Town of Williston Phosphorus Control Plan

Final Report

March 29, 2021

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Disclaimer:

This project was supported by the Federal Highway Administration, the Vermont Agency of Transportation, the Chittenden County Regional Planning Commission, and the Town of Williston. The contents of this report do not necessarily reflect the official views or policy of the U.S. Department of Transportation or the Vermont Agency of Transportation.

1.0 INTRODUCTION **1**
2.0 MUNICIPAL BASELOAD AND P-REDUCTION REQUIREMENTS **1**
2.1 Phosphorus Load for All Developed Lands in Williston 1
2.2 Municipal Phosphorus Load and Reduction Requirements 2
3.0 EXISTING P-REDUCTION CREDITS FOR NON-STRUCTURAL BMPS **5**
3.1 Street Sweeping 6
3.2 Catch Basin Cleaning Credit 7
3.3 Municipal Roads General Permit Upgrades – Gravel Roads 8
3.4 Municipal Roads General Permit Upgrades – Paved Roads 8
3.5 P-Credit for Stormwater Offset Permits 9
4.0 EXISTING PHOSPHORUS CREDITS FOR STRUCTURAL BMPS **9**
5.0 PHOSPHORUS CREDIT SUMMARY **12**
6.0 OPPORTUNITIES TO MEET REMAINING PHOSPHORUS REDUCTION REQUIREMENTS **12**
6.1 Structural BMP Retrofits 13
6.2 Non-Structural Practices for P-credit 13
6.3 Cost-Effectiveness and Municipal Planning Considerations for Proposed BMPs 16
6.4 Remaining Actions to Meet the MS4 PCP Requirements 16
6.5 PCP Next Steps 16
7.0 LITERATURE CITED **18**

Appendix A: PCP Overview Map (24”x36”)
Appendix B: MRGP Compliance Summary (8.5”x11”)
Appendix C: Retrofit Summary Sheets (8.5”x11”)
Appendix D: Floodplain Restoration Supporting Documentation (8.5”x11” and 11”x17”)

Electronic Attachments: BMP Tracking Table – Existing (20210326_Williston_Existing_BMPTrackingTable.xlsx)
BMP Tracking Table – Proposed (20210326_Williston_Proposed_BMPTrackingTable.xlsx)

List of Figures

Figure 1 Example of misclassified developed pervious lands. 3

List of Tables

Table 1 Town-wide phosphorus baseload (all developed lands) 2
Table 2 Baseload summary for 3-acre sites covered under Williston MS4 permit 4
Table 3 Baseload summary for municipal properties 4
Table 4 Municipally owned controlled developed lands summary – Main Lake Segment 5
Table 5 Municipally owned controlled developed lands summary – Shelburne Bay Segment 5
Table 6 Catch basin P-credit summary 7
Table 7 BMP tracking table summary 11
Table 8 P-reduction and existing P-credits summary 12
Table 9 Roads eligible for enhanced street sweeping program 14
Table 10 Costs and P-credit summary for proposed BMPs 17

1.0 Introduction

The EPA established phosphorus Total Maximum Daily Load (TMDL) values for twelve (12) segments of Lake Champlain in 2016 (USEPA, 2016). The TMDLs provide a maximum phosphorus load to the Lake required to meet water quality standards and goals. Phosphorus loads from developed lands are a critical part of the TMDL. Each entity subject to a Municipal Separate Storm Sewer System (MS4) permit is required to meet a phosphorus load reduction for developed lands, based on the receiving lake segment. The Town of Williston and the Chittenden County Regional Planning Commission (CCRPC) hired Fitzgerald Environmental Associates (FEA) in 2019 to develop a phosphorus control plan (PCP) for the Town to meet these requirements for the TMDL and the Town MS4 permit.

This report describes the phosphorus baseload calculations required to determine the PCP targets, accounting of all existing phosphorus reduction credits (P-credits), and recommendations for meeting the remaining P-credits.

1. **Baseload calculation:** Using information provided by VTDEC and by the Town, we determined the Town's phosphorus baseload and the corresponding phosphorus reduction requirements under the Lake Champlain P TMDL and the MS4 permit.
2. **Existing P-credits:** We calculated existing phosphorus reduction credits (P-credit) for all Town-owned structural stormwater best management practices (BMPs) and for a range of non-structural practices. All Town-owned BMPs were entered into the BMP tracking table developed by VTDEC. We used VTDEC's currently approved methods for estimating phosphorus removal through non-structural BMPs (Massachusetts TMDL empirical equations). FEA visited all the existing BMPs and updated the modeling inputs as necessary based on field survey. Several of the BMPs changed classification which significantly increased phosphorus removal efficiency.
3. **Opportunities to meet remaining P-credits**: We provide a range of structural and non-structural options to meet the remaining P-credits. These options include retrofits to existing BMPs, construction of new stormwater treatment systems that are included in the Allen Brook Flow Restoration Plan, floodplain reconnection projects, and enhanced street sweeping. Preliminary estimates of capital costs and annual maintenance requirements are included.

Based on our review of the municipal baseload, the Town is required to provide an annual phosphorus reduction of 263.6 pounds. This plan documents that the existing structural and non-structural practices managed by the Town are providing 234.3 pounds/year of phosphorus removal. The remaining reduction of 29.3 lb/year can be achieved through a range of structural and non-structural practices described in this report. Overall, the proactive approach the Town has taken towards development of stormwater treatment practices has made considerable progress towards meeting the PCP.

2.0 Municipal Baseload and P-Reduction Requirements

2.1 Phosphorus Load for All Developed Lands in Williston

An initial estimate for the Town-wide phosphorus baseload associated with all developed lands (regardless of ownership) was provided by VTDEC. A GIS shapefile was also provided for the Town which mapped all impervious surfaces and developed pervious areas. This data set is generated from 1-meter impervious land cover data classified from 2011 NAIP imagery for the Champlain Basin, intersected with 30-meter National Land Cover Dataset (NLCD) landcover data from 2006. The data was further refined by

VTDEC to classify roadway impervious as "paved" or "gravel" based on the road surface type listed in the VTrans road centerline dataset.

Phosphorus loading rates were established in the Lake Champlain P TMDL for each developed land cover type within each major section of Lake Champlain. The Town of Williston is predominantly located in the drainage area for the Winooski River (Main Lake segment), a small portion is within the LaPlatte River watershed (Shelburne Bay lake segment). Loading rates for the Main Lake segment are slightly higher than those for the Shelburne Bay Lake Segment, as shown in Table 1.

