



STEVENS BROOK FLOW RESTORATION PLAN (FRP) STUDY

ST. ALBANS, VERMONT

ECOSYSTEM RESTORATION PROGRAM GRANT #ERP 2013-1-01

FINAL REPORT January 2014



Town of St. Albans

A great place to live, work, and play



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I. Disclaimer

The intent of this report is to present the data collected, evaluations, analysis, designs, and cost estimates for the Stevens Brook Flow Restoration Plan Study, completed under a contract between the City of St. Albans and Watershed Consulting Associates, LLC. Funding for the project was provided from the Vermont Ecosystem Restoration Program (ERP) under grant contract ERP #2013-1-01. The plan presented is intended to provide the watershed impervious surface owners (the City of St. Albans, the Town of St. Albans, and the Vermont Agency of Transportation (VTRANS) a basis for the development of Flow Restoration Plans (FRPs) for compliance with the National Pollutant Discharge Elimination System (NPDES) General Permit 3-9014 (2012) for Stormwater Discharges from Small Municipal Separate Storm Systems (MS4) (VTDEC 2013). This planning study presents one recommended potential collection of Best Management Practices (BMPs) needed to meet the Stevens Brook FRP target; there are a multitude of other potential BMP project combinations that could also sufficiently meet FRP goals. **The MS4s are not bound in any way to the proposed BMP list or the implementation schedule presented in this report.** The Town and VTRANS may coordinate with the City to complete a joint FRP for their MS4 permit compliance using this report as a guide, or each owner may complete their own independent FRPs for compliance with General Permit 3-9014.



1 Project Overview

In December 2012, the State of Vermont Department of Environmental Conservation (VTDEC) designated the City and Town of St. Albans, VT as well as VTRANS within the geographic boundaries of the Stevens Brook and Rugg Brook impaired watersheds as small MS4 communities. These communities are now subject to the requirements under the National Pollutant Discharge Elimination System (NPDES) General Permit 3-9014 (2012) for Stormwater Discharges from Small Municipal Separate Storm Systems (MS4). The MS4 general permit requires the development of Flow Restoration Plans (FRPs) for each MS4 with impervious surfaces that drain to an impaired watershed on the EPA approved 303(d) list. The objective of the FRP is to identify BMP controls which address the Stevens Brook Total Maximum Daily Load (TMDL) flow targets, with the ultimate goal to remove Stevens Brook from the State of Vermont's Impaired Waters EPA 303(d) list.

The development of this DRAFT FRP was completed by Watershed Consulting Associates, LLC (WCA) under a VT DEC Ecological Restoration Program grant- #ERP 2013-01-1. The goal of this project was to develop a FRP for the Stevens Brook Watershed (SBW), to assist the City and Town of St. Albans and VTRANS in the effort to help protect and restore Vermont's stormwater-impaired streams. The allocation of impervious ownership between the City, Town and VTRANS in the watershed was determined and guided the plan development. The MS4 communities will be able to use this DRAFT plan to prepare and submit a final FRP for the Stevens Brook Watershed in compliance within their MS4 permit and thereby have a long-term plan to address water impairments from impervious runoff.

2 Background

Stevens Brook, upstream of Pearl Street in the City, is currently on the State of Vermont's impaired waters list (EPA 303(d)), determined to be primarily a result of stormwater runoff. In the effort to restore Stevens Brook and lift its impaired designation, a flow-based Total Maximum Daily Load (TMDL) was developed for Stevens Brook, which outlines required reductions in stormwater high flows and increase in baseflow. The flow targets are the basis for the Flow Restoration Plan (FRP), developed in accordance with the MS4 General Permit Subpart IV.C.1 as a required part of the MS4's Stormwater Management Program (SWMP).

The purpose of the FRP is to outline a plan for the retrofit of existing impervious cover with stormwater management Best Management Practices (e.g. detention basins, bioretention filters, etc) to meet the TMDL flow targets. The TMDL set forth that watershed hydrology must be controlled in the SBW to reduce high flow discharges and increase base flow in order to restore degraded water quality and achieve compliance with the Vermont Water Quality Standards (VWQS). Components of the FRP, as outlined in the MS4 general permit include the identification of retrofits to existing BMPs with expired State stormwater permits, new BMP controls, and design plans for selected BMPs, a financial plan, and a regulatory analysis.



Three MS4's including the City and Town of St. Albans, and VTRANS own impervious cover within the Stevens Brook impaired watershed. The contributing MS4's are allowed to prepare a joint FRP for the watershed, or separate plans addressing their individual contribution. The TMDL flow targets are watershed-wide; therefore, the approach for this independent study was to develop a watershed-wide FRP, with consideration of the individual MS4's flow-target allocation based on impervious ownership.

2.1 TMDL Flow Targets

Vermont developed TMDLs for impaired watersheds using flow as a surrogate for pollutant loading. The basis for the TMDL development was based on the comparison of modeled Flow Duration Curves (FDCs) between impaired and attainment watersheds. The Program for Predicting Polluting Particles Passage through Pits, Puddles, and Ponds, Urban Catchment Model (P8) was used to model gauged and ungauged watersheds in Vermont and develop Flow Duration Curves (FDCs) from which a normalized high flow and low flow per sq mi (cfs/sqmi) were extracted. An FDC is a curve displaying the percentage of time during a period that flow exceeds a certain value, with the "low" flow represented by the 95th percentile of the curve and the "high" flow represented by the 5th percentile. The high and low flow values from the FDCs were then compared between "impaired" watersheds and comparable "attainment" watersheds to determine a percent change (i.e. reduction of high flow, increase of low flow). The percent change was reported in the EPA approved TMDL for each impaired watershed.

