Quantifying Nutrient Reductions Achieved by Erosion Remediation Projects on Vermont's Roads

Presentation to

Clean Water Advisory Committee meeting

Chittenden County RPC

May 4, 2021

The UNIVERSITY of VERMONT

VERMONT AGENCY OF TRANSPORTATION

UVM Research Team

Beverley Wemple
Geography & RSENR

Mandar Dewoolkar
Civil & Environmental Engineering

Emma Estabrook
RSENR

Scott Hamshaw
Civil & Environmental Engineering

Student Interns: Frank Piasecki, Luc Burnier

Technical Advisory Committee

- Emily Parkany and Tanya Miller, VTRANS Research
- Jennifer Callahan, VTRANS, project champion
- Joel Perrigo, VTRANS, project champion
- Alan May, VTRANS
- Ashley Bishop, VTRANS District 5
- Jim Ryan, ANR DEC
- Emily Schelley, ANR DEC
- Amy Macrellis, Stone Environmental
- Chris Jolly, FHWA Division Office
- Chris Dubin, CCRPC
- Rob Moore, LVPC

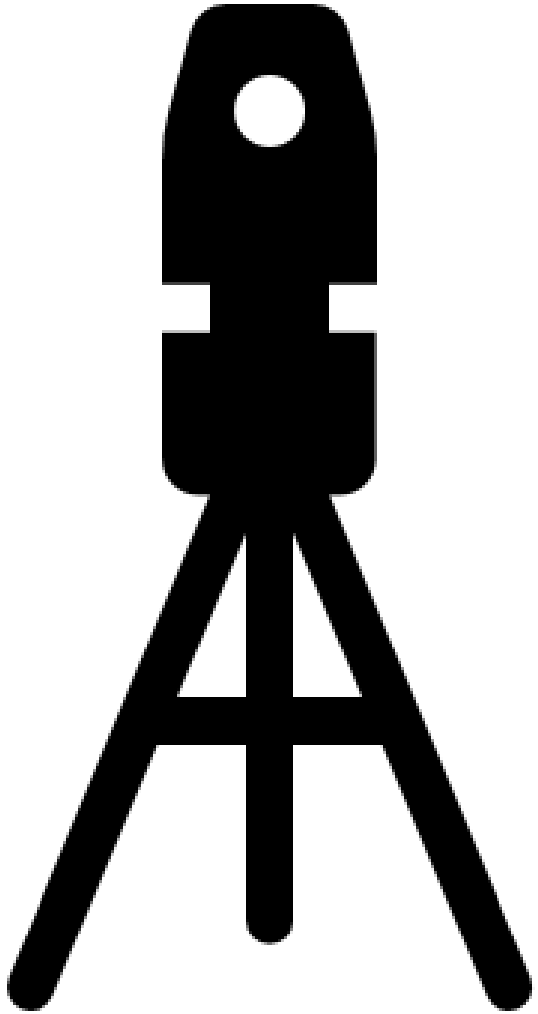
Project Objectives

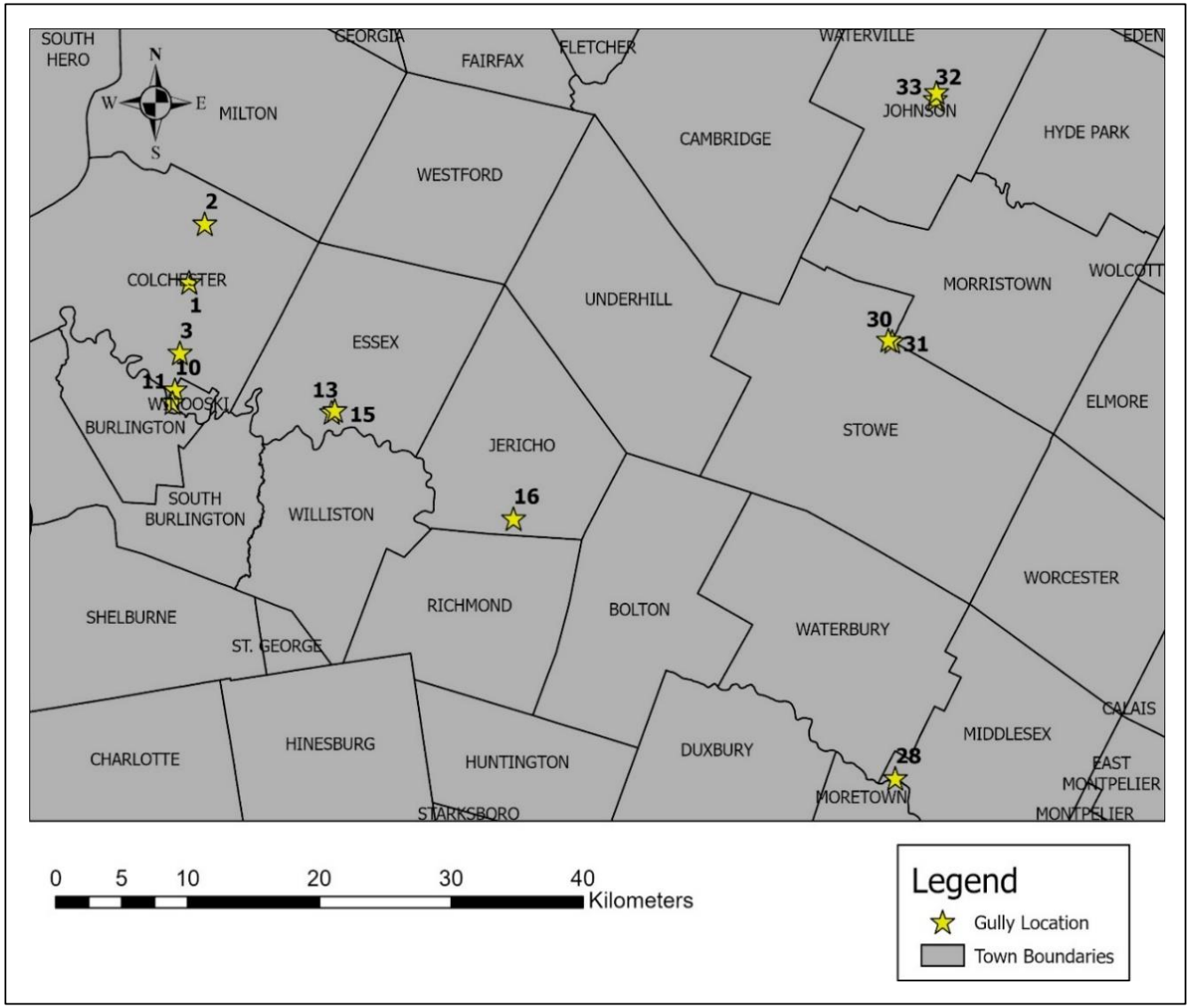
1. Quantify rates of sediment and phosphorus (P) production associated with erosion at concentrated road drainage points on unpaved and paved roads
2. Assess the effectiveness of intervention measures (rock stabilization, energy-dissipating structures, disconnection practices, regenerative storm conveyance) in reducing sediment and P mobility from roads.
3. Develop a framework for providing credits for erosion mitigation measures that can be implemented under the Lake Champlain TMDL.

Objective 1: Quantifying rates of sediment and phosphorus production

- Terrestrial lidar repeat surveys
  - 13 sites, Chittenden, Lamoille, Washington counties
- Airborne lidar feature detection
  - 9831 culverts inspected, northern Vermont