Table 1: *Town-wide phosphorus baseload (all developed lands).*

Lake Segment	Land Cover	Area (acres)	P Loading Rate (kg/year)	P Load (kg/year)
Main Lake	Developed Pervious	3,056.2	0.231	704.5
	Developed Impervious	1,029.5	1.117	1,149.9
	Paved Roads	277.3	0.802	222.4
	Gravel Roads	33.7	2.207	74.4
Shelburne Bay	Developed Pervious	38.4	0.172	6.6
	Developed Impervious	12.5	0.952	11.9
	Paved Roads	8.7	0.735	6.4
	Gravel Roads	3.1	2.075	6.4
			Town Total	**2,182.5**

2.2 Municipal Phosphorus Load and Reduction Requirements

The TMDL established P-reduction targets for the developed lands within each lake segment based on targets for total existing and future growth. The lake segments in Williston both have the same reduction requirement of 20.2%. The Town is responsible for meeting this 20.2% reduction in P-loading for developed lands on all municipally owned and controlled properties. A draft dataset of municipally owned and controlled properties and the corresponding municipal P-load and required P-reductions was prepared by VTDEC in 2019. FEA reviewed this dataset and developed updated mapping of municipally owned and controlled parcels. The FEA updates included minor updates for road right-of-way (ROW) mapping for areas that were misclassified as Town or private, and the addition of the new Catamount Family Center property as Town owned. Review of the developed pervious dataset identified several municipally controlled areas of meadow and forest land that were misclassified as developed. FEA coordinated with VTDEC to remove 18 areas of misclassified developed pervious larger than 2 acres (Figure 1). This land cover correction removed approximately 106 acres of developed pervious from the Town baseload calculation, totaling 24kg P/year.

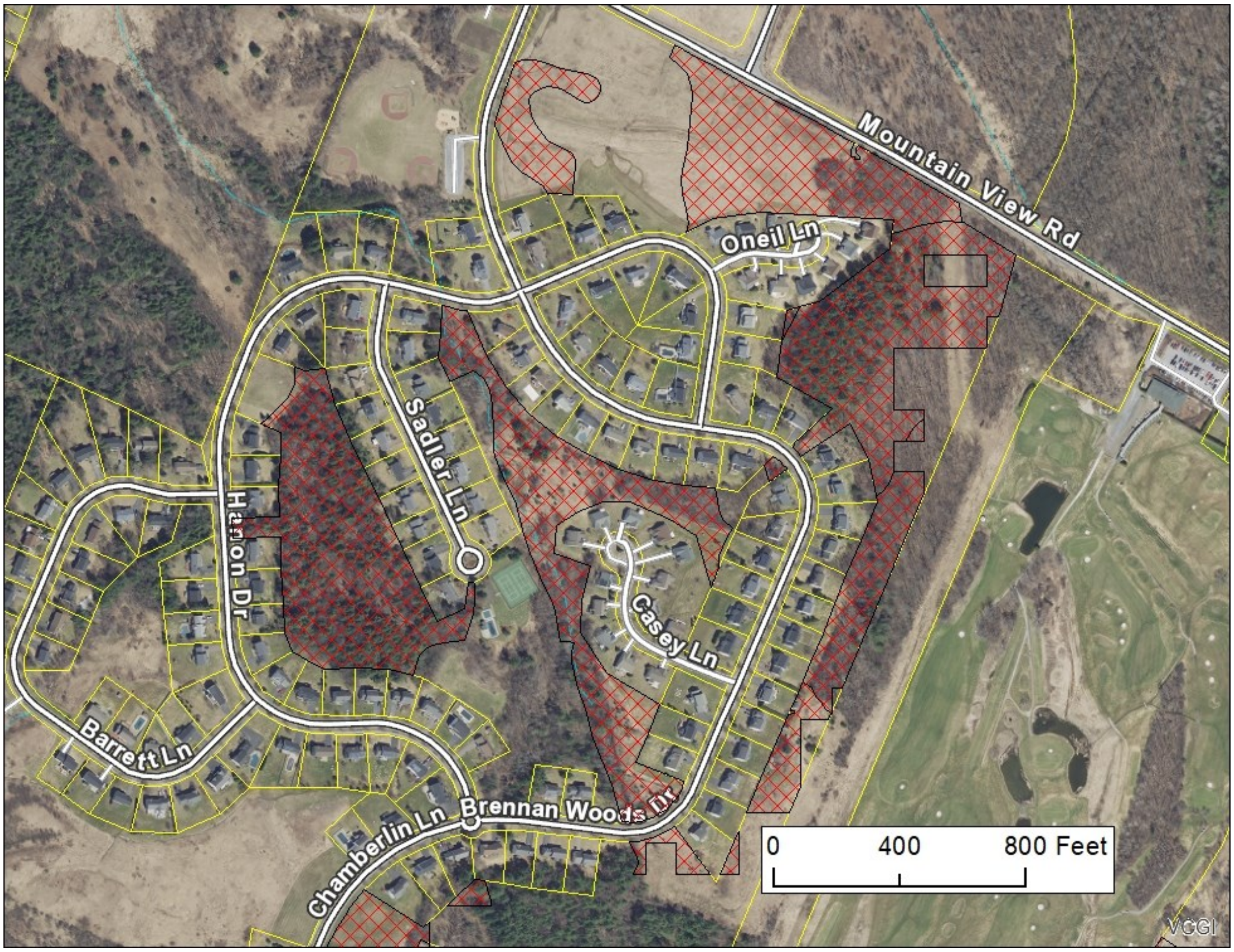

Figure 1: *Approximately 33 acres of forest and meadow (red hatching) that were misclassified as "developed pervious" within the Brennan Woods neighborhood, a 3-acre site that is under municipal control.*

The Town has existing or pending agreements with 12 "3-acre sites" to manage the stormwater treatment systems once they are upgraded to required standards. Properties and units of development with more than 3 acres of impervious surfaces, and that do not meet the 2002 Stormwater Management Manual treatment standards are defined by VTDEC as 3-acre sites are subject to the General Permit 3-9050. The 3-acre sites are required to provide stormwater treatment for 50% of the 1-inch rain event (50% of water quality volume). VTDEC estimated that providing this treatment volume would result in an average P-removal efficiency of 35%. As a result, all P-loads from 3-acre sites under MS4 control have a requirement of 35% P-removal.

