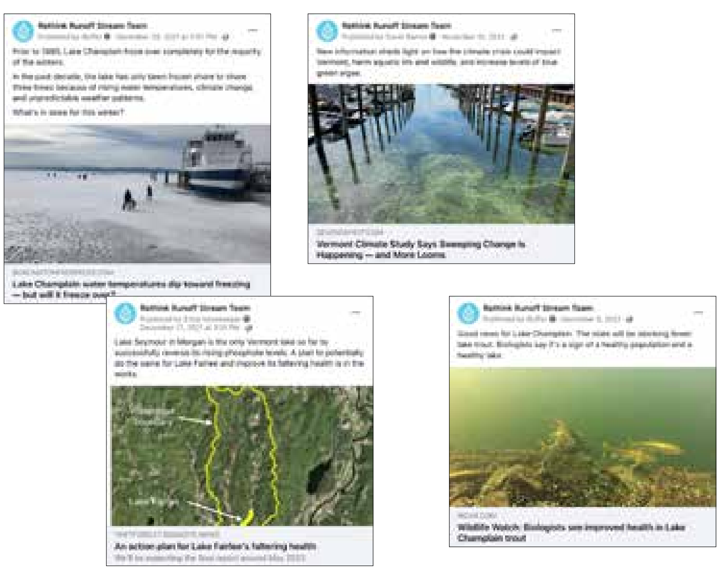
SALT INTOLERANT PLANTS

These plants are not salt-tolerant, so you want to avoid placing them in areas away from where you salt in the winter.

COMMON NAME	SCIENTIFIC NAME	TYPE	HEIGHT	DESCRIPTION	EXPOSURE	BLOOM
Big Bluestem	Andropogon gerardii	Grass	3-7'	Purple, good for erosion prevention due to large root system	Full Sun	Fall
Milkweed	Asclepias tuberosa	Perennial	1-2.5'	Orange flower	Full Sun	Summer
Coneflower	Echinacea purpurea spp.	Perennial	1-2'	Varieties include purple and white flowers	Full Sun/ Partial Shade	Summer
Boneset	Eupatorium perfoliatum	Perennial	4-6'	Flattopped clusters of small, fluffy, white flowers	Full Sun/ Partial Shade	Summer
Bee Balm	Monarda didyma	Perennial	3'	Red, pink, salmon colored flowers, aggressive	Full Sun/ Partial Shade	Summer
Bloodroot	Sanguinaria canadensis	Perennial	6-10"	White flower, toxic	Partial Shade/ Shade	Spring
Red Osier Dogwood	Cornus sericea	Shrub	6-12'	White flowers, red stems in winter, provides food and cover	Full Sun	Spring/ Summer

Learn more at RETHINKRUNOFF.ORG

C. SAMPLE SOCIAL MEDIA POSTS: NEWS



D. SAMPLE SOCIAL MEDIA POSTS: CONTENT

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2021 Creative

E. SEARCH ADS: SAMPLE COPY AND VARIABLE HEADLINES

Winterize Your Lawn This Fall | Prep Now for Green Grass Later | 5 Tips to Winterize Your...
www.rethinkrunoff.org
Try these five fertilizer-free lawn care tips for green grass next summer. Avoid fertilizers wit...
View assets details

Rain Gardens Reduce Runoff | Choose Plants to Reduce Runoff | Can Plants Reduce Runoff? ...
www.rethinkrunoff.org
By choosing certain plants, you can reduce stormwater runoff & keep Lake Champlain...
View assets details

Build a Rain Barrel This Fall | Rain Barrels Reduce Runoff | DIY Rain Barrel Instructions...
www.rethinkrunoff.org
Build a rain barrel to help reduce stormwater runoff around your house. Keep rainwater aw...
View assets details

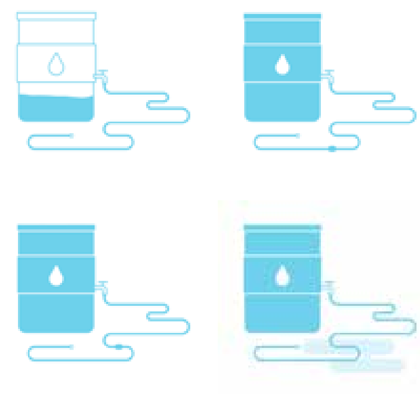
- Plan Your Garden This Fall
- Choose Plants to Reduce Runoff
- Can Plants Reduce Runoff?
- Rain Gardens Reduce Runoff
- By choosing certain plants, you can reduce stormwater runoff & keep Lake Champlain clean.
- Fall is the best time to plan out your gardens. Choose plants that will reduce runoff.
- Find out what plants can help reduce rainwater around your home
- Choose plants that reduce rainwater runoff with our handy guide

- Rain Barrels Reduce Runoff
- DIY Rain Barrel Instructions
- Reduce Your Water Bill
- Rain Barrels Reduce Water Use
- Build a Rain Barrel This Fall
- Want to Build a Rain Barrel?
- One More DIY Fall Project
- Collect rainwater and use it on your garden and plants.
- Build a rain barrel to help reduce stormwater runoff around your house.
- Reduce stormwater runoff and keep Lake Champlain clean with a rain barrel.

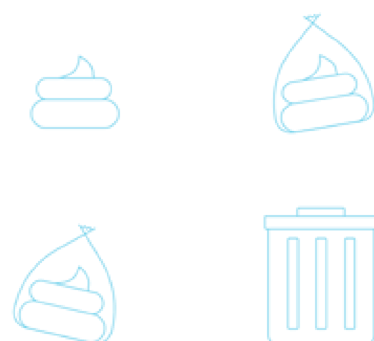
- Prep Your Lawn for Next Spring
- Fall Lawn Care That Works
- Prep Now for Green Grass Later
- 5 Tips to Winterize Your Lawn
- Toss The Scotts For Lawn Care
- 5 Fertilizer-Free Lawn Tips
- Winterize Your Lawn This Fall
- Why Rake Leaves? Mow & Mulch
- Skip The Fertilizer & Do This
- Avoid fertilizers with these five key tips. Your lawn and Lake Champlain will thank you!

F HTML 5 ANIMATIONS

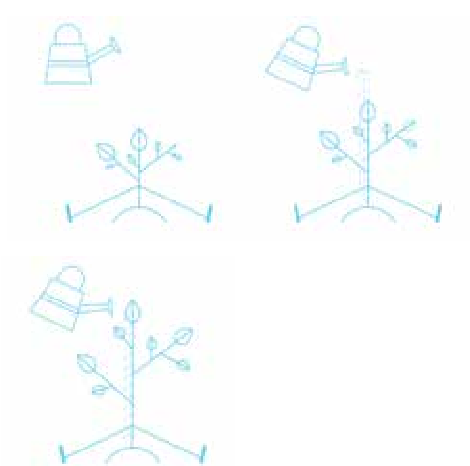
RAIN BARREL



PET WASTE



PLANTING A TREE



Media Buy Breakdown

Below is a cost breakdown of media buys, compared with previous years. We continued our Winter Campaign with a focus on both pet waste and reducing salt use. Similar to our past efforts to shift outreach year-round, our Winter Campaign ran in January and February, traditionally a quieter time from an advertising standpoint.

Digital media buys include Google ads, Facebook ads and WCAX. TV includes WCAX and Xfinity media buys.

Overall ,our 2021 media buy strategy continued earlier efforts to create a more year-round approach. For 2021, we reduced our broadcast spend, pushing more into digital/digital video (Facebook, Google and YouTube).

In Fall 2021, we introduced Google Search ads, to complement Google Display ads and YouTube ads.

On the social media front, we also began promoting content-based posts that also offered a direct Call-To-Action leading to our website.

2016 – MEDIA BUY			
SOURCE	SPRING	SUMMER	FALL
RADIO	$4,500	-	$3,258
DIGITAL	$7,500	-	$4,985
TV	$5,500	-	$2,379
PRINT	$2,500	-	
TOTAL	$20,000	-	$10,622

2017 – MEDIA BUY			
SOURCE	SPRING	SUMMER 05/28-08/02	FALL
RADIO	$3,088	-	$1,080
DIGITAL	$3,600	$3,826	$4,582
TV	$2,015	-	$1,833
PRINT	$1,755	$585	$1,170
TOTAL	$13,191	$4,235	$8,666

2018 – MEDIA BUY			
SOURCE	SPRING	SUMMER 6/16-08/27	FALL
RADIO	$2,675	-	$1,044
DIGITAL	$3,394	$7,534	$2,987
TV	$3,710	-	$2,472
PRINT	$1,755	-	$1,006
TOTAL	$11,534	$7,534	$7,509

2019– MEDIA BUY				
SOURCE	WINTER	SPRING	SUMMER* 5/27-09/2	FALL
RADIO	$360	$1,008		$1,025
DIGITAL	$1,800	$2,320	$5,830	$3,000
TV		$5,830		$3,306
PRINT	$503	$2,012		$1,006
TOTAL	$2,663	$11,170	$5,830	$7,509

2020– MEDIA BUY				
SOURCE	WINTER	SPRING	SUMMER 7/1-9/1	FALL
RADIO		$375		$375
DIGITAL	$1,800	$4,557.51	$400	$3,430.33
TV		$5,788.75		$2,063.83
PRINT		$1,579.50		$1,053
TOTAL	$1,800	$12,301	$400	$6,922

2021– MEDIA BUY				
SOURCE	WINTER	SPRING	SUMMER 7/1-9/1	FALL
RADIO	$725.40	$375		$375
DIGITAL	$2,640.00	$7,380.00	$3,429.45	$4195.54
TV		$5,600.00		$680
PRINT		$1,455.00		$1,053
TOTAL	$3,365.40	$14,810	$3,429.45	$6,922

Media Buy Breakdown by Vendor

CAMPAIGN	WINTER	SPRING	SUMMER	FALL
WCAX BROADCAST		X		X
XFINITY BROADCAST		X		
GOOGLE	X	X	X	X
YOUTUBE		X	X	X
VTDIGGER.ORG				
VPR RADIO	X			X
WVMT RADIO		X		X
SEVEN DAYS		X		X

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Google Advertising Metric

CAMPAIGN	IMPRESSIONS	INTERACTIONS	COST
DISPLAY	3,405,317	3,287	$4,755.87
VIDEO	571,872	339,690	$5,704.81
SEARCH	20,488	419	$768.16

Impressions are the number of times the ads are served to web users. For Display and Search, Interactions are the number of times a web user clicks on the ad.

Video ads are consider pre-roll or mid-roll, meaning they are shown either directly before, or in the middle of a video the web user is watching. These ads are typically skipable after the first five seconds. Interactions include web users who click on the ads, or watch the entire ad.

Facebook Advertising Metrics

CAMPAIGN	IMPRESSIONS	CLICKS	REACH	COST
MS. DROP	113,535	618	21,083	$2,054.92
FALL 2021	571,872	87	42,513	$680.23
WINTER 2021	10,432	139	2,258	$200.70
PAGE LIKES	3,142	10	1,390	$55.09

Impressions are the number of ads served to Facebook users. Clicks are the number of people who click on an ads. Reach is the number of individual Facebook users that see the ad.

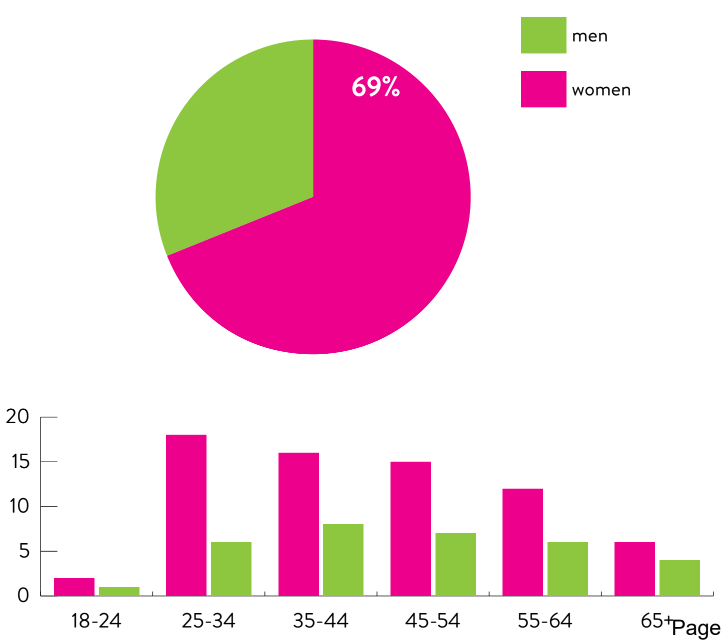
Our increased focus on social media also provides us with age- and gender-related information about users who like our Facebook page (Likes) and individuals who follow our Instagram page (Followers).

In this case, reach refers to the overall unique users in each platform that have seen our posts, either through other users liking and sharing our content, users using the Explore features, or users who see promoted posts.

Facebook Likes Demographics

Facebook Reach: 60,998

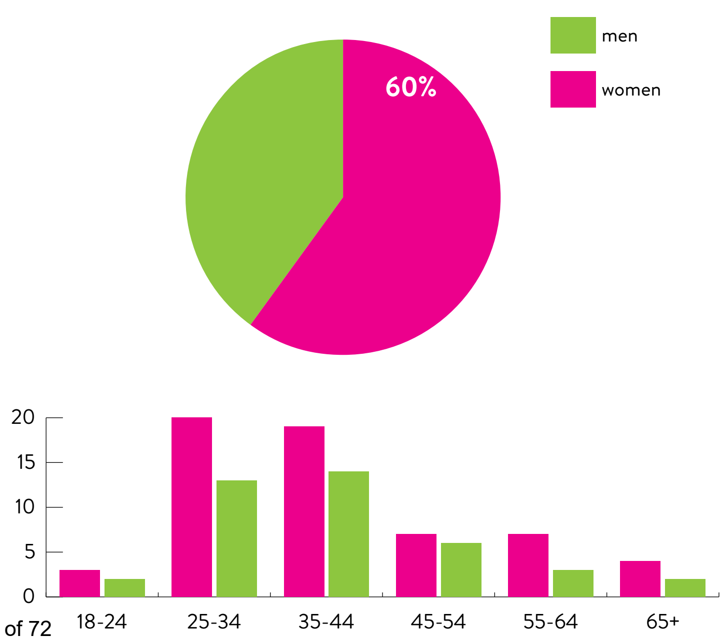
Likes: 318



Instagram Follower Demographics

Instagram Reach: 19,384

Followers: 349



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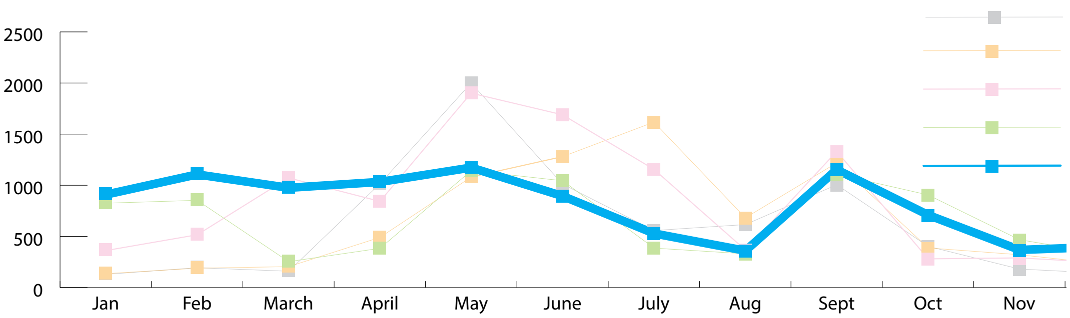
e hello@pluckvermont.com w pluckvermont.com

Website Metrics for 2016–2021

Our 2021 website metrics bounced back after a slower 2020 calendar year (due to COVID). Overall, our users, sessions and page views all increased by close to 20% when compared with 2020. In addition, when compared with 2019 (the last full pre-COVID year), our sessions (10,557 vs. 10,111), users (9,436 vs. 8,531), and pageviews (16,001 vs. 15,769) increased as well.



