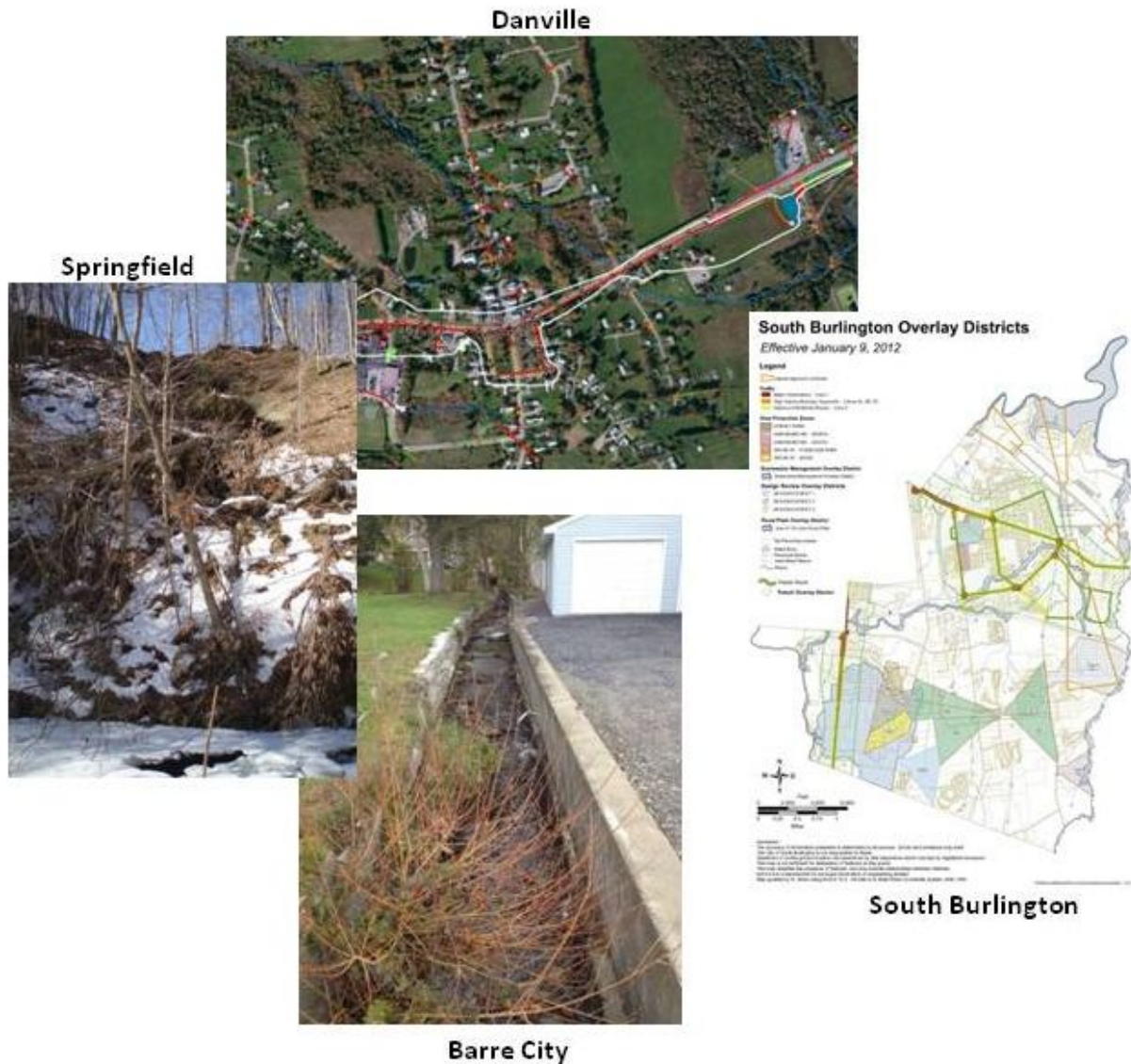


VERMONT STORMWATER MASTER PLANNING GUIDELINES



AGENCY OF NATURAL RESOURCES
VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION
Clean Water Initiative Program
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I. What is stormwater and why is it an issue?

Stormwater runoff is any form of precipitation (rain or melting snow and ice) that runs off the land. Under natural conditions, this runoff is but a small percentage of the total precipitation with the vast majority of water either infiltrating into subsurface soils and deep groundwater reserves or evapotranspiring into the air. This process is generally known as the hydrologic cycle.

Experience has shown that human developments have a significant impact on the hydrologic cycle. These impacts are usually a result of increasing impervious area. As impervious cover increases, infiltration and evapotranspiration rates decrease which leads to a subsequent increase in stormwater runoff.

The concept of a municipal stormwater management plan was a result of a national stakeholder process. The stakeholders concluded that a comprehensive municipal stormwater management plan was the most cost-effective approach for addressing stormwater runoff. The goal of stormwater planning is to protect or maintain the health of streams, lakes and aquatic life as well as to provide opportunities for human uses of water by mitigating the effects of urban development.

II. Why do we need to plan for stormwater?

- (1) Pollutants are mobilized in runoff from impervious and roadway surfaces including: sediment, nutrients, pathogens (animal waste, overflows from combined sewer systems), metals, hydrocarbons, wash-off of air pollution particulate matter, trash and debris;
- (2) Runoff leads to flow alterations: changes in land use perviousness lead to changes in hydrologic patterns often leading to channel erosion and channel instability;
- (3) Runoff leads to habitat alterations, and to siltation/sedimentation changes in rivers and lakes which impact macroinvertebrates (insect life) and fish;
- (4) To maintain healthy and viable communities and to prevent sprawl we need to minimize impacts to water quality from our downtowns and designated growth centers;
- (5) The current estimated cost to restore water quality for the 19 water bodies in the state principally impaired by stormwater runoff in Vermont is well over \$100 million dollars;
- (6) Runoff impacts human use and enjoyment of surface waters.

Federal and State laws will require the following water pollution mitigation plans or Total Maximum Daily Loads (TMDLs) to be implemented:

- Nutrient-based TMDLs
 - Lake Champlain Phosphorus TMDL
 - Lake Memphremagog Phosphorus TMDL
 - Connecticut River Long Island Sound Nitrogen TMDL
- Flow-based TMDLs
 - 19 urban or developed land stormwater impaired watersheds
- Bacteria-based TMDLs
 - 22 bacteria impaired stream or river segments

Other state and local planning efforts such as the ones listed below, acknowledge how regional and localized flooding and water quality problems can stem from ineffective or lack of effective management of stormwater runoff, giving further justification for sound stormwater planning and management:

- (1) State All-Hazards Mitigation Plans;
- (2) State local road and bridge funding tied to water quality practice implementation;
- (3) Surface drinking water source protection plans;
- (4) Road and culvert inventories and asset management of those inventories; and,
- (5) Voluntary or mandated adoption of the six minimum measures of the federal municipal separate storm sewer system (MS4) permit.

III. How is stormwater runoff typically managed?

Stormwater runoff has historically been addressed by way of engineered systems. A standard technique is to use piped conveyance. Piped conveyance is a strategy that moves water to a specific discharge point using piping, catch basins or inlets and links impervious surfaces together.

Piped conveyance systems unfortunately are singular in function and do not provide any additional ecological benefits. They do little to prevent stormwater runoff from occurring in the first place. Their use does not get us closer to the natural hydrologic cycle. Since 1978 the state has regulated stormwater runoff from new development. In 2002 the state adopted unified sizing criteria that addressed 4 different storm sizes and groundwater recharge. In 2002 a modest stormwater requirement for redevelopment also became law. Many urbanized areas predate the state stormwater regulations and are piped conveyance systems with no stormwater treatment. State stormwater regulations cover about 5% of all the impervious cover in Vermont.