FEA reviewed the parcel mapping, neighborhood plans, and other documents provided by the Town to identify the boundaries of each 3-acre site. Table 2 summarize the P-loads associated with the 3-acre sites under municipal control and Table 3 summarizes all municipally owned and controlled sites (municipal parcels and Town road ROW).

Table 2: *Baseload summary for 3-acre sites (non-Municipal) covered under the Williston MS4 permit.*

		Area (acres)					Load (kg/year)			
3-acre Site	**Expired Permit**	**Dev Imp.**	**Dev Pervious**	**Paved Road**	**Unpaved Road**	**Total**	**Dev Imp.**	**Dev Pervious**	**Road**	**Total**
Brennan Woods	1-1272	16.2	73.2			89.3	18.06	16.90		34.96
Coyote Run	1-1507	4.2	12.0	0.1		16.4	4.74	2.78	0.09	7.60
Golf Links	2-1180	5.6	13.6	0.0		19.2	6.20	3.15	0.02	9.37
Heritage Meadows	1-1258	4.5	12.2	0.0		16.7	5.05	2.81	0.00	7.86
Indian Ridge (Taft Farms)	1-1217	4.7	23.8			28.5	5.25	5.49		10.75
Meadow Run and Forest Run	2-1190	7.9	24.3	0.4		32.7	8.87	5.62	0.35	14.84
Meadowridge	2-1107	8.6	32.1	0.3	0.1	41.0	9.65	7.41	0.41	17.47
Old Stage Estates	2-1146	4.5	14.0			18.5	5.04	3.23		8.27
Pinecrest	1-1047	3.6	2.3	1.9		7.9	4.03	0.54	1.55	6.11
South Ridge	1-0664	12.2	35.3	0.0		47.5	13.60	8.16	0.02	21.79
Taft Farms Condominiums	1-0513	2.7	11.2	1.7		15.7	3.07	2.59	1.38	7.04
Williston Commons	1-1052	3.0	19.4	0.9	0.1	23.4	3.32	4.49	1.01	8.82
					Total	**353.9**			**Total**	**154.2**

Table 3: *Baseload summary for municipally owned sites (ROW and properties)*

		Area (acres)					Load (kg/year)			
Municipally Owned/Controlled	**Permit**	**Dev Imp.**	**Dev Pervious**	**Paved Road**	**Unpaved Road**	**Total**	**Dev Imp.**	**Dev Pervious**	**Road**	**Total**
Road/ROW	N/A	28.1	160.3	216.7	27.3	432.4	31.3	36.8	233.4	301.5
Municipal Property	N/A	9.8	49.2	2.3	0.0	61.4	11.0	11.4	1.9	24.3
					Total	**493.8**			**Total**	**325.8**

FEA created a baseload shapefile by intersecting town parcel data with the lake segment boundaries and the developed land cover dataset. Municipal ownership/control is included to identify the parcels subject to the PCP. Based on guidance from VTDEC, the P-reduction requirements must be met for each lake segment, however, the Main Lake and Shelburne Bay segments may be combined for this PCP. The municipal P baseload and P-reduction requirements are shown for each lake segment in Tables 4 and 5. Based on the loading rates and land use classifications provided by VTDEC, and our updated mapping of municipally owned and controlled parcels, the municipal P-baseload from developed lands is **480.0 kg/yr (1,056 lb/yr)**, and the reduction required by the TMDL is **119.8 kg/yr (263.6 lb/yr)**.

Table 4. *Area and P-loads of municipally owned and controlled developed lands in the Main Lake segment (Winooski River) with P load reductions required by the TMDL.*

	Municipally Owned			Municipally Controlled 3-Acre		
Land Cover	**Area (acres)**	**P-Load (kg/yr)**	**P-Reduction (kg/yr)**	**Area (acres)**	**P-Load (kg/yr)**	**P-Reduction (kg/yr)**
Developed Impervious	37.5	41.8	8.5	77.8	86.9	30.4
Developed Pervious	205.8	47.5	9.6	270.5	62.5	21.9
Paved Roads	211.4	169.5	34.2	5.4	4.3	1.5
Unpaved Roads	26.5	58.4	11.8	0.2	0.5	0.2
Developed Lands Total	**481.1**	**317.3**	**64.1**	**353.9**	**154.2**	**54.0**

Table 5. *Area and P loads of municipally owned in in the Shelburne Bay segment (LaPlatte River) with P load reductions required by the TMDL.*

	Municipally Owned			Municipally Controlled 3-Acre		
Land Cover	**Area (acres)**	**P-Load (kg/yr)**	**P-Reduction (kg/yr)**	**Area (acres)**	**P-Load (kg/yr)**	**P-Reduction (kg/yr)**
Developed Impervious	0.48	0.46	0.092	No 3-acre sites		
Developed Pervious	3.75	0.65	0.13			
Paved Roads	7.67	5.63	1.14			
Unpaved Roads	0.85	1.75	0.35			
Developed Lands Total	**12.73**	**8.49**	**1.71**			

3.0 Existing P-Reduction Credits for Non-Structural BMPs

Routine road/stormwater maintenance activities completed by the Town are considered non-structural BMPs and are counted towards the municipal P-reduction target. VTDEC has identified standard methods for estimating P-reduction credits for some of these activities (VTDEC, 2020). This PCP includes calculations for street sweeping, catch basin cleaning, and road erosion improvements required under the Municipal Roads General Permit (MRGP) as specified in the guidance documents distributed by VTDEC in June 2020.

3.1 Street Sweeping

P-Credit Method (Existing Practices)

Existing street sweeping routes were provided as a line shapefile by the Town of Williston. FEA created a 60-ft buffer (30-ft on either side of the road centerline) with a flat end cap to encompass the swept area. FEA examined the resulting polygons to verify the polygons overlapped the full swept roadway and did not overlap large portions of roadways that are not swept, making minor edits to the buffer shapefile where these criteria were not met.

The roadway buffers were then intersected with the town-wide developed lands layer. Based on spot comparison of the developed lands layer with the UVM 2016 land cover layer, the developed lands layer did a better job of capturing the paved roadway. The UVM 2016 land cover layer does not consider the road surface underneath tree canopy and appeared to overestimate the road width in some areas, perhaps due to road shoulders classified as impervious.