	2021	2020	2019
SESSIONS	10,557	8,908	10,111
USERS	9,436	7,861	8,531
PAGEVIEWS	16,001	13,112	15,769

Total Sessions/Visits (1/1—12/31)

TOTAL	TIME PERIOD
10,557	2021
8,908	2020
10,111	2019
7,832	2018
7,407	2017
6,004	2016
4,659	2015
7,728	2014
3,541	2013
2,787	2012

Top Vermont Cities and Towns

TOTAL	USERS
BURLINGTON*	1,152
SOUTH BURLINGTON*	589
COLCHESTER*	539
ESSEX*	487
SHELBURNE*	196
STOWE*	65
JERICHO	58
WILLISTON	51
MIDDLEBURY	28
MONTPELIER	27

MILTON: 13
WINOOSKI 6

* SAME POSITION AS LAST YEAR

Website Visits by Device

DEVICE	2021	2020	2019	2018	2017	2016
DESKTOP	46.9%	51.25	40.2%	50.1%	52.8%	65.7%
MOBILE	44.6%	41.28%	44%	40.6%	36.4%	24.5%
TABLET	8.5%	7.47%	15.8%	9.3%	10.8%	9.8%

Most Visited Pages

PAGE	TOTAL
HOMEPAGE	4,465 (27.90%)
/EDUCATIONAL-RESOURCES/PICK-UP-DOG-POOP/	1,239 (7.74%)
/WHAT-YOU-CAN-DO/	1,076 (6.72%)
/EDUCATIONAL-RESOURCES/REDUCE-ROAD-SALT/	702 (4.39%)
/THE-STREAM-TEAM/	551 (3.44%)
/WHAT-YOU-CAN-DO/REDUCE-FERTILIZER-USE/	551 (3.44%)
/WHAT-YOU-CAN-DO/PICK-UP-DOG-POOP/	528 (3.30%)
/WHAT-YOU-CAN-DO/PLANT-A-RAIN-GARDEN/	472 (2.95%)
/EDUCATIONAL-RESOURCES/FOR-KIDS/CREATE-YOUR-OWN-WATER-CYCLE/	460 (2.87%)
/EXPLORE-THE-LAKE-CHAMPLAIN-BASIN/	410 (2.56%)

Website Event Tracking

DEVICE	2021	2020
MAILCHIMP FORM	48	61
RAIN GARDEN PDF	56	N/A
RAIN BARREL PDF	17	8
SOIL TEST CTA	18	5
SCIENCE EXPERIMENT PDF	15	N/A

Frequently Asked Questions

Q: ***What can I do on my property to improve water quality?***

Answer: Find any and all ways to repurpose rain water. Install a rain barrel and use the water you collect to wash your car, or water your plants. Also, check out the **BLUE CVT** program— more details on the inside panel!

Q: ***Can I have my stormwater utility fee automatically deducted from my bank account, like I do with my property taxes?***

Answer: Currently the answer is no, however we have begun to look into this and are hopeful that we can offer this service in the future.

Below: Examples of Residential Rain Barrels

Water Quality Testing

Annual water quality testing at public recreation areas will again be conducted this summer. The testing will occur over ten weeks beginning mid-June and continuing through the end of August. 12 Samples are taken on Mondays and Wednesdays and sent to a water quality testing lab to ensure the waters are safe for swimming and other recreational sports.

In the unlikely event of a beach closure, signs will be posted at swimming areas and additional tests will be completed until it is determined the water is safe for swimming. Tests results and a map of testing locations are available on the stormwater utility website.

Stormwater Utility Information

The Town's stormwater utility began in 2017 as part of the Malletts Bay Initiative. The utility implements clean water programs, manages capital projects, and oversees regulations designed to improve and protect the community's water resources. For more info:

www.colchestervt.gov/1837/StormwaterUtility

Water Quality Hotline: **(802)-264-5628**

General stormwater inquiries: **(802)-264-5620**

PRST STD
US POSTAGE
PAID
Burlington, VT
05401
Permit#478

ECRWSS

POSTAL PATRON

TOWN OF COLCHESTER
781 Blakely Road
Colchester, VT 05446

CLEAN WATER NEWSLETTER

Town of Colchester
Stormwater Utility

CLEAN WATER NEWSLETTER
SPRING 2021

Above: A view looking back at Colchester while walking on the causeway.

Do Not FEAR.. Warmer Temperatures are HERE!

In this latest Clean Water Newsletter from the Colchester Department of Public Works, we will be discussing:

- Spring Yard Cleanup Tips
- BLUE® CVT Program
- Upcoming/ Completed Stormwater Utility Projects
- Summer Water Quality Testing

Did You Know?

The Public Works Department's Smith Creek Water Quality Study was recently featured by the American Public Works Association. To check out the article, visit **tinyurl.com/ColchesterVTStudy**

Spring Yard & Brush Cleanup Tips

1. Keep and use your Lawn Clippings

Yard waste is a major source of pollution in surface waters. Leaves and lawn clippings make their way to streams and rivers, raising nitrogen and phosphorus levels to the point where it can be dangerous for most aquatic wildlife.

When mowing your lawn, keep clippings off of sidewalks, streets, and driveways. If unable to mulch your clippings, bag the clippings and store them in a compost area where the organic material can be used as a fertilizer as a later date.

Please do not dump yard waste along streams, near catch basins, or near storm drains.

2. Clean up after pets!

Pet waste that is left on the landscape to decompose contains bacteria that is harmful to waterways. Pick up pet waste and place in the garbage, or look into dog waste composting—there are dog-specific, affordable and effective options available.

3. Remove leftover winter salt or sand

Salt and sand are another growing hazard to waterways. Increased salt levels in surface waters can raise salinity levels high enough to kill vegetation and endanger marine wildlife. Please check your site to ensure excess salt or sand from the winter is removed or stored out of the rain for next season. The Town does this on our 91 miles of roadways using the street sweeper.

4. Fertilize with care

Consider testing your soil to be sure fertilizer is needed. $15 soil tests are offered by UVM —call 656-3030 for more information. Use fertilizers sparingly and sweep up any that falls on driveways, sidewalks and walkways. Excess fertilizer will wash away in spring rains, polluting your local waterways with phosphorus and wasting your hard earned money. **Avoid spreading fertilizers on windy days, or days where it is going to rain.**

Upcoming Water Quality Projects

– Galvin Hill and Coon Hill Drainage Work

This summer 2021 project involves roadway improvements including restoration of roadside ditches, installing new culverts and headwalls, and replacing older culverts. These 80% grant funded improvements will be occurring along approximately 1,350 feet of roadway on Coon Hill Road, and 1,000 feet of Galvin Hill Road.

– Police Station Outfall Improvements

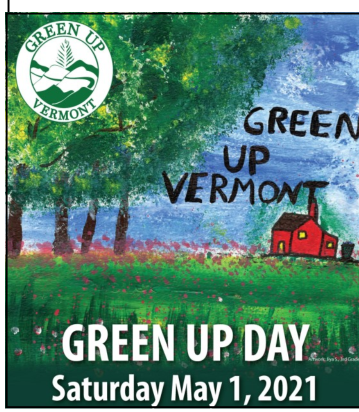
This project includes repair work on a Town-owned outfall located behind the Police Station that drains 3.7 acres of impervious surface to Smith Creek. The Public Works Department has received 100% grant funding for this construction project from the State of VT. Construction will take place between early June and late August 2021.

– Stormwater Pipe Lining

Over the next two months the Department of Public Works will be overseeing the lining of 1,000 linear ft of stormwater piping. This is a less costly method of restoring the structural integrity of these pipes than having to dig up public roadways, which eliminates traffic disruptions and minimizes costs to utility customers.

May 1st: Green Up Day

Green Up Day 2021 is Saturday, May 1st! Green up bags will be available for contactless pickup at the Police Station beginning April 24th. A sign-up sheet will be located outside the front entrance for people to put # of bags taken, # of people helping and location of trash pickup. Bags can be left on the side of any public road in a place where town staff and a truck can safely stop--and not on the bike path or school grounds, if that's the area being cleaned. Bags can also be dropped off in the container in front of the town offices by May 2nd. Metal should be kept separate and placed **next to** the bags along with other bulky items. Thank you in advance to all who volunteer to keep our community clean and green!



BLUE® CVT Program

Year 3 of **BLUE® CVT** has begun!

Residential properties under 4 units are eligible to apply for this program that provides financial rebates for stormwater improvements constructed. A **BLUE® CVT** employee trained in stormwater mitigation strategies will arrange an appointment to survey your property and discuss any water quality concerns you may have. They'll provide a detailed report with recommendations for your site. If you choose to implement any of the recommendations, you'll receive a rebate!

The site evaluation, report, and recommendations are provided **FREE— there is no obligation to construct improvements after an evaluation.** Should you choose to construct any of the improvements recommended, rebates as high as $1,500 are available depending on the project type and your property's connectivity to surface waters.

New this year: The property who mitigates the most amount of stormwater runoff will receive a **bonus $100**! For more information, visit **tinyurl.com/BLUECVT**.

Stormwater Utility Billing

Annual stormwater utility invoices are mailed each January to addresses on file with the Assessor's Office. **The Department of Public Works received some of these invoices as returned to sender from the Post Office.** We will make every effort to identify and correct any address that is returned as undeliverable. However, stormwater fees are still owed even if an address on file is no longer accurate, or is not deliverable in winter months. At this time we cannot offer electronic delivery of invoices or automatic deductions. However credit and debit card payments are available—check out the stormwater utility website for more information.

To update billing information, please call 802-264-5621 or email kadams@colchestervt.gov with your preferred mailing address and Colchester site information.

BLUE ® CVT Rebate Program Wins Award!

The Town recently received a **Best Stormwater Idea in New England** "Stormy Award" for our BLUE ® CVT program! The New England Stormwater Collaborative seeks to recognize "simple, imaginative, unique, and inventive" stormwater ideas, and our program was recognized in the Funding and Outreach category.

The BLUE®CVT program provides watershed education and financial rebates to residential property owners who make drainage improvements that either reduce the amount of runoff leaving their site, or improve the quality of water leaving their site. This past summer was the third year of the program, where we offered a bonus of $100 to the owner who constructed the largest installation! In all, the program has evaluated 68 properties and led to the mitigation of 7,327 sq ft of impervious surface. Stay tuned next summer to see how the program evolves.

Stormwater Information

The Town implements clean water programs, reviews development applications, manages capital projects, and oversees regulations designed to improve and protect the community's water resources. For more info please visit:

www.colchestervt.gov/1837/StormwaterUtility

Water Quality Hotline: **(802)-264-5628**

General stormwater inquiries: **(802)-264-5620**

PRST STD
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05401
Permit#478

ECRWSS

POSTAL PATRON

TOWN OF COLCHESTER
781 Blakely Road
Colchester, VT 05446

CLEAN WATER NEWSLETTER

Town of Colchester
Public Works Department

CLEAN WATER NEWSLETTER
FALL 2021

Welcome to another beautiful fall season—now is the time for hot apple cider, pumpkin carving, and crunching through leaves at Bayside Park, pictured above. The Public Works Department has been busy working on clean water projects and planning for future field seasons. This newsletter includes:

- Info on Completed Construction Projects
- Planned 2022 Improvements
- Grant Funding Received
- Spring 2022 Billing Information

? Did You Know ?

In 2020, Town street sweepers collected 925 cubic yards of material on public roadways (132 dump trucks full!). Removing this leaf and other debris is important to keep drainage networks functioning.

Ongoing Assessment Projects

Culvert Assessment
This fall, Public Works staff is preparing to inspect each Town-owned roadway culvert to evaluate the condition of the structure, identify any areas of erosion, determine whether the culvert should be upsized in the future to build resiliency into the system with regard to flooding/heavy rain events, and use that information to prepare a funding plan for upcoming improvements.

Above: Drainage outfall in good condition.

Outfall Assessment
The Town received a $12,000 grant from the Chittenden County Regional Planning Commission to perform a similar assessment for Town-owned outfalls, which are discharge points for roadway drainage. It is important to make sure erosion is not occurring at these locations that are near or sometimes directly adjacent to waterways. This information will help prioritize future maintenance efforts by Town Highway crews and identify locations that are good candidates for upgrades.

Completed Water Quality Projects

- **Galvin Hill and Coon Hill Drainage Work**

New stone lined ditches and culverts were installed along approximately 1,350 feet of roadway on Coon Hill Road, and 1,000 feet of Galvin Hill Road. This $66,000 project was 80% grant funded and will improve drainage and reduce erosion on these roads.

- **Stormwater Pipe Lining**

In the spring of 2021 over 1,000 feet of stormwater piping was fitted with rigid, heavy duty liners. This maintenance strategy is roughly 4x less costly than digging up older pipes to replace them, allowing each dollar to be stretched further and reducing traffic impacts to the traveling public. This annual program will resume next year with another 10 pipe segments to be completed.

- **Police Station Outfall Improvements**

100% grant funded outfall repair work was completed this summer behind the Colchester Police Station (photo below shows completed project). These upgrades ensure the stormwater system serving the Town office complex is functioning in a way that protects Smith Creek from erosion.

Water Quality Information

FAQ: Why is managing phosphorus important?

Phosphorus is one of the primary water quality challenges in Lake Champlain. Found in lawn fertilizers, manure, human and animal waste, riverbank soils, and stormwater runoff, phosphorus causes algal blooms and excessive aquatic plant growth. When there is too much phosphorus in the water, certain plants or algae can dominate the ecosystem and choke out other species. Excessive nutrients can cause cyanobacteria blooms, also known as blue-green algae, and can be harmful to aquatic species, other animals, and humans.

All communities in Vermont must comply with Municipal Road General Permit requirements, which requires upgrades and maintenance of roadway drainage networks to reduce erosion. Recent upgrades on Galvin Hill and Coon Hill Roads (see other panel) were for purposes of meeting these requirements. Colchester has also developed a Phosphorus Control Plan to identify additional ways we can reduce our nutrient loading to the Lake from roadways and other impervious surfaces. These projects funded by stormwater fees and grants received must be constructed by 2036 to meet state mandates. Projects include the installation of treatment facilities like gravel wetlands and bioretention areas in key locations that treat stormwater runoff prior to reaching local waterways.

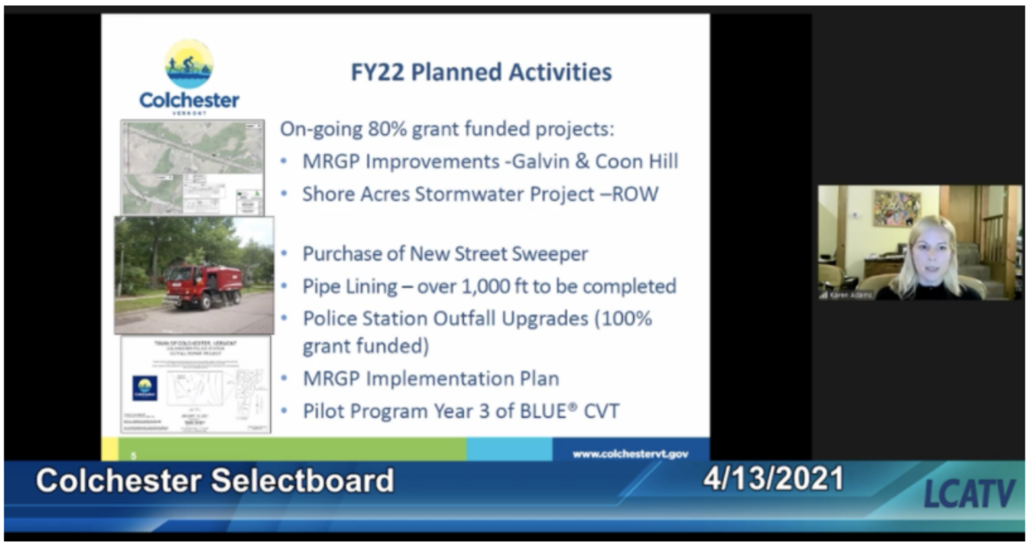
Spring 2021 Billing Information

Annual stormwater invoices will be mailed in January 2022 with payments due February 25, 2022. These fees fund critical system repairs, keep the town stormwater system in compliance with permits, plan for future upgrades and improvements, perform water quality testing, and explore new stormwater treatment programs like BLUE®CVT.

Commercial properties are eligible for credits to reduce their site fee. For more information about credits, visit the webpage listed on the back panel.

Two major takeaways from April 13's Colchester Selectboard meeting

Meredith Rathburn
Published on Apr 18, 2021



Technical services manager in the public works department, Karen Adams, presents the stormwater utility budget and plans for 2021.
Screenshot Courtesy LCATV / Town of Colchester

During the Colchester Selectboard meeting on April 13, the FY22 stormwater utility budget along with the FY22 wastewater utility budget were approved.

These budgets include new construction projects on underground pipes and roadways. There are many planned projects for the coming year, including roadway improvements on Galvin and Coon Hill roads which are part of the Phosphorus Control Plan. The Shore Acres Stormwater Project will help improve water quality in that area.

The budgets also include the purchasing of a new street sweeper, pipelining or restoring structural integrity of pipes by lining them and the BLUE program.

The proposed FY22 Stormwater Budget increased by 3% this year going from $962,733 in FY21 to $991,615. For the first time since the start in 2017, the Equivalent Residential Unit rate or the base fee rate increased by 2.8% going from $52 to $53.50.

Newsletters

Colchester Today
Have the latest local news delivered every morning so you don't miss out on updates.

Local Weather
Get our expert short-term forecast, summary of the weather details and news of any severe weather.

News Alerts
We'll send breaking news and news

The Selectboard meeting consisted of discussing these budgets, approving the updated 2021 local emergency management plan and hearing about the progress of the merging of three Colchester Fire Departments.

Here are two major takeaways:

1. The BLUE program is entering its third year offering incentives, or financial rebates, to residents for stormwater improvements they make on their properties.

Karen Adams, the technical services manager in the public works department, presented the stormwater utility budget.

“Every little bit of stormwater that can be managed on a homeowner site is less that comes into the town system, and it improves water quality overall,” Adams said.

