Stormwater Master Plan
City of Montpelier, Vermont

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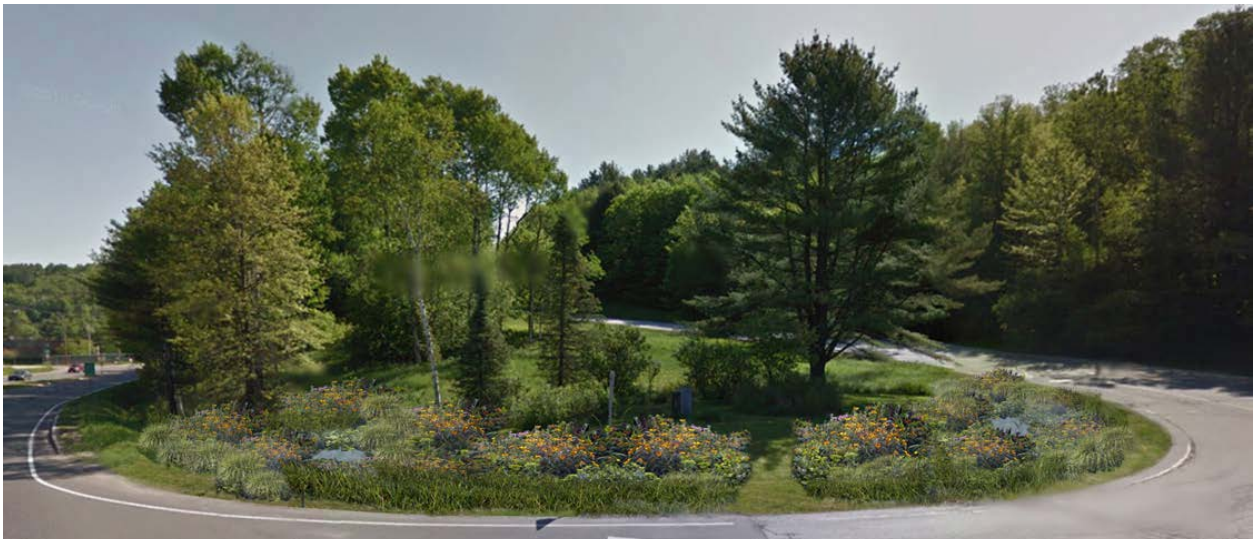

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Cover: Illustrative concept designs for National Life Drive intersection (top) and College Street (bottom).

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Acknowledgements

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Executive Summary

Why is Stormwater a Concern?

The City of Montpelier, like many other Vermont cities and villages, historically took advantage of the power of water by developing mills, industry, and commerce near flowing water. The Winooski River runs through the heart of downtown, and confluences with three significant waterways within the City boundaries: the Dog River, the North Branch, and the Stevens Branch. In addition, there are a number of smaller drainages in the City including, most notably, Blanchard Brook. Montpelier's residents and municipal operations live and work today with a legacy of over 200 years' worth of development and infrastructure located both along these waterways and on their surrounding picturesque--but often steep--hillsides.

A significant amount of the pollution in our waterways comes from actions around our homes and businesses, in our yards, in our cars, and outdoors. Individually, these activities contribute small amounts of pollutants that are washed into streams when it rains or as snowmelts—pollutants like dirt, road salt and sand, oil, antifreeze, pesticides, and fertilizer. Unlike wastewater, stormwater often is not treated before flowing into Montpelier's streams and rivers, and eventually into Lake Champlain.

The State of Vermont has regulations to help mitigate the stormwater impacts of larger land development projects. Projects with over an acre of impervious cover (like buildings, driveways, and parking) must include stormwater management facilities, and must obtain a permit from the State. Smaller-scale projects are not required (by the State) to include stormwater management—and most impervious surfaces in Vermont are unregulated. Of the estimated 140,000 acres of impervious surface in Vermont, only about 10% is currently covered by a permit. At the municipal level, there are also often competing priorities within water quality—should the highest priority be building and maintaining stormwater practices, or completing "good housekeeping" activities like street sweeping or catch basin cleaning that keep pollutants out of the water? Should a municipality invest in reducing areas with combined sewers, or is it better to treat runoff from otherwise un-managed impervious surfaces?

Stormwater management is essential to achieving many of Vermont's water quality goals—and it is increasingly becoming less "optional". Runoff from developed impervious surfaces is estimated to contribute nearly 20% of the total phosphorus delivered to Lake Champlain annually, and the *Phosphorus TMDL for Vermont Segments of Lake Champlain* requires the overall contribution from existing developed lands to be reduced by more than one-fifth (20.9%). As part of the *Vermont Lake Champlain Phosphorus TMDL Phase 1 Implementation Plan*, the Vermont Agency of Natural Resources has committed to developing and issuing a general permit to require development and implementation of stormwater management plans for municipal roads, and a separate program and permit to address stormwater from existing developed lands with 3 acres or more of impervious cover, by the end of 2017. In addition, Vermont's new Combined Sewer Overflow (CSO) Rule, effective September 15, 2016, includes substantial new requirements for minimum control measures, public notification activities, and development of a long-term control plan. The CSO Rule is centered on overflows that occur when the combination of stormwater and sanitary wastewater during a storm event is too large for the sewer system to handle. In short: having a comprehensive plan at the municipal level for dealing with stormwater issues is becoming critically important.

What is a "Stormwater Master Plan"?

The City of Montpelier's current stormwater-related activities are multi-faceted, complex, and not always intentional—a balancing act between municipal capacity and priorities, local plans and regulations, existing and prospective land development, transportation system management, and sometimes rapidly changing state regulations and economic conditions. A Stormwater Master Plan assimilates existing information, collects additional data where necessary, develops solutions to existing problems, and sets priorities for possible implementation projects. This assessment is intended to plan for stormwater management specifically, and watershed management activities generally, in a more deliberate and efficient manner.

Stormwater master planning at the municipal scale offers two primary benefits: A broad overview of existing conditions and future considerations based on anticipated development, and the opportunity to identify stormwater mitigation projects that have the greatest return on investment.

Goals for stormwater master planning, and for Montpelier's Stormwater Master Plan, include:

- Identifying as many needs as possible, along with conceptual projects or solutions to meet those needs
- Prioritizing potential projects based on criteria that account for both local and state-level priorities
- Supporting the near-term implementation of one (or more) projects
- Providing a basis to move from reactive, one-off projects to a comprehensive and proactive program

How were Stormwater Management Needs Identified?

One of the first steps towards creating a comprehensive stormwater master plan was to develop a thorough understanding of previous work (Section 3) and the City's current related activities (Sections 4 and 5). Information was inventoried, assessed, and documented from a variety of sources, including:

- Existing plans and data (documentation of existing conditions and known problems)
- Local interviews and public input
- Local zoning and land development regulations
- Location of existing state/municipal landholdings, including rights-of-way, as well as significant areas of existing impervious cover
- Planned capital improvements and areas of anticipated future development
- Windshield and walking surveys to identify, verify, and/or document the location and nature of existing drainage problems and stormwater management concerns

Wherever a potential stormwater management need existed, the location was documented and information about the need was consistently recorded (Section 6). A total of 58 potential problem areas were identified throughout the City. Each problem area was given an initial classification with the intent of generally assessing the severity of existing problems, removing low priority problem areas from the dataset, and providing general guidance on the relative order in which needs should be addressed when considered city-wide:

Total Areas Identified	Initial Stormwater Need or Problem Area Classification
4	Stable, but problem could escalate with future change in surrounding land use.
9	Limited erosion and/or drainage problems are present; issues may be readily addressed. Two of these are also strategic retrofit opportunities.
17	Moderate erosion and/or drainage problems are present; issues may be readily addressed. Three of these are also strategic retrofit opportunities.
5	Significant erosion and/or drainage problems are present; issues may be readily addressed.
23	Strategic retrofit opportunity

How Were Potential Retrofits Prioritized?

The stormwater problem areas identified through the screening were carried forward through a more detailed examination and prioritization process that considered possible regulatory changes, future growth, and the suitability of different types of best management practices to each identified problem area Some of the criteria used for prioritization included the severity of the problem, water quality or infrastructure impacts of the problem (and thus benefits of the solution), ease of taking action (including site access, ownership, and ease of maintenance), municipal needs and priorities (for instance, integration of the solution with upcoming capital improvements or co-benefits for combined sewer overflow control), availability of funding to fix the problem, and potential for a demonstration project or educational component.

Initially, the prioritization of all of the identified problem areas and opportunities (Section 8) resulted in 22 of the identified problem areas being "short-listed". In consultation with City staff, this short list was narrowed to ten highest-priority projects, seven of which were advanced to concept design (Section 9). In addition to the seven concept designs, three sites were chosen as models for illustrative concepts for integrating green stormwater management practices into other City infrastructure (such as roadways and parking lots) in the future.

The seven opportunities advanced to concept design were:

- **Northfield Street / Route 12 (stormwater problem area ID WR-06):** Three green stormwater management opportunities were identified in this area, which is associated with the upcoming full-depth reconstruction of Vermont Route 12 between the Memorial Drive intersection and Freedom Drive. Stormwater planters and swales constructed in gently sloping portions of this area would both reduce runoff volumes entering the closed drainage system and improve the quality of any runoff ultimately flowing to the Winooski River.
- **Wheelock Street (WR-12):** The existing grass and stone-lined swale is currently stable, but has a history of moderate to severe erosion during major storm events. Replacing this swale with a step-pool conveyance designed to capture sediment and safely convey storm flows would improve the resiliency of this roadway and drainage system, and ultimately reduce associated maintenance and repair costs.
- **Hubbard Park road system (NB-09):** Several erosion and drainage issues, some of which are presently active, were identified in Hubbard Park's gravel road network. A series of strategies, including ditch and culvert improvements, plunge pools, and ditch turn-outs to sediment basins, were identified and are already being implemented by Parks Department staff.

- **Hubbard Park 'frog pond' (NB-12):** Once high-priority areas of erosion within the park's gravel road network are addressed, the existing pond near the main entrance can be improved to restore its geometry, provide improved sediment removal, as well as limited additional treatment and storage of runoff from the park before entering the City's closed drainage system.

- **Finch Street / 'stump dump' (NB-14):** A series of measures, including improved ditching, water bars, and turn-outs; bank stabilization; and improved management of street sweepings and organic material storage, can be implemented to limit storm runoff reaching an un-named tributary to the Winooski River's North Branch.

- **Harrison Avenue (NB-16):** As part of the planned reconstruction of this roadway and associated utility work, the sidewalk and road shoulders could be reconfigured to use stormwater swales instead of closed drainage, and to upgrade the drainage swale currently lining the east and south sides of the recreational field to reduce runoff volumes and improve water quality for the runoff ultimately reaching the City's closed drainage system.

- **Grandview Terrace (BB-07):** Montpelier's Department of Public Works looks for opportunities to decrease roadway width (where applicable) to reduce the amount of impervious surface, and therefore reduce stormwater run-off. Narrowing roadways reduces run-off and also uses fewer resources to construct and maintain, resulting in increased savings. For maximum water quality benefit, roadway narrowing should be coupled with road shoulder protection and restoration following pavement and subbase removal. Pavement narrowing and shoulder restoration were completed on Grandview Terrace and Spring Hollow Lane in 2016, and is used here as a generic example, to illustrate how shoulder restoration options may be applied in future projects.

The three locations chosen for development of green stormwater management concept illustrations were:

- **National Life Drive and Memorial Drive (WR-04):** Stormwater from National Life Drive flows into the landscaped area at National Life and Memorial Drive and is conveyed and discharged to the river via a culvert. A gravel wetland at this location could capture and treat stormwater and improve the quality of water flowing to the river, while landscaping improvements would add an attractive aesthetic to this gateway location.

- **College and Marvin Streets (NB-04):** Excess paved width on College Street could be converted to include landscaped stormwater swales. The reduction in pavement and expansion of storage and infiltration area at the top of the hill would both decrease stormwater volumes and impacts downstream, and improve water quality.

- **Parking lots west of Main Street (NB-01):** Untreated stormwater from this parking lot sheet flows into the North Branch of the Winooski River, and areas along the bank are eroding. Several possible 'green' tools could be employed on this and other City-owned parking areas, including landscaped stormwater planters in place of narrow islands, incorporating pervious paver systems that allow water to infiltrate into the ground, and directing runoff to drywells that collect and infiltrate stormwater.

What's Next for the Stormwater Master Plan?

This Stormwater Master Plan is intended to be a living document. The City's priorities will inevitably shift as projects are completed, as funding is (or is not) available to pursue retrofits, and as major weather events, such as the flooding that occurred in May 2011, upend a carefully-prioritized stormwater program without warning. In the short term, the City will work to address specific problem areas identified in this plan—either

directly with existing staff and resources, or by working with partners like the Friends of the Winooski River or the Winooski Natural Resources Conservation District to pursue grant opportunities.

Additionally, the Department of Public Works will seek opportunities to improve management of stormwater runoff that arise as part of routine municipal projects, such as the substantial reconstruction of a road surface or intersection. Grant funds may be available to cover the incremental cost of addressing stormwater runoff as part of such projects, especially when stormwater management is considered early in the design process.

1. Introduction

Water knows no political boundaries, and thus evaluations of water quality tend to be undertaken within watershed boundaries and involve land areas in multiple towns. From a water quality perspective, it would be ideal to manage water resources along watershed lines—but the reality is that many decisions, particularly those about land use, are made at the level of towns or individual sites.

A City-wide Stormwater Master Plan is responsive to existing landscape characteristics across all watersheds within local political bounds. It connects land use, stormwater management, floodplain management, river management, and public infrastructure needs to more effectively address all of the issues which contribute to water quality impairment or improvement. Within this Plan, localized stormwater problems are examined at a larger scale (e.g., city-wide) to determine their relative contributions and aid in setting priorities for addressing challenges related to stormwater runoff. As adjoining municipalities also take increasingly comprehensive views of stormwater management issues and planning, these plans are one-stop resources that can improve coordination and increase opportunities for collaboration in meeting watershed-related needs across political boundaries.

1.1. Project Background

As precipitation falls on an undisturbed, natural landscape and moves through the hydrologic cycle, it flows through a complex system of vegetation, soil, groundwater, and surface water. Natural events have shaped these components over time to create a system that can efficiently handle stormwater through evaporation, transpiration, infiltration, and runoff. Alterations to the landscape change the way it responds to precipitation events. Management of land use, rainfall, storm runoff, and surface water (streams and lakes) are interrelated, and the management practices chosen all influence water quality and stream health.

Watersheds are interconnected networks in which a change at any location can carry throughout the system. There are many factors that influence exactly how stormwater runoff from a particular site will affect other areas of the watershed. The degree and type of impact varies from location to location, but it can be significant relative to other sources of pollution. Stormwater runoff affects water quality, water quantity, habitat and biological resources, public health, and the aesthetic appearance of the receiving water. Stormwater controls, in contrast, are typically conceived and implemented on a project-by-project basis. These projects are analyzed for their individual stormwater impacts, not in the context of their impact on an interconnected hydrologic and hydraulic system. It is well documented, however, that the cumulative effects of individual land surface changes dramatically influence flooding conditions and contribute to water quality degradation (NRC 2009).

What is a watershed? A watershed is any area of land in which all water runoff from its surface flows to the same drainage point. Watersheds are sometimes referred to as drainage areas. Watersheds are important because they are the basic unit of analysis for all surface water management. They come in all shapes and sizes, and are defined based on the intended study area.

Watershed management practices have direct impacts on water quality in local creeks and streams (such as Blanchard Brook or the North Branch), as well as downstream waterbodies (the Winooski River and, ultimately, Lake Champlain). Any decisions that affect land use have stormwater management ramifications and, in turn, impact all downstream water resources. The findings of one recent study (Troy et al. 2007) suggest that "land-use changes in the Basin have increased phosphorus levels in Lake Champlain, especially conversion of agricultural areas and forests to developed uses."

Vermont's streams, rivers and lakes are vital economic resources. The quality of local receiving waters affects both economic interests and quality of life in the surrounding areas. Throughout the Champlain basin, the local economy depends, in part, on the revenue gained from outdoor activities enjoyed in and on the water. Protecting the quality of surface waters is one of the most important commitments communities can make to protect the economic interests of residents.

Taken together, these elements emphasize the need for a holistic planning effort that considers the interconnected nature of land use, stormwater management, and river management in order to achieve overall watershed goals.

1.2. Project Goals

The ultimate objective of this stormwater master planning project is to support the City in improving stormwater management, by providing a list of high priority water resource concerns and conceptual solutions that will support the development and implementation of future restoration projects in an efficient and targeted manner.

This Stormwater Master Plan first incorporates information from existing plans and datasets to create a single, town-specific resource to guide future stormwater management activities. The resulting Stormwater Management Planning Library, included as Appendix B, is a valuable resource for water quality-related work in the City.

This Stormwater Master Plan also:

- Reviews and documents existing Department of Public Works practices such as street sweeping and catch basin cleaning;
- Provides a means for comparing information about different neighborhoods and the anticipated benefits of individual stormwater improvements projects, both within a particular neighborhood and across the City;
- Provides recommendations to address stormwater problems, including:
  - A prioritized list of problem areas that can assist the City in directing resources to high priority projects; and
  - Options for potential revisions to City regulations or ordinances needed to encourage location-specific management activities;
- Highlights opportunities to implement stormwater treatment in areas currently served by combined sewers;
- Presents conceptual solutions for stormwater management measures in select high priority problem areas; and
- Reviews existing, available funding sources that are available to support better stormwater management.

2. General Description of Montpelier's Watersheds

The City of Montpelier is located in Washington County in central Vermont. The City has a total area of 10.3 square miles, and as of the 2010 census, the population of Montpelier was 7,855. The Winooski River runs through the heart of downtown Montpelier, and confluences with three significant waterways within the City boundaries: the Dog River, the North Branch, and the Stevens Branch. In addition, there are a number of smaller drainages in the City including, most notably, Blanchard Brook. Each of these watersheds is described below, and watershed boundaries are shown on Figure 1 in Appendix A.

2.1. Winooski River

The Winooski River flows into the southeast corner of Montpelier from the Town of Berlin, and confluences with the North Branch in the center of downtown before flowing west into Middlesex and ultimately to Lake Champlain. The Upper Winooski watershed encompasses the area of land that drains into the Winooski River from its headwaters in Cabot downstream to Montpelier. The river thus defines a significant valley shared by many landowners, encompassing a watershed area of 316 square miles upstream of its confluence with the North Branch (Round River Design 2010, see Appendix B). Within Montpelier, the Winooski River above the City's wastewater treatment facility discharge point is considered to be impaired by *E. coli* bacteria, due to the wastewater collection system passing combined sewer overflows (VTDEC 2014).

While land uses and management practices in Montpelier contribute to the water quality impacts observed in the Winooski River, those impacts begin well upstream of the City and cannot not be treated or solved entirely within the City's boundaries (see Appendix B). For instance, patterns of elevated *E. coli* observed in Montpelier's stretch of the Winooski also occur in the Winooski mainstem far up in the watershed (upstream of the Cabot WWTP).

It is worth noting that historically, the majority of concerns related to resilience and flooding along the mainstem of the Winooski in Montpelier have been related to ice jams and the attendant flooding. Significant storm events in May 2011, however, served to broaden the City's focus to include the growing number of high intensity rainfall events and the damage caused by unmanaged stormwater runoff. This master planning effort helps to address this concern by supporting City efforts to be more comprehensive in managing runoff from the developed landscape.

The small, mostly un-named tributaries to the Winooski River in Montpelier, as well as those along the Winooski's North Branch, tend to have water quality and geomorphic issues that are somewhat different from those affecting Montpelier's major rivers. These small tributaries tend to be prone to erosion and downcutting, as well as localized flooding—but due to their very small drainage areas, water quality and related issues are not often monitored until public or private infrastructure is affected.

2.2. Winooski River North Branch

The North Branch is a large tributary of the Winooski River which drains approximately 78 square miles. The watershed extends from its confluence with the Winooski in downtown Montpelier north to the town of Elmore and is roughly bordered to the east by the Woodbury Mountain Range and to the west by the Worcester Mountain Range (Johnson Company 2009, see Appendix B). The North Branch flows through the towns of Elmore, Calais, Worcester, East Montpelier, and Middlesex before entering Montpelier. As with the Winooski River in Montpelier, the North Branch from its confluence with the Winooski to approximately one mile upstream is considered to be impaired by *E. coli* bacteria, due to the wastewater collection system passing combined sewer overflows (VTDEC 2014).

2.3. Blanchard Brook

The Blanchard Brook watershed includes approximately 1.2 square miles in Montpelier and East Montpelier. The river originates along Main Street as it leads north towards East Montpelier, and flows south through Sabin's Pasture and out into the Winooski River. In contrast with other Montpelier watersheds, land uses in the Blanchard Brook watershed area are primarily low- to medium-density residential development and undeveloped land.

2.4. Other Watersheds in Montpelier

A small area in the southwest corner of the City lies within the Dog River watershed, and a similarly small area in the southeast corner of the City lies within the Stevens Branch watershed. Both of these areas drain to the Winooski River and ultimately to Lake Champlain.

3. Existing Plans and Data

Numerous and varied groups and individuals have invested considerable effort in evaluating different components of Montpelier's water, wastewater, and stormwater infrastructure; water resources; and the important interface between water resources and local land use decisions. At times these evaluations followed watershed boundaries, and at other times they have followed political boundaries. The following sections identify these evaluations and highlight information most relevant to Montpelier and most relevant to developing a list of strategic, prioritized projects that could be undertaken to improve water quality and increase resilience to future flooding. A detailed review of each assessment is included as Appendix B of this report.

3.1. Watershed-Based Assessments

The ongoing assessments described below are generally led by the State of Vermont's Agency of Natural Resources (ANR). These include:

- Basin planning efforts, whose main purpose is to guide ANR in its own work and in collaborative projects with the public, municipalities, and other state and federal agencies. The basin plans have a five-year scope. The City of Montpelier is located in the Winooski River Basin (Basin #8), where a draft plan was approved in May 2012 by the Agency of Natural Resources.

- Stream geomorphic assessment work, undertaken to understand the natural tendencies of a particular reach of stream or river, its current condition, and what changes may be anticipated in the future. To date, stream geomorphic assessments have been completed for the Dog River, the Stevens Branch, the North Branch, and the mainstem of the Winooski River in Montpelier.

- In-stream water quality assessment work, including water chemistry and biological assessments. This information is available through the Vermont Integrated Watershed Information System (IWIS), the VTDEC-Watershed Management Division's online data portal for water quality information, at https://anrweb.vt.gov/DEC/IWIS/.

- Total Maximum Daily Load (TMDL) development, to establish the maximum amount of a pollutant (e.g., bacteria, nutrients, excess stormwater flows) that a waterbody can assimilate and still meet state-established water quality standards. TMDLs are based on the relationship between pollution sources and in-stream or in-lake water quality conditions. A TMDL addresses a single pollutant or stressor for a waterbody, so more than one TMDL may need to be developed for a particular receiving water. On June 17, 2016, EPA established new phosphorus TMDLs for the twelve Vermont segments of Lake Champlain. The state's Phase 1 Implementation Plan for this TMDL provides the framework for how these phosphorus pollution limits will be met, and is still in draft form, though the public comment period closed on September 7, 2016. The implementation plan ultimately will require the application of additional best management practices (BMPs) throughout the Lake Champlain watershed.

3.2. City-Wide Assessments and Programs

In addition to the watershed-based assessments, a number of assessments and datasets are developed on a municipality-by-municipality basis. These are important to fold into any effort to develop a list of strategic, prioritized projects that could be undertaken to improve water quality in and around Montpelier. These include direct feedback from the City, work by the Vermont Agency of Transportation and Vermont Department of Environmental Conservation, and past and current planning initiatives.

- In meetings with Stone Environmental, City Public Works officials identified more than 20 areas of concern and priority projects throughout Montpelier, many of which are areas that sustained damage during the May 2011 flood event. The City has implemented a significant number of corrective measures and controls in many of the most impacted areas over the past four years; these projects were also reviewed during the field evaluation (Section Stormwater Problem Areas5). See Figure 7 and Table 4 in Appendix B for a map and table of areas of concern and priority projects, as well as a map of the locations of concerns identified.

- VTrans-sponsored programs, including both routine inspections of bridges and culverts and grant opportunities provided by the Better Backroads Program, have identified a few potential projects to protect existing infrastructure whose implementation would also improve stormwater management. However, the information in the agency's online bridge and culvert inventory is known to be out-of-date and incomplete for the City of Montpelier.

- Vermont DEC-sponsored programs, including detailed stormwater infrastructure mapping completed in support of Illicit Discharge Detection and Elimination (IDDE) efforts and state-issued post-construction stormwater permitting records, were examined in order to identify additional stormwater management opportunities. The infrastructure mapping data represent an important supplement to VTrans' online bridge and culvert inventory and were invaluable during evaluations of existing problem areas and retrofit opportunities (Section 5). In addition, the age, style, size, and upkeep of existing facilities permitted by DEC – particularly facilities constructed prior to 2002 – may make them candidates for improvement to enhance stormwater management capabilities.

- The City's Code of Ordinances, most recently updated in 2012, has two key sections that related to stormwater management: Natural Resources (Chapter 13); and Zoning and Subdivision Regulations (Chapter 15). The Natural Resources chapter has an article specific to river and streams, which prohibits encroachment upon the channels of the City's major rivers and prohibits dumping on the banks of either river. The Zoning Regulations contain sections dedicated to Floodplain Development (Section 309) and Storm Drainage (Section 723). The City is currently engaged in an effort to substantially overhaul its zoning regulations. As part of overhaul, the City anticipates that a stand-alone chapter on River Hazard Areas – which includes both river corridors and flood hazard areas – will be added to the zoning regulations. Part 3 of the proposed draft Montpelier Unified Development Regulations adds requirements for implementing low-impact development and green stormwater infrastructure in new development and redevelopment situations, including but not limited to management of "one inch of rainfall from all impervious surfaces on the lot".

- The City's Flood Hazard Mitigation Plan makes many recommendations related to management of ice jams, and includes two important considerations for stormwater management: preserving existing open space within the floodplain, and seeking alternate locations for snow dumping and storage. In addition, a 2002 plan for management of riverbank vegetation makes specific planting and vegetation

management recommendations for various segments of the mainstem of the Winooski as it flows through Montpelier.

4. Current Department of Public Works "Good Housekeeping" Practices

Roadways are a major component of impervious cover in most Vermont communities. From a stormwater management perspective, streets are often directly connected impervious cover – meaning stormwater runoff from roads flows largely untreated via gutters and storm sewers to the nearest waterbody. Paved roads can also sometimes be pollutant hotspots - accumulating trace metals, oil, grease, and hydrocarbons as a result of vehicular traffic, as well as debris attributed to pavement degradation and littering. Street sweeping and catch basin cleaning programs are both "good housekeeping" activities that play an important role in helping to physically reduce the amount of dirt present on a street surfaces and thereby limit pollutant loads delivered to local receiving waters.

The City of Montpelier tracks the volume (cubic yards) of material swept from streets and the volume removed from catch basins on a daily basis. In 2015, for instance, 494 cubic yards of material was swept from streets, 125 cubic yards of material was removed from catch basins, and 490 bags of leaves were removed through the City's curbside pick-up program. Department of Public Works staff reported that they sweep every paved street at least once per year, and that many have been swept multiple times. In addition, the City is working to clean all catch basins at least once every other year. A monthly summary of cleaning activities over the past six months in presented in Table 1.

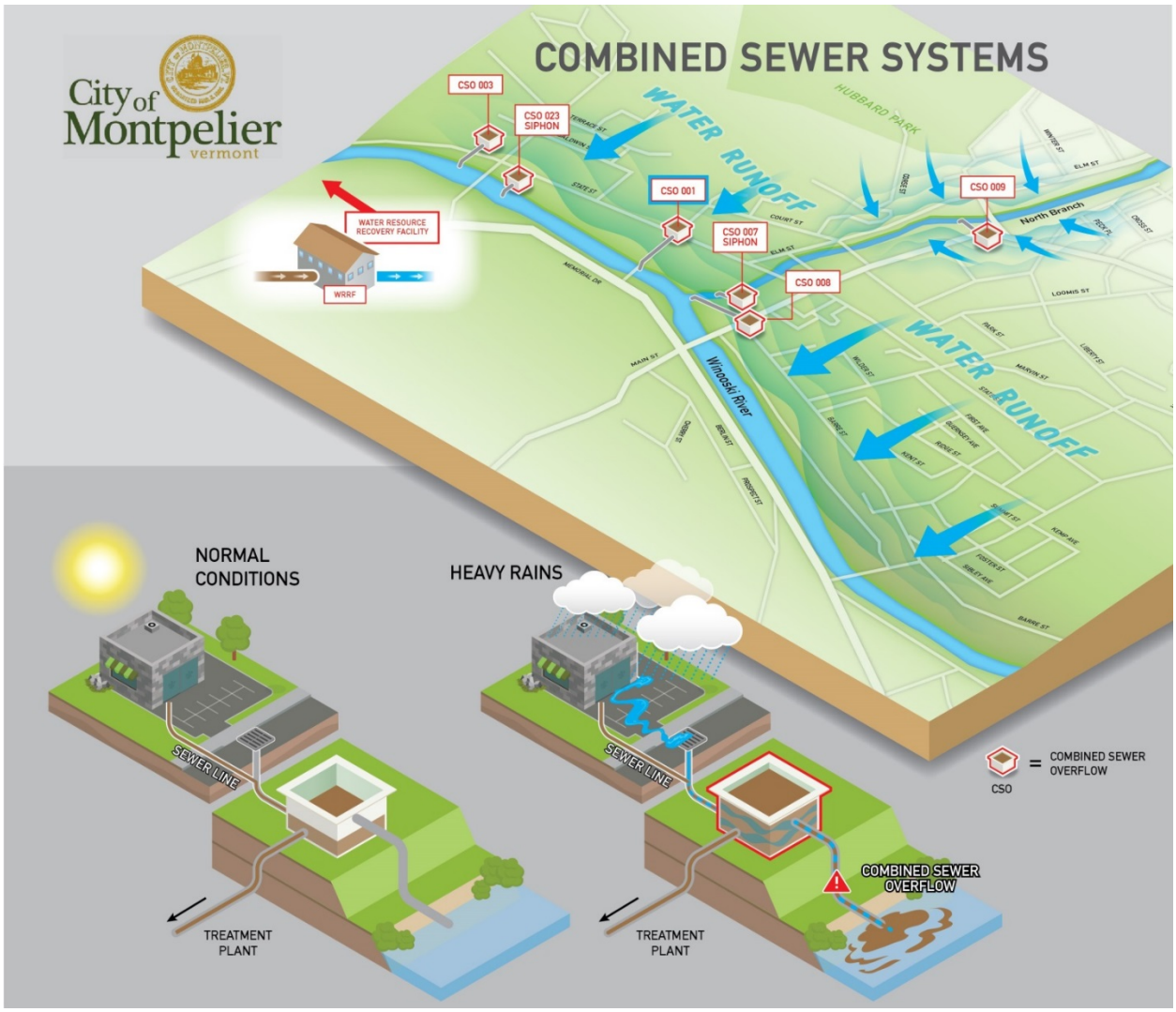
Table 1. Volume of Material Removed via Street Sweeping and Catch Cleaning, March-August, 2016

Month	Volume of Material Removed via Street Sweeping (cu. yd.)	# of Catch Basins Cleaned	Volume of Material Collected from Catch Basins (cu. yd.)
March	136	not recorded	8
April	71	132	37
May	14	39	4
June	10	40	12
July	7	81	29.5
August	18	78	22.5

It is important to continue to track these activities over time, in order to be able to document and take credit for the volume of material kept out of local waterways. It is also important to track additional metrics, such as the number of catch-basins cleaned or the lane-miles swept. Over time, as road maintenance crews become more efficient with sanding material and citizens become more knowledgeable about fixing sources of driveway erosion, for example, the volume of material collected from streets and catch-basins is likely to decrease—even though the number of catch-basins cleaned or lane miles swept may actually be increasing.

5. Combined Sewer Overflow Reduction Practices and Status

In 1962, the Montpelier Water Resource Recovery Facility was completed. To bring the waste water to the new facility, the city intercepted all the outfalls to the river and built a transmission main to the new facility. This is when the original 25 combined sewer overflow (CSO) structures were constructed. Between 1995 and 2009, the city separated the storm and sanitary sewer systems. As of September 2016, a total of six overflow structures remain, as illustrated below.



Combined sewer overflows are regulated by the EPA under the Federal Clean Water Act. In Vermont, this is delegated by EPA to the Vermont ANR, Department of Environmental Conservation, Watershed Management Division. NPDES is the national program for issuing permits and conducting enforcement. The City has a NPDES Discharge Permit with compliance schedules described in 1272 Orders.

The nine minimum controls from EPA's CSO Control Policy, per Vermont's newly adopted 2016 CSO Rule are:

- Proper operation and regular maintenance programs for the collection systems and CSO outfalls
- Maximum use of the collection system for storage without endangering public health or property, or causing solids deposition problems
- Review and modification of pretreatment requirements to assure that CSO impacts are minimized
- Maximization of flow to the treatment plant for treatment consistent with an evaluation of alternative treatment options
- Prohibition of CSOs during dry weather
- Control of solid and floatable materials in CSOs
- Establishment of pollution prevention programs to minimize contaminants in CSOs
- Public notification to ensure that the public receives adequate notification of CSOs and CSO impacts, which shall, at a minimum comply with § 34-404 of this Rule
- Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls

From 1990 through 2015, Montpelier has been in compliance with standards and reporting criteria included in the 1990 CSO Rule and established in the City's discharge permit, as recently verified by DEC. The new CSO rule (in effect September 15, 2016) requires reporting to the state within one hour of discovery and submitting a discharge volume estimate within 12 hours.

Since the first preliminary engineering report (PER) was submitted to the state in 1992, and as a result of a phased separation approach, the City of Montpelier has:

- Reduced the number of catch basins connections to the combined sewer system from 525 to about 40.
- Reduced the number of overflow structures from 25 to 6.
- Substantially reduced the frequency of overflows. In the early 1990s, overflows occurred with almost every rainfall event. Now an inch of rainfall in 4 hours or less is typically required to initiate an overflow.
- Further reduced wet weather overflow events by raising weir elevations in overflow structures (started in 2015).
- Completed additional CSO separation projects in-house in 2015-2016, with more projects planned for future years.
- Spent approximately $10,000,000 to date on CSO elimination.

Vermont CSO communities have two choices to achieve compliance with the Vermont Water Quality Standards from this point forward: eliminate overflows, or provide pre-discharge treatment (solids removal and disinfection).

Originally, the cause of overflows was based on the following contributions to Montpelier's combined sewer system:

1. 60% combined storm sewers (storm water)
2. 30% roof tops and inflow
3. 10% infiltration (springs) and sump pumps.

The number one cause of overflows, which used to be introduction of ground-level storm runoff into the sanitary system, has largely been addressed. Roof top connections to the combined sewer system was the next largest cause of overflows, and is now a primary contributor. This is clean water being collected from over eight acres of impervious rooftop surfaces and piped directly to the City's sewers. The goal of eliminating overflows cannot be reached without separation of these clean-water discharges. Infiltration will be addressed in phases, as sanitary sewers are reconstructed over time. A few of the combined sewer systems will need to be retained (such as the system on Cliff Street, where shallow bedrock and steep slopes make complete separation impossible). Ultimately, in these cases, some storage of peak flows or treatment may be necessary.

The City's next steps in addressing combined sewer overflows include:

- Implement a monitoring system to collect accurate information regarding overflow durations and volumes.
- Develop a CSO Overflow Reduction Plan and ensure compliance with the new CSO Rule (Effective 9/15/16). Note: The Montpelier Water Resource Recovery Facility's next NPDES discharge permit will include a 1272 Order which will establish a 2-year timeframe to assess the system and write a control plan.
  - Phase 1 – Implement Minimum Controls & Develop Long Term Control Plan
  - Phase 2 – Implement Long Term Control Plan until VWQS achieved.
- Continue roof drain separation (21 confirmed connections and 49 suspected connections remain from the 2007 CSO Monitoring Phase II Report)

In support of these next steps, a number of policy questions and future projects remain, including:

- Voluntary or mandatory separation?
- Storm water utility- tax roof drain connections? Provide incentives? Impose penalties?
- Consider further weir adjustments and corresponding collection pipe capacity?
- Subsidize check valve installation in low elevation sewer services?
- Mandatory downtown check valve ordinance?
- East State Street Separation Project?

6. Stormwater Problem Areas

One of the goals of this plan is to "develop a prioritized list of stormwater problem areas that can assist the City in directing resources to high priority projects." To achieve this goal, a thorough effort was made to identify existing problem areas, and then to evaluate existing conditions and potential solutions.

6.1. Identification and Initial Evaluation of Problem Areas

The first task was to identify the location and nature of existing drainage problems and stormwater management concerns, and to gather field data for further analysis where appropriate. The approach to identifying potential problem areas included the following elements:

- Reviewing existing plans and data, as described in Section 3, and noting the location of any concerns related to stormwater
- Engagement with local officials, including regular meetings with the City Planner, Public Works Director, and key DPW staff, as well as presentations to City Council
- Targeted site visits to verify problem areas during fall 2015 and spring 2016
- Documentation (with photos) of existing problem areas

A "problem area data sheet" was developed and used as a guide to ensure that consistent information was collected as site visits were completed. A total of 58 potential problem areas were identified and geo-located (Figure 2). The data sheets for all of the problem areas identified in Montpelier are provided in Appendix C of this report.

6.2. Initial Screening Evaluation of Problem Areas

Working from the list of potential problem areas, the Consultant Team visited each potential problem area to directly observe the site. Where an unresolved problem was found, photos were taken of any areas of active erosion, and observations were recorded about the source or cause.

Each problem area was given an initial score with the intent of generally assessing the severity of existing problems, removing low priority problem areas from the dataset, and providing general guidance on the relative order in which the problems should be addressed when considered city-wide (Appendix C). Scores were assigned as described in Table 2.

The problem areas identified during this initial evaluation were carried forward through a more detailed examination and prioritization process that considered possible regulatory changes, future growth, and the suitability of different types of best management practices to each identified problem area, as described in Sections 7 and 8).

Table 2. Scoring Criteria for Preliminary Evaluation of Stormwater Problem Areas.