During this exercise, we noticed that Winter Sport Lane, Merchants Row, and Spruce Lane were misclassified as unpaved roads or had been paved since the creation of the developed lands layer. We revised the loading rates to that of paved roads for this analysis.

All roadways swept by the Town of Williston are within the Winooski River (Main Lake) drainage (Appendix A). All swept roads are Town owned. There are 98.2 acres of paved roadway in the sweeping area. The loading rate for paved roads in this lake segment is 0.802 kg/ac/year. Therefore, the total P-load of swept impervious is 78.8 kg/year (173.6 lb/yr). **The Town's Stormwater Program has no records of street sweeping prior to 2010, therefore we are assuming that full credit is appropriate for the current street sweeping practices.**

Estimated P-Credit (Existing Practices)

VTDEC currently accepts P-reduction credits following the Massachusetts TMDL method (US EPA, 2016 and VTANR, 2020) using a simple reduction factor for an enhanced sweeping program based on the type of street sweeper and the frequency of sweeping. This reduction factor is applied to the total P load from swept roads. For biannual sweeping, $\text{Credit}_{\text{sweeping}}$ is defined as the product of the phosphorus load from swept impervious surfaces (swept impervious area multiplied by P load export rates based on land use) and the phosphorus reduction factor based on sweeper type and frequency (0.02 efficiency factor for a vacuum assisted sweeper per MA Method Table 2-3).

- Town of Williston Swept Paved Road Load: 78.8 kg/year (173.6 lb/yr)
- Annual Street Sweeping Credit = Annual Load * 0.02
- All curbed roads are swept twice per year
- **P-reduction Credit Based on Existing Sweeping of Paved Roads: 1.6 kg/yr (3.5 lb/year)**

MA Method Appendix F Table 2-3 (US EPA 2016): *Phosphorus reduction efficiency factors ($PRF_{sweeing}$) for sweeping impervious areas.*

Frequency	Sweeper Technology	$PRF_{sweeping}$
2/year (spring and fall)	Mechanical Broom	0.01
2/year (spring and fall)	Vacuum Assisted	0.02
2/year (spring and fall)	High-Efficiency Regenerative Air Vacuum	0.02
Monthly	Mechanical Broom	0.03
Monthly	Vacuum Assisted	0.04
Monthly	High Efficiency Regenerative Air-Vacuum	0.08
Weekly	Mechanical Broom	0.05
Weekly	Vacuum Assisted	0.08
Weekly	High-Efficiency Regenerative Air Vacuum	0.10

3.2 Catch Basin Cleaning Credit

P-Credit Methods

The catch basin cleaning credit is based on the P-load from impervious surfaces within the area draining to catch basins and the cleaning frequency. To simplify the analysis, we assumed that all the area within the Town ROW drained to catch basins, and that routine catch basin cleanouts occurred within the street sweeping zones provided by the Town. The roads, buildings, and other impervious land cover classes within ROW were used to determine the total impervious area draining to catch basins within the street sweeping zones. The total impervious and paved road area in street sweeping zones is 102 acres. **This analysis assumes that the catch basin cleaning program was started after 2010. Any years of catch basin cleaning between 2000 and 2010 will reduce the P-credit.**

Estimated P-Credit (Existing Practices)

The MS4 stormwater SOP document (VTANR 2020) uses a simple reduction factor (0.02) based on an assumption of annual catch basin cleaning (Table 6). The Town cleans catch basins on a 5-year rotation; therefore a 20% scaling factor was applied to the reduction.

MA Method Appendix F Table 2-4 (US EPA 2016): *Phosphorus reduction efficiency factor (PRF_{CB}) for semi-annual catch basin cleaning.*

Frequency	Practice	PRF_{CB}
Annual	Catch Basin Cleaning	0.02
5 year	Catch Basin Cleaning	0.004

Table 6: *Paved Road and Impervious Loading and Catch Basin P-Credit by Lake Segment.*

Lake Segment	Roadway (acres)	Other Impervious (acres)	Paved Road Loading Rate (kg/ac/yr)	Other Impervious Loading Rate (kg/ac/yr)	P Load (kg/yr)	Amount of P Load Removed by Catch Basin Cleaning (kg/yr)
Main Lake (Winooski)	87.3	14.4	0.80	1.12	85.97	**0.34**

- **Existing P-Reduction Credit with Cleaning of All Catch Basins in Street Sweeping Zones Semi-Annually: 0.34 kg/year (0.75 lb/year)**

3.3 Municipal Roads General Permit Upgrades – Gravel Roads

VTDEC developed guidance for calculating P-credits for road improvements required to meet the MRGP standards (VTDEC, 2020). The deadline for completing all work required by the MRGP work is the same or earlier than the PCP deadline (2036), therefore we are considering the P-credits in the following section as "existing", i.e., the Town is obligated to meet these P reductions.

The 2017/2018 road erosion inventory (REI) conducted by CCRPC identified 26 gravel road segments and 2 non-curbed paved road segments that did not meet (DNM) MRGP standards. An additional 37 gravel road segments partially met (PM) the MRGP standards. The Town of Williston completed the required improvements to meet MRGP standards on 13 segments on Butternut Road and Governor Chittenden Road in 2017 and 2019 using funding from the VTDEC Grants in Aid Program. All road segments that partially meet or do not meet the MRGP are shown in Appendix A and described in Appendix B.

VTDEC has released loading rates based on MRGP status, road type, hydrologic connectivity, and road slope expressed in kg-P/km/yr. Roads mapped as "did not meet" receive an 80% P-reduction credit and roads maps as "partially meet" receive a 40% P-reduction credit, when brought up to MRGP compliance. Appendix B provides a summary of noncompliant gravel and paved segments with planned upgrades and already upgraded segments (highlighted) with calculated P load and reduction credits. **Based on current guidance, P-credits for completed and planned MRGP upgrades to road segments total 28.8 kg/yr.**

3.4 Municipal Roads General Permit Upgrades – Paved Roads

Paved road segments with catch basins, defined as high priority due to hydrologically connected drainage outlets with 3 or more cubic yards of erosion, must be stabilized by December 31, 2025. The 2019 inventory data documented 3 high-priority outlets with more than 3 cubic yards of erosion (Appendix A). Two of the gullies, Stonybrook Drive and Marshall Avenue at East Commerce Park, had erosion volumes listed as 9CY and 150CY respectively. FEA visited both these sites and determined that the erosion volumes in the REI were incorrectly calculated (dimension units were changed for later versions of REI). The current erosion volumes for the sites are approximately 5CY for Stonybrook and 10CY for Marshall Avenue at East Commerce Park. Erosion volume and dimensions were not listed for the gully at the Taft Farms Senior Center. FEA visited this gully and we estimated an erosion volume of 250CY. We observed a recently repaired gully at an outlet southeast of the intersection of Stillwater Lane and Talcott Road. Williston DPW repaired this gully after 2010 and before the REI (estimated 2014). We estimated that approximately 50CY of rock was used to fill the eroded bank.