The BLUE program will be advertised in the utility spring newsletter, where people can sign up to participate in the program. In past years, using the newsletter has helped fill all of the spots.

A survey was done to see how the program can be improved. Now, instead of flat rebates, the program is offering $1 per square foot of impervious surface mitigated up to a certain cap.

This will hopefully incentivize larger projects, said Adams.

2021 BLUE Stormwater Mitigation Program
Final Report

Prepared by:
Juliana Dixon, Salix-Solutions
juliana@salix-solutions.com

Abstract

2021 brought many successes to the program, despite the challenges of COVID-19. There were 10 properties evaluated, 1 BLUE® certification and 4 mitigation projects implemented (mitigating roughly 3,700 ft$_2$), with more than $3,000 in rebates issued throughout the town of Colchester.

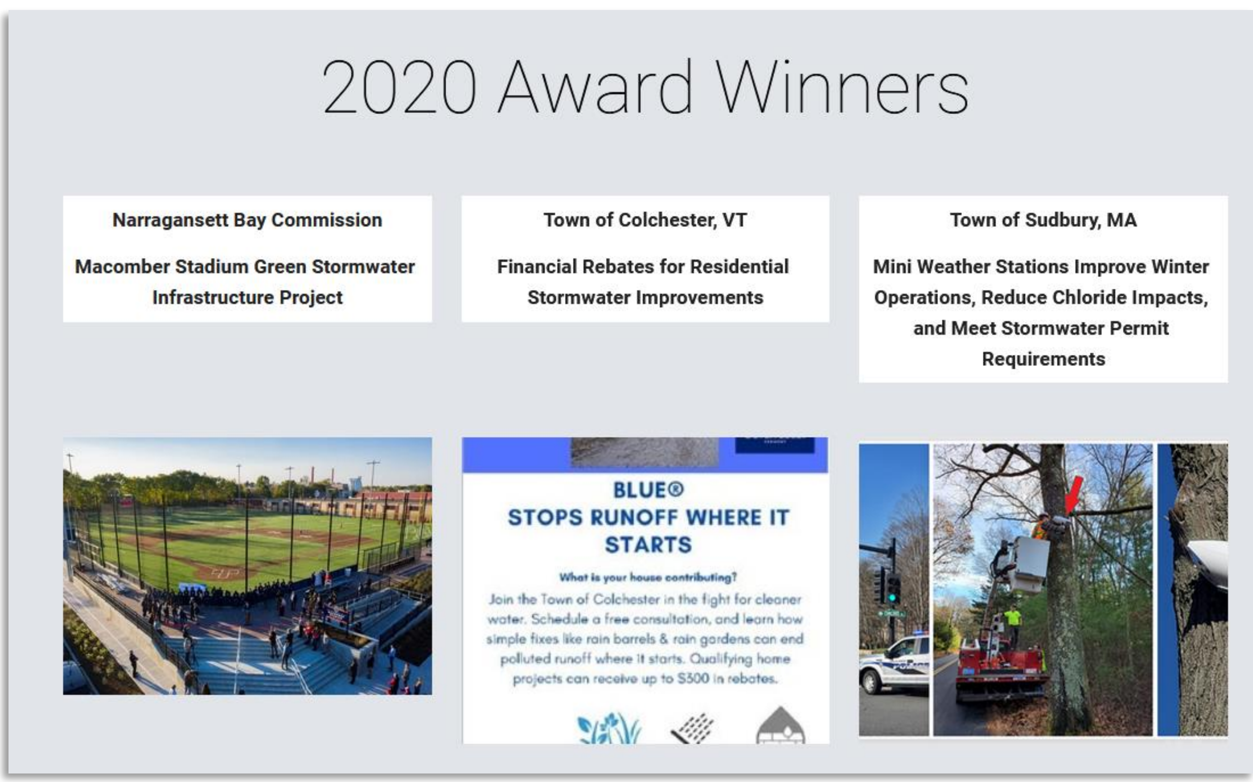
86 Mallets Head

Introduction

2021 marked the third year of BLUE® stormwater mitigation programing for the Town of Colchester. In many ways the partnership solidified, streamlining program operations between the Town and Salix Solutions. In other ways barriers restricted the Team's ability to meet objectives despite our best efforts. COVID-19 remains a very present factor affecting staffing, homeowner access to contractors, property evaluations at times, and methods of outreach.

Both Salix Solutions and the Town of Colchester experienced staff turnover and internal complications, impeding efforts to grow the program and bring new homeowners to the water quality conversation.

Despite this, more than 3,700 ft^2 of impervious surface was mitigated – nearly 83% of last year's achievement, we encountered significant accolades on the program, and received notification that we won the New England Stormy Award!



The team at Salix Solutions was once again honored to receive very positive feedback from many program participants, bolstering our sense that the collaboration has left a marked benefit to the residents of the Town of Colchester.

2021 Program Objectives

● 25 property evaluations
● 10 mitigation projects implemented
● Not to exceed $9,380 in labor & mileage
● Issuance of up to $6,600 in rebates available
● Issuance of a $100 bonus to the property that mitigated the most impervious surface
● Continuation of water quality conversations in pursuit of a more educated population

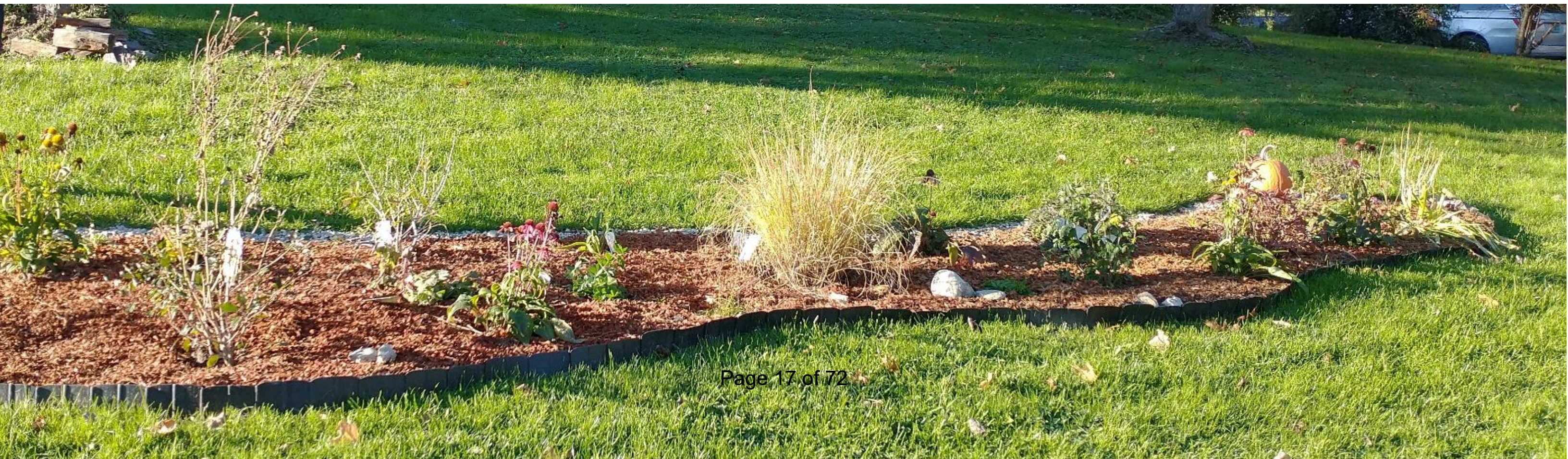
2021 Program Accomplishments

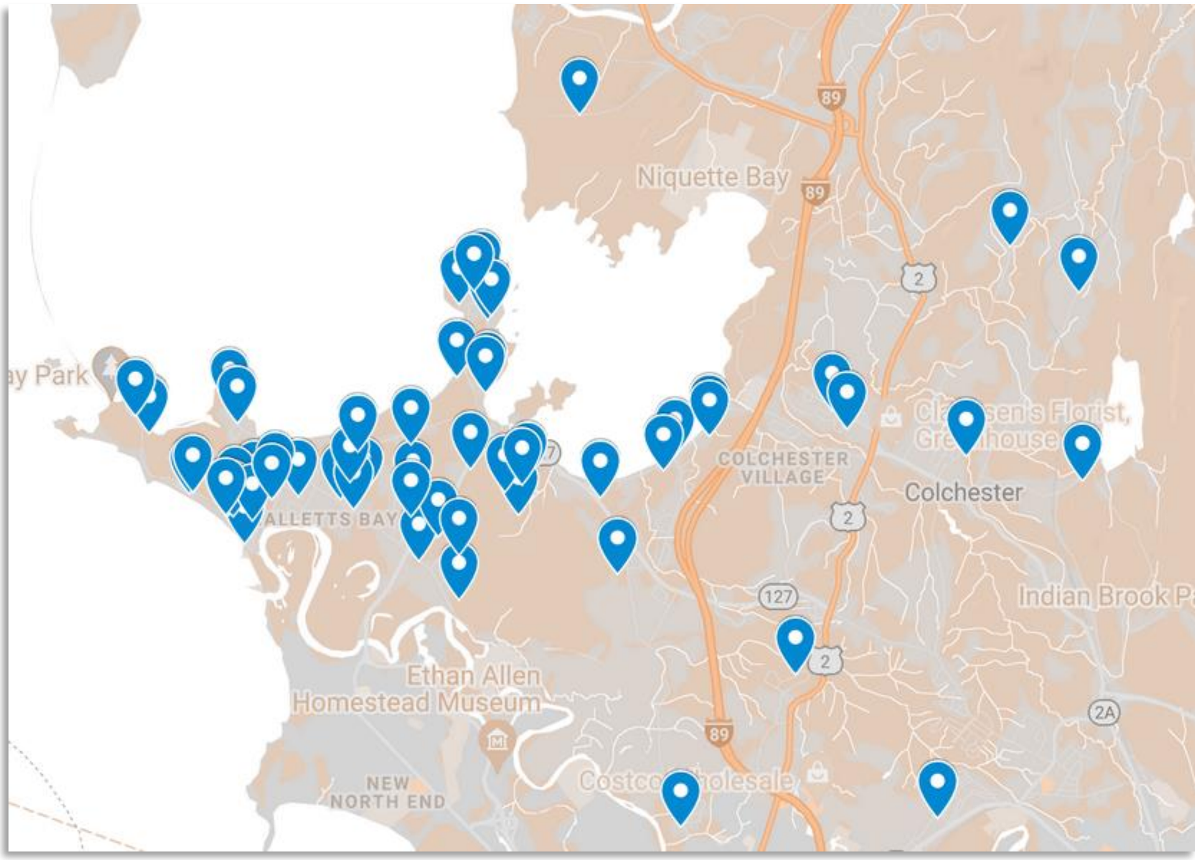
● 10 Property Evaluations
● 4 mitigation installations on two properties
● $3,000 in rebates issued
● An estimated 3,700 ft^2 were mitigated
● an estimated 81,400 gallons of stormwater captured annually
● Total program cost of $7,093.08
● $100 bonus awarded to 304 Shore Acres

Soft goals of the project were also vital to the program. The program was designed to extend water quality education and information to landowners within the Town of Colchester, conduct site assessments, provide site reports and recommendations, and provide technical support for the installation of green stormwater infrastructure.

Soft goals included:
● Improving landowner understanding of threats to Vermont's water resources
● Inspiring property owner motivation to take action for the protection of Vermont's waters
● Identifying opportunities to reduce or fully mitigate nutrient-laden runoff from private property, and engage homeowners in the solutions choice and design process
● Identify opportunities to mitigate chemical and pathogen pollution in stormwater runoff from private property, and to inspire homeowners to consider behavior changes that will make a difference
● Recommend the installation of green infrastructure as appropriate and assist property owner understanding of the watershed benefits of these installations

304 Shore Acres





BLUE CVT participants 2019 - 2021

Methods

For the 2021 season, marketing efforts were more limited than they were the previous season. Reduced staff resources affected the amount of touchpoints on Front Porch Forum and other social media sites, while the mailer at the beginning of the season did not go out due to covid staffing complications. One new marketing tactic was the use of a school flier that went home on one of the last days of school. While the flier went home with every student, it is suspected that the timing was less than ideal, as many students drop their backpack and don't take the time to go through every paper. Most 2021 program participants either knew about the program from previous years, or discovered it through word of mouth.

Clients would initiate contact via email or through the 'request an appointment' form on the BLUE® website. All requests would be responded to within one business day to schedule the site evaluation. Prior to the evaluation, a preliminary desk analysis was conducted. The Agency of Natural Resources Atlas was utilized to identify soil type, hydrological connection, impermeable surface area, stormwater infrastructure and to identify any sensitive habitat or natural resources within the vicinity. The evaluation appointment was confirmed via a telephone call or email prior to the site visit.

Evaluation sessions began with an educational component, commingled with an interview.

Lifestyle habits such as lawn care, animal waste disposal, medication care, septic pumping habits etc. were discussed. The importance of stormwater friendly habits and solutions were discussed for both how they contribute to water quality concerns as well as a full explanation of why and how BLUE recommendations reduce impact. Discussions were tailored to each landowner, with awareness of the individual's prior knowledge level, priorities and perspectives as the efforts of the program are non-regulatory and considered an effort to build a Culture of Clean Water.

Following the education and interview, the physical property was evaluated. Areas of concern for the homeowner were discussed as well as an analysis of impermeable surfaces, drainage features, low spots and the drainage characteristics of the property. Photos were taken and notes recorded. If available, the VT Homeowner's Guide to Stormwater Management was given to property owners to help them understand Green Stormwater Infrastructure options and visualize how an installation might look and function on their property.

Within one week of the evaluation, a report was sent to the property owner (sample attached). Reports include the results of the interview questions, analysis and recommendations for problem areas, information of solution options and next steps for implementation and qualifying for a rebate. Property owners receive a follow-up phone call a couple of weeks after receiving the evaluation. This call is to answer any questions about the process and gage interest in implementing a mitigation project.

Water Quality Threats

The overwhelming extent of cyanobacteria blooms, chemicals, and pathogens in the Lake Champlain Basin have become an apparent concern to its residents. Annually, the state of Vermont contributes 69% of the volume of phosphorus entering Lake Champlain, a drastically higher load than that of neighboring regions, New York State (23%) and Quebec (8%). Vermont's contribution is sourced from a combination of sectors including agriculture, developed lands, forests, streambanks, and wastewater treatment facilities. Excess phosphorus coupled with increasingly warm temperatures have resulted in a higher frequency of observed cyanobacteria blooms in Lake Champlain. Cyanobacteria blooms may contain harmful cyanotoxins such as Microcystin or Anatoxin that threaten the health of humans and animals. If ingested, these cyanotoxins can cause organ damage, muscle paralysis, or even death. Though not a direct issue for Colchester, an often-overlooked threat is combined sewage overflows from municipalities with aging wastewater infrastructure and increased impervious footprints. High volumes of stormwater containing chemical pollutants, pathogens, and pharmaceuticals inundate the town's sewer system and ultimately discharge into Lake Champlain due to the limited capacity of the infrastructure. It is of urgent priority to address these water quality threats in order to protect the lake and its valuable natural resources that are essential to Vermont's economy, culture, and ecosystems.

304 Shore Acres

2021 Program Accomplishments

This year, implementations in Colchester included a gutter system with a rain chain and dry well designed to capture and infiltrate roof runoff, and two rain gardens designed to capture both driveway runoff and roof / slope runoff reducing pressure on the Shore Acres drainage system. These were exciting improvements for the homeowners, both of whom are motivated to help communicate the benefits of these installations to more local residents.

Overcoming Hurdles

2021 programming was overshadowed by the COVID-19 pandemic similarly to 2020. This year covid safety protocols were already in place and as such were not as much of a barrier as the previous season, but staffing was indirectly affected by the pandemic, proving more complicated than was anticipated.

Planned adjustments for 2022 programing

If the Town of Colchester decides to move forward with the program in partnership with Lake Champlain Sea Grant, the following suggestions may inspire greater action:

- Carry more copies of the VT Homeowner's Guide to Stormwater Management, assisting property owners to visualize potential installations during the site assessment
- Develop a handout to facilitate homeowner understanding of the term 'hydrologically connected'
- Increase the connectivity of messaging to help homeowners understand their property in the context of the greater watershed
- Implement a feedback form to capture participant thoughts and recommendations for program improvement
- We would also like to tailor outreach and educational materials as appropriate, working with Town staff to target high priority areas
- Implement more Tea-and-Talks in neighborhoods with a passionate landowner
- Offer a water quality talk to middle and high school classes prior to sending home program fliers

Conclusions

2021 was a moderately successful year, despite unpredicted challenges. While evaluation goals were not fully met, participating homeowners expressed highly positive feedback, and representation for the Town of Colchester in the field is believed to be very strong. Even given the limitations, projects were implemented, and several homeowners are hoping to continue their work next season.

We again thank the Town of Colchester for the partnership, and want to express our pleasure at the strong working relationship we have enjoyed.