IV. Stormwater master planning: making better use of limited dollars by targeting high priority stormwater projects.

The cost to complete and implement the plans above as well as maintain our existing wastewater, stormwater and drinking water infrastructure are enormous and well beyond any one year's allocation of financial resources (VTDEC, 2013). It will take many years of concerted effort to achieve the goals that we have set to conserve and improve Vermont's waters. We can be more effective with federal, state and municipal dollars, if we plan carefully and implement practices cost effectively. Taking a more cost-effective approach in addressing stormwater involves targeting areas based on our knowledge of: (1) where pollution is generated; and, (2) where it can be captured and removed efficiently and at the least expense. For urbanized areas and rural road networks, developing stormwater master plans is a first step in that effort. In the appendix of these guidelines is a table listing all Vermont towns, the current status of stormwater master planning in the town and a suggested template, or templates, the town could use to better manage its runoff.

V. Why will stormwater master plans be more effective than what we are doing today?

First, stormwater master plans can prevent problems from happening either by mitigating impacts before they create problems or by avoiding the creation of problems; prevention is cheaper than restoration. If we are to avoid the high cost of restoring degraded surface waters, we must better

manage stormwater runoff before the waters become impaired. Second, plans are developed with public involvement and comment and so should be as comprehensive as possible in listing all known problems. Third, because plans are based on a prioritized list of projects or a strategic approach they are more likely to succeed than a reactionary approach that addresses problems as they arise. Historically almost all municipalities have responded to stormwater runoff or drainage problems the latter way, and frequently during an emergency or after a structural failure has occurred. Stormwater management plans contain important information about preserving natural features and functions of a watershed, and provide a list of evaluated alternatives such as using traditional pipe (gray) infrastructure versus more efficient and economic green infrastructure.

VI. What can we expect if stormwater master plans are developed and implemented?

- A better targeting of limited funds to high priority projects;
- Community road-maps to achieve and protect water quality into the future;
- “Demonstration Projects” for under-tested but promising technology;
- Fewer downstream stormwater impacts from upstream (local or regional) incremental and sub jurisdictional (nonregulated) growth;
- Increased awareness and involvement by a more educated public of stormwater runoff and its long-term impacts; and,
- Greater awareness and ownership by the public in finding and implementing stormwater solutions.

VII. How does a stormwater master planning effort start?

There are many ways for a master plan to be developed. For example, plans have been created by a developer or large landowner in order to provide an orderly and more easily permitted means to develop a subdivided parcel. Plans have been developed by a municipality to address a localized stormwater flooding or instream erosion problem. These guidelines will provide a number of different master plan examples that either exist in Vermont today or have the potential to work in Vermont. In order to be successful any plan must be understood by, and have the support of, the majority of landowners it will impact.

VIII. Does stormwater management make sense in rural towns of the state without urbanization or large areas of impervious surfaces?

Stormwater runoff that degrades surface and groundwater comes from impervious surfaces and all land clearing and land use conversion activities (Booth, 2000, 2002; DeGasperi et. al., 2009). State and Federal laws are largely crafted around the impact that runoff from impervious surfaces has on surface and ground water. Impervious surfaces create the largest volume of runoff per unit area, but all land clearing activities have an impact. Golf courses, ski trails, timber stand improvements, hobby farms, corn fields, suburban lawns, all increase runoff volume and can cause negative impacts on receiving waters. These land uses can deliver pollutants and water volume more directly as a result of decreased soil and vegetation absorption and enhanced pathways or drainage routing. Rural towns can better manage the runoff from these areas when a documented problem arises or has the potential to occur. We increase the flood resiliency of our watersheds and reduce the risk of downstream property damage or personal

loss during certain storm events by improving runoff management via detention and infiltration. We will also increase our flood resiliency by increasing conveyance capacity of the system through basic maintenance of our drainage structures such as the removal of sediment from piping and inlets.

IX. How can stormwater master planning interface with growth center planning?

Growth center planning in Vermont emphasizes the protection and enhancement of historic growth patterns by providing a formal designation with benefits for downtowns, village centers, new town centers and areas around these centers (VTDHCA, 2007) including designated neighborhood development areas. As part of the growth center planning process, municipalities must undertake several steps that parallel steps often needed to create a stormwater master plan.

Growth center planning requires:

1. A 20-year development build-out analysis;
2. A 5-year capital improvement plan for wastewater and stormwater infrastructure, with a 20-year projection estimate;
3. An inventory of existing and planned public parks and open spaces; and,
4. The identification of all existing natural resources, a discussion of the anticipated impacts by the proposed growth center and a plan to mitigate those impacts.

The mitigation of existing stormwater impacts to water resources can best be addressed through a comprehensive approach of stormwater management. Designated new town centers typically accomplish this requirement by receiving a state stormwater discharge permit for the entire town center similar to the example shown in Template 1a. Several of the master stormwater plan templates described below have been used in the other designated growth areas as well.

X. What is the basic outline of a stormwater master plan?

The following describes a framework or road map that can apply to a range of stormwater problem needs. Not all water quality problems, either based on local or regional problems, need the same level of effort for plan development. It is important to note that master plans can emphasize structural improvements such as stormwater treatment practices, nonstructural practices such as enhanced tree canopy, impervious cover disconnection, a zoning overlay district/ordinance impacting new development or a combination of both structural and nonstructural. Ultimately stormwater master plans should be inserted into implementation tables of VTDEC Tactical River Basin plans which are developed every 5 years. The inclusion of the master plan, as well as a schedule for implementation of the master plan tasks in the basin plan, will be a prerequisite for VTDEC Clean Water Initiative Program grant funding in the future.

The templates described in this document exemplify roughly three size scales: (1) site or local, (2) community, subwatershed or watershed and (3) regional or multi town. The basic ingredients of a stormwater master plan can be summarized in outline form on the following page.

Model Outline for Stormwater Master Plans

- I. *Problem Definition*
 - a. *Water quality or water quantity problems*
 - I. *Biological or chemical monitoring data of receiving waters;*
 - II. *Receiving stream or river geomorphic data.*

- II. *Existing Data Collection*
 - a. *Geographic Information Systems (GIS) data – Stormwater infrastructure, impervious surfaces, soils, wetlands, watershed-subwatershed boundaries, culvert and bridge inventories, roads, stormwater best management practices, tree canopy cover, elevation data, slope, build out analyses and land use;*
 - b. *Existing reports/studies of water quality problems (i.e. water quantity or water quality modeling analyses, class 3 or 4 road assessments/inventories, sanitary surveys, surface water drinking water protection plans, stormwater illicit discharge assessments, municipal capital development plans;*
 - c. *Existing Data Analysis - Define priorities for receiving water restoration based on current data, define water quality and/or quantity goals, define data gaps and plan to fill data gaps.*

- III. *New Data Collection*
 - a. *Conduct field surveys (windshield, public polls, public meetings, DPW –Street Dept. meetings, watershed walks, etc.) and compile list of sites contributing to the water quality problem;*
 - b. *Define any field data gaps and plan to fill gaps;*
 - c. *Field data analysis;*
 - d. *Compile list of sources associated with defined water problem;*
 - e. *Prioritize list based using decision matrix that can lead to feasible project selection, funding and implementation.*

- IV. *Existing and proposed program, procedure or practice evaluation*
 - a. *Define existing programs, procedures or practices that address problem;*
 - b. *Define new programs, procedures or practices that could address problem.*

- V. *Summary and Recommendations*
 - a. *Summarize current conditions;*
 - b. *Propose additional system knowledge acquisition based on II c and III b;*
 - c. *Proposed actions for existing development;*
 - d. *Proposed actions for new development;*
 - e. *Coordinate V c and V d actions with municipal capital development plans;*
 - f. *Coordinate public comments/input.*

XI. State or regional contacts for outline problem definition and existing information assistance

Municipalities can find assistance in acquiring the necessary information for a plan from the following sources:

- Vermont Department of Environmental Conservation River Basin Planners:
<http://dec.vermont.gov/sites/dec/files/wsm/mapp/docs/TBP%20Contacts%20Map.pdf>
- Vermont Department of Environmental Conservation River Management Technical Assistance:
http://dec.vermont.gov/sites/dec/files/wsm/rivers/docs/rv_River_Scientist_Regions.pdf
- Vermont Center for Geographic Information: <http://vcgi.vermont.gov/>
- Vermont Department of Environmental Conservation Clean Water Initiative Stormwater Mapping and Illicit Discharge and Detection Elimination Program:
<https://dec.vermont.gov/water-investment/cwi/solutions/developed-lands/idde>
- Vermont Association of Planning and Development Agencies: <http://www.vapda.org/>
- Center for Watershed Protection: Methods to Develop Restoration Plans for Small Urban Watersheds:
http://www.bebuffered.com/downloads/center_watershed_protection_methods_develop_rest.pdf
- Vermont League of Cities and Towns Water Resources Assistance:
<https://www.vlct.org/municipal-assistance/water-resources-assistance-program>
- Vermont Natural Resources Council Overlay Districts Information:
<http://vnrc.org/resources/community-planning-toolbox/tools/overlay-districts/>

XII. Case studies in Vermont: examples of existing stormwater master plans

Vermont has a number of examples of approaches to stormwater problems that involve stormwater master planning for small villages up to large cities. These examples typically rely on a combination of zoning and public works projects to achieve their goals. These guidelines review 9 templates and briefly discuss the approach each used. The templates are arranged in an order starting with small sites or subwatersheds, increasing to larger watersheds, and then finally to regional or town wide applications. All of the approaches can be considered for use by a municipality. All of these approaches have some limitations and each approach should be revised over time as new information becomes available. The templates cover areas that range in size from one hundred acres to entire townships. In the appendix of these guidelines a table is provided listing all Vermont towns, the current status of stormwater master planning in the town and a suggested template or templates the town could use to better manage its runoff.

Template 1a: Site, local or small watershed approach with planned build out analysis and traditional (end of pipe or centralized) stormwater management

A stormwater master plan can use a local or site industrial park approach for managing stormwater similar to how a developer may propose to manage it. A good example of this is the Middlebury Industrial Park. The key concept is to develop a master drainage plan for each catchment area in the park that considers all future build-out conditions and provides either an end-of-pipe stormwater management structure(s), at the catchment area outlet, or decentralized treatment within the park drainage areas at designated areas.



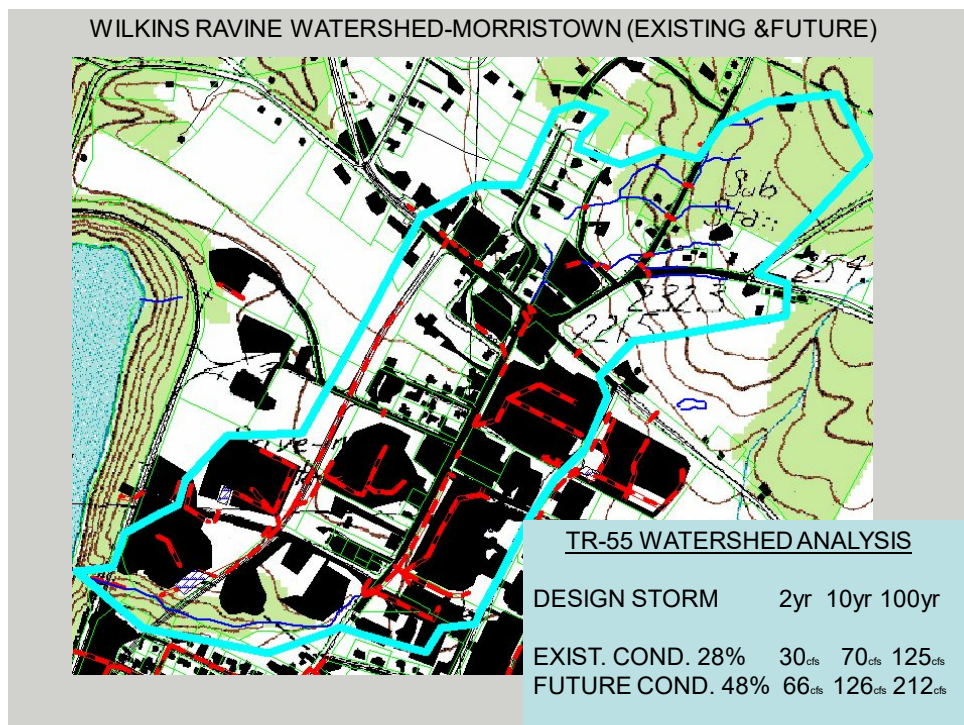
Middlebury Industrial Park – Middlebury

Key: Stormwater Ponds (blue), Parcels in park (aqua blue), swales (green), drainage system (red), streams (grey).

This approach allows the entire park to meet a defined stormwater treatment requirement. Typically, large new development projects must meet the Vermont 2002 Stormwater Management Manual design criteria for groundwater recharge (Rev), water quality volume (WQv), channel protection volume (CPv), 10-year peak discharge flood control (Qp10) and the 100-year peak discharge flood control (Qp100). This approach works best when the entity developing the plan initially owns or controls most of the land and has the financial resources or natural resources available to meet these requirements. The advantage to this approach is that the majority of permitting is done up front and therefore minimizes permitting expense and time as each lot is developed. In the Middlebury Industrial Park case 45 acres of impervious cover (roads, buildings, and parking) in the 120-acre park have their permit in place. The stormwater treatment system in the park is a very large wet pond; this also serves as an auxiliary fire protection pond. It can typically take 5-10 years to see complete build out of a park such as this. The owner and/or municipality must manage the stormwater system without a full park association membership sharing in the cost during this period. Ultimately however, the entire system can be handled through a cooperative municipal-park association arrangement where each member pays only their share of the cost prorated to the amount of impervious cover they own. There are numerous examples of industrial or commercial parks statewide that have been developed in this manner. This approach is well suited for municipalities with small urbanized areas or designated growth centers and most land under single ownership such as a municipal industrial park. This template does not fully meet the Model Outline for Stormwater Master Plans (specifically numerals I, II, III and IV).

Template 1b: Site, local or small watershed retrofit approach with traditional (end of pipe or centralized) stormwater management

For more urbanized areas of the state experiencing growth or for growth centers, stormwater master plans may often need to include stormwater treatment retrofits as well as or in addition to future controls based on a build out analysis in order to mitigate the unintended negative consequences of rapid urbanization. One example of this can be seen in the **Town of Morristown**. Since 1965 the commercial north end district of Morristown has been growing, the district is also the regional growth



center for Lamoille County. The district largely drains to an unnamed tributary of the Lamoille River called the Wilkins Ravine. In the late 1990's wastewater expansion feasibility studies conducted by the Town concluded that stormwater infrastructure in the growth center was inadequate. In 2000, an Act 250 permit application for a new development was denied due to the potential for increased erosion and siltation of the Wilkins Ravine and the threat to the trout fishery and habitat of the Lamoille River. In 2001, a culvert upgrade to reduce surcharging stormwater led in 2002 to a failure of a railroad embankment and a massive sediment discharge to the river. In response to this problem, Morristown, with assistance from VTDEC, developed a stormwater master plan consisting of a three-phase approach and requiring the implementation of 12 specific tasks. The three phases were:

- Stabilize and clean up the Wilkins Ravine receiving runoff from the north end commercial growth district.
- Install stormwater quality treatment controls and, where possible, quantity treatment controls in the developed area drainage network upstream of the Ravine.
- Reduce the overall volume of stormwater discharging to the Ravine by retaining water on-site and infiltrating to groundwater as much clean runoff as possible.

As part of this plan a TR-55 hydrologic analysis was conducted to estimate the current and future peak runoff from the district. The analysis assumed a 20% increase in the amount of impervious cover (from 28% to 48%) for the future build out condition. Over a period of about 10 years local landowners, the Town, the State, and the US EPA have invested almost one million dollars in stormwater infrastructure upgrades, treatment practices and erosion stabilization. The upgrades and practices are by in large designed and constructed to handle the future build out scenario. In addition, by encouraging, or directing when required, stormwater infiltration in the district, the Town can insure that the drainage system will not require future size upgrades or overwhelm maintenance schedules of the treatment structures. This approach works with municipalities with moderate urbanized areas or growth centers, greater than average growth potential, and multiple land ownership. This template covers all of the elements in the Model Outline for Stormwater Master Plans.