The high-flow ($Q_{0.3\%}$) was determined to be relatively equivalent to the 1-year Design storm flow, therefore BMPs designed to the Channel Protection volume (CP_v) Storage standard address the high-flow reduction.

The approved TMDL flow targets for Stevens Brook are as follows:

	High Flow Target, Q 0.3 (± %)	Low Flow Target, Q 95 (± %)
TMDL Targets for Stevens Brook	-24.4%	24.3%

While the low-flow goal is important to ensure flow during the dry summer months, it is not an actionable requirement in the EPA approved TMDL, and therefore was not the primary focus of the FRP BMP identification for this study.

The Vermont DEC worked with an external consultant to develop a VT-specific hydrologic model, the Vermont Best Management Practice Decision Support System (BMPDSS) to predict progress toward the TMDL flow targets based on proposed BMP implementation schemes. The BMPDSS model is used to predict peak flows at the watershed outlet for a base condition (pre-2002), existing condition (Post-2002), and a BMP implementation scenario, all compared on a percent change basis.



2.2 MS4 Allocation of Flow Targets

Allocation of the high-flow flow target by MS4 was approximated based on relative impervious ownership and impervious cover currently managed with a Channel Protection (CP_v) storage BMP. However, there are limitations to this method because the BMPDSS model is an aggregate model, in which upstream BMPs affect downstream flow and runoff doesn't necessarily follow political boundaries. A correction factor was applied based on the flow target to account for the relative error in separation of the BMPDSS results by MS4.

Approximately 71% of the impervious cover within the SBW is within the City, 22% within the Town, and about 7% on the VTRANS Right-of-Way (Table 1). Based on the impervious cover ownership, the City's allocation was determined to be the largest of the target, with a flow reduction of 17.3%, followed by the Town's reduction of 5.4%, and VTRANS reduction of 1.7%.

Table 1: MS4 Flow Target Allocation

Stevens Brook TMDL Flow Target Allocation by Impervious Ownership					
MS4 Impervious Owner	Total Area w/in Watershed (acres)	Impervious Area (acres)	Percent Impervious (%)	% of Stevens Impervious Cover	Target High Flow Q 0.3 (± %) Reduction by MS4
St. Albans City	575.7	197.5	34.3%	70.9%	-17.3%
St. Albans Town	1078.3	61.8	5.7%	22.2%	-5.4%
VTrans	64.3	19.3	30.0%	6.9%	-1.7%
Watershed Total	1718.3	278.6		100.0%	-24.4%

3 Existing Data Review

3.1 Permit Review

As per subpart IV.C. of the approved MS4 general permit, all expired stormwater permits in the watershed were acquired and reviewed. Existing stormwater systems approved under an expired permit were field verified for compliance with the written permit (Table 2). Field retrofit assessments were then completed at each site with CP_v detention structures for system upgrades to Vermont 2002 Stormwater standards.

**Table 2: Expired Permit Stormwater BMPs**

Site Name	Permit #	Permit Expiration Date	Address	CPv Storage
City of St. Albans				
St. Albans Town Education Center	1-1206	12/31/1999	169 South Main Street	Y
The Switchyard	2-0907	7/1/1985	Lake & Pine Streets	Y*
St Albans Industrial Park Access Road	2-0147	7/1/1985	Lemnah Drive	---
Lower Welden Street Housing Project	2-0963	7/1/1985	94-100 Lower Welden ST	---
St Albans Industrial Park Lot #1	2-1157	7/1/1988	Lemnah Drive	---
Coote Field Industrial Park	1-0702	3/31/1993	Lake Street/Houghton St.	---
St Albans City Industrial Park Lot #4	1-1264	6/3/2001	Lemnah Drive	---
Town of St. Albans				
Northwestern Medical Center Campus	1-1477.0102	3/31/2006	Home Health Circle	Y
Grice Brook Retirement Community	1-1194	12/31/1999	Grice Brook Circle	Y
Hill Farm Estates	1-0650	12/31/1992	Hill Farm Estates Rd	---

*It was determined that The Switchyard currently meets the CPv standard, despite its current Expired permit, and was therefore more proposed for retrofit

3.2 VTDEC BMPDSS Model Review

Progress toward the flow targets was assessed using the VT BMPDSS model. VT DEC developed “Base” condition models for all impaired watersheds. The base scenario includes all stormwater BMPs installed prior to issuance of the VT Stormwater Standards in 2002, and impervious cover based on quickbird satellite imagery. A “Post2002” model scenario was then developed with all existing BMPs designed to the VT SW standards, providing credit toward the flow target. A theoretical “optimized” model was also run which simulates a full build-out BMP implementation scenario optimized by cost, high-flow reduction, and low-flow augmentation. The optimized model was complete to forecast the effort and cost to achieve the flow targets.

Initially, the optimized run was reviewed to inform the initial desktop screening for BMP placement and the required effort. However, the optimized run only estimated a -6.22% reduction of the high-flow, whereas the target is a -24.3% reduction. The estimated detention volume of the optimized proposed BMP’s was used by the Team as a guide for the required effort to reach a portion of the target, and informed the team that the required storage may need to be 4x greater.

The next step in order to develop a proposed BMP “Credit” scenario, was to review the existing Base and Post2002 models for accuracy, including the addition of new projects since the model was prepared and potentially omitted BMPs.



