City of Rutland Phosphorus Control Plan

Final Report

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Project Partners:

Fitzgerald Environmental Associates, LLC.

Applied Watershed Science & Ecology

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Rutland Natural Resources Conservation District
170 South Main Street, Suite #4
Rutland, VT 05701

&

City of Rutland
Department of Public Works
1 Strongs Avenue
Rutland, VT

Prepared By:
Fitzgerald Environmental Associates, LLC.
18 Severance Green, Suite 203
Colchester, VT 05446
(802) 876-7778
www.fitzgeraldenvironmental.com

in collaboration with:

SLR International Corporation
1 South Main Street
Waterbury Village, VT 05676

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1.0 Introduction

The EPA established phosphorus Total Maximum Daily Load (TMDL) values for twelve (12) segments of Lake Champlain in 2016 (US EPA, 2016a). The TMDLs provide a maximum phosphorus (P) load to the Lake required to meet water quality standards and goals. Reducing phosphorus loads from developed lands is a critical component of the TMDL. Each entity subject to a Municipal Separate Storm Sewer System (MS4) permit (VTDEC, 2018a) is required to meet a phosphorus load reduction for developed lands, based on the receiving lake segment. The City of Rutland is a designated MS4 and therefore subject to requirements of their VTDEC MS4 Individual Permit.

The Rutland Natural Resources Conservation District (RNRCD) hired Fitzgerald Environmental Associates (FEA) and partner SLR International in 2021 to prepare a Phosphorus Control Plan (PCP) for the City of Rutland consistent with the requirements outlined in the Lake Champlain Phosphorus (P) Total Maximum Daily Load (TMDL) and 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 City, we determined the City's phosphorus baseload and the corresponding phosphorus reduction requirements under the Lake Champlain P TMDL and the MS4 permit.
2. **Existing P-credits:** Based on review of City-owned structural best management practices (BMPs), we determined that nine (9) existing structural BMPs and one (1) natural resources project were eligible for existing phosphorus reduction credits (P-credits). We calculated P-credits from these BMPs and non-structural practices to upgrade roads and outfalls to municipal roads general permit (MRGP) standards. All structural BMPs were entered into the BMP tracking table developed by VTDEC.
3. **Opportunities to meet remaining P-credits**: Through review of BMP P-credit potential in consultation with the City, this plan provides a range of structural BMP options to meet the remaining P-credits. These options include construction of new stormwater treatment practices and floodplain reconnection projects. Preliminary estimates of capital costs, annual maintenance requirements, and cost-effectiveness are included.

2.0 Municipal Baseload and P-Reduction Requirements

2.1 Phosphorus Load for All Developed Lands in the City of Rutland

An initial estimate for the City-wide phosphorus baseload associated with all developed lands (regardless of ownership) was provided by VTDEC. A GIS shapefile was also provided for the City 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 were 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. All of the City of Rutland is within the Otter Creek lake segment. Loading rates for the Otter Creek segment is shown in Table 1.

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

Lake Segment	Land Cover	Area (acres)	P Loading Rate (kg/acre/year)	P Load (kg/year)
Otter Creek	Developed Impervious	892.8	1.15	1026.7
	Developed Pervious	2387.1	0.292	697.0
	Paved Roads	280.8	0.818	229.7
	Gravel Roads	1.2	2.115	2.5
			City Total:	**1,955.9**

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.

Developed Lands

FEA completed a preliminary analysis of the developed lands baseload for municipally owned and controlled parcels within the City limits. FEA developed a summary Excel spreadsheet and shapefiles for the pertinent datasets:

- Municipally owned and controlled parcel boundaries (65 parcels)
- Municipally owned roads and right-of-way (ROW)
- Combined Storm Sewer (CSS) areas
- Parcel boundaries within the Stone Ridge Neighborhood (46 parcels) associated with one (1) 3-9010 State Stormwater Permit (3215-9010) subject to the 3-acre rule

Municipally owned developed lands within the CSS drainage areas are not subject to the MS4 permit. These developed lands do not need to be included in the baseload unless the sewer and stormwater systems are separated. The baseload and target P-reduction were adjusted to reflect the current CSS extents within the City.