Template 1c: Site, local or small watershed retrofit approach with green stormwater infrastructure (GSI) stormwater management

A more sophisticated master plan example using a green stormwater infrastructure (GSI) approach can be found with the **City of South Burlington's** Bartlett Brook watershed. For a rural state such as Vermont the opportunities to use green stormwater infrastructure are immense. The goal of this form of stormwater management is to distribute or spread out the runoff versus concentrating it. GSI utilizes multiple small pervious areas to distribute the runoff. It minimizes the generation of large volumes and concentrated flows preventing the typical downstream erosion and water quality problems more characteristic of curb and gutter piped drainage systems. If a community has not developed traditional drainage infrastructure or is faced with the need to expand or repair stormwater infrastructure, this approach, when matched with the correct soils, is by far the least energy and capital intensive. Several highly urbanized areas in the state where stormwater and sewage are combined together (combined sewer systems) can also benefit from this approach because of the cost savings.

As part of suburban South Burlington, the Bartlett Brook watershed has experienced significant growth in the last 50 years. The watershed soils are predominantly well drained (NRCS hydrologic group A). While highly suitable for infiltration these soils are also highly prone to erosion when runoff is diverted on to the soil's steep slopes. For 30 years, the City has recognized that stormwater runoff can cause significant erosion and water quality problems for the stream; Bartlett Brook is also listed by VTDEC as stormwater impaired. In 1980 the City adopted a zoning overlay district to try and mitigate the impacts

of new stormwater discharges. In 2010 recognizing the changing science of stormwater mitigation the City revised the requirements of the overlay district to mandate the use of GSI. The purpose of the district in part is to:

- To promote stormwater management practices that maintain predevelopment hydrology through site design, site development, building design and landscape design techniques that infiltrate, filter, store, evaporate and detain stormwater close to its source;
- To promote public safety from flooding and streambank erosion, reduce public expenditures in removing sediment from stormwater drainage systems and natural resource areas, and to prevent damage to municipal infrastructure from inadequate stormwater controls.

To accomplish this purpose the City has undertaken an extensive computer modeling and flow monitoring study of the stream to accurately assess the most damaging and erosive stormwater runoff events (1.5 yr. frequency: 2.2"/24 hour). The City requires that all new development disturbing more than ½ acre to use GSI practices and that the peak discharge rate from the proposed development site for this rain event not exceed the predevelopment rate. South Burlington's plan also includes additional requirements as part of state and federal permits including: (1) compliance with the six minimum measures of the MS4 permit (Template 3c); (2) stream flow monitoring; and, (3) the development of a stormwater flow restoration plan for the Brook (Template 2c). This approach works best with municipalities with larger urbanized areas, well drained soils, and multiple land ownership. This template covers all the elements in the Model Outline for Stormwater Master Plans. *Note: in 2016 the City adopted citywide stormwater regulations similar but not identical to this overlay district.*

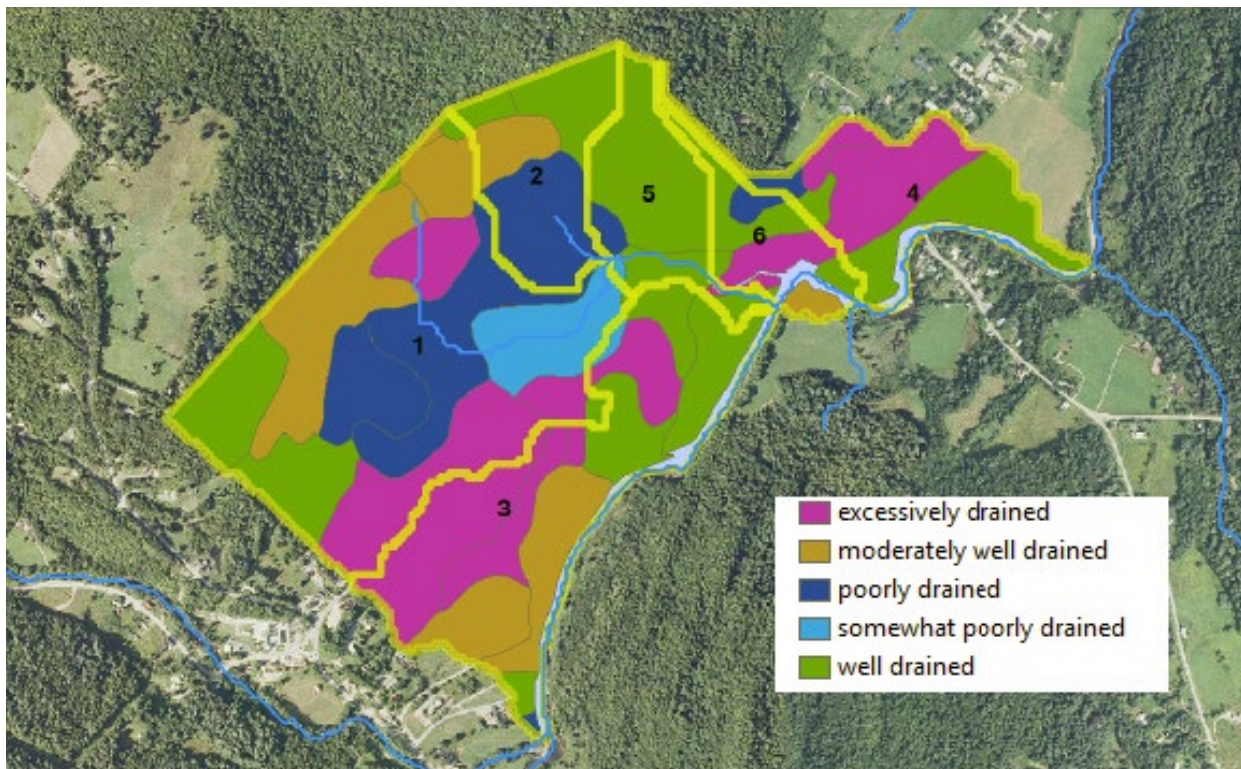


Example of severe erosion in the Bartlett Brook watershed

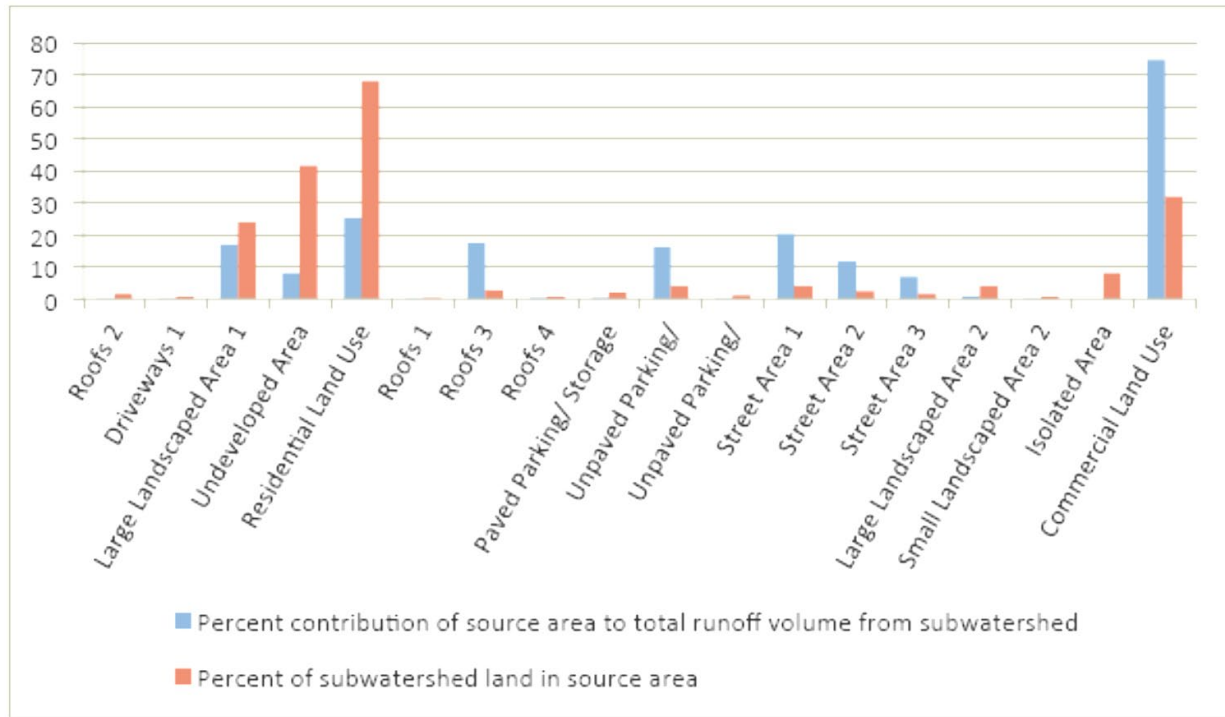
Template 2a: Hybrid site & community retrofit approach with green stormwater infrastructure (GSI) stormwater management