Level	Classification
1	Outside of project scope, or infeasible to remedy due to project size.
2	Stable, but problem could escalate with future change in surrounding land use.
3	Limited erosion and/or drainage problems are present; issues may be readily addressed.
4	Moderate erosion and/or drainage problems are present; issues may be readily addressed.
5	Significant erosion and/or drainage problems are present; issues may be readily addressed
6	Strategic retrofit opportunity

7. Criteria for Prioritizing Stormwater Management Opportunities

In coordination with the identification and characterization of existing stormwater-related problems, an effort was undertaken to identify and anticipate the potential impacts of the future on the City's stormwater management activities and priorities. These fell into two broad categories: projected growth and known capital projects, and anticipated regulatory requirements.

7.1. Projected Growth and Anticipated Capital Projects

The Stone team worked with the City to identify areas likely to see significant growth as well as planned or potential capital projects with significant City involvement. These areas are indicated on Figure 3 and are discussed in more detail below.

7.1.1. Future Growth Areas

The City Planning and Community Development Department identified three specific areas of the City where future growth is likely to be concentrated. These are Sabin's Pasture, Crestview, and Isabel Circle. Parcel boundaries for all three locations are displayed in Figure 3. Should it occur, development in all three of these areas is likely to be subject to both construction and post-construction State Stormwater Permit Program requirements, as it almost certainly will involve more than one acre of land disturbance and/or the creation of more than one acre of new impervious surface. Evaluation of current stormwater-related challenges and opportunities completed during earlier phases of this stormwater master planning effort did not identify specific issues in the immediate down-slope vicinity of Sabin's Pasture or the Crestview area that might be exacerbated by concentrated future development of these two parcels. At least two current stormwater 'problem areas' were identified in the drainage areas down-slope of the Isabel Circle parcel (Figure 3). While construction and post-construction stormwater management permitting and resulting best management practices will be required for development activities on this parcel, it is much less likely that designs on this parcel will be required by state permitting programs to take down-stream impacts into account. For most post-construction BMPs in the current (2002) Vermont Stormwater Management Manual, practice outlet velocities are required to be non-erosive, but impacts down-stream of the permitted site are not required to be assessed unless the site is subject to the Overbank Flood Protection Treatment Standard (e.g., the project site to be permitted is greater than 5 acres in size). The Isabel Circle parcel is roughly 77 acres in total, but substantial portions of it are steeply sloping and unlikely to be included in major development proposals.

7.1.2. Infill and Expansions of Existing Development

In addition to the three areas where there is significant development potential, there are substantial high- and medium-density developed areas in the City where anticipated changes to City zoning may encourage infill development or redevelopment projects. This "intensification" within already built areas is likely to result in more modest land disturbance and impervious surface creation, which is often referred to as sub-jurisdictional as it is unlikely to trigger State Stormwater permitting requirements. Left unchecked, the cumulative impact of such series of small projects on local drainages can be significant.

The City's current Zoning and Subdivision Regulations require submittal of a stormwater management plan for review and approval by the Development Review Board (Section 723). Stormwater control facilities must accommodate the 25 year storm event frequency, and within the plan, existing treatment and conveyance facilities which may be affected or impacted by the development must be identified and analyzed. The use of "best available technology" to minimize stormwater runoff is required (examples provided include retention basins, recharge trenches, swales and minimal use of impervious surfaces) but a performance standard for these measures (e.g., "must capture and treat the 90th percentile storm") is not provided.

The City's substantially updated Land Development Regulations are not yet adopted, and so specific areas where infill development and redevelopment are most likely to occur are not identified on Figure 3. The current draft of the Land Development Regulations (Section 3009, Stormwater Management) includes strong but sensibly tiered requirements for incorporating low-impact development (LID) concepts and green stormwater infrastructure (GSI) practices into future development projects where those projects will not trigger state requirements; as written, the current draft Land Development Regulations are likely to largely offset any potential impacts. New development and redevelopment exceeding the exemption thresholds in this section will be required, at minimum, to manage the first inch of runoff from site impervious surfaces (Sections 3009.H-I), with a strong preference for the use of LID/GSI practices where possible. Disturbed areas on the site not covered by impervious surface, incorporated into a structural stormwater treatment practice, or engineered as structural fill or slope will be required to be covered with topsoil that meets specified minimum depth and quality requirements once development is complete (Section 3009.J), consistent with the anticipated draft Vermont Stormwater Management Manual's Post-Construction Soil Depth and Quality Standard.

7.1.3. Anticipated Capital Projects

Beyond these areas of potential future growth, infill, and re-development, Stone obtained information from the Department of Public Works relative to planned capital projects slated for the next five years. It is often possible to incorporate stormwater treatment practices as part of significant capital projects at little additional cost. In reviewing existing datasets (Section 3) and especially in the initial evaluation of stormwater problem areas (Section 6), particular attention was given to opportunities that coincide with full-depth road reconstruction projects, as well as sidewalk projects adjacent to an existing green space. These areas are also highlighted in Figure 3, and concept designs for two of these opportunities (Northfield St. and Harrison Ave.) were ultimately developed (Section 9).

7.2. Anticipated Regulatory and Pollutant Reduction Requirements

There are currently several state-level rulemaking and other regulatory initiatives – most stemming from the passage of Vermont's Clean Water Act (Act 64) in June of 2015 – that have important implications for the City of Montpelier. Rulemaking is underway or was recently completed related to stormwater runoff from municipal roads and management of combined sewer overflows. While changes in post-construction stormwater permitting for existing properties with over 3 acres of unpermitted impervious surface are a few years away, the DEC Stormwater Program recently recommended to the Legislature that the state's post-construction permitting threshold for new impervious cover be lowered to 0.5 acres (from the current 1 acre or more of impervious cover for new construction).

The suite of state-level rulemaking and other regulatory initiatives that may have implications for the City of Montpelier includes:

- Municipal roads

- Developed land and post-construction stormwater management
- Combined sewer overflows
- Water quality criteria for chlorides
- Integrated water quality planning

The status of and key points for each of these efforts are described in detail in Appendix D—but it is important to be aware that some of this information is still evolving and may not be fully resolved for some time to come.

Several criteria specific to these anticipated regulatory requirements were developed, in order to be able to factor these initiatives into decisions regarding the relative priority that might be assigned to the implementation of different projects and practices. These criteria are discussed below. These additional criteria are not included in the prioritization and implementation matrix (Section 8)—however, they constitute part of the decision making process that narrowed the group of over 50 initially identified problem areas to the suite of high-priority projects that advanced to concept design (Section 9).

- Promote stable conveyance? (Y/N)
  - The stated purpose of the Municipal Roads General Permit will be to implement a customized, multi-year plan to stabilize existing road drainage systems. Projects that are intended promote stable conveyance within the right-of-way are not yet required, but in the future, they will be required as part of compliance with the permit.
- Total impervious cover? (<1 acre, 1-3 acres, >3 acres)
  - Requirements for stormwater management are based on a "common plan of development." A common plan of development or sale means a contiguous area where multiple separate and distinct land disturbing activities may be taking place at different times, on different schedules, but under one proposed plan. That said, a public entity (like a municipality or state agency) need not consider all construction projects within their entire jurisdiction to be part of an overall "common plan." Only the interconnected parts of a project would be considered to be a "common plan" (for example, a building and its associated parking lot and driveways). Evaluations of total impervious cover will be made based on "common plan."
  - As part of Vermont's Lake Champlain Phosphorus TMDL Phase 1 Implementation Plan, Vermont DEC will issue a general permit for existing development to address stormwater management for parcels that currently have no stormwater management permits or permits with pre-2002 designs, and which contain more than 3 acres of impervious surface. Parcels subject to this permit will ultimately be required to install retrofits, and thus retrofits to such properties, especially if they are not controlled by the City, may be a lower priority for the time being.
  - Proposed revisions to the Vermont Stormwater Management Manual expand treatment requirements for parcels undergoing redevelopment. Redeveloped sites (with more than an acre of impervious surface) will be required to capture and treat 50% of the first inch of rain on the redeveloped impervious areas, or to reduce existing impervious surfaces by 25% and restore these areas to meet the new post-construction soil depth and quality standard. Parcels with more than an acre of impervious surface with planned redevelopment will be required to install retrofits, and may therefore be a lower priority for the City in the short term.

- Type of treatment (D/I)
  - Reducing peak flows within the combined sewer system is essential to reducing the volume and frequency of overflows. Stormwater management practices can accomplish this by either temporarily storing and detaining stormwater runoff (while ultimately returning that runoff to the system), or by infiltrating and thereby eliminating the stormwater from the combined sewer system. Therefore, and depending on other characteristics of the drainage area or sewershed, it may be important to consider whether practices detain (D) or infiltrate (I) storm flows in areas served by combined sewers.
- Potential chloride concern? (Y/N)
  - Salt used to de-ice parking lots, sidewalks, streets and highways is a significant source of chloride to the environment; in Vermont salt usage tends to be highest in privately-held parking lots. Unfortunately, our ability to remove chloride from stormwater once it has dissolved is very limited. Further, infiltrating stormwater runoff with high concentrations of stormwater can contaminate groundwater and result in elevated chloride concentrations, particularly in smaller streams like Blanchard Brook; elevated concentrations of chlorides can be harmful to aquatic plants and animals. Contributing drainage areas for infiltration-based stormwater management practices should be evaluated for salt use and alternative practices considered for heavy use areas.

7.3. Range of Alternatives for Practice Implementation

There are a wide array of best management practices (BMPs) and green stormwater infrastructure (GSI) practices available for retrofit applications in developed areas like the City of Montpelier. BMP selection involves consideration of many factors including physical site characteristics, treatment objectives, and aesthetics. Typically, there is not a single answer to the question of which BMP (or BMPs) should be selected for a site; there are usually multiple solutions ranging from standalone BMPs to treatment trains that combine multiple BMPs to achieve the water quality objectives. Table 3 is a simple matrix that, for a range of BMPs, summarizes factors that should be considered when selecting a BMP for a particular application.

In the matrix, BMPs are evaluated based on a range of criteria, including community factors, pollutant removal, and physical feasibility considerations. Each of the criteria are discussed briefly below:

- Safety concerns: although well-designed stormwater features can be community amenities, storm water ponds, wetlands and bioretention areas can also pose hazards including strong currents during storm events, steep drop-offs, unsafe winter ice and contaminated water and sediment. With care taken in siting and design, many of these safety concerns can be mitigated, if not eliminated.
- Aesthetically pleasing: many well-designed stormwater practices can be designed as landscape features, creating a development focal point, recreational area and/or wildlife habitat. This criteria indicates the ability of each practice to be adapted to serve as an amenity for its surrounding environ.
- Flow attenuation: development (clearing, grading and construction) can remove surface depressions and limit opportunities for stormwater to soak away into the ground below leading to higher peak flows. This criteria indicates the ability of each practice temporarily detain flows in order to reduce the peaks.
- Volume reduction: as described above, development can limit opportunities for stormwater to soak away into the ground below leading to increased volumes of stormwater runoff. This criteria indicates

the ability of each practice retain stormwater runoff, by either promoting infiltration and/or evapotranspiration.

- Total suspended solids (TSS) removal: as stormwater runoff washes across the ground surface it often picks up sediment particles and other debris. This criterion indicates the ability of each practice to remove solid particles, typically via settling or filtration.
- Total phosphorus (TP) removal: phosphorus is a fundamental component of organic manner, including grass clippings and leaf litter. As stormwater washes across the ground surface it often picks up organic materials, delivering them to local receiving waters. This criterion indicates the ability of each practice to reduce phosphorus concentration, typical via settling, filtration and, to a lesser extent, plant uptake.
- Suitable for hotspot: there are areas within the developed landscape where pollutant concentrations are likely to be higher, such as vehicle fueling or maintenance areas. Practices that promote infiltration are not suitable for these locations; rather, stormwater from hotspots should be filtered or run through an appropriate treatment device prior to discharge.
- Drainage area: this criteria indicates the amount of land area that is recommended to drain to a single BMP installation.
- Soils: soils that are well-drained are able to readily accept stormwater for infiltration, and tend to be sandy; poorly-drained soils have a limited capacity to infiltrate stormwater, and tend to be comprised largely of clay or silt particles.
- Suitability on sloping sites: for practices that promote infiltration, it can be challenging to sufficiently encourage stormwater runoff to soak away into the ground below on sites with steeper slopes. There are modifications that can be made to certain types of practices, such as adding check dams to swales, to overcome this limitation.

Table 3. Stormwater Practice Implementation Alternatives - BMP Selection Matrix

BMP Type	Community Factors		Targeted Pollutants					Physical Feasibility Considerations		
	Safety Concerns?	Aesthetically Pleasing?	Flow Attenuation	Volume Reduction	Total Suspended Solids (TSS) Removal[1]	Total Phosphorus (TP) Removal[1]	Suitable for Hotspot?	Drainage Area	Soils	Suitability on Sloping Sites
Treatment Swale	N	MODERATE	LOW	LOW	65%	25%	S	5 Acre Max.	NR	Suitable
Wet Pond / Constructed Wetland	S	MODERATE	HIGH	LOW	70%	45%	S	10 Acre Min.	Well drained soils may require liner	Not suitable
Gravel Wetland	S	HIGH	HIGH	MODERATE	90%	65%	S	1 Acre Min.	Well drained soils may require liner	Not suitable
Rain Garden / Bioretention	S	HIGH	MODERATE	MODERATE	90% [2]	65% [2]	N	5 Acre Max.	Poorly drained soil may require underdrain	Adaptable
Infiltration Trench / Basin	S	MODERATE	HIGH	HIGH	90%	60-65%	N	5/10 Acre Max.	Well-drained soils only	Not suitable
Sand Filter	N	LOW	LOW	LOW	90%	65%	Y	10 Acre Max.	NR	Adaptable
Permeable Pavement	N	MODERATE	MODERATE	MODERATE	90%	45%	N	NR	Poorly drained soil may require underdrain	Not suitable
Disconnection	N	LOW	MODERATE	MODERATE	75%	45%	N	1,000 ft^2 to a single point, or max contributing impervious width of 75 ft	NR	Suitable
Level Spreader/Turnout	N	LOW	MODERATE	LOW	10%	0%	N	1 Acre Max.	NR	Suitable
Swirl Concentrator/ Vortex Separator	S	LOW	LOW	LOW	30%	40%	Y	NR	NR	Suitable
Treebox Filter	N	HIGH	MODERATE	LOW	90%	50-80%	Y	¼ Acre Max.	NR	Adaptable

Y = Yes, Applicable
N = Not Applicable
S = Sometimes Applicable
NR = Not Restricted

[1] TSS and TP removal rates from NHDES Stormwater Manual, Appendix E, BMP Pollutant Removal Efficiency (http://des.nh.gov/organization/divisions/water/stormwater/documents/wd-08-20b_apxb.pdf)

[2] Assumes Rain Garden/Bioretention facilities are not underdrained. If facilities are underdrained, reduced phosphorus removal would be expected.

8. Prioritization of Stormwater Management Opportunities and Implementation Matrix

Stone completed a field screening that identified more than 50 stormwater management opportunities in the City of Montpelier during fall 2015 and spring 2016 (Section 6). The locations of the opportunities are shown on Figure 2, and the nature of each identified problem and potential opportunity is summarized in Table 4. The types of BMPs selected to address each problem area were generally selected using the matrix presented in Section 7.3 and Table 3.

During and following the field screening, Stone recorded observations about each site which are used in the implementation matrix (Table 4) to develop a score for each opportunity relative to several criteria:

- **Existing environmental concerns** – score was assigned based on the type(s) of problems present, with 1 point added for each of the following concerns presented by the site's current condition: water quality concerns; infrastructure vulnerability; localized drainage issues/flooding; streambank or in-stream erosion; and overbank flooding. Although sites were generally anticipated to receive between 1 and 3 points, the maximum score a site could receive was 5.
- **Environmental priority –** relative environmental impact on nearest receiving water (e.g., proximity, location) and how "active" the problem area was during the site visit, with 1 being the smallest impact and 5 being the greatest impact.
- **Constructability –** relative ease with which a project could be implemented, including whether the recommended practice(s) could be constructed on City-owned land or with a willing landowner-partner, existing access to the site, and the amount of additional assessment and engineering design work that would be required to move the project to implementation. The maximum score a site could receive was 3, indicating a project that should move quickly and easily to implementation.
- **Ease of operation –** including the amount and frequency of maintenance likely to be required and whether maintenance activities would be straightforward to complete. The maximum score a site can receive is 3, indicating a project with infrequent maintenance needs that are easily completed.

In addition, 1 extra point was awarded to projects identified in the three areas the City identified as having the most potential for additional development (e.g., Sabin's pasture, Crestview, and Stonewall Meadows, see Section 7.1.1).

The type of ownership of each project location, whether the project is located in an area currently connected to the combined sewer system, and an initial indication of project cost are also presented in the matrix (Table 4). These measures are not included in the score tabulated for each potential project, but are provided to give additional context for project prioritization.

Table 4. Stormwater Opportunity Prioritization and Implementation Matrix

Site ID	Site Name	Need	Proposed Approach	Soil Survey Mapped HSG	Existing Environmental Concerns (scale 1-5)	Environmental Priority (scale 1-5)	Constructability (scale 1-3)	Ease of Operation (scale 1-3)	Area of Anticipated Growth (yes = 1; no = 0)	Implementation Score	Project Type	CSO Area? (Y or N)	Estimated Implementation Cost
WR-01	DOL Parking Lot	Edge of parking lot is not properly stabilized, and concentrated flow along the edge is causing modest erosion	Level shoulder to ensure sheetflow from parking lot; establish robust vegetation	C	2	1	3	3	0	9	B	N	L
WR-02	GMP Parking Lot	Stormwater from the parking lot is directed into a V-shaped swale with evidence of erosion	Bioswale	C	3	2	2	2	0	9	A	N	L
WR-03	Green Mountain Dr.	Retrofit opportunity	Existing catch basins on Green Mountain Dr. could be capped and runoff redirected into existing green space.	C	1	1	2	2	0	6	A	N	L
WR-04	National Life Dr. & Memorial Dr./Route 2	Existing culvert that conveys some stormwater runoff from swale along National Life Drive down to Memorial Dr. is failing and stormwater is flowing around the pipe.	Subsurface gravel wetland	C	3	3	2	2	0	10	D	N	MH
WR-05	30 National Life Dr.	Retrofit opportunity	"Daylight" stormwater runoff currently conveyed through closed pipe system to existing grassed channel to the southeast of 30 National Life Dr. Swale would likely need to be improved with check dams added.	C	2	2	2	2	0	8	D	N	M
WR-06	Econo Lodge/Route 12/Northfield St	Retrofit opportunity	The City has indicated planned full-depth reconstruction of Northfield St between Memorial Dr. and Freedom Dr. will take place in 2017. As part of this project, a stormwater swale could be installed along the western side of Northfield St. adjacent to the curbed lawn island in front of the Econo Lodge motel building. Also along the western side of Northfield St, a stormwater swale could be installed in front of the four houses immediately to the south of the Lutheran Church.	C	2	2	2	2	0	8	D	N	M
WR-07	Taplin St	Management of stormwater runoff along this steep, narrow street is challenging	Stabilization measures have been installed at the top (south) end of the street and the situation appears relatively stable.	D	2	1	1	2	0	6	C	N	M
WR-08a	Old Country Club Rd	Erosion and bank slumping evident in roadside ditches	Reshape existing drainage to extent possible given site constraints; stabilize side slopes with stone or vegetation, as appropriate.	B	3	3	3	2	0	11	C	N	M
WR-08b	Old Country Club Rd	Culvert at the east end of old Country Club Rd was severely damaged during the May 2011 flood event and has not been removed or repaired	Culvert should be removed or replaced; if culvert is removed, reshape and stabilize side slopes.	B	4	5	2	3	0	14	C	N	H
WR-10	2 Main St/Show's	Dumpsters and bagged garbage stored on edge of parking lot immediately adjacent to the river.	Alternative locations for garbage storage should be evaluated; site constraints may make relocating materials challenging.	fill	2	2	1	3	0	8	A	N	L
WR-11	Gov. Davis Ave Parking Lot	Retrofit opportunity	Install porous pavement when lot is resurfaced.	fill	1	1	2	1	0	5	B	Y	H
WR-12	60 State St Parking Lot	Retrofit opportunity	Utilize existing green space/islands for bioretention treatment	fill	2	2	2	2	0	8	B	N	M
WR-13	Wheelock Street	Retrofit opportunity	Existing swale provides conveyance without much treatment; add appropriately spaced check dams	D	2	1	3	2	1	11	C	N	L
WR-14	Dunpatrick Circle	Retrofit opportunity	Construct subsurface gravel wetland in the cul-de-sac green space	C	2	1	2	2	1	8	C	N	M
WR-15a	Bailey Ave	Significant stormwater runoff along the west-side shoulder of Bailey Ave accesses and erodes off-street parking areas	Build small berm along parking lot entrance to prevent stormwater runoff from entering	fill	3	3	3	1	0	10	C	Y	L
WR-15b	Bailey Ave	Retrofit opportunity	Bioretention, possibly underdrained, in existing green space along the east-side of Bailey Ave between the sidewalk and the street.	fill	3	3	2	2	0	10	D	Y	MH
WR-16	Montpelier High School	Significant sediment mobilization from "overflow parking" area in front of the school	Renovate informal parking area with geogrid or other reinforcement	C	3	3	2	3	0	11	C	N	M

Site ID	Site Name	Need	Proposed Approach	Soil Survey Mapped HSG	Existing Environmental Concerns (scale 1-5)	Environmental Priority (scale 1-5)	Constructability (scale 1-3)	Ease of Operation (scale 1-3)	Area of Anticipated Growth (yes = 1; no = 0)	Implementation Score	Project Type	CSO Area? (Y or N)	Estimated Implementation Cost
WR-17	VSECU Parking Lot	Retrofit opportunity	Bioretention, possibly underdrained, in existing green space between the edge of the parking lot and the bike path	C	2	2	2	2	0	8	A	N	M
WR-18	Hackamore Rd	Erosion along road shoulder	Replace gravel shoulder with grass channel to convey flow; rock-line drainage ditch where Hackamore Dr. comes into Towne Hill Rd.	C	3	2	2	3	1	11	C	N	L
WR-19	VT NEA & Leahy Press, Wheelock St	Retrofit opportunity	Improve existing drainage swale along the north edge of parking areas to slow runoff and promote infiltration	D	2	1	2	2	0	7	A	N	L
WR-20	State Office Parking Lots	Retrofit opportunity	Bioretention, possibly underdrained, in existing green space behind 116 State St	fill	1	2	2	2	0	7	B	N	M
WR-21	State Street	Retrofit opportunity	Bioretention, possibly underdrained, in existing green space along the south-side of State St between the sidewalk and the street.	fill	2	2	2	2	0	8	C	Y	M
WR-22	A Quilter's Garden, Barre-Montpelier Rd	Culvert conveying hillside runoff between 338 and 342 River St to Stevens Branch has failed and there is significant erosion	Remove culvert to daylight drainage and create suitable drainage feature, such as step-pool conveyance	C	3	4	2	2	1	12	A	N	MH
WR-23	161 River St.	A gully to the west of 161 River St. appears to convey a significant sediment/debris load to the City's storm sewer system.	Reshape and rock line existing drainage feature and add appropriately spaced check dams or install step-pool conveyance	D	2	2	2	2	0	8	A	N	M
WR-24	11 Dairy Ln.	Retrofit opportunity	There is a large open area behind 11 Dairy Ln that could be retrofitted to provide treatment for the Greenfield Terrace neighborhood	C/D	1	2	1	1	1	6	A	N	MH
WR-25	169 Berlin St.	Retrofit opportunity	There is a large open space across from 169 Berlin St. that could be retrofitted – likely with subsurface storage or treatment – to provide treatment for the Berlin St. – Cedar Hill – Wilson St. neighborhood.	C/D	2	2	2	2	0	8	A	N	H
SB-01	Crossway Saab / Cody Chevrolet	Undersized culvert on Crossway Saab property captures intermittent stream and conveys under Route 302 through the Cody Chevrolet property to Stevens Branch. Significant sediment deposits at observed at culvert outlet. .	Complete detailed evaluation of hillside drainage; replace or remove outright undersized culvert adjacent to Crossway Saab	fill	4	5	2	2	1	14	D	N	H
SB-02	Moonlight Terrace	Erosion and sediment transport along road shoulder	Reshape and rock line existing drainage swale; add appropriately spaced check dams	fill	2	3	3	2	1	11	C	N	L
NB-01	Parking Lots west of Main Street	Existing overbank drainage from parking lot is causing streambank erosion and compromising integrity of edge of parking lot	Bioretention, possibly underdrained, in existing green space / parking islands.	fill	3	3	2	2	0	10	C	N	M
NB-02	Union Elementary School	Existing stormwater system is poorly sited given current use of the school's outdoor areas; several catch basins are buried, ones that are visible show significant sediment accumulation	Planned improvements to the school's outdoor areas present opportunity for stormwater renovation; numerous opportunities for GSI retrofits on both upper and lower playgrounds	B	3	3	2	2	0	10	C	N	H
NB-03a	Marvin & Bingham Streets	Retrofit opportunity	Install bioretention treatment area at the southeast corner of intersection to capture road runoff	B	1	1	2	2	0	6	C	N	M
NB-03b	Marvin Street	Erosion along road shoulder	Reshape and rock line existing drainage swale; add appropriately spaced check dams; consider making street one-way in order to provide sufficient room for swale	B	2	2	1	2	0	7	C	N	L
NB-04	College & Marvin Streets	Retrofit opportunity	"Green Street" retrofit could take advantage of the fact that there are no curbs separating the road edge from the adjoining green space to manage road runoff	C/D	1	1	3	2	0	7	C	N	M

Site ID	Site Name	Need	Proposed Approach	Soil Survey Mapped HSG	Existing Environmental Concerns (scale 1-5)	Environmental Priority (scale 1-5)	Constructability (scale 1-3)	Ease of Operation (scale 1-3)	Area of Anticipated Growth (yes = 1; no = 0)	Implementation Score	Project Type	CSO Area? (Y or N)	Estimated Implementation Cost
NB-05	College St & Woodrow Ave.	Retrofit opportunity	"Green Street" retrofit could take advantage of the fact that there are no curbs separating the road edge from the adjoining green space to manage road runoff	C/D	2	1	3	2	0	8	C	N	M
NB-06	Heaton Woods	Retrofit opportunity	Bioretention or other treatment could be installed at the intersection of access drive and Heaton St.	C/D	1	1	2	2	0	6	C	N	M
NB-07	Washington County Mental Health Services	Retrofit opportunity	Bioretention or other treatment could be installed in the green space between the building and Heaton St.	C/D	1	1	2	2	0	6	A	N	M
NB-08	Emmons St.	Retrofit opportunity	Limiting parking to the west-side of Emmons St would for "Green Street" retrofit	C/D	1	1	2	2	0	6	A	N	M
NB-09	Hubbard Park road system	There are approximately 2 miles of gravel road in the park and there is active erosion along many of them.	Develop a comprehensive inventory of road related erosion problems in Hubbard Park, including a capital budget plan to correct these problems over a specific period of time.	C	3	4	3	2	0	13	C	Y	M
NB-10	Gould Hill Rd.	Erosion and sediment transport along road shoulder	Reshape and rock line existing drainage swale; add appropriately spaced check dams	B/C	3	3	2	2	1	11	C	N	L
NB-11	Trillium Hill Rd.	Private road is poorly crowned with insufficient ditching, causing water to run down the road surface	Roadway should be graded so water does not remain on the road surface (2-4% crown); may be an opportunity to construct bioretention or other treatment at the north-west corner of the intersection with Route 2.	D	3	3	2	2	1	11	A	N	MH
NB-12	Hubbard Park "frog pond"	Significant sediment has been allowed to accumulate in the pond the existing outlet structure is in a state of disrepair.	The pond should be renovated to increase residence time; the outlet structure should be redesigned and emergency spillway improved	C/D	3	3	2	2	0	10	C	Y	M
NB-13	Summer St.	Retrofit opportunity	A bump-out was added in front of the pocket park at 12 Summer St to slow traffic in this area; the bump-out would be recessed to serve as stormwater infiltration area	fill	1	1	3	2	0	7	C	Y	L
NB-14	Finch St / stump dump	Erosion and pile creep from sand and gravel storage at the site is causing sediment to reach adjacent drainage features	Develop and implement a site-specific pollution prevention plan for the site, anticipated to include a mix of good housekeeping (e.g., proper material storage) and best management (e.g., diversions, regarding, etc.) measures	A	2	4	3	2	0	11	C	N	M
NB-15	58 E State St.	Catch basins in parking lot appear to be connected to the combined sewer system	Area is mapped as having soils reasonably well-suite for infiltration; install bioretention in existing green space between building/parking lot and East State St	B	2	2	2	2	0	8	A	Y	M
NB-16	Harrison Ave.	Retrofit opportunity	The City has indicated planned water main replacement and road paving in 2018. As part of this construction stormwater could be redirected to an existing swale that surrounds small recreational field and the swale improved to enhance treatment.	B	2	1	3	2	0	8	C	N	M
NB-17	60 State St Parking Lot	Retrofit opportunity	Utilize existing green space/islands for bioretention treatment	fill	2	2	2	2	0	8	B	N	M
NB-18	Towne St.	Stormwater runoff from above Towne St. crosses through a culvert under Towne St. and has formed a gully in the woods between Towne St and Main St.	Install "upturned elbow" on upstream end of culvert to temporarily detain stormwater and promote infiltration.	C	3	2	2	2	0	9	D	Y	L
NB-19	St Augustine Cemetery/North St.	There is a long history of erosion in the gully that runs along the northern edge of the St. Augustine Cemetery, between Murray Hill and North St.	Upgrade the detention pond on Murray Hill to meet VSMM 2002. Reshape and rock-line section of the channel immediately to the east of North St to stabilize.	B	3	2	2	1	0	8	A	N	MH
BB-01	Arsenal Dr.	Road runoff is turned out over a steep section of hillside, in an area where lawn clippings are also being composted	"Green Street" retrofit could take advantage of the fact that there are no curbs separating the road edge from the adjoining green space to manage road runoff	C/D	2	2	2	2	1	9	D	N	L

Site ID	Site Name	Need	Proposed Approach	Soil Survey Mapped HSG	Existing Environmental Concerns (scale 1-5)	Environmental Priority (scale 1-5)	Constructability (scale 1-3)	Ease of Operation (scale 1-3)	Area of Anticipated Growth (yes = 1; no = 0)	Implementation Score	Project Type	CSO Area? (Y or N)	Estimated Implementation Cost
BB-02	8 McKinley St.	Small pond constructed to managed runoff; erosion visible below the pond	The pond should be renovated to increase residence time and spillway improved; step-pool conveyance would be well suited for conveying flows down the slope below the pond	C/D	3	4	1	1	1	10	A	N	MH
BB-03	Hinkley St.	Retrofit opportunity	"Green Street" retrofit could take advantage of the fact that there are no curbs separating the road edge from the adjoining green space to manage road runoff	C/D	1	1	3	2	1	8	C	N	L
BB-04	Towne Hill Rd. & Main St.	Erosion evident in roadside drainage	Reshape and rock line existing drainage swale; add appropriately spaced check dams	C	3	3	2	2	1	11	C	N	M
BB-05	Easy St.	Significant erosion of both the road surface and in the adjacent roadside drainage	Roadway should be graded so water does not remain on the road surface (2-4% crown); reshape and rock line existing drainage swale; add appropriately spaced check dams	D	3	3	2	2	1	11	A	N	M
BB-07	Grandview Terrace	Grandview Terrace was put on a "road diet" when it was repaved in 2015 and the overall width reduced ~4 ft; erosion is occurring along the gravel road shoulders installed in areas formerly treatment with pavement	At a minimum, topsoil should be added to road shoulders in an effort to establish robust vegetation; mailboxes will need to be relocated to the pavement edge. A design detail should be developed for road shoulders on newly-narrowed streets	C	3	3	2	3	1	12	C	N	M
BB-08	28 Spring Hollow Rd.	Drainage was recently maintained, but not stabilized; ditch banks are over-steepened and ditch has V-shape	Reshape existing drainage swale and establish robust vegetation	C	2	3	1	2	1	9	A	N	L
BB-09a	Woodcrest Rd	Retrofit opportunity	Replace existing drainage swale with bioswale; establish robust vegetation	C	1	1	3	2	1	8	C	N	M
BB-09b	Woodcrest & Towne Hill Roads	Retrofit opportunity	Install bioretention treatment area at the north-east corner of intersection to capture road runoff	C	1	1	2	2	1	7	C	N	M
BB-10	438 Towne Hill Rd.	Erosion evident in roadside drainage	Reshape existing drainage swale and establish robust vegetation	C	2	2	2	2	1	9	D	N	L
BB-11	Dover & Phillips Roads	Sediment transport evident in roadside drainage along Dover Rd to the north of the intersection with Phillips Rd	Replace existing drainage swale with bioswale; establish robust vegetation	C	2	2	2	2	1	9	D	N	M
BB-12	Chestnut Hill Rd	The old concrete culvert to the east of 60 Chestnut Hill Rd appears to be undersized	Ultimately, the culvert should be replaced; in the interim a splash pad beneath the outfall would reduce localized erosion	D	2	2	3	2	0	9	D	N	L/MH
BB-13	Chestnut Hill Rd	Retrofit opportunity	Removing the curb along the east side of the street, below 135 Phillips Rd, would allow for a swale to be installed to manage stormwater runoff	D	2	1	3	2	0	8	C	N	M

Project Type "key":

A	Private property
B	State property or right-of-way
C	Public property (town-owned land or right-of-way)
D	Hybrid; part public land, part private land

Estimated Implementation Cost "key":

L	less than $20,000
M	$20-$50,000
MH	$50-$100,000
H	more than $100,000

9. Conceptual Solutions for High Priority Stormwater Problems and Opportunities

Initially, the prioritization of all of the identified problem areas and opportunities (Section 8) resulted in 22 of the identified problem areas being assigned an implementation score of 10 or higher. In consultation with City staff, this short list (Table 5) was narrowed to ten highest-priority projects, seven of which were advanced to concept design. In addition to the seven concept designs, three sites were chosen as models for illustrative concepts for integrating green stormwater management practices into other City infrastructure (such as roadways and parking lots) in the future (Section 9.1).

During this process, two potential opportunities (Northfield Street/Route 12 and Harrison Avenue) were added from the list of upcoming capital projects (Section 7.1.3). Other retrofit projects were ultimately assigned a lower priority because improvements are anticipated to be captured in other upcoming projects (for example, issues along Old Country Club Road will be managed as part of planned bike path improvements), or because roadway improvements have recently been completed (for example, along Bailey Avenue).

Table 5. Summary of Priority Stormwater Retrofit Projects and Opportunities

Site ID	Site Name	Project Type	Implementation Score >=10?	Priority Location?	Notes on Planned Improvements, if any
WR-04	National Life Dr. & Memorial Dr./Route 2	D	Y	Y	Nat. Life Drive is City street, Memorial Drive is VTrans. Potential future pedestrian crossing. Develop illustrative concept as case example of a centralized green infrastructure practice.
WR-06	Northfield St./Route 12	D	N	Y	Full-depth reconstruction planned – opportunity to incorporate green infrastructure
WR-08a	Old Country Club Road	C	Y		Will be addressed as part of bike path project
WR-08b	Old Country Club Road	C	Y		
WR-12	Wheelock Street	C	Y	Y	Consider including NEA inlet improvement
WR-15a	Bailey Ave.	C	Y		Road recently repaved, lower priority
WR-15b	Bailey Ave.	D	Y		
WR-16	Montpelier High School	C	Y		
WR-18	Hackamore Rd.	C	Y		Recently repaved
SB-01	Crossway Saab / Cody Chevrolet	D	Y		Ecosystem Restoration Program grant application submitted
SB-02	Moonlight Terrace	C	Y		
SB-04	A Quilter's Garden, Barre-Montpelier Rd.	A	Y		Partner with WNRCD? On private property.
NB-01	Parking lots west of Main St.	C	Y	Y	Illustrative concept as a case example for integrating green infrastructure in City parking lots

Site ID	Site Name	Project Type	Implementation Score >=10?	Priority Location?	Notes on Planned Improvements, if any
NB-02	Union Elementary School	C	Y		
NB-04	College & Marvin Streets	C	N	Y	Illustrative concept as a case example for integrating green infrastructure in City streets
NB-09	Hubbard Park road system	C	Y	Y	
NB-10	Gould Hill Road	C	Y		Submitted for repair using Better Roads funding
NB-11	Trillium Hill Road	A	Y		
NB-12	Hubbard Park 'frog pond'	C	Y	Y	Phase construction to be completed during or after improvements to Hubbard Park road system implemented
NB-14	Finch Street / 'stump dump'	C	Y	Y	
NB-16	Harrison Ave.	C	N	Y	
BB-02	8 McKinley Street	A	Y		
BB-04	Towne Hill Rd. & Main St.	C	Y		
BB-05	Easy St.	A	Y		
BB-07	Grandview Terrace	C	Y	Y	Use to present typical road shoulder restoration options for use in future repaving and 'road diet' projects

Ultimately, the three locations chosen for development of green stormwater management concept illustrations (Section 9.1) were:

- WR-04, National Life Drive & Memorial Drive
- NB-04, College and Marvin Streets
- NB-01, Parking lots west of Main Street

The seven opportunities advanced to concept design were (Appendix E):

- WR-06, Northfield Street / Route 12
- WR-12, Wheelock Street
- NB-09, Hubbard Park road system
- NB-12, Hubbard Park 'frog pond'
- NB-14, Finch Street / 'stump dump'
- NB-16, Harrison Avenue
- BB-07, Grandview Terrace

Green Stormwater Management Opportunities

The following section describes opportunities to incorporate green infrastructure systems into specific locations in Montpelier to reduce the volume and improve the quality of stormwater runoff. These opportunity sites have been identified through the master plan process and represent areas where runoff issues can be addressed through green stormwater practices. There are other opportunities in the city as well; these examples are intended to be illustrative of a range of stormwater management issues and opportunities for responses that incorporate green practices. For each site there is a summary of the existing conditions; an explanation of applicable green stormwater management practice(s) that would be appropriate in this location. An example of the practice is shown, using Vermont examples where possible, and a graphic illustration of existing conditions (current photo) and a rendering illustrating the applied stormwater practice. Examples of green stormwater management practices applicable in Montpelier are described below:

Gravel Wetland. Gravel wetlands are created wetlands that collect, store and infiltrate stormwater through treatment basins with subsurface gravel layers. Plantings associated with these projects are typically native grasses and woody plants and appear informal and natural.