Notes from the Field

Lawn converted to perennials at 2069 East Rd

Opportunity for erosion mitigation at 2159 Middle Rd

Opportunity for shoreline protection at 158 Horizon View

Opportunity for chemical pollutant reduction at 86 Mallets Head

Opportunity for shoreline hardscape removal at 8 Beach Rd

Colchester VERMONT

BLUE

BLUE® Evaluation Results
2159 Middle Rd

BLUE® Level:	☐ None at this time	💧 Basic	☐ Advanced	☐ Leader

BASIC

Wastewater Management

Yes No N/A

💧 ☐ ☐ (1a) Septic system legally compliant with current law and maintained every 3-5 years (or more frequently if required by law)

Homeowner is committed to proper maintenance of the septic.

A suggestion we discussed is asking the septic service provider where they dispose of septic waste and request they take it to a wastewater treatment plant, as opposed to field application, due to common household pharmaceutical use and potential for contamination.

💧 ☐ ☐ (1b) Utilize Phosphorus-free detergents

Homeowner commits to using phosphorus-free detergents.

💧 ☐ ☐ (1c) Personal Care Products, Pharmaceuticals, and all toxic substances, including automotive vehicle fluids are recycled or disposed of in accordance with EPA-recommended practices

Homeowner commits to properly disposing of all toxic substances and personal care products according to EPA recommendations.

Landscape

💧 ☐ ☐ (1d) Utilize only fertilizers that soil tests indicate are needed

Homeowner uses compost created on site. If interested in soil tests to ensure meeting plant needs, tests such as this one can be found at most landscaping *stores, and are easy to use, allowing you to apply only the nutrients found to be deficient in appropriate amounts.*

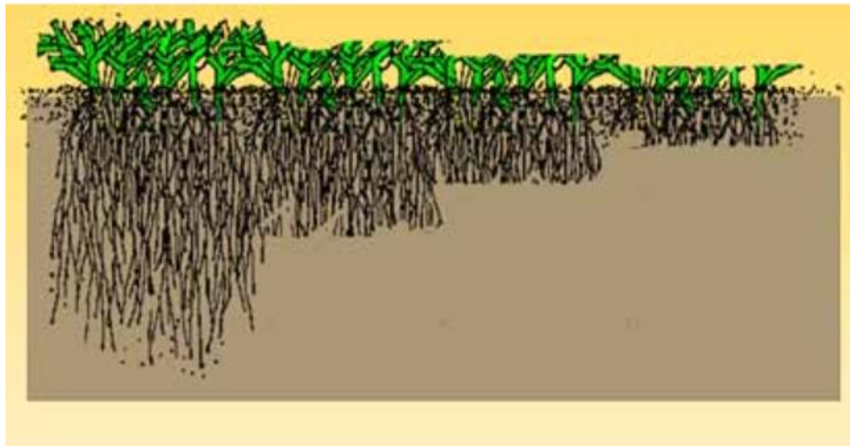
☐ ☐ (1e) Commit to a pesticide-free lawn while using no other pesticides within 100 feet of receiving water

Homeowner commits to a pesticide-free lawn.

☐ ☐ (1f) Grass clippings left in place or properly disposed of and lawn mowed no shorter than 3 inches

We commend your 'mow-where-you-go' approach to lawn management! Your choice to mow at a 3-4in blade height has increased the land's stormwater management potential, and leaving areas unmown provides habitat for native birds and pollinators, and encourages biodiversity.

We discussed the correlation between grass blade height and root depth and complexity. Below are a couple of graphics illustrating the increase in soil stabilization via root depth when grass is allowed to grow longer. This increase in root depth will allow more water to be retained in the landscape.



Root depth increases with grass height.
Deep roots = healthy lawns.

☐ ☐ (1g) No trash or other manmade refuse stored or disposed of within 50 feet of bank or shore

No waste is stored in such a way that leachate is a concern. Homeowner composts yard and food waste > 100 ft of stream.

☐ ☐ (1h) All animal waste is collected and disposed of in the trash or composted or buried a minimum of 50 feet from shore or wetland boundary, 100 feet if composting/disposal area slopes toward waterway or waterbody

There are currently no dogs living on the property.

Infrastructure

☐ ☛☐ (1i) Stormwater remediation maintained on site *via* retention ponds, swales, rain gardens, dripline trenches, and barrels, as appropriate

We commend your water conservation efforts! Several rain barrels installed on the house capture roof runoff to use for crop irrigation.

We agree that focusing on mitigation of runoff from neighbor's lawn pools in the north side of the grassy area would be impactful on this property. Suggestions to reduce the pooling include, planting water-loving species (willows - maybe propagated from trees located near the road), building a berm or series of berms to slow the flow across the front lawn.

Location for berm or series of berms and additional plantings.

Berm, planted

Berm not yet seeded

Buildings

☐ ☐ (1j) Redirect downspouts, sump-pump drainage, perimeter drains to maintain water onsite

All roof runoff is managed using rain barrel collection systems. Sump-pumps and perimeter drains are not utilized on this property.

Homeowner expressed interest in scaling rain barrel systems. Here are [some ideas for additional rain harvesting systems]() and images below.

Paved surfaces

☐ ☐ (1k) Use of approved environmentally friendly sealers (no coal-tar or petroleum)

Driveway is not currently sealed with environmentally friendly sealers, but homeowner is interested in pursuing eco-friendly alternatives in the future.

Coal-Tar Sealant Alternatives

- ENVIROSEAL LAS-320™ asphalt sealer is not petroleum based, and is EPA approved
- AFM DynoSeal Driveway/ Asphalt Sealer
- INTEGRA-SEAL by UNIQUE Paving Materials, asphalt-based, zero VOCs, no PAHs
- Eco-Seal Brand Sealer
- Latex-ite® Blacktop Driveway Sealers
- Black Jack® Asphalt Sealers

Coal tar sealant is a thick, black goop applied to driveways, asphalt parking lots and playgrounds, primarily in the eastern United States. This shiny, black sealant contains toxic compounds known as polycyclic aromatic hydrocarbons, or PAHs, which can seep into the environment. The sealcoat contains high levels of toxic chemicals that can cause cancer and environmental harm.

PAHs are poisonous to fish and other aquatic life and they've been linked to cancer in humans. PAHs develop whenever carbon is heated or combusted. As such, the contaminants are common in used motor oil, industrial emissions and automobile tires. They're also plentiful in coal tar pitch, which is a key ingredient in coal tar paver.

More than 200 types of PAH compounds are found in coal tar pitch, and at least seven types of PAHs are classified by the Environmental Protection Agency as probable human carcinogens.

The gravel road is a potential source of sediment loss and erosion over time due to the steep slope. Some suggestions for slowing the flow include, implementing water bars or rubber razors (potentially using old tires).

Location of several rubber razors that could be inserted into the slope of the gravel road, with rip rap or an infiltration trench on the side of the road

Nature of runoff to be mitigated

☐ ☐ (1l) Is the property subject to run-on? If so, is it from public property?

Yes, there is run-on and pooling that occurs in the spring and heavy rains on the north side of the property from the neighbor's mown lawn. Solutions are discussed above. Shrubs and trees could be planted in this area to stabilize the *lawn and a berm could be installed to direct water to a pooling location for evapotranspiration.*

Thank you for taking the time to participate in BLUE® CVT!

This property is a couple steps away from becoming BLUE® certified! We look forward to supporting you as you continue to help manage water quality on your property, and in turn, protect Lake Champlain.

For BLUE® certification:

1. If you are willing to commit to the ongoing environmental stewardship of your lot, you may sign the *Homeowner Agreement* confirming a commitment to using watershed friendly principles as detailed on the attached 'Practices Sheet'.

This certification is good for three years. We appreciate your commitment to watershed stewardship through the BLUE® program!

For Rebate Funding:
If you would like to move forward with any of the following water mitigation projects, you may apply for rebate funding of up to $1500 for your property:

1. Gravel driveway maintenance	costs up to $1,500
2. Installation of berm in north lawn and plantings	costs up to $300
3. Live staking or hardscape in the seasonal drainage ditch	variable

1. Decide if you would like to move forward with any of these projects.
2. Decide whether you intend to self-install or hire a contractor.
3. Submit a site design plan to BLUE® CVT staff.
4. Upon approval of the site plan, you may begin your project!
5. When the project is complete, BLUE® CVT staff will inspect the installation, if the installation is true to the approved site plan, the rebate form may then be submitted.
6. BLUE® CVT staff will process your rebate, and you will receive a check in the mail.

Feel free to reach out to us with any questions or for additional support.

Salix Solutions, BLUE® certifying team:
Jill Sarazen ▪ blue.stormwater@outlook.com

Minimum Control Measure #2: Public Involvement & Participation Rethink Runoff Stream Team Summary of Activities

Prepared by Winooski Natural Resources Conservation District

2021 Calendar Year

Overview

Although the pandemic continued to present challenges for the Stream Team in 2021 the Winooski Natural Resources Conservation District (WNRCD) was able to engage many residents in meaningful actions to improve stormwater in their community. We organized a watershed field-day for students in the Winooski Middle School summer school program, reinstated our volunteer water quality monitoring program, explored new opportunities for remote community engagement with the Adopt-a-Drain program and recruited volunteers to install a new rain garden at the Milton Municipal building.

RRST Estimated Impact by Municipality

The table below depicts the estimated number of individuals engaged in each RRST municipality in 2021. This table reflects **in-person** interactions where it was possible to log participants' town of residence. For information about residents reached through digital efforts on the website and social media outlets, see final report from Pluck.

Municipality	# of people reached in-person in 2021
Burlington	4
Colchester	0
Town of Essex	0
Village of Essex Junction	2
Milton	3
Shelburne	0
South Burlington	14
Williston	3
Winooski	16

TOTAL	42

Table 1: Interaction with the Stream Team by municipality

Organizational Partnerships

The Rethink Runoff Stream Team partnered with **2** non-municipal organizations in 2021:

1. **Hamline University:** Created the Adopt-a-Drain website based on social science research to engage more volunteers in maintaining the health of storm drains in MS4 communities across the country. This year RRST municipalities engaged in a discussion about joining the Adopt-a-Drain program. See "Projects" section for more details
2. **Winooski Middle School:** A summer school teacher at Winooski Middle School asked if RRST could present a hands-on watershed lesson to students. See "Outreach Events" section for more details.

Outreach ---

Social Media

The Stream Team coordinator periodically updated the Facebook and Instagram pages with information about upcoming outreach events or volunteer opportunities.

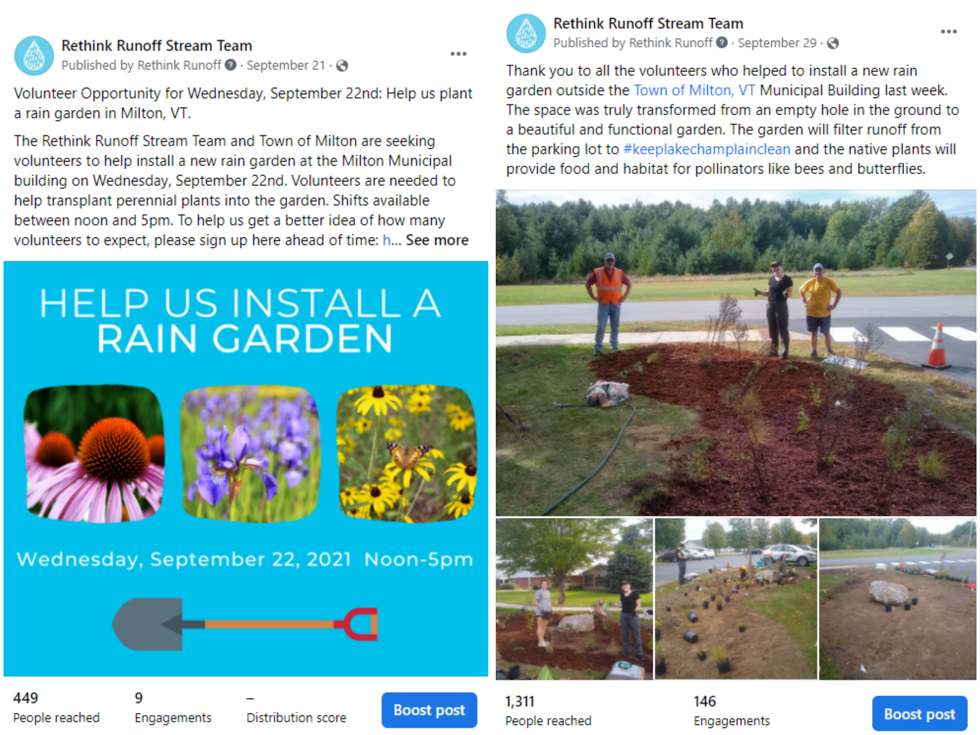


Figure 1: Two Facebook posts from 2021 related to the Milton Municipal Rain Garden installation project

RRST Website

We maintained the "events" section of the website and occasionally helped to develop ideas for new web content in collaboration with Pluck Design.

Newsletter

At the end of 2021 there were **799** subscribers to the RRST newsletter (an increase from 770 in 2020). One newsletter was published this year in December.

Outreach Events

One "outreach" event was held in 2021. A total of **16** people participated.. The event is described in more details below:

1. **Winooski Middle School Watershed Field Day:** The Stream Team Coordinator delivered a 2-hour hands-on lesson to 12 students and 4 teachers at Winooski Middle School as part of their summer school program. Students met the coordinator at Landry Park in Winooski. The focus of the lesson was watersheds and community. Students looked at a map of watersheds that drain to Lake Champlain, built their own 3D watershed model, explored Morehouse Brook and played a game about ecological connections. Two WNRCD summer interns helped to facilitate small-group activities for students. Teachers provided positive feedback after the event and expressed an interest in continued partnership for the 2021/22 school year. Total # of people reached in-person in Winooski = 16

Figure 2: Students at Winooski Middle School participate in hands-on watershed activities at Morehouse Brook in Landry Park.

Projects ---

Three in-person "project" events were held in 2021 and planning for a fourth initiative (Adopt-A-Drain) began. A total of ***29*** people participated in hands-on volunteer events in their communities. The projects are described in detail below:

1. Milton Rain Garden Installation
2. Stream Team Water Quality Sampling
3. Adopt-a-Rain Garden Program
4. Planning for Regional Adopt-a-Drain Program

Milton Project: Rain Garden Planning and Installation

Summary: RRST assisted staff at the Town of Milton with the design and installation of a new rain garden at the Municipal Building on Bombardier Road. The Stream Team Coordinator provided municipal staff with a tailored list of recommended plants for the project. All project supplies were paid for by the town, but the Stream Team Coordinator did harvest about 30 perennial transplants from other over-crowded gardens to add to the planting plan. 5 community volunteers assisted with planting & mulching the garden on installation day.

Advertising: Advertising was completed through direct email outreach to our list of active volunteers, posting on social media and inviting community members to share a post on Front Porch Forum.

Impact: 5 community volunteers and three staff members participated in two planting shifts throughout the day. Volunteers learned more about the function of the rain garden and the pollinator and wildlife benefits of the plants that were selected. The area was quickly transformed from an empty hole to a beautifully planted and mulched stormwater feature. Most participants accepted a Stream Team t-shirt and sticker as thanks for assisting. The Stream Team Coordinator is currently working with town staff to design an educational sign to accompany the garden since it is in a location with high foot-traffic.

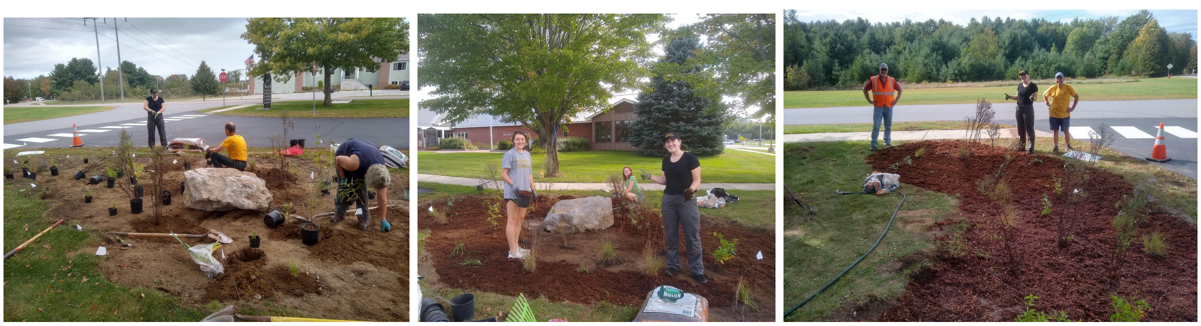


Fig 3: Community volunteers, Milton municipal staff and WNRCD communications intern help to install perennial plants in a new rain garden at the Milton Municipal Building.

Water Quality Monitoring

Summary: The Stream Team has maintained an ongoing water quality monitoring program since 2012. Community science volunteers collect water samples in urban or suburban streams that are impacted by excessive nutrient loading, high chloride and other pollution.