Review of the VTDEC developed pervious dataset identified several municipally controlled areas of meadow and forest land that were misclassified as developed. We also observed areas where lawns and other types of developed pervious lands were misclassified and not counted towards developed land phosphorus loads. Based on the errors we observed in both directions and the relatively small P load associated with these errors (equivalent to roughly 1 kg of baseload in each direction), no adjustment to the developed lands dataset is proposed.

Municipally Owned and Controlled Parcels and ROW

FEA created a baseload shapefile by intersecting municipally owned and controlled parcels and the road ROW with the developed land cover dataset. Municipal ownership is included to identify the parcels subject to the PCP. The target P-reduction percentage for developed lands within the Otter Creek lake segment is 15%. The City is responsible for meeting this 15% reduction in P-loading for developed lands on all municipally owned and controlled properties.

There is one (1) 3-acre site (Stone Ridge) which will be incorporated into the City's MS4 permit. At this time, the City does not plan to take municipal control of other permits associated with 3-acre sites. Developed lands on private property within 3-acre sites are required to have a 35% P-reduction for all lake segments (municipal ROW within the 3-acre sites have a 15% P-reduction). Based on correspondence between the City and VTDEC, the portion of the former College of St. Joseph property purchased by the City is not subject to 3-acre permitting requirements. Now known as the Rutland Community Recreation Center, developed lands on this property are subject to the 15% target P-reduction for municipally owned developed lands.

The P baseload and P-reduction requirements for municipally owned and controlled lands are shown in Table 2.

Table 2: Baseload summary for municipally owned and controlled lands

Land Type	Land Use Class	Area (acres)	Loading Rate (kg/ac/yr)	Base Load (kg/yr)	Target Percent	Required Baseload reduction (kg/year)
Municipal Parcels and ROW	Developed Impervious	57.87	1.15	66.55	15%	9.98
	Developed Pervious	231.99	0.292	67.74	15%	10.16
	Paved Roads (ROW)	165.59	0.818	135.45	15%	20.32
	Unpaved Roads (ROW)	1.10	2.115	2.34	15%	0.35
3-Acre (Stone Ridge)	Developed Impervious	3.69	1.15	4.25	35%	1.49
	Developed Pervious	9.52	0.292	2.78	35%	0.97
	Paved Roads (Private)	0.07	0.818	0.05	35%	0.02
	Totals:	**469.83**		**279.16**		**43.29**

Based on the loading rates and land use classifications provided by VTDEC, and our updated mapping of municipally owned lands, the municipal P-baseload from developed lands (excluding CSS areas) is 279.16 kg-P/year (615 lb-P/year). **Based on the developed lands phosphorus reduction requirements, the annual P-reduction target for municipally owned and controlled lands is 43.29 kg-P/year (95 lb-P/year).**

FEA Review of 3-acre Permit Sites

Incorporating "3-acre sites" into the MS4 permit requires the City to take on the baseload and P-reduction requirement from private developed lands within the area associated with the permit. Properties and units of development with more than 3 acres of impervious surfaces, and those 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. Three-acre sites are required to provide stormwater treatment for 50% of the water quality volume (WQv) storm (1" rainfall), and the full channel protection volume in stormwater-impaired watersheds (i.e., Moon Brook). VTDEC estimated that providing this treatment volume would result in an average P-removal efficiency of 35%. As a result, all P-loads from privately owned developed lands on 3-acre sites under MS4 control have a 35% P-reduction requirement. This removal does not have to be met on site.

It is our understanding that the Stone Ridge neighborhood (expired permit 3215-9010) will be incorporated into the City's MS4. As shown in Table 1, the Stone Ridge 3-acre site represents roughly 2.5% of the City's baseload and 5.7% of the P-reduction target.