Stormwater Planters. These are urban rain gardens with vertical walls and open or closed bottoms that collect and absorb runoff from sidewalks, parking lots, and streets. Planter boxes are ideal for space-limited sites in dense urban areas and as a streetscaping element.

Stormwater Swales. Stormwater swales are depressed graded linear landscape features that can be natural or created and are designed to detain, treat and infiltrate stormwater through both grading and absorbent soils. The planting character can be naturalistic, manicured or mowed grass.

Stormwater Curb Extensions. Stormwater curb extensions combine elements of curbing inlets, rain gardens, porous pavers, and stormwater planters to remove runoff from the roadside and provide improved stormwater management. Frequently they are combined with safer pedestrian walkways and crosswalks.

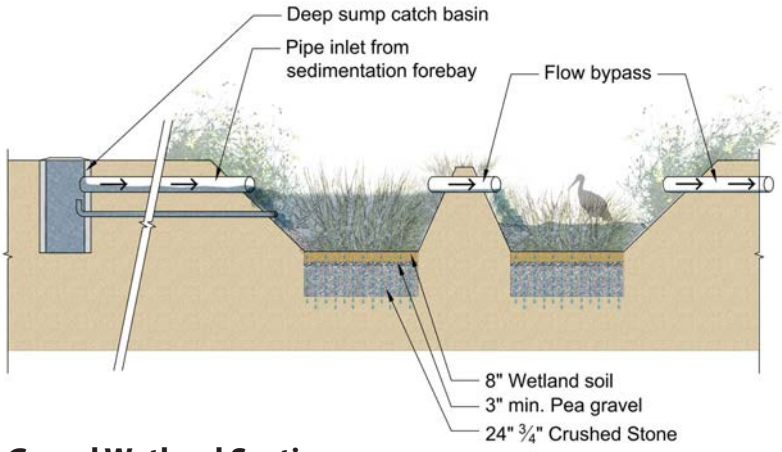
Permeable Paving. Permeable pavements are paved surfaces of concrete, asphalt or unit pavers with permeable pores or spaces that allow stormwater to infiltrate from the paved surface to a deep crushed stone subsurface bed where it is treated and stored. These pavements are particularly appropriate where there is limited landscape space, where land values are high and where flooding or icing is a problem.

Trees. Trees reduce and slow stormwater by intercepting precipitation in their leaves and branches and they absorb water through their root systems. Subsurface structures (such as tree root cells) provide for lightly compacted soil that stores stormwater and greatly improves street tree health. Coupled with porous pavers, these structures also allow for stormwater infiltration and treatment.

National Life - Gravel Wetland

Overview

A gravel wetland is a created landscape feature that is designed to mimic the look and function of a natural wetland. The constructed wetland captures stormwater and removes sediment and other pollutants through a system of vegetated treatment basins with subsurface gravel layers. In this system, stormwater flows into a forebay, where large objects are caught and large particles are allowed to settle. From the forebay, stormwater enters vegetated treatment basins where stormwater is retained and treated through filtration, uptake of pollutants by vegetation, and associated natural processes. This system is effective at reducing peak flows and improving water quality.



Gravel Wetland Section

Benefits

- Large treatment capacity
- Reduces peak flow
- Improves water quality
- Strong performance in cold climates
- Attractive landscape feature
- Low maintenance

Constraints

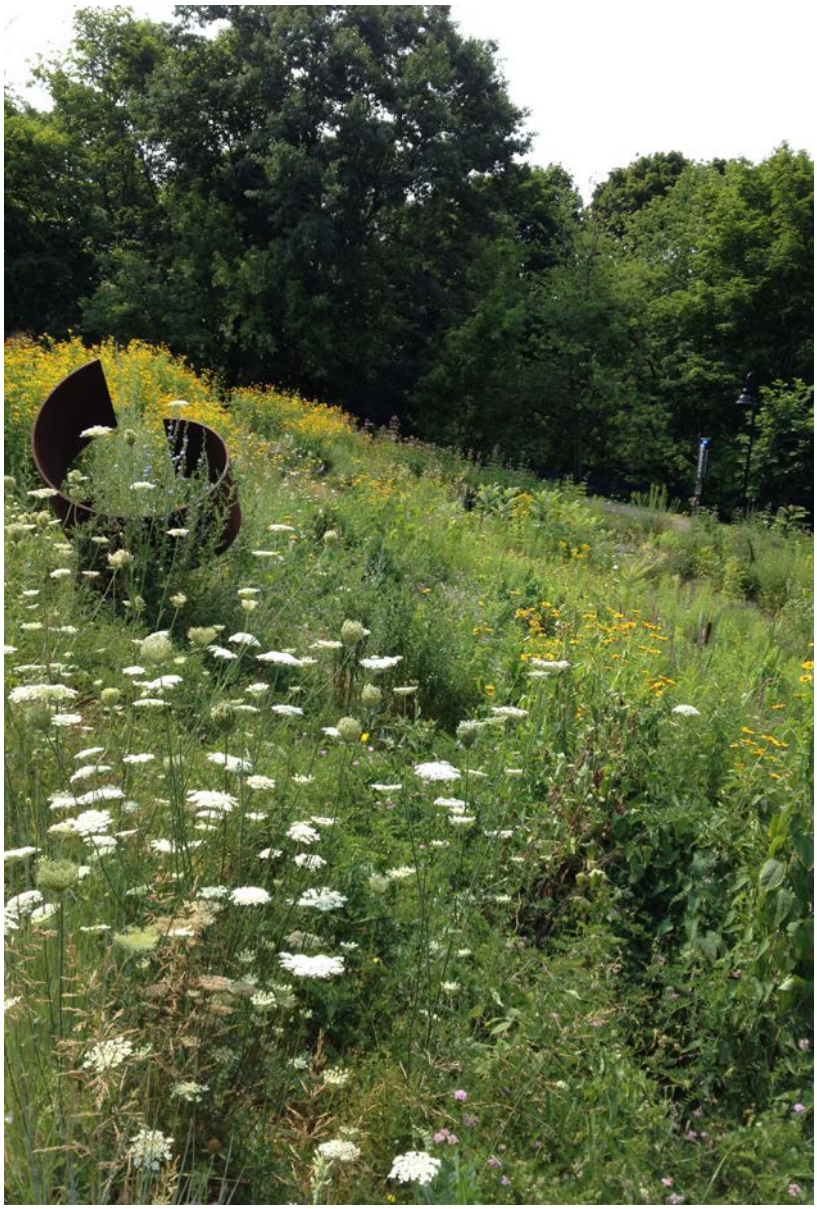
- Requires large area
- Plantings may extend into state highway (Memorial Drive) right-of-way

Maintenance Considerations

- Periodic landscape maintenance
- Periodic removal of trash and debris

Example

Created gravel wetland (right) at Champlain College, in Burlington. This wetland includes walking paths, interpretative signage and public art within a meadow of wildflowers and perennials.



Existing Condition

Currently stormwater from National Life Drive sheet flows into the landscaped area at National Life and Memorial Drive where it flows along a grassed swale and enters a piped drainage system and it is conveyed to the river and discharged via a culvert under Memorial Drive.

Gravel Wetland

The above rendering re-imagines this location with a created gravel wetland. A gravel wetland at this location could capture and infiltrate stormwater and improve the quality of water flowing to the river. The landscaping could add an attractive aesthetic to this gateway location.

College Street Stormwater Swales

Overview

Currently there is excess paved width in College Street which can be converted to landscaped stormwater swales. A stormwater swale is a shallow depression that accepts and infiltrates stormwater runoff. Stormwater is absorbed through the ground and by the landscaping. The swale can be enhanced with a sub-base of crushed stone to provide additional stormwater storage capacity and a perforated pipe under-drain can carry excess stormwater to existing storm drains. Landscaping associated with the swales also improves the aesthetics of the streetscape.

Benefits

- Requires less infrastructure to build
- Provides an attractive aesthetic to the street

Constraints

- Need to accommodate pedestrian circulation in areas with on-street parking.
- Soil conditions known to be high in silts and clays, facilities may require underdrain.
- Street narrowing to accommodate swales may require sharrows, possible conflict with Montpelier in Motion Plan?

Maintenance Considerations

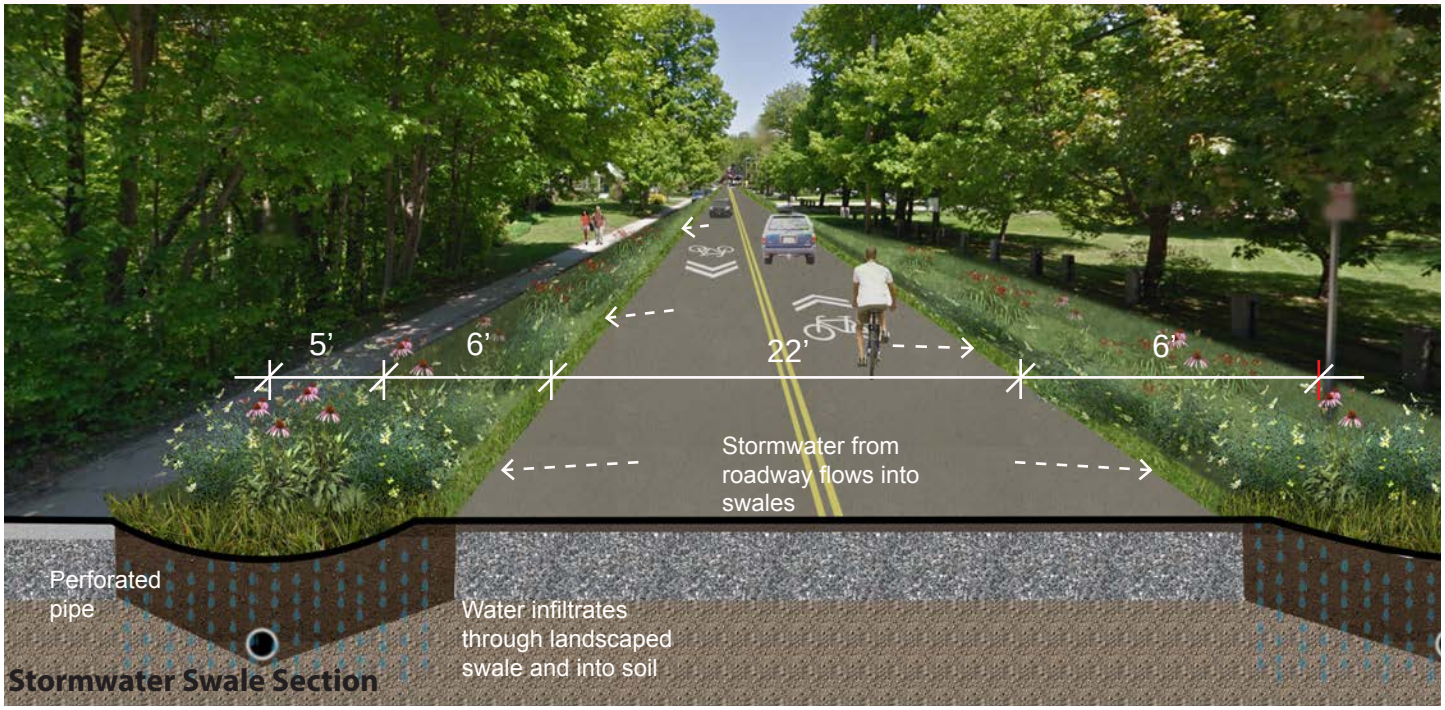
- Periodic landscape maintenance (mowing or dead-heading, removal of invasives)

Example

Landscaped stormwater swale in Portland, Oregon (below).

Existing Condition

Currently there is excess paved width in College Street which can be converted to landscaped stormwater swales. The existing street section includes a five foot sidewalk, a grass strip approximately three feet in width, and a 34-foot roadway. This street is designated as a ‘share-the-road’ street in the bicycle and pedestrian master plan.



Stormwater Swales

The above rendering re-imagines this location with a narrower paved street and stormwater swales on both sides of the street. The width of the street can be significantly reduced to two 11-foot travel lanes which would leave two six-foot stormwater swales on either side of the street. The lack of curbing on this street facilitates stormwater collection. The reduction in pavement and expansion of storage and infiltration area at the top of the hill would both decrease stormwater volumes and impacts downstream and improve water quality.

Heney-Jacobs Parking Lot - Stormwater Planters, Pervious Paving, Stormwater Drainage Well

Overview

Untreated stormwater from this parking lot sheet flows into the North Branch of the Winooski River. There are areas along the bank that are eroding due to the drainage. There are several possible 'green' tools to address stormwater management in this (and other) downtown parking lots. First, there are a couple of narrow landscaped islands which can be retrofitted as stormwater planters that accept and infiltrate stormwater. A new stormwater planter is added in one location where stormwater collects and drains into the river. Another opportunity would be to incorporate pervious paving which allows water to pass through the surface and infiltrate into the ground to reduce the volume of stormwater runoff from the parking area. There have been instances of failures of porous asphalt and concrete in Vermont, but unit pavers have been used successfully in parking areas. Periodic vacuuming of pervious surfaces is required to remove sediment that can clog infiltration pores. A third approach for this area is a subsurface well that collects stormwater and discharges it into surrounding stone storage media and/or soil through perforations in the well structure.

Benefits

- Reduces volume, controls erosion
- Provides an attractive landscape aesthetic to the area

Constraints

- Working around utilities in retrofit situation
- Potential loss of parking spaces

Maintenance Considerations

- Periodic landscape maintenance
- Periodic vacuuming of pervious paver system
- Snow storage and removal

Examples

Porous unit pavers in Burlington parking lot (left) and stormwater planter in White River Junction (right).

Existing Condition. The existing parking lot behind Main Street is a large paved area that drains into the North Branch of the Winooski River.

Pervious Paving and Stormwater Planters

The above rendering re-imagines this location with porous pavers beneath the parking stalls and the landscaped island converted to a stormwater planter.

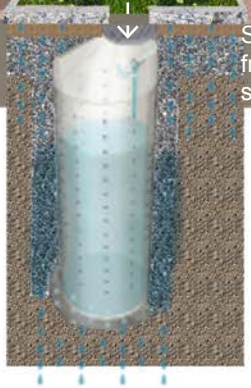
Existing Condition. The existing parking lot behind Main Street at the river's edge. The parking lot drains into the river and there is significant erosion at the low spot where the water drains into the river (see photos below).

Pervious Paving and Stormwater Planters. Paving beneath the parking stalls can be replaced with pervious pavers. The edge of the parking area can be curbed to prevent stormwater flow into the river. The parking space at the low point of the lot where water drainage is eroding the bank can be converted to a stormwater planter that collects and infiltrates stormwater.

Stormwater flows into the river from a low point in the parking area causing bank erosion and water quality problems.

Existing Condition. The existing parking lot behind Main Street at the river's edge.

Stormwater Drywell. A subsurface drainage well that collects stormwater and then discharges the water through perforations in the well to surrounding stone storage media and soils is another option here. Stormwater may enter the well from inlet structures or through pretreatment systems (e.g., stormwater planter as shown above). The drainage well provides a large volume storage facility within a relatively small footprint.



10. Funding Sources for Stormwater Management Improvements

10.1. Ecosystem Restoration Program Grant

Since 2008, Vermont DEC has made available competitive grant funding through its Ecosystem Restoration Program (ERP), now part of the Clean Water Initiative. These grants are typically available two times per year, in the spring and fall (see http://dec.vermont.gov/watershed/cwi/grants).

Previous ERP grant applications have indicated that a prioritized plan, such as Stormwater Master Plan, is a prerequisite for projects to be eligible for implementation funding. Thus, the City should be well-positioned with regard to obtaining additional ERP funding to support implementation. That said, discharges that are or could be regulated as point source discharges (e.g., projects addressing runoff from parcels with more than 3 acres of privately owned impervious cover) are unlikely to be a priority for ERP funding.

10.2. Lake Champlain Basin Program Grants

Since 1992, the Lake Champlain Basin Program has awarded nearly $6.5 million in local implementation grants. While the Basin Program offers a number of different local grant programs in most years, the two that are most pertinent to the implementation of this plan are:

- Pollution Prevention – to support technical projects which address LCBP's pollution prevention priorities, including urban stormwater management; and,
- Education & Outreach – for projects that increase awareness, knowledge, skills, and commitments to Lake Champlain issues.

LCBP has indicated that the next round of grant funding will likely be announced in late fall of 2016. Information on grant opportunities available through the Basin Program is available at http://www.lcbp.org/about-us/grants-rfps/.

10.3. Vermont Better Roads Grant Program

Through the Better Roads Program, the Vermont Agency of Transportation provides funding to support projects on municipal roads that improve water quality and result in maintenance cost savings. In 2017, paved roads became eligible for funding through the program for the first time. The program awards four types of grants:

- Road inventory and capital budget planning ("Category A");
- Correction of a road related erosion problem and/or stormwater mitigation retrofit for both gravel and paved roads ("Category B");
- Correction of a streambank or slope-related problem ("Category C"); and,

- Structure/culvert upgrades ("Category D").

The City of Montpelier received a Category A grant during the most recent funding cycle. Funding opportunities are typically announced in the late winter or early spring, and are available at: http://vtrans.vermont.gov/highway/better-roads.

10.4. Vermont Watershed Grants Program

Half of the proceeds derived from the sale of the Vermont Conservation License Plate go towards funding the Vermont Watershed Grants Program; the other half of proceeds go towards helping the Vermont Non-Game and Natural Heritage Program. The Watershed Grants Program distributes grant dollars for local and regional water-related projects within Vermont. Grant funds are available for water-related projects that:

- Protect or restore fish and wildlife habitats;
- Protect or restore water quality, and shorelines;
- Reduce phosphorus loading and/or sedimentation as part of DEC's Ecosystem Restoration Program objectives;
- Enhance recreational use and enjoyment;
- Identify and protect historic and cultural resources;
- Educate people about watershed resources; or
- Monitor fish and wildlife populations and/or water quality.

The total funding available through this program is significantly more limited than the other grant programs discussed above, making applications extremely competitive. More information on this grant opportunity is available at: http://dec.vermont.gov/watershed/cwi/grants/watershed-grants.

10.5. Clean Water State Revolving Fund (CWSRF)

Vermont's CWSRF Program provides low interest loans for clean water projects – including combined sewer overflow abatement and stormwater conveyance and/or treatment projects –to municipalities. Several types of loans are available covering the planning, design and construction project phases. The demand for CWSRF funding tends to outpace availability, so projects are ranked using criteria defined in the Vermont Environmental Protection Rules, Chapter 2. More information on the CWSRF loan program is available at: http://dec.vermont.gov/facilities-engineering/water-financing/cwsrf.

11. Next Steps

This document represents an extensive effort to identify and evaluate potential stormwater problem areas throughout the City of Montpelier. Several high priority potential stormwater improvement projects, including conceptual solutions, were identified in Section 8 that the City could pursue directly, or could work with partners to pursue funding to address.

Beyond addressing the specific problem areas identified in this plan, there are often opportunities to improve management of stormwater runoff that arise as part of routine municipal projects, such as the substantial reconstruction of a road surface or intersection. Grant funds may be available to cover the incremental cost of addressing stormwater runoff as part of such projects, if stormwater management is considered early enough in the design process. It is often significantly more cost-effective and efficient to incorporate stormwater management measures into a planned municipal project as compared to the construction of a "stand alone" stormwater management retrofit. The Harrison Avenue and Northfield Street retrofit concepts described in Section 8 are prime examples of how to take strategic advantage of such opportunities.

In addition to exploring opportunities to address current stormwater management needs, the City of Montpelier can take steps to prevent future stormwater problems by expanding how stormwater management is addressed in zoning regulations. The current draft of the Land Development Regulations (Section 3009, Stormwater Management) includes strong but sensibly tiered requirements for incorporating low-impact development (LID) concepts and green stormwater infrastructure (GSI) practices into future development projects where those projects will not trigger state requirements. As drafted, the stormwater management requirements in the proposed Land Development Regulations are likely to largely offset any potential stormwater impacts from future sub-jurisdictional new development and redevelopment activities. The proposed language also represents a substantial change from current requirements, which are primarily concerned with safe conveyance of runoff into the City's closed drainage systems. This section has been flagged by the Planning Commission for independent expert review, which we also recommend to ensure that the proposed regulation meets the City's needs and goals with regard to water quality and flood resilience as efficiently as possible and without placing an undue burden on future applicants and review boards.

12. References

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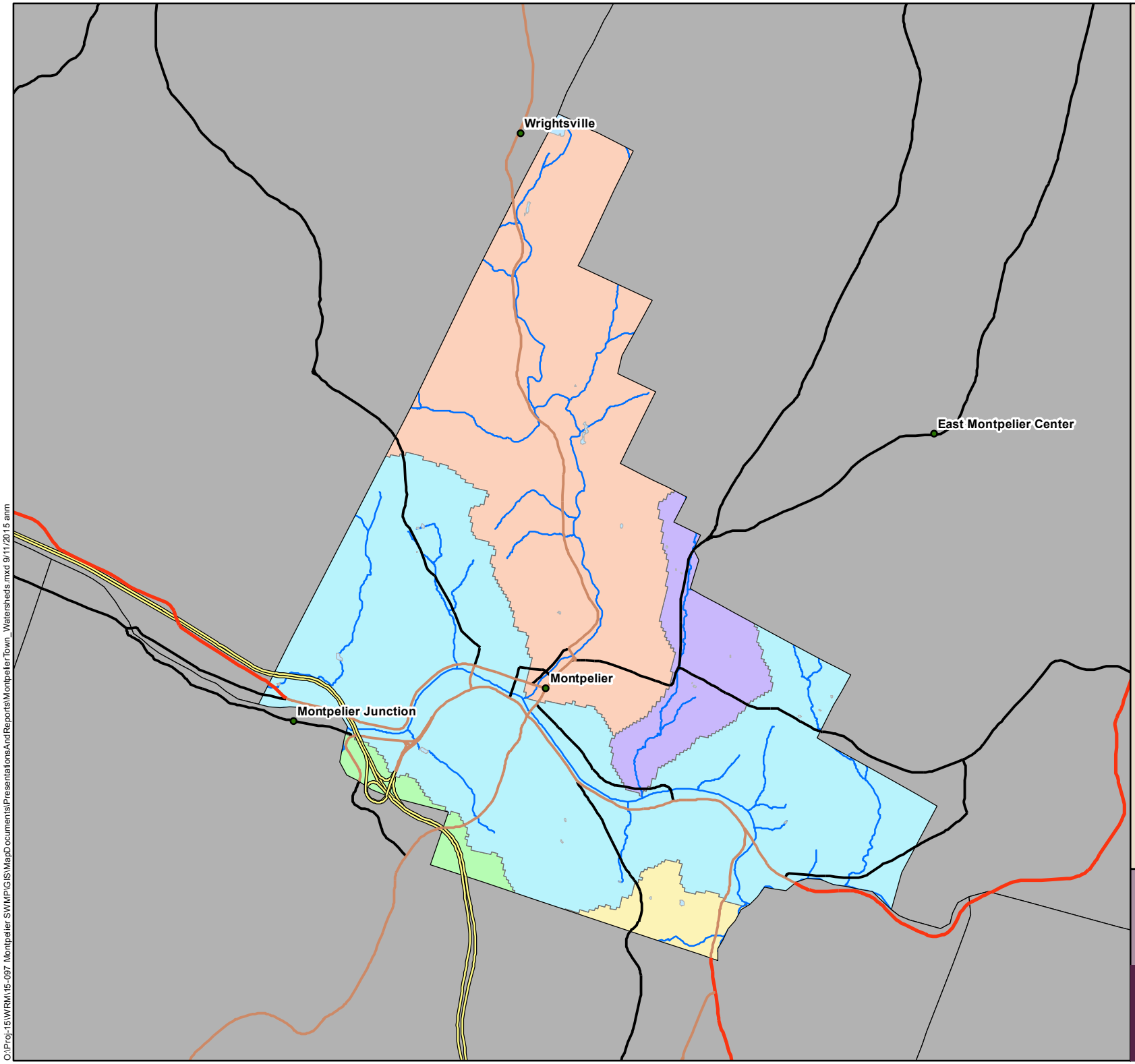
Appendix A. Maps



N

0 0.4 0.8 Miles

River or Stream

Montpelier Watersheds

- Blanchard Brook
- Dog River
- North Branch Winooski River
- Stevens Branch Winooski River
- Winooski River

Sources: Watershed Boundaries: NHD Plus 2; Administrative Boundaries, Roads: VCGI.

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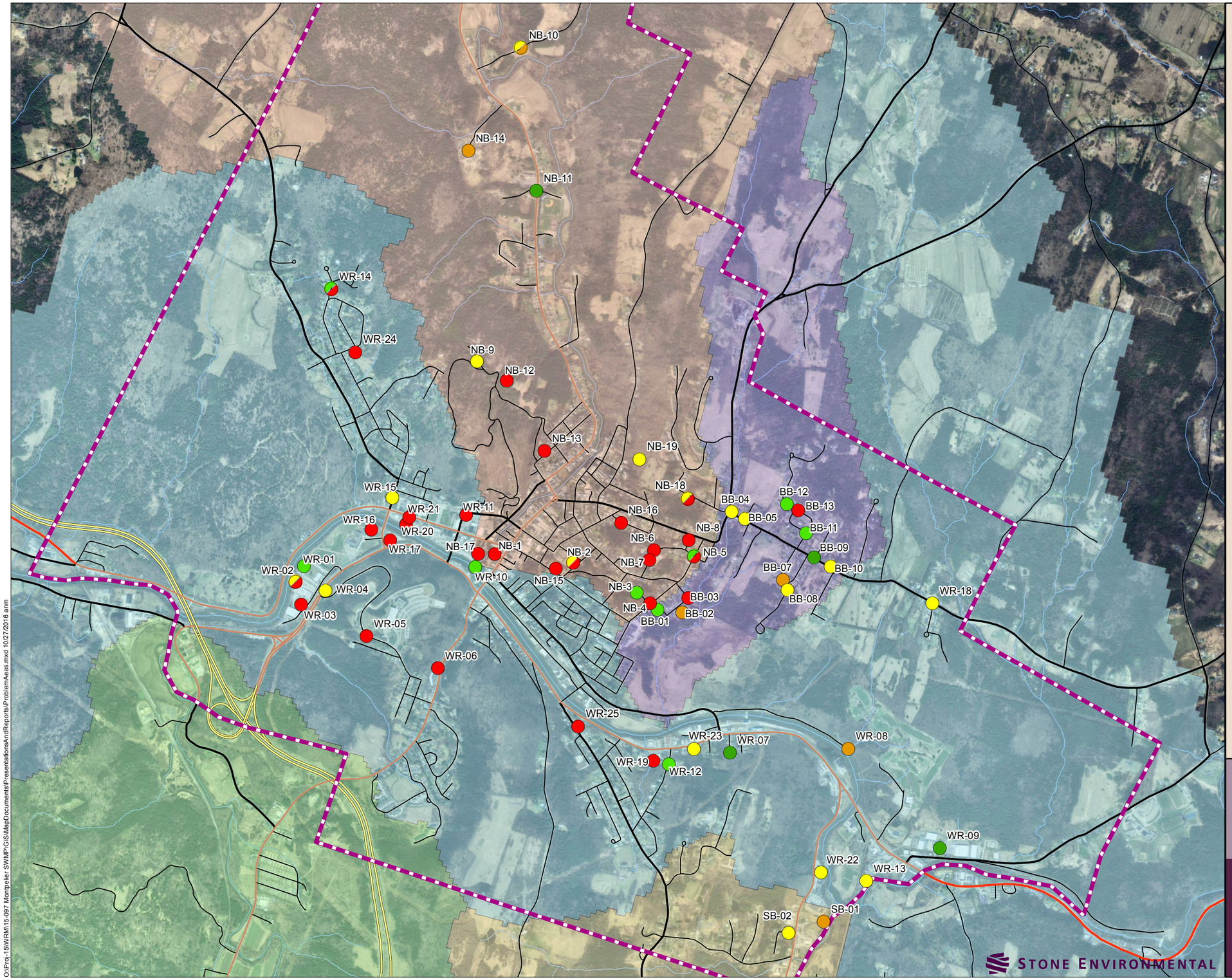
Watershed Boundaries

Figure 1

City of Montpelier Stormwater Master Planning

O:\Proj-15\WRM\15-097 Montpelier SWMP\GIS\MapDocuments\PresentationsAndReports\MontpelierTown_Watersheds.mxd 9/11/2015 anm



O:\Proj-15WRM\15-097 Montpelier SWMP\GIS\MapDocuments\PresentationsAndReports\ProblemAreas.mxd 10/27/2016 anm

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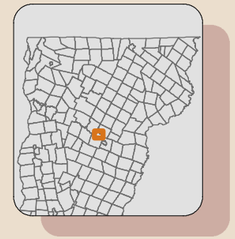


Legend

Problem Area Classification

1	6
2	1,4
3	3,6
4	4,5
5	4,6

City Boundary

Montpelier Watersheds

- Blanchard Brook
- Dog River
- North Branch Winooski River
- Stevens Branch Winooski River
- Winooski River

Level	Classification
1	Infeasible to remedy issue/ outside of project scope
2	Stable, but problem could escalate with future change in surrounding landuse
3	Limited erosion and/or drainage problems are present
4	Moderate erosion and/or drainage problems are present
5	Significant erosion and/or drainage problems are present
6	Strategic retrofit opportunity

0 0.275 0.55 Miles

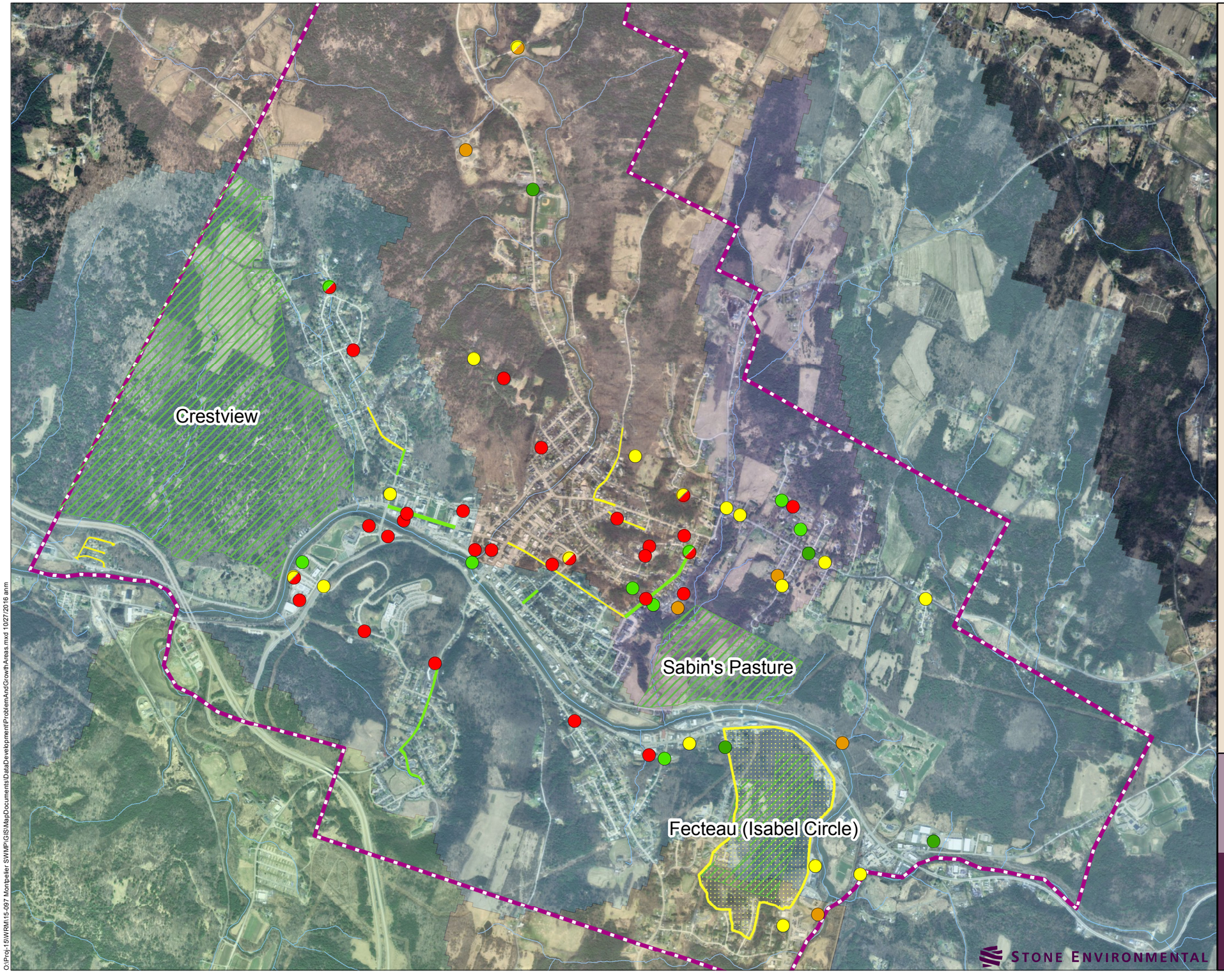
Stormwater treatment opportunities in Montpelier, ranked according to severity of erosion and type.

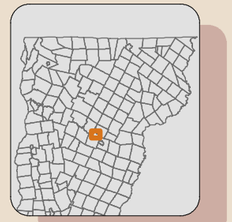
Sources: Treatment Sites: Stone Environmental Inc
Hydrography, Town Boundaries, Roads: VCGI

Stormwater Problem Area Locations

Figure 2

Montpelier Stormwater Master Planning





Legend

City Boundary

Growth Area Type

- Future Growth Areas
- Potential Drainage Areas

Planned Roadway Projects

- Repaving and sidewalk work
- Full-depth reconstruction

Problem Area Classification

1	6
2	1,4
3	3,6
4	4,5
5	4,6

Montpelier Watersheds

- Blanchard Brook
- Dog River
- North Branch Winooski River
- Stevens Branch Winooski River
- Winooski River

Level	Classification
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5	Significant erosion and/or drainage problems are present
6	Strategic retrofit opportunity

0 0.275 0.55 Miles

Stormwater treatment opportunities in Montpelier, ranked according to severity of erosion and type.

Future areas of potential concentrated development and planned roadway projects as identified by City staff.

Sources: Treatment Sites: Stone Environmental Inc
Hydrography, Town Boundaries, Roads: VCGI

Future Growth Areas and Planned Roadway Projects with Current Problem Area Locations

Figure 3

Montpelier Stormwater Master Planning

O:\Proj-15\WRM\15-097 Montpelier SWMP\GIS\MapDocuments\DataDevelopment\ProblemAndGrowthAreas.mxd 10/27/2016 anm

Appendix B. Stormwater Management Planning Library

FINAL

STORMWATER MASTER PLAN, REVIEW OF EXISTING PLANS AND DATA

CITY OF MONTPELIER

October 2015, updated September 2016

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STONE ENVIRONMENTAL INC

Table of Contents

1. BACKGROUND

Water has no political boundaries, and so evaluations of water quality tend to be undertaken along watershed boundaries and to involve land areas in multiple municipalities, counties, and, in the case of the Lake Champlain, countries. Although from a strict water quality perspective it would be ideal to manage water resources along watershed lines, the reality is that many decisions, in particular decisions about land use, are made at the local level. This report is designed to summarize the information currently available from the suite of reports that speak to water quality in the various ponds and streams that pass through or are located wholly within the City of Montpelier, Vermont. Although water quality assessment data dating back to the early 1970s is available for the Lake Champlain watershed, this summary focuses on assessments and reports that have been prepared in the past twenty years.

Relevant GIS-based data for the project area, including soils, topography, receiving waters, land use, impervious cover, and stormwater infrastructure are catalogued in this technical memorandum. In addition, information from plans, models, and other available reports related to the condition of City's watersheds and surface waters, as well as municipal ordinances directly or indirectly related to stormwater management, are summarized. This work will serve as the foundation for developing a Montpelier-specific "master plan" for stormwater management.

2. INTRODUCTION

The City of Montpelier is located in Washington County in central Vermont. The City has a total area of 10.3 square miles[1]. As of the 2010 census, the population of the town was 7,855.[2] The Winooski River runs through the heart of downtown Montpelier, and confluences with three significant waterways within the City boundaries: the Dog River, the North Branch, and the Stevens Branch (see Map 1). In addition, there are a number of smaller drainages in the City including, most notably, Blanchard Brook.

Numerous and varied groups and individuals have invested considerable effort in evaluating different components of Montpelier's water, wastewater, and stormwater infrastructure; water resources; and the important interface between water resources and local land use decisions. At times these evaluations followed watershed boundaries, and at other times they have followed political boundaries. The following sections identify these evaluations and highlight information most relevant to Montpelier and most relevant to developing a list of strategic, prioritized projects that could be undertaken to improve water quality and increase resilience to future flooding.

3. WATERSHED-BASED ASSESSMENTS

The ongoing assessments described below are generally led by the State of Vermont's Agency of Natural Resources (ANR). These include:

[1] 2015 Wikipedia, https://en.wikipedia.org/wiki/Montpelier,_Vermont

[2] 2010 US Census data, http://www.census.gov/2010census/popmap/

- Basin planning efforts, whose main purpose is to guide ANR in its own work and in collaborative projects with the public, municipalities, and other state and federal agencies. The basin plans have a five-year scope. The City of Montpelier is located in the Winooski River Basin (Basin #8), where a final plan was approved in May 2012 by the Agency of Natural Resources.
- Stream geomorphic assessment work, undertaken to understand the natural tendencies of a particular reach of stream or river, its current condition, and what changes may be anticipated in the future. To date, stream geomorphic assessments have been completed for the Dog River, the Stevens Branch, the North Branch, and the mainstem of the Winooski River in Montpelier.
- In-stream water quality assessment work, including water chemistry and biological assessments.

3.1. Winooski River Basin Water Quality Management Plan [3]

The Winooski River Basin Water Quality Management Plan, most recently revised in May 2012, provides an overview of the Winooski River Basin's surface waters and a description of ongoing and future steps to restore and protect those waters. Utilizing recommendations from a broad array of stakeholders, the Plan summarizes strategies and specific actions to guide efforts to sustain and improve water quality and aquatic habitat over the next five years.