A hybrid community and site scale example of a green stormwater infrastructure option for managing stormwater through a master plan can be seen in the **Town of Waitsfield**. Green stormwater infrastructure can be used for both large and small urbanized areas of the state that are developed on moderate to deep and well to excessively well drained sands or gravels (NRCS hydrologic group A and B soils). In Waitsfield a plan was developed at two different scales: the “community planning scale” and the “site scale”. The plan develops a list of priority areas in the community subwatersheds to be further refined at the site scale. At the site scale GSI retrofit concepts are prepared such as rain gardens, infiltration swales, etc., that are appropriate and “fit” the site. At the site scale there is outreach to property owners or property managers to educate them about the benefits of GSI and gauge their interest. This is followed by both volume and pollutant modeling to determine the benefits that could be achieved from the retrofits. The modeling evaluates different sources within a site area separating out the runoff from roofs, driveways, parking areas, commercial areas, pervious areas, etc. A summary table of GSI concepts is created and a prioritized implementation plan developed based on land owner cooperation and project benefit. This template works best with municipalities with small urbanized areas, well drained (NRCS A-B) soils and multiple land ownership. This template does not fully meet the Model Outline for Stormwater Master Plans (specifically, numerals I, II, and IV).

Waitsfield subwatersheds and soil drainage categories included in GSI stormwater master plan

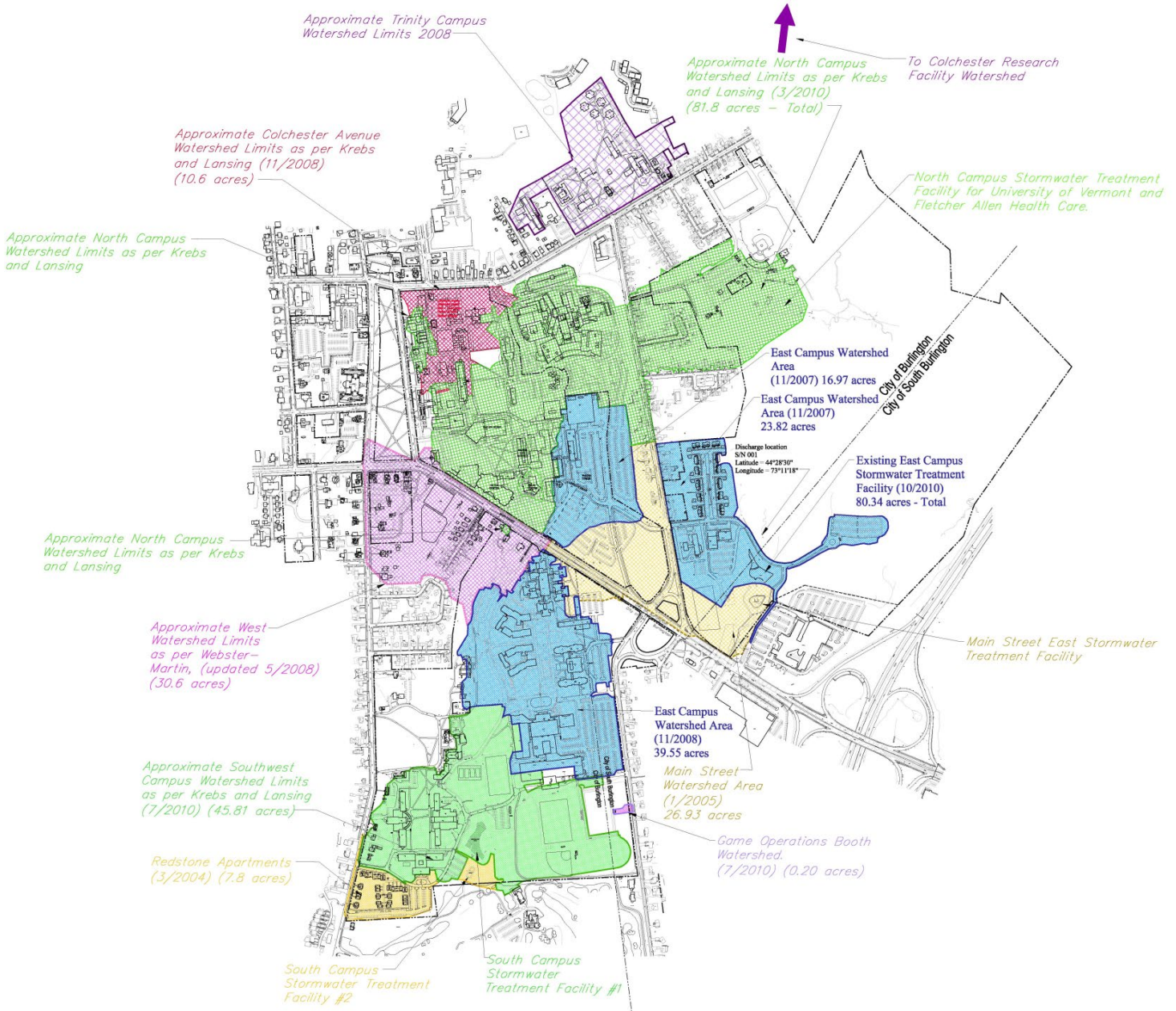


Runoff contributions from source areas in a Waitsfield subwatershed



Template 2b: Community or watershed approach with planned build out analysis and traditional (end of pipe or centralized) stormwater management

A more complex and community or watershed scale version of the traditional industrial park master plan approach (Template 1a) can be seen on the **University of Vermont** campus. In this case the entire campus has been broken up into approximately eight individual subwatersheds. Each subwatershed is assessed for its potential for growth as envisioned through a long-term campus master plan for development at the University. For the overall campus approximately seventy-five percent of the land or 306 acres drains to a stormwater treatment structure at the subwatershed outlets. These treatment structures are built to the most recent design standards. This approach allows the University to use less valuable land for stormwater treatment on campus and minimizes the permitting and time necessary whenever a new addition or improvement is made to the campus grounds. The University's stormwater management plan also includes additional tasks that are required by state and federal permits including compliance with the six minimum measures of the MS4 permit (Template 3c), creation of stormwater pollution prevention or stormwater no exposure plans for any industrial facilities on site, stream flow monitoring and the development of stormwater flow restoration plans (Template 2c) for the four stormwater impaired watersheds it overlays. This approach works best with municipalities with moderate urbanized areas or designated growth centers and when most if not all of the land is under single ownership such as a new town center, an academic campus or a recreational resort. This template covers all of the elements in the Model Outline for Stormwater Master Plans.