Gully erosion at the Stonybrook outlet

VTDEC has provided guidance on estimating P-reduction credit for stabilizing outfall erosion. The required inputs are the erosion volume and the estimated duration of the erosion (to estimate annual erosion volume). Based on guidance from VTDEC we assume that the gullies formed over a 30-year period. This volume is then used to calculate the annual P load associated with the erosion. The Town has a total of 315CY of gully erosion that is required to be stabilized (MRGP).

Following the VTDEC calculations, these gully stabilization projects represent a total post-mitigation P-credit of 4.9kg P/year.

3.5 P-Credit for Stormwater Offset Permits

The Town has been the permittee on eight (8) stormwater offset permits. Six (6) of these permits were closed in 2020, however the associated lands are in conservation easements. The offset permits were primarily reforestation projects to improve buffer vegetation along Allen Brook. Each permit specified an annual sediment removal value (offset charge capacity). These values ranged from 12 to 6,000 pounds of sediment per year, with a total of 8,239 pounds of sediment per year for the 8 permits combined. Based on preliminary guidance provided by VTDEC for the Lake Champlain P TMDL: "applicants (Town) may use existing sediment offset capacity, currently measured in pounds of sediment, which may be converted to phosphorus at an exchange rate of 1,500 pounds of sediment per pound of phosphorus." More recent guidance from VTDEC for estimating the phosphorus content in sediment from gully erosion estimates 1 pound of phosphorus per 2,500 pounds of sediment for gully stabilization projects (VTDEC 2020). **Assuming the lower conversion rate from the 2020 guidance, the existing offset projects provide a P-credit of 1.5 kg P/year.**

4.0 Existing Phosphorus Credits for Structural BMPs

The Town provided FEA with a list of all the stormwater permits that are included in their MS4 permit (locations shown on map in Appendix A). FEA reviewed all of the permits included in the MS4 and determined that most were appropriate for inclusion in the PCP. Permits for impervious constructed after 2010 or for pre-2002 development with no changes to the BMP were not included in this PCP. The structural BMPs included in this PCP were typically constructed for private neighborhoods and were assumed by the Town as part of the Allen Brook Flow Restoration Plan (Dubois and King, 2016). VTDEC provided FEA with HydroCAD models for many of the BMPs included in the MS4 permit. The HydroCAD models were developed by several consulting companies as part of the Flow Restoration Plan (FRP). Most BMPs had modeling information for the original design and proposed or as-built designs for BMP retrofits required to meet the FRP. The Town provided as-built and proposed retrofit plans for the remaining BMPs. Three additional BMPs were constructed by the Town for water quality and road drainage improvements, not associated with a stormwater operational permit.

A total of 29 BMPs were entered into the BMP Tracking Table developed by VTDEC. Sixteen of the BMPs were retrofits to existing practices designed to increase extended detention volume for the FRP, and the remaining 13 BMPs are new construction. Detention basins were classified as "wet" or "dry" following guidance from VTDEC. Basins were classified as "wet" if at least 20% of the water quality volume was stored below the lowest outlet (permanent pool).

FEA visited all the BMPs included in the MS4 permit. We found that several BMPs had simplified HydroCAD models that did not include permanent pool storage. Updating these models with the correct permanent pool volumes changed the BMP classification from "dry" to "wet", significantly increasing treatment efficiency. As-built plans and recently updated construction design plans were used to improve the accuracy of the modeling for BMPs where available. Updates to the FRP modeling are described below:

Southridge BMP reclassified as a Wet Pond

- **Allenbrook Meadows** – FRP modeling included a single extended detention basin.
  - FEA field visit on 6/20/20 documented a distributed system of dry wells, infiltrating swales, and a small underdrained bioretention system.
  - Reviewed design plans from WCA (dated 2014) to calculate treatment volume and updated the BMP Tracking Table with drainage areas from field observations and LiDAR topography data.
- **Brennan Woods** – FRP modeling included 0.5' of permanent pool depth, classifying pond as a dry basin.
  - FEA field visit on 6/29/20 observed deeper permanent pool in the forebay and near the outlet structure
  - Reviewed design plans from L&D (dated 1/5/16) and updated models with additional permanent pool depth and volume from plans.
  - Updated FRP modeling data to increase treatment volume and reclassified as a wet pond in BMP Tracking Table
- **Heritage Meadows** – FRP modeling had no permanent pool storage, classifying pond as a dry basin.
  - FEA visited the site on 6/20/2020 and observed a 3 foot deep permanent pool
  - Reviewed design plans from L&D (dated 10/21/15) and updated models with additional permanent pool depth and volume from plans.
  - Updated FRP modeling data to increase treatment volume and reclassified as a wet pond in the BMP Tracking Table.
- **Indian Ridge (Winslow Pond)** – FRP modeling package from VTDEC included a dry detention basin (Winslow Ave Pond B) but did not have an EFA and was not included in the FRP.
  - FEA visited the site on 6/29/2020 and observed an overgrown dry detention basin with a collapsed outlet structure.
  - Design plans were not available from VTDEC or from the Town. FEA collected survey cross-sections using a centimeter-grade GPS unit to verify the accuracy of the pre-2002 HydroCAD model provided by VTDEC.
  - Due to the collapsed outlet structure and no effective storage, the basin was not included in the existing BMP credit calculations for the PCP.
- **Meadow Run and Forest Run** – A dry detention pond along Whitewater Circle was described in the Allen Brook FRP (Dubois and King, 2016) and was included in the EFA modeling packaged from VTDEC.
  - FEA visited the site with the Town on 6/29/2020 and determined that the pond was not constructed. Further discussion with the Town cited river corridor concerns as the primary reason for blocking the project.
  - Preliminary grading for the proposed pond was included in FRP and matches up with the EFA model. We added the BMP to the Tracking Table, however it is not included in calculations for existing P-credits.
- **Old Stage Estates** – FRP modeling package from VTDEC included a dry detention basin (East Pond) with 0.5' of permanent pool depth.
  - FEA visited the site on 6/20/2020 and observed 2-3 feet of permanent pool in the forebay and main pond near the outlet structure.