Terrestrial LiDAR Surveys

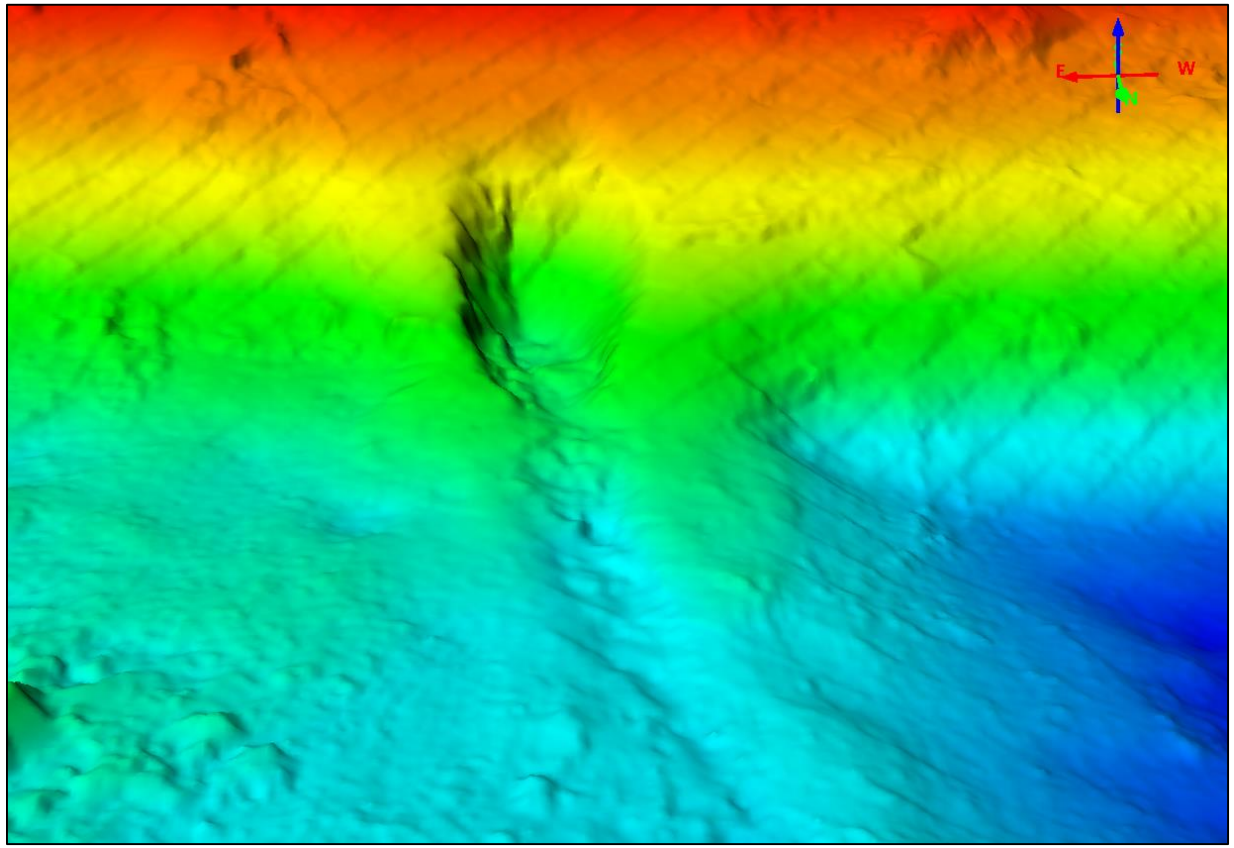




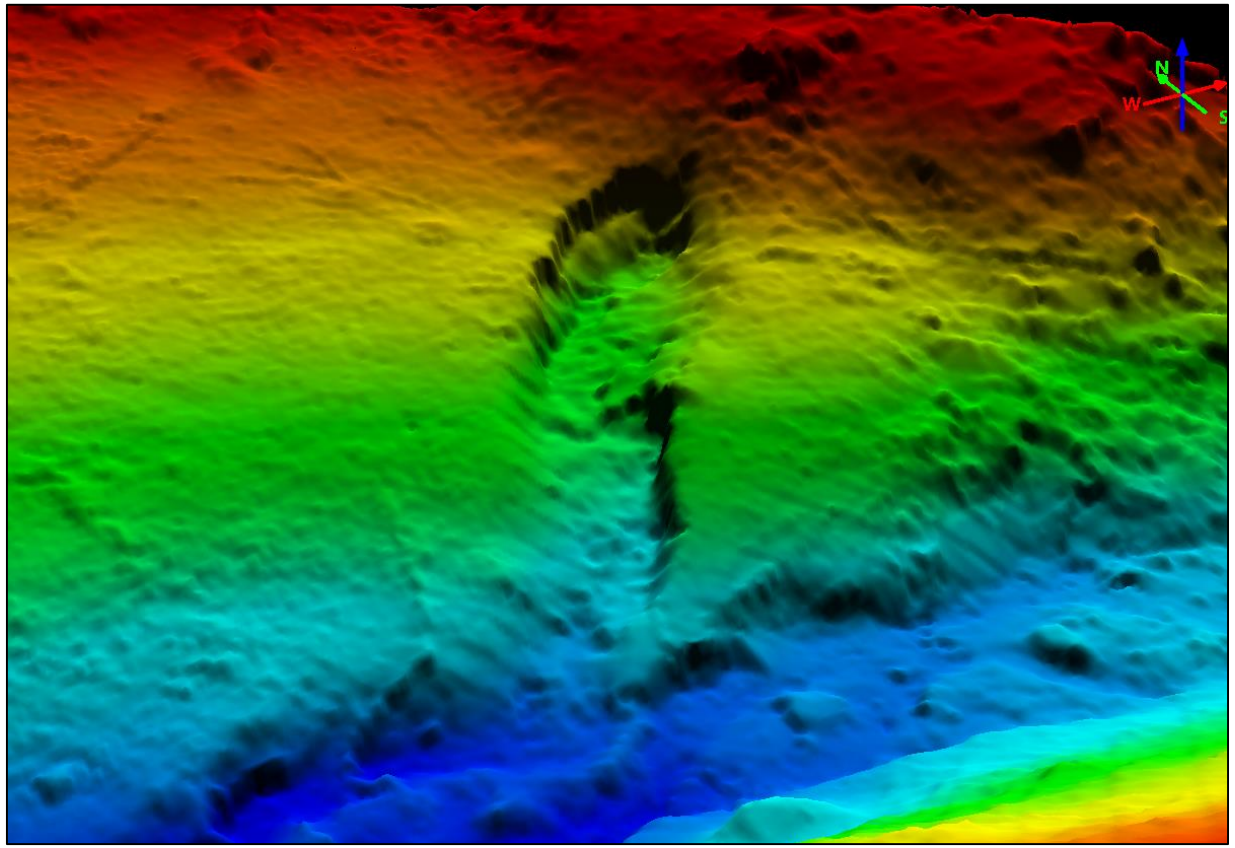
Site Name (ID)	Town
I-89 North (1)	Colchester
I-89 North (2)	Colchester
I-89 South (3)	Colchester
Young (10)	Colchester
Elm (11)	Winooski
Corduroy (13)	Essex
Vale (15)	Essex
Milo White (16)	Jericho
I-89 Middlesex (28)	Middlesex
Maple Run (30)	Stowe
Maple Run (31)	Stowe
Clay Hill (32)	Johnson
Clay Hill (33)	Johnson

LiDAR Surveys

Survey Digital Elevation Models

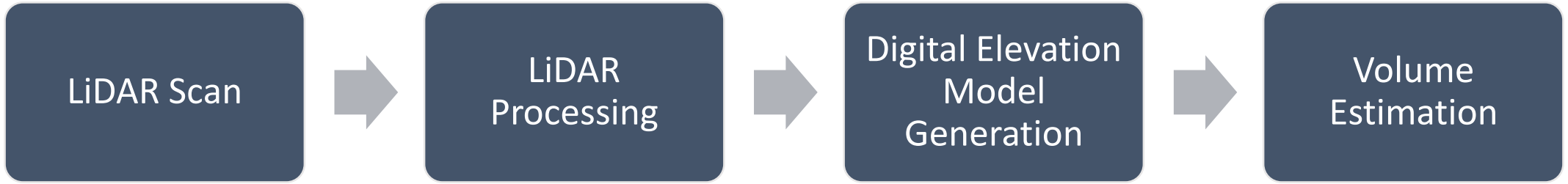


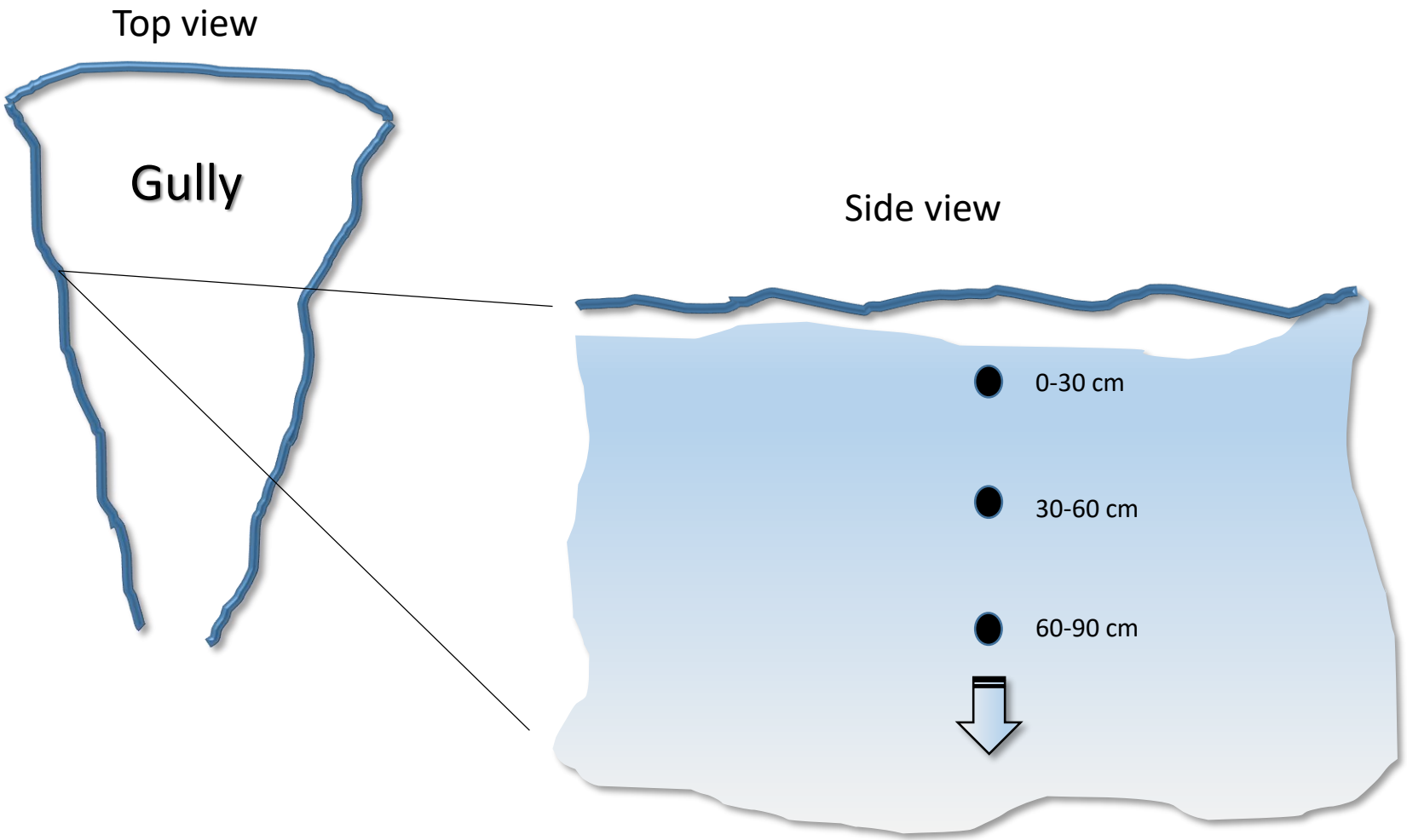
Site name: Vale Drive, Essex (15) | **Survey method**: Terrestrial LiDAR | **Survey date**: 7/24/2020



Site name: Young Street, Colchester (10) | **Survey method**: Terrestrial LiDAR | **Survey date**: 7/16/2020

LiDAR survey and analysis workflow





Soil sampling

Soil sampling and analysis workflow

Sample Collection

Oven drying & weighing for bulk density

BD = mass/vol

Microwave assisted acid digest of sample

+

ICP-MS

(TP_{conc} in mgP/kgS)

P Loss estimation:

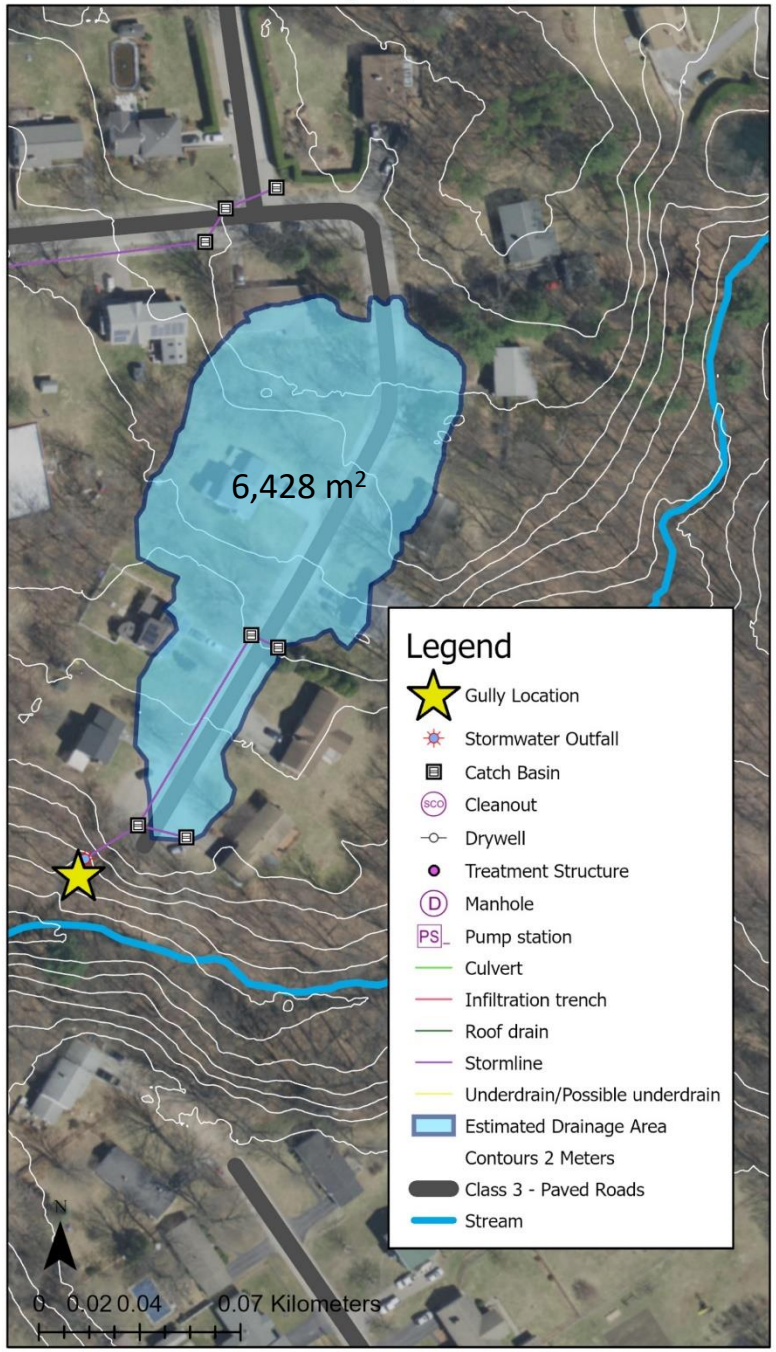
$Mass_{gully\_S} = Vol_{gully\_S} * Mass/Vol_{sample\_S}$