Key strategies with implications for Montpelier include the following:

- Working with towns to protect river corridors and promote flood resiliency by establishing Fluvial Erosion Hazard zones and buffer zones in local zoning.
- Encouraging use of rivers and lakes in the basin to increase people's appreciation.
- Assisting towns to address aging wastewater treatment facilities and associated sewer pipes through the Clean Water State Revolving Fund (CWSRF) and other funding programs.
    - The Plan specifically notes that VT DEC will continue to work with the City to eliminate combined sewer overflows (CSOs).

A specific action called out in the Plan is:

- Assisting Montpelier in using recently completed town tree canopy maps to implement Green Infrastructure practices.

3.2. Stream Geomorphic Assessment Final Reports[4]

Stream geomorphic assessments have been completed for the mainstem of the Winooski River in Montpelier, as well as the North Branch, and the reaches of both the Stevens Branch and Dog River where they confluence with the Winooski. The assessment results are designed to direct future stream corridor restoration and protection measures. The nature of each section of the watershed is characterized and each reach described. Potential restoration projects identified during this work with ties to stormwater management and/or high flows are listed and briefly described below by stream and stream reach.

[3] http://www.watershedmanagement.vt.gov/mapp/docs/mp_basin8final.pdf

[4] https://anrweb.vt.gov/DEC/SGA/finalReports.aspx

3.2.1. Dog River Corridor Plan[5]

Only Segment M01-A of the Dog River is within the City of Montpelier. This segment begins at the confluence of the Dog River and the Winooski River near Junction Road on the Berlin-Montpelier town line and continues upstream to just below the Nelson Drive bridge. There are no specific measures identified for this segment, but the River Corridor Plan notes:

- The importance of defining Fluvial Erosion Hazard Zones for the Dog River; and,
- Improving stormwater management and construction practices in the Dog River watershed would reduce siltation of critical aquatic habitat and improve geomorphic stability.

3.2.2. North Branch Corridor Plan[6]

Segments M01 – M05 of the North Branch are within the City of Montpelier. There are a number of opportunities identified for restoring and protecting riparian areas along the North Branch; however, the majority of this work would take place on private property. In addition, the Corridor Plan noted that the high number of stormwater inputs on Segments M01 and M02 (from the confluence with the Winooski to the Mountaineers ball field) was adversely impacting the river. The following, specific opportunity was also identified:

- Replace Undersized Structure - Cummings Street bridge currently undersized (width = 80% of bankfull). Some erosion noted near abutments.

This structure is currently scheduled for replacement in 2016, with a final design under development at VTrans. The bridge clear span will be widened by 22’ (from 59’ to 81’), and although the replacement crossing will still be slightly narrower than the rest of the channel, the significant “pinch point” that currently exists will be largely mitigated by this project.

3.2.3. Stevens Branch Watershed River Corridor Management Plan[7]

The portions of the Stevens Branch assessed as part of the River Corridor Management Plan are well upstream of the City of Montpelier, and therefore the Plan does not offer any specific insights relevant to this stormwater management plan

3.2.4. Upper Winooski River: Plainfield to Montpelier, River Corridor Management Plan[8]

The Upper Winooski Corridor plan identifies a number of watershed-scale strategies that would benefit the Upper Winooski River including:

- The establishment and maintenance of riparian forests along the entire river corridor.

[5] https://anrweb.vt.gov/DEC/SGA/report.aspx?rpid=155_CPA&option=download

[6] https://anrweb.vt.gov/DEC/SGA/report.aspx?rpid=82_CPA&option=download

[7] https://anrweb.vt.gov/DEC/SGA/report.aspx?rpid=152_CPA&option=download

[8] https://anrweb.vt.gov/DEC/SGA/report.aspx?rpid=32_CPB&option=download

- On-site stormwater management retrofitting for all existing residential and commercial building sites, and implementation of low-impact design (LID) techniques for all future development.
- Replacing and/or retrofitting undersized bridges and culverts and ensuring all new structures are sized for geomorphic stability as well as habitat connectivity along the river corridor.
- Practicing soil conservation and erosion control practices (AMPs and BMPs) on all agricultural land, logging operations, construction areas, and other sites where soil is disturbed.
- Floodplain and river corridor planning and protection (such as adoption of Fluvial Erosion Hazard zones, stream setbacks, wetland regulations, etc.) to eliminate future floodplain encroachment.
- Development of an ecosystem services analysis of the Upper Winooski River and development of mechanisms (i.e. social, market, regulatory) that will allow these services to be appropriately valued and recognized by the watershed community.

In addition, the Corridor Plan highlights the importance of river corridor protection and restoration along reach M18, within the City of Montpelier.

3.3. LaRosa Volunteer Data[9,10] (2007 – 2015)

In 2010, the Friends of the Winooski River formed the Four Rivers Partnership to monitor water quality in the mainstem of the Winooski River and a number its tributaries in the Barre-Montpelier area, including six sites within the City of Montpelier. The Four Rivers Partnership extends a water quality monitoring effort that started in the headwaters of the Winooski in 2007. The sites are sampled for *E. coli*, chloride, total phosphorus, and turbidity levels. All sample results are available online at the sources listed below.

The geometric mean of *E. coli* measurements collected by the Friends at all Montpelier stations are generally elevated. Further, the geometric mean for 2014, the most recent year which data is available, was generally higher than in other years at most sites. The total phosphorus concentrations recorded at several sites were at or greater than the VT standard for medium gradient, cold water streams (15 ug/L), including all three sites on the mainstem of the Winooski within City limits. Mean chloride concentrations were well below the Vermont "chronic" standard for average chloride of 230 mg/L. All of the individual samples taken at these sites had chloride levels below the VT "acute" maximum allowable concentration standard for chloride of 580 mg/L.

While land uses and management practices in Montpelier are likely contributing to the water quality impacts observed in the Winooski River, those impacts begin well upstream of the City and cannot not be treated or solved entirely within the City's boundaries. For instance, similar patterns of elevated *E. coli* occur in the Winooski mainstem far up in the watershed (upstream of the Cabot WWTP). Further, while total phosphorus concentrations in the Winooski mainstem in Montpelier were above the VT standard for medium gradient cold water streams in 2014, total phosphorus concentrations in the headwaters portion of the Winooski near Martin Bridge in Marshfield average 14 ug/L, only slightly below the standard.

[9] http://www.winooskiriver.org/water-quality.php

[10] http://www.vtwaterquality.org/cfm/larosavm/mp_larosavolmon.cfm

4. MUNICIPALITY-SPECIFIC ASSESSMENTS

In addition to the watershed-based assessments, a number of assessments and datasets are developed on a municipality-by-municipality basis. These are important to fold into any effort to develop a list of strategic, prioritized projects that could be undertaken to improve water quality in and around Montpelier. These include direct input from the City, work by the Vermont Agency of Transportation, and past and current planning initiatives.

4.1. City Input

In meetings with Stone Environmental, City Public Works officials identified more than 20 areas of concern and priority projects throughout Montpelier, many of which are areas that sustained damage during the May 2011 flood event. The City has implemented a significant number of corrective measures and controls in many of the most impacted areas over the past four years; these projects will also be reviewed during the field evaluation. See Figure 2 for a map of concern areas and priority projects.

4.2. Vermont Agency of Transportation-Sponsored Programs

4.2.1. Vermont Online Bridge and Culvert Inventory Data[11]

Vermont has 2,699 long structures (bridges and culverts) greater than 20 feet on interstate, state, and town routes and another 1,276 short structures between 6 and 20 feet on the state system that the state Agency of Transportation (VTrans) inspects. Inspections are conducted every 24 months on long structures and every 60 months on short structures unless conditions warrant more frequent inspections. Data collected as part of these inspections can help identify not only bridges and culverts with structural deficiencies but also structures that may be adversely impacting water quality. The system contains information for one bridge in Montpelier (on Towne Hill Road), and 267 culverts. The City has noted that this dataset is known to be incomplete. Of the mapped culverts in Montpelier, 49 are identified as being in "Fair" or "Poor" overall condition, meaning that when last assessed, the culverts were 25-50% open, or had existing or developing deficiencies (Map 2). No culverts were identified as being in "critical" or "urgent" overall condition. Montpelier's entries in the bridge and culvert inventory were last updated in October 2007 – well before the May 2011 storm or Tropical Storm Irene.

4.2.2. Stream Geomorphic Assessment, Failure Modes Data[12]

Failure Modes- Problems and Causes

This document records the failure modes of select bridges and culverts. The tables provide a structure number and a road name for the structure. There is information for 12 structures within the City of Montpelier on the North Branch, and an additional 9 structures on the mainstem of the Winooski. Typical problems associated

[11] https://www.vtculverts.org/

[12] https://anrweb.vt.gov/DEC/SGA/datasets/structures/reports.aspx?did=81

with structures within the City include damage due to erosion of adjacent property, poor structure location or alignment, inlet obstructions, and, along the North Branch, beaver activity.

4.2.3. Better Roads Program[13]

The Better Roads (formerly Better Backroads) Program helps fund work on gravel roads to alleviate erosion issues and improve water quality, using grants to municipalities, under the leadership of VTrans and VANR. In 2013, in response to federal funding requirements and program needs, VTrans and VANR made a variety of changes to this program, including use of state (rather than federal) funding, and movement of administrative and technical assistance from the Northern Vermont Resource Conservation and Development Council to VTrans.

The Vermont Local Roads Program[14], sponsored by the Vermont Agency of Transportation (VTrans) and the Federal Highway Administration (FHWA), provides information, training and technical assistance to cities, towns and villages in Vermont. This is done through seminars and workshops, distribution of materials and technical assistance to fulfill service requests. The administration and technical assistance offered through this program will be transitioned from St. Michael's College to VTrans.

The City of Montpelier was awarded a grant from the Better Backroads Program in 2006 to address erosion issues along Hubbard Park Road, and received a grant in 2016 to support road inventory and capital budget planning.

4.3. Vermont DEC Clean Water Initiative Program

4.3.1. Stormwater Mapping and Illicit Discharge Detection and Elimination Program

In 2000, the Vermont Legislature required DEC to implement a statewide program to promote detection and elimination of improper or illegal connections and discharges. (Sec. 3. 10 V.S.A. § 1264 (b)(9)). Illicit discharges are discharges of wastewater or industrial process water into a stormwater only drainage system. As part of this work, DEC has developed GIS (Geographic Information System) stormwater drainage maps for approximately ninety communities – including Montpelier.

Maps for Montpelier were completed during summer 2015 and show the connectedness of stormwater infrastructure throughout the City, including information on yard drains and driveway culverts where available. This information is useful in augmenting the more limited data on culverts that is currently available through the Vermont Online Bridge and Culvert Inventory, described in Section 4.2.1.

Efforts to identify and eliminate potential illicit discharges in Montpelier began in 2001, with a follow-on effort complete in 2009. Further work is taking place during the 2016 field season and, given the size of the City, it is likely that Montpelier will need to make an on-going commitment to monitoring for illicit discharges.

[13] http://vtransengineering.vermont.gov/sections/environmental/betterbackroads

[14] http://vermontlocalroads.org/

4.3.2. Ecosystem Restoration Projects[15]

Beyond the stormwater mapping and stream geomorphic assessment work discussed in Sections 4.3.1 and 3.2, respectively, the Ecosystem Restoration Program (ERP) has provided funding to the City to incorporate green stormwater infrastructure into the on-going Taylor Street redevelopment and Multitransit Center construction.

4.4. Vermont DEC Stormwater Permitting Program

4.4.1. State Stormwater Permits

Currently, Vermont DEC requires that a stormwater permit be obtained when any construction, new development, or redevelopment results in impervious or disturbed area equal to or greater than one acre, with stricter requirements in watersheds that are classified as stormwater impaired. The State has developed a suite of technical standards for stormwater-related mitigation that are outlined in the Vermont Storm Water Management Manual, Volumes I and II. For example, the goal of a stormwater management program during construction is to mitigate sediment loss during storm events—while during and after construction, the objective is to maintain as much of the pre-developed hydrology as possible. The State is currently in the process of revising its Storm Water Management Manual, and has indicated that it expects to release a draft manual for public comment in late 2015.

4.4.2. Environmental Research Tool[16]

ANR's Environmental Research Tool allows the user to look up the location of stormwater permits that have been issued by ANR, as well as hazardous waste sites, brownfields, and spills. There are 18 post-construction stormwater permits that have been issued to sites in Montpelier accessible through the tool. Most of the issued permits are up-to-date (they have not expired), though in several instances, annual or semi-annual inspections may not have been regularly completed or submitted to ANR. The age, style, size, and upkeep of an existing permitted facility – particularly facilities constructed prior to 2002 – may make it a strong candidate for improvement to enhance stormwater management capabilities.

Permit no.	Site name	Expiration Date	Restatement of Compliance Due Date
4820-9010	384 River Street	07/26/17	07/29/13
7196-9015	Capital Complex Additional Parking	01/13/25	07/15/18
6679-INDS	Community Colleges of Vermont Montpelier Academic Facility	09/28/16	07/15/12
1-1099.XXXX	Crestview Estates	09/30/97	N/A - expired
3146-9015.1	Distribution Center & Dry Storage Warehouse	09/05/24	07/15/15
3229-9010.R	Montpelier Capital Complex	02/08/21	02/08/16
3261-9010.R	Montpelier Public Works Garage	12/09/20	05/05/15

[15] http://www.vtwaterquality.org/erp/projects/

[16] https://anrweb.vt.gov/DEC/ERT/StormWater.aspx

3594-INDS	Montpelier-Berlin Pathway	09/05/19	07/15/15
3205-9010.R	Murray Hill Development	01/18/21	01/18/16
3206-9015.1	Murray Hill Development	09/21/17	06/01/12
3405-9015	National Life Insurance Company Office Building	02/03/21	07/15/14
3239-9010.R	North Park Drive	02/24/21	07/15/13
3492-9010.R	Sherwood Forest Condominium Development	10/06/20	07/15/12
4036-9010.R	State Street Improvements M 6400 17 S	03/22/21	07/15/13
4216-9015	The Family Center	12/15/08	N/A - expired
3248-9010.R	Third Greaves Farm Condominiums	09/14/20	07/15/13
4257-9015	Tractor Supply Company Store	07/24/16	07/15/14
5596-9010	Westview Meadows	08/04/18	07/15/16

4.5. City of Montpelier Code of Ordinances[17]

The City of Montpelier's Code of Ordinances was most recently updated in 2012. There are two key sections of the Code that relate to stormwater management: Natural Resources (Chapter 13); and Zoning Regulations (Chapter 15).

The Natural Resources chapter has an article specific to river and streams, which includes two conditions: one prohibiting encroachment upon the "bed of the North Branch or of the Winooski River within the city", and a second that prohibits placement of "rubbish or waste material of any kind" on the banks of either river.

The Zoning Regulations contain sections dedicated to Floodplain Development (Section 309) and Storm Drainage (Section 723), both of which have ties to this project. The City is currently engaged in an effort to substantially overhaul its Zoning Regulations. It will be important to ensure that recommendations stemming from the development of this stormwater master plan can be easily integrated into this larger framework. As part of the overhaul, the City anticipates that a stand-alone chapter on River Hazard Areas – which will include both river corridors and flood hazard areas – will be added to the Zoning Regulations.

Section 309 details the review of and permitting process that applies to any development project proposed for within the special flood hazard area. The City has adopted a Floodplain District overlay zone that imposes additional requirements above those required by the underlying zoning district, as required by the National Flood Insurance Program.

Section 723 provides the Director of Public Works with significant discretion to require stormwater management practices. This section states that "The best available technology shall be used to minimize stormwater runoff, increase on-site infiltration, encourage natural filtration functions, simulate natural drainage systems, and minimize discharge of pollutants to ground and surface water. Best available technology may include measures such as retention basins, recharge trenches, swales and minimal use of impervious surfaces." This language provides a strong foundation for future stormwater management efforts, and would be strengthened by incorporating an explicit performance standard – such as managing the first inch of rainfall –

[17] http://www.montpelier-vt.org/community/206/Ordinances.html

that minimizing stormwater runoff could be measured against. Part 3 of the proposed draft Montpelier Unified Development Regulations[18] does add requirements for implementing low-impact development and green stormwater infrastructure in new and redevelopment situations, including but not limited to management of "one inch of rainfall from all impervious surfaces on the lot". The draft Development Regulations do not make a distinction between areas served by combined and separate storm sewer systems.

4.6. Montpelier Flood Hazard Mitigation Plan[19]

In 1998, the City developed a Flood Hazard Mitigation Plan. The stated purpose of the Plan is to assess the flood risks which confront the City and to articulate a comprehensive strategy for implementing technically feasible flood mitigation activities. This plan specifically notes:

- The Montpelier reach of the Winooski River offers very limited environmental habitat or species diversity, due to urban degradation and the encroachment of development into the stream bed zone.
- The area can be characterized as having thin to nonexistent riparian zones (and therefore extremely limited flora or fauna) with a stream bed that is generally wide and shallow, and which is dominated by shifting sands and gravels (providing poor aquatic habitat).
- The Winooski and North Branch Rivers do serve as an amenity to the City and to visitors. Existing recreational paths along sections of the river provide passive recreation and aesthetics, while more paths are being planned. Current in-stream recreational use is limited to fishing and minor canoe activity.
- The 100 year flood plain encompasses 478.6 acres or 7.2% of the entire city. Nearly 27% of the city's individual properties are at least partially within the flood plain, and 21.5% of all of the city's structures are located within the flood plain.

The report contains a number of recommendations, many of which are related to the management of ice jams. Recommendations that merit further consideration as part of the development of the stormwater master plan include:

- Encouraging the preservation of existing open space in the floodplain. Approximately 25 acres of open space existed in the floodplain at the time the report was prepared (1998) which was made-up mostly of the Elm Street Recreation Field, Green Mountain Cemetery, Montpelier High School playing fields, and the Statehouse lawn.
- Seeking alternate locations for snow dumping and storage. The report notes that the City's Code of Ordinances (Chapter 3, Article V) prohibits the placement of snow from private property in the public way.

Recently, the City has voluntarily eliminated snow storage along Old Country Club Road; the City continues to evaluate options for improving snow handling and disposal.

[18] http://www.placesense.com/current/montpelier

[19] http://www.montpelier-vt.org/upload/groups/128/files/FloodPlan1998.pdf

4.7. Enhancing our River Environment: A Proposed Plan for the Management of the Winooski Riverbank Vegetation in Montpelier[20]

This plan, developed in 2002, has several stated goals. These include: 1) enhancing the beauty of the river corridor; 2) stabilizing the Winooski's banks with vegetation to mitigate erosion; 3) identifying areas where selection of species of planted trees and shrubs corresponds with the type of soil present; and 4) taking advantage of small pockets of open space to be used for public enjoyment. The report makes specific planting and vegetation management recommendations for various segments of the mainstem of the Winooski as it flows through Montpelier. The implementation of the plan was envisioned to be primarily a volunteer effort to be carried out by the Tree Board, Conservation Commission, and Friends of the Winooski River, with assistance from the Conservation District, City Tree Warden, Cemetery Commission, Public Works Department, state agencies, and riverbank property owners.

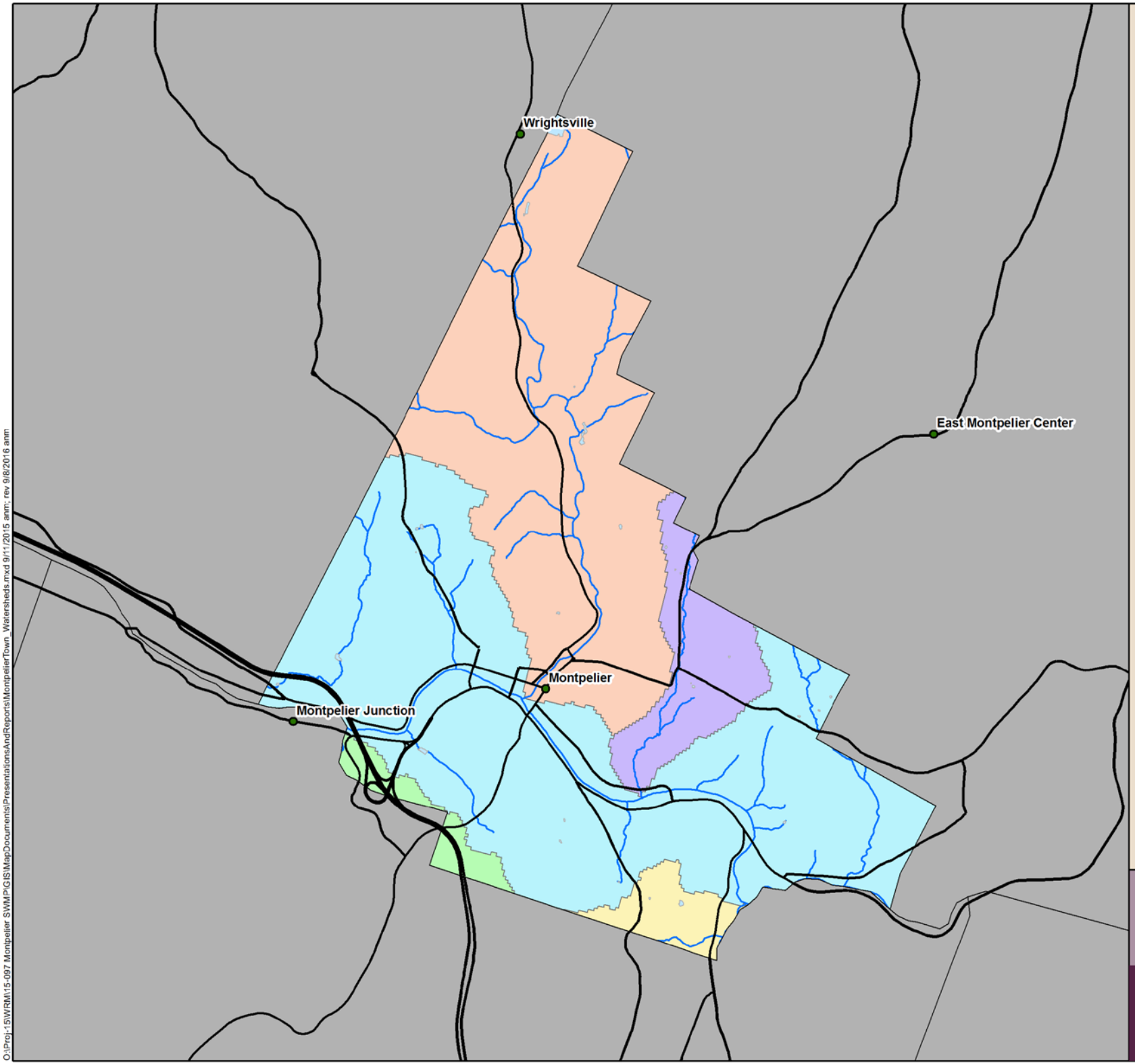
5. CONCLUSIONS

This report is part of a larger project, funded by Vermont DEC, which will ultimately lead to a set of community-specific, prioritized projects to address stormwater runoff. Rather than starting from scratch in identifying stormwater management needs, the project (and this report) is drawing from existing reports and water quality assessments, and augmenting this information with interviews with local officials.

As this report demonstrates, there are numerous agencies and entities whose activities touch on various aspects of water quality in the Winooski River watershed, and in the City of Montpelier. This work is dynamic and ongoing, and so, while this summary is believed to be comprehensive, it will be important to periodically review and update the content to ensure the most current information can be incorporated. A comprehensive inventory of existing water quality assessments serves as a basis for connecting land use, stormwater management, floodplain management, river management activities, and public infrastructure needs to more effectively address all of the issues which contribute to degradation of a watershed.

[20] http://www.montpelier-vt.org/upload/pages/369/files/vegetationmanagementplan.pdf

MAPS



N

0 0.4 0.8 Miles

River or Stream

Montpelier Watersheds

- Blanchard Brook
- Dog River
- North Branch Winooski River
- Stevens Branch Winooski River
- Winooski River

Sources: Watershed Boundaries: NHD Plus 2; Administrative Boundaries, Roads: VCGI.

STONE ENVIRONMENTAL INC

Watershed Boundaries

Map #1

City of Montpelier Stormwater Master Planning

O:\Proj-1\SWRM\15-097 Montpelier SWMP\GIS\MapDocuments\Presentations\AndReports\MontpelierTown_Watersheds.mxd 9/11/2015 anm; rev 9/8/2016 anm

N

0 0.25 0.5 0.75 1 Miles

Stormwater Problem Severity
- Unknown
- Minor
- Moderate
- Significant
- Severe
- Stormwater Problem Areas

VT Culvert Inventory
- "Fair" or "Poor" condition
- DEC Mapping Priority 1 Retrofits
- City of Montpelier Boundary
- River or Stream

Roads - State level
- Interstate
- US HIghway
- VT State Highway
- US/State Highway - City

Roads - Local
- Town Highway - 3
- Town Highway - 4
- Private Y
- Private N
- Forest Highway, Legal Trail
- Unknown

Sources: Priority 1 Retrofits: VT DEC; Stormwater Problem Areas: City of Montpelier, Administrative Boundaries, Roads: VCGI, Flowlines: NHD Plus 2, Imagery: ESRI

STONE ENVIRONMENTAL INC

Identification of Stormwater Problem Areas

Map #2

City of Montpelier Stormwater Master Planning

O:\Proj-15\WRM15-097 Montpelier SWMP\GIS\MapDocuments\Presentations\AndReports\Montpelier_StrmwtrProblemAreas.mxd 9/15/2015 anm; rev 9/8/2016 anm

Appendix C. Problem Area Data Sheets

Problem Area Data Sheet

Problem Area ID: WR-01	Latitude: 44.258732	Longitude: -72.590663

Watershed: Winooski River (VT DEC Subwatershed 23)

Location: Department of Labor Parking Lot

Problem Type: Erosion

Identification Source: VTDEC Montpelier Stormwater Infrastructure Mapping Project

Ownership: State

Classification: 3

Date of Field Data Collection: September 9, 2015

Description of Observed Conditions:

Large portion of green space in satellite photos has been paved as part of the parking lot expansion. Workers on site indicated a stormwater infiltration system was installed under the new pavement. Green strip at the edge of the new paved area should be reshaped to allow sheet flow from adjacent parking spaces.

Field Photos

Photo 1. New paved area (previously green space)

Photo 2. West edge of new parking area

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
1	2	2	2	N	Y	N	N

Problem Area Data Sheet

Problem Area ID: WR-02	Latitude: 44.258195	Longitude: -72.591873

Watershed: Winooski River (VT DEC Subwatershed 21)

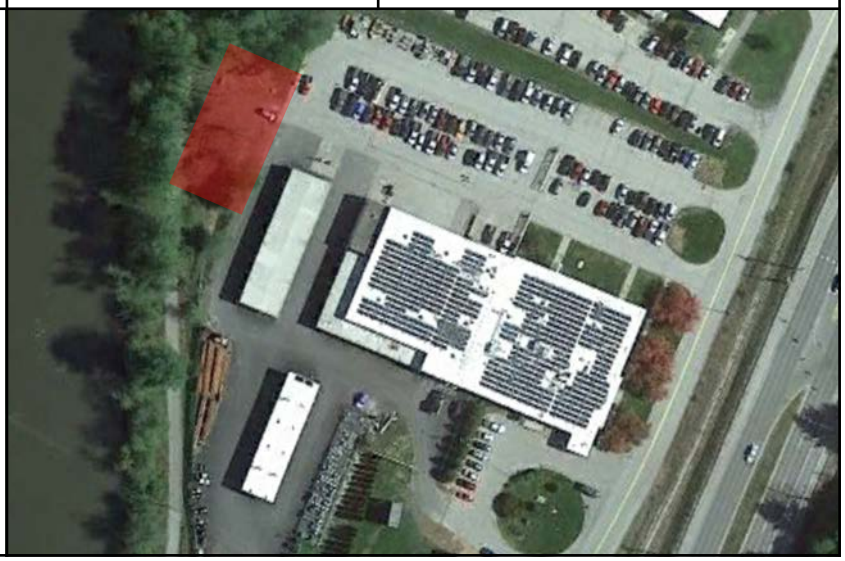
Location: Green Mountain Power parking lot

Problem Type: Erosion

Identification Source: VTDEC Montpelier Stormwater Infrastructure Mapping Project

Ownership: Private

Classification: 4/6



Date of Field Data Collection: September 9, 2015

Description of Observed Conditions:

Stormwater is directed into a steep-sided, eroded swale. VT DEC retrofit concept for an infiltration basin in this area appears to be a viable option.

Field Photos

Photo 1. View of swale behind parking lot

Photo 2. Pipe outlet across the fence

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	2	2	N	Y	N	N

Problem Area Data Sheet

Problem Area ID: WR-03	Latitude: 44.256907	Longitude: -72.591447

Watershed: Winooski River (VT DEC Subwatershed 24)

Location: Green Mountain Power campus

Problem Type: Unmanaged impervious

Identification Source: VTDEC Montpelier Stormwater Infrastructure Mapping Project

Ownership: Private

Classification: 6

Date of Field Data Collection: September 9, 2015

Description of Observed Conditions:

The two catch basins (including the one pictured in Photo 2, below) could be capped, and rainwater should be redirected in the circular green space or the lawn area where the solar panels are installed.

Field Photos

Photo 1. Solar panel installation that could be modified to incorporate stormwater management

Photo 2. Catch basin that could be plated over (1 of 2)

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	1	1	N	Y	N	N

Problem Area Data Sheet

Problem Area ID: WR-04	Latitude: 44.257685	Longitude: -72.589562

Watershed: Winooski River (VT DEC Subwatershed 6)

Location: National Life Drive

Problem Type: Infrastructure, erosion

Identification Source: VTDEC Montpelier Stormwater Infrastructure Mapping Project

Ownership: Private/City/State

Classification: 4

Date of Field Data Collection: September 9, 2015

Description of Observed Conditions:

Elevation of the open green space on east side of Memorial Drive makes it a good candidate site for runoff capture. Stormwater water currently conveyed through the area in a 24" (?) diameter pipe; stormwater is flowing around pipe, resulting in moderate erosion.

Field Photos

Photo 1. View of green space. Pipe runs to the left of the birch tree.

Photo 2. Exposed pipe (in box) and eroded area

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	3	2	N	Y	N	N

Problem Area Data Sheet

Problem Area ID: WR-05	Latitude: 44.255167	Longitude: -72.586394

Watershed: Winooski River (VT DEC Subwatershed 1)

Location: National Life Drive

Problem Type: Infrastructure

Identification Source: VTDEC Montpelier Stormwater Infrastructure Mapping Project

Ownership: Private/City

Classification: 6

Date of Field Data Collection: September 9, 2015

Description of Observed Conditions:

Open green space on the right side (driving uphill) of National Life Drive. There is an existing, subsurface storage pipe system in this green space that was installed by National Life as part of their permit that will need to be considered. Capping the catch basin in Photo 2 and constructing a berm at location indicated in Photo 1 to turn water out into the swale could be effective. Pipe running downhill from the catch basin in Photo 2 is not deep; there may be an opportunity to "daylight" additional stomwater into the swale. Depending on the drainage area, the swale may need to be reinforced and/or require check dams.

Field Photos

Photo 1. Berm would be constructed on low area behind location indicated by the arrow.

Photo 2. Catch basin uphill of green space

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	1	1	N	Y	N	N

Problem Area Data Sheet

Problem Area ID: WR-06	Latitude: 44.253390	Longitude: -72.580873

Watershed: Winooski River (VT DEC Subwatershed 38)

Location: Northfield St/Route 12

Problem Type: Unmanaged impervious

Identification Source: VTDEC Montpelier Stormwater Infrastructure Mapping Project

Ownership: Private/State

Classification: 6

Date of Field Data Collection: September 9, 2015

Description of Observed Conditions:

There is green space along the west side of Vermont 12, both north and south of Derby Drive, that could be suitable for stormwater management. This includes "depaving" the overly-wide shoulder in front of the Econo Lodge. The City has indicated that this section of roadway is scheduled for paving in 2017.

Field Photos

Photo 1. VT-12 facing downhill (north), at the EconoLodge

Photo 2. VT-12 facing south, at the Derby Drive

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
1	2	1	1	Y	Y	N	Y

Problem Area Data Sheet

Problem Area ID: WR-07	Latitude: 44.248710	Longitude: -72.558281

Watershed: Winooski River

Location: Taplin Street

Problem Type: Unmanaged impervious

Identification Source: SWMP Assessment

Ownership: Public

Classification: 2

Date of Field Data Collection: September 10, 2015

Description of Observed Conditions:

Drainage at the top of the street has been stabilized with riprap (Photo 1). In addition, there is a concrete manhole with small inlets at its base and an overflow inlet located out-of-site in this photo beyond the rip-rap. No ditches along the sides of the steep street but little erosion was visible along the permanent edge. The City has plans to construct a small retention basin with an outlet control structure on Isabel Circle, which is at the top of this drainage area.

Field Photos

Photo 1. Rock pile constructed in the yard of the topmost house in the line of flow

Photo 2. View down the steep street

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
1	1	1	1	N	Y	N	N

Problem Area Data Sheet

Problem Area ID: WR-08	Latitude: 44.248940	Longitude: -72.549133

Watershed: Winooski River

Location: Old Country Club Rd

Problem Type: Infrastructure, erosion

Identification Source: SWMP Assessment/VTrans

Ownership: Public

Classification: 5

Date of Field Data Collection: September 10, 2015

Description of Observed Conditions:

Significant, ongoing erosion around culvert damaged by Irene (Photo 1). Rehab of the surrounding area could be implemented to reduce erosion, regardless of whether the culvert is ultimately replaced. Banks of roadside ditches on Old Country Club Rd. are also over steepened and eroding (Photo 2).

Field Photos

Photo 1. Damaged culvert and severe storm damage.

Photo 2. Erosion of area draining into the ditch on side of the road.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
3	3	3	2	Y	Y	Y	Y

Problem Area Data Sheet

Problem Area ID: WR-09	Latitude: 44.243424	Longitude: -72.542053

Watershed: Winooski River

Location: Gallison Hill Rd

Problem Type: Infrastructure

Identification Source: SWMP Assessment

Ownership: Private

Classification: 2

Date of Field Data Collection: September 11, 2015

Description of Observed Conditions:

Permitted facility (#3146). Pond appears to be maintained (Photo 1). Little erosion around storm water flow paths around pond. Ditches on west side of campus could use some maintenance (Photo 2).

Field Photos

Photo 1. Pond between the two building complexes

Photo 2. Ditch that could be reshaped and stabilized to provide better treatment for storm water before it reaches the pond.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
1	1	1	1	N	Y	N	N

Problem Area Data Sheet

Problem Area ID: WR-10	Latitude: 44.259022	Longitude: -72.577985

Watershed: Winooski River (VT DEC Subwatershed 91)

Location: Shaw's parking lot

Problem Type: Pollution prevention

Identification Source: VTDEC Montpelier Stormwater Infrastructure Mapping Project

Ownership: Private

Classification: 3

Date of Field Data Collection: September 10, 2015

Description of Observed Conditions:

Dumpster and bagged garbage stored on edge of parking lot immediately adjacent to river; should be removed. Runoff from the parking lot also drains directly into the Winooski.

Field Photos

Photo 1. Area behind Shaw's

Photo 2. Food waste left in bags near flow path to river

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	1	2	1	N	Y	N	N

Problem Area Data Sheet

Problem Area ID: WR-11	Latitude: 44.261911	Longitude: -72.578699

Watershed: Winooski River (VT DEC Subwatershed 149)

Location: Governor Davis Ave Parking Lot

Problem Type: Unmanaged impervious

Identification Source: VTDEC Montpelier Stormwater Infrastructure Mapping Project

Ownership: State

Classification: 6

Date of Field Data Collection: September 10, 2015

Description of Observed Conditions:

Potential for a small, linear bioretention at toe of green space to capture/infiltrate a portion of parking lot runoff. Site also received excess runoff from the State House during large/intense wet weather events through a weir/manhole by the Pavilion Office Building. Site is somewhat constrained due to the steep slope of the available green space. When lot is resurfaced, consideration should be given to the use of a porous pavement.

Field Photos

Photo 1. Proposed green space around staircase

Photo 2. Gov. Davis Ave parking lot

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	1	1	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: WR-12	Latitude: 44.248057	Longitude: -72.563002

Watershed: Winooski River (VT DEC Subwatershed 57)

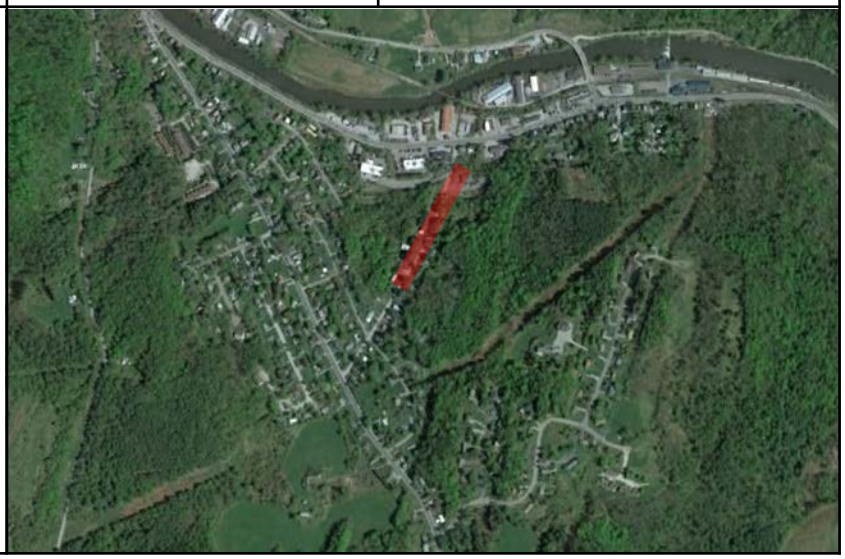
Location: Wheelock Road

Problem Type: Unmanaged impervious

Identification Source: SWMP Assessment

Ownership: Private

Classification: 3



Date of Field Data Collection: September 28, 2015

Description of Observed Conditions:

Road is too steep for a Green Streets project, but there seems to be enough vegetation to retain storm flow. Ditch draining the parking lot of Vermont-NEA has deteriorated, and the catch basin could use a riser.

Field Photos

Photo 1. Catch basin and ditch could be improved.