- Reviewed design plans from L&D (dated 2/23/16) and updated model based on plans and field observations (pond was measured to be deeper than shown on plans). Updated BMP Tracking Table treatment volume and reclassified as a wet pond.

- **South Ridge** – FRP modeling package from VTDEC included 4 dry detention basins with 0.5 to 0.75' of permanent pool storage.
  - FEA visited the ponds on 5/22/20 and observed that all 4 had deeper permanent pool storage, up to 3 feet deep in the forebay and 2 feet deep near the outlet structure.
  - Reviewed design plans from L&D (dated 10/15/15) which showed proposed grading supporting our field observations. Updated the HydroCAD modeling based on proposed grading from the plans and BMP Tracking Table with increased treatment volumes and all 4 ponds reclassified as wet ponds.

A summary of the BMP Tracking Table inputs and P-credits is provided in Table 7. The complete BMP Tracking Table spreadsheet is included as an electronic attachment (20210326_Williston_PCP_Existing_BMPTrackingTable.xlsx)

The total P-credit for the existing BMPs under municipal control is 69.4 kg/year.

Table 7: *BMP Tracking Table summary*

Neighborhood/ System	Permit	Impervious Area (ac)	Pervious Area (ac)	P-load (kg/yr)	Treatment Volume (cf)	BMP Type	Retrofit	P-Credit kg/yr
Allenbrook Bioretention	2-0954	1.27	2.75	2.05	550	Bioretention (w/ underdrain)	No	0.31
Allenbrook Dry Wells	2-0954	0.75	0.75	1.01	320	Infiltration Chambers	No	0.54
Allenbrook Infiltration Swales	2-0954	0.75	0.75	1.01	250	Infiltration Chambers	No	0.45
Brennan Woods	1-1272	14.91	56.5	29.71	120,000	Wet pond	Yes	3.22
Coyote Run Pond 1	1-1507	2.99	10.08	5.67	41,400	Wet pond	Yes	2.74
Coyote Run Pond 2	1-1507	2.48	4.95	3.91	37,250	Wet pond	Yes	1.97
Golf Links North	2-1180	3.15	15.55	7.11	31,800	Wet pond	Yes	0.46
Golf Links South	2-1180	4.24	34.23	12.64	30,884	Wet pond	Yes	0.78
Heritage Meadows	1-1258	4.84	11.95	8.17	16,620	Wet pond	Yes	3.42
Indian Ridge (Taft Farms)	1-1217	4.15	12.54	7.53	37,900	Wet pond	Yes	3.94
Lamplite	N/A	2.63	6.83	4.52	16,500	Infiltration Trench	No	4.43
Meadow Run and Forest Run	2-1190	3.18	3.37	4.33	21,600	Wet pond	Yes	1.92
Meadowbrook	4306-INDO	2.75	7.83	4.88	21,344	Wet pond	No	2.65
Meadowridge P1	2-1107	7.87	70.42	25.06	33,370	Extended Dry Detention Pond	No	2.14
Meadowridge P2	2-1107	2.94	11.84	6.02	51,620	Wet pond	No	3.60
Meadowridge P3	2-1107	2.02	27.17	8.53	33,540	Wet pond	No	4.47
Old Stage Estates P2	2-1146	2.94	11.84	6.02	24,000	Wet pond	No	3.21
Old Stage Estates P3	2-1146	1.68	13.76	5.06	12,681	Wet pond	No	2.38
Palmer Court	N/A	0.4	0.35	0.53	1,000	Bioretention (w/ underdrain)	No	0.23
Pamela Court	N/A	2.29	10.1	4.89	2,100	Dry Swale (infiltrating)	No	2.93

Table 7: *BMP Tracking Table summary*

Neighborhood/ System	Permit	Impervious Area (ac)	Pervious Area (ac)	P-load (kg/yr)	Treatment Volume (cf)	BMP Type	Retrofit	P-Credit kg/yr
Pleasant Acres	2-0231	0.19	2.05	0.69	3,140	Extended Dry Detention Pond	No	0.08
South Ridge Pond 1	1-0664	4.14	9.89	6.91	36,850	Wet pond	Yes	3.67
South Ridge Pond 2	1-0664	6.76	28.91	14.23	60,228	Wet pond	Yes	7.21
South Ridge Pond 3	1-0664	2.28	6.23	3.99	13,100	Wet pond	Yes	1.89
South Ridge Pond 4	1-0664	2.67	7.86	4.80	24,400	Wet pond	Yes	2.54
Taft Farms Condominiums	1-0513	1.77	2.95	2.66	11,590	Wet pond	Yes	1.16
Turtle Pond	2-1191	1.77	9.24	4.11	66,600	Wet pond	Yes	0.05
Whitney Hill*	1-0963	2.65	5.53	4.24	12,436	Wet pond	Yes	1.97
Williston Commons	1-1052	3.79	20.03	8.86	84,420	Wet pond	Yes	5.07
*retrofit is planned for summer 2021							**Total**	**69.4kg/year**

5.0 Phosphorus Credit Summary

The suite of structural and non-structural stormwater practices currently in place or programmed (e.g., future MRGP upgrades) by the Town have made substantial progress towards meeting the required reductions for developed lands phosphorus load. Table 8 summarizes the current P-load reduction required for municipally owned and controlled lands and existing P-credits from structural and non-structural BMPs managed by the Town. The Town is meeting approximately 90% of their PCP target with the “existing” treatment as described in Sections and 3.0 and 4.0 of this report (Table 8).