Municipal Baseload and P reduction Requirement

Table 3 summarizes the baseload and reduction requirement from municipally owned lands (City parcels and ROW) and the Stone Ridge 3-acre site. **Table 8 in Section 7 summarizes how the City's baseload and P reduction requirement is projected to change based on implementation of the proposed BMPs.**

Table 3. P-loads and of municipally owned developed lands and the Stone Ridge 3-acre site with P load reductions required by the TMDL.

Parcel Type / 3-Acre Site	Load (kg/yr)	Required Reduction (%)	Required Reduction (kg/yr)
Municipal Parcels and ROW	272.1	15.0%	40.8
Stone Ridge*	7.1	35.0%	2.5
Developed Lands Total:	279.2		43.3

* Municipal parcels and right of ways are not included in 3-acre P load and reduction target calculation. Municipal lands are subject to the lake segment (15.0% for Otter Creek) reduction target, not the 3-acre reduction targets (35%).

3.0 Existing P-Reduction Credits for Non-Structural BMPs

Routine road/stormwater maintenance activities completed by the City 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, 2022). This PCP includes review of existing street sweeping and catch basin cleaning practices and calculations for road erosion improvements required under the Municipal Roads General Permit (MRGP) as specified in the guidance documents distributed by VTDEC in June 2022.

3.1 Street Sweeping and Catch Basin Cleaning

City representatives have stated that each catch basin in the City is cleaned annually. Downtown streets are swept weekly and the remaining City streets are swept three (3) times between May and October with a vacuum sweeper. To the best of the City's knowledge, the current street sweeping and catch basin cleaning practices were initiated prior to the year 2000. Therefore, these practices are not considered eligible for P-reduction credits because they predate the State's TMDL P monitoring period.

3.2 Municipal Roads General Permit Upgrades – Paved and Gravel Roads with Open Ditches

VTDEC developed guidance for calculating P-credits for road improvements required to meet the MRGP standards (VTDEC, 2022). The deadline for completing all work required by the MRGP 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 City is obligated to implement MRGP BMPs that will result in a P reduction that can be credited as part of the PCP (VTDEC, 2022).

The 2020 road erosion inventory (REI) conducted by the Rutland Regional Planning Commission (RRPC) identified ten (10) paved road segments (i.e., paved with open ditches) and no gravel road segments that did not meet MRGP standards. An additional ten (10) gravel road segments and one (1) paved road segment (i.e., paved with open ditches) partially met the MRGP standards. MRGP compliance status is available on VTDEC MRGP Report Viewer (link).

VTDEC specifies loading rates based on MRGP status, road type, hydrologic connectivity, and road slope expressed in kg-P/km/yr. Once improved to bring into MRGP compliance, roads initially classified as "did not meet" receive an 80% P-reduction credit and roads initially classified as "partially meet" receive a 40% P-reduction credit. Table 4 provides a summary of noncompliant gravel and paved segments with planned upgrades and already upgraded segments with calculated P load and reduction credits. Based on current guidance, P-credits for completed and planned MRGP upgrades to road segments total 6.1 kg-P/yr.