Photo 2. The road is steep but has vegetation on either side.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	1	1	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: WR-13	Latitude: 44.241584	Longitude: -72.547747

Watershed: Winooski River (VT DEC Subwatershed 83)

Location: Casella Waste Systems property

Problem Type: Erosion

Identification Source: VTDEC Montpelier Stormwater Infrastructure Mapping Project

Ownership: Private

Classification: 4

Date of Field Data Collection: September 14, 2015

Description of Observed Conditions:

Permitted facility (#4790). Standing water from rain the day before remained on the gravel machinery parking area (Photo 1). In the image, the river is to the left. There is a vegetated berm-like structure preventing flow into the river along most of that side of the parking lot, but one flat section allows flow into the river (Photo 2). A strip of gravel and grass along the right side of the lot (relative to Photo 1) was under standing water. A Casella Waste Systems employee stated there is one catch basin draining the paved lot at the front of the property.

Field Photos

Photo 1. Casella Waste Management vehicle storage area, located on a "peninsula" between the railroad and the Winooski River

Photo 2. Evidence of water from parking lot flowing towards river; dumpsters stored near river bank

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	3	2	N	Y	N	N

Problem Area Data Sheet

Problem Area ID: WR-14	Latitude: 44.274457	Longitude: -72.589144

Watershed: Winooski River

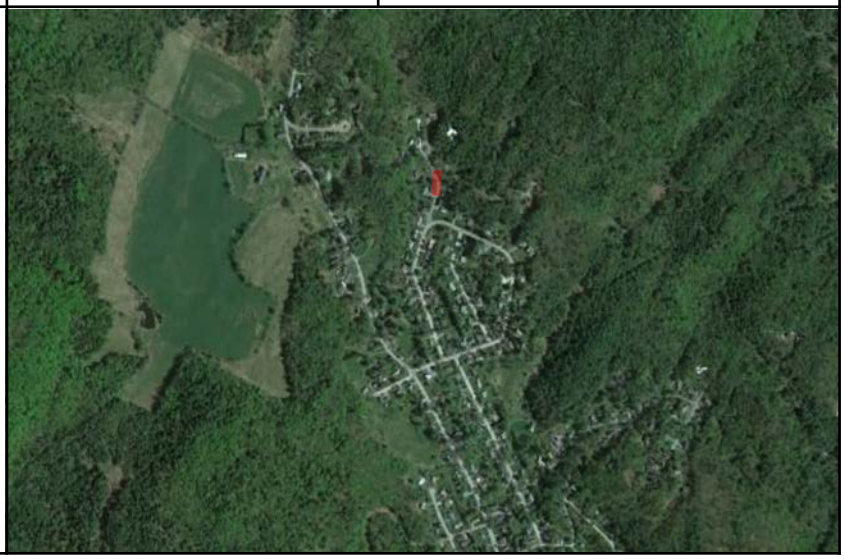
Location: Dunpatrick Circle

Problem Type: Unmanaged impervious, erosion

Identification Source: VTrans/CVRPC

Ownership: City/Private

Classification: 3/6



Date of Field Data Collection: November 5, 2015

Description of Observed Conditions:

The are a number of drainage features that all intersect in the vicinity of Dunpatrick Circle. Water from this area ultimately becomes part of a more significant surface water feature along the west side of Terrace Street.

Field Photos

Photo 1. Cul-de-sac presents potential retrofit opportunity.

Photo 2. Existing natural areas along Dunpatrick Circle could potentially be used to better manage stormwater.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	1	1	Y	Y	Y	Y

Problem Area Data Sheet

Problem Area ID: WR-15	Latitude: 44.262860	Longitude: -72.584403

Watershed: Winooski River

Location: Bailey Ave.

Problem Type: Unmanaged impervious, erosion

Identification Source: SWMP Assessment

Ownership: City/Private

Classification: 4

Date of Field Data Collection: November 4, 2015

Description of Observed Conditions:

Significant stormwater runoff along the shoulders of Bailey Ave accesses and erodes off-street parking areas; there is a need to comprehensively address stormwater runoff along this block.

Field Photos

Photo 1. Runoff along the shoulder of Bailey Ave is accessing and eroding an off-street parking area.

Photo 2. Potential "green street" location along the east-side of Bailey Ave.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	2	2	Y	Y	Y	Y

Problem Area Data Sheet

Problem Area ID: WR-16	Latitude: 44.261085	Longitude: -72.586039

Watershed: Winooski River

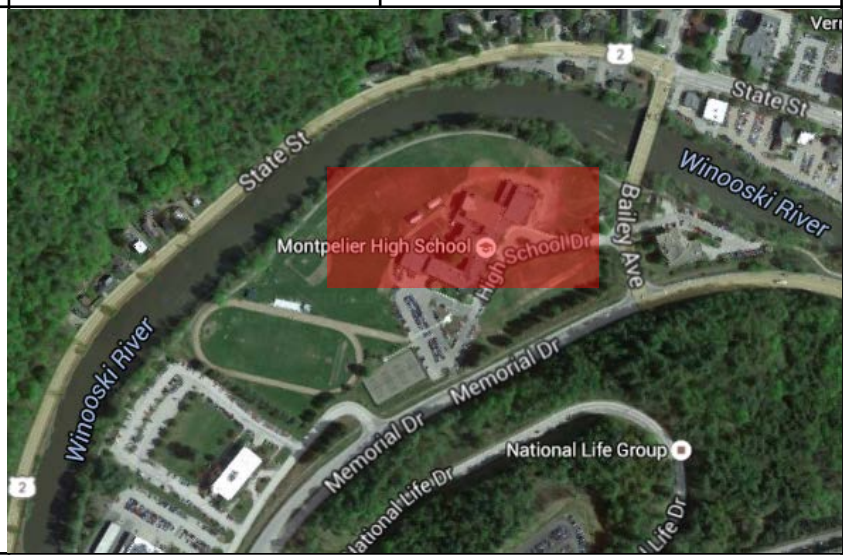
Location: Montpelier High School

Problem Type: Unmanaged impervious, erosion

Identification Source: SWMP Assessment

Ownership: City

Classification: 6



Date of Field Data Collection: November 4, 2015

Description of Observed Conditions:

There are a number of opportunities for improved stormwater management on the Montpelier High School campus. These include: addressing sediment transport from the overflow parking area in front of the school (Photo 1), retrofitting the green space in the traffic loop in front of the school to accept stormwater runoff, and improving stormwater management measures designed to capture runoff from the back parking lot which show evidence of short circuiting (Photo 2).

Field Photos

Photo 1. Overflow parking area

Photo 2. Existing stormwater management in back parking lot

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	3	2	Y	Y	Y	N

Problem Area Data Sheet

Problem Area ID: WR-17	Latitude: 44.260495	Longitude: -72.584568

Watershed: Winooski River

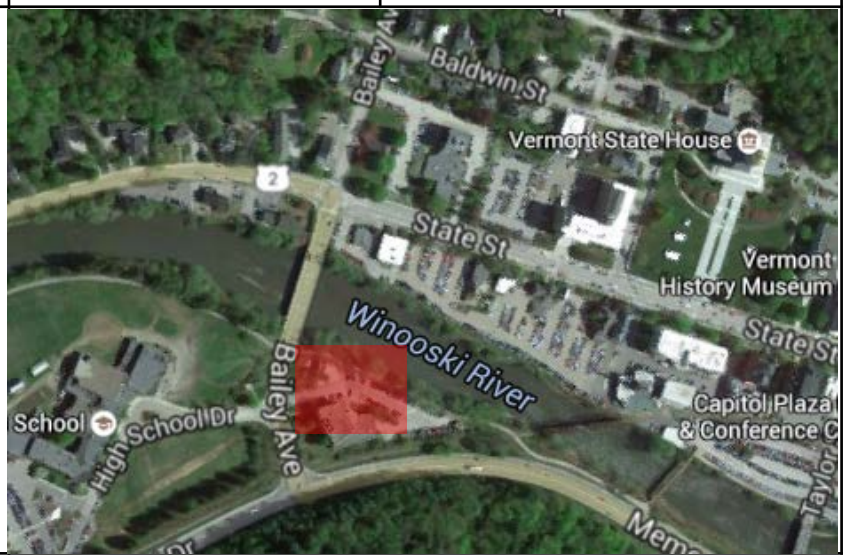
Location: VSECU, 1 Bailey Ave

Problem Type: Unmanaged impervious

Identification Source: SWMP Assessment

Ownership: Private

Classification: 6



Date of Field Data Collection: November 4, 2015

Description of Observed Conditions:

The VSECU parking lot represents a significant amount of unmanaged impervious surface that drains directly to the Winooski River. There is an existing green space between the northern edge of the lot and the Montpelier bike path that has a landscape position that would allow it to readily accept stormwater management.

Field Photos

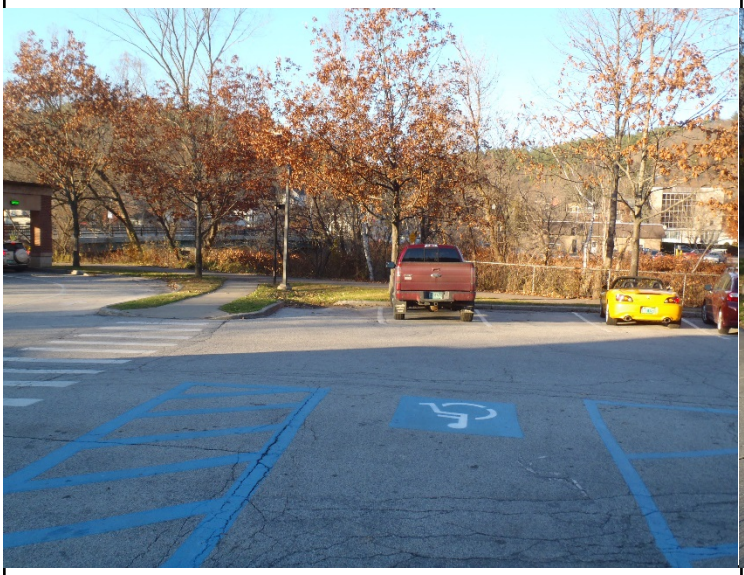


Photo 1. Parking lot is graded to drain toward existing green space

Photo 2: Sediment accumulation notes at corner of parking lot

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	1	1	N	Y	N	N

Problem Area Data Sheet

Problem Area ID: WR-18	Latitude: 44.257003	Longitude: -72.542647

Watershed: Winooski River

Location: Hackamore Dr

Problem Type: Unmanaged impervious, erosion

Identification Source: SWMP Assessment

Ownership: City

Classification: 4

Date of Field Data Collection: November 5, 2015

Description of Observed Conditions:

Erosion along the road shoulder was observed at the north end of Hackamore Dr, near the intersection with Towne Hill Rd – including and accumulation of sediment in the drainage ditch along Towne Hill.

Field Photos

Photo 1. Erosion along the road shoulder

Photo 2. Sediment accumulation in drainage ditch

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	2	2	Y	Y	Y	N

Problem Area Data Sheet

Problem Area ID: WR-19	Latitude:	Longitude:

Watershed: Winooski River

Location: VT NEA and Leahy Press, Wheelock St

Problem Type: Unmanaged impervious

Identification Source: SWMP Assessment

Ownership: Private

Classification: `6

Date of Field Data Collection: November 18, 2015

Description of Observed Conditions:

The are significant areas of unmanaged impervious surface, mainly parking areas, associated with both of these facilities that could benefits from improved stormwater management. In addition, these lots have been reported to receive significant "run-on" from uphill residential development. There is an existing drainage swale along the north edge of these parking areas that could be improved to better manage stormwater; there are also opportunities to better manage stormwater runoff in the upper watershed.

Field Photos

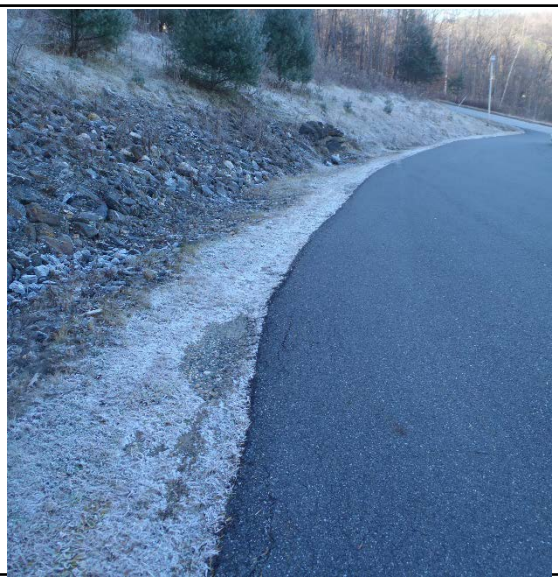


Photo 1. Drainage swale along north edge of VT NEA parking area

Photo 2. Parking area at Leahy Press

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	1	1	1	N	Y	N	Y

Problem Area Data Sheet

Problem Area ID: WR-20	Latitude: 44.261379	Longitude: -72.583344

Watershed: Winooski River

Location: State Parking Lots

Problem Type: Unmanaged impervious

Identification Source: SWMP Assessment

Ownership: State

Classification: 6

Date of Field Data Collection: November 18, 2015

Description of Observed Conditions:

Small islands of green space within the existing state-operated parking areas between State St and the Winooski River could be retrofit to provide stormwater management for a portion of the surrounding impervious surface.

Field Photos

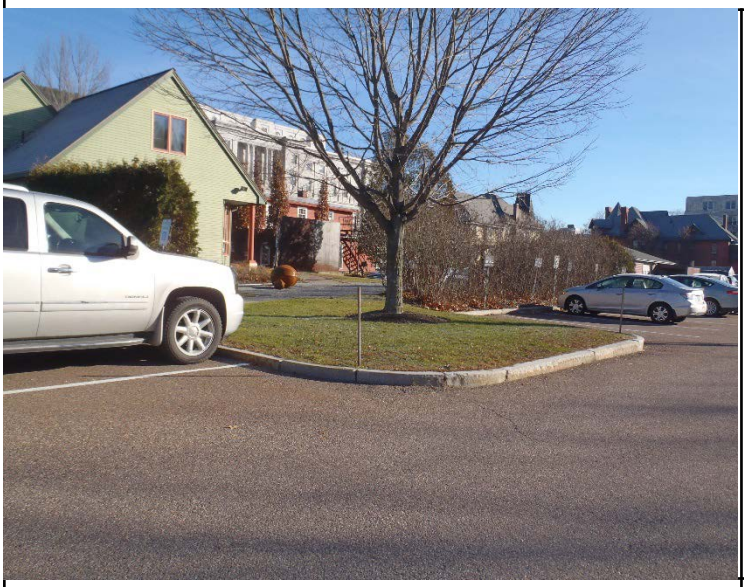


Photo 1. Green space behind Visitor Center

Photo 2. Green space in lot behind 116 State St

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
1	2	1	1	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: WR-21	Latitude: 44.261774	Longitude: -72.583092

Watershed: Winooski River

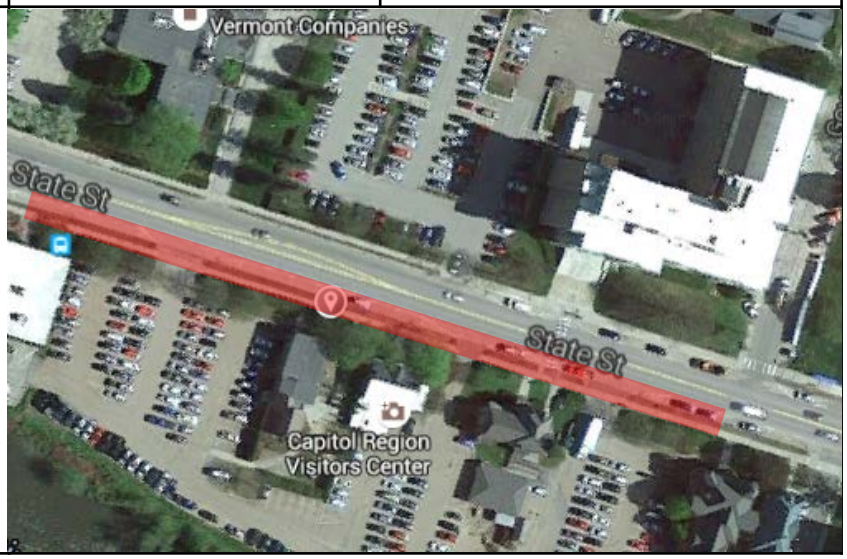
Location: State St

Problem Type: Unmanaged impervious

Identification Source: SWMP Assessment

Ownership: City

Classification: 6



Date of Field Data Collection: November 18, 2015

Description of Observed Conditions:

There is existing green space along the south-side of State St that could be retrofit using a "Green Street" style approach to improve stormwater management for road (and sidewalk) related runoff.

Field Photos

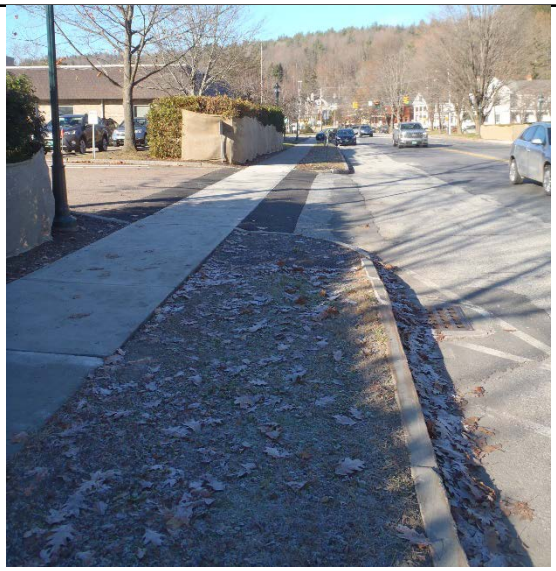


Photo 1. Green space, looking west along State St.

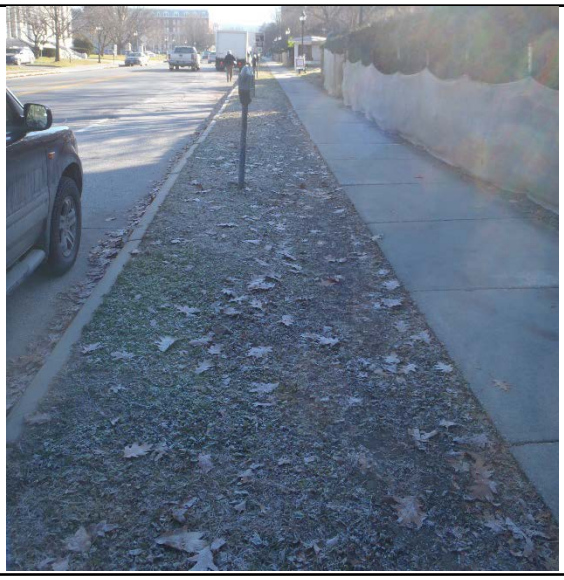


Photo 2. Green space, looking east along State St.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	2	1	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: WR-22	Latitude: 44.242150	Longitude: -72.551193

Watershed: Winooski River

Location: A Quilter's Garden
Barre-Montpelier Road

Problem Type: Infrastructure, erosion

Identification Source: SWMP Assessment

Ownership: Private

Classification: 4

Date of Field Data Collection: June 16, 2016

Description of Observed Conditions:

Undersized culvert to the north and east of the Quilter's Garden which used to convey an intermittent stream blown out in May 2011. Area where culvert had been is actively eroding.

Field Photos

Photo 1. Damaged area where culvert used to be.

Photo 2. Visible evidence of active erosion.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
3	3	3	2	N	Y	Y	Y

Problem Area Data Sheet

Problem Area ID: WR-23	Latitude: 44.249178	Longitude: -72.560441

Watershed: Winooski River

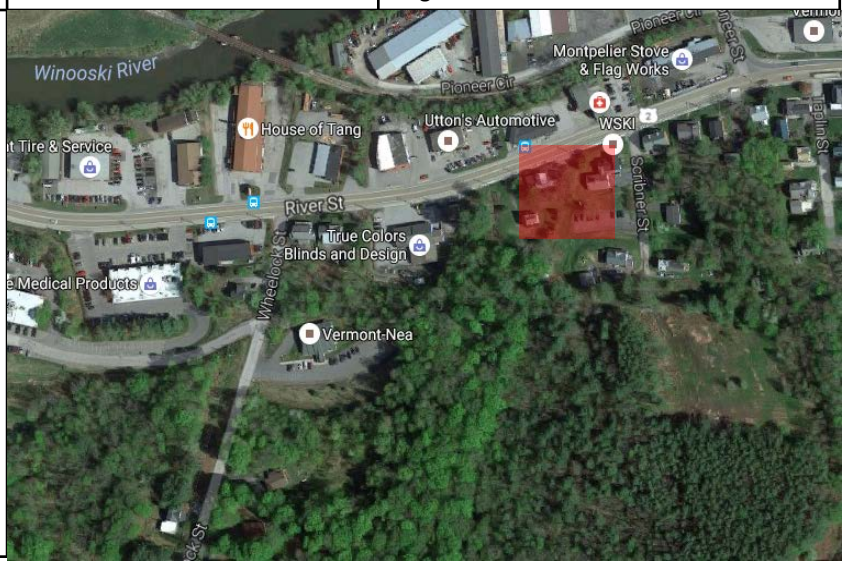
Location: 161 River St

Problem Type: Erosion

Identification Source: SWMP Assessment

Ownership: Private

Classification: 4



Date of Field Data Collection: October 16, 2016

Description of Observed Conditions:

A gully has formed between 143 and 161 River St. Some rock has been installed where the gully drops into the City's storm sewer system. Snow fence at 161 River St (visible in the background of the photo) suggests gully may be impacting driveway.

Field Photos

Photo 1. Base of gully at River St.

Photo 2. Evidence of slope failure along western embankment of gully.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	2	2	Y	Y	Y	N

Problem Area Data Sheet

Problem Area ID: WR-24	Latitude: 44.270769	Longitude: -72.587287

Watershed: Winooski River

Location: 11 Dairy Ln

Problem Type: Retrofit opportunity

Identification Source: SWMP Assessment

Ownership: Private

Classification: 6

Date of Field Data Collection: October 16, 2016

Description of Observed Conditions:

There is a large open area behind 11 Dairy Lane that could be retrofitted to provide treatment for the Greenfield Terrace neighborhood.

Field Photos

Photo 1. Looking south from east of 11 Dairy Ln

Photo 2. Looking south from west of 11 Dairy Ln

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	1	1	N	Y	N	Y

Problem Area Data Sheet

Problem Area ID: WR-25	Latitude: 44.250207	Longitude: -72.570074

Watershed: Winooski River

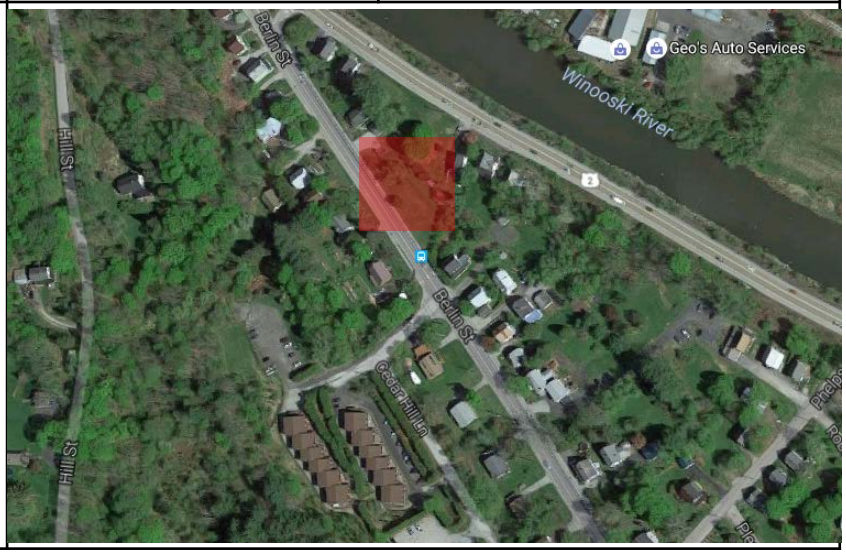
Location: 169 Berlin St

Problem Type: Retrofit opportunity

Identification Source: SWMP Assessment

Ownership: Private

Classification: 6



Date of Field Data Collection: October 16, 2016

Description of Observed Conditions:

There is a large open area across from 169 Berlin St that could be retrofitted to provide treatment for the Berlin St. – Cedar Hill – Wilson St. neighborhood. Flat areas of site are somewhat limited with site dropping off quickly and steeply to the northeast which may limit treatment options.

Field Photos

Photo 1. Looking northwest across open area.

Photo 2.looking northeast across open area.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
3	2	1	1	N	Y	N	Y

Problem Area Data Sheet

Problem Area ID: SB-01	Latitude: 44.239333	Longitude: -72.551040

Watershed: Stevens Branch (VT DEC Subwatershed 71)

Location: Crossway Saab/Cody Chevrolet

Problem Type: Erosion, unmanaged impervious

Identification Source: VTDEC Montpelier Stormwater Infrastructure Mapping Project

Ownership: Private

Classification: 5

Date of Field Data Collection: September 10, 2015

Description of Observed Conditions:

Undersized culvert on Crossway Saab property captures intermittent stream and conveys under Route 302 through the Cody Chevrolet property to Stevens Branch. Significant sediment deposits at culvert outlet, likely attributable to actively eroding channel above Crossway Saab. In addition, there is significant headcutting due to overland flow behind Cody Chevrolet which contributes to the sediment load being delivered to Stevens Branch.

Field Photos

Photo 1. Stone channel conveying sediment-laden water to undersized culvert; culvert was plugged with debris when photo was taken.

Photo 2. Culvert outlet pool behind Cody Chevrolet Note eroded banks.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
3	3	3	3	Y	M	Y	Y

Problem Area Data Sheet

Problem Area ID: SB-02	Latitude: 44.238707	Longitude: -72.553753

Watershed: Stevens Branch

Location: Moonlight Terrace

Problem Type: Unmanaged impervious, erosion

Identification Source: SWMP Assessment

Ownership: City

Classification: 4

Date of Field Data Collection: November 18, 2015

Description of Observed Conditions:

The drainage ditch along the southside of Moonlight Terrace appears to receive a high sediment load. The ditch has previously been stabilized with rip rap and two check dams, but additional check dams are likely needed given the road slope.

Field Photos

Photo 1. Looking west along Moonlight Terr away from the Barre-Montpelier Rd.

Photo 2. Looking east along Moonlight Terr

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	1	2	1	Y	Y	Y	Y

Problem Area Data Sheet

Problem Area ID: NB-01	Latitude: 44.259739	Longitude: -72.576481

Watershed: North Branch (VT DEC Subwatershed 104)

Location: Lots to west of Main Street

Problem Type: Unmanaged impervious

Identification Source: VTDEC Montpelier Stormwater Infrastructure Mapping Project

Ownership: City

Classification: 6

Date of Field Data Collection: September 11, 2015

Description of Observed Conditions:

Expand/improve existing islands in parking lot for storm water capture and treatment prior to discharge to the Winooski River.

Field Photos

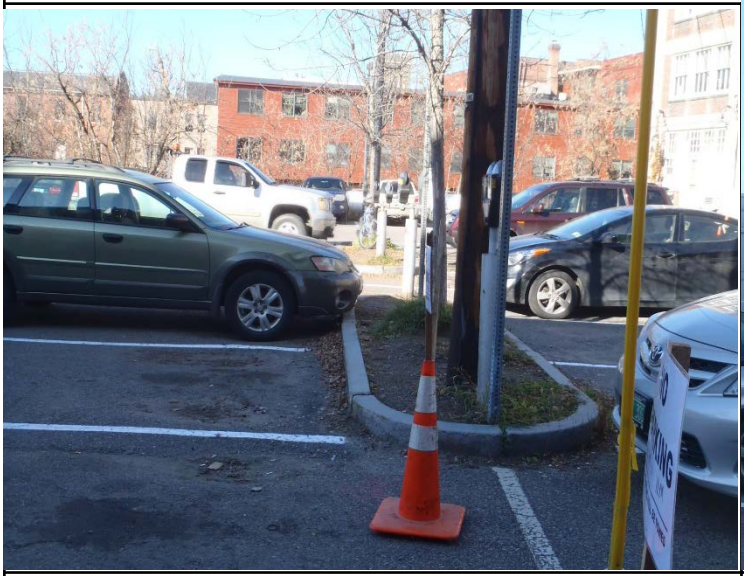


Photo 1. Islands in parking lot could be reconfigured to promote stormwater management.

Photo 2. More islands.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	2	1	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: NB-02	Latitude: 44.259273	Longitude: -72.570421

Watershed: North Branch (VT DEC Subwatershed 109)

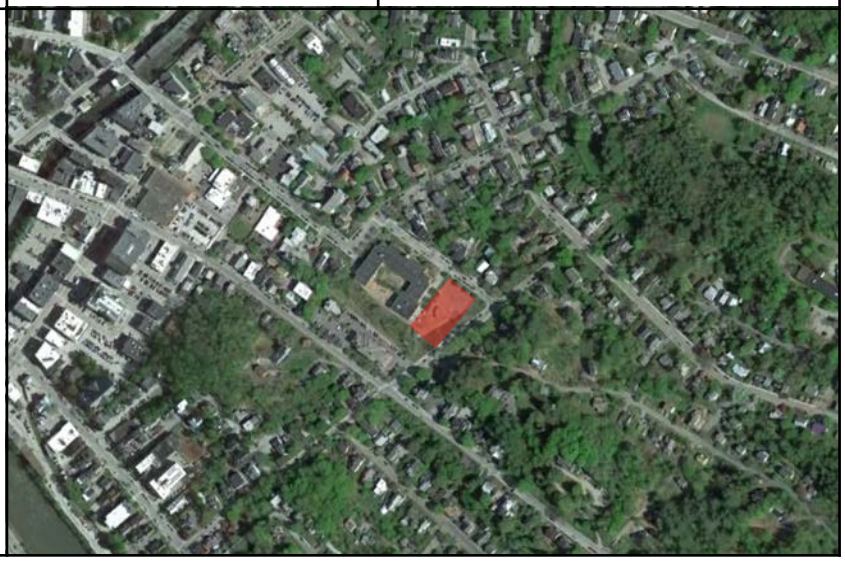
Location: Union Elementary School

Problem Type: Unmanaged impervious

Identification Source: SWMP Assessment

Ownership: City

Classification: 4/6



Date of Field Data Collection: September 17, 2015

Description of Observed Conditions:

Due to its landscape position, Union Elementary School receives considerable run-on from south and east. There are a number of catch basins on the school property that are partially or fully located within the school's outdoor recreation areas, and thus collect a considerable amount of wood chips used to treat these areas. The school is actively fundraising to make improvements to these recreation areas, and hopes to incorporate improved stormwater management efforts into the overall renovation.

Field Photos

Photo 1. Surface of the playground area contributing to sediment buildup in the catchbasin (under picnic table).

Photo 2. View from the top of the hill toward the playground (new surface recently added)

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	3	2	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: NB-03	Latitude: 44.2576	Longitude: -72.5655

Watershed: North Branch (VT DEC Subwatershed 109)

Location: Marvin Street

Problem Type: Unmanaged impervious, erosion

Identification Source: SWMP Assessment

Ownership: City/Private

Classification: 3

Date of Field Data Collection: September 17, 2015

Description of Observed Conditions:

Marvin Street is steep and narrow, making the construction and maintenance of appropriate roadside drainage difficult (particularly along the section between Hubbard and Bingham Streets) (Photo 1). Potential opportunity for bioretention at the corner of Marvin and Bingham (Photo 2), though this site is on private property.

Field Photos

Photo 1. Erosion on roadside requiring ditch maintenance

Photo 2. Potential bioretention location at the corner of Marvin and Bingham Streets

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
1	2	2	1	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: NB-04	Latitude: 44.257005	Longitude: -72.564457

Watershed: North Branch (VT DEC Subwatershed 109)

Location: College St at Marvin St

Problem Type: Unmanaged impervious

Identification Source: SWMP Assessment

Ownership: City

Classification: 6

Date of Field Data Collection: September 17, 2015

Description of Observed Conditions:

College Street is wide, with no curbs separating the road edge from the adjoining green space. “Green Street” retrofit could be used to capture/treat runoff and add the benefit of traffic calming.

Field Photos

Photo 1. Corner of Marvin and College. Traffic moves fast on College St.

Photo 2. Facing the opposite direction as Photo 1. (Photo from Google Maps)

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	2	1	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: NB-05	Latitude: 44.259627	Longitude: -72.561070

Watershed: North Branch (VT DEC Subwatershed 109)

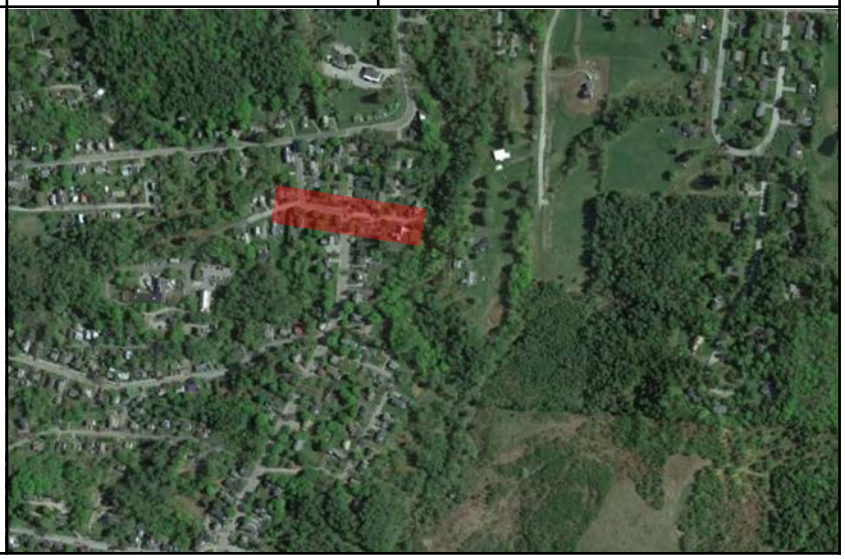
Location: College St and Woodrow Ave

Problem Type: Erosion, unmanaged impervious

Identification Source: SWMP Assessment

Ownership: Public

Classification: 3/6



Date of Field Data Collection: September 17, 2015

Description of Observed Conditions:

Catch basin at the corner is full of sediment. Flat green strips on either side of College St (especially the north side, photo 1) are well-suited for a Green Streets project. Parking may need to be reorganized but no curbs need to be removed. Additionally, erosion along the north side of Woodrow Ave could be addressed as part of this project (Photo 2).

Field Photos

Photo 1. North side of College St.

Photo 2. Minor erosion along Woodrow Ave.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	2	1	Y	Y	Y	N

Problem Area Data Sheet

Problem Area ID: NB-06	Latitude: 44.259946	Longitude: -72.564180

Watershed: North Branch (VT DEC Subwatershed 109)

Location: Heaton Woods

Problem Type: Unmanaged impervious

Identification Source: SWMP Assessment

Ownership: Private

Classification: 6

Date of Field Data Collection: September 17, 2015

Description of Observed Conditions:

A bioretention or other treatment could be installed on the green corner at the turn-in to Heaton Woods (Photo 1). Catch basin on Woodrow Ave could be capped and stormwater diverted into the treatment area.

Field Photos

Photo 1. Location of potential bioretention area. Image from Google Maps.

Photo 2. View of the proposed rain garden location showing the catch basin to be capped

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	1	2	1	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: NB-07	Latitude: 44.259420	Longitude: -72.564521

Watershed: North Branch (VT DEC Subwatershed 109)

Location: Washington County Mental Health Services

Problem Type: Unmanaged impervious

Identification Source: SWMP Assessment

Ownership: Private

Classification: 6

Date of Field Data Collection: September 17, 2015

Description of Observed Conditions:

This facility contains a significant amount of unmanaged impervious surface. There is green space in front of the building along Heaton St. that could be retrofit to manage runoff from the parking lot.

Field Photos

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	1	1	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: NB-08	Latitude: 44.260530	Longitude: -72.561470

Watershed: North Branch (VT DEC Subwatershed 109)

Location: Emmons St

Problem Type: Unmanaged impervious

Identification Source: SWMP Assessments

Ownership: City

Classification: 6

Date of Field Data Collection: September 17, 2015

Description of Observed Conditions:

Limiting parking to the west-side of the street would allow for beneficial landscape positioning of a "Green Streets" application on the east side of the road. The catch basin on Main Street could be capped, and the runoff redirected to the treatment area.

Field Photos

Photo 1. Emmons St. looking south

Photo 2. Corner of Emmons St. and Main St.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	1	1	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: NB-09	Latitude: 44.270448	Longitude: -72.577875

Watershed: North Branch

Location: Hubbard Park

Problem Type: Erosion, unmanaged impervious

Identification Source: SWMP Assessment

Ownership: Public

Classification: 4

Date of Field Data Collection: September 28, 2015

Description of Observed Conditions:

There is active erosion along many of the main roads (examples presented in Photos 1 & 2) in park. A comprehensive assessment of the road network within the park would provide an important foundation for understanding and addressing the highest priority needs within the park.

Field Photos

Photo 1. Roadside erosion in Hubbard Park

Photo 2. Roadside erosion in Hubbard Park

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	3	2	Y	N	Y	Y

Problem Area Data Sheet

Problem Area ID: NB-10	Latitude: 44.287871	Longitude: -72.574495

Watershed: North Branch

Location: Gould Hill Road

Problem Type: Erosion, unmanaged impervious

Identification Source: SWMP Assessment/VTRANS

Ownership: Public/Private

Classification: 4/5

Date of Field Data Collection: September 28, 2015

Description of Observed Conditions:

Rock-lined ditch at lat/long listed above needs improved stabilization (Photo 1). Oversteepened embanks are also causing roadside erosion is significant in places as well (Photo 2). Drainage along gravel portion of road is poor, partly due to challenging terrain. Significant gully observed below cross culvert outlet at 574 Gould Hill Rd. Boards and asphalt berms under guardrails further concentrate flows. Additionally, culvert 23055127 is classified in VOBCIT as being in "poor" condition.