Table 8: *Summary of the required P-reduction and existing P-credits for the Town.*

Item	Phosphorus (kg/yr)	Phosphorus (lb/yr)
Required Reduction	**119.8**	**263.6**
Non-Structural BMP Credit		
Street Sweeping	*1.6*	*3.5*
Catch Basin Cleaning	*0.3*	*0.7*
MRGP Improvements	*28.8*	*63.4*
Gully Stabilization	*4.9*	*10.8*
*Offset Permits**	*1.5*	*3.3*
Structural BMP Credit		
Existing Town BMPs	*69.4*	*153.8*
Remaining Required Reduction	**13.3**	**29.3**

6.0 Opportunities to Meet Remaining Phosphorus Reduction Requirements

The proactive approach the Town took towards meeting the Allen Brook FRP has resulted in considerable progress towards meeting the PCP requirements. FEA has worked with the Town to develop a list of structural and non-structural practices and retrofits that can be used as a framework to meet the remaining required P-credits. Additional details are provided in Appendix C (structural BMP retrofits) and Appendix D (floodplain restoration).

6.1 Structural BMP Retrofits and Implementation

The Town was proactive in implementing and retrofitting BMPs to address the Allen Brook FRP. Some of these practices can be retrofitted to significantly increase P-credits while maintaining the volumes required for the FRP. Two additional BMPs described in the FRP are not currently slated for construction, if constructed these BMPs would provide credit towards the PCP and FRP. The BMPs recommended for retrofits or implementation to increase P-credits are described below with more detail included in Appendix C. Details for these BMPs are provided in the electronic attachment (20210326_Williston_PCP_Proposed_BMPTrackingTable.xlsx).

- **Meadowridge Extended Detention Dry Basin** – The recently constructed extended dry detention basin has a large drainage area with the highest phosphorus load for the Municipally controlled BMPs (25.05kgP/year). The existing basin has a low phosphorus removal efficiency (8.5%). Increasing the permanent pool volume by at least 6,000cf would change the BMP to a wet pond and would increase P-removal credits by approximately **8.6kgP/year**.
- **Pamela Court Infiltrating Swale** – Increasing the treatment volume by 100% would increase P-reduction credits by approximately **0.5kgP/year**.
- **Allenbrook Meadows Infiltration Features** – Minor grading modifications to existing dry wells and "yard drains" could significantly increase treatment volume and increase drainage area, increasing P-credits by approximately **0.5-0.7kgP/year**.
- **Meadow Run and Forest Run BMP** - A proposed pond along Whitewater Circle was included in the FRP analysis but has not been constructed due to river corridor conflicts. The pond as shown in the FRP model would provide a P-credit of **3.6kgP/year**. It may be possible to achieve the same level of P-credits through infiltration features along the ROW or along the existing outlet culvert, outside of the river corridor.
- **Indian Ridge BMP -** A detention basin at the end of Winslow Avenue has no water quality storage and is likely providing negligible FRP storage volume. The feature could be retrofitted to a wet pond with excavation and installation of an outlet control structure. This would provide a potential P-credit of **0.5-0.7kgP/year**.

6.2 Non-Structural Practices for P-credit

Enhanced Street Sweeping

VTDEC has accepted the "Wisconsin Method" for targeted street sweeping programs to increase P-credits (VTANR 2020 and WI DNR 2018). This method specifies an enhanced sweeping program to collect leaf litter from roadways at least 4 times during the leaf drop period (October and November). The additional credit (17% removal) is applicable to any sweeping areas with at least 17% canopy cover mapped within the ROW. FEA completed a canopy cover analysis using the 2016 0.5-meter resolution land cover data from UVM for each road included in the existing sweeping routes. 30 roads totaling 9 miles meet the requirements for this enhanced credit (Table 9). We have discussed this option with the Town and based on current costs of street sweeping we estimate that this enhanced sweeping effort would have an approximately annual cost of $10,000. **The 17% phosphorus removal rate for the road area would generate an additional 3.95kg/year of P-credit.**

Table 9: *Roads eligible for enhanced street sweeping P-credits.*

Road	Length (mi)	Road	Length (mi)
AVENUE C	0.38	N WILLISTON RD	0.74
BARRETT LN	0.39	OBRIEN CT	0.17
BITTERSWEET CIR	0.49	OLD STAGE RD	1.10
COUNTRY LN	0.13	PALMER CT	0.06
FAWN PL	0.10	PINECREST CIR	0.07
GAIL TER	0.19	S BROWNELL RD	0.23
HANON DR	0.79	SHARON DR	0.16
HICKORY HILL RD	0.18	SHIRLEY CIR	0.05
HILLCREST LN	0.22	SHUNPIKE RD	0.06
HILLSIDE DR	0.35	STIRRUP CIR	0.39
HORSESHOE DR	0.15	STONYBROOK DR	0.18
JENSEN RD	0.22	SUNDOWN DR	0.34
MCMULLEN LN	0.12	VILLAGE GRV	0.18
MORGAN PKWY	0.22	WILDFLOWER CIR	0.63
N BROWNELL RD	0.61	WINTER SPORT LN	0.10

Street Sweeping and Catch Basin Cleaning Updates

Several municipalities and VTDEC are currently working with the USGS to quantify the effective phosphorus content of street and municipal solids to provide Vermont specific estimates for non-structural practices. Based on previous sampling completed by FEA and a UVM student group for a pilot study funded by the City of South Burlington, we believe that the phosphorus removal from these practices is currently underestimated following the approved P-credit methods from VTDEC (2020). We anticipate that the removal credits for the existing street sweeping and catch basin cleaning programs in the Town of Williston may increase, potentially by up to 50%. **This would represent an increase in P-credits of approximately 1.6kgP/year.**

Floodplain Reconnection Projects

FEA is working with VTDEC and the City of South Burlington to develop and approve a phosphorus crediting system for floodplain reconnection projects applicable to MS4 PCPs. While no methodology has been formally accepted by VTDEC, FEA has presented an approach to VTDEC that appears to provide a defensible and conservative estimate of P attenuation from floodplain restoration projects. The same approach has been used to evaluate three (3) potential floodplain reconnection sites in Williston. FEA worked with the Town of Williston to identify and prioritize locations for floodplain reconnection projects along Allen Brook, with a focus on Town-owned land. Three locations were selected to assess for project feasibility and potential P-credits.