3.2.1 Base Model

The following considerations were documented upon review of the **Base model**:

- Combined sewer subwatersheds were **included** in the P8-UCM modeling effort by Tetra Tech--used to develop synthetic flow duration curves, from which the flow targets were derived. An estimated 205 additional acres of drainage to Stevens Brook was modeled by Tetra Tech, resulting in a potential over-estimation of the high flow percent reduction. VT DEC is aware of this matter.
- WCA's subwatershed delineations (WCA 2009) for the City and Town of St. Albans were used by VT DEC in the VT BMP DSS Base and Credits models, therefore Combined Sewer subwatersheds were **excluded** from the VT BMP DSS model.
- Stevens-Rugg Diversion structure was accounted for within the Base model. The discharge coefficient (model parameter) was modified to ensure that water was routed over the diversion. The discharge coefficient needs to be manually altered by the user in order for the model to operate properly.

3.2.2 Post2002 Model

The following considerations were documented upon review of the **Post2002 model**:

- Sites with existing permits (not-expired) were all accounted for within the BMPDSS.
- Any new permits issued in the past few years, or currently proposed development projects would need to be investigated and added to the model.

3.2.3 BMPDSS Model Revisions

The team field verified the drainage areas and design of the BMPs included in the Base and Credit models and compared the field observations to the DEC model inputs for any discrepancies. In addition, the team field verified drainage areas for non-permitted Low Impact Development (LID) Projects within the watershed for addition to the Credit model.

Updated input files for the Base and Credit models were submitted to the State DEC in order to run the updated models including revised subwatersheds, BMP locations, BMP drainage areas, and BMP design parameters (e.g. size, depth of soil).

The **Base model** was revised as follows:

- ❖ Revised Drainage areas for two existing BMP's reducing the overall Stevens Brook Watershed by 12 acres.
- ❖ Revised five (5) subwatersheds to account for new BMP practices and field verified drainage paths.



The **Post 2002 model** was updated to include all BMPs installed after the VT 2002 Stormwater Design standards (“Post 2002”) including:

- ❖ Rugg Street Rain Gardens (5)
- ❖ Bishop St. Rain Gardens (6)
- ❖ Quintin Court Rain Gardens (5)
- ❖ Firehouse Tree Box Filters
- ❖ Infiltration Trench on Driscoll Dr.
- ❖ Gravel Wetland at the St. Albans Park and Ride (Fig. 1)
- ❖ Taylor Park Pervious Concrete Sidewalks and Proposed Rain Gardens



Figure 1: Gravel Wetland at St. Albans Park & Ride

There were several existing permitted sites that do not have volume-based or infiltration BMPs and therefore those sites were not included in the model. There were two new pending permits, #6520-INDS and #6602-INDS with proposed construction that were not included in the Post2002 model because the permit was unavailable at the time of the plan development. However, if these projects are moved to the construction phase they will need to be added to the Post2002 model. WCA confirmed with the St. Albans Town Zoning Manager that the project covered under permit #5841-INDS is on hold indefinitely, and therefore, the BMPs associated with this project were not added to the model.

Rain Gardens:

Rain gardens for three green street projects were considered in the Post2002 model (Bishop, Rugg, Quintin). The sizes of drainage areas for individual rain gardens were too small to be counted in the model due to the low resolution of the Hydraulic Response Unit (HRU), which are 30m x 30m. Therefore, the drainages areas of these practices were lumped into one larger drainage area so that they could be incorporated into the model.

Diversion Structure:

The Vermont DEC modeled the diversion structure in the Base and Post2002 models as a “regulator” which acts as a flow splitter, diverting flow from Stevens to Rugg Brook. The existing structure was designed to divert flow from Stevens to Rugg Brook during high flows by way of a culvert and weir structure. The discharge coefficient (model parameter) was reduced from the default value of 0.6 to a lower value of 0.37, in order allow the model to divert flow from Stevens Brook according to the Dubois & King design; 15% of the 1-year storm to be diverted from Stevens to Rugg Brook. Alterations to the diversion structure in 2006 are reflected in the Credit (Post 2002) model. WCA corresponded with DEC about the parameters selected for the diversion and it was determined that the structure was correctly modeled according to the diversion structure design parameters and therefore these inputs were not altered.

4 Required Controls Identification

The process of BMP identification consisted of first assessing the existing BMPs with expired permits for retrofit potential to meet the VT 2002 design standards. Upon review of the existing BMPs, WCA determined that additional new BMPs would be required to meet the high-flow target.

The team then conducted an initial desktop assessment of the watershed to identify open spaces ideal for BMP implementation with priority on City and Town owned land. In addition, the spread of BMPs was considered to provide storage throughout the watershed, and focused on areas with a high-percentage of impervious coverage where flows were expected to be highest. After an initial list of retrofits were identified, a field assessment was completed at each site documenting the engineering feasibility of each retrofit including utility conflicts, natural resources, transportation constraints, collateral benefits (visibility, pedestrian safety), ease of operation and maintenance, and the amount of impervious treated. The team also verified drainage areas for the proposed BMPs. The proposed BMPs were then designed using HydroCAD to meet the CP_v storage criteria for warm waters. CP_v estimates for each BMP are summarized in Table A-2 (Appendix 2), along with HydroCAD model outputs in Appendix 3.