Field Photos

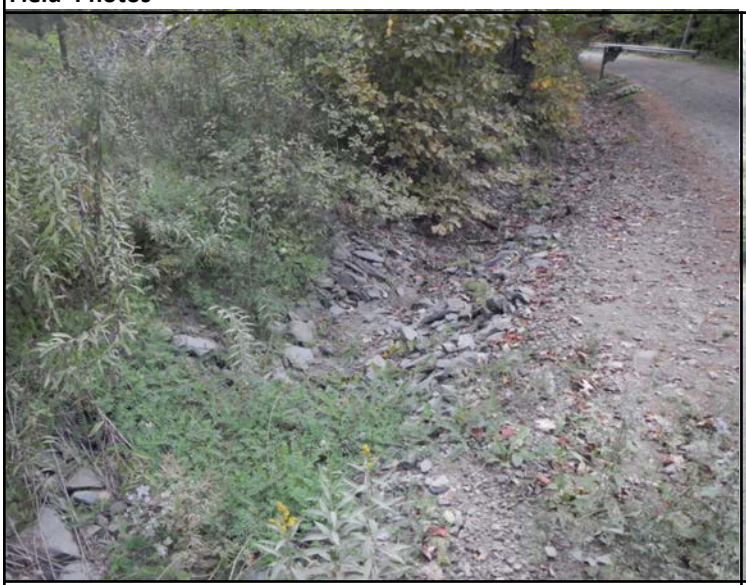


Photo 1. Rock-lined ditch in need of improvement.

Photo 2. Erosion along the road.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
3	2	3	2	Y	Y	Y	Y

Problem Area Data Sheet

Problem Area ID: NB-11	Latitude: 44.279933	Longitude: -72.573296

Watershed: North Branch

Location: Trillium Hill Road

Problem Type: Erosion, unmanaged impervious

Identification Source: SWMP Assessment

Ownership: Private

Classification: 2

Date of Field Data Collection: September 28, 2015

Description of Observed Conditions:

The private road - Trillium Hill – shows evidence of water running down the road surface and poor drainage (Photo 1). In speaking with property owners, they believe the road was improperly installed originally and is cost-prohibitive to fix.
Additionally, a riser could be used on the catch basin between Trillium Hill and the CCV parking lot to create storage.

Field Photos

Photo 1. Eroded road

Photo 2. Catch basin that needs to be raised

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	3	2	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: NB-12	Latitude: 44.269354	Longitude: -72.575557

Watershed: North Branch

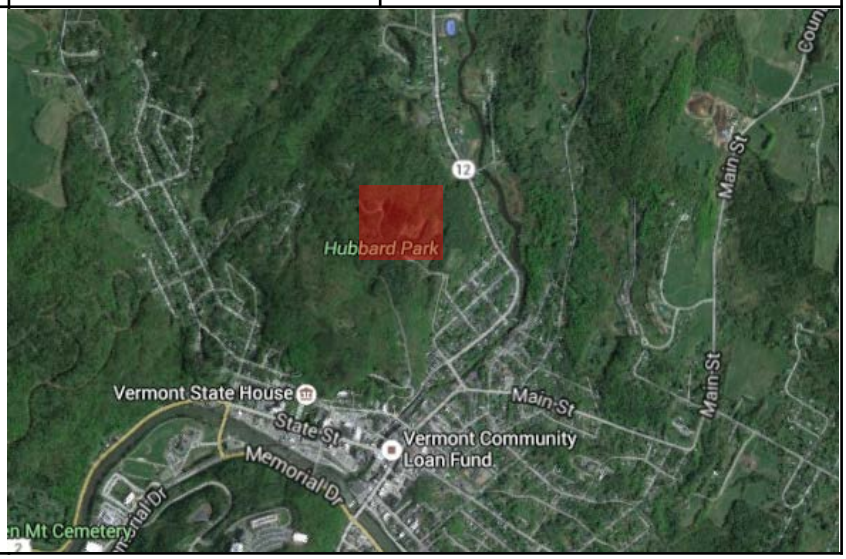
Location: Hubbard Park "Frog Pond"

Problem Type: Infrastructure

Identification Source: SWMP Assessment

Ownership: City

Classification: 6



Date of Field Data Collection: November 18, 2015

Description of Observed Conditions:

The stormwater management pond (also called the "frog pond") near the Parkway Road park entrance could be retrofit to improve stormwater management. There is a significant sediment delta that has accumulated at the pond entrance and the outlet structure is in a state of disrepair. The pond appears to provide little residence time for settling currently.

Field Photos

Photo 1. Sediment accumulation at pond inlet

Photo 2. Existing pond outlet structure

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	3	2	Y	Y	Y	N

Problem Area Data Sheet

Problem Area ID: NB-13	Latitude: 44.265426	Longitude: -72.572485

Watershed: North Branch

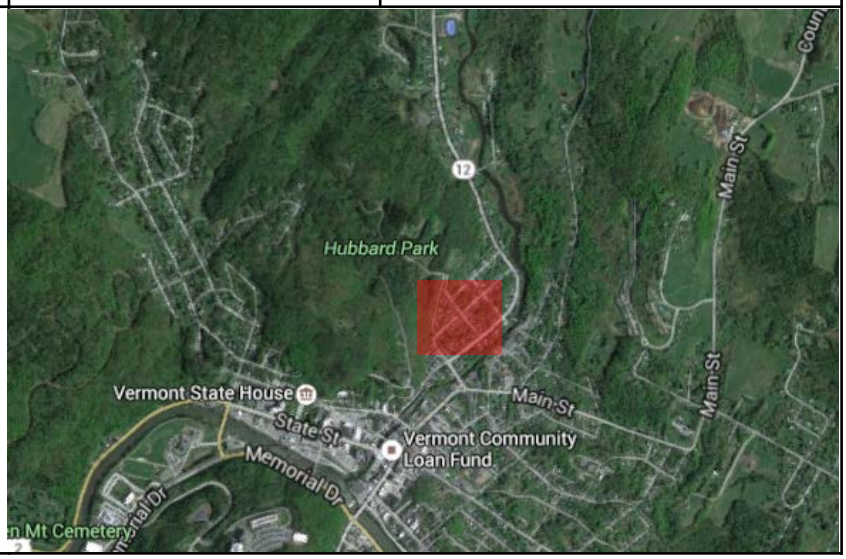
Location: Summer Street

Problem Type: Unmanaged impervious

Identification Source: SWMP Assessment

Ownership: City

Classification: 6



Date of Field Data Collection: June 16, 2016

Description of Observed Conditions:

The City previously installed a bump-out in front of a small, neighborhood park to promote better line-of-sight. The area could be recessed to also accept storm flows from Summer St.

Field Photos

Photo 1. Looking northeast along Summer St

Photo 2. Looking to the southwest along Summer St

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
1	2	2	1	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: NB-14	Latitude: 44.282012	Longitude: -72.578673

Watershed: North Branch

Location: Finch St/stump dump

Problem Type: Erosion

Identification Source: SWMP Assessment

Ownership: City

Classification: 5

Date of Field Data Collection: March 17, 2016

Description of Observed Conditions:

The City's "stump dump" is a location where stockpiles of gravel and road sand area stored, as well as miscellaneous construction materials. In addition, residents are able bring Christmas trees and other organic yards wastes for disposal and/or reuse. Small watercourses surround the stump dump on all sides, and sideslopes between the working area and these watercourses are generally over-steepened and subject to erosion. In addition, unmanaged road runoff concentrates along road shoulders, causing erosion.

Field Photos

Photo 1. Erosion along haul road shoulder.

Photo 2. Material stockpile slumping into watercourse.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
3	3	2	2	N	Y	Y	N

Problem Area Data Sheet

Problem Area ID: NB-15	Latitude: 44.259079	Longitude: -72.571939

Watershed: North Branch

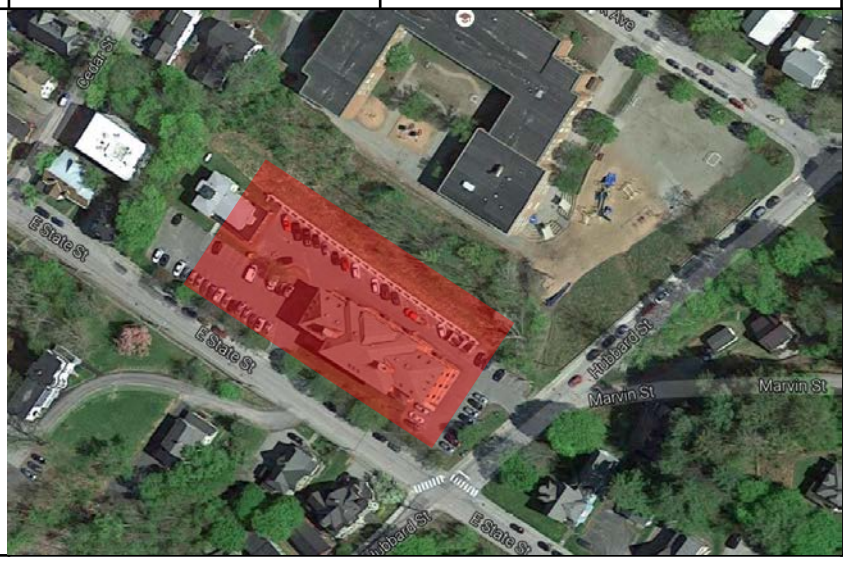
Location: 54 East State St

Problem Type: Unmanaged impervious

Identification Source: SWMP Assessment

Ownership: City

Classification: 6



Date of Field Data Collection: June 16, 2016

Description of Observed Conditions:

Runoff from the parking lot and building roof at 54 East State St are currently unmanaged, and the catch basins serving this site are connected to the City's combined sewer system.

Field Photos

Photo 1. Existing green space along southern boundary of 54 East State St.

Photo 2. Existing parking lot island at 54 East State St

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	2	2	Y	Y	Y	N

Problem Area Data Sheet

Problem Area ID: NB-16	Latitude: 44.261486	Longitude: -72.566709

Watershed: North Branch

Location: Harrison Ave

Problem Type: Unmanaged impervious

Identification Source: SWMP Assessment

Ownership: City/private

Classification: 6

Date of Field Data Collection: August 10, 2016

Description of Observed Conditions:

The City has indicated that water main replacement and road paving is planned for Harrison Ave in 2018, which provides an opportunity to consider stormwater management solutions for this neighborhood. There is an existing recreation field in the south west corner of this neighborhood, surrounded by a swale that could provide an opportunity for enhanced treatment.

Field Photos

Photo 1. Harrison Ave is narrow with sidewalk immediately adjacent to the roadway.

Photo 2. Swale surrounds small recreation field south of Harrison Ave.; swale could be improved/expanded to provide treatment.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	1	2	1	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: NB-17	Latitude: 44.259752	Longitude: -72.577768

Watershed: North Branch (VT DEC Subwatershed 150/151)

Location: Montpelier Public Parking Lot

Problem Type: Unmanaged impervious

Identification Source: VTDEC Montpelier Stormwater Infrastructure Mapping Project

Ownership: City

Classification: 6

Date of Field Data Collection: September 11, 2015

Description of Observed Conditions:

Potential retrofit in southeast corner of lot to capture/treat runoff from parking lot prior to discharge into the Winooski. There may be opportunities to reconfigure parking in lot to the west to create bioretention islands in the lot.

Field Photos

Photo 1. Small, existing island that could be reconfigured to except stormwater runoff

Photo 2. Strip of downward-sloping green space looking toward railway bridge

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	2	1	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: NB-18	Latitude: 44.263041	Longitude: -72.561703

Watershed: North Branch

Location: Towne St

Problem Type: Erosion

Identification Source: SWMP Assessment

Ownership: City/Private

Classification: 4/6

Date of Field Data Collection: September 1, 2016

Description of Observed Conditions:

Stormwater runoff from above Towne Rd crosses through a culvert under Towne Rd and has formed a gully in the woods between Towne Rd and Main St. The is a catch basin in the woods, about 2/3s of the way down the slope which takes some of this flow but is also connected to the combined sewer system. There is an opportunity to temporarily retain some of the stormwater above Towne Rd by installing an upturned elbow on the culvert.

Field Photos

Photo 1. Evidence of gully erosion in woods to the south of Towne St.

Photo 2. Culvert inlet above Town St with retrofit potential.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
3	2	2	1	Y	Y	Y	Y

Problem Area Data Sheet

Problem Area ID: NB-19	Latitude: 44.265072	Longitude: -72.564984

Watershed: North Branch

Location: Between North St and St Augustine Cemetery

Problem Type: Erosion

Identification Source: SWMP Assessment

Ownership: Private

Classification: 4

Date of Field Data Collection: September 1, 2016

Description of Observed Conditions:

There is a long history of erosion in the gully that runs along the northern edge of the St Augustine Cemetery, between Murray Hill and North St. Current situation is being exacerbated by poor site management practices as part of active construction at 262 North St.

Field Photos

Photo 1. Evidence of gully erosion in woods between Murray Hill and North St.

Photo 2. Downstream end of gully at North St; site disturbance at 262 North St evident on left-hand side of photo.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	2	1	N	Y	N	Y

Problem Area Data Sheet

Problem Area ID: BB-01	Latitude: 44.256666	Longitude: -72.563895

Watershed: Blanchard Brook (VT DEC Subwatersheds 109/126)

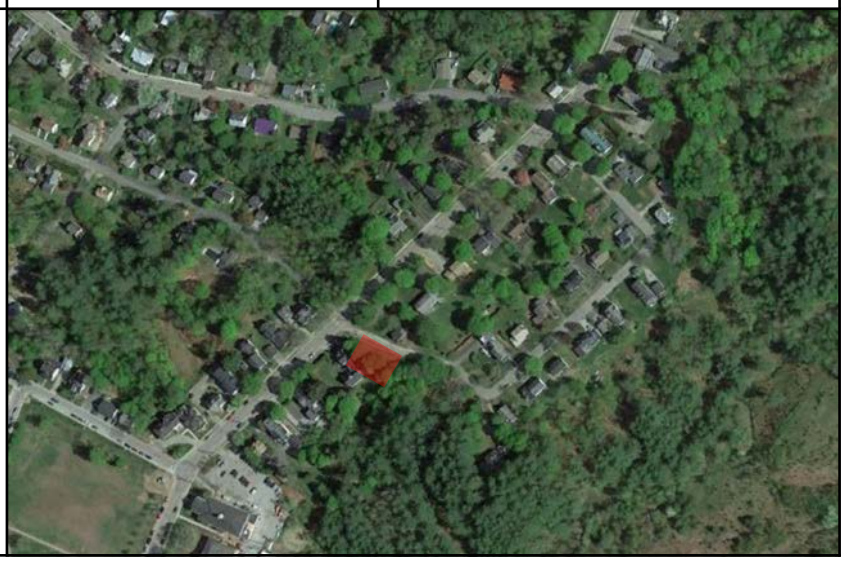
Location: Arsenal Drive

Problem Type: Erosion, unmanaged impervious

Identification Source: SWMP Assessment

Ownership: City/Private

Classification: 3



Date of Field Data Collection: September 17, 2015

Description of Observed Conditions:

Stormwater runoff from approximately 150' immediately east of College St. is turned out over a steep hillside and through an area where lawn waste is being composted. "Green Street" retrofitting could be used to better manage road runoff.

Field Photos

Photo 1. View of Arsenal Drive toward College St. Hill slope is to the left of this photo.

Photo 2. Runoff turnout visible; view down the slope with lawn waste containment structures

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	2	1	N	Y	N	N

Problem Area Data Sheet

Problem Area ID: BB-02	Latitude: 44.256503	Longitude: -72.561980

Watershed: Blanchard Brook (VT DEC Subwatershed 126)

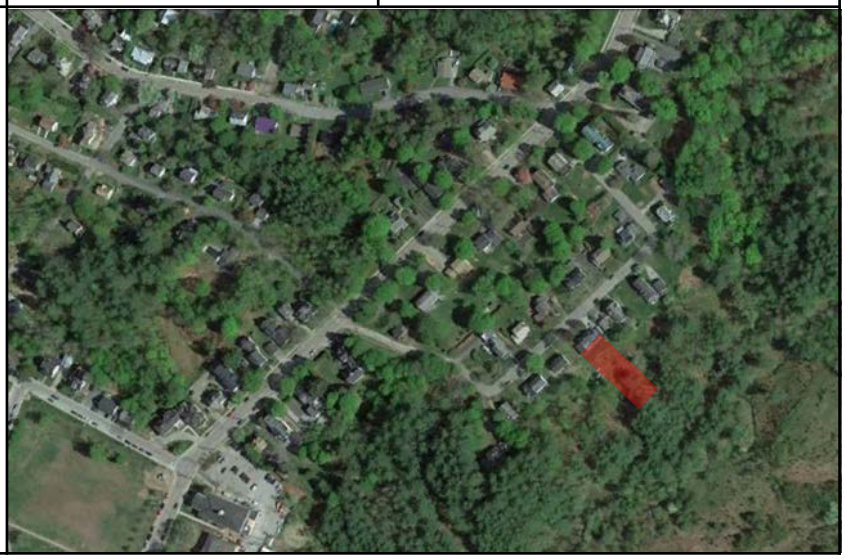
Location: 8 McKinley St

Problem Type: Erosion

Identification Source: SWMP Assessments

Ownership: Private

Classification: 5



Date of Field Data Collection: September 17, 2015

Description of Observed Conditions:

City constructed a small splash pad/energy dissipation area approximately ¼ of the way down the slope in the backyard of #8 McKinley St as part of a CSO separation project. Homeowner indicated a willingness to consider improvements to the pond. Some erosion was visible below this structure.

Field Photos

Photo 1. Pool about ¼ of the way down the slope in the back yard.

Photo 2. View down the slope from the pond.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
3	2	2	2	N	Y	Y	Y

Problem Area Data Sheet

Problem Area ID: BB-03	Latitude: 44.257311	Longitude: -72.561528

Watershed: Blanchard Brook (VT DEC Subwatersheds 109/126)

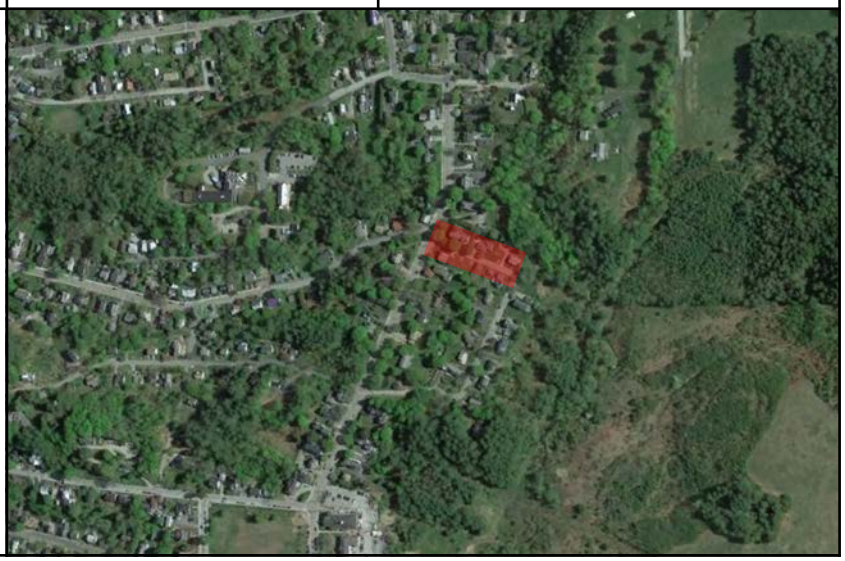
Location: Hinkley Street

Problem Type: Unmanaged impervious

Identification Source: SWMP Assessment

Ownership: Public

Classification: 6



Date of Field Data Collection: September 17, 2015

Description of Observed Conditions:

Hinkley Street is wide, with no curbs separating the road edge from the adjoining green space. “Green Street” retrofit could be used to capture/treat runoff and add the benefit of traffic calming.

Field Photos

Photo 1.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	1	2	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: BB-04	Latitude: 44.262094	Longitude: -72.558453

Watershed: Blanchard Brook (VT DEC Subwatershed 120)

Location: Towne Hill Rd/Main St

Problem Type: Erosion, unmanaged impervious

Identification Source: SWMP Assessment

Ownership: Public

Classification: 4

Date of Field Data Collection: September 17, 2015

Description of Observed Conditions:

Roadside drainage at the intersection of Towne Hill Rd and Main St is eroding. Drainage could be reshaped and stabilized to both reduce erosion and improve treatment.

Field Photos

Photo 1. Ditch running into creek.

Photo 2. More permanent vegetation should be planted in this ditch.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	3	2	2	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: BB-05	Latitude: 44.261693	Longitude: -72.557134

Watershed: Blanchard Brook (VT DEC Subwatershed 120)

Location: Easy Street

Problem Type: Erosion, unmanaged impervious

Identification Source: SWMP Assessment

Ownership: Private

Classification: 4

Date of Field Data Collection: September 17, 2015

Description of Observed Conditions:

Significant erosion of both the road surface and in the adjacent ditch was observed (Photo 1). A storm water treatment practice at the corner of Easy St and Towne Hill Rd could be effective in slowing and treating flow. The ditch itself should also be appropriately shaped and stabilized, and the road should be crowned.

Field Photos

Photo 1. Easy Street and roadside ditch to the right.

Photo 2. Ditch in need of repair.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	3	2	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: BB-07	Latitude: 44.258303	Longitude: -72.554199

Watershed: Blanchard Brook (VT DEC Subwatershed 131)

Location: Grandview Terrace, SW end

Problem Type: Unmanaged impervious, erosion

Identification Source: SWMP Assessment/VTrans

Ownership: City/Private

Classification: 5

Date of Field Data Collection: September 17, 2015

Description of Observed Conditions:

Grandview Terrace was resurfaced during the summer of 2015. Concentrated flow along the edge of the shoulder has already started to erode the gravel and it is accumulating around the catch basins at the bottom of Grandview Terrace. The paved turnout was installed too high, making it ineffective for directing storm water. The shoulder at ~140 Grandview Terrace is in poor shape as well, and requires maintenance.

Field Photos

Photo 1. Erosion at catch basin

Photo 2. Ineffective turnout structure.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
3	2	3	3	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: BB-08	Latitude: 44.257749	Longitude: -72.553852

Watershed: Blanchard Brook (VT DEC Subwatershed 131)

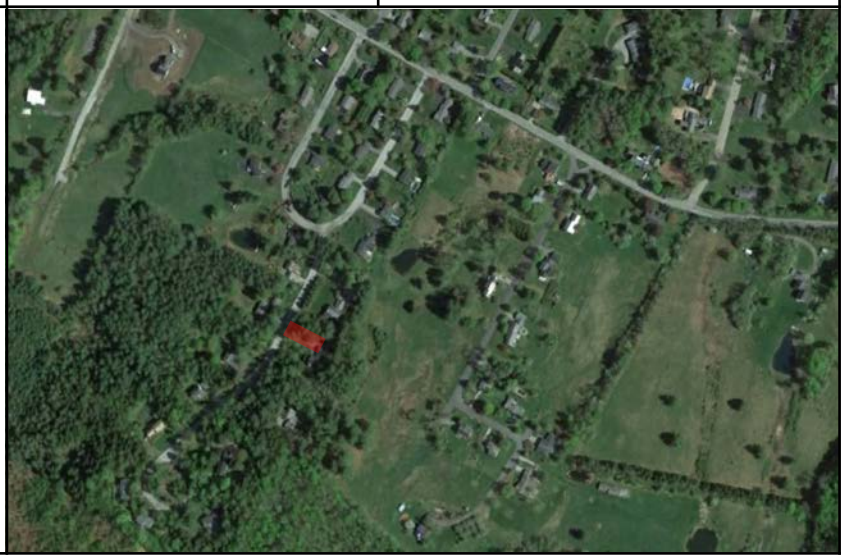
Location: Spring Hollow Road

Problem Type: Erosion, drainage

Identification Source: SWMP Assessments

Ownership: Private

Classification: 4

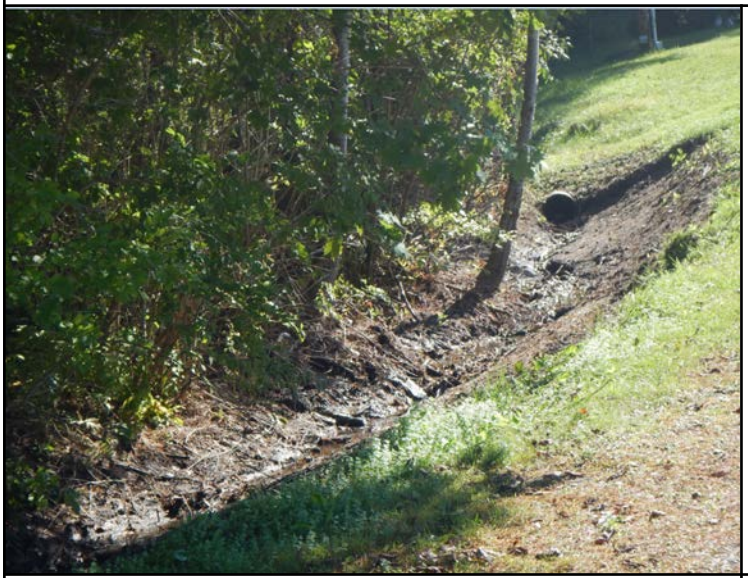


Date of Field Data Collection: September 17, 2015

Description of Observed Conditions:

Drainage at 28 Spring Hollow Road has recently been maintained, but was not stabilized. The V-shape and oversteepened banks of the drainage ditch will also need to be addressed.

Field Photos



Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
2	2	3	2	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: BB-09	Latitude: 44.259568	Longitude: -72.551785

Watershed: Blanchard Brook (VT DEC Subwatershed 127)

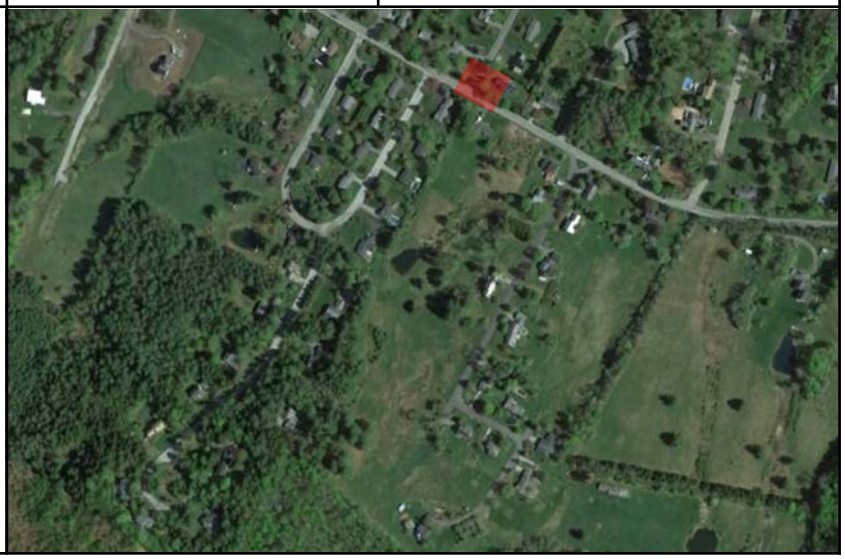
Location: Woodcrest Road

Problem Type: Unmanaged impervious

Identification Source: SWMP Assessments

Ownership: City

Classification: 2



Date of Field Data Collection: September 17, 2015

Description of Observed Conditions:

"Green Street" or other retrofit within the ROW on Woodcrest Rd could be used to capture/treat runoff and add the benefit of traffic calming (Photo 1). On the opposite side of Woodcrest Rd a riser could be added to the catch basin to more effectively manage storm flows (Photo 2).

Field Photos

Photo 1. Potential rain garden site at the corner of Woodcrest and Towne Hill Rds.

Photo 2. Catch basin that needs to befitted with a riser.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
1	2	2	1	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: BB-10	Latitude: 44.259040	Longitude: -72.550512

Watershed: Blanchard Brook (VT DEC Subwatershed 127)

Location: 438 Towne Hill Road

Problem Type: Erosion

Identification Source: SWMP

Ownership: City/Private

Classification: 4

Date of Field Data Collection: September 17, 2015

Description of Observed Conditions:

The narrow ditch on the east side of the road needs to be reshaped and stabilized. Catch basin immediately to the west also shows signs of erosion.

Field Photos

Photo 1. Narrow ditch that needs to be expanded.

Photo 2. Erosion around catch basin.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
1	2	2	1	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: BB-11	Latitude: 44.260909	Longitude: -72.552409

Watershed: Blanchard Brook (VT DEC Subwatershed 127)

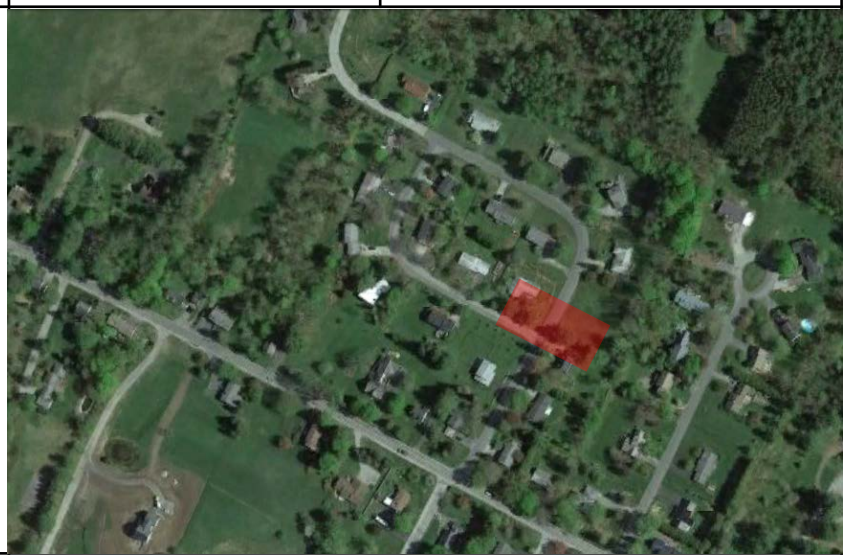
Location: Dover Rd. at Phillips Rd.

Problem Type: Erosion, unmanaged impervious

Identification Source: SWMP Assessment

Ownership: City/Private

Classification: 3



Date of Field Data Collection: September 17, 2015

Description of Observed Conditions:

The catch basin at the corner of Dover and Phillips could be raised. Stormwater storage/treatment could be provided in the green space as well(Photo 1). The ditch on the property across Dover Rd. could be reshaped and stabilized to reduce erosion (Photo 2).

Field Photos

Photo 1. Catch basin and potential treatment area.

Photo 2. Narrow ditch that could be reshaped.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
1	2	2	1	Y	Y	N	N

Problem Area Data Sheet

Problem Area ID: BB-12	Latitude: 44.262527	Longitude: -72.553891

Watershed: Blanchard Brook (VT DEC Subwatershed 127)

Location: Chestnut Hill Road

Problem Type: Erosion

Identification Source: VTDEC Montpelier Stormwater Infrastructure Mapping Project

Ownership: Private

Classification: 3

Date of Field Data Collection: September 17, 2015

Description of Observed Conditions:

The old concrete culvert to the east of 60 Chestnut Hill Road appears to be undersized and should eventually be replaced. For now, a splash pad beneath the outfall would help reduce localized erosion.

Field Photos

Photo 1. A splash pad at the outfall could reduce localized erosion.

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
1	2	2	1	N	Y	Y	N

Problem Area Data Sheet

Problem Area ID: BB-13	Latitude: 44.262167	Longitude: -72.553011

Watershed: Blanchard Brook (VT DEC Subwatersheds 127/129)

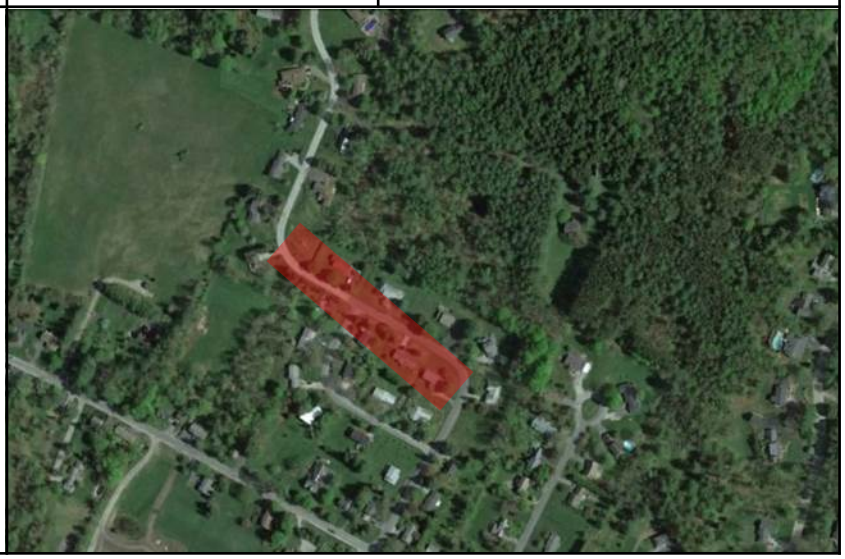
Location: Chestnut Hill Road

Problem Type: Unmanaged impervious

Identification Source: SWMP Assessments

Ownership: City

Classification: 6



Date of Field Data Collection: September 17, 2015

Description of Observed Conditions:

Stream channel is currently unraveling below the road; this channel was partially stabilized following a 2008 storm event. Removing the curb on the east side of the street below 135 Phillips Road would allow for a grassed swale to manage stormwater runoff.

Field Photos

Prioritization Ranking Factors

Relative Impact	Frequency	Current Condition	Urgency	Impact to public infrastructure?	Realistic to fix?	Impacts beyond water resources?	Part of a larger or systemic problem?
1	2	2	1	Y	Y	N	N

Appendix D. Details of Anticipated Regulatory Requirements

There are currently several state-level rulemaking and other regulatory initiatives – most stemming from the passage of Vermont's Clean Water Act (Act 64) in June of 2015 – that have important implications for the City of Montpelier. Rulemaking is underway related to stormwater runoff from municipal roads and management of combined sewer overflows. While changes in post-construction stormwater permitting for existing properties with over 3 acres of unpermitted impervious surface are a few years away, the DEC Stormwater Program recently recommended to the Legislature that the state's post-construction permitting threshold for new impervious cover be lowered to 0.5 acres (from the current 1 acre or more of impervious cover for new construction).

The status of and key points for each of these efforts is included below—but it is important to be aware that much of this information is evolving and may not be fully resolved for some time to come.

D.1 Municipal Roads

Act 64 created a new permit process for municipalities aimed at addressing stormwater run-off from local roadways, both paved and unpaved. Phased implementation of a new general permit for municipal roads will begin in 2018, with all municipalities signed up by 2021[1]. As currently envisioned, municipalities will first be required to develop a long-term (e.g., 20-year) transportation capital plan, which will include an implementation schedule that prioritizes the most impactful projects. Outreach from VTrans and DEC to Regional Planning Commissions and towns began in late winter of 2016, and a stakeholder process to develop the general permit and standards has proceeded through spring and summer of 2016.

The general permit will require:

- A management plan to oversee implementation and bring roads up to standards over a period of several years. The general permit will *not* require separate approval for every maintenance activity or upgrade.
- Implementation of practices to reduce erosion and stormwater discharges being generated from roads and drainage systems. New roads will likely continue to be permitted as they are now. All practices will be required to be consistent with the VTrans Road and Bridge standards[2].
- The general permit will likely include requirements for increased street cleaning activities for all roads with curb-and-catchbasin systems that discharge within 500 feet of surface waters. The requirements could range from cleaning all catchbasins within 5 years, to weekly street sweeping, to

[1] http://dec.vermont.gov/watershed/stormwater/permit-information-applications-fees/municipal-roads-program

[2] http://localroads.vermont.gov/sites/localroads/files/files/resources/materials/Vermont-Town-Road-and-Bridge-Standards.pdf

leaf management, to stabilizing eroded drainage outfalls. Towns will likely be able to pick one or more options. While the City is already regularly completing a number of these activities, is important for a city the size of Montpelier to keep abreast of developments in this area, as adjustments to current practice may become necessary.

D.2 Developed Lands - Post-Construction Stormwater Management

Several reports and guidance documents have recently been released by the DEC Stormwater Program, in accordance with the overall timeline established in Act 64 and in the Lake Champlain Phosphorus TMDL Phase I Plan:

- Development of a stormwater management practices handbook for sub-jurisdictional activities was due January 1, 2016. The Green Stormwater Infrastructure Simplified Sizing Tool and guidance, developed by Stone for VLCT with funding and support from DEC, may be used by DEC to meet this deliverable (see http://www.vlct.org/municipal-assistance-center/water-resources-assistance/).This tool and guidance is most applicable for development and re-development projects with less than half an acre of impervious cover following project completion.

- A report on lowering the state's post-construction stormwater management permitting threshold for impervious surfaces from one acre to 1/2 acre was delivered to the Legislature on January 15, 2016. In the report, the DEC Stormwater Program recommended lowering the threshold. Although testimony related to this report was taken in the House Fish, Wildlife & Water Resources Committee, this initiative is not currently included in any session bill. If the Legislature ultimately votes to lower the jurisdictional threshold for post-construction stormwater permitting, it is likely that this permit program will capture a somewhat greater portion—though not the entirety—of development and re-development activity in the City.

- The revised Vermont Stormwater Management Manual entered the formal rule-making process in late August 2016, and the public comment period begins on September 15, 2016[3].

- Not imminent, but still important: All developed properties with 3 or more acres of impervious surface will eventually require a state stormwater permit. The developed lands general permit must go into effect before January 2018, with all projects in the Lake Champlain basin under a permit and with retrofit plans in place by 2023. If a site does not have a stormwater system designed to the 2002 Vermont Stormwater Management Manual or more current standards, it will need to implement stormwater management practices. The City could be proactive in identifying all parcels, or at least all publicly owned parcels, containing more than 3 acres of impervious cover, which will likely fall into jurisdiction under this program. The City could seek ERP grant funding for addressing runoff from City-owned properties, if any. Implementation funding could also come from other sources, such as VTrans TAP or the CWSRF.