$Mass_{gully\_P} = Mass_{gully\_S} * TP_{conc}$

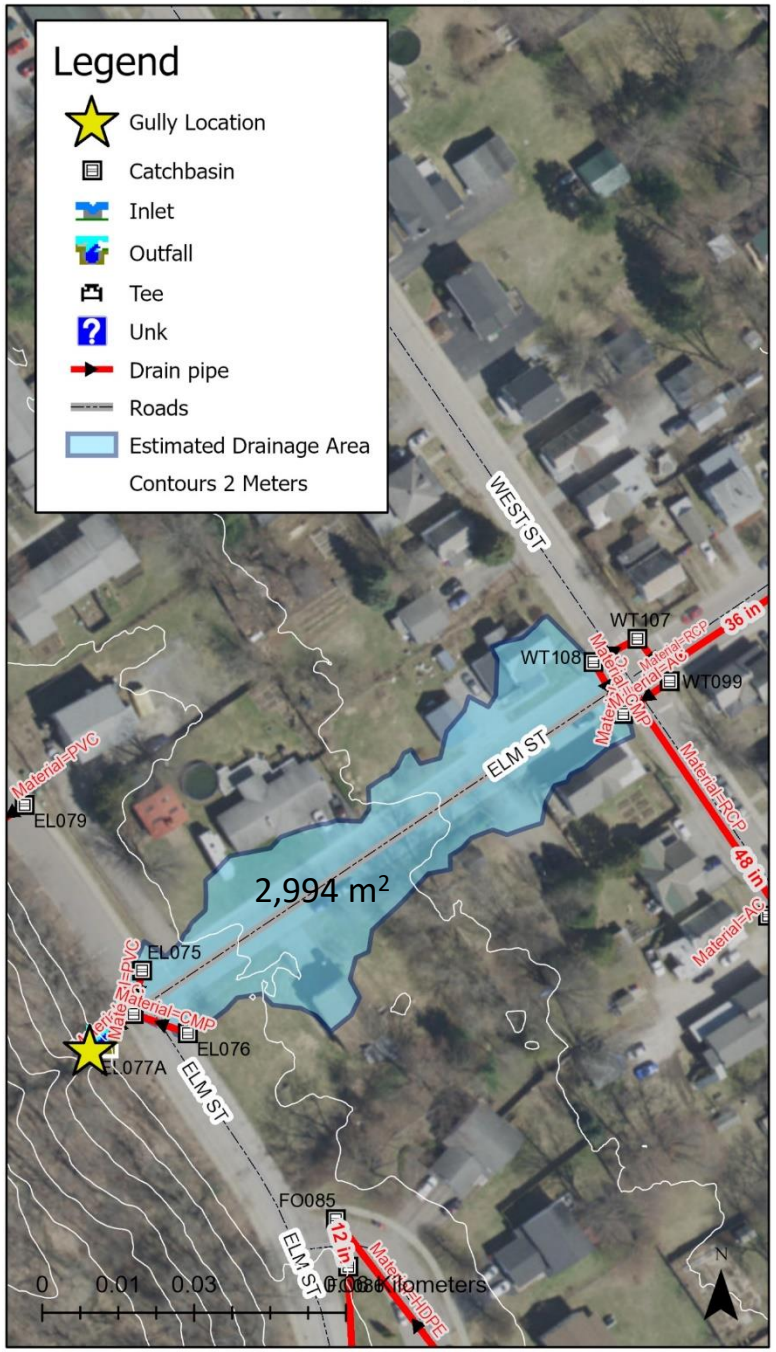
Survey timeline

Q1	July-Sept ‘19	Baseline surveys; selected resurveys after Halloween storm
Q2	Oct-Dec ‘19	
Q3	Jan-Mar ‘20	
Q4	Apr-June ‘20	Post snowmelt surveys – May
Q5	July-Sept ‘20	Installation of erosion control measures – July-November
Q6	Oct-Dec ‘20	Repeat surveys – August – October
Q7	Jan-Mar ’21	
Q8	Apr-June ‘21	Post snowmelt surveys - May