This year VT DEC's LaRosa Program provided financial support for analysis of the water samples at the Vermont Agriculture and Environmental Laboratory (VAEL), wrote the Quality Assurance Project Plan (QAPP), transported samples from partners' offices to the lab, and took on the responsibility of analyzing data from all state-wide partners. This change allowed us to focus more on volunteer recruitment and engagement and less on behind-the-scenes paperwork. Of note, the state-wide data analysis has not been published yet, so a Stream Team

Data Analysis document is not available with this report.

Fourteen Stream Team volunteers collected biweekly water quality samples at fourteen sites on eight streams in 2021. Volunteers collected biweekly grab samples from June 2 - August 11. Grab samples were analyzed for total phosphorus, chloride, and at some sites, nitrogen. These parameters were also sampled at all sites after two rain events. Eight of the sites were new this year and some required special equipment for sampling like a throw-bucket or dipper stick. Appropriate tools were purchased and/or created to assist with sampling while maintaining volunteer safety around swift waters.

The training day for volunteer samplers took place in late May. This year two sessions were offered - one in person at the stream adjacent to the WNRCD Williston Office and one online - to accommodate volunteers' schedules and comfort with gathering in-person. During both trainings the Stream Team coordinator demonstrated sampling procedures, described the data collection sheets, explained how the collected data would be used and answered questions. Throughout the season, volunteers returned their samples through a contactless dropoff system to the WNRCD office. The Stream Team coordinator ensured all samples were properly checked-in and prepared for delivery to the lab. The Stream Team coordinator sent bi-weekly emails to WQ volunteers to check in about sampling procedure and share interesting local water tidbits, and other ways to get involved.

Advertising: Advertising was completed through direct email outreach to our list of active volunteers. Recognizing that covid-restrictions may make a fully in-person training impossible, we targeted samplers with prior experience. Next year we look forward to adding new volunteers to the team.

Impact: In total volunteers collected 250 individual samples. This data provides information about long term trends that may help towns analyze effectiveness of stormwater BMPs or identify new opportunities for action. Perhaps more importantly, we believe that engaging community members directly in clean-water work creates greater public understanding of the issues VT watersheds are facing and creates greater public support for clean-water initiatives like GSI installation or wastewater treatment plant improvements. In 2022 we plan to add data from this sampling season to the Stream Storytelling online map and use it as an educational tool during outreach events.

Figure 4: Stream Team volunteers collect water samples at sites at various sites across the RRST service area

Stream Team Volunteers 2021	
Municipality	**# of Volunteers**
Burlington	3
Colchester	0
Village of Essex Junction	2
Town of Essex	0
Milton	1
South Burlington	6
Shelburne	0
Williston	1
Winooski	0
Non-RRST Municipalities	1
TOTAL	**14**

Table 2: Stream Team Water Quality Sampling Volunteers by town

Fig 5: Stream Team Water Quality Sampling sites map. See interactive online version here: *https://www.google.com/maps/d/u/0/edit?mid=15P_lsNKpOTLeedE0uaGgRXeEcyNGrGr0&usp=sharing*

Adopt-a Rain Garden Program Summary

The Stream Team's Adopt-a-Rain Garden program is an opportunity for individuals to assist in keeping public rain gardens in their community functional and attractive. This involves basic maintenance activities like picking up trash, pruning, pulling weeds, installing new mulch, and informing the coordinator of non-functioning gardens. There are currently seven public rain gardens managed by Stream Team. In 2021 all seven gardens were cared for by approximately 10 volunteers. The gardens that have been removed from this list are either now cared for by municipal staff or hired landscaping crews, so it is no longer appropriate to recruit community volunteers. We plan to add 1-4 new gardens for adoption in 2022. See table below for more details.

Rain Garden Volunteers 2021	
Location	**Adopter Name**
Williston Annex	Rita D.
Callahan Park, Burlington	Brad K.

Chamberlin School, South Burlington	Chris P.
Coast Guard Station, Burlington	Larry K.
Farrell Park, South Burlington	Roan O.
South Burlington Fire Station	Cub Scouts 678
South Burlington Library	Cub Scouts 678

Table 3: 2021 Rain Garden Adopters 2021

Regional: Adopt-a-Drain Launch

Summary: This year we completed significant behind-the-scenes research and coordination to launch a robust Adopt-a-Storm-Drain program similar to Adopt-a-Rain-Garden. Based on early interest from the Village of Essex Junction and the City of Burlington in improving and/or starting new storm drain steward programs and based on the success of a small pilot program in 2020 (see 2020 RRST Annual Report) we began to explore options for offering "Adopt a Drain" as a rotating program for interested municipalities. The goal of the program would be to recruit volunteers to care for storm drains in their neighborhood by clearing trash, sediment, salt and other pollutants on a regular basis.

In early conversations we discussed the feasibility of municipal staff creating and maintaining in-house interactive maps where volunteers could view "adoptable" drains and sign up to help. After discussing the idea with GIS specialists in multiple towns (including Burlington where a pilot platform had already been developed, but experienced technical difficulties), the Adopt-a-Storm-Drain initiative developed by Hamline University was brought to our attention.

Adopt-a-Storm-Drain is a model developed by staff at Hamline University based on research about best practices for community engagement around stormwater. Their website offers a template for towns to input available drains and for volunteers to sign up and find training resources easily. Their interface is supported by technical staff at the university, which means we can spend more time engaging people in our communities and less time working on coding and data management.

Challenges: The main challenge of this project was that the Adopt-A-Storm-Drain package comes at an additional cost to current MS4 dues. With most MS4 staff and the Stream Team Coordinator working and meeting remotely, the process of discussing this opportunity was lengthy. Gauging the level of interest from each municipality and assessing which funding options would be most feasible took many months, but we have now determined the cohort of municipalities that would like to participate and plan to move forward with a project launch in 2022.

Impact: With the Chittenden County RPC as the administrative partner, the five MS4 communities entered into an MOU with Hamline University (effective Jan 2022) to gain access to the web platform and volunteer training resources. The Stream Team Coordinator will help to launch the program by taking the lead on volunteer recruitment as a core goal for 2022. We believe launching the Adopt-a-Storm-Drain program is a great fit for these communities in a year that will still be impacted by COVID restrictions. We anticipate that this program will engage hundreds of community volunteers in a project that can be completed without requiring any in-person interaction. Adopting a storm drain is a small and simple action that may inspire community members to participate in other Rethink Runoff activities in the years to come and consider the ways water flows through their neighborhood.

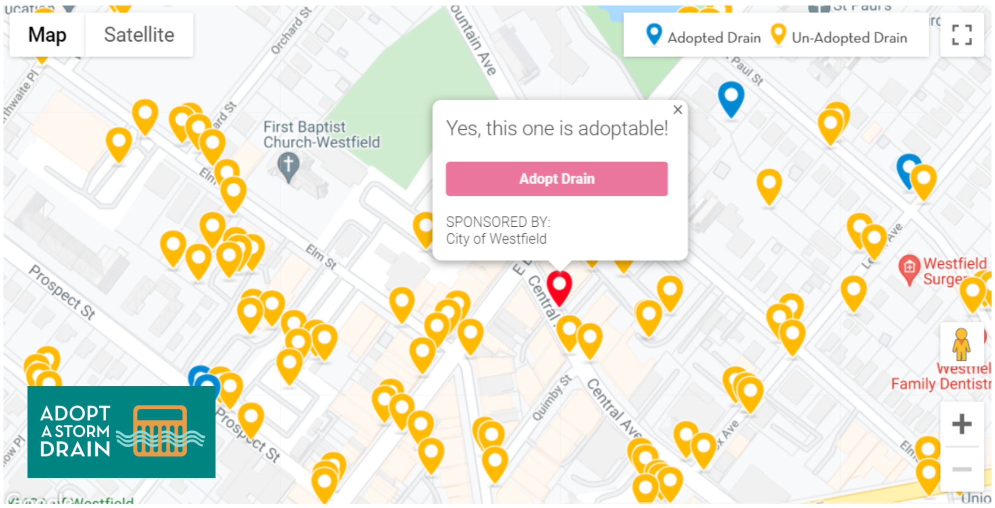


Figure 6: Screenshot from Adopt-a-Drain Website illustrating volunteer sign-up map format

Volunteer Appreciation Summary

Due to covid we were not able to host an in-person volunteer event. All volunteers were offered Stream Team t-shirts and stickers at the time of the event and many accepted one or both. We are planning to send handwritten thank-you notes and a small gift in the mail to our most dedicated volunteers in early 2022.

This document was prepared by the Winooski Natural Resources Conservation District, which is contracted by Chittenden County's MS4 Committee to run the RRST program.

ENDYNE Inc.
Environmental Laboratories

Colchester, Town of	PROJECT: IDDE
PO Box 55 100580	WORK ORDER: **2108-23280**
Colchester, VT 05446	DATE RECEIVED: August 10, 2021
	DATE REPORTED: August 11, 2021
Atten: Robin Parry	SAMPLER: Steffen

Laboratory Report

Enclosed please find the results of the analyses performed for the samples referenced on the attached chain of custody. All required method quality control elements including instrument calibration were performed in accordance with method requirements and determined to be acceptable unless otherwise noted.

The column labeled Lab/Tech in the accompanying report denotes the laboratory facility where the testing was performed and the technician who conducted the assay. A "W" designates the Williston, VT lab under NELAC certification ELAP 11263; "R" designates the Lebanon, NH facility under certification NH 2037 and "N" the Plattsburgh, NY lab under certification ELAP 11892. "Sub" indicates the testing was performed by a subcontracted laboratory. The accreditation status of the subcontracted lab is referenced in the corres ponding NELAC and Qual fields. The Williston, VT facility is also ISO/IEC 17025:2017 accredited for Total Coliform and E coli by SM9223B.

The NELAC column also denotes the accreditation status of each laboratory for each reported parameter. "A" indicates the referenced laboratory is NELAC accredited for the parameter reported. "N" indicates the laboratory is not accredited. "U" indicates that NELAC does not offer accreditation for that parameter in that specific matrix. Test results denoted with an "A" meet all National Environmental Laboratory Accreditation Program requirements except where denoted by pertinent data qualifiers. Test results are representative of the samples as they were received at the laboratory

Endyne, Inc. warrants, to the best of its knowledge and belief, the accuracy of the analytical test results contained in this report, but makes no other warranty, expressed or implied, especially no warranties of merchantability or fitness for a particular purpose.

Reviewed by:

Harry B. Locker, Ph.D.
Laboratory Director

Laboratory Report DATE REPORTED: 08/11/2021

CLIENT: Colchester, Town of WORK ORDER: **2108-23280**
PROJECT: IDDE DATE RECEIVED: 08/10/2021

001 Site: D4-001 Date Sampled: 8/10/21 Time: 9:00

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
E. coli	6.3	MPN/100ml	SM 9223B(04)	8/10/21 15:14	W AKJ	A	

002 Site: CP-1402 Date Sampled: 8/10/21 Time: 9:00

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
E. coli	1300	MPN/100ml	SM 9223B(04)	8/10/21 15:14	W AKJ	A	

003 Site: B3-018 Date Sampled: 8/10/21 Time: 9:00

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
E. coli	650	MPN/100ml	SM 9223B(04)	8/10/21 15:14	W AKJ	A	

004 Site: C3-005 Date Sampled: 8/10/21 Time: 9:00

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
E. coli	< 1.0	MPN/100ml	SM 9223B(04)	8/10/21 15:14	W AKJ	A	

005 Site: CP-1428 Date Sampled: 8/10/21 Time: 9:00

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
E. coli	260	MPN/100ml	SM 9223B(04)	8/10/21 15:14	W AKJ	A	

006 Site: C3-019 Date Sampled: 8/10/21 Time: 9:00

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
E. coli	330	MPN/100ml	SM 9223B(04)	8/10/21 15:14	W AKJ	A	

007 Site: CP-1399 Date Sampled: 8/10/21 Time: 9:00

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
E. coli	2.0	MPN/100ml	SM 9223B(04)	8/10/21 15:14	W AKJ	A	

008 Site: CP-1397 Date Sampled: 8/10/21 Time: 9:00

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
E. coli	920	MPN/100ml	SM 9223B(04)	8/10/21 15:14	W AKJ	A	

009 Site: C3-003 Date Sampled: 8/10/21 Time: 9:00

Parameter	Result	Units	Method	Analysis Date/Time	Lab/Tech	NELAC	Qual.
E. coli	9.8	MPN/100ml	SM 9223B(04)	8/10/21 15:14	W AKJ	A	

ENDYNE, INC.
160 James Brown Drive
Williston, Vermont 05495
(802) 879-4333

CHAIN-OF-CUSTODY-RECORD

Special Reporting Instructions/PO#:

Project Name: IDDE State of Origin: VT __ NY __ NH __ Other __	Client/Contact Name: TOWN OF COLCHESTER Phone #:	Sampler Name: STEFFEN PACKARD Phone #:
Endyne WO #	Mailing Address:	Billing Address:

Sample Location	Matrix	GRAB	COMP	Date/Time Sampled	Sample Containers No.	Sample Containers Type/Size	Sample Preservation	Analysis Required	Field Results/Remarks	Due Date
D4-001				08/10/0900					E.coli	
CP-1402										
B3-018										
C3-005										
CP-1428										
C3-019										
CP-1399										
CP-1397										
C3-003										

2108-23280
2108-23280
Colchester, Town of
IDDE

Relinquished by:	Date/Time	Received by:	Date/Time	Received by:	Date/Time
[signature]	08/10/21/11:45			[signature]	8/10/21 11:45am

1	pH	6	TKN	11	Total Solids	16	Sulfate	21	1664 TPH/FOG	26	8270 PAH Only	LAB USE ONLY
2	Chloride	7	Total P	12	TSS	17	Coliform (Specify)	22	8015 GRO	27	8081 Pest	Delivery: Client
3	Ammonia N	8	Total Diss. P	13	TDS	18	COD	23	8015 DRO	28	8082 PCB	Temp: 21.5°
4	Nitrite N	9	BOD	14	Turbidity	19	VT PCF	24	8260B	29	PP13 Metals	Comment:
5	Nitrate N	10	Alkalinity	15	Conductivity	20	VOC Halocarbons	25	8270 B/N or Acid	30	Total RCRA8	
31	Metals (Total, Diss.) Ag, Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Sn, Tl, U, V, Zn											
32	TCLP (volatiles, semi-volatiles, metals, pesticides, herbicides)					33	Other					
34	Corrosivity	35	Ignitability	36	Reactivity	37	Other					
38	Other											

(White - Laboratory / Yellow - Client)

2021 - Samples & Observations on August 10th

Location	ID#	Flow	pH	E.Coli	Notes
Lexington Ro	6 / CP1397	YES	7.0	920	Rusty Color
112 Wyndhan	7 / CP1399	YES	7.2	2	Slime / Rusty Colo
Coventry Roa	8 / CP1398	DRY			BROKEN OUTFLOW - Tree Fall
196 Liberty L	11 / CP1402	YES	7.6	1600	Bank Erosion
122 Foreman	18 / CP1428	YES	7.2	260	Homeowner Mitigation Falling Apart
12 Woodrose	5 / OC1483	DRY			No Change
Severance Ro	48 / CP1391	DRY			Less Yard Waster This Year
Young Street		NO	7.2		Continued Erosion / Debris
Opposite Int	B3-016	NO	7.2		Piles of Pallets
Between Moo	B3-017	DRY			Buried
Moorings Baf	B3-018	YES	7.2	650	Disgusting growth in baffle
1086 E. Lakes	C2-001	NO	8.0		Pipe is short of lake
1063 E. Lakes	C2-002	No evidence of drainage			Recent Construction
E, Lakeshore	C2-003	DRY			Good shape
1277 E. Lakes	C2-004	DRY			Pipe disconnected
Lefevre's	C2-005	DRY			Good Shape
230 Stone Dr	C2-006	DRY			Heavy vegetation - No water
230 Stone Dr	C2-007	DRY			Heavy vegetation - No water
Tower Ridge	C3-002	DRY			No new erosion
Everbreeze	C3-003	YES	7.2	9.8	Flow comes out above pipe
Blakely Road	C3-004	NO	6.8		Low, lots of frogs
Opposite Wil	C3-005	YES	6.8	0.9	Flow comes out around pipe
Opposite Wil	C3-006	Lake covers drainage			Significant ice damage to structure
Acorn Lane -	C3-018	SITE GONE - New Driveway Covered it			
Acorn Lane -	C3-019	YES	8.0	330	Steady flow, moderate erosion
Champlain Dr	C3-021	NO	8.0		Debris
118 Orchard	C3-025	DRY			Significant erosion / Pipe damaged
Route 2 & 7 (	C4-015	DRY			No change
Shaw's 1	C4-017	DRY			Pond very low
Hampton Inn	C4-018	DRY			Heavy vegetation - No water
Shaw's 2	C4-019	DRY			Pond very low
Main Street	D3-010	DRY			Good shape
Fort Ethan A	D4-001	YES	7.2	6.3	Flow comes out around pipe
Fort Ethan A	D4-003	DRY			Pond dry, construction debris

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781 Blakely Road • Colchester, Vermont • 05446 • 802.264.5500

www.colchestervt.gov

MEMORANDUM

TO:	Karen Adams, Technical Services Manager
FROM:	Cathyann LaRose, Director of Planning & Zoning
DATE:	March 16, 2022
RE:	Stormwater Reporting Calendar Year 2021

Please find attached a spreadsheet enumerating projects advanced to construction for the period beginning January 1, 2021 through December 31, 2021 with more than one acre but less than five acres of disturbance. In calendar year 2021, the Department issued 644 permits and conducted 593 inspections.