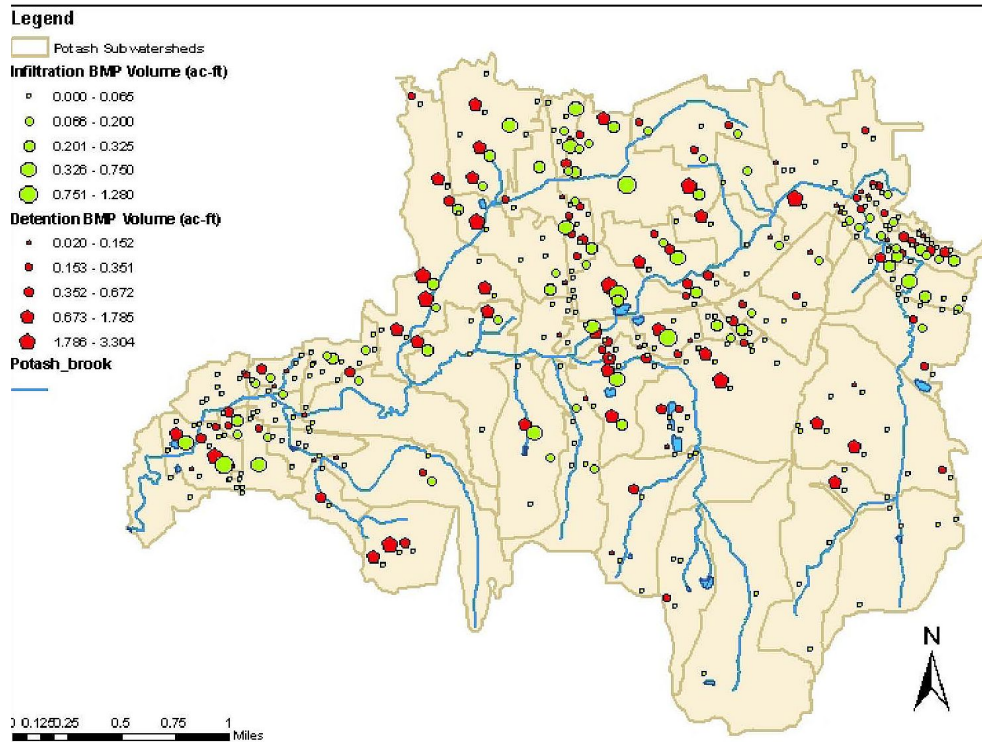
University of Vermont overall campus watershed and stormwater management map

Template 2c: Watershed flow restoration plan (FRP) approach

A more sophisticated form of the retrofit template (Template 1b) at the watershed level, and one which involves more expensive data acquisition, is a stormwater flow restoration plan (FRP). While this template does not necessarily fit most stormwater problems found in the state, it is important to provide this example and the “lessons learned” from its development. Municipalities can avoid making streams hydrologically unstable by learning from past mistakes of unplanned urbanization. There are **12 communities in the state** (Burlington, Colchester, Essex, Essex Junction, Rutland City, Rutland Town, St. Albans City, St. Albans Town, Shelburne, S. Burlington, Williston and Winooski) that have or share

thirteen small streams that do not meet the state Class B water quality standards as a result of the volume and sediment load from stormwater runoff. There are a number of high elevation streams at **6 ski resorts** (Stratton, Mt Snow, Sugarbush, Bromley, Killington and Jay Peak) that also do not meet state water quality standards due to stormwater runoff. There are **7 additional municipalities** that have streams that are close to not meeting the Class B standards for the same reasons. These streams experience frequent erosive bank full channel flooding events and often diminished channel low flows all of which degrade the aquatic life community leading to water quality violations. In order to reestablish a hydrologic regime capable of supporting the Class B standards a stream flow restoration plan for both the high flows (Q0.3) and the low flows (Q95) must be developed.

Stormwater infiltration and detention structures needed for flow restoration plan in the Potash Brook watershed, South Burlington



The basic elements of the flow restoration plan (FRP) are:

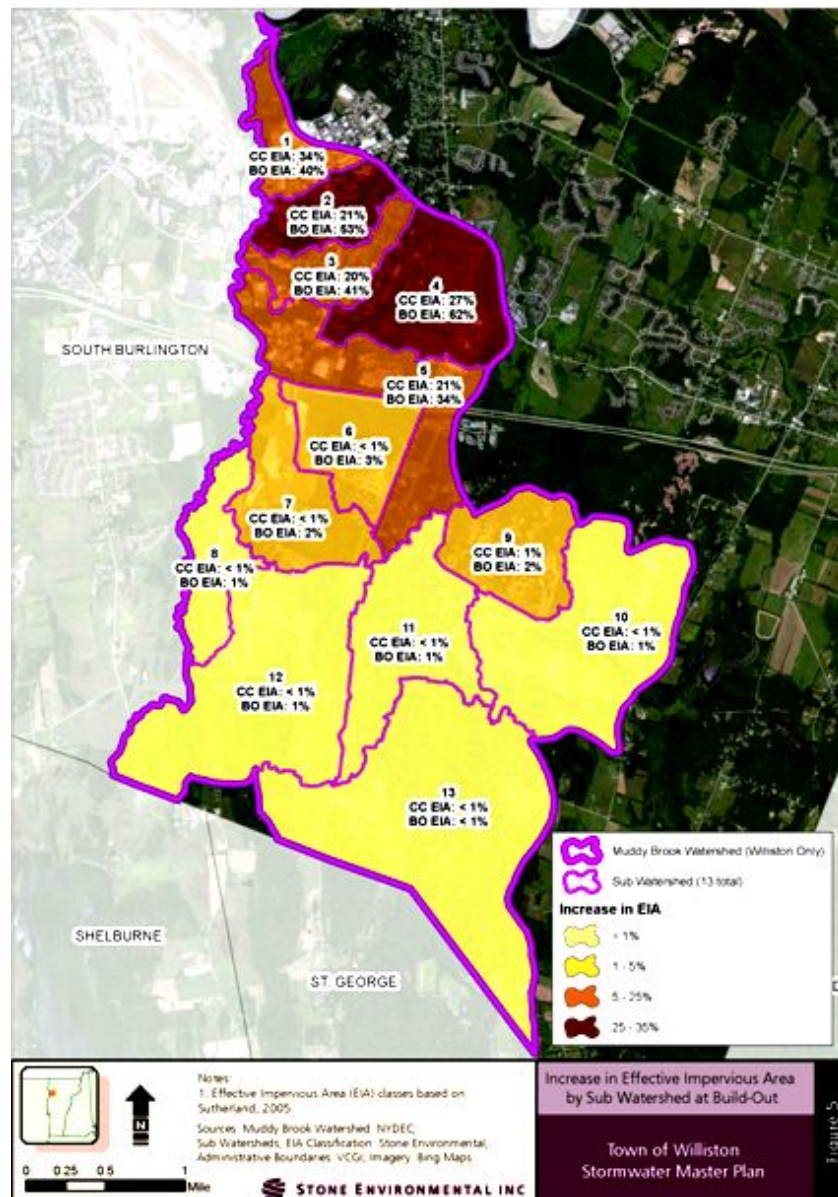
- (1) The documentation through geomorphic study of the sediment/water imbalance;
- (2) Baseline environmental data gathering;
- (3) The use of attainment (meets Class B standard and is similar in watershed characteristics such as soils, slope, land use) watersheds to compare the impaired watershed to as a measure of success;
- (4) The use of high and low flow hydrologic targets derived from the attainment stream for the impaired stream to achieve;
- (5) Stream flow hydrologic monitoring and modeling of the impaired and attainment streams; and,
- (6) Adaptive stormwater management practices to mitigate the high flows and increase the low flows.

This approach to water resource management is firmly grounded in the sciences of stream geomorphology and aquatic biology. VTDEC has acquired the necessary data and tools to develop the FRPs with the thirteen communities. However, each community is responsible for final plan development, a compliance schedule for implementing the plan and the financial resources to implement the plan. Five ski resorts have developed plans similar to this template and to date have successfully remediated water quality impairments at two. In both the urban and ski resort examples extensive water quality and stream geomorphic monitoring studies have been conducted in collaboration with VTDEC. The watersheds have been broken out into subwatersheds and GIS infrastructure inventories have been completed. A suite of stormwater best management practices to address the water quality impairments have been, or will be, constructed as part of a long-term water quality or water volume remediation plan. Finally, a capital improvement plan with an adequate funding source has been defined as an integral companion to the stormwater management plan. This template is useful for extreme and widespread water quality or water volume remediation problems. This template covers all of the elements in the master plan.