Table 4: P-Credit for Road and Outlet Upgrades to Meet MRGP Standards

Segment ID	Road Name	Road Type	Slope (%)	Standards	Loading Rate (kg-P/km/yr)	Segment Load (kg-P/yr)	Load Reduction Efficiency	P Removal Credit (kg-P/yr)
11769.1	CLEMENT RD	Paved	2.00	DNM	4.732	0.473	80%	0.379
14976.1	CURTIS AV	Paved	2.00	PM	2.84	0.284	40%	0.114
25294.1	GREENS HILL LN	Paved	2.00	PM	2.84	0.284	40%	0.114
47754.1	PARK ST	Paved	3.00	DNM	4.732	0.473	80%	0.379
51047.1	PORTER PL	Paved	3.00	PM	2.84	0.284	40%	0.114
23475.1	GILRAIN AV	Gravel	3.00	PM	2.55	0.255	40%	0.102
33782.1	LALOR AV	Paved	4.00	PM	2.84	0.284	40%	0.114
34732.1	LINCOLN AV	Paved	4.00	PM	2.84	0.284	40%	0.114
55184.1	RONALDO CT	Paved	4.00	DNM	4.732	0.473	80%	0.379
45989.1	OAK ST EXT	Paved	4.00	PM	2.84	0.284	40%	0.114
25603.1	GROVE ST	Paved	5.00	DNM	6.31	0.631	80%	0.505
51435.1	PREVILLE AV	Paved	5.00	PM	3.786	0.379	40%	0.151
41648.1	MOULTHROP AV	Paved	5.00	PM	3.786	0.379	40%	0.151
5883.1	BRIGHTVIEW AV	Paved	5.00	DNM	6.31	0.631	80%	0.505
64265.1	STRATTON RD	Paved	5.00	DNM	6.31	0.631	80%	0.505
23548.1	GLEASON RD	Paved	6.00	PM	3.786	0.379	40%	0.151
48838.1	PERRY LN	Paved	6.00	PM	3.786	0.379	40%	0.151
69022.1	VICTOR PL	Paved	7.00	DNM	6.31	0.631	80%	0.505
8603.1	CAMPBELL RD	Paved	7.00	DNM	6.31	0.631	80%	0.505
48920.1	PHILLIPS ST	Paved	7.00	DNM	6.31	0.631	80%	0.505
8604.1	CAMPBELL RD	Paved	8.00	DNM	6.31	0.631	80%	0.505
					Total	9.31		6.06

Outlet ID	Erosion Value	Erosion (cu yd)	Sediment Bulk Density (kg/cu ft)	Age of Erosion (years)	Sediment Erosion Rate (kg-TSS/yr)	Sediment to TP Weight Conversion (kg-P/kg-Tss)	P Erosion Rate (kg-P/year)	Load Reduction Efficiency	P Removal Credit (kg-P/yr)
O1941	Rill	0.1	35.08	5	9	6.94E-04	0.01	80%	0.01
O2066	Gully	0.2	35.08	15	14	6.94E-04	0.01	80%	0.01
O2148	Rill	0.1	35.08	5	13	6.94E-04	0.01	80%	0.01
O2255	Gully	3.3	35.08	15	210	6.94E-04	0.15	80%	0.12
O2257	Gully	0.9	35.08	15	56	6.94E-04	0.04	80%	0.03
O2337	Rill	0.2	35.08	5	28	6.94E-04	0.02	80%	0.02
RUT011	Rill	0.9	35.08	5	176	6.94E-04	0.12	80%	0.10
						Total	0.35		0.28

3.3 Municipal Roads General Permit Upgrades – Paved Roads with Catch Basins

Those paved road segments with catch basins defined as Very High Priority due to hydrologically connected drainage outlets with 3 or more cubic yards (CY) of erosion must be stabilized by December 31, 2025. The 2020 inventory data documented 1 high-priority outlet with more than 3 CY of erosion. The erosion volume documented in the REI by RRPC for the high-priority gully off Grove Street was 3.3 CY. An additional six (6) outlets had rill or gully erosion of less than 3 CY. Road segments draining to an outlet that does not meet MRGP standards are considered to have the same MRGP status as the outlet. In total,

the seven outlets are connected to 42 road segments classified as not meeting or partially meeting MRGP standards.

VTDEC has provided guidance on estimating P-reduction credit for stabilizing outfall erosion (VTDEC, 2022). 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 gully formed over a 5-year (rill erosion) or 15-year (gully erosion) period. This volume is then used to calculate the annual P load associated with the erosion. For these projects we assume post-mitigation erosion rates will be reduced by 80%. Following the VTDEC calculations, stabilizing all seven (7) unstable outlets will yield a total post-mitigation P-credit of 0.3 kg-P/year. The credit may need to be adjusted in the future if and when the City completes the stabilization work. For example, depending on access rights and land ownership, the City may not be able to address the full extent of the documented erosion in some cases.

4.0 Existing Phosphorus Credits for Structural BMPs

Based on information provided by RNRCD and the City for completed projects on City-owned property, our team estimated P-reduction credits for each of the existing stormwater BMPs.