Colchester Projects, Under Construction as of December 2021 over 1 acre

Colchester Planning & Zoning Department Monthly Report

Permit #	APN	Description	Acres Disturbed	ImperviousArea	Date Issued	OWNER	STATUS
28164	16-020120-0000000	5 Bedroom single family home	1-5		8/5/2021	RYAN GARDNER	Under Construction
CU2105	04-030013-0000000	Construction of a 4-story 36 unit apartment bı	1-5		11/1/2021	IRELAND INDUSTRIES INC	Under Construction
SP2115	78-008030-0000000	Modify 2-24-20 Site Plan approval for Extensic	1-5		3/1/2021	RUPERTS CASTLE TRUST C/O BURTON GOLDSTEN	Under Construction
SP2120	04-030013-0000000	Construction of a 4-Story 36 unit apartment bı	1-5		11/1/2021	IRELAND INDUSTRIES INC	Under Construction
FP2116	16-020030-0000000	The proposed development is on a 10.84 acre	1-5		3/25/2021	FREDERICK GEORGE BLONDIN/JOAN ALICE BLONDIN LVG TRUST	Under Construction
SP2117	01-007001-0000000	The proposed project involves dewatering the	1-5		5/4/2021	J HUTCHINS INC	Under Construction
28185	16-020140-0020000	1 new 4 bedroom single family home	1-5		7/9/2021	RYAN GARDNER	Complete
28186	16-020140-0030000	1 new 4 bedroom single family home	1-5		7/9/2021	RYAN GARDNER	Under Construction

Colchester
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Department of Public Works

Annual Municipal Separate Storm Sewer System (MS4) Training

Colchester
VERMONT

What is MS4?

- MS4 stands for Municipal Separate Storm Sewer System
- MS4 permits are issued to municipalities having storm sewer systems that discharge to waters of the state i.e. Lake Champlain, Winooski River, Lamoille River, etc.
- MS4 construction and maintenance standards are similar to those of the Municipal Roads General Permit (MRGP) issued to municipalities not covered by MS4

MS4 Training Requirements

- MS4 permits require annual training of municipal maintenance crews that covers:
  - Procedures to minimize discharge of sediments, toxins, phosphorous, nutrients, and other harmful contaminants
  - Understanding of location and characteristics of natural resources that may be vulnerable to municipal operations
  - Sources of contamination that may be generated by municipal operations and how they impact natural resources
  - Procedures to minimize the potential effects of municipal operations on natural resources
  - Specific conditions and requirements of the Town's permit
  - Procedures for complying with any federal and state laws for proper disposal of wastes

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MS4 Natural Resources

- 30 miles of shoreline on Lake Champlain
  - 10 square miles of lake within Malletts Bay
- 9 miles of shoreline along Winooski River
- 3 miles of shoreline along Lamoille River
- 186 acre Colchester Pond
- 165 mapped wetlands
  - 3,066 acres
- Numerous brooks, streams, and unnamed tributaries

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MS4 Natural Resources

- During municipal operations, we need to consider the impacts we may have on natural resources:
  - Lakes
  - Rivers
  - Ponds
  - Streams – perennial and intermittent
  - Wetlands

LAKES, RIVERS AND PONDS ARE PRETTY EASY TO IDENTIFY
WHAT ABOUT STREAMS AND WETLANDS?

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Characteristics

- Wetland – land consisting of marshes or swamps, may be permanently or seasonally flooded, and contains aquatic plants
  - Often found in lowland areas but may be present at higher elevations that hold water
  - Presence of aquatic plants such as cattails, buttonbush, and spotted joe pye weed



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Characteristics

- Perennial Stream – flows year round under normal rainfall conditions
  - Aquatic plants and organisms may be present
  - Defined channel, stream bed, and/or banks

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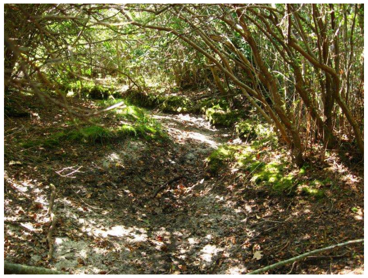
Characteristics

- Intermittent Stream – only flows during periods of high runoff such as spring snow melt and heavy rain
  - Defined channel
  - Seasonal



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Special Considerations

- Wetlands will typically have required disturbance boundaries where no work may take place without a special permit and hazard mitigation steps taken
  - This may require state approval, additional engineering design work, or special equipment, materials, or construction methods
- Streams should not be altered in any way without approval from the state
  - This includes work replacing cross culverts, repairing head walls, or work within the state designated buffer zone
  - Emergency protective measures may be taken without prior state approval to preserve life or protect against severe imminent damage to public or private property, or both

Types of Contamination

- Trash/Litter
- Sediment such as sand, silt, gravel
- Toxins such as VOCs (Volatile Organic Compounds) like gas, oil, paint, and other petroleum based products or other chemicals that may be spilled
- Phosphorous or other nutrients from things like fertilizer and decaying leaves

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Sources of Contamination

- Litterbugs/Illegal dumping
- Vehicle/equipment leaks
- Spills
- Excavation activities
- Runoff picking up pollutants from driveways, lawns, roadways, etc
- Poor stormwater management practices

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Contamination Prevention

- How do we prevent, or at least minimize, contamination of the natural resources in our area?
  - Vehicle/Equipment Inspection and Maintenance
    - Check for and correct leaks and drips
  - BMP's – Best Management Practices
    - Seed/mulch/stabilize excavations ASAP
    - Protect basin inlets during activity
    - Inspect/Clean basins regularly
    - Silt fence or erosion matting where appropriate
  - Public Education and Awareness

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Our Programs – What We Do

- Green-Up Day/Litter Picking
- Spring Sweeping – pick up the silt, sand, and debris/litter before it gets into basins and waterways
- Fall Sweeping – pick up the leaves and other phosphorous and nutrient carrying debris
- Basin Inspection/Cleaning – remove build up from the basin sumps before it enters the pipes and eventually discharges to a waterway
- Collected materials – stockpile in a suitable location and test for contaminants
- Disposal – properly dispose of collected materials either in an approved clean fill site or landfill if certain contaminants are found thru testing

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Our Programs – What We Do

- Road grading – proper crown and dirt curb removal to improve drainage, which protects the road's surface and minimizes material loss into the ditch
- Chloride application – prevents airborn dust on gravel roads which can enter runoff or accumulate in nearby wetlands or other waterways
- Ditching – proper construction and stabilization, direct runoff away from waterways whenever possible
- Smart Salt/Sand application in winter – avoid using sand where it can accumulate in stormwater systems and limit salt use when possible to reduce chloride load in runoff

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Rules, Regulations, and Other Fun Stuff

- Ditches – stabilization type based on slope, *shall* be stabilized as soon as possible after disturbance
  - 0-5% Grass lined minimum
  - 5-8% Stone check dams minimum
  - 8%+ Stone lined
- Spills – any chemical or hazardous material spill of 2 gallons or more *shall* be reported to a supervisor and reported to VTDEC
- Illicit Discharge – any unauthorized discharge or connection to a public stormwater system or waterway *shall* be reported immediately
- PCP – Phosphorous Control Plan
  - Town is currently developing this for state approval
  - State requires a PCP to reduce phosphorous load going in to Lake Champlain

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ANY QUESTIONS?

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Before & After

Police Station Outfall Repair

Spring 2021

Fall 2021

Project Narrative:
There is significant erosion at the stormwater outfall located behind the Colchester Police Station at 835 Blakely Road. The outfall discharges into Smith Creek, which drains into Malletts Bay. Runoff from a total area of approximately 3.7 acres is collected and routed to this outfall. This catchment area is comprised of parts of the properties for the Colchester Police Station, University of Vermont Medical Center, and Town Offices.

The existing drainage system includes a combination of catch basins, drainage manholes, and infiltration practices connected by drainpipes. The two existing infiltration practices were added on the site of the Town Offices when they were constructed in 2007, and catch basins and yard drains collect the remainder of runoff from the outfall catchment area. This runoff is then conveyed to and discharged from the Smith Creek outfall.

Construction of a plunge pool is proposed at the outfall for energy dissipation and flow diffusion purposes. Discharge and outlet velocity must be estimated at this outfall to appropriately size the plunge pool.

Phosphorus Loading:
The erosion at the Smith Creek outfall has resulted in significant phosphorus lost from the bank to the stream, subsequently discharging to Mallett's Bay. AutoCAD analysis suggests an estimated sediment loss of approximately 85 CY, or 2300 CF. Municipal Roads General Permit (MRGP) guidance outlines a method for estimation of phosphorus loading. This approach is explored below.

$$Rate\ of\ Erosion = E = \frac{V * S}{T}$$

Where:

E = sediment erosion rate, kg sediment (TSS)/year
V = total volume of erosion measured from outlet, CF
S = sediment bulk density, 43.48 kg/CF
T = age of erosion observed, kg sediment (TSS)/year

$$E = \frac{2300\ CF * 43.48\ kg/CF}{5\ years} = \mathbf{20,000\ kg\ sediment\ (TSS)/year}$$

$$Phosphorus\ Loading\ Rate = P_i = E * S_C$$

Where:

P_i = phosphorus loading rate, kg (P)/year
S_C = sediment to phosphorus wt. conversion, 0.000396 kg (P)/kg sediment (TSS)

$$P_i = (20{,}000\ kg\ sediment\ (TSS)/year) * 0.000396 = \mathbf{7.92\ kg\ (P)/year}$$

This analysis indicates that the Smith Creek outfall has experienced approximately 100,000 kg of sediment erosion, or 20,000 kg of sediment erosion per year over the last 5 years, which is an assumed value based on observations of recent erosion. This translates to nearly 8 kg of phosphorus discharged into Smith Creek annually, or a total of nearly 40 kg over the last 5 years. It is clear that there is significant erosion at the Smith Creek outfall, and mitigative measures must be taken to armor the bank and reduce erosion in the future.

Modeling:

A hydrologic and hydraulic model was built in HydroCAD to estimate the outfall discharge in various storm scenarios. Rainfall values for the storm events were estimated using Northeast Regional Climate Center (NRCC) data, and the values are shown below in Table 1. These values are based on a 24-hour storm duration under a Type II rainfall distribution.

Table 1: *Precipitation by storm event for project site in Colchester, VT*

Storm Event, 24-hr Duration	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Precipitation, P (in)	2.19	2.65	3.07	3.72	4.30	5.54

The HydroCAD model was built to reflect the drainage conditions present at the site under each of the examined storm event scenarios. The routing diagram is shown below in Figure 1. 'EXIST DMH 1477' represents the drainage manhole immediately upstream of the outfall, so the outflows at that node and the inflows at the 'Smith Creek' node represent the outfall discharge for each storm event.

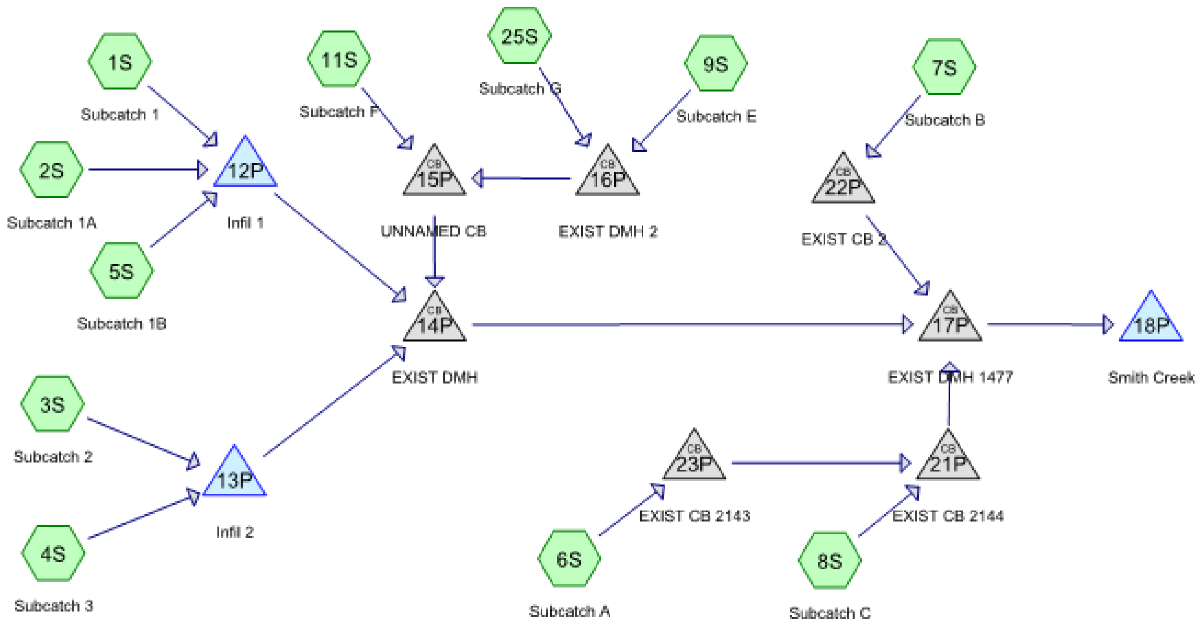

Figure 1: *Routing diagram for HydroCAD model of Smith Creek outfall*

The HydroCAD model was run for each of the listed storm events. The peak discharge and velocity at the outfall into Smith Creek is shown below in Table 2 for each of the storm events.

Table 2: *Smith Creek outfall peak discharge and velocity for each modeled storm event*

Storm Event, 24-hr Duration	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Outfall Discharge, Q (cfs)	0.78	1.19	1.62	2.35	4.99	11.02
Outfall Velocity, V (fps)	2.12	2.37	2.57	2.84	3.56	5.73

The peak discharge and velocity increase dramatically for the storm events with greater return periods. This is the result of runoff volume exceeding the storage capacity of the on-site infiltration practices and overflow entering outlet devices, eventually being discharged through the Smith Creek outfall. At lower return periods, the reduced flows did not exceed the storage capacity of the infiltration practices and were instead entirely infiltrated into the ground rather than being conveyed to the outfall.

Design Standards:

The Vermont Stormwater Manual provides a set of guidelines and requirements for design of plunge pools, as discussed in Section 6.5.2.1 (p. 6-19).

Required Elements (for pipes ≤18" dia. and flows ≤9 cfs):

- Max allowable discharge for 18” pipe is 10 cfs for Q10
- See Section 5.3.2 of VTrans Hydraulic Manual, 2015 for stone fill thickness and other design requirements
    - Summarized on VTrans Design Criteria and Standards webpage for culvert crossings, found at https://vtrans.vermont.gov/highway/structures-hydraulics/hydraulics/designcriteria-standards
- Base of plunge pool is square, width calculated as follows:
    - Base width = 3 * Discharge Pipe Size
- Side slopes for all four sides no greater than 2:1
- Min depth is 1 ft
- Max depth is 3 ft

Design Guidance (for pipes ≤18” dia. And flows ≤9 cfs):

- Plunge pool should be installed in undisturbed soil instead of fill material to prevent shifting of pool after installation.
- Confirm that riprap consists of well-graded mixture of stone. Smaller stones should be used to fill voids between larger stones.
- Confirm that plunge pool has easy access for maintenance.

Design Parameters:

As discussed in the VT Stormwater Manual, plunge pools are typically sized for a 10-year, 24-hour storm event. The parameters used for sizing of the proposed plunge pool are listed below.

Outfall Pipe Diameter: 18”

10-year, 24-hour Storm Precipitation: 3.07”
10-year, 24-hour Outfall Discharge, Q_{10} = 1.62 cfs
10-year, 24-hour Outfall Velocity, V_{10} = 2.57 fps

Plunge Pool Sizing:

According to the VSMM, the base of a plunge pool with outfall pipe dia. ≤ 18” and Q_{10} ≤ 9 cfs is square, with both the width and length equivalent to 3 times the pipe diameter.

$$Base\ Width = Base\ Length = 3 * Pipe\ Diameter = 3 * 18" = 3 * 1.5' = \mathbf{4.5'}$$

The base of the proposed plunge pool will be 4.5’ x 4.5’.

The minimum and maximum depths of a plunge pool with outfall pipe dia. ≤ 18” and Q_{10} ≤ 9 cfs are 1 ft and 3 ft, respectively. There is no specific guidance on selecting a depth for lower-flow scenarios. Given the 10-year design discharge value of 1.62 cfs (<<9 cfs) and the site constraints, the selected depth for design is 1 ft.

Base: 4.5’ x 4.5’
Side Slopes: 2:1
Depth: 1’
Top: 8.5’ x 8.5’
Basin Volume: 44 CF

Riprap Sizing:
As indicated in the VSMM guidelines, for an 18” pipe outfall Type II Stone Fill should be used to line the plunge pool.