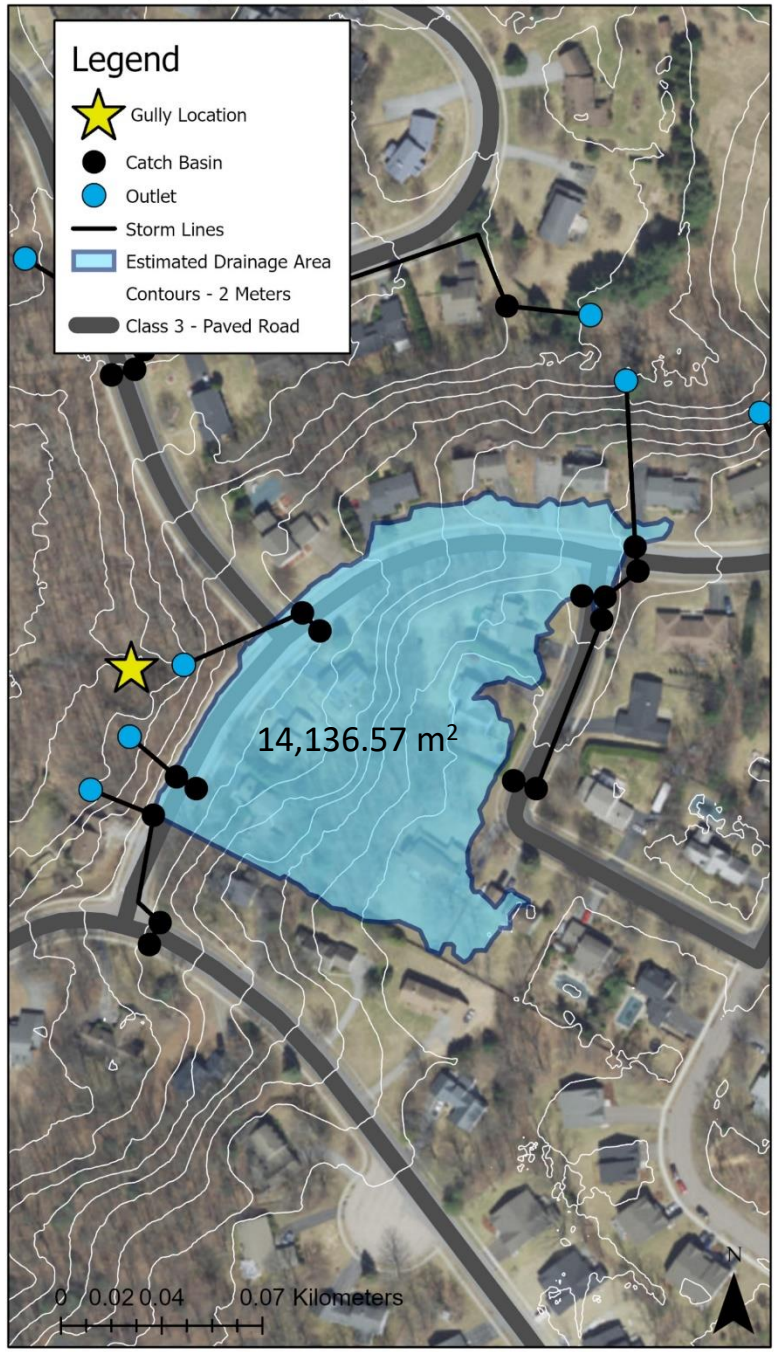
Young Street (10) Gully Site Map

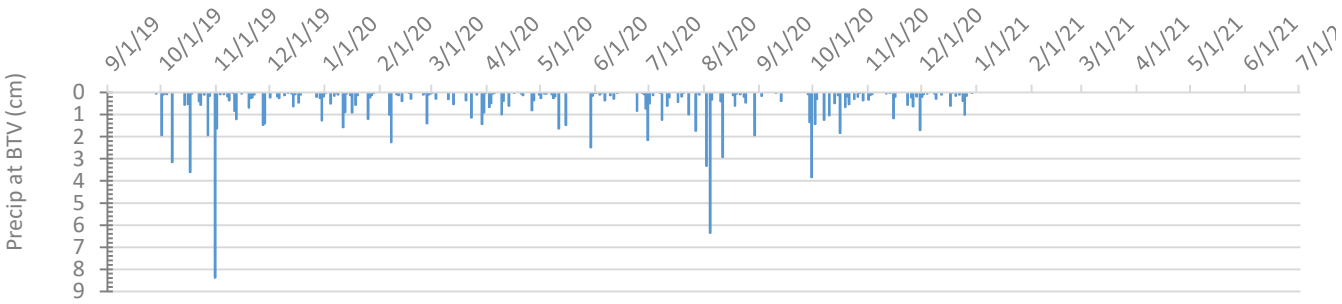


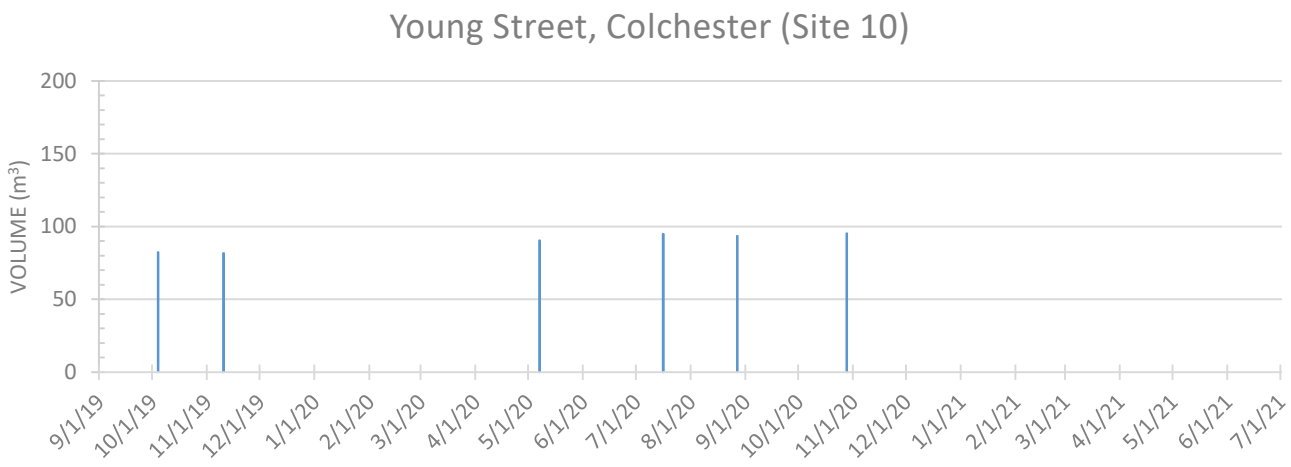
Elm Street (11) Gully Site Map

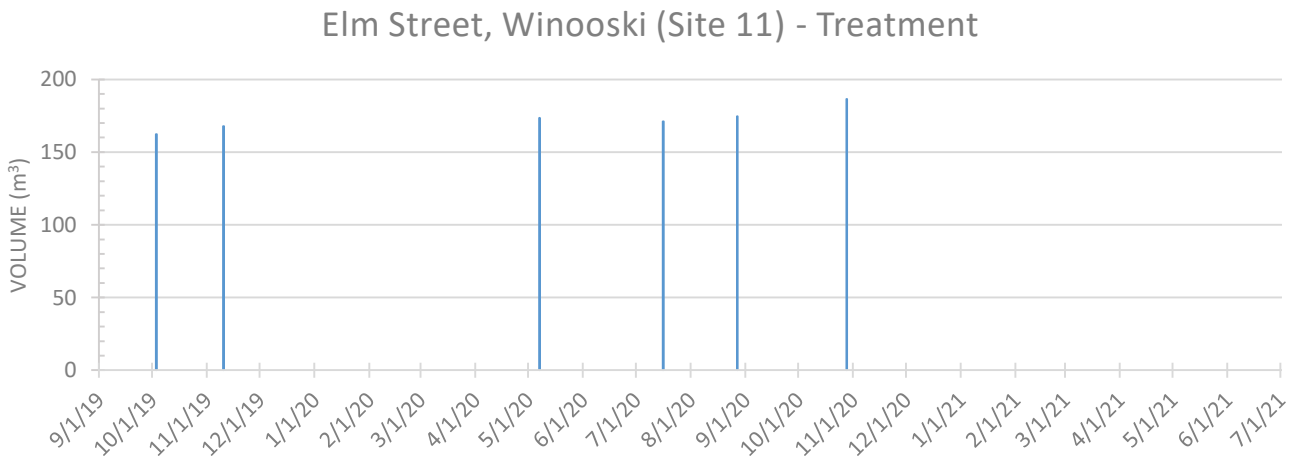


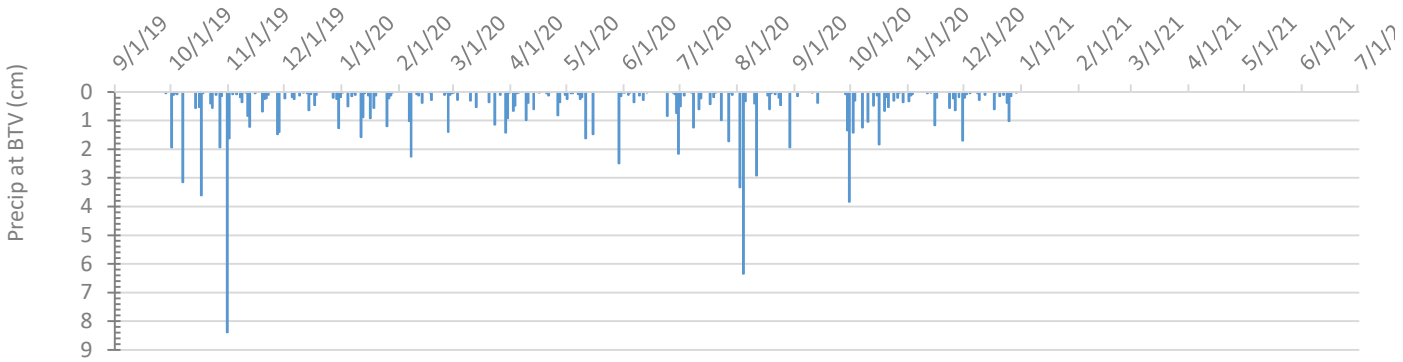
Corduroy Road (13) Gully Site Map

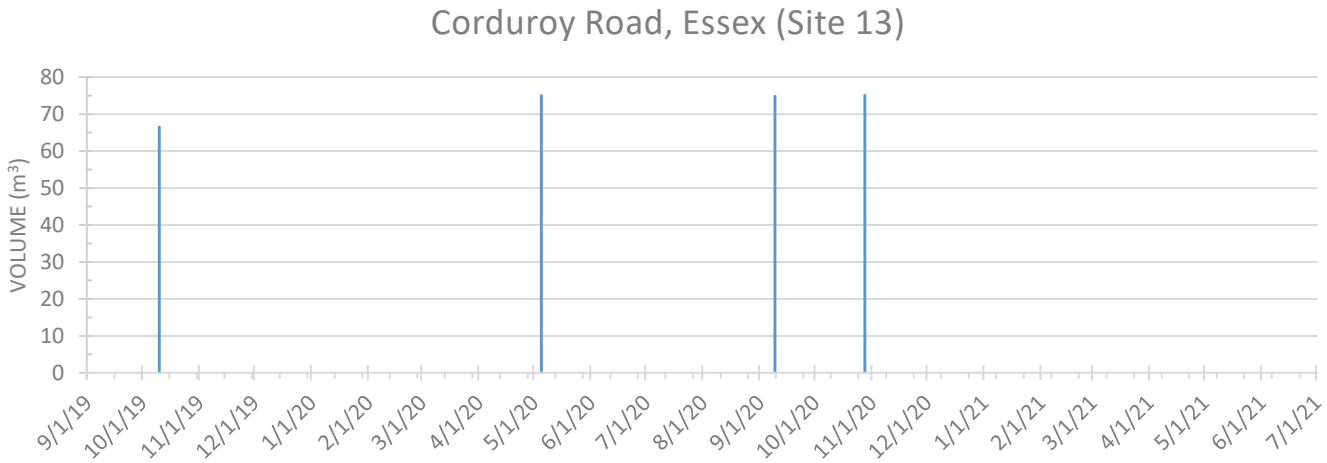


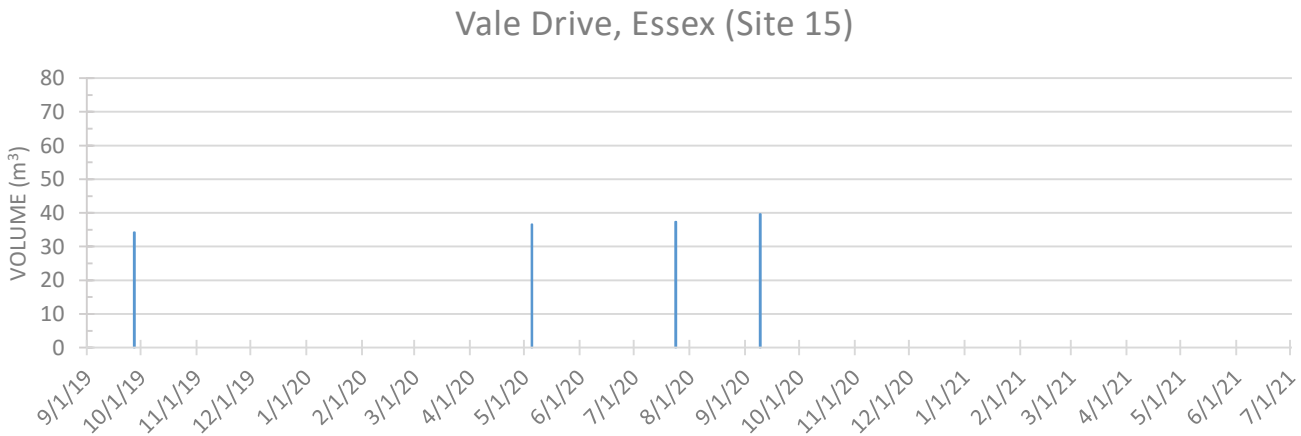

Precip at BTV (cm)
0
1
2
3
4
5
6
7
8
9
9/1/19
10/1/19
11/1/19
12/1/19
1/1/20
2/1/20
3/1/20
4/1/20
5/1/20
6/1/20
7/1/20
8/1/20
9/1/20
10/1/20
11/1/20
12/1/20
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21


Young Street, Colchester (Site 10)
VOLUME (m³)
200
150
100
50
0
9/1/19
10/1/19
11/1/19
12/1/19
1/1/20
2/1/20
3/1/20
4/1/20
5/1/20
6/1/20
7/1/20
8/1/20
9/1/20
10/1/20
11/1/20
12/1/20
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21
7/1/21

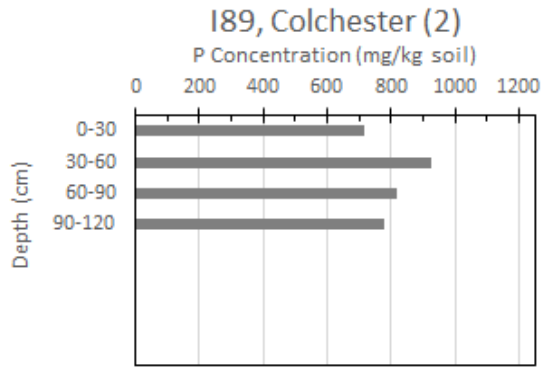

Elm Street, Winooski (Site 11) - Treatment
VOLUME (m³)
200
150
100
50
0
9/1/19
10/1/19
11/1/19
12/1/19
1/1/20
2/1/20
3/1/20
4/1/20
5/1/20
6/1/20
7/1/20
8/1/20
9/1/20
10/1/20
11/1/20
12/1/20
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21
7/1/21

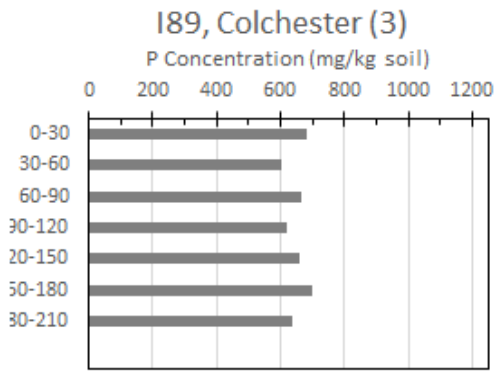

Precip at BTV (cm)
0
1
2
3
4
5
6
7
8
9
9/1/19
10/1/19
11/1/19
12/1/19
1/1/20
2/1/20
3/1/20
4/1/20
5/1/20
6/1/20
7/1/20
8/1/20
9/1/20
10/1/20
11/1/20
12/1/20
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21

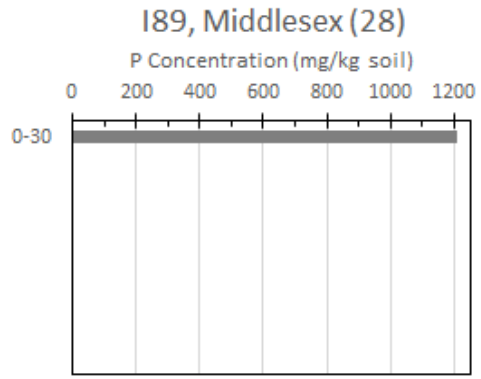

Corduroy Road, Essex (Site 13)
VOLUME (m³)
0
10
20
30
40
50
60
70
80
9/1/19
10/1/19
11/1/19
12/1/19
1/1/20
2/1/20
3/1/20
4/1/20
5/1/20
6/1/20
7/1/20
8/1/20
9/1/20
10/1/20
11/1/20
12/1/20
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21
7/1/21

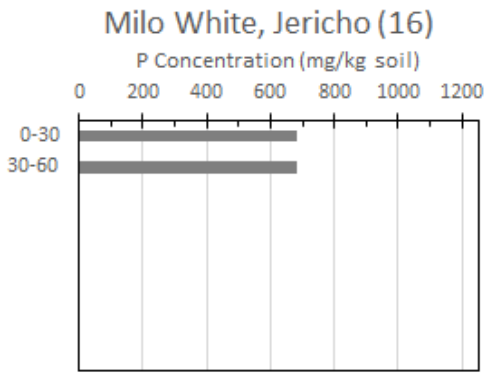

Vale Drive, Essex (Site 15)
VOLUME (m³)
0
10
20
30
40
50
60
70
80
9/1/19
10/1/19
11/1/19
12/1/19
1/1/20
2/1/20
3/1/20
4/1/20
5/1/20
6/1/20
7/1/20
8/1/20
9/1/20
10/1/20
11/1/20
12/1/20
1/1/21
2/1/21
3/1/21
4/1/21
5/1/21
6/1/21
7/1/21