Existing Stormwater Basins Eligible for P-Reduction Credits

FEA field-verified BMP dimensions, outlet elevations, and outlet configurations using a centimeter-grade GPS unit. FEA determined the extended detention volume as described in the VTDEC SOP (2022) and calculated the P-reduction credit for each existing BMP in the VTDEC BMP Tracking Table. Table 5 provides a summary of existing structural BMPs with calculated P load and reduction credits. Additional information on each BMP is presented below and in Appendix B. **Based on current guidance, P-credits for existing stormwater basins 4.5 kg-P/yr.**

Georgetti Park Arena Infiltrating Bioretention Basin (Designed by Chenette Associates and Watershed Consulting Associates):

- The Rutland NRCD provided FEA with the final design plans for the bioretention basin. The basin was built per the final design plans.
- Practice is located on City property and maintained by the City.

Northwest Primary School Rain Garden (Designed by VTDEC):

- The Rutland NRCD stated that this basin was built to capture excess runoff from school property not controlled by existing stormwater treatment practices (stone swales and a level spreader). No design plans were available for the basin. Parcel mapping shows part of the school parking lot is owned by the City.
- FEA surveyed the basin footprint and outlet elevation using a centimeter-grade GPS unit.
- The school is not required to obtain stormwater permit coverage under the 3-acre rule. To receive P-reduction credits for this BMP, the City would need to establish a maintenance agreement with the school district to ensure proper operation and maintenance of the BMP.

Rotary Park Infiltrating Bioretention Basin (Designed by Watershed Consulting Associates):

- The Rutland NRCD provided FEA with the conceptual design plan for the bioretention basin. The basin was built following the conceptual design.
- Practice is located on City property and maintained by the City.

Southern Boulevard Sand Filter (Designed by Otter Creek Engineering):

- The Rutland NRCD provided FEA with the final design plans for the sand filter. The basin was built per the final design plans.
- Practice is located on City property and maintained by the City.

Existing Hydrodynamic Separators Eligible for P-Reduction Credits

FEA reviewed the available information for five (5) existing hydrodynamic separators. FEA estimated the WQv peakflow and compared it to the treatment capacity of each separator and calculated the P-reduction credit for each existing BMP based on the 10% treatment efficiency in the VT Stormwater Treatment Practice (STP) Calculator. Table 5 provides a summary of existing structural BMPs with calculated P load and reduction credits. Additional information on each BMP is presented below. **Based on current guidance, P-credits for existing hydrodynamic separators is 15.8 kg-P/yr.**

Adams Street Swirl Separator (Designed by Enman Kesselring Consulting Engineers):

- The Rutland NRCD provided FEA with the final design plans for the Contech Vortech 5000 stormwater treatment unit.
- FEA recreated the HydroCAD model Watershed Consulting Associates prepared for the Tenney Brook Stormwater Master Plan to compare a WQv peak flow to the treatment capacity of the separator. WQv peakflow is a conservative estimate given the model was constructed as a single subwatershed with one time of concentration and a Type II storm. Variability in curve number, time of concentration, and rainfall distribution will likely dampen the peak flow in most cases, allowing the system to treat a greater portion of the WQv storm. Based on our modeling, we estimate that the system treats 100% of the WQv storm volume and should be considered eligible for credit.

Piedmont Drive Swirl Separator (Designed by Otter Creek Engineering):

- The State of Vermont Stormwater Program provided FEA with the final design plans and permit application for the Stormwater 360TM Model PC1319 stormwater treatment unit.
- FEA recreated the HydroCAD model from the stormwater permit application to compare a WQv peak flow to the treatment capacity of the separator. FEA updated the WQv rainfall from 0.9" to 1" and updated the model calculation setting to calculate a separate runoff for each curve number. These changes increased the modeled WQv peakflow from approximately 10 cfs to 38 cfs. The WQv peakflow is a conservative estimate given the model was constructed as a single subwatershed with one time of concentration and a Type II storm. Variability in curve number, time of concentration, and rainfall distribution will likely dampen the peak flow in most cases, allowing the system to treat a greater portion of the WQv storm. Based on our modeling, we estimate that the system treats 94% of the WQv storm volume and should be considered eligible for credit.