Figure 2: VTRANS Median Swale- Five proposed in Credits Model

WCA prepared conceptual designs for the recommend BMPs, designed to the Vermont 2002 Stormwater Standards for CP_v storage (1-year Design Storm), provided in Appendix 4. BMP feasibility was determined based on available space, mapped NRCS soils, existing 1-ft topographic elevation control derived from 2008 Rock River LIDAR, and mapped stormwater and wastewater infrastructure. Additional above ground utility constraints were noted in addition to land ownership, operation and maintenance, and safety considerations. An in-depth engineering assessment will still be required at each site to confirm the presence/absence of utilities, natural resource constraints, and potential transportation impacts, as part of the final design process.

4.1 BMPDSS Model Results

The final recommended BMPs list was developed based on an iterative assessment using the BMPDSS modeling tool. The results of the model runs are summarized in Table 3 below.

Table 3: BMPDSS Model Run Results Summary

VT BMPDSS Model Run	Model Run Date	Unadjusted flow percent reduction (%)	% of TMDL High-Flow Target Met
DEC Existing BMPs Post2002 Model	DEC 10/15/12	-0.60%	2.4%
Existing BMPs Post2002 Model	WCA 4/12/13	-0.92%	3.6%
Proposed Credits Model	WCA 6/25/13	-18.0%	72%
Proposed Credits2 Model	WCA 10/15/13	-23.9%	98%
Final Proposed BMP Credits3 Model	WCA 12/21/13	-28.1%	115%



The DEC existing conditions model estimated that **2.4%** of the TMDL high-flow target was addressed with existing BMP controls. WCA reviewed DEC's model, field verified the existing stormwater BMP's, and researched past stormwater projects in the watershed with help from the Regional Planning Commission, local contacts, and City personnel. WCA identified eight(8) additional LID practices not included in the existing model, as well as a few drainage area corrections. The model corrections resulted in an increase to **3.6%** progress toward the high-flow target, making it evident that small-scale LID projects would not be enough to address the flow-targets and that a focus on large-scale detention BMP's would be more beneficial toward meeting the high-flow goal.

Once the initial model was revised, an initial BMP list was assessed in the BMPDSS Credits run, estimated to address **72%** of the high-flow reduction including Expired permit retrofits. WCA then assessed the watershed for additional BMP's to address the remaining flow reduction. A revised model run ("Credits2") was complete with several additional BMPs and estimated to address 98% of the target. A final model run with the recommended BMP list and revised design estimated a -28.1% reduction in the high-flow, addressing **115%** of the flow target. A 15% factor of safety was estimated, suggesting that the proposed BMPs plan was conservative and may be reduced.

4.2 P8 model and TMDL Target Revision Considerations:

The TMDL high-flow and low-flow targets were developed using the P8 model. At the time the model was developed, the combined-sewershed mapping for the City and Town of St. Albans was not available. Therefore, an additional 205 acres were included in the runoff analysis. It is not known how the additional acreage included in the model affected the overall percent impervious for the watershed, however a majority of the combined-sewersheds are located within the urban center, suggesting that the percent impervious would be less if the combined-sewersheds were excluded from the watershed in the P8 model runs. Percent impervious is a sensitive parameter in the P8 model, directly influencing the calculated runoff from the watershed. The additional acreage could potentially have resulted in an over-estimation of the high-flow reduction required to bring the watershed to the attainment condition.

5 Proposed Best Management Practices (BMPs)

The final Credits scenario included the addition of twelve(12) new Channel Protection Volume (CP_v) BMP's (e.g. Figure 1), nine(9) new infiltration BMPS, and five(5) retrofits to existing BMPs with expired permits. Credit toward the flow target is also from existing stormwater structures including four (4) BMPs designed to Post 2002 standards and eight(8) LID infiltrative practices. (Table 4). Additional information is summarized for each BMP in Table A-2 (Appendix 2), including the impervious cover treated, percent impervious of the BMP drainage area, total area treated, and estimated CP_v volume storage by the HydroCAD design model and presented on the attached map (Appendix 1).

**Table 4: Final Proposed BMPs for the Stevens Brook FRP Study**

Proposed BMP ID	Model	BMP Type	BMP Land Ownership	Permit #	Impervious Managed (ac)
City					
GMP Cooling Ponds Retrofit	Proposed	Retrofit Basins	Private	NP	54.60
Hungerford- Lower Basin	Proposed	Basin	Private	NP	31.67
Greenwood Cemetary	Proposed	Basin	City/Private	NP	5.23
Lemnah Dr.	Proposed	Basin	City	NP	5.09
St. Albans Town Education Center	Retrofit	Retrofit Basin	Private	1-1206	8.95
65 Bishop St- Pocket Yard	Proposed	Storage Chambers	City/Private	NP	4.89
Industrial Park (SB Collins)	Proposed	Basin	Private	2-1157	3.79
Governor Smith Retrofit	Retrofit	Retrofit Basin	Private	NP	0.83
Homeland Security	Proposed	Storage Chambers	Federal	NP	2.75
Houghton St.- State of VT	Proposed	Basin	State	NP	1.52
Maple St.	Proposed	Infiltration	Private	NP	1.00
Town					
NWMC-Main Pond (Hill Farm Estates)	Retrofit	Retrofit Basin	Private	1-1477, 1-0650	19.46
Grice Brook Retirement Community	Proposed	Basin	Private	1-1194	2.76
NWMC-South Pond A	Retrofit	Retrofit Basin	Private	1-1477	3.75
East View Subdivision - New Pond	Proposed	Basin	Private	NP	2.74
NWMC-South Pond B	Retrofit	Retrofit Basin	Private	1-1477	0.95
VTRANS					
Upper Fairfield	Proposed	Basin	Private	NP	3.23
Fairfield	Proposed	Basin	VTRANS	NP	2.20
SDC118	Proposed	Median	VTRANS	NP	0.53
Median A1	Proposed	Median	VTRANS	NP	0.52
SDC140b	Proposed	Median	VTRANS	NP	0.51
SDC105b	Proposed	Median	VTRANS	NP	0.48
SDC408	Proposed	Median	VTRANS	NP	0.44
SDC98b	Proposed	Median	VTRANS	NP	0.41
Median A2	Proposed	Median	VTRANS	NP	0.41
SDC105c	Proposed	Median	VTRANS	NP	0.40