Template 3a: Large watershed or regional approach with planned build out analysis and traditional (end of pipe or centralized) stormwater management

An example of a watershed scale plan with a build out analysis approach can be seen in the **Town of Williston**. Since 1990, Williston's population has more than doubled. As a result of this rapid growth, the subsequent urbanization of the town, and the subsequent increase in state and federal water quality permit requirements Williston has embarked on the development of a town-wide stormwater master plan including all of the Allen Brook, and the town-wide extent of the Muddy Brook watershed (termed a *Town-wide Watershed Improvement Plan*). The plan development involved a review of existing data and data gap identification, collection of all existing watershed related data, identification of problem areas from existing reports, local knowledge, and a field survey. A classification of problem areas from high to low based on a decision matrix was constructed and followed by field confirmation of all significant problem areas. Unique to this form of master planning is the modeling of scenarios to determine anticipated future peak stormwater flow rates and flow volumes for the 2-year, 10-year, 25-year, & 100-year 24-hour design storms. Williston's plan incorporates the expected impact of existing State of Vermont stormwater permit requirements on projected future flow rates and volumes and identifies sub-watersheds where existing stormwater management regulations appear to be inadequate to control future stream flows. The plan also predicts future design flow rates and volumes (2-year, 10-year, 25-year, & 100-year) for all Level 3 (high priority) in-stream problem areas.

The Town of Williston's plan also includes additional tasks that are required by state and federal permits including compliance with the six minimum measures of the MS4 permit (Template 3c), stream flow monitoring and the development of a stormwater flow restoration plan (Template 2c) for a stormwater impaired watershed. This approach works with municipalities with larger urbanized areas or growth centers, greater than average growth, and multiple land ownership. This template covers all of the elements in the master plan outline.



Town of Williston Muddy Brook Watershed future stormwater impact areas

Darker Areas show subwatersheds where current state and local requirements may not be sufficient to protect water quality standards with build out.

Template 3b: Regional or multi town approach with rural road focus

The **Franklin County Towns** of Swanton, Richford, Enosburgh, Georgia, Highgate, Fairfield and Sheldon in collaboration with the Friends of Northern Lake Champlain watershed association have developed a regional and primarily rural road focus to their approach for managing stormwater runoff. This approach involves gathering and summarizing existing water quality plans and studies and other related data; supplementing existing information with field data where necessary in order to evaluate conditions within each town/village, and the development of a comprehensive, municipality-specific water resources summary.

The master plan for each town includes:

- (1) A water quality library report;
- (2) A problem area report;
- (3) Problem area maps; and,
- (4) A prioritized list of projects.


This approach can be easily reconciled with any existing municipal road inventories and priority projects can be added to a municipality’s capital planning process. This template will work well with municipalities with very small urbanized areas and most impervious cover as existing roads (gravel and paved). Almost all Vermont municipalities can be characterized as predominantly rural with smaller urbanized areas. This template therefore can apply to the rural areas of most towns. A different template should be applied to the urbanized area(s) within the town. This template meets all of the master plan elements but could be enhanced by describing the “summary and recommendations” mentioned in the Model Outline for Stormwater Master Plans described above (in numeral V).

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Enosburgh Master Plan Problem Area Example

Problem Area Data Sheet

Problem Area ID: TB-7	Latitude: 44°52'16.39"N	Longitude: 72°47'53.04"W
Watershed: Tyler Branch		
Location: Town Garage on Route 108		
Problem Type: Local Drainage		
Identification Source: Town Feedback		
Ownership: Local		
Classification Level: 4		
Problem Description:		
Stormwater management at the Town Garage needed is problematic, including areas around both current salt and sand storage.		

Date of Field Data Collection: 7/13/2012

Field Photos	
	
Photo 1. Parking lot run-off	Photo 2. Salt shed

Description of Observed Conditions:

Erosion from Town Garage parking lot and salt shed flows directly into Tyler Branch (Photo 1). Town has tried to address the issue by placing jersey barriers along the sand pile and access road. While this has helped reduce the amount of sand being washed directly into Tyler Branch, it has caused the stormwater to concentrate and is causing erosion along foundation of salt shed downhill to stream. Entire town lot is sloped downhill toward stream. Sand pile is outside and above salt shed. No nearby land farther away from the stream is owned by the Town.

Template 3c: Regional or multi town approach with municipal separate storm sewer system (MS4) minimum measure focus

Another regional example of a stormwater master plan that can be adopted by municipalities or groups of municipalities is a plan based on the federal municipal separate storm sewer system (MS4) permit requirements. In 1990 the US EPA began requiring certain large urbanized areas (Phase I) of the United States to be subject to the requirements of the MS4 permit. In 2000 the Vermont Legislature recognized the cost-effective nature of these measures and encouraged by statute, the adoption of these practices by all municipalities. In 2003, EPA expanded the permit jurisdiction to small MS4s (Phase II) which impacted some municipalities in Vermont. A small MS4 is any publicly owned MS4 not already covered by the Phase I program as a medium or large MS4 and which was located in “urbanized areas” (UAs) as defined by the Bureau of the Census, and on a case-by-case basis those small MS4s located outside of UAs that the permitting authority designates. As of 2019 there are **15 designated MS4s** (Burlington, Burlington International Airport, Colchester, Essex, Essex Junction, Milton, Rutland City, Rutland Town, St. Albans City, St. Albans Town, Shelburne, S. Burlington, University of Vermont, Williston and Winooski) and one TS4 (Transportation separate storm sewer system) the Vermont Agency of Transportation, subject to the Phase II rule in Vermont. In 2004 a Lake Champlain Basin Program study recommended increasing the number of towns subject to the permit requirements. The study recommended including all towns in New York and Vermont with populations of at least 3000 people and with at least 50% of the township area located in the lake watershed (Winsten, 2004).

The requirements of the permit are essentially six minimum measures. These measures were developed through a national stakeholder process. The permit requires that over a 5-year period the designated MS4 adopt, implement or contract with others the required minimum measures, in a comprehensive manner such as through a master plan or municipal program. The six minimum measures are:

- (1) Develop a public education and outreach effort on the impacts of stormwater runoff;
- (2) Involve the public in the stormwater plan development;
- (3) Develop and implement an illicit discharge, detection and elimination plan for nonstormwater discharges to the stormwater system;
- (4) Adopt a construction erosion control ordinance or reference a qualifying program;
- (5) Adopt a post-construction stormwater management ordinance or reference a qualifying program; and,
- (6) Develop and implement a good housekeeping/pollution prevention plan for all municipal facilities including public street sweeping and catch basin cleaning.

Taken alone or in conjunction with other plans described above these six measures are simply good common sense. If adopted statewide they would greatly contribute to reducing the impact of stormwater runoff in Vermont. Examples of regional collaboration by municipalities to effectively meet these requirements and examples of nine MS4 stormwater management plans can be found at: <http://www.smartwaterways.org/resources/local-resources/>. This template does not fully cover Model Outline for Stormwater Master Plan (numerals I-V) and is better viewed as part of a more comprehensive stormwater management framework that could work in conjunction with any of the Templates.

XIII. Unified project prioritization matrix for stormwater master plans

In order to select projects with the greatest water quality pollutant reduction, that are the most cost effective for a municipality to implement and that address the largest number of co-benefits a unified scoring matrix below has been developed to assist in project prioritization.

Unified Scoring Prioritization for Stormwater Master Plans

The following table is to assist in the standardized prioritization of projects identified in a Stormwater Master Plan (SWMP).