Northwest Neighborhood Swirl Separators (Designed by Otter Creek Engineering):

- The City of Rutland provided FEA with the record drawings for the three stormwater treatment units. The models were a Vortechs 5000 (Northwest 1), Vortechs 9000 (Northwest 2), and Vortechs PC 1319 (Northwest 3).
- FEA constructed simple HydroCAD models of the three watersheds to compare the WQv peak flow to the treatment capacity of the separators. The WQv peakflow is a conservative estimate given the model was constructed as a single subwatershed with one time of concentration and a Type II storm. Variability in curve number, time of concentration, and rainfall distribution will likely dampen the peak flow in most cases, allowing the system to treat a greater portion of the WQv storm. Based on our modeling, we estimate that the systems treat 100% (Northwest 1), 88% (Northwest 2), and 97% (Northwest 3) of the WQv storm volume and should be considered eligible for credit.
- FEA calculated the City's developed lands baseload for the former CSS areas that are treated by the three separators

Existing Structural BMPs P-Reduction Credits

A summary of the BMP Tracking Table inputs and P-credits is provided in Table 5. **The total P-credit for the existing structural BMPs is 20.5 kg/year.**

Table 5: BMP Tracking Table Summary for Existing BMPs

Site Name	Existing BMP Type	Approx. Construction Year	Watershed	Landowner	Watershed Area (Acres)	Impervious Area (acres)	% Impervious	Storage Volume (ft^3)	P Load (kg)	Adjusted P Load (kg)	P Removal Credit (kg)	Notes
Giorgetti Arena Parking (GAP)	Infiltrating Bioretention	2017	East Creek	City of Rutland	2.58	1.43	55%	2742	1.98	1.98	1.71	
Northwest Primary School (NPS)	Rain Garden	2016	East Creek	Rutland School District	2.26	1.83	81%	504	2.23	2.23	0.77	
Rotary Park	Infiltrating Bioretention	2021	Tenney Brook	City of Rutland	0.66	0.58	87%	1077	0.69	0.69	0.63	
Southern Boulevard	Sand Filter	2015	Moon Brook	City of Rutland	5.69	1.27	22%	8534	2.75	2.75	1.43	
Adams Street	Hydrodynamic Separator	2016	East Creek	City of Rutland	11.12	3.21	29%	N/A	6.00	6.00	0.6	Vernon separation, has not yet occurred (2023, 2024), Confirm adequate separator sizing (D&K)
Piedmont Drive	Hydrodynamic Separator	2008	Moon Brook	City of Rutland	147.20	38.60	26%	N/A	76.10	74.8*	7.48	Prorated for Northeast Primary 3-acre site
Northwest 1	Hydrodynamic Separator	2014	Tenney Brook	City of Rutland	4.62	3.95	85%	N/A	6.47	6.47	0.65	
Northwest 2	Hydrodynamic Separator	2014	Tenney Brook	City of Rutland	14.36	11.70	81%	N/A	19.93	18.84*	1.88	Prorated for Rutland Middle School 3-acre site
Northwest 3	Hydrodynamic Separator	2014	Tenney Brook	City of Rutland	37.99	34.08	90%	N/A	53.64	53.03*	5.30	Prorated for Rutland Middle School 3-acre site

* reduced by anticipated P-Reduction at nested 3-acre sites (Northeast Primary and Rutland Middle School)

Total **20.45**

5.0 Existing Phosphorus Credits for Natural Resources Projects

FEA and SLR have been working with VTDEC Rivers and Stormwater Divisions to develop a method for calculating phosphorus credits for floodplain restoration and reconnection projects. We assessed the floodplain P storage credit for the Dunklee Pond Dam removal project on Tenney Brook. The project was completed in 2021. Based on discussions between FEA and VTDEC, MS4s may take credit for a portion of this storage credit that is scaled by the proportion of the watershed load that comes from developed lands. The project is also eligible for P credit for improving stream stability. The stream stability sector is considered independent of the developed lands sector within the Lake Champlain TMDL, and therefore stream stability credits may not be included in the PCP as there is no mechanism for cross-sector trading (US EPA, 2016a).