Based on the MS4's proposed impervious cover managed and the final model's estimated flow reduction, it was determined that all the MS4's met their Flow Target Allocation (Table 1) with the proposed BMPs (Table 4).

5.1 City BMPs

St. Albans Town Education Center Basin Retrofit (CITY/ Expired Permit)

The St. Albans Town Education Center (SATEC) basin was permitted under expired permit 1-1206. The existing basin is undersized, and has limited outlet control. The proposed retrofit is to expand the pond and add additional flow control and potential water quality treatment as well.

The site is located on the school property. The school and the City will need to decide if the expired permit will be incorporated into MS4 or the RDA program. Assistance from VTDEC will be required to help determine the optimal regulatory approach.





Green Mountain Power Cooling Ponds Retrofit (CITY):

Abandoned cooling ponds owned by Green Mountain Power are proposed for use as a large-scale water quality treatment/flow detention facility. A new storm line connection would be required from South Main St to Allen St along Lower Weldon St. The design team estimated that the cooling ponds could be retrofitted to provide water quality treatment and mitigate over 6 acre-feet of runoff volume.



The cooling ponds are located adjacent to the CVPS St. Albans diesel plant substation, which is an active UST and Diesel hazardous waste site (#20114205). A Site Investigation was complete summer 2013, as follow up to the substation remediation. Green Mountain Power (formerly CVPS) submitted a Site Investigation Report August 2013, which stated the investigation findings did not warrant additional remedial actions. The investigation is pending approval from the VT DEC Sites Management Section (SMS). Land-use restrictions for the ponds will need to be determined before further development of this retrofit opportunity is completed.

The VTDEC Hazardous waste division will need to be engaged during development of this project. The ponds are privately owned therefore an easement or sale of the land would be needed for the project to move forward.

Hungerford Lower Basin (CITY):

A large-scale retrofit project (feasibility and preliminary design completed under ERP contract #29-18102) is proposed on the Hungerford Property within the Town. Runoff is proposed to be routed from the Stevens Brook impaired watershed into a water quality treatment/flow detention structure on the Hungerford Family Trust property. The BMP is estimated to provide over 20 % of the flow target reduction.



Environmental permitting feasibility and framework needs to be discussed in depth with VTDEC. Land is privately owned and therefore an easement or sale of the land would be required.



65 Bishop St. Pocket Yard Swale

An underground storage system is proposed for implementation on a City-owned parcel located North of 65 Bishop St possibly extending onto adjacent private land (see photo at right). The site is one of few open spaces within the large residential area east of the City downtown. A new stormwater line would divert flow from an existing catch basin capturing a 33 acre drainage area. An easement would be required in order to implement the new stormwater line. Acquisition of adjacent private land would be required to accommodate the entire structure. The BMP is proposed on City-owned land but also may extend onto adjacent private land. To route flow into the BMP an easement would be required across private properties.



CR: http://www.stormtech.com/images/pic_engineer.jpg

Greenwood Cemetery Basin

The proposed BMP would be located on private open land adjacent to the existing Greenwood Cemetery. A water quality/flow detention BMP is proposed. It would capture runoff from a 23 ac area located in the residential district of the City. Flow from an existing stormwater line would be diverted into the facility and then discharged back to the same line.



The BMP is proposed on private land, which may be reserved for expansion of the existing cemetery. An alternative BMP design is possible within the City ROW (Upper Gilman Rd.) if it is deemed infeasible to use the private land for the proposed BMP.

Lemnah Drive Basin

A water quality treatment/flow detention BMP is proposed along Lemnah Dr. just south of the Stevens Brook Crossing and parallel to the railroad. This BMP would serve to detain and treat runoff from the industrial area along Lemnah Dr. and some City homes and streets.



The proposed project is on City-owned land. Redevelopment plans along Lemnah Dr. could impact BMP placement. There is potential opportunity to



incorporate the retrofit with the stormwater management needs of the planned Lemnah Dr. redevelopment project.

Industrial Park Basin (CITY/Expired Permit)

A water quality/flow detention basin is proposed for an existing drainage way, just East of the SB Collins property. The site currently collects drainage from an outlet pipe connected to a system of catch basins east of the railroad tracks, and from the SB Collins facility by a second pipe.

The industrial park including SB Collins holds an expired permit #2-0147 as well as Lot 1 east of the Railroad tracks (expired permit #2-1157). The permittee and City will need to decide if the expired permit will be incorporated into the MS4 or RDA program. The site appears to be partially within the Central VT RR ROW, which will require RR approval. Additional assistance from VTDEC will be required to help determine the optimal regulatory approach.