While Stone Fill Type II is recommended by the SWMM, this material has minimal fines and is prone to allowing subsurface flow within the channel. As a result, environmental stone, or E-stone, is recommended in lieu of typical VTrans stone fill. E-stone includes some finer materials to help fill void space and limit subsurface flow. E-stone fill is hard, blasted, angular rock other than serpentine rock containing the fibrous variety chrysotile (asbestos). Refer to the VTrans Design Criteria and Standards webpage linked above in the ‘Design Standards’ section for further discussion of E-stone. This reference recommends specification of E-stone type based on flow velocity for a 50-year design discharge at the structure outlet.

As discussed previously, the 50-year, 24-hour design discharge is 4.99 cfs with a velocity of 3.56 fps. See Table 3, shown below, for E-stone sizing design guidance.

Table 3: *E-stone sizing design guidance*

Type	Velocity Range (fps)*	Embeddedness (in)
E1	$V \leq 9$	18
E2	$9 < V \leq 11$	24
E3	$11 < V \leq 13$	36
E4	$13 < V \leq 15$	48

*Maximum velocity should be based on a minimum 50-year design flow rate and calculated at the structure outlet.

Table 3 indicates that E-stone, Type E1 should be used for 50-year design discharge velocities of <9 fps (3.56 < 9) with an embedded depth of 18 inches, or 1.5 ft. As specified in the Vermont Standard River Management Principles and Practices (VSRMPP) Appendix M, E-stone Type E1 is a well-graded material with a d_{max} of 18 inches and a d_{50} of 12 inches, while at least 25% of the particles shall have a maximum dimension of 2 inches.

Stream Channel Hydraulics:

While E-stone Type E1 is adequate for the velocities in the plunge pool, riprap armoring is proposed on the plunge pool outfall channel to Smith Creek. The riprap must also be sized for this outfall channel since it will be exposed to flows within the stream channel for Smith Creek. To do this, StreamStats was used to estimate Smith Creek flows in different storm scenarios. See Figure 2, shown below, for the StreamStats watershed delineation of the Smith Creek outfall location and Table 4, also shown below, for the StreamStats peak flow statistics.

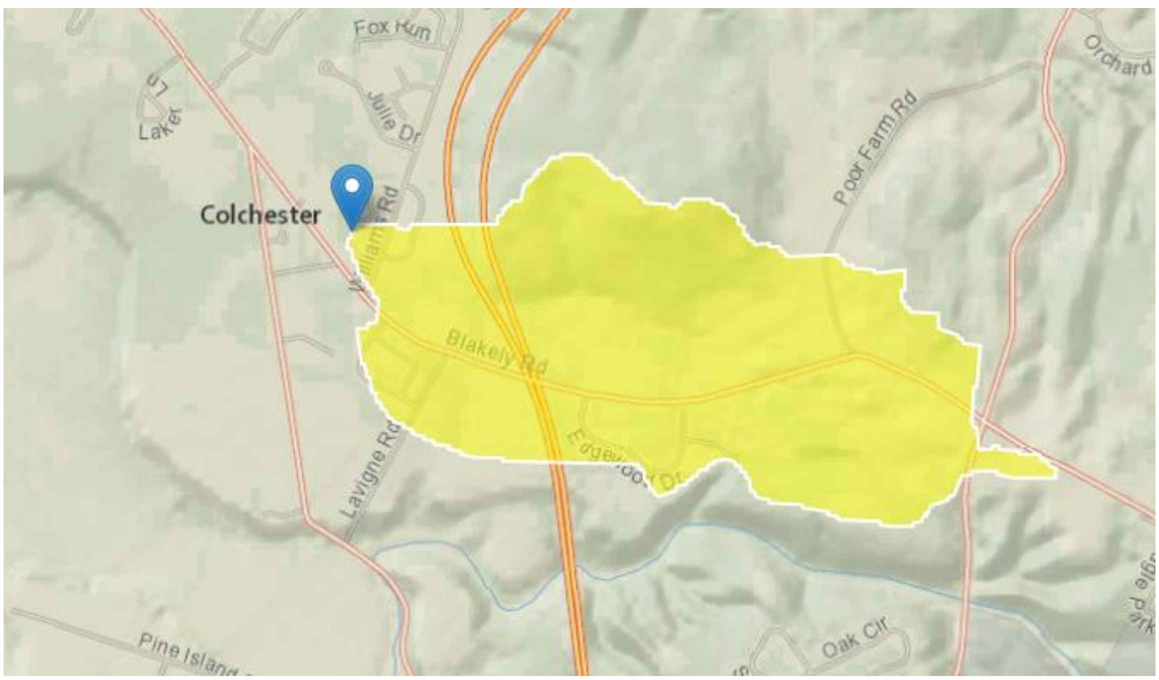

Figure 2: *Estimated drainage basin for Smith Creek at outfall location*

StreamStats estimated the drainage area for the Smith Creek outfall location to be 0.97 square miles, with a mean annual precipitation of 37.3 inches based on data from 1981 to 2010. Flood scenarios are provided in the context of exceedance probabilities. These represent the probability that a storm in any given year will produce flow in excess of the listed discharge values. In other words, a 50% annual exceedance probability (AEP) flood represents a storm flow that will be exceeded on average once every 2 years, or a flood that there is a 50% chance of occurring every year. This is carried throughout the other flood scenarios, so 20%, 10%, 4%, 2%, and 1% floods represent the 5-year, 10-year, 25-year, 50-year, and 100-year flood scenarios, respectively. For this analysis, since E-stone riprap is sized based on 50-year flow velocities, the 10-, 25-, and 50-year flood scenarios were assessed to estimate flow velocity. The estimated discharges for these three flood scenarios are 66.9 cfs, 89.3 cfs, and 109 cfs.

By estimating the velocity, the water surface elevation (WSE) can also be estimated. This should also dictate design decisions since the WSE will ideally be less than the plunge pool outfall weir elevation of 164.0'. If the WSE does overtop the weir the plunge pool would still work as an energy dissipator for the proposed outfall, but it would likely lead to sediment deposition within the plunge pool and require additional maintenance to keep the pool clean.

Table 4: *StreamStats peak flow statistics for Smith Creek at outfall location*

Peak-Flow Statistics Parameters[Statewide Peak Flow]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	0.97	square miles	0.18	689
LC06STOR	Percent Storage from NLCD2006	1.48	percent	0	18.5
PRECPRIS10	Mean Annual Precip PRISM 1981 2010	37.3	inches	33.5	70.4

Peak-Flow Statistics Flow Report[Statewide Peak Flow]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SEp
50_percent_AEP_flood	32.2	ft^3/s	18.2	57.1	34.8
20_percent_AEP_flood	51.6	ft^3/s	28.5	93.3	36.1
10_percent_AEP_flood	66.9	ft^3/s	35.5	126	38.6
4_percent_AEP_flood	89.3	ft^3/s	44.7	178	42.5
2_percent_AEP_flood	109	ft^3/s	52.5	226	44.9
1_percent_AEP_flood	130	ft^3/s	60.5	279	47.3
0_5_percent_AEP_flood	154	ft^3/s	68.1	348	50.8
0_2_percent_AEP_flood	189	ft^3/s	78.5	455	55.2

Peak-Flow Statistics Citations

Olson, S.A.,2014, Estimation of flood discharges at selected annual exceedance probabilities for unregulated, rural streams in Vermont, with a section on Vermont regional skew regression, by Veilleux, A.G.: U.S. Geological Survey Scientific Investigations Report 2014–5078, 27 p. plus appendixes. (http://pubs.usgs.gov/sir/2014/5078/)

Estimating stream velocity and water surface elevation requires the use of Manning's Equation since more detailed cross-section and water stage data further upstream and downstream of the outfall were not collected. Manning's Equation is shown below.

$$Q = \frac{1.486}{n} * A * R_h^{2/3} * S^{1/2}$$

Where:

Q = flow/discharge (cfs)
n = Manning's roughness coefficient
A = cross-sectional flow area
R_h = hydraulic radius
S = stream channel slope

Using data from the survey, StreamStats, and visual observations, all of the parameters except A and R_h can be determined. However, these two parameters can be estimated in terms of depth of flow, d, so Manning's Equation can be solved for d, which can then be used to estimate water surface elevation and flow velocity.

To estimate these two parameters, three different cross-sections perpendicular to the Smith Creek channel flow direction were examined at the outfall: one at the upstream limits of riprap, one at the center of the plunge pool outfall channel, and one at the downstream limits of riprap. These cross-section locations are shown below in Figure 3 as white lines crossing Smith Creek. Cross-section 1 refers to the most upstream cross-section (shown at the bottom of the image) with cross-section 3 referring to the furthest downstream. Stream cross sections were estimated based on contours from the survey data.

Since more detailed cross-section data was not collected, the three cross-sections were used in lieu of modeling for estimation of velocity and WSE. Manning's Equation dictates that each of these cross sections be treated as discrete and unrelated scenarios, so each were analyzed independently and the greatest value for both critical parameters was considered controlling.

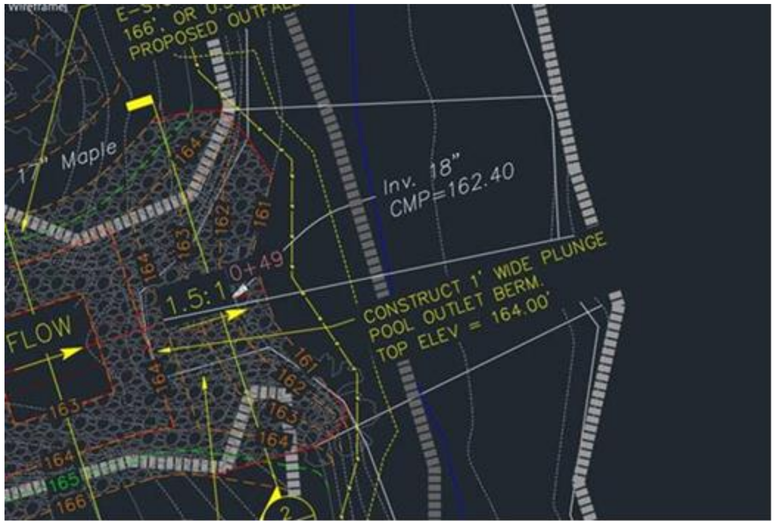

Figure 3: *Smith Creek cross-section locations*

By solving Manning's Equation for d, flow velocity and water surface elevation can be estimated. Calculations for these parameters at each cross-section are presented in the attached Backup Calculations document. Estimated results are exhibited below in Table 5.

Table 5: *Flow velocities and water surface elevations for each cross-section under 10-, 25-, and 50-year storms*

Storm Scenario	Flow Velocity (fps)			Water Surface Elevation (ft)		
	XS 1	XS 2	XS 3	XS 1	XS 2	XS 3
10-year	7.26	4.72	3.85	161.79	162.16	162.37
25-year	8.01	5.14	4.20	161.99	162.44	162.69
50-year	8.52	5.44	4.41	162.15	162.66	162.95

For the three cross-sections assessed in this analysis, the maximum velocity was 8.52 fps for cross-section 1 under a 50-year storm scenario and the maximum WSE was 162.95' for cross-section 3 under a 50-year storm scenario. This indicates that the upstream cross-section controls flow velocity through the stream channel at the outfall while the downstream cross-section controls the flow depth. As discussed previously, the upper limit of flow velocity for E-stone Type E1 is 9 fps for a 50-year storm, so this analysis indicates that Type E1 riprap is adequately sized for the plunge pool outfall channel on the stream bank of Smith Creek. Additionally, the maximum WSE of 162.95' is less than the plunge pool outfall weir elevation of 164.0'. This indicates that the weir would not be overtopped by a 50-year storm, and potential maintenance requirements for the plunge pool should be minimized.

It is worth noting that by treating these three cross-sections as independent analysis scenarios, there is some level of inaccuracy in this analysis. This cannot take into account the continuation or relationship of flow between the cross sections, instead estimating flow characteristics based on the inherent assumption that each cross-section is unaffected by variation in geometric or qualitative characteristics within the channel. In reality, flow velocities at cross-section 1 would be lower than estimated since flow would back up and slow down at cross-section 2, while flow depth at cross-section 3 would be lower than estimated since velocities would increase from cross-section 2 as the channel narrows. Hydraulic modeling would allow a more comprehensive analysis of these three flow scenarios, but given the limited data available from the survey and the fact that none of the estimated velocities or water surface elevations exceed thresholds at which the design would need modification, this approach is adequate.

Site Restoration

Following the construction of the proposed plunge pool, site restoration practices will be essential to return the vegetation and soil to their original conditions. Proposed site restoration practices include:

- Placement of 4 inches of new topsoil over the entire regraded area for regrowth of vegetation
- Placement of permanent rolled erosion control product over entire regraded area to hold soil in place and prevent further erosion
    - Proposed in place of mulch due to steep slopes (2:1)
- Placement of Vermont Conservation seed mix at 80 lb/acre over entire regraded area to promote re-establishment of undergrowth layer of vegetation
    - Root structures will improve soil stability
    - Undergrowth will add to aesthetic appeal
- Placement of 5 new deciduous trees outside maintenance access corridor
    - Root structures will improve soil stability
    - Trees will add to aesthetic appeal

BACK-UP CALCULATIONS

Cross-Section 1:

Cross-section 1 is located at the upstream limit of the proposed riprap. See Figure 1, shown below, for a plot of this cross-section.

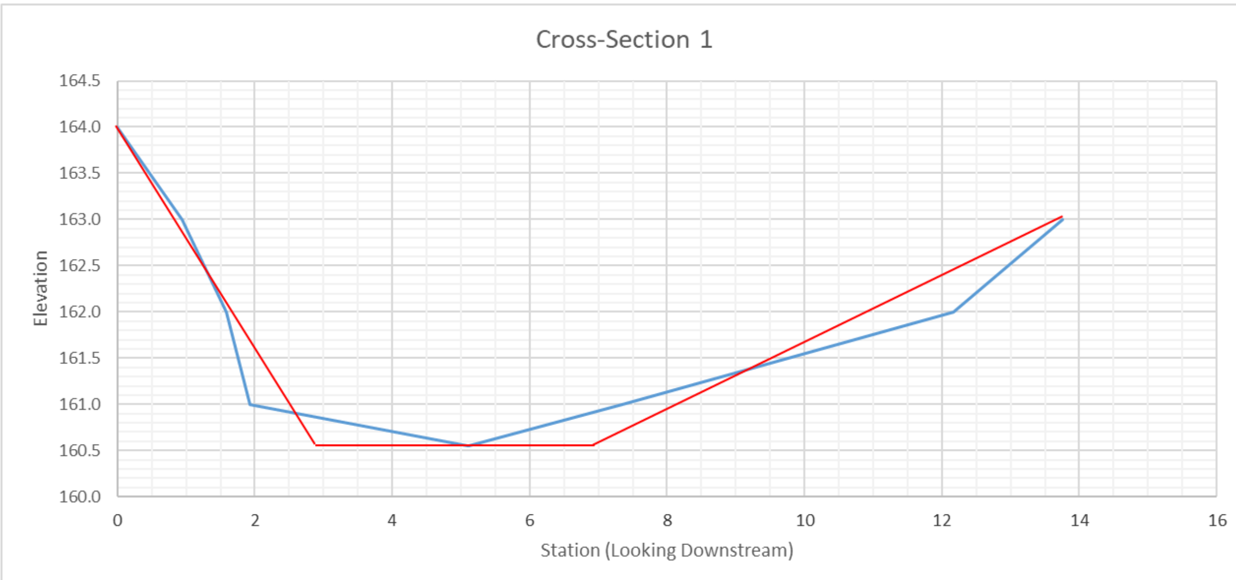

Figure 1: *Smith Creek Cross-Section 1*

The blue line indicates the cross-section based on the contours from the topographic survey data, with the stations measured from the 164 contour on the west (outfall) side of the stream across to the 163 contour on the east side of the stream. Estimation of flow depth from Manning's Equation requires rearranging of cross-sectional flow area and hydraulic radius in terms of d. To get these two parameters in terms of d, the cross-section needs to be simplified to either a rectangular, triangular, or trapezoidal shape. Given the real cross-section, the Smith Creek channel was estimated to be most similar to a trapezoidal shape. This is represented by the red line, which was sketched onto the plot to indicate the shape most representative of the existing channel. This cross-section was then used to estimate the geometric channel characteristics indicated below in Figure 2.