Photo: Reconnected Floodplain Along Tenney Brook at the Former Site of Dunklee Pond

Total Phosphorus Storage Credit

Floodplain phosphorus storage credits are assigned on a per acre basis and scaled depending on the pre- and post-project floodplain connectivity (FFI, 2021). SLR prepared the dam removal and floodplain restoration design plans. Based on their review of the plans and knowledge of pre- and post-project floodplain connectivity, a phosphorus storage rate of 9.1 kg/acre/year (20 lb/ac/year) was selected for improving floodplain connectivity from low to high.

The total credit is reduced by 50% one year after project implementation, so a 4.5 kg/acre/year (10 lb/ac/year) phosphorus storage credit was assigned to the project. The post-project floodplain area is 1.9 acres, resulting in a total P storage credit is 8.6 kg/ac/year (19 lb/acre per year). The Functioning Floodplains Initiative working group has recommended to VTDEC that this credit be divided amongst the load and wasteload sectors in the contributing watershed based on their area distribution.

Phosphorus Storage Credit to City of Rutland

Following discussions with VTDEC Stormwater regarding MS4 P crediting, we prepared a summary of developed lands and associated P loads (Table 6) to calculate the potential credit the City can take towards its PCP. The potential MS4 credit from the total floodplain storage credit is a function of the remaining non-jurisdictional P load from developed lands, once the expected TMDL jurisdictional P load reductions are accounted for. **The potential MS4 P reduction credit is estimated to be 7.8 kg-P/year (17.1 lb-P/year),** which is a fraction of the total credit based on the 90% scalar shown in Table 6. However, it is understood that the remaining 10%, or 0.8 kg P, could be credited to a Clean Water Services Provider (CWSP).

Table 6: Tenney Brook at Dunklee Pond Dam Watershed Developed Lands Summary

Entity/Sector	Acres	P Load (kg/yr)	Jurisdictional TMDL P Reduction	P Load Reduction (kg/yr)*	Remaining P Load (kg/yr)
City of Rutland	50.4	25.2	15%	3.8	21.3
Town of Rutland	35.0	17.5	15%	2.6	14.8
VTrans	27.2	13.6	15%	2.0	11.4
3 Acre	94.2	47.1	35%	16.4	30.4
Non-Muni, Non 3-Acre	488.3	244.2	0%	0.0	244.2
				Total Remaining Developed Lands P Load:	322
				Tenney Brook at Dunklee Pond Dam Watershed Total P Load**:	382
				Tenney Brook at Dunklee Pond Dam Watershed Total Remaining P Load:	357
				Remaining Developed Load/Total Remaining Watershed Load:	**90%**

*The jurisdictional TMDL P reduction is subtracted from the developed lands P load and total watershed P load to calculate the fraction of the total watershed P load that is non-jurisdictional P load from developed lands. This is the fraction of the storage credit that is eligible for PCP credits.

**Total P Load from NHD Plus watersheds is derived from the VT Clean Water Roadmap (https://anrweb.vt.gov/DEC/CWR/CWR-tool). The load for the downstream-most watershed was prorated based on land cover to remove the area downstream of the Dunklee Pond dam from the total load.

6.0 Phosphorus Credit Summary

The suite of structural and non-structural stormwater practices currently in place or programmed (e.g., future MRGP upgrades) by the City, along with the Dunklee Pond dam removal project, have made substantial progress towards meeting the required reductions for developed lands phosphorus load. Table 7 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 City. The City is meeting approximately 80% of their projected PCP target with the existing and programmed practices as described in Sections and 3.0, 4.0, and 5.0 of this report (Table 7).

Table 7: Summary of the required P-reduction and existing P-credits for the City.