D.3 Combined Sewer Overflows

DEC recently adopted substantial changes to Vermont's Combined Sewer Overflow (CSO) Rule for the first time since it was promulgated in 1990. The revised rule was adopted on August 28, 2016 and became effective on September 15, 2016. The rule contains a number of significant changes, including:

[3] http://dec.vermont.gov/watershed/stormwater/manual_update

- A requirement to implement the full suite of minimum control measures outlined in the federal CSO Policy. New requirements for Vermont communities include:
  - **Review and modification of pretreatment requirements**, which generally involves developing an inventory of non-domestic dischargers, assessing potential volume- and pollutant-related impacts of these facilities during wet weather events, evaluating the feasibility of modifying pretreatment program requirements for these dischargers, and then implementing requirements as necessary.
  - **Control of solids and floatable materials**, which is typically accomplished by implementing one or more of the following activities: preventing extraneous solids and floatables from entering the sewer system via street sweeping; discouraging households from flushing personal hygiene products; using physical controls (e.g., catch basin hoods, baffles, end-of-pipe netting systems) to keep floatables in the sewer system or capture them before discharge.
  - **Establishment of a pollution prevention program**, which may include activities such as hazardous waste collection, bulk refuse disposal, product bans or substitutions to reduce problematic packaging waste (e.g., plastic shopping bags), and water conservation.
  - **Public notification activities**, such as: posting informational signs near CSO outfalls, posting affected use areas (e.g., swimming holes), and maintaining a website to keep the public apprised of problems and changing conditions. Vermont's draft CSO policy goes further than the federal policy by proposing to require event reporting as follows (and as described on DEC's website:
    - WWTFs are required to submit a public alert as soon as possible, but no longer than one hour from discovery of an untreated discharge from the wastewater treatment facility. This time requirement is extended to no longer than four hours if the operator does not have telephone or internet service at the location or they are working to control or stop the untreated discharge. Sewer Overflow and Release Incident Reports provide additional details on these events and are required to be reported by WWTFs within 12 hours of discovery.
- A requirement for Vermont communities to develop a long-term control plan (LTCP), as opposed to relying on engineering studies. The federal CSO Policy lists minimum elements that should be addressed, as appropriate, in the development of an LTCP. These are:
  - Undertaking system characterization, monitoring, and modeling activities to support the selection and implementation of cost-effective CSO controls;
  - Coordination and communication with the public and regulatory agencies for the purpose of discussing proposed controls. Vermont's draft policy requires a public participation process involving the affected public, including persons who reside downstream from the CSO outfalls and persons who use and enjoy downstream waters;
  - Give priority to controlling CSOs that discharge to sensitive areas, such as waters with primary contact recreation, public drinking water intakes, or waters with threatened or endangered species;
  - Evaluate and consider a reasonable range of control alternatives. Vermont's draft policy specifically encourages municipalities to evaluate and implement green stormwater infrastructure approaches to the greatest extent possible;

- Develop cost/performance curves to compare control alternatives in relation to performance, cost, and environmental benefit in choosing the most appropriate solution;
- Develop an operational plan that provides a framework for the coordinated operation of the combined sewer system in a manner that reduces overflows and provides maximum levels of treatment to wet weather flows;
- Develop an implementation schedule, based on a combination of financial, environmental, and other site-specific factors; and,
- Conduct post-construction compliance monitoring to aid in determining the effectiveness of the controls.

- Prohibition of the connection of new sources of stormwater or wastewater to any combined sewer system if such connection would result in a net increase of stormwater or wastewater to the combined sewer.
- A requirement to establish and maintain a ***network*** (emphasis added) of precipitation recording stations.
- Updating the design storm recommended as the basis for design from a 24-hour, 2.5 inch storm and a peak flow derived from a precipitation event of greater than 1.07 inches in one hour, to location-specific 24-hour and 1-hour design storms with a 5-year recurrence interval. For Montpelier, this would increase the 24-hour storm depth to 2.8 inches, and the 1-hour storm depth to 1.2 inches.

D.4 Water Quality Criteria for Chlorides

In 2014, Vermont promulgated water quality criteria for chlorides. Elevated chloride concentrations have been shown to have adverse impacts on aquatic biota. These effects are often most strongly felt in small streams in more densely developed areas or in close proximity to transportation corridors, where excess chloride from de-icing salts used on road surfaces and parking lots can have a demonstrable impact. Studies in New Hampshire have shown that as much as half of in-stream chloride loads can be traced to private roadways and parking lots.

The volume of the Winooski River as it passes through the City is such that chloride use in Montpelier is unlikely to cause a contravention of the chloride water quality standard in that water body. In smaller streams, such as the Stevens Branch or Blanchard Brook, chloride use could have a measurable impact. It is important to be aware of potential chloride concerns because in other cold weather states, including New Hampshire and Minnesota, Total Maximum Daily Load (TMDL) plans have been required to clean up water bodies that have deemed by the state to be chloride-impaired. Further, managing chloride in stormwater runoff is different and more challenging than managing other common stormwater pollutants such as sediment and phosphorus. Chloride is highly soluble and is conservative, meaning that once it is mixed into stormwater it generally cannot be removed using typical stormwater best management practices, such as swales, basins, or ponds.

D.5 Integrated Water Quality Planning

Integrated water quality planning is a voluntary option that EPA has made available nationally for regulated municipalities, which allows communities with numerous Clean Water Act (CWA) obligations to:

- Examine all of these obligations as a whole;

- Identify the community's relative priorities for addressing human health and water quality improvements (and what tools will used preferentially, such as green infrastructure); and then
- Address these priorities through appropriate sequencing and scheduling of work based on implementing projects with the highest cost benefit (including non-water quality benefits) first.

The goal of integrated planning is to examine and evaluate, at a high level, the multitude of strategies that exist for achieving established watershed management goals. Integrated planning may be important for the City because the Lake Champlain Phosphorus TMDL is anticipated to require significant investments in municipal wastewater treatment facilities throughout the Champlain basin, and the Montpelier Water Resources Recovery Facility will be no exception. Resources invested in the wastewater treatment facility will, by definition, not be available for other water quality initiatives. Integrated water quality planning provides a framework for considering local priorities in achieving the human health and water quality objectives of the CWA that might, for example, delay investment in the WRRF in order to prioritize implementation of stormwater controls.

The integrated water quality planning process also allows permittees to undertake a financial capability analysis, which can be used to evaluate sustainable spending levels for the cumulative investment needed to meet all CWA obligations. The financial capability analysis can then feed into discussions and permitting timelines that may allow for longer compliance schedules than those typically dictated in State permits.

The City of Burlington is currently pursuing an integrated water quality planning initiative; it may be instructive for Montpelier to track this effort and consider whether a similar approach may be applicable to the City.

Appendix E. Concept Designs for Priority Stormwater Problem Areas

STONE ENVIRONMENTAL

535 Stone Cutters Way / Montpelier / VT / 05602 / USA
802.229.4541 / info@stone-env.com / www.stone-env.com

July 5, 2016

MEMO

To: Mike Miller
Tom McArdle

From: Julie Moore, P.E.

Stone Project No. 15-097
Subject: Montpelier Stormwater Master Planning – Vermont Route 12 South, Green Streets opportunities

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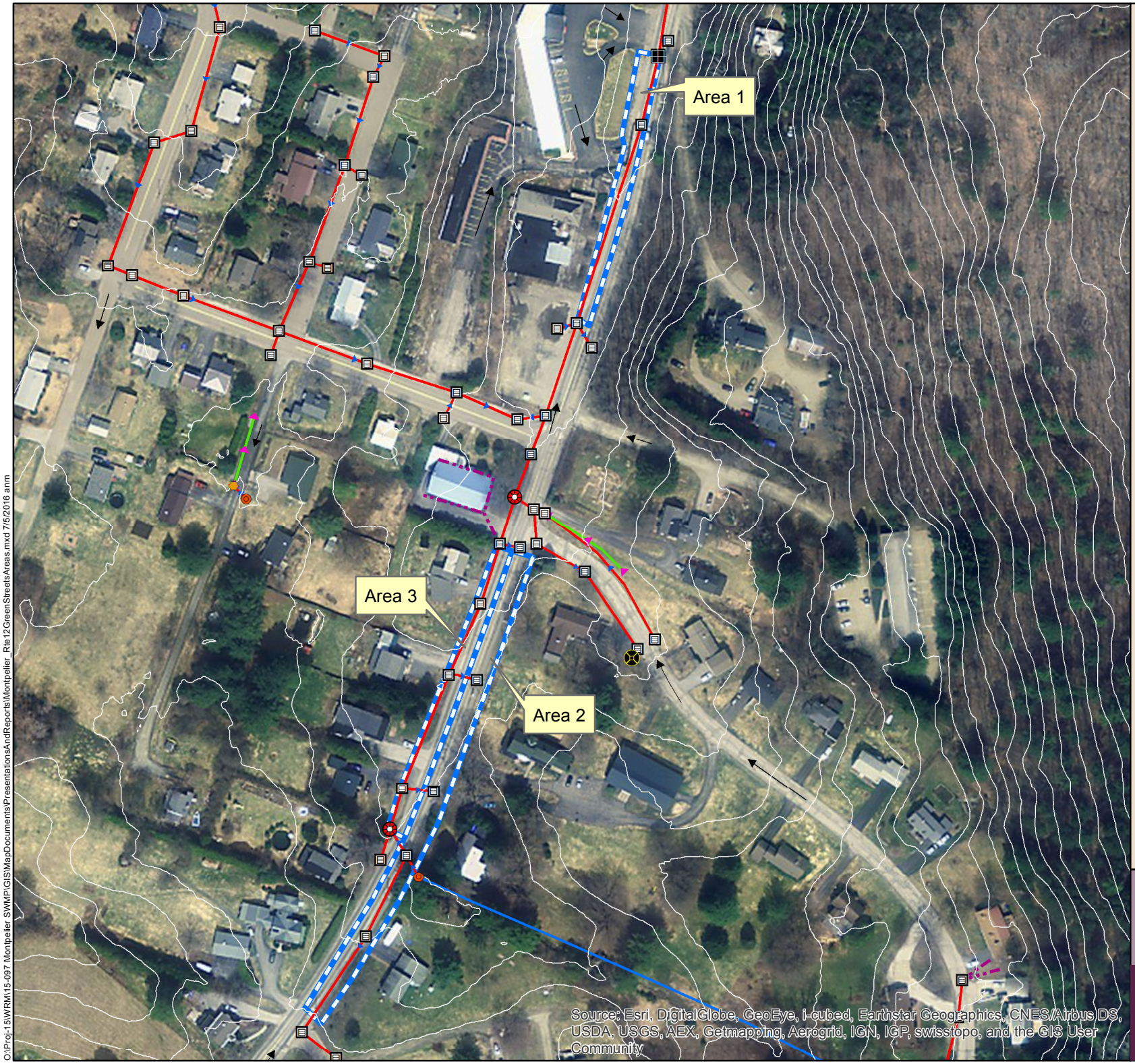
On June 21, 2016, Stone completed a field screening that identified three stormwater management opportunities associated with the upcoming full-depth reconstruction of Vermont Route 12 between the Memorial Drive intersection and Freedom Drive. Stone recorded observations about each area, including current conditions and areas for improvement, with particular attention to green stormwater infrastructure retrofits that could be opportunistically completed in coordination with the full-depth reconstruction work. The three primary areas of interest are highlighted on the attached map and further described on the following pages. This memo makes direct reference to previously-submitted design concepts developed by GPI for other areas in the City that would also have application in the Route 12 corridor.



N

0 80 160 Feet

LiDAR Contours (2 ft. elevation)
Drainage Area
River or Stream

Sources: Stormwater Infrastructure: DEC and City of Montpelier; LiDAR, Roads: VCGI; Streams and Waterbodies: NHD Plus 2.

Note: Streamlines on this map were delineated by DEC using a 10-meter DEM (20-foot contour interval), and have not been corrected to the LiDAR-generated topographic contours.

STONE ENVIRONMENTAL INC

VT Rte. 12 Green Streets Opportunities

Map #1

City of Montpelier Stormwater Master Plan

O:\Proj-15\WRM\15-097 Montpelier SWMP\GIS\MapDocuments\PresentationsAndReports\Montpelier_Rte12GreenStreetsAreas.mxd 7/5/2016 anm

1. Area 1: Econolodge Stormwater Swale

The western side of Northfield St. near the Econolodge, from roughly in front of the abandoned restaurant building to the catchbasin at the main entrance to the motel, currently drains to the catch-basin at the northeast corner of a curbed lawn island in front of the new motel building. The curbed lawn area appears to end at the City's right-of-way, which is entirely paved between the lawn and VT Route 12. This paved area could instead be made into a stormwater swale (similar to the College Street Stormwater Swale concept), with an underdrain tying back into the storm drainage system at the northern end of the facility. The success of this concept depends largely on potential conflicts with other underground infrastructure, particularly the water system.

Area 1, potential stormwater swale treatment area, looking south (left) and north (right).

2. Area 2: Stormwater Swales, Colonial Drive Loop

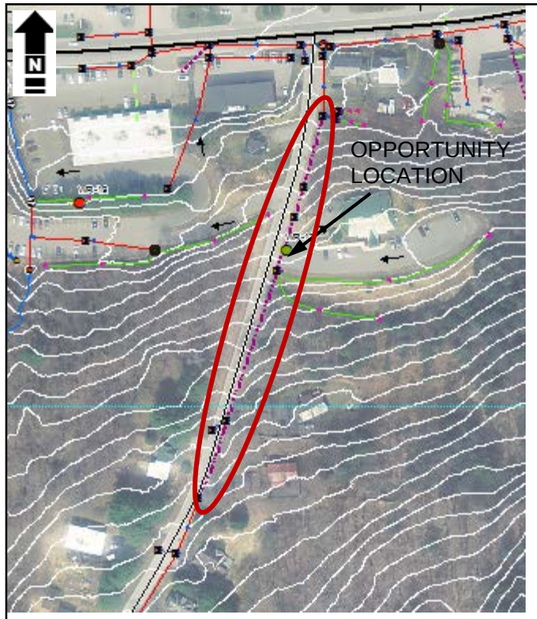
Along the eastern side of Northfield Street, between the northern and southern intersections with Colonial Drive, is a substantial opportunity to retrofit the existing three-foot-wide green strip between the pavement edge and the sidewalk into a stormwater swale. This concept would also be similar to the College Street Stormwater Swale concept, but with a narrower width to fit within the existing green strip (more like Stormwater Planters concept from the Heney-Jacobs Parking Lot opportunity sheet). The roadway in this area is not curbed, and catch basins on this side of the road already tie to the stormline on the west side, so underdrains in the retrofit stormwater swales could be tied back into the existing closed drainage system without disturbing the existing infrastructure.

Area 2, potential stormwater swale treatment area, looking south (left) and north (right).

3. Area 3, Stormwater Swales, Derby Drive South

Along the west side of Northfield Street across from Area 2, there is an opportunity to retrofit existing grass swales into stormwater swales, particularly in front of the four houses south of the Lutheran Church. This concept would also be similar to the College Street Stormwater Swale concept, but modified as necessary to fit within the existing right-of-way. Based on parcel mapping, the right-of-way appears to be very constrained on this side of the road as compared to Area 2, and so this opportunity may require negotiation with the abutting landowners beyond what would be reasonable within the anticipated timeline for the roadway reconstruction project. At minimum, however, care should be taken to maintain sheetflow from the roadway into the grass swales, to minimize short-circuiting of runoff flowing down the road shoulder and directly to catch-basins rather than traveling into the grass swales.

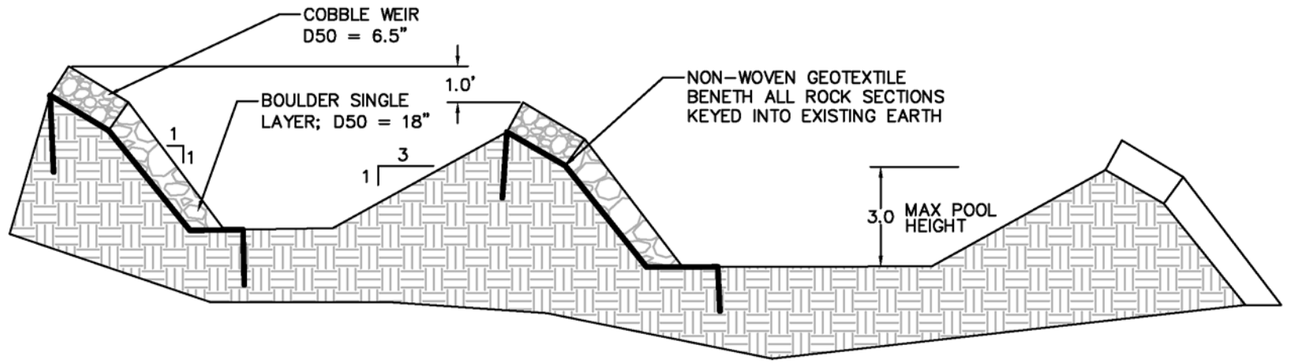
Area 3, potential stormwater swale treatment area, looking south.



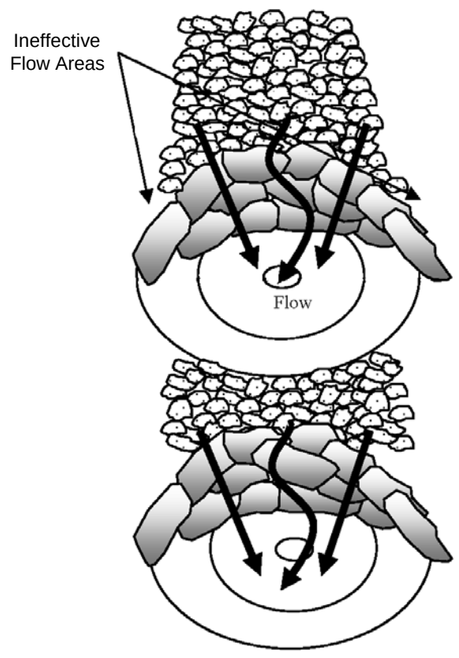

Existing steep but stable grass and stone-lined swale


Existing catch-basin entering City's closed drainage

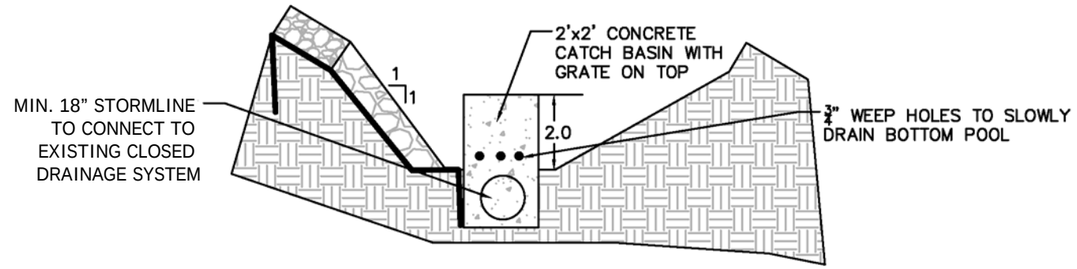
STEP POOL CONVEYANCE, CROSS-SECTION (TYPICAL)



RIFFLE-POOL SEQUENCE FOR STEP POOL CONVEYANCE, PLAN VIEW (TYPICAL)



STEP POOL INLET RETURNING TO CLOSED DRAINAGE SYSTEM, CROSS SECTION (TYPICAL)



Step-Pool Conveyance Design Guidance

- AREAS OF THE EXISTING SWALE WHERE SLOPE IS >10% ARE RECOMMENDED FOR RETROFIT AS STEP-POOL CONVEYANCE
- A STEP POOL CONVEYANCE USES A SERIES OF SHALLOW POOLS AND RIFFLE OR CASCADE GRADE CONTROLS TO CONVEY STORM FLOW. IT CAN BE USED IN PLACES WEHRE STEEP SLOPES MAKE TRADITIONAL STORMWATER CONVEYANCES DIFFICULT TO IMPLEMENT AND MAINTAIN, ESPECIALLY DURING HIGH-INTENSITY STORMS.
- CONSTRUCTED DEPTH OF TYPICAL POOLS SHOULD NOT BE LESS THAN 18" AND SHOULD NOT EXCEED 3'.
- POOLS SHOULD BE CONSTRUCTED WITH A MINIMUM SIDE SLOPE OF 3:1 H:V TO ENSURE STABILITY.
- STEP POOLS SHOULD BE PARABOLIC IN SHAPE.
- NON-WOVEN GEOTEXTILE MAY BE PLACED BETWEEN COBBLE/ROCK SECTIONS AND EXISTING EARTH AND KEYED INTO BANK AS SHOWN. TO PREVENT UNDERCUTTING, A CONTINUOUS SHEET OF FILTER FABRIC SHOULD BE USED ALONG THE CROSS-SECTION.
- ROCK 'COBBLE WEIR' AT POOL SPILLOVER TO BE 1' THICK. ROCK SIZE IS D50 = 6". ROCK 'BOULDER LAYER' IN STEP POOL TO BE SINGLE LAYER THICK. ROCK SIZE IS D50 = 18".
- LINING THE BOTTOMS OF THE STEP POOLS WITH RECYCLED GRANITE CURBING IS RECOMMENDED TO FACILITATE CLEANOUT, ESPECIALLY WITHIN THE FIRST POOL IN A SERIES.
- IF POSSIBLE, IMPROVEMENTS TO THIS SWALE SHOULD ENCOMPASS INSTALLATION OF A NEW CATCHBASIN AND STONE LINING OF WESTERN 10 FT. OF DITCH AT THE ENTRANCE TO VERMONT NEA (PHOTO AT LEFT).
- AREAS OF THE EXISTING SWALE WHERE SLOPE IS 5-10%, IF ANY, MAY BE CONSTRUCTED AS STONE-LINED SWALES, FOLLOWING BETTER ROADS GUIDANCE AS PRESENTED IN CONCEPT DESIGN SHEET #E-3.

Plan view image source: http://www.dep.wv.gov/WWE/Programs/stormwater/MS4/Documents/Specification_4.2.7_Regenerative_Stormwater_Conveyance_WV-SW-Manual-11-2012.pdf

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Montpelier Stormwater Master Plan

**Wheelock Street (WR-12):
Step-Pool Conveyance Improvements to Existing Stone-Lined Swale**

DESIGNED BY:	ANM	DATE:	8/23/2016
DRAWN BY:	ANM	DATE:	9/1/2016
CHECKED BY:	JSM	DATE:	9/2/2016

SHEET: E-1
PROJECT NO.: 15-097

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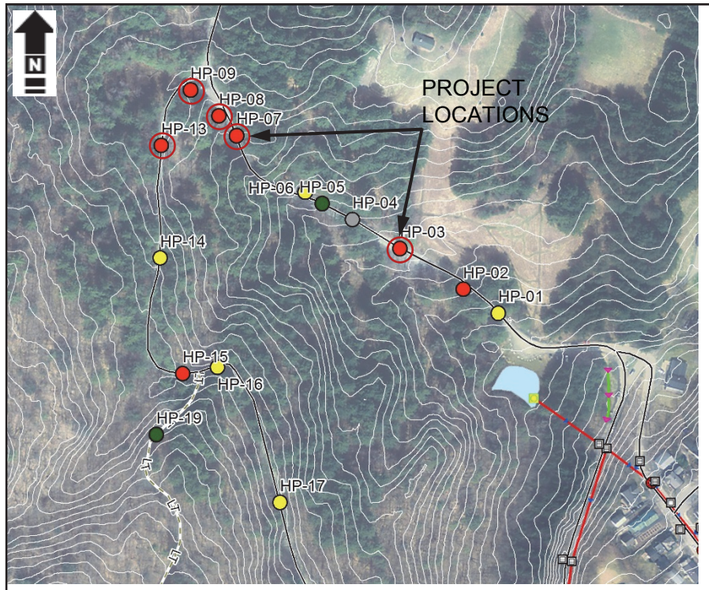


Construction Guidance:

- PLUNGE POOL / SEDIMENT BASIN CAPACITY, BETTER BACKROADS GUIDANCE:
  - <200 FT BETWEEN CROSS CULVERTS = 100-200 CF BASIN VOLUME
  - RECOMMEND MAXING OUT VOLUME FOR THE AVAILABLE SPACE WHERE FEASIBLE
  - MINIMUM 6” RIPRAP DEPTH AS ARMORING AT BASIN INLETS AND AT OVERFLOW/OUTLET POINTS
  - LANDSCAPE SETTING POTENTIALLY ALLOWS FOR LARGER BASINS AT CULVERT OUTLETS AT HP-03, HP-08 AND HP-09. LARGER BASIN NOT NECESSARY AT HP-13.
- CONSTRUCT PLUNGE POOLS / SEDIMENT BASINS TO MINIMUM DIMENSIONS AS FOLLOWS:
  - HP-03: EXCAVATE AND CONSTRUCT BASIN AT OUTLET OF EXISTING CULVERT. MINIMUM DIMENSIONS: 28” DEEP, 56” WIDE, 112” LONG; ADJUST AS NECESSARY OR DESIRED TO FIT AVAILABLE SPACE AND EXISTING SLOPE. PLACE RIPRAP AT OUTFALL AND DOWNSLOPE OVERFLOW POINT. USE BASIN AT HP-04 AS MODEL.
  - HP-07: CREATE TURNOUT APPROXIMATELY HALFWAY BETWEEN TOP OF DITCH/SLOPE AND OUTLET TO STREAM. EXCAVATE AND CONSTRUCT BASIN AT TURNOUT, MINIMUM DIMENSIONS AND RIPRAP PLACEMENT AS FOR HP-03. SEE SHEET 2 FOR ROCK APRON DETAIL AT TURNOUT.
  - HP-08: CLEAN OUT AND DEEPEN/RE-SHAPE EXISTING SEDIEMNTATION BASIN, USING HP-03 DIMENSIONS AS GUIDE. INSTALL RIPRAP AT OVERFLOW POINT. SEE SHEET 2 FOR ENDWALL AND STONE-LINED DITCH DETAILS.
  - HP-09: EXCAVATE AND CONSTRUCT BASIN AT OUTLET OF EXISTING CULVERT. MINIMUM DIMENSIONS AS FOR HP-03. PLACE RIPRAP AT OUTFALL AND DOWNSLOPE OVERFLOW POINT.
  - HP-13: LOCATE AND CLEAN OUT DOWN-SLOPE END OF CULVERT. INSTALL HEADWALL AND CONSTRUCT PLUNGE POOL AT DOWN-SLOPE END OF CULVERT. MINIMUM DIMENSIONS: 18” DEEP, 36” WIDE, 72” LONG. SEE SHEET 2 FOR CULVERT ENDWALL DETAILS.

Materials Estimate: Plunge Pools/Sedimentation Basins (per basin)

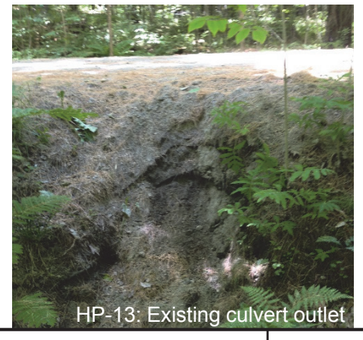
Item	Quantity	Unit
Excavation	4	CY
#4 riprap, placed	1	CY


HP-03: Existing culvert outlet

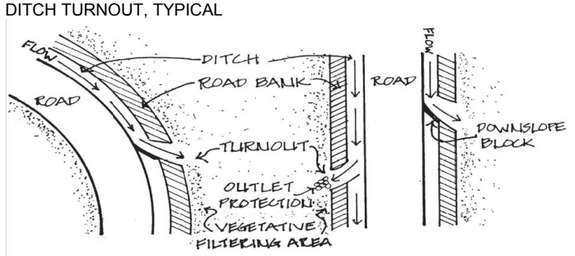

HP-07: Existing ditch


HP-08: Existing basin and ditch

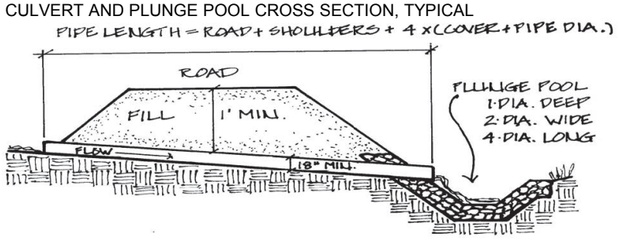

HP-09: Existing culvert outlet


HP-13: Existing culvert outlet

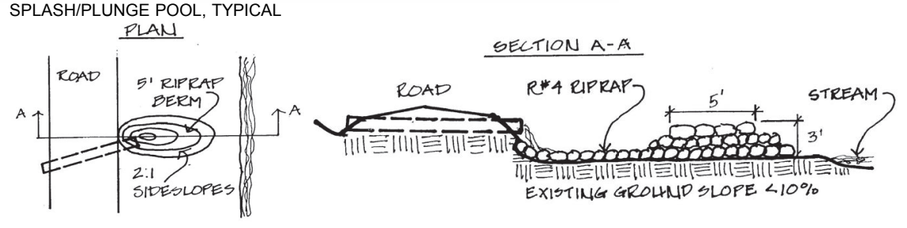
DITCH TURNOUT, TYPICAL



CULVERT AND PLUNGE POOL CROSS SECTION, TYPICAL



SPLASH/PLUNGE POOL, TYPICAL



Schematics from the Better Backroads Manual, 2009. Http://vtransengineering.vermont.gov/sites/aot_program_development/files/2009%20Better%20Backroads%20Manual.pdf

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Montpelier Stormwater Master Plan

Hubbard Park: Plunge Pools / Sediment Basins

DESIGNED BY:	ANM	DATE:	6/22/2016
DRAWN BY:	ANM	DATE:	7/1/2016
CHECKED BY:	JSM	DATE:	7/5/2016

SHEET: E-2
PROJECT NO.: 15-097

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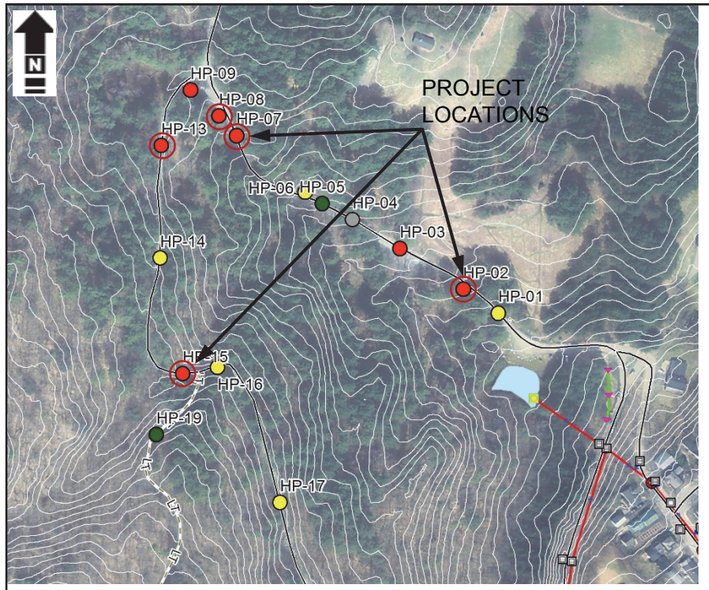
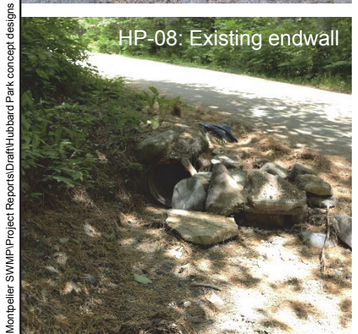


Construction Guidance:

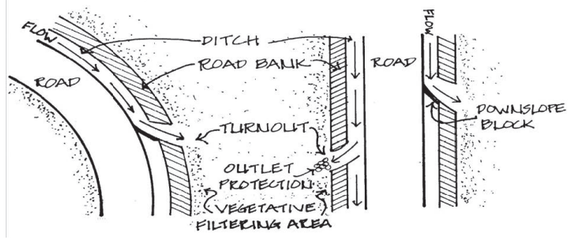
- HP-02: CLEAN OUT AND DEEPEN TURNOUTS PER TYPICAL DETAIL.
- HP-07: INSTALL ROCK APRON ON SLOPE BETWEEN DITCH TURNOUT AND STREAM. ROCK APRON DIMENSIONS: 18" DEEP, 4.5' WIDE AT TOP OF APRON, 14.5' WIDE AT BOTTOM OF APRON, 10' LONG. ADJUST LENGTH AS NECESSARY IF DISTANCE BETWEEN DITCH TURNOUT AND STREAM IS LESS THAN 10 FEET.
- HP-08: REPAIR CULVERT ENDWALL PER HEADER TYPICAL DETAIL. RESHAPE AND STONE LINE DITCH ON UPSLOPE SIDE OF CULVERT. STONE LINED DITCH VOLUMES:
  - EXCAVATION: 3' DEEP, 2' BOTTOM WIDTH, 2:1 SIDES.
  - ASSUME AGGREGATE VOLUME AT MIN MUST BE EXCAVATED, SO:
    - 21 CF PER LF X 50 LF = 1050 CF = 39 CY
  - STONE LINED DITCH MATERIAL:
    - EROSION CONTROL STONE
    - 1 FT DEPTH X 14 FT WIDTH =14 CF/LF X 50 LF = 700 CF = 26 CY
- HP-13: LOCATE AND CLEAN OUT DOWN-SLOPE END OF CULVERT. REPAIR CULVERT ENDWALL (OR INSTALL ENDWALL) PER TYPICAL DETAIL. SEE SHEET 1 FOR PLUNGE POOL DESIGN DETAILS.
- HP-15: REPAIR CULVERT ENDWALL PER TYPICAL DETAIL. INSTALL ROCK APRON AT DOWN-SLOPE END OF CULVERT, USING DIMENSIONS FROM HP-07.

Materials Estimates:

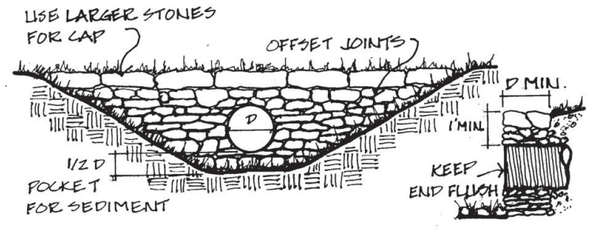
Item	Quantity	Unit
Rock Apron (HP-07 and HP-15, per outlet)		
#4 riprap, placed	5	CY
Stone-Lined Ditch (HP-08)		
Excavation	39	CY
#4 riprap, placed	26	CY



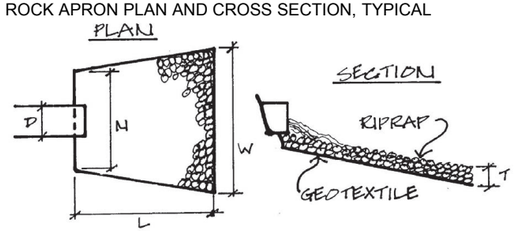
DITCH TURNOUT, TYPICAL



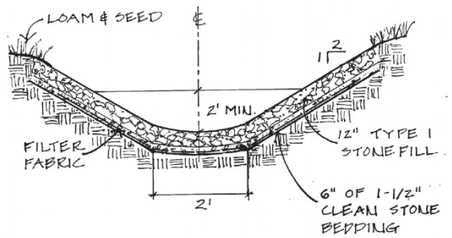
CULVERT HEADER, TYPICAL



ROCK APRON PLAN AND CROSS SECTION, TYPICAL



STONE LINED DITCH, TYPICAL



Schematics from the Better Backroads Manual, 2009. Http://vtransengineering.vermont.gov/sites/aot_program_development/files/2009%20Better%20Backroads%20Manual.pdf

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Montpelier Stormwater Master Plan

Hubbard Park:
Turnouts, Stone-Lined Ditches, Culvert Headers, and Stabilized Outfalls

DESIGNED BY:	ANM	DATE:	6/22/2016
DRAWN BY:	ANM	DATE:	7/1/2016
CHECKED BY:	JSM	DATE:	7/5/2016

SHEET: E-3
PROJECT NO.: 15-097

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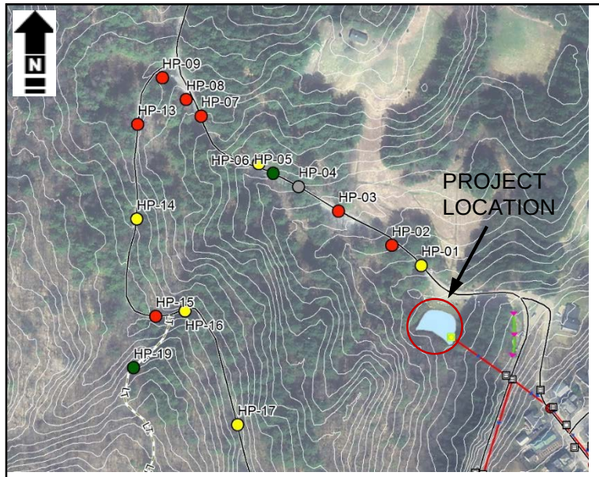
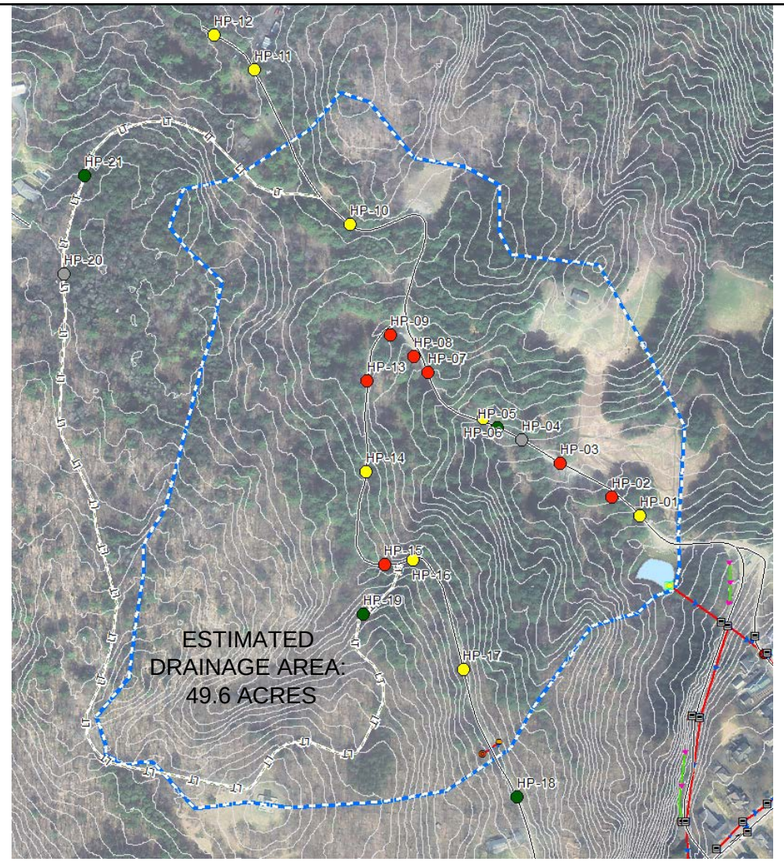



Existing pond inlet, looking downstream


Existing pond inlet, looking upstream

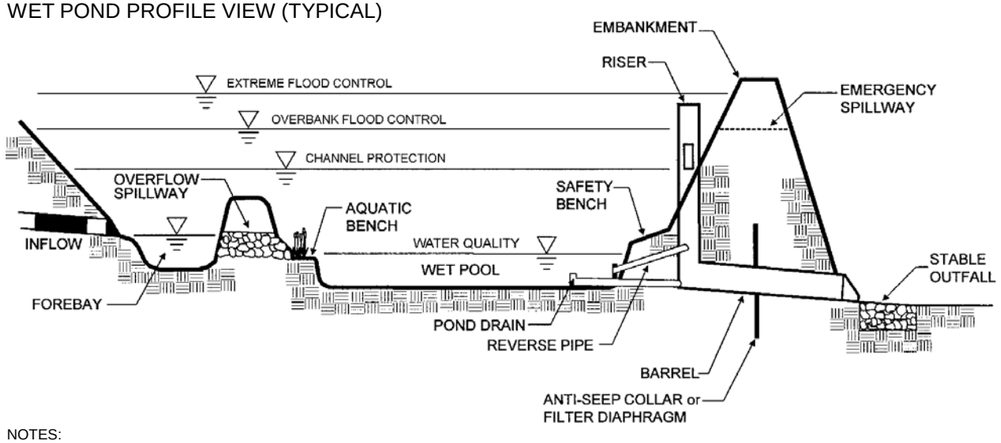



Existing pond outlet structure

Design Guidance:

- IMPROVEMENTS AT THE POND SHOULD BE IMPLEMENTED AFTER THE HIGH PRIORITY AREAS OF EROSION ALONG PARKWAY STREET AND CORSE STREET/TOWER LOOP ARE STABILIZED (SEE FIGURES XX AND YY) .
- IMPROVEMENTS IN CERTAIN UPSTREAM AREAS THAT REQUIRE ADDITIONAL ENGINEERING DESIGN , ESPECIALLY POSSIBLE STEP POOL CONVEYANCE AT HP-05, MAY BE CONSTRUCTED AT THE SAME TIME AS IMPROVEMENTS TO THE POND.
- DESIGN IMPROVEMENTS TO THE EXISTING POND RECOMMENDED AS FOLLOWS:
    - EXCAVATE SEDIMENT ACCUMULATION TO RESTORE POND GEOMETRY. CONSIDER EXTENDING POND FOOTPRINT SLIGHTLY TO THE NORTHWEST/INLET END TO INCREASE AVAILABLE AREA FOR SEDIMENT STORAGE.
        - ESTIMATED WATER QUALITY VOLUME (WQV) FOR THE AREA DRAINING TO THE POND IS 0.24 ACRE-FEET (78,200 GALLONS, 10,450 CU. FT.).
        - CURRENT POND SURFACE AREA IS ~5,900 SQ. FT.
    - CONSTRUCT SEDIMENT FOREBAY AT EXISTING POND INLET. THE FOREBAY SHOULD BE SIZED TO CONTAIN AT LEAST 10% OF THE WQV (OR ~1,000 CU. FT.). THE FOREBAY OUTLET SHOULD BE DESIGNED WITH NON-EROSIVE CONDITIONS AND PLACED TO MAXIMIZE THE FLOW PATH OF WATER THROUGH THE FOREBAY.
    - LINING THE BOTTOM OF THE FOREBAY WITH RECYCLED GRANITE CURBING IS RECOMMENDED TO FACILITATE CLEANOUT. ENSURE THAT VEHICHLE ACCESS CAN BE MAINTAINED TO THE FOREBAY FOR EASE OF MAINTENANCE.
    - REPLACE THE EXISTING POND OUTLET STRUCTURE. IF POND VOLUME IS SUFFICIENT, CONSIDER INSTALLING A RISER WITH MULTIPLE OUTLET LEVELS TO RETAIN A PERMANENT POOL AND SOME AMOUNT OF EXTENDED-DETENTION STORAGE FOR LARGER STORMS, WHILE RETAINING A PROTECTED, OPEN RISER TOP FOR RETURN OF LARGER STORM FLOWS TO THE CITY'S CLOSED DRAINAGE SYSTEM.