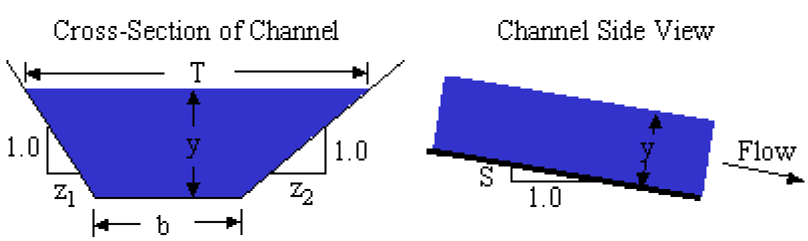

Figure 2: *Stream channel characteristics*

In this figure, b represents the bottom width, T represents the top width, y represents the flow depth, and z_1 and z_2 represent side slope parameters, while S represents the channel slope. For the simplified cross-section 1, these parameters were estimated to be:

b = 4 ft, z_1 = 0.81, z_2 = 2.78, S = 0.0694 (from survey data)

y, or d, represents the flow depth, and T is a function of the flow depth, bottom width, and side slopes. Solving Manning's Equation for d (or y) requires that the cross-sectional flow area (A) and hydraulic radius (R_h) be put in terms of d. This is demonstrated below.

$$A = Cross - Sectional\ Flow\ Area = \frac{1}{2} * [b + T] * d$$

$$T = b + 0.81d + 2.78d$$

$$A = \frac{1}{2} * [2b + 3.59d] * d = \frac{1}{2} * [(2 * 4) + 3.59d] * d = (4 + 1.8d) * d = \mathbf{4d + 1.8d^2}$$

Hydraulic radius represents the cross-sectional flow area divided by wetted perimeter, which is the total perimeter of the flow area.

$$R_h = \frac{Flow\ Area}{Wetted\ Perimeter} = \frac{A}{P}$$

Solve for hypotenuse of triangle for z_1 and z_2 to find slope contribution to wetted perimeter:

$$x_1 = \sqrt{1^2 + 0.81^2} = 1.29, x_2 = \sqrt{1^2 + 2.78^2} = 2.95$$

$$P = b + 1.29d + 2.95d = 4 + 4.24d$$

$$R_h = \frac{\mathbf{4d + 1.8d^2}}{\mathbf{4 + 4.24d}}$$

For the 10-year storm scenario, solve Manning's Equation in terms of d:

$$Q = \frac{1.486}{n} * A * R_h^{2/3} * S^{1/2}$$

Q = 66.9 cfs, S = 0.0694
n = 0.04 (clean, winding channel with some pools and shoals; http://www.fsl.orst.edu/geowater/FX3/help/8_Hydraulic_Reference/Mannings_n_Tables.htm)

$$66.9 = \frac{1.486}{0.04} * A * R_h^{2/3} * 0.0075^{1/2} \rightarrow AR_h^{2/3} = 6.84$$

$$6.84 = (4d + 1.8d^2) * \left(\frac{4d + 1.8d^2}{4 + 4.24d}\right)^{2/3} \rightarrow \boldsymbol{d = 1.24\ ft}$$

Given a depth of 2.19 ft, the cross-sectional flow area can be solved.

$$d = 1.24\ ft \rightarrow A = 4d + 1.8d^2 = (4 * 1.24') + [1.8 * (1.24')^2] = \boldsymbol{9.22\ ft^2}$$

Given a cross-sectional flow area of 9.22 ft^2 and a discharge of 66.9 cfs, the flow velocity can be solved using the continuity equation.

$$Q = VA \rightarrow V = \frac{Q}{A} = \frac{66.9\ cfs}{9.22\ ft^2} = \boldsymbol{7.26\ fps}$$

The water surface elevation can be estimated by adding the estimated flow depth to the bottom elevation of the cross-section as determined from the survey.

$$WSE = 160.55' + 2.19' = \boldsymbol{161.79'}$$

This process was repeated for the 25- and 50-year storm scenarios, and the collective results for cross-section 1 are exhibited in Table 1.

Table 1: *Smith Creek flow velocity and water surface elevation estimates for cross-section 1 under 10-, 25-, and 50-year storm scenarios*

Storm Scenario	Q (cfs)	$AR^{2/3}$ =	d (ft)	A (sf)	V (fps)	WSE (ft)
10-year	66.9	6.84	1.24	9.22	7.26	161.79
25-year	89.3	9.12	1.44	11.15	8.01	161.99
50-year	109	11.14	1.6	12.79	8.52	162.15

Cross-Section 2:
Cross-section 2 is located at the center of the plunge pool outfall channel. See Figure 3, shown below, for a plot of this cross-section.

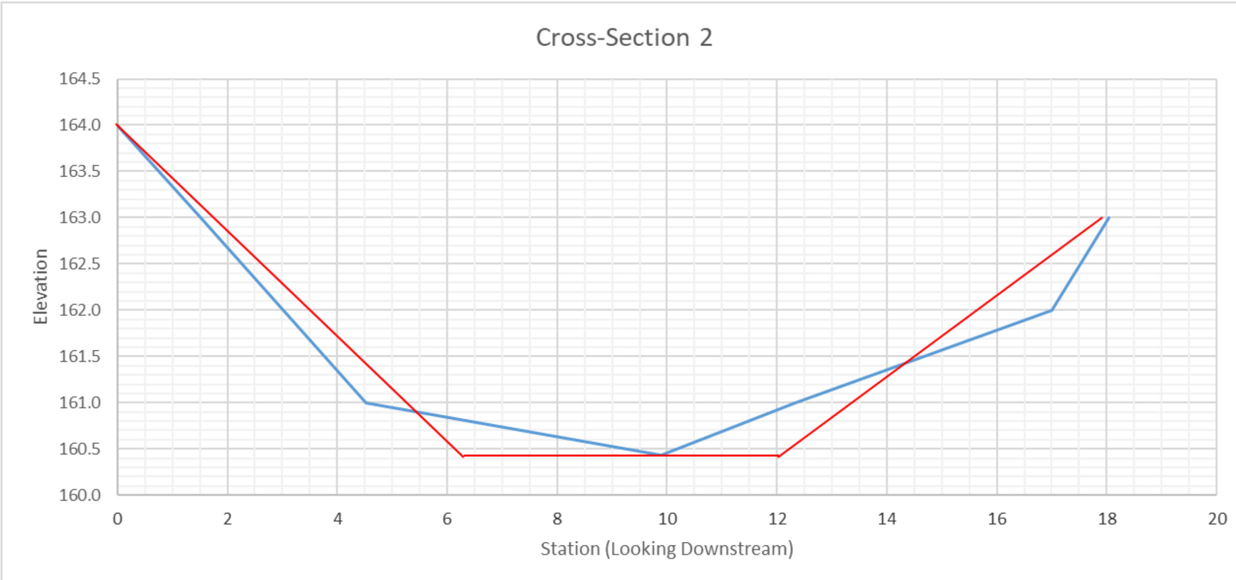

Figure 3: *Smith Creek Cross-Section 2*

The blue line indicates the cross-section based on the contours from the topographic survey data, with the stations measured from the 164 contour on the west (outfall) side of the stream across to the 163 contour on the east side of the stream. Given the real cross-section, the Smith Creek channel was estimated to be most similar to a trapezoidal shape. This is represented by the red line, which was sketched onto the plot to indicate the shape most representative of the existing channel. This cross-section was then used to estimate the geometric channel characteristics. For the simplified cross-section 2, these parameters were estimated to be:

b = 5.8 ft, z_1 = 1.77, z_2 = 2.35, S = 0.0098 (from survey data)

y, or d, represents the flow depth, and T is a function of the flow depth, bottom width, and side slopes. Solving Manning's Equation for d (or y) requires that the cross-sectional flow area (A) and hydraulic radius (R_h) be put in terms of d. This is demonstrated below.

$$A = Cross - Sectional\ Flow\ Area = \frac{1}{2} * [b + T] * d$$

$$T = b + 1.77d + 2.35d$$

$$A = \frac{1}{2} * [2b + 4.12d] * d = \frac{1}{2} * [(2 * 5.8) + 4.12d] * d = (5.8 + 2.06d) * d$$
$$= \mathbf{5.8}\boldsymbol{d} + \mathbf{2.06}\boldsymbol{d}^{\mathbf{2}}$$

Hydraulic radius represents the cross-sectional flow area divided by wetted perimeter, which is the total perimeter of the flow area.

$$R_h = \frac{Flow\ Area}{Wetted\ Perimeter} = \frac{A}{P}$$

Solve for hypotenuse of triangle for z_1 and z_2 to find slope contribution to wetted perimeter:

$$x_1 = \sqrt{1^2 + 1.77^2} = 2.03, x_2 = \sqrt{1^2 + 2.35^2} = 2.55$$

$$P = b + 2.03d + 2.55d = 5.8 + 4.58d$$

$$R_h = \frac{\mathbf{5.8d + 2.06d^2}}{\mathbf{5.8 + 4.58d}}$$

For the 10-year storm scenario, solve Manning's Equation in terms of d:

$$Q = \frac{1.486}{n} * A * R_h^{2/3} * S^{1/2}$$

Q = 66.9 cfs, S = 0.0098
n = 0.04 (clean, winding channel with some pools and shoals; http://www.fsl.orst.edu/geowater/FX3/help/8_Hydraulic_Reference/Mannings_n_Tables.htm)

$$66.9 = \frac{1.486}{0.04} * A * R_h^{2/3} * 0.0075^{1/2} \rightarrow AR_h^{2/3} = 20.76$$

$$18.19 = (5.8d + 2.06d^2) * \left(\frac{5.8d + 2.06d^2}{5.8 + 4.58d}\right)^{2/3} \rightarrow \boldsymbol{d = 1.73\ ft}$$

Given a depth of 1.73 ft, the cross-sectional flow area can be solved.

$$d = 1.73\ ft \rightarrow A = 5.8d + 2.06d^2 = (5.8 * 1.73') + [2.06 * (1.73')^2] = \mathbf{14.18\ ft^2}$$

Given a cross-sectional flow area of 14.18 ft^2 and a discharge of 66.9 cfs, the flow velocity can be solved using the continuity equation.

$$Q = VA \rightarrow V = \frac{Q}{A} = \frac{66.9\ cfs}{14.18\ ft^2} = \mathbf{4.72\ fps}$$

The water surface elevation can be estimated by adding the estimated flow depth to the bottom elevation of the cross-section as determined from the survey.

$$WSE = 160.43' + 1.73' = \mathbf{162.16'}$$

This process was repeated for the 25- and 50-year storm scenarios, and the collective results for cross-section 2 are exhibited in Table 2.

Table 2: *Smith Creek flow velocity and water surface elevation estimates for cross-section 2 under 10-, 25-, and 50-year storm scenarios*

Storm Scenario	Q (cfs)	$AR^{2/3}$ =	d (ft)	A (sf)	V (fps)	WSE (ft)
10-year	66.9	18.19	1.73	14.18	4.72	162.16
25-year	89.3	24.28	2.01	17.36	5.14	162.44
50-year	109	29.64	2.23	20.02	5.44	162.66

Cross-Section 3:

Cross-section 3 is located at the downstream limits of proposed riprap. See Figure 4, shown below, for a plot of this cross-section.

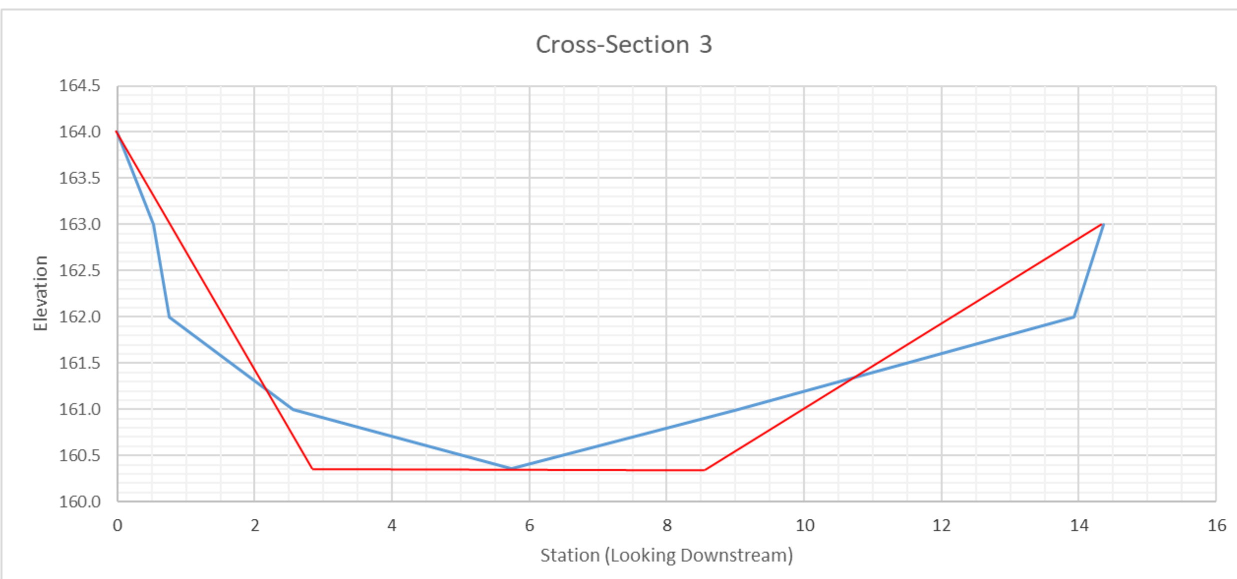

Figure 4: *Smith Creek Cross-Section 3*

The blue line indicates the cross-section based on the contours from the topographic survey data, with the stations measured from the 164 contour on the west (outfall) side of the stream across to the 163 contour on the east side of the stream. Given the real cross-section, the Smith Creek channel was estimated to be most similar to a trapezoidal shape. This is represented by the red line, which was sketched onto the plot to indicate the shape most representative of the existing channel. This cross-section was then used to estimate the geometric channel characteristics. For the simplified cross-section 3, these parameters were estimated to be:

b = 5.5 ft, z_1 = 0.77, z_2 = 2.35, S = 0.0075 (from survey data)

y, or d, represents the flow depth, and T is a function of the flow depth, bottom width, and side slopes. Solving Manning's Equation for d (or y) requires that the cross-sectional flow area (A) and hydraulic radius (R_h) be put in terms of d. This is demonstrated below.

$$A = Cross - Sectional\ Flow\ Area = \frac{1}{2} * [b + T] * d$$

$$T = b + 0.77d + 2.35d$$

$$A = \frac{1}{2} * [2b + 3.12d] * d = \frac{1}{2} * [(2 * 5.5) + 3.12d] * d = (5.5 + 1.56d) * d$$
$$= \mathbf{5.5d + 1.56d^2}$$

Hydraulic radius represents the cross-sectional flow area divided by wetted perimeter, which is the total perimeter of the flow area.

$$R_h = \frac{Flow\ Area}{Wetted\ Perimeter} = \frac{A}{P}$$

Solve for hypotenuse of triangle for z_1 and z_2 to find slope contribution to wetted perimeter:

$$x_1 = \sqrt{1^2 + 0.77^2} = 1.26, x_2 = \sqrt{1^2 + 2.35^2} = 2.55$$

$$P = b + 1.26d + 2.55d = 5.5 + 3.81d$$

$$R_h = \frac{\mathbf{5.5d + 1.56d^2}}{\mathbf{5.5 + 3.81d}}$$

For the 10-year storm scenario, solve Manning's Equation in terms of d:

$$Q = \frac{1.486}{n} * A * R_h^{2/3} * S^{1/2}$$

Q = 66.9 cfs, S = 0.0075
n = 0.04 (clean, winding channel with some pools and shoals;
http://www.fsl.orst.edu/geowater/FX3/help/8_Hydraulic_Reference/Mannings_n_Tables.htm)

$$66.9 = \frac{1.486}{0.04} * A * R_h^{2/3} * 0.0075^{1/2} \rightarrow AR_h^{2/3} = 20.79$$

$$20.79 = (5.5d + 1.56d^2) * \left(\frac{5.5d + 1.56d^2}{5.5 + 3.81d}\right)^{2/3} \rightarrow \boldsymbol{d = 2.01\ ft}$$

Given a depth of 2.01 ft, the cross-sectional flow area can be solved.

$$d = 2.01\ ft \rightarrow A = 5.5d + 1.56d^2 = (5.5 * 2.01') + [1.56 * (2.01')^2] = \boldsymbol{17.36\ ft^2}$$

Given a cross-sectional flow area of 17.36 ft^2 and a discharge of 66.9 cfs, the flow velocity can be solved using the continuity equation.

$$Q = VA \rightarrow V = \frac{Q}{A} = \frac{66.9\ cfs}{17.36\ ft^2} = \boldsymbol{3.85\ fps}$$

The water surface elevation can be estimated by adding the estimated flow depth to the bottom elevation of the cross-section as determined from the survey.

$$WSE = 160.36' + 2.01' = \boldsymbol{162.37'}$$

This process was repeated for the 25- and 50-year storm scenarios, and the collective results for cross-section 3 are exhibited in Table 3.

Table 3: *Smith Creek flow velocity and water surface elevation estimates for cross-section 3 under 10-, 25-, and 50-year storm scenarios*

Storm Scenario	Q (cfs)	$AR^{2/3}$ =	d (ft)	A (sf)	V (fps)	WSE (ft)
10-year	66.9	20.79	2.01	17.36	3.85	162.37
25-year	89.3	27.76	2.33	21.28	4.20	162.69
50-year	109	33.88	2.59	24.71	4.41	162.95

Submission Complete

Watershed Management Division Generic Application/Report Submission and Fee Payment Form

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