Item	Phosphorus (kg/yr)	Phosphorus (lb/yr)
Required Reduction	**43.3**	**95.4**
Non-Structural BMP Credit		
MRGP Improvements	*6.1*	*13.4*
MRGP Outlet Stabilization	*0.3*	*0.6*
Structural BMP Credit		
Stormwater Basins	*4.5*	*10.0*
Hydrodynamic Separators	*15.9*	*35.1*
Natural Resources BMP Credit		
Dunklee Pond Dam Removal	*7.8*	*17.1*
Remaining Required Reduction	**8.7**	**19.3**

7.0 Opportunities to Meet Remaining Phosphorus Reduction Requirements

The City's structural BMPs and restoration of the Tenney Brook floodplain at the site of the former Dunklee Pond dam have resulted in considerable progress toward meeting the PCP requirements. Our team has worked with the City to develop a list of practices that can be used as a framework to meet the remaining required P reductions. Additional details are provided in Appendices B (structural BMP summary table), D (Proposed BMP maps and summary sheets). Table 8 summarizes the iterative effect of the Proposed BMPs on the City P-reduction requirement and baseload by factoring in BMP P-reduction credits and planned CSS area disconnections.

7.1 Structural BMP Opportunities

The PCP appendices present seven (7) options for new and retrofit structural BMPs. The BMPs span a wide range of treatment practices for potential P-reduction and credit. These included BMPs described in the Moon Brook Stormwater Master Plan (Watershed Consulting Associates, 2019) and Tenney Brook/East Creek Stormwater Master Plan (Watershed Consulting Associates, 2014), sites with planned combined sewer separation projects, and a selection of other potential sites for new or retrofit BMPs.

A total of seven (7) BMPs were entered into the BMP Tracking Table developed by VTDEC. All BMPs are new construction.

Moon Brook and Tenney Brook/East Creek Stormwater Master Plan New BMPs (3)

The Vermont Achievement Center gravel wetland and Allen Street underground infiltration BMPs are new structural BMPs to treat older impervious surfaces. Both have conceptual designs and initial outreach completed during development of the Moon Brook SWMPs. HydroCAD printouts included in the SWMPs for new BMPs were developed by Watershed Consulting Associates and reviewed for potential PCP credit by our team.

The Lincoln Avenue Right-of-Way site was selected for further soils review given NRCS soils mapping indicating potentially favorable conditions for infiltration and the large drainage area that could be directed to the wide City right-of-way. The City of Rutland dug the test pit for FEA to review. Soils had more silt and clay than predicted, and there was evidence of a seasonal high groundwater table at 42", ruling out a large underground infiltration feature. Surface runoff from the road could be directed to smaller practices, with small P-removal benefits.

Hydrodynamic Separators and Combined Sewer Separation (3)

SLR has completed design plans for a hydrodynamic separator (Contech VX11000) to treat the Charter Hills neighborhood draining to Combination Pond in the Moon Brook watershed. This project is likely to be implemented. Part of the planned work on Combination Pond is the native revegetation of a 50-foot buffer around the pond that is also creditable toward the PCP as it is outside of the 100-foot-wide corridor used for the stream-stability load allocations.

Our team also evaluated the projected baseload increase and credit for BMPs to be installed for the future Meadow Street and Main Street separations. The City has indicated they are likely to install hydrodynamic separators along the new storm lines. We summarized the additional baseload and P reduction requirements the City will take on with the implementation of the separation projects. Installation of the hydrodynamic swirl separators will result in a net P removal credit benefit to the City.

Other BMP Sites (2)

We evaluated two additional BMP opportunities that were not included in previous planning efforts. The City purchased a portion of the former College of Saint Joseph property for a recreation center. This site was selected for further soils review to determine whether an infiltration practice may be a feasible BMP for the site. The City of Rutland dug the test pit for FEA to review. The soils were predominantly sand. FEA evaluated soil infiltration rates with a Modified Phillip Dunne Infiltrometer and found high infiltration rates (>2 in/hr). Water pooled at 42" in the test pit, potentially due to stormwater runoff from the nearby outlet infiltrating and slowing down at a restrictive very fine sand layer. A shallow infiltration basin is possible, maintaining the required 36" separation to the seasonal high groundwater