Governor Smith Rd. Pond Retrofit (CITY)

The existing Governor Smith Rd. Subdivision pond was designed and implemented after 2002. The pond is not permitted under a state stormwater permit because the project was below the 1 acre threshold. The pond was modeled, based on the record drawing, and determined to be not up to the CPv standard. A proposed reduction in the low flow orifice would provide additional CPv storage and credit toward the flow-targets.



The pond is privately owned, therefore the HOA would need to be engaged as a partner with the City in order to implement the proposed pond outlet retrofit.

Homeland Security Storage Unit (CITY)

A subsurface storage unit is proposed for placement beneath the Homeland Security Facility parking lot. There is no available space for an open detention structure; therefore an underground storage unit was determined the best option for this location. The storage unit would capture drainage from a 2.8 ac impervious area including the parking lot and roof of the facility.





The Parking lot is part of a Federal Facility. Homeland Security will need to be engaged as a partner with City for implementing the retrofit project.

Houghton St. Basin (CITY)

An existing shallow swale west of the State of Vermont facility along Houghton St. currently captures runoff from the parking lot, and roof of an adjacent building. The proposed retrofit would involve adding water quality improvements and flow control.

The project site is owned by the State of Vermont. Implementing a retrofit on State property would support the Vermont Governor's Green Infrastructure Initiative.



Maple St. Infiltration/Detention Basin (CITY)

An open lot just north of an existing parking lot along Maple St. was identified as an ideal site for a shallow infiltration/flow detention basin. The structure would capture runoff from 1.3 acres of impervious coverage on the existing privately owned lot.

The proposed project would be located on private land and within the City ROW. The landowner would need to be engaged as a partner with the City for project implementation.



5.2 Town BMPs

NWMC Main Pond Expansion/Hill Farm Estates Retrofit (Expired Permit)

The existing NWMC main pond is permitted under expired permit #1-1477. Available open space adjacent to the existing stormwater pond and the expired permit make this site ideal for retrofit. The goal with the retrofit would be to route additional drainage to the expanded pond from the Hill Farm Estates subdivision (under expired permit #1-0650) north of the medical center, and upgrade the pond to 2002 standards.





Assistance from DEC is recommended to coordinate with the Hill Farm Estates Homeowners Association and the Medical Center to determine the best regulatory approach in order to renew the expired permits, and develop a cost share to fund the pond retrofit. Additionally, it will be important to coordinate with the NWMC planning staff on their proposed expansion plans for the Center.

Grice Brook Retirement Community Basin (Expired Permit)

The existing site is permitted under expired permit #1-1194. Runoff from the Grice Brook Retirement Community currently drains from the site via a series of swales and culverts to a steep embankment with significant erosion (see photo at right). Runoff eventually enters the SATEC pond, which is undersized and has limited outlet control. A new pond is proposed at the bottom of the slope to provide water quality benefit and flow control.



VTDEC wetlands program/ACOE is to be engaged at the start for the project planning process to evaluate wetland presence and function/value at the site location. The site is located on the Town school property and therefore a land sale or easement would be required. Drainage area of the pond includes agricultural runoff as well as the permitted Grice Brook facility. A cost share is recommended between the parties contributing drainage and the Town. The expired permittees and the Town will need to decide if expired permits for the Grice Brook facility will be incorporated into MS4 or the RDA program. Assistance from VTDEC will be required to help determine the optimal regulatory approach.

NWMC North “Pond A” Retrofit (TOWN/Expired Permit)

The existing NWMC North “Pond A” was designed prior to 2002 Stormwater standards. Retrofits to the pond include a reduction of the low-flow orifice for additional flow control and potential installation of pretreatment forebays.



The site is located on private property. The permittee and the Town will need to decide if the expired permit will be incorporated into MS4 or the RDA program. Assistance from VTDEC will be required to help determine the optimal regulatory approach.



NWMC South “Pond B” Retrofit (TOWN/Expired Permit)

The existing NWMC South “Pond B” located to the south of the Franklin County Rehab Center was designed prior to 2002 Stormwater standards. Retrofits to the pond include a reduction of the low-flow orifice to 1” and installation of pretreatment forebays.

The permittee and the Town will need to decide if the expired permit will be incorporated into MS4 or the RDA program. Assistance from VTDEC will be required to help determine the optimal regulatory approach.



East View Subdivision Basin (TOWN)

The East View Subdivision currently lacks a stormwater management system on-site. A water quality/detention basin is proposed to manage runoff from the development before discharging the runoff out of the impaired watershed.

The proposed project is located on private land and within the Town ROW. The HOA is to be engaged as a partner with the Town for project implementation. Plans for a new sidewalk along Congress St. will need to be considered with the BMP implementation.



5.3 VTRANS BMPS

Upper Fairfield Basin (VTRANS)

The proposed location for the Upper Fairfield retrofit site is located off of Fairfield Hill Rd (VT 36, VTRANS-owned) on a private parcel within the Town, capturing approximately 34 ac of drainage from VT36 and neighboring homes and driveways. A water quality treatment/flow control basin is proposed.

Private land would need to be acquired in order to implement the BMP. The land as of November 2013 is advertised for sale. The benefit of the proposed facility location is the ability to control flow at the top of the watershed, before stormwater flows enter the main stream channel and gains velocity and erosive strength.





Fairfield Rd. Basin (VTRANS)

A water quality/flow detention retrofit is proposed within the I-89 ROW, designed to capture runoff from a 28 ac area including a portion of Fairfield Rd (VT-36) and Town residences along the road. The structure will need to be designed according to FHWA guidelines for safety. A new culvert under Fairfield Rd. would be required to route flow from the north side of VT-36 into the facility.