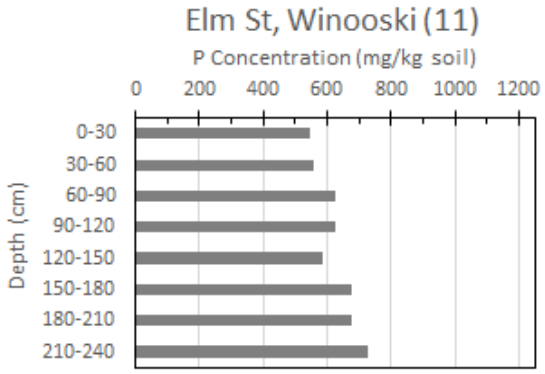
Gully phosphorus concentrations

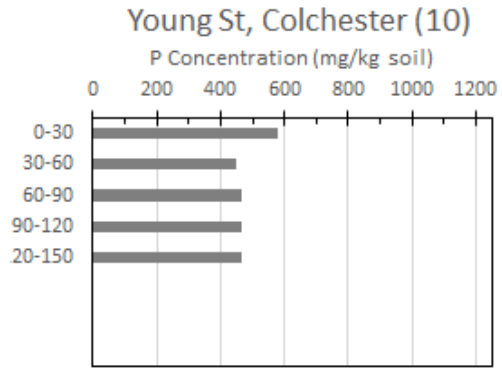


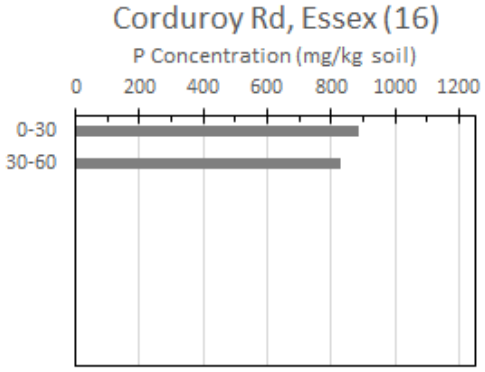


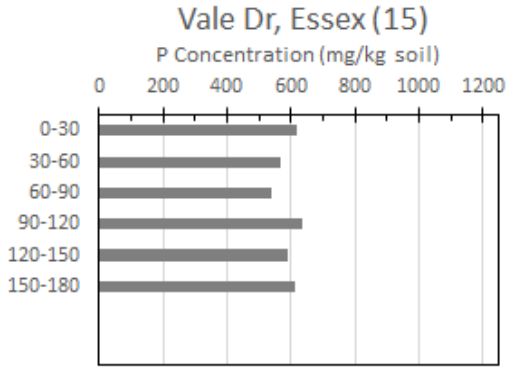


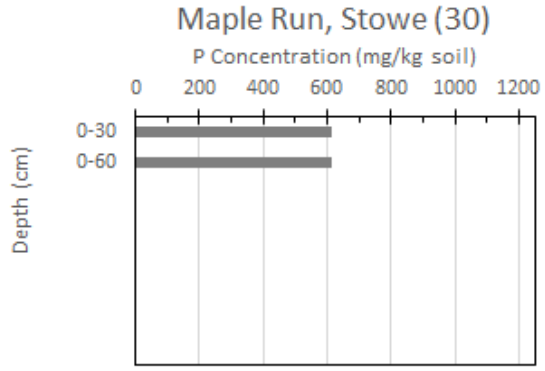


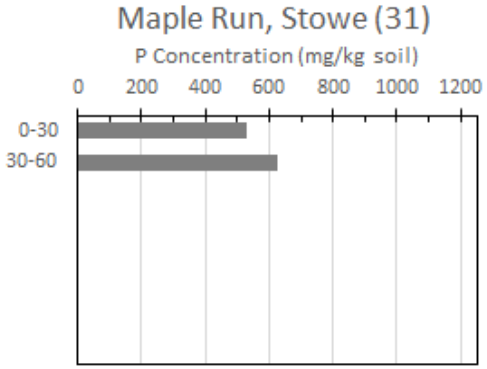


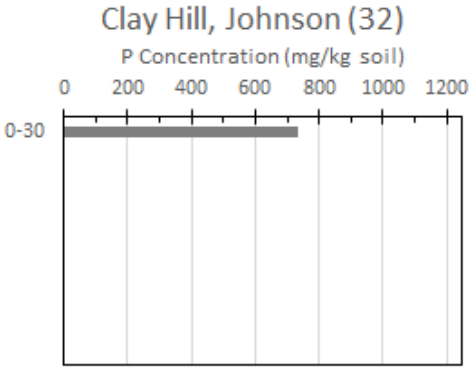


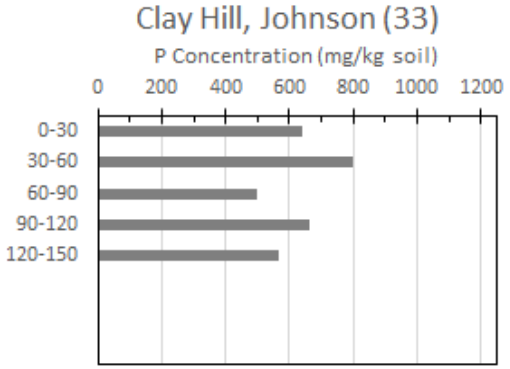




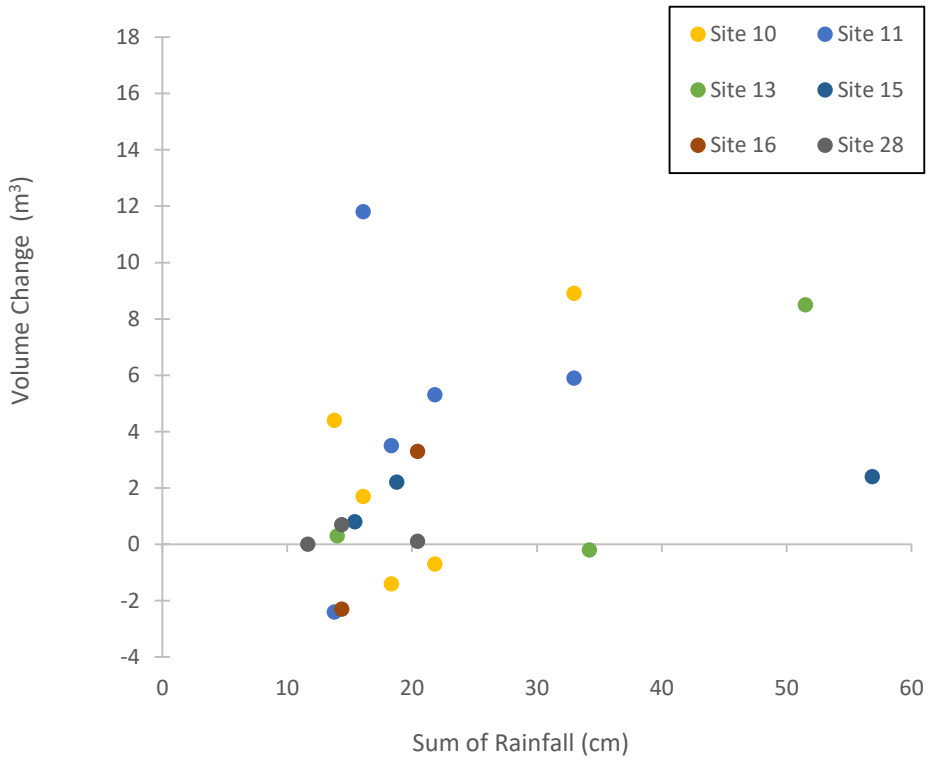




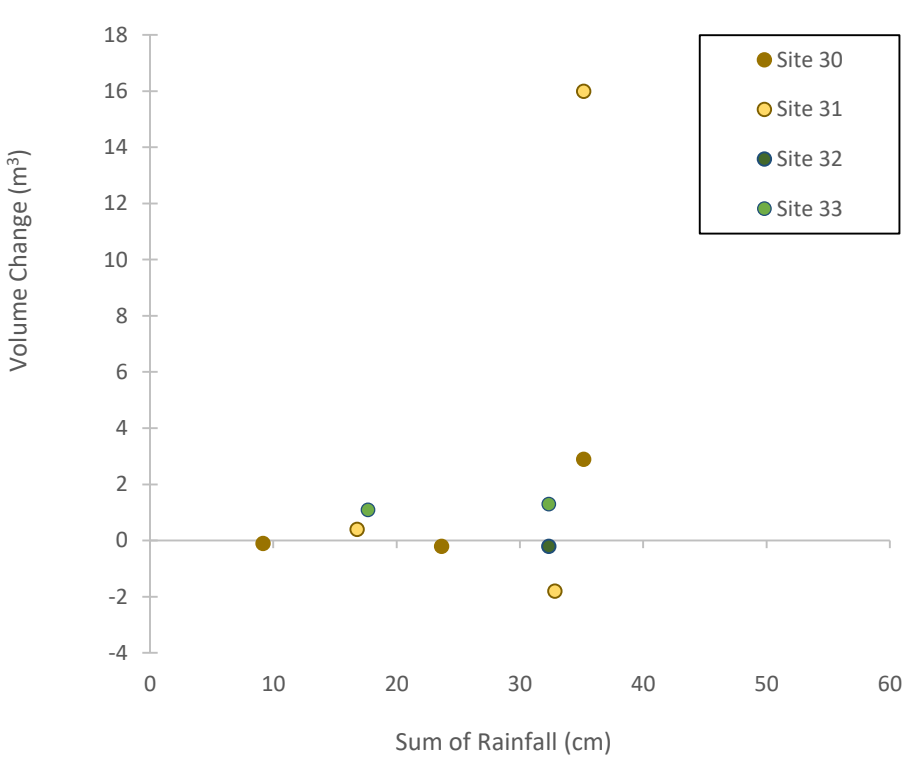




Gully change in time



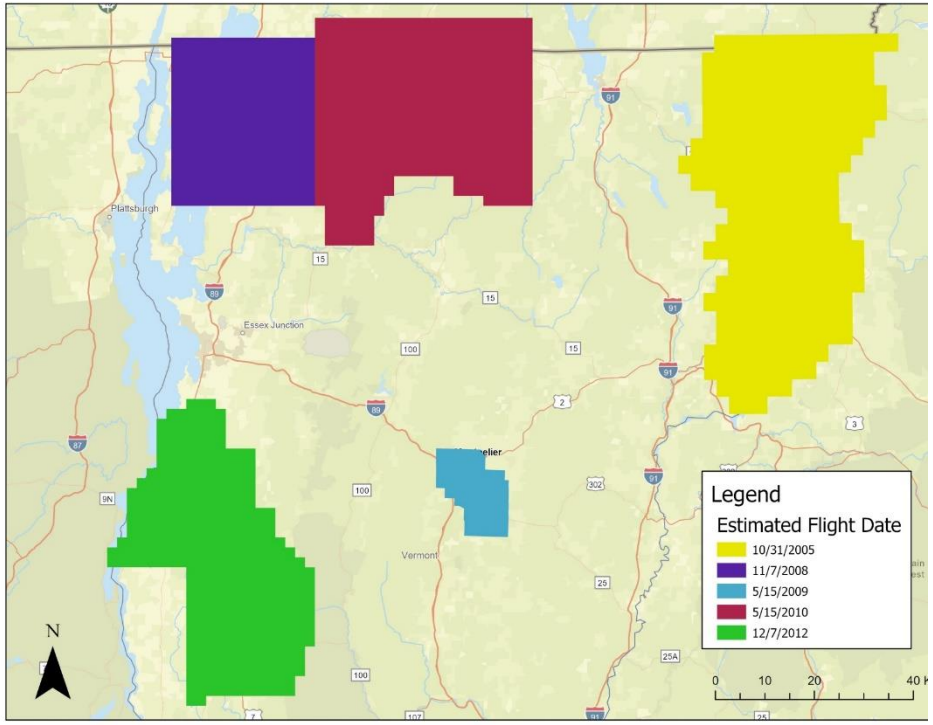
Chittenden and Washington Co. sites
(Burlington airport precipitation)

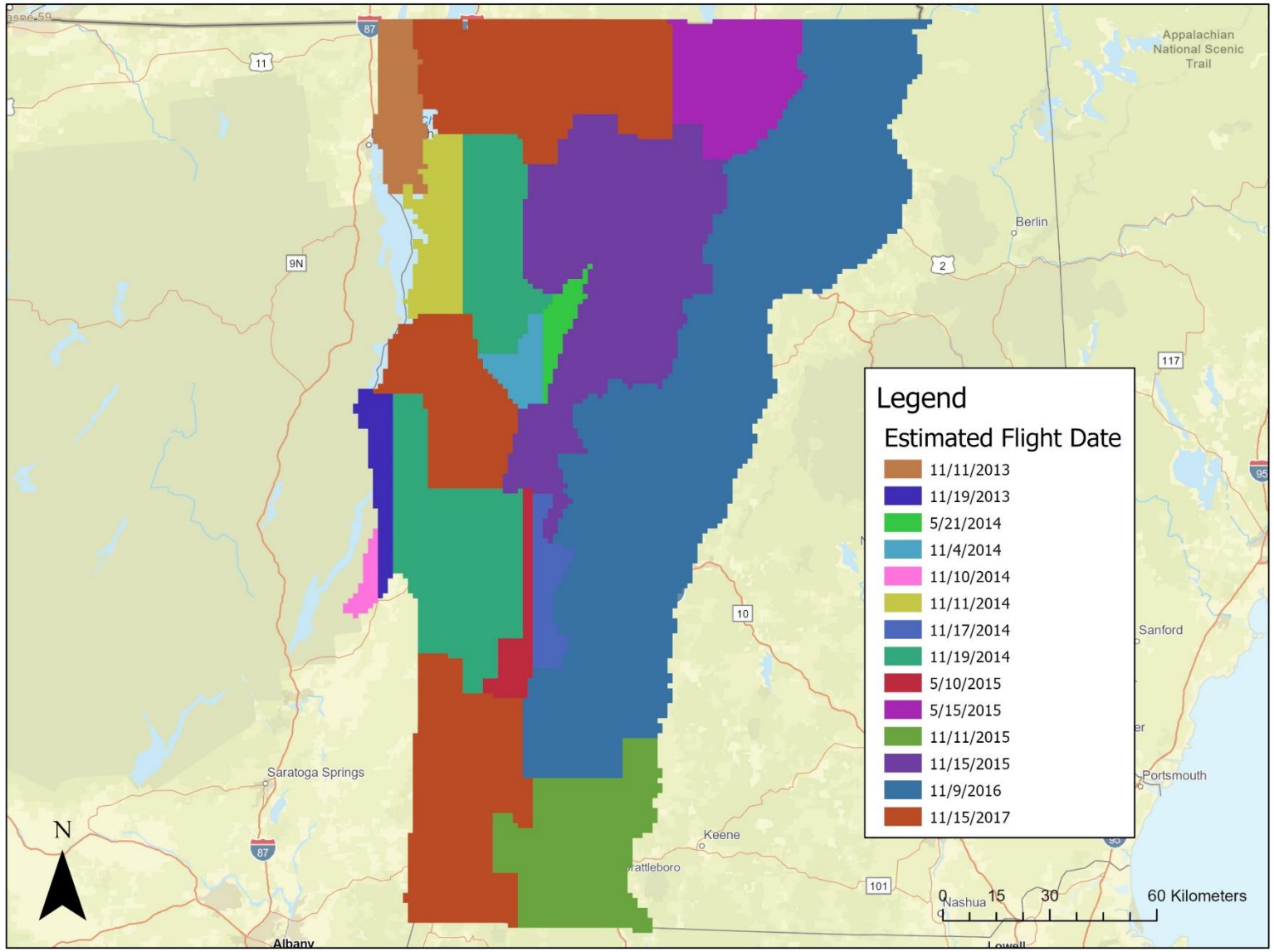


Lamoille Co. sites
(Morrisville airport precipitation)