Criteria	Proposed Weight	Max points
Water Quality/Environmental impact		
Sediment reduction (using STP calculator for sediment) (not yet developed)	0-4 (natural groupings within the range of sediment reductions for proposed projects for a specific plan. 0=very low reduction, 4= very high sediment reduction)	4
Phosphorus/nutrient reduction (using STP Calculator)	0-4 (natural groupings within the range of phosphorus reductions for proposed projects for a specific plan. 0=very low p reduction, 4= very high P reduction)	4
Impervious area managed	1-4 (natural groupings within the range of impervious surface managed for proposed projects for a specific plan. More impervious treated gets more points)	4
Percent of Water Quality & Channel Protection Volume treated*	0-3 (0= no WQ treated, 1= ½ WQV treated, 2=meeting WQV, 3=meets WQV and CPV). Do not apply to road projects.	3
Percent of Recharge criteria met *	0-3 (0 = no infiltration, 1 =infiltrates less than recharge volume, 2= meets full recharge, 3= exceeds recharge 1.5 times or more) Do not apply to road projects.	3
Streambank or other gully erosion mitigation	0-2 (calculate volume= Length x avg. width x avg. depth, use natural groupings to divide volume into 3 categories)	2
Green infrastructure opportunity	0-1 (0=no, 1=yes)	1
* WQV, CPV and Recharge criteria as outlined in 2017 Vermont Stormwater Management Manual		
Total Water Quality Score (out of 21, or 15 if road project)		
Feasibility Criteria		
Public land or Private Landowner support	0-3 (3=public land, 2=willing private land owner, 0=unwilling or unknown willingness of private landowner)	3
Project and Permitting complexity (number of permits required)	0-2 (2= simple permitting, 0= complex permitting-potential denial)	2
Infrastructure conflicts	1 (Y= 0, N=1)	1
Total Estimated Project Cost)	Enter engineering estimate+ construction estimate (no points)	
Project efficiency (\$/lbs. of P removed)	1-12 (Use natural grouping of \$/lbs. removed)	12
Ease of O&M and ease of access for O&M	0-2 (based on municipal input on what is easiest to maintain, 0=high maintenance, 2=easy maintenance)	2
Total Feasibility Score (out of 20)		
Other considerations/Co-benefits (0=doesn't address concern, 1=addresses concern)		
Educational benefits and or Recreational benefits	1	1
Natural habitat creation/protection	1	1
Infrastructure improvement (culvert replacement)	1	1
Outfall erosion control	1	1
Connected to receiving water	3=all runoff infiltrates on site, 2= runoff receives some treatment before reaching receiving water. 1=runoff drains via infrastructure directly to receiving water with no erosion or additional pollutant loading, 0 =runoff drains directly to receiving water	3
Flood mitigation (known problem)	1	1
Existing local concerns	1	1
Total Co-benefits Score (out of 9)		
Overall Score (out of 50 or 44)		

XIV. Funding sources for stormwater master planning

The following table matches state funding opportunities with each master planning template. Note that all grant eligibility conditions must be met for a project to be eligible for funding:

Funding Sources for Stormwater Master Planning					
Template	Meets VTDEC Clean Water Initiative Project Eligibility Requirements? (Awards up to \$75,000)	Meets VT DHCA Municipal Planning Project Eligibility Requirements? (Awards up to \$20,000) ¹	Meets VTrans Better Back Roads Project Eligibility Category A Requirements (Awards up to \$8,000)	Meets FEMA Hazard Mitigation Grant Eligibility Requirements? (Awards up to \$50,000)	Meets Current VTrans Better Connections Project Eligibility (Awards up to \$67,500)
1a	Yes	Yes	No	Maybe	Yes
1b	Yes	Yes	No	Maybe	Yes
1c	Yes	Yes	No	Maybe	Yes
2a	Yes	Yes	No	Maybe	Yes
2b	Yes	Yes	No	Maybe	Yes
2c	Yes	Yes	No	Maybe	Yes
3a	Yes	Yes	No	Maybe	Yes
3b	No	Maybe	Yes	Maybe	Yes
3c	No	Yes	No	Maybe	Yes

¹ Maximum award is \$35,000 if the applicant is a consortium of towns

XV. References

Booth, D., D. Hartley, and R. Jackson, 2002. Forest cover, Impervious Surface Area and the Mitigation of Stormwater Impacts. *Journal of the American Water Resources Association* 38(3).

Booth, D., 2000. Forest cover, Impervious Surface Area and the Mitigation of Urbanization Impacts in King County, Washington. University of Washington, Seattle, WA.

DeGasperi, Curtis L., Hans B. Berge, Kelly R. Whiting, Jeff J. Burkey, Jan L. Cassin, and Robert R. Fuerstenberg, 2009. Linking Hydrologic Alteration to Biological Impairment in Urbanizing Streams of the Puget Lowland, Washington, USA. *Journal of the American Water Resources Association* 45(2).

Vermont Department of Housing and Community Affairs. 2007. Growth Center Planning Manual for Vermont Communities. Montpelier, VT.

Vermont Department of Environmental Conservation. 2013. Water Quality Remediation, Implementation and Funding Report, Montpelier, VT.

Winsten, J. 2004. Policy Options for Reducing Phosphorus Loading in Lake Champlain. Lake Champlain Basin Program, Grand Isle, VT.

XVI. Template References

Example Stormwater Master Plans and Master Plan Webinars are posted on the VTDEC web site at:
<http://dec.vermont.gov/watershed/cwi/solutions/municipal-stormwater>

- 1a. VTDEC Watershed Management Division Stormwater Section stormwater permit file # 3010-9010.A.
- 1b. Pease, J., "Creating Partnerships at the Local Level: Morristown Vermont Case Study."
Presentation at the 2008 New England Nonpoint Source Conference, Groton CT.
<http://click.neiwpsc.org/npsconference/08-presentations/Pease.pdf>
- 1c. City of South Burlington Land Development Regulations (May 2012, page 175) 12.03 Stormwater Management Overlay District: http://www.sburl.com/vertical/Sites/%7BD1A8A14E-F9A2-40BE-A701-417111F9426B%7D/uploads/LDRs_9-24-13_Complete_No_Maps.pdf
City of South Burlington Zoning Overlay District map:
<http://www.southburlingtonvt.gov/Planning/Regulations%20&%20Plans/LDRs%20Effective%2012-11-2017%20Map%204%20Overlays.pdf>
- 2a. Hurley, S. 2012. Green stormwater infrastructure Opportunities in Waitsfield, Vermont. Final Report, VTDEC Ecosystem Restoration Grant 2011-CCC-2-01.
- 2b. VTDEC Watershed Management Division Stormwater Section MS4 stormwater permit file for the University of Vermont, Notice of Intent for permit #3-9014, March 2008.
- 2c. VTDEC Watershed Management Division Stormwater Section web site:
<http://dec.vermont.gov/watershed/stormwater/impaired-waters/stormwater-tmdls>
Dubois & King Inc., 2012. Town of Williston Allen Brook Flow Restoration Plan Draft Report.
http://dec.vermont.gov/sites/dec/files/wsm/erp/docs/erp_AllenBrook.pdf
- 3a. Stone Environmental Inc. 2013. Town of Williston Town-Wide Watershed Improvement Plan, Phase 1 Final Report. Project ID 12-055. Montpelier, VT.
- 3b. Stone Environmental Inc. 2013. Stormwater Management Plan for the Town of Enosburgh and the Village of Enosburgh Falls Final Report. Project ID 112475-W. Montpelier, VT.
- 3c. US EPA Stormwater Phase II Final Rule Fact Sheet Series, Minimum Control Measures
<https://www.epa.gov/npdes/stormwater-phase-ii-final-rule-fact-sheet-series>

XVII. Glossary

Act 250: Vermont's land use and development law

Green stormwater infrastructure (GSI): an approach to managing stormwater runoff that utilizes the natural infiltration capacity of the soil to filter and absorb water that otherwise becomes runoff. The utilization of existing soils and the natural vegetation of those soils can be a very cost-effective method for reducing stormwater pollution loads and stormwater runoff volume.

NRCS: United States Natural Resources Conservation Service

Stormwater retrofit: A structural or nonstructural practice installed after development has occurred in a watershed to reduce pollutants from stormwater runoff.

TMDL: A TMDL or Total Maximum Daily Load is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. Water quality standards identify the uses for each waterbody, for example, drinking water supply, contact recreation (swimming), and aquatic life support (fishing), and the scientific criteria to support that use. The Clean Water Act, section 303, establishes the water quality standards and TMDL programs.

TR-55: NRCS Hydrologic modeling program used for calculating predevelopment and post development stormwater peak discharges for varying storm sizes.

XVII. Credits

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