The proposed BMP would treat runoff from VTRANS and Town impervious cover, and therefore a cost-share is recommended.



VTRANS Median BMPs (VTRANS/8 Median Sites)

Eight (8) sites within the VTRANS I-89 ROW were identified as potential sites for water quality/flow detention BMPs to detain and treat runoff from I-89. The sites are all located in existing vegetated stormwater conveyances within in the I-89 median. Key features of the structures include earthen check dams designed to create up to 1.5' of ponding depth behind each dam, amended soils consisting of a 50/50 blend of sand and native soil at the surface, and a pure sand filter below. The structures are designed with a perforated underdrain to be located below the sand filter, connected to the nearest downstream, outlet structure or daylighted. A typical plan is attached under Appendix 4 to demonstrate the typical layout of the median sand filter BMP, which would be replicated for all median sites.



The sites are all on VTRANS land. Environmental permitting including primarily potential wetland impacts needs to be considered for each site. Designs are required to comply with FHWA safety standards for the interstate system.



6 Design and Construction Schedule

A potential design and construction (D&C) schedule was outlined for implementation of the proposed FRP over 20 years from the date of the MS4 permit issuance. The proposed D&C follows a recommended prioritization of the proposed BMP's, included in Appendix 5 (A-5), separated into five 4-year phases. The time schedule accounts for acquisition of necessary permits and/or regulatory approvals. The expired permit BMP retrofits are proposed for implementation during the first two (2) phases, in compliance with the MS4 permit goal to upgrade all currently permitted stormwater BMPs that do not meet Vermont 2002 stormwater design standards.

The flow restoration targets are subject to adjustment by the Secretary, as specified in section IV.J.3. of the MS4 permit, based on biological monitoring data and/or other confounding information concerning flow reduction progress. Adjustments to the flow targets may impact the proposed D&C, particularly if the monitoring data shows compliance with the biological markers before full implementation of the proposed FRP. Furthermore, the attached D&C developed in completion of this grant (ERP #2013-1-01), is for planning purposes only, and does not obligate the MS4's to the defined implementation schedule.

7 Financial Plan

Subject to the requirements of the MS4 permit, a financial plan is required as a part of the Flow Restoration plan which demonstrates the means by which the plan will be financed as well as initial BMP cost estimates. The TMDL is a watershed-wide reduction in the high-flow, and therefore the proposed BMP's are located throughout the watershed. WCA considered MS4 permittee ownership, and strived to identify BMPs with a sole MS4 owner, however optimal BMP locations did not always follow property boundaries. As a result, WCA recommends the MS4 permittees—the City, Town and VTRANS, engage in a cost-sharing plan. The challenges with cost-sharing will be considered in the final FRP proposed financial plan, and may dictate the recommended strategy. Outreach with the Northwest Regional Planning Commission is recommended in preparation of the financial plan for guidance and insight into outside funding sources.

BMP Cost Estimates:

Due to variability in BMP type and size, several cost estimate tools were used to develop the initial cost estimates. All estimates were calculated as a base construction cost multiplied by a conservative fixed Design/Engineering (D&E) and permitting rate of 30%¹. The cost estimates presented are preliminary, based on average costs which may vary due to site specific challenges, unforeseen land acquisition costs, etc.



For new detention BMPs with **over 1 ac-ft of CP_v storage**, initial cost estimates were developed based on the impervious acre managed (MIA), according to the VT DEC EFA impact fee estimate of \$30,000 per MIA, adjusted for inflation. Cost estimates for new infiltration and detention BMPs **below 1 ac-ft CP_v storage** were estimated using a generalized cost tool developed by Tetra Tech based on US EPA 1999 a and b factsheets, documented in a Memo to VT DEC (A-4), and adjusted for inflation from 2000-2014. **Small scale retrofit projects** were estimated separately based on a median value for basin retrofits per MIA².

The Tetra Tech cost model is used in the VTBMPDSS optimization tool to generate initial cost estimates, and has been used by other VT municipalities to estimate BMP costs for FRP preparation. The total cost estimate was estimated according to the following cost equation:

$$\text{Total Cost} = \text{Installation cost (I)} + \text{Fixed cost (F)} + \text{Land cost (L)}$$

Installation costs were based on the estimated CP_v storage volume. The land cost was assumed to be \$0.00 for this level of cost estimation in the absence of land procurement costs. The Tetra Tech model estimates a fixed cost based on the number of eligible parcels within a subwatershed, and is more applicable for the BMPDSS modeling tool. Therefore, an adjusted fixed cost was used, based on a 2006 EPA Stormwater Costs publication (EPA 2006), which found that a typical cost for design and permitting was approximately 30% of the installation costs. This estimate is considered conservative and accounts for special case scenarios and complex design situations which are often the case with urban retrofit projects.

Detention BMPs:

I = (**\$5 per ft³**) *Inflation Factor
 Inflation Factor = (0.30 * (14 years))
 F = I * (30% fixed cost for design and permitting)
 L = \$0 (site specific)

Infiltration BMPs:

I = (**\$6 per ft³**) *Inflation Factor
 Inflation Factor = (0.30 * (14 years))
 F = I * (30% fixed cost for design and permitting)
 L = \$0 (site specific)

The following initial costs were estimated for the proposed BMPs (Table 2), and are subject to change based on site specific constraints, EFA analysis, and land procurement costs.

¹ EPA. (2006). Urban Stormwater Preliminary Data Summary. Pg. 6-1.