- Upper Site: Town property along the Williston Community Park, west of North Williston Road
- Middle Site: Town property north of the Fire Department and east of Talcott Road
- Lower Site: Private property (Griswold Farm) south of River Cove Road
    - This site has not been discussed with the landowner and would require an easement

A hydrologic analysis was completed to estimate recurrence interval flood discharges based on continuous stream monitoring data from the USGS and Stone/FEA gaging station located at the Route 2A bridge over Allen Brook. One-dimensional hydraulic models were created for the upper and middles sites and were calibrated based on field survey measurements. The hydraulic models showed that the existing floodplains are only accessed during the largest flood events (estimated 50 to 100-year floods). Proposed conditions models were developed for both sites based on conceptual designs to either raise the bed of the channel with instream structures or lower the floodplain, both approaches resulting in more frequent overbank flow. The middle site includes instream structures (i.e., rock weirs) that would raise the bed elevation by up to 3 feet to increase floodplain access. The upper site includes bank cuts to establish a floodplain area that would be accessible for flows larger than the 1-year flood.

Incised channel near the Williston Fire Department (middle floodplain site)

Deeply incised channel with severe bank erosion at the upper floodplain site.

Based on our assessment, the middle project site would require a very substantial bed raising practice to restore floodplain access, raising concerns for long-term bed and structure stability. The proposed bench cut at the upper site is a commonly implemented floodplain restoration practice and represents a long-term water quality improvement with minimal maintenance/stability concerns. We also explored the option for a bench cut project on the Griswold property (lower site) near the confluence of Allen Brook with the Winooski River. For each of these projects, the P-credit is calculated based on the annual phosphorus load (volume x concentration) of water that accesses the floodplain, and additional factors for the type of floodplain and the proportion of the upstream load that comes from developed lands. The proportion of the total phosphorus load from developed lands is relatively small at the upper project site (31%). This is further reduced by existing allocation of phosphorus reductions within the jurisdictional developed lands load as explained in Appendix D. The developed lands represent approximately 50% of the total load at the Griswold site, increasing the potential P-credits applicable to the PCP. It is important to note that other project partners and funding sources could collaborate with the Town and receive P-credits for the non-developed load. Partnerships to maximize P-credit from floodplain projects should be further investigated and will likely be an opportunity to increase cost-effectiveness.

Based on our assessment, a floodplain cut at the Upper Site (Williston Community Park) to create roughly 0.5 acres of floodplain accessible at the 1-year flood would generate a P-credit of 1.82kg/year.

A preliminary analysis of the Griswold property indicates that a P-credit of up to 5kg/year is possible through floodplain restoration.

6.3 Cost-Effectiveness and Municipal Planning Considerations for Proposed BMPs

Approximate capital costs and maintenance costs were developed for the range of structural and non-structural practices described above. These costs were based on a VTANR spreadsheet utilizing data from a large study of BMP costs in the Chesapeake region for the CAST program (VTDEC, 2020; CAST, 2020). Maintenance costs were estimated for a 20-year period. Typical BMP "useful life" estimates range from 20-50 years with proper maintenance. The cost estimates shown in Table 10 are preliminary for planning purposes only and should not be included in Municipal budget planning without further scoping.

6.4 Remaining Actions to Meet the MS4 PCP Requirements

The Town of Williston has made significant progress towards meeting the phosphorus reductions required for the municipal baseload, as described in the Lake Champlain TMDL. The structural and non-structural BMPs described in Sections 3 and 4 will require significant capital expenditures (MRGP) and ongoing costs and effort (BMP maintenance and road practices). Based on the analysis described in this report, the Town will be required to obtain an additional 26.2lb/year (11.9kg/year) of P-credits. The structural and non-structural BMP opportunities listed above in Section 6 include 59.7lb/year of potential P-credits. The proposed practices listed in Section 6 have a wide range of cost-effectiveness. Implementation of the least-cost projects, if feasible, could meet the remaining P-credits for less than $100,000. Costs increase significantly if new BMP construction is required, however these projects would also benefit the FRP. The next 15 years will be busy for Municipal stormwater management; however, the Town of Williston is in a strong position to meet the phosphorus reduction targets and do their part to improve water quality in the Lake Champlain Basin.

6.5 PCP Next Steps

This PCP presents multiple pathways for the Town of Williston to meet its remaining required phosphorus reduction. Following submission of this PCP to VTDEC on or before April 1, 2021 to meet its obligations under the MS4 General Permit, we expect the Town will continue reviewing and exploring the alternatives summarized in Table 10. Additional design, engineering, and permitting will be required for new and retrofit structural BMPs and floodplain reconnection projects. The Town of Williston will report progress on advancing projects toward the PCP target each year to VTDEC in the Annual PCP Report.

***Table 10:** Planning level cost estimates and P-credits for alternative structural and non-structural BMPs to meet remaining PCP target.*

Project	P-credit kg (lb)	Est. Capital Cost	Maintenance	Additional Maintenance (over 20 years)	Total Cost (Efficiency $/lb)	Notes
Meadowridge Retrofit	8.63 (19.0)	$15,000	No Increase	$0	$15,000 ($790/lb P)	No additional maintenance for retrofit
Pamela Court Retrofit	0.50 (1.1)	$15,000	Small Increase	$4,000	$19,000 ($17,300/lb P)	Extend the infiltrating swale to the north and deepen existing swale
Allenbrook Retrofits	0.61 (1.3)	$13,000	No Increase	$0	$13,000 ($10,000/lb P)	
Meadow Run/ Forest Run New BMP	3.57 (7.9)	$180,000	New BMP	$30,000	$210,000 ($26,600/lb P)	Important FRP benefit
Indian Ridge New BMP	0.73 (1.6)	$25,000	New BMP	$10,000	$35,000 ($22,000/lb P)	Some FRP benefit
Enhanced Street Sweeping	3.95 (8.69)	$0	Approximately 2-3x the current annual effort	$200,000	$10,000/year* ($23,000/lb P)	*Annual cost for contractor
Street Sweeping/ Catch Basin Credit Updates	1.6 (3.52)	$0	No increase	$0	No cost	Calculation adjustment, no change in municipal effort
Upper Floodplain Project	1.8 (4.0)	$70,000	Some monitoring may be required, but no or limited maintenance is anticipated.	$0	$70,000 ($17,500/lb P)**	Floodplain projects becomes more cost-effective with a partner, i.e., Clean Water Service Provider (CWSP) and State and/or Federal Funds
Griswold Floodplain Project	5.2 (11.4)	$125,000		$0	$125,000 ($11,000/lb P)**	
Total:	**26.59 (58.5)**					

** actual floodplain project efficiency $5,000 - $6,000/lb P for full P reduction credit, i.e., MS4 available credit + CWSP available credit.

7.0 Literature Cited

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