WET POND PROFILE VIEW (TYPICAL)



NOTES:

- THE EXISTING POND OUTLET STRUCTURE RETURNS STORM FLOWS TO THE CLOSED DRAINAGE SYSTEM. THERE IS NO SEPARATE EMERGENCY SPILLWAY OR STABLE OUTFALL. THIS DESIGN CONCEPT DOES NOT ENVISION THE CONSTRUCTION OF NEW OUTFALLS OR EMERGENCY SPILLWAYS SUCH AS THOSE SHOWN IN THE SCHEMATIC.
- THE AREA AND GEOMETRY AVAIILABLE FOR IMPROVEMENTS TO THE EXISTING POND WILL LIMIT THE POSSIBILITIES FOR EXTENDED DETENTION OF STORM FLOWS GREATER THAN THE WATER QUALITY VOLUME. WHILE THE SCHEMATIC SHOWS THE FULL RANGE OF POSSIBILITIES FOR EXTENDED DETENTION, DETAINING THESE VOLUMES IS NOT LIKELY TO BE FEASIBLE.

Schematic from the Vermont Stormwater Management Manual, 2002. http://dec.vermont.gov/sites/dec/files/wsm/stormwater/docs/Resources/sw_manual-vol1.pdf

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Montpelier Stormwater Master Plan

Hubbard Park: "Frog Pond" Improvements (NB-12)

DESIGNED BY:	ANM	DATE:	9/2/2016	SHEET: E-4
DRAWN BY:	ANM	DATE:	9/2/2016	PROJECT NO.: 15-097
CHECKED BY:	JSM	DATE:	XXXX/2016	

O:\O:\Proj-15\WRM\15-097 Montpelier SW MP\Data\NB-12 frog pond 2016 09 02.pptx

BASIS OF DESIGN

FR-01: THE STREAM EXITING THE SITE HAS TAKEN ON A RUST COLOR. IT SHOULD BE INVESTIGATED FURTHER TO DETERMINE THE CAUSE OF THE DISCOLORATION. IT IS LIKELY THAT THE BRIDGE TRUSS AT FR-02 IS A CONTRIBUTING FACTOR.

FR-02: REMOVE THE BRIDGE TRUSS FROM THE STANDING WATER AND FIND A MORE SUITABLE STORAGE LOCATION.

FR-03: EXCAVATE AND CREATE A SEDIMENTATION BASIN TO ALLOW SUSPENDED SOLIDS TO SETTLE AND VELOCITIES TO SLOW PRIOR TO ENTERING THE ESTABLISHED WATERWAYS.

FR-04: EXCAVATE AND CREATE A STONE-LINED DITCH TO CONVEY RUNOFF FROM THE ROAD SURFACE TO THE SEDIMENTATION BASIN.

FR-05: FR-05 COVERS DITCHING OPPORTUNITIES ACROSS THE ENTIRETY OF THE SITE. THERE IS A SUBSTANTIAL AMOUNT OF SEDIMENT TRANSPORT - DITCHES WITH CHECK DAMS THAT CAN BE REGULARLY CLEANED SHOULD BE INSTALLED. WATER BARS CAN BE CONSTRUCTED TO DIRECT RUNOFF. WATER BARS SHOULD BE CONSTRUCTED IN SUCH A WAY THAT THEY CAN BE EASILY DRIVEN OVER AND WILL WITHSTAND HEAVY VEHICULAR TRAFFIC. TURNOUTS AND SETTLING BASINS CAN ALSO BE INSTALLED IN DITCHES WHERE SPACE ALLOWS.

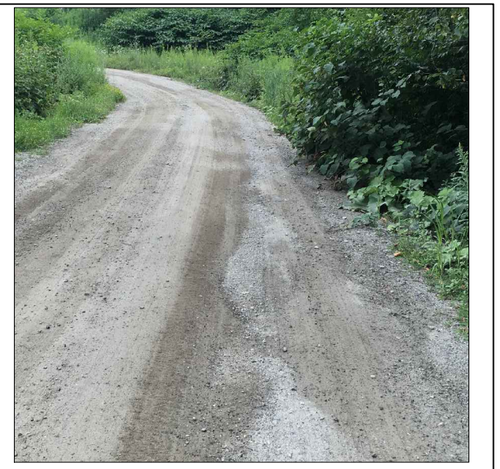
FR-06: THE LOCATION THAT IS BEING USED AS AN OFFLOADING SITE FOR MATERIAL PULLED FROM THE STREET SWEEPER AND CATCH BASIN SUMPS NEEDS TO BE CONTAINED. SILT FENCE SHOULD BE INSTALLED ALONG THE NORTHERN AND EASTERN PORTIONS OF THE DUMPING AREA.

FR-07: ALL ORGANIC MATTER SHOULD BE STORED IN A SINGLE LOCATION. THE LOCATION SHOULD HAVE A THREE-SIDED FENCED-IN AREA THAT CAN OPERATE AS A HOLDING STRUCTURE. IF BUILT OUT OF WOODEN SLATS. THIS AREA CAN OPERATE AS A LARGE COMPOSTING FACILITY. 2-3' SHOULD BE EXCAVATED WITHIN THE ENCLOSURE TO HELP RETAIN AND SLOW RUNOFF FROM THE DECOMPOSING ORGANIC MATTER.

FR-08: EMBANKMENTS ACROSS THE SITE HAVE BEGUN TO SLUMP. THE TOE SHOULD BE STABILIZED IN ACCORDANCE TO THE VEGETATED STONE OR GABION WALL DETAILS. SILT FENCE SHOULD BE PLACED BEYOND THE TOE TO TO HELP PROTECT AGAINST ANY FURTHER SLUMPING. AT THE TOP OF THE EMBANKMENT, FENCING OR BALLARDS SHOULD BE INSTALLED TO DETER INDIVIDUALS FROM DRIVING OR PARKING TOO CLOSE TO THE EDGE. THIS WILL ALSO RESTRICT DUMPING OVER THE EMBANKMENT TO RETAIN THE EXISTING DRAINAGE AREAS AT THE TOE.

FR-01: STAINING IN THE STREAM

FR-02: BRIDGE TRUSS IN STANDING WATER



FR-03/04: DITCHING/SEDIMENT BASIN OPPORTUNITY

FR-05: DITCHING/WATER BAR/TURNOUT AND SETTLING BASIN OPPORTUNITIES

FR-06: VACUUM TRUCK DUMPING SITE

FR-07: ORGANIC MATERIAL DUMPING SITE

FR-07: ORGANIC MATERIAL DUMPING SITE

FR-08: STABILIZE BANK

DRAWING CREDITS

Drawn On: 8/22/16
Drawn By: BAM
Checked On: Date
Checked By: Initials
Project No.: 15-097

REVISIONS

#	Date	Drwn	Chk'd	App'd	Description

DRAWING SCALE

File: O:\Proj-15\WRM\15-097 Montpelier SWMP\CADD\FinchRoad.dwg

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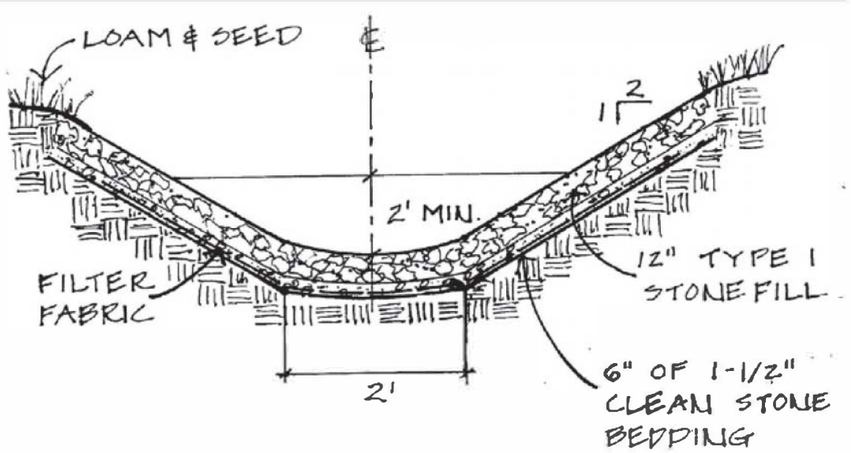
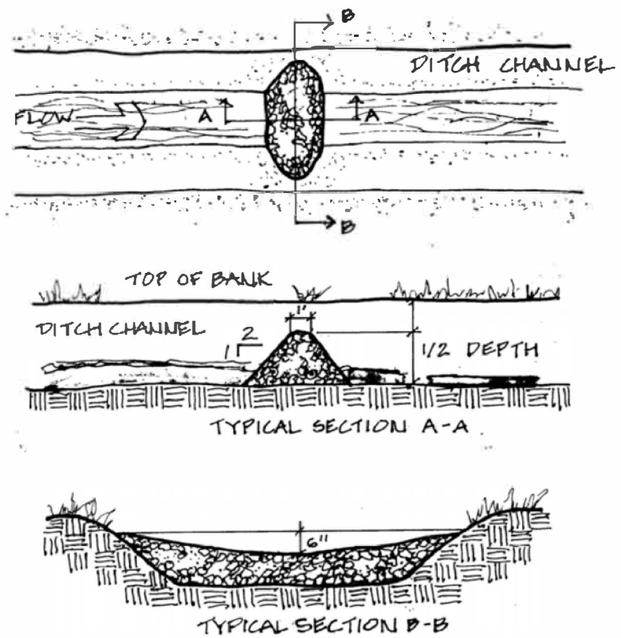
Stormwater Improvements
Finch Road
Montpelier Stormwater Master Plan
Montpelier Vermont

FIGURE NO.

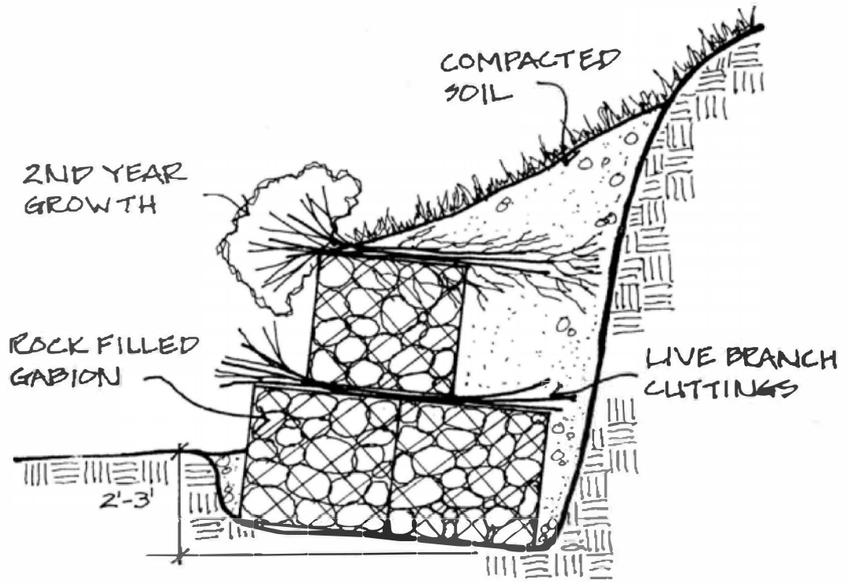
E-5



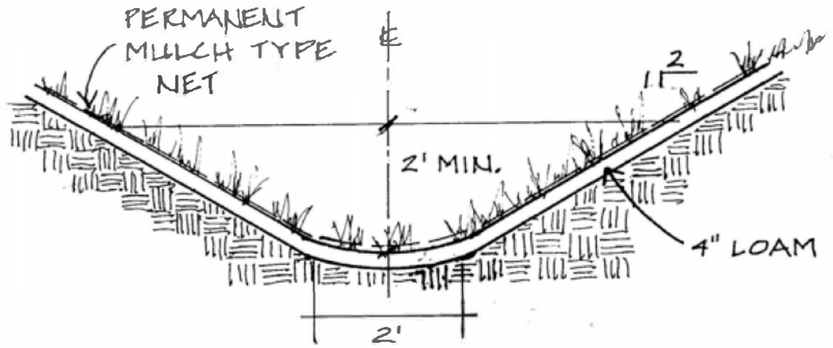
STONE LINED DITCH (TYP.)



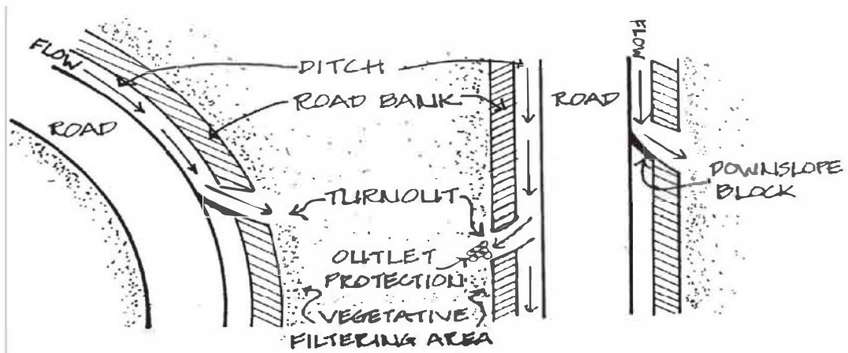
STONE CHECK DAM (TYP.)



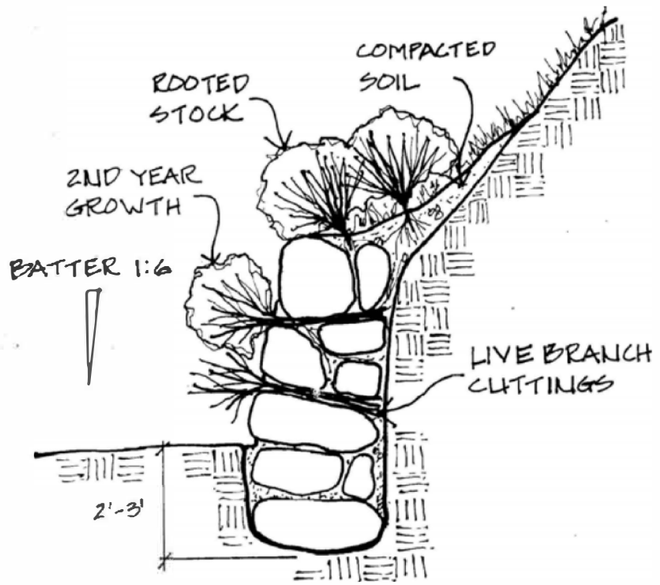
VEGETATED GABION WALL (TYP.)



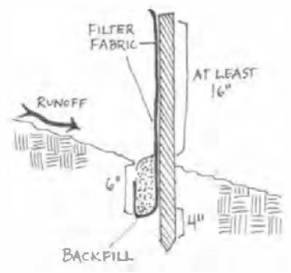
GRASS LINED DITCH (TYP.)

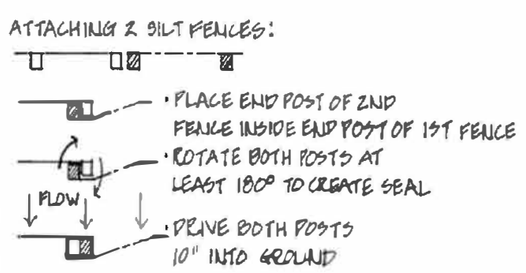


DITCH TURNOUT (TYP.)

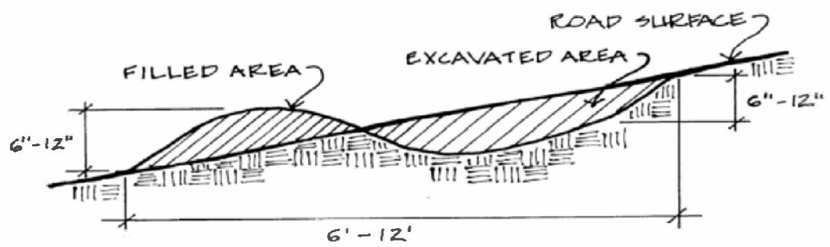


VEGETATED ROCK WALL (TYP.)





SILT FENCE (TYP.)



WATER BAR CROSS SECTION (TYP.)

DETAILS FROM THE VERMONT BETTER BACKROADS MANUAL: http://vtrans.vermont.gov/sites/aot/files/highway/2009%20Better%20Backroads%20Manual.pdf

DRAWING CREDITS

Drawn On:	8/22/16
Drawn By:	BAM
Checked On:	Date
Checked By:	Initials
Project No.:	15-097

REVISIONS

#	Date	Drwn	Chk'd	App'd	Description

DRAWING SCALE

File: O:\Proj-15\WRM\15-097 Montpelier SWMP\CADD\FinchRoad.dwg

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Stormwater Improvements
Finch Road
Montpelier Stormwater Master Plan
Montpelier Vermont

FIGURE NO. E-6

DRAWING CREDITS

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Drawn By: BAM
Checked On: Date
Checked By: Initials
Project No.: 15-097

REVISIONS

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DRAWING SCALE

0 100 200 Feet

File: O:\Proj-15\WRM\15-097 Montpelier SWMP\CADD\HarrisonAvenue.dwg

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Harrison Avenue Stormwater Improvements
Project Layout
Monpelier Stormwater Master Planning

Montpelier Vermont

FIGURE NO.

E-7

HA-03: BEGINNING OF EXISTING DRAINAGE SWALE

HA-07: EXISTING LOW POINT, CONSTRUCT SEDIMENT TRAP

HA-03: LOOKING NORTH UP THE EXISTING DRAINAGE SWALE

HA-05: ESTABLISH A GRASS SWALE ALONG THE EDGE OF ROAD

HA-01--HA-04: DURING ROAD RECONSTRUCTION, RELOCATE SIDEWALK, CAP EXISTING DRAINAGE GRATES, INSTALL NEW SUBSURFACE DRAINAGE TO THE SOUTH SIDE OF THE NEW ROAD, AND INSTALL A DITCH ALONG THE NORTH ROAD EDGE.

BRIDGE OVER EXISTING DRAINAGE SWALE AT SOUTH EDGE

HA-08: UNKNOWN COLLECTION / OUTLET STRUCTURE IN SWALE

DRAWING CREDITS

Drawn On: 8-25-16
Drawn By: BAM
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Project No.: 15-097

REVISIONS

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DRAWING SCALE

File: O:\Proj-15\WRM\15-097 Montpelier SWMP\CADD\HarrisonAvenue.dwg

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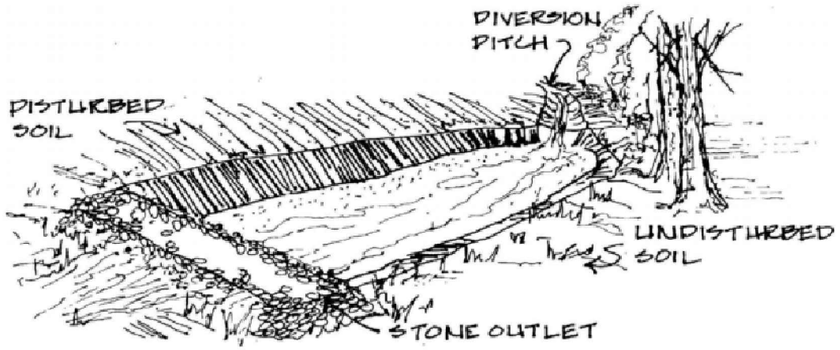
Harrison Avenue Stormwater Improvements
Location Definitions
Montpelier Stormwater Master Planning

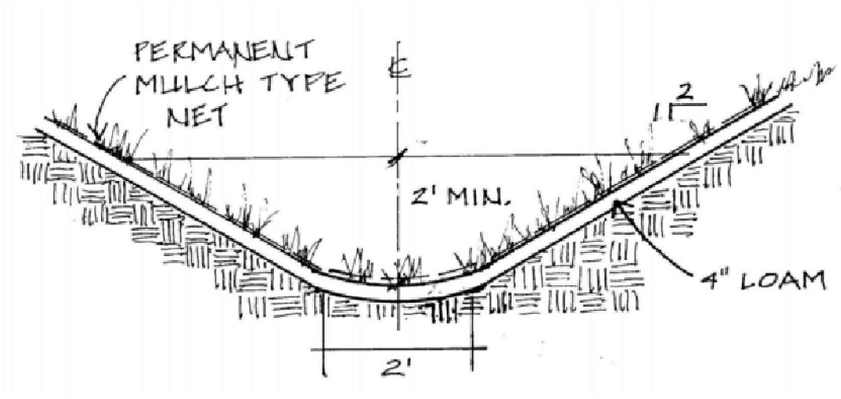
Montpelier Vermont

FIGURE NO.

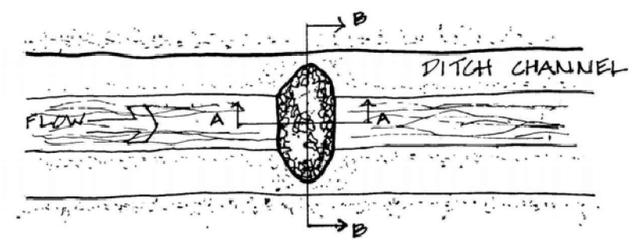
E-8

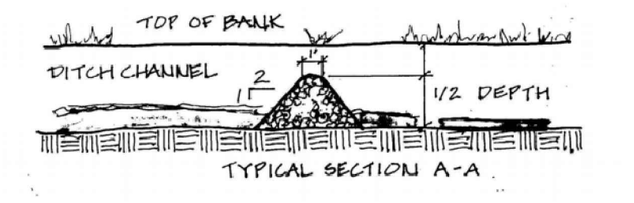


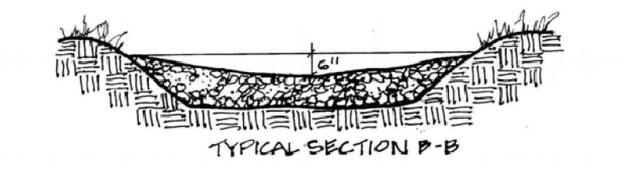
SEDIMENT TRAP (TYP.)



GRASS LINED DITCH (TYP.)







STONE CHECK DAM (TYP.)

BASIS OF DESIGN

HA-01: RELOCATE EXISTING SIDEWALK TO THE SOUTH SIDE OF HARRISON AVENUE

HA-02: CAP EXISTING SUBSURFACE DRAINAGE AND CATCH BASINS ON HARRISON AVENUE.

HA-03: INSTALL NEW SUBSURFACE DRAINAGE AND CATCH BASINS TO THE SOUTH SIDE OF HARRISON AVENUE.

HA-04: INSTALL A GRASS-LINED DITCH AND DRIVE CULVERTS TO THE NORTH SIDE OF HARRISON AVENUE. OUTLET THE DITCH TO THE CATCH BASIN ON THE CORNER OF HARRISON AVENUE AND LOOMIS STREET.

HA-05: ESTABLISH A GRASS SWALE BETWEEN THE SOUTH EDGE OF HARRISON AVENUE AND THE RECREATION FIELD. THE SWALE WILL ULTIMATELY DRAIN TO A SEDIMENT TRAP AT THE WEST EDGE OF THE RECREATION FIELD.

HA-06: RESHAPE EXISTING DRAINAGE SWALE THAT RUNS ALONG THE EAST AND SOUTH EDGES OF THE RECREATION FIELD. OUTLET THE NEW SUBSURFACE DRAINAGE TO THE HEAD OF THE SWALE.

HA-07: INSTALL A SEDIMENT TRAP AT THE WEST EDGE OF THE RECREATION FIELD. DISCHARGE NEW SUBSURFACE DRAINAGE TO THE SEDIMENT TRAP. TRAP TO OUTLET TO HA-08.

HA-08: DETERMINE OUTFALL LOCATION AND REPLACE WITH A HORIZONTAL ORIFICE AND TRASH RACK.

DETAILS FROM THE VERMONT BETTER BACKROADS MANUAL: http://vtrans.vermont.gov/sites/aot/files/highway/2009%20Better%20Backroads%20Manual.pdf

DRAWING CREDITS
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DRAWING SCALE

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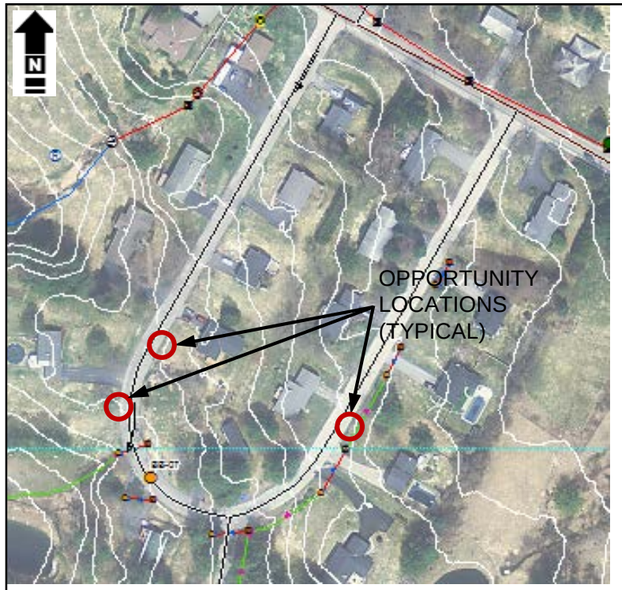
Harrison Avenue Stormwater Improvements
Details & Notes
Montpelier Stormwater Master Planning
Montpelier Vermont

FIGURE NO. E-9



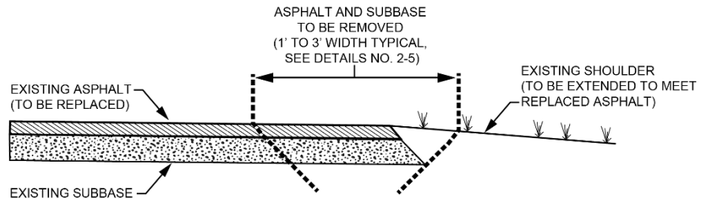

Existing mailbox access and low-slope shoulder


Existing moderately sloping shoulder, grass swale, and mailbox access

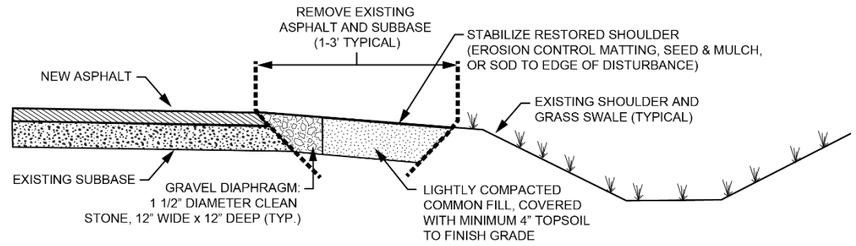

Existing shoulder sloping towards roadway

Shoulder Restoration Construction Guidance

DETAIL 1: EXISTING CONDITION, PRIOR TO ROADWAY NARROWING AND REPAVING (TYPICAL)

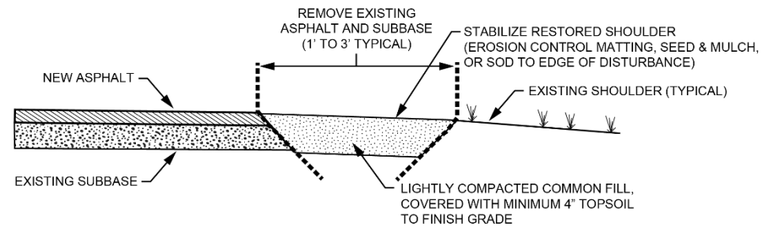


DETAIL 2: SHOULDER RESTORATION, MODERATELY SLOPING ROADWAY AND SHOULDER, AFTER ROADWAY NARROWING AND REPAVING (TYPICAL)



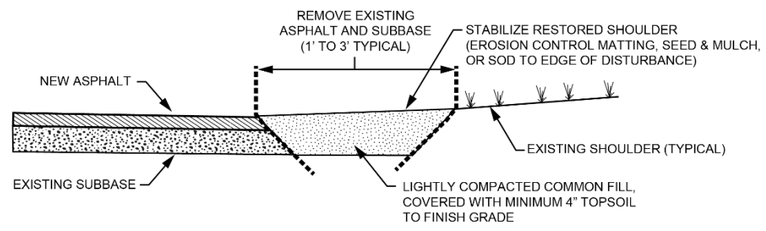
DETAIL 2 NOTES:
1. UP TO 1" VERTICAL DROP FROM EDGE OF PAVEMENT TO TOP OF GRAVEL DIAPHRAGM DESIRABLE TO MAINTAIN SHEETFLOW.
2. ENSURE NO SOIL BERM EXISTS BETWEEN NEW PAVEMENT AND EXISTING LAWN OR SWALE.
3. RUNOFF SHOULD TRAVEL FROM PAVEMENT INTO GRAVEL DIAPHRAGM AND THEN SHEETFLOW INTO DOWN-SLOPE AREA.

DETAIL 3: SHOULDER RESTORATION, SLIGHTLY SLOPING ROADWAY AND SHOULDER, AFTER ROADWAY NARROWING AND REPAVING (TYPICAL)



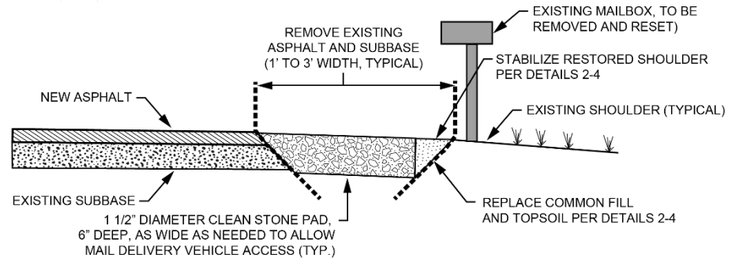
DETAIL 3 NOTES:
1. UP TO 1" VERTICAL DROP FROM EDGE OF PAVEMENT TO TOP OF RESTORED SHOULDER DESIRABLE TO MAINTAIN SHEETFLOW.
2. ENSURE NO SOIL BERM EXISTS BETWEEN NEW PAVEMENT AND EXISTING LAWN OR SWALE.
3. RUNOFF SHOULD TRAVEL FROM PAVEMENT ONTO RESTORED SHOULDER AND THEN SHEETFLOW INTO DOWN-SLOPE AREA.

DETAIL 4: SHOULDER RESTORATION, SHOULDER SLOPING DOWN TO ROADWAY, AFTER ROADWAY NARROWING AND REPAVING (TYPICAL)

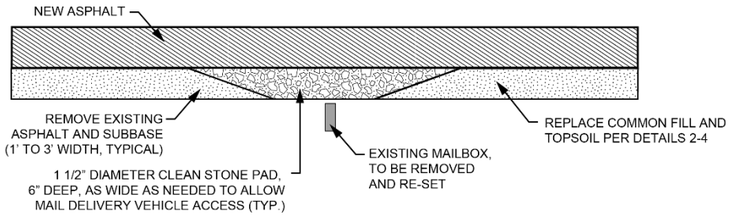


DETAIL 4 NOTES:
1. ENSURE NO SOIL BERM EXISTS BETWEEN NEW PAVEMENT AND EXISTING LAWN OR SWALE.
3. RUN-ON, IF ANY, SHOULD TRAVEL FROM RESTORED SHOULDER ONTO PAVEMENT BY SHEETFLOW.

DETAIL 5A: SHOULDER RESTORATION, MAILBOX ACCESS (PROFILE VIEW, TYPICAL)



DETAIL 5B: SHOULDER RESTORATION, MAILBOX ACCESS (PLAN VIEW, TYPICAL)



DETAIL 5A AND 5B NOTES:
1. ENSURE THAT RUNOFF CAN TRAVEL VIA SHEETFLOW INTO AND PAST THE MAIL DELIVERY VEHICLE ACCESS.
2. CLEAN STONE PAD MAY BE REPLACED WITH ASPHALT EXTENSION AND SHOULDER RESTORATION PER DETAILS 2-4.
3. RUNOFF SHOULD TRAVEL FROM PAVEMENT ONTO RESTORED SHOULDER AND THEN SHEETFLOW INTO DOWN-SLOPE AREA.
4. CLEAN STONE PAD OR ASPHALT EXTENSION SHOULD STOP 6-8" FROM MAILBOX FACE PER USPS GUIDELINES.

NOTES APPLICABLE TO ALL DETAILS:

1. ONE WAY TO REDUCE STORMWATER RUN-OFF IS TO REDUCE THE AMOUNT OF IMPERVIOUS SURFACES.
2. MONTPELIER'S DEPARTMENT OF PUBLIC WORKS LOOKS FOR OPPRTUNITIES TO DECREASE ROADWAY WIDTH (WHERE APPLICABLE) TO REDUCE THE AMOUNT OF IMPERVIOUS SURFACE, AND THEREFORE REDUCE STORMWATER RUN-OFF.
3. NARROWING ROADWAYS NOT ONLY REDUCES RUN-OFF BUT ALSO USES FEWER RESOURCES TO CONSTRUCT AND MAINTAIN, RESULTING IN INCREASED SAVINGS.
4. FOR MAXIMUM WATER QUALITY BENEFIT, ROADWAY NARROWING SHOULD BE COUPLED WITH ROAD SHOULDER PROTECTION AND RESTORATION FOLLOWING PAVEMENT AND SUBBASE REMOVAL.
5. GRANDVIEW TERRACE IS USED HERE AS A GENERIC EXAMPLE, TO ILLUSTRATE HOW SHOULDER RESTORATION OPTIONS MAY BE APPLIED IN FUTURE PROJECTS IN THE CITY OF MONTPELIER. PAVEMENT NARROWING AND SHOULDER RESTORATION WERE COMPLETED ON GRANDVIEW TERRACE AND SPRING HOLLOW LANE IN 2016.

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Montpelier Stormwater Master Plan

"Road Diet" Shoulder Restoration Options

DESIGNED BY:	ANM	DATE:	8/19/2016
DRAWN BY:	ANM	DATE:	8/23/2016 REV 9/6/2016
CHECKED BY:	JSM	DATE:	8/24/2016

SHEET: E-10
PROJECT NO.: 15-097

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