²Center of Watershed Protection (CWP). 2007. Urban Stormwater Practices Retrofits V.I. Manual: Appendix E. Table E.1.

**Table 5: Proposed BMPs Cost Estimates**

Proposed BMP ID	BMP Type	Impervious Cover Managed (ac)	Channel Protection Volume		Cost Estimate
			CF	ac-ft	
City					
GMP Cooling Ponds Retrofit	Retrofit Basins	54.60	274428	6.30	\$ 2,129,400.00
Hungerford- Lower Basin	Basin	31.67	181340	4.16	\$ 979,417.00
Greenwood Cemetary	Basin	5.23	48482	1.11	\$ 265,161.00
Lemnah Dr.	Basin	5.09	44257	1.02	\$ 258,012.30
St. Albans Town Education Center	Retrofit Basin	8.95	42253	0.97	\$ 286,455.00
65 Bishop St- Pocket Yard	Storage Chambers	4.89	28967	0.67	\$ 147,862.00
Industrial Park (SB Collins)	Basin	3.79	22651	0.52	\$ 187,226.00
Governor Smith Retrofit	Retrofit Basin	0.83	18513	0.43	\$ 14,779.78
Homeland Security	Storage Chambers	2.75	13983	0.32	\$ 58,656.00
Houghton St.- State of VT	Basin	1.52	9235	0.21	\$ 75,088.00
Maple St.	Infiltration	1.00	6316	0.15	\$ 69,958.23
Total:				15.85	\$ 4,472,015.31
Town					
NWMC-Main Pond (Hill Farm Estates)	Retrofit Basin	15.32	156816	3.60	\$ 776,926.80
Grice Brook Retirement Community	Basin	2.76	58806	1.35	\$ 139,779.90
NWMC-South Pond A	Retrofit Basin	3.75	32496	0.75	\$ 67,099.50
East View Subdivision - New Pond	Basin	2.74	9801	0.23	\$ 135,356.00
NWMC-South Pond B	Retrofit Basin	0.95	6708	0.15	\$ 16,998.54
Total:				6.08	\$ 1,136,160.74
VTRANS					
Upper Fairfield	Basin	3.23	62421	1.43	\$ 163,761.00
Fairfield	Basin	2.20	31799	0.73	\$ 108,531.80
SDC118	Median	0.53	2544	0.06	\$ 28,177.34
Median A1	Median	0.52	2468	0.06	\$ 27,335.57
SDC140b	Median	0.51	2359	0.05	\$ 26,128.28
SDC105b	Median	0.48	2333	0.05	\$ 25,840.31
SDC408	Median	0.44	2047	0.05	\$ 22,672.57
SDC98b	Median	0.41	1968	0.05	\$ 21,797.57
Median A2	Median	0.41	1881	0.04	\$ 20,833.96
SDC105c	Median	0.40	1799	0.04	\$ 19,925.72
Total:				2.56	\$ 465,004.12
Watershed Total:				24.49	\$ 6,073,180.18

8 Regulatory Analysis

Included in the MS4 permits issued to the City, the Town and to VTRANS, a FRP must be implemented within a 20 year timeframe to address the flow target reductions as approved in the Stevens Brook TMDL. Details of the process to permit retrofit projects are still being discussed and finalized by the State. As part of this plan, retrofits are being proposed on sites tied to an expired State operational stormwater permit. Retrofit projects completed on



stormwater systems previously covered under a now expired State operational permit will be either transferred to the MS4, or the private permittees may request coverage under a Residual Designation Authority (RDA) permit from the State. The decision as to how these retrofit projects are covered in the future will be subject to discussion and agreement with the private landowners, the MS4, and the State. If retrofit projects are to be covered under the MS4 permit, the MS4 will elect to take over operation and maintenance (O&M) of the stormwater system and will report on any pertinent O&M activities as part of the MS4 requirements. If the retrofit project is to be covered under an RDA permit, the private landowners holding the RDA permit will retain the responsibility of O&M on the retrofit stormwater system. The VT DEC has not yet introduced an RDA permit for Stevens Brook, and therefore, the timelines as well as the specific standards of this permit are not presently known. For the purposes of the BMPs proposed as part of this plan it was assumed that a future RDA permit will require, at a minimum, maximizing CPv control on the site.

9 FRP Implementation

This Flow Restoration Plan Study was completed to assist the City of St. Albans, and the other MS4 permittees—the Town of St. Albans and VTRANS with the development of their Flow Restoration Plans for Stevens Brook, in compliance with Part III of the MS4 general permit. This plan is not a regulatory document. According to Subpart I.V. C. of the General permit, the MS4 is required to submit a final Flow Restoration Plan (FRP) within 3 years of the permit issuance. The FRP will become a part of the permittees Stormwater Management Program (SWMP) upon approval. The MS4s within the Stevens Brook watershed have the option to submit separate FRP's or complete a joint FRP for the entire watershed. The presented study was prepared on a watershed basis; however, the BMPs were delineated by MS4, and therefore can be adapted for both approaches. A final Design and Construction (D&C) Schedule will need to be submitted with the FRP. Once the MS4s prepare a final FRP, implementation of the FRP is required according to the proposed Schedule. Additionally, updates on FRP progress toward the flow target reductions are required as a part of the SWMP annual reports. In summary, the proposed plan would meet the requirements for a final FRP under Subpart IV. C., however, the presented plan was prepared for completion of the Grant project, and therefore is not binding to the MS4's involved.