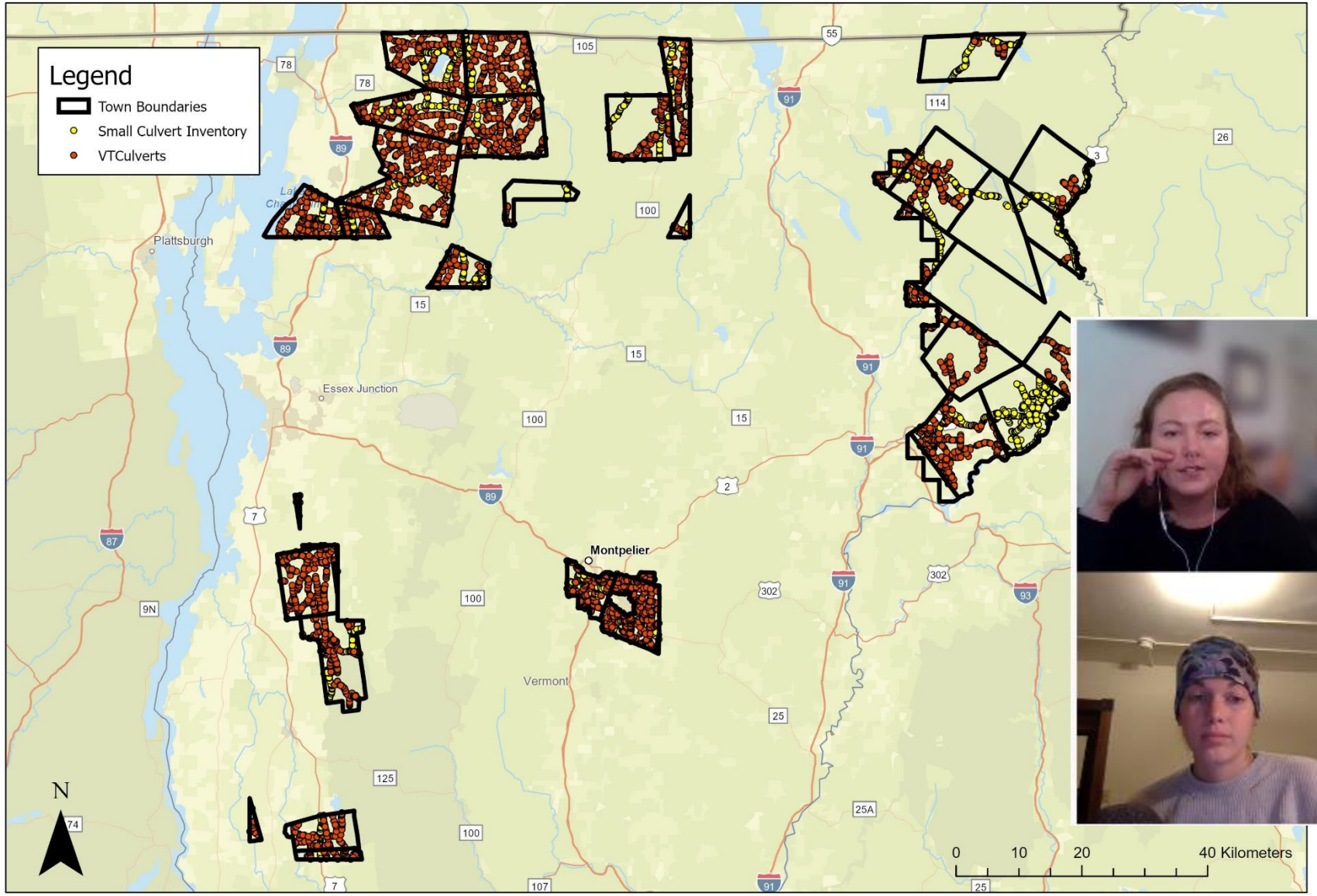
Airborne Lidar

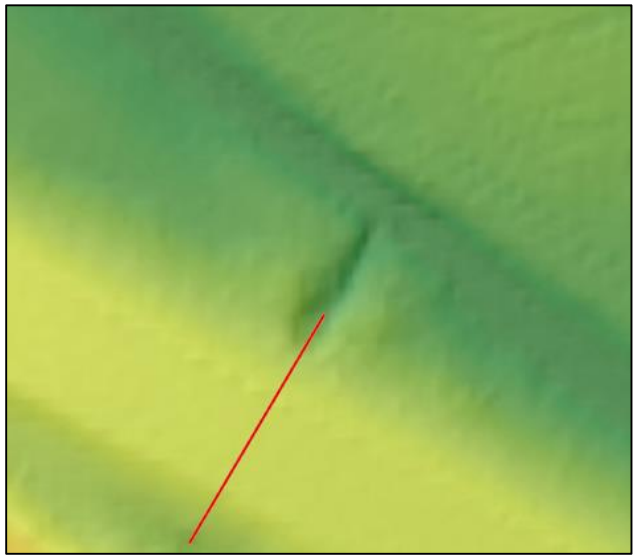
Multi-date lidar for feature detection

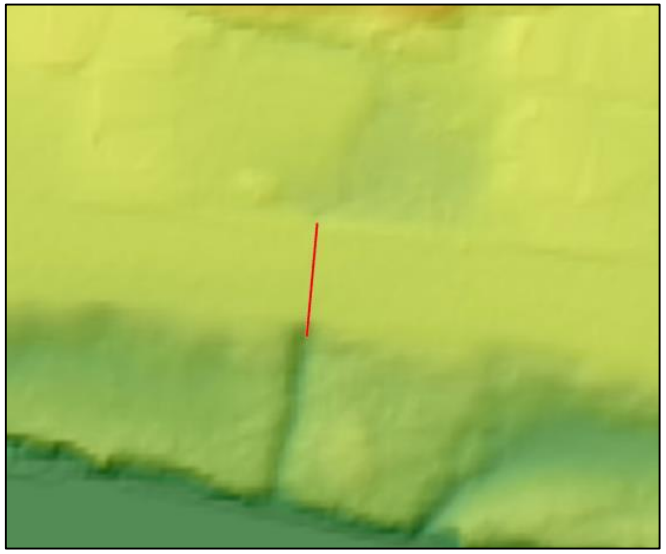




Culvert inventories for feature inspection



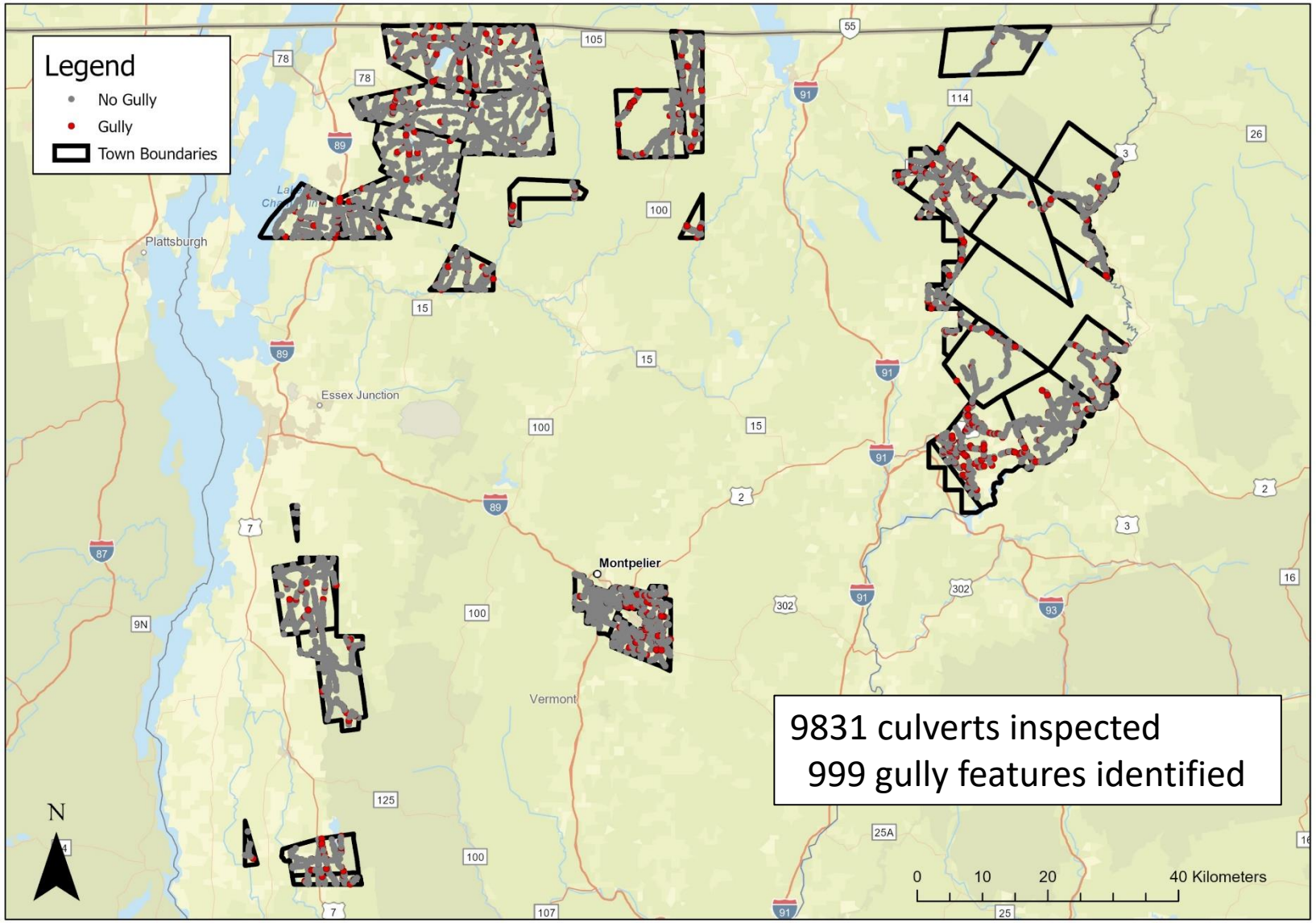




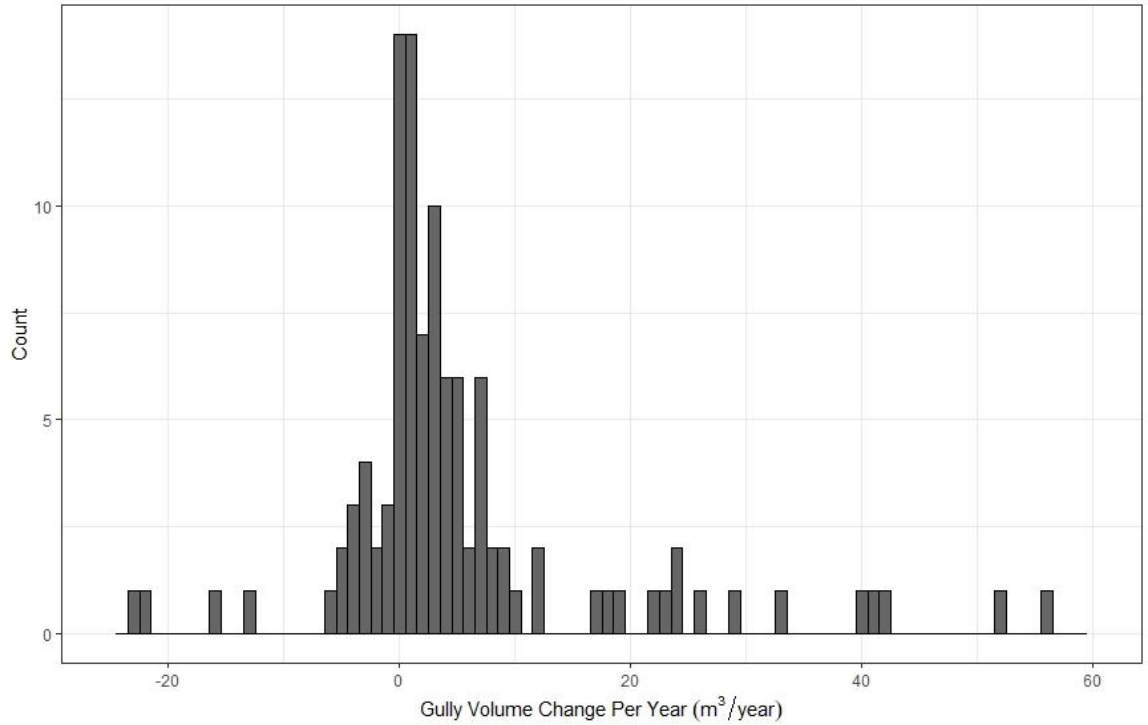
Available datasets:

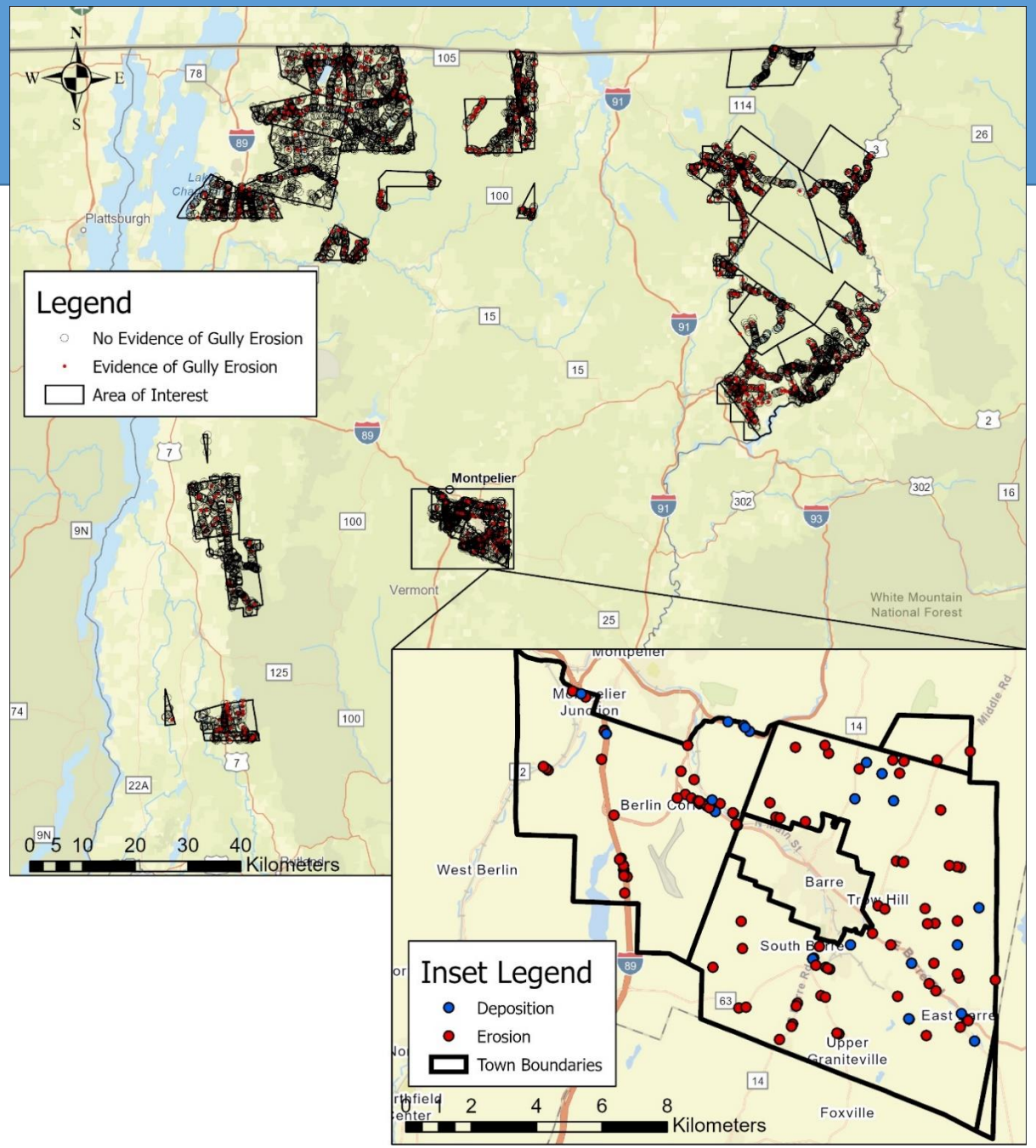
- VTCulverts.org
- Small Culvert Inventory

Evidence of Gully Erosion



Gully Volume Change

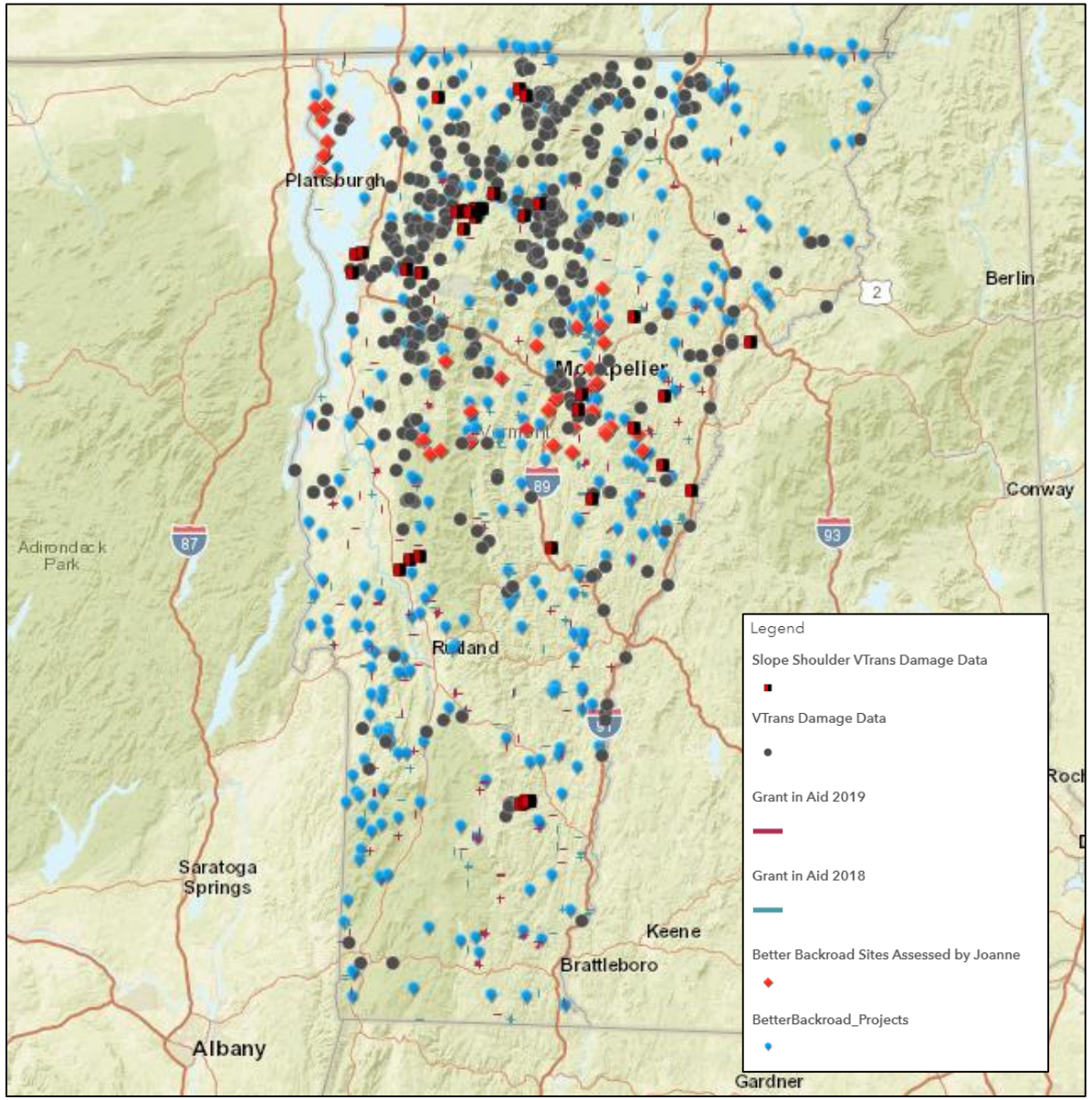


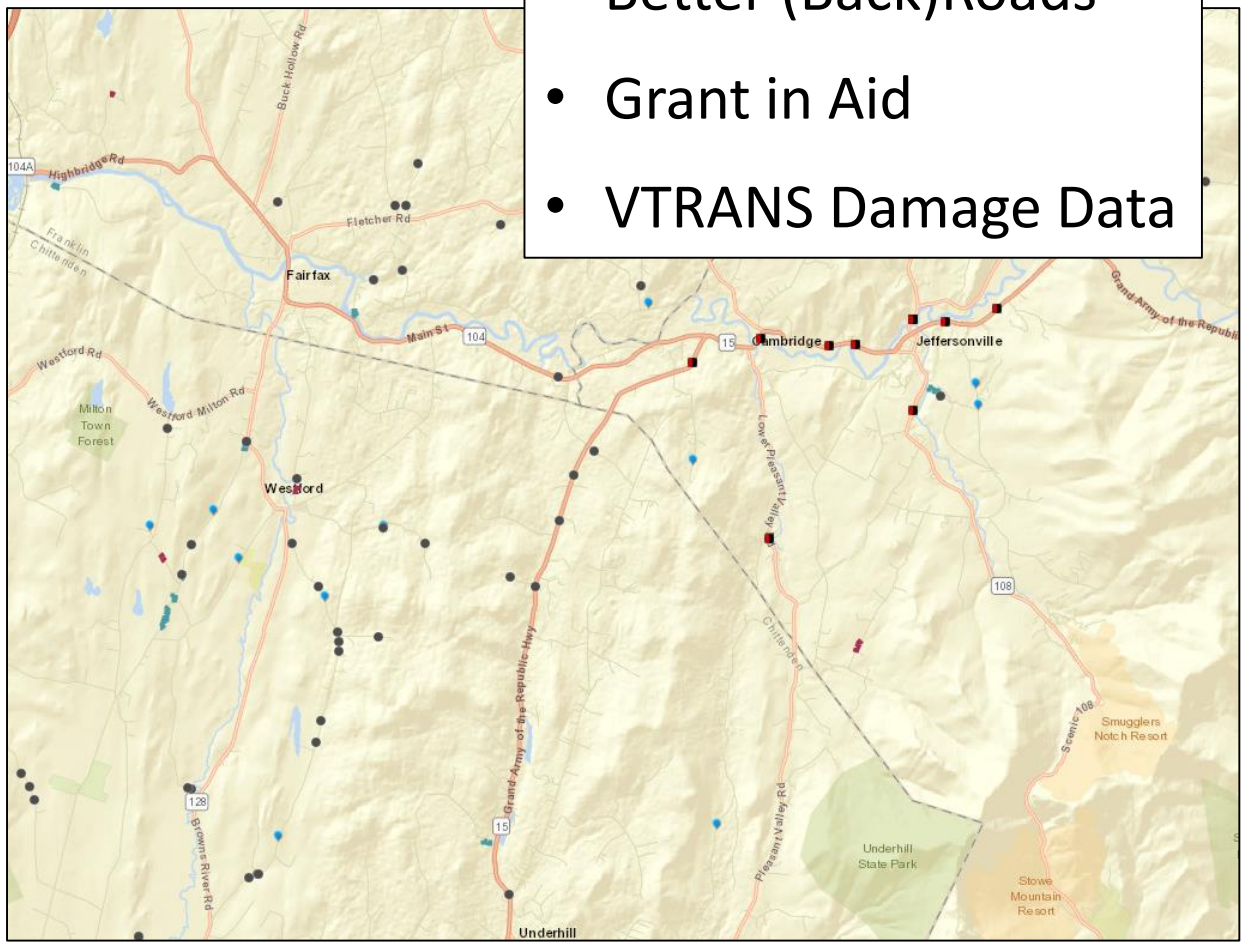


Objective 2: Assess effectiveness of intervention measures

- Post-installation comparison of “control” and “treated sites”
- Retrospective assessment of past erosion control projects

Retrospective field assessment

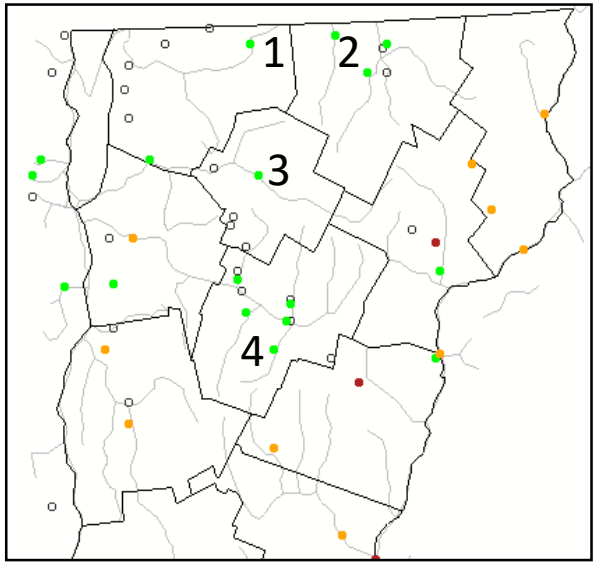




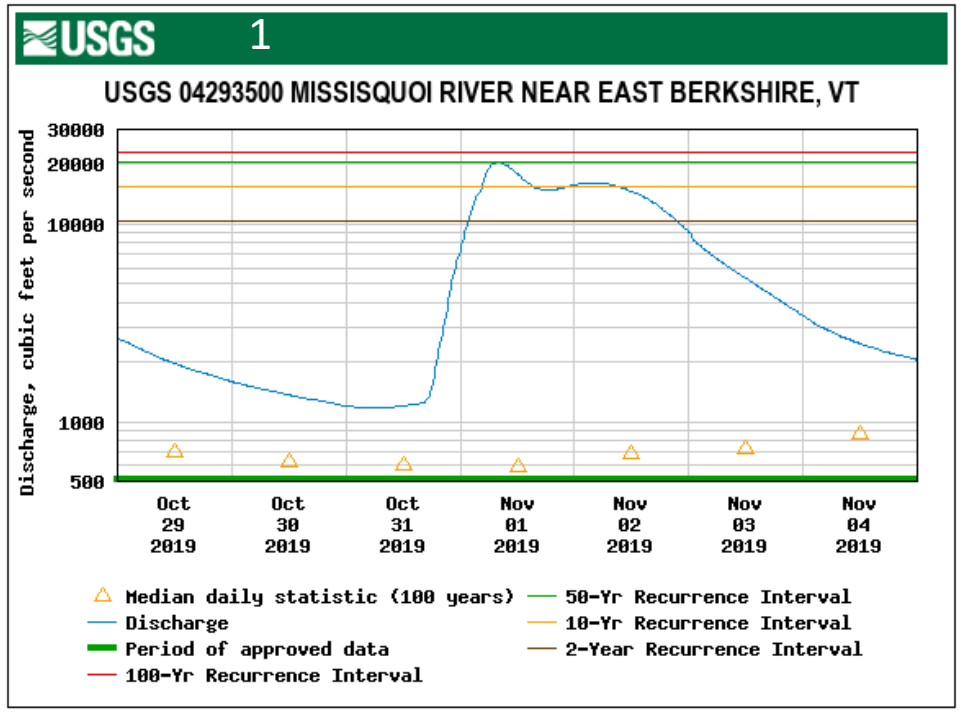
Available datasets:

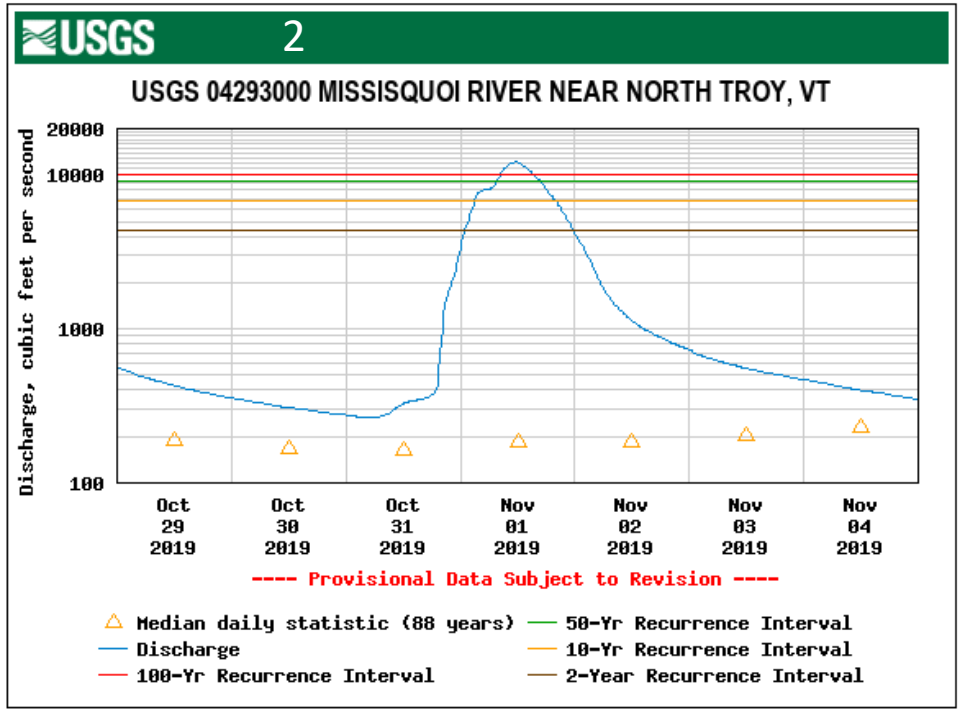
- Better (Back)Roads
- Grant in Aid
- VTRANS Damage Data

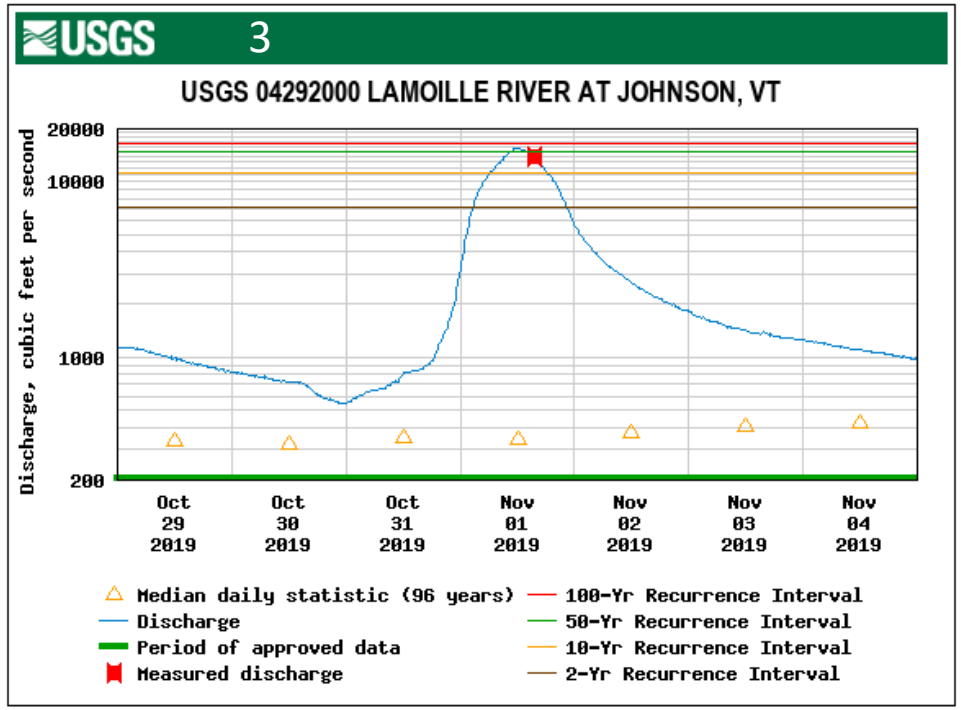
Approach – focus on sites impacted by “Halloween” 2019 storm

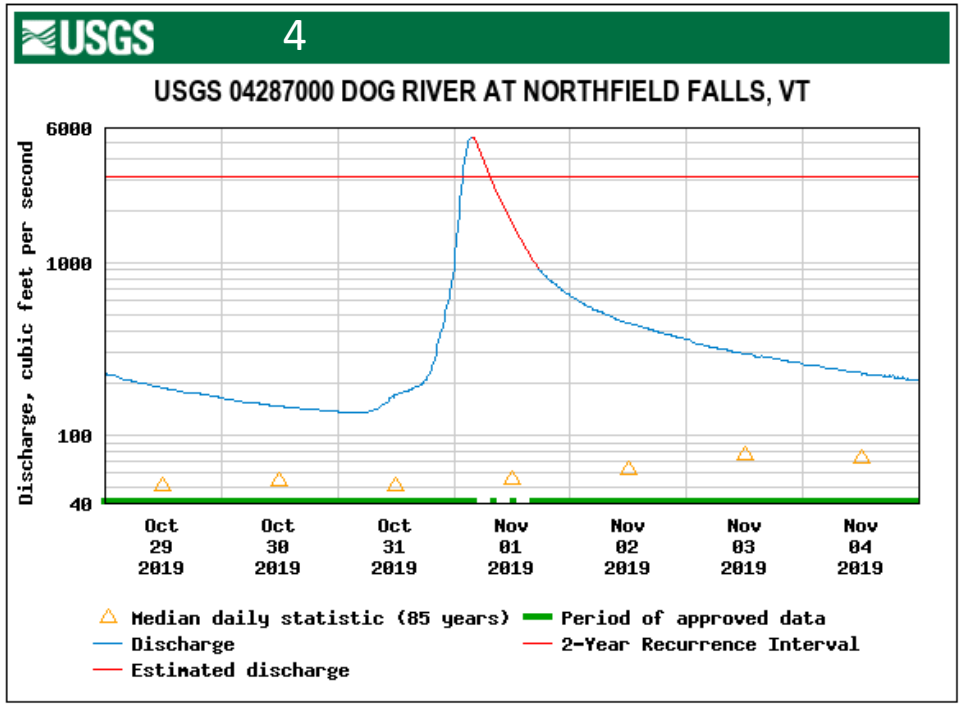


Locator map and hydrograph data from https://waterdata.usgs.gov/vt/nwis/rt on 10/5/2020







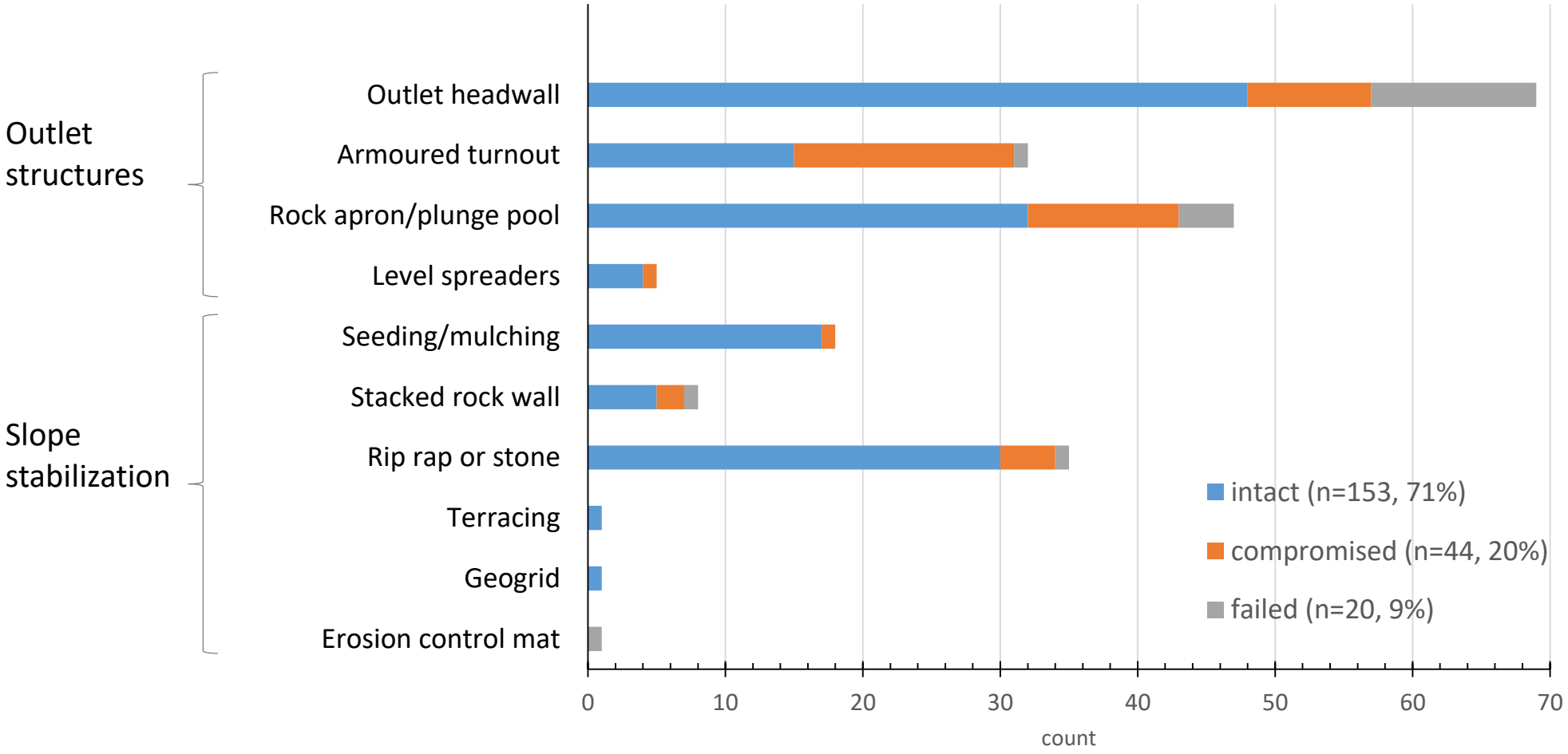


intact

compromised

failed

Retrospective assessment – BMP effectiveness



additional 296 Ditch practices assessed: 70% intact, 27% compromised, <4% failed

Project Completion

- Spring 2021 surveys beginning this week
- Analysis of airborne lidar dataset (gully occurrence, gully change) in progress
- Draft report and TAC consultation in June
- Final report due to VTRANS 7/31/2021

Questions / feedback: contact Beverley Wemple at bwemple@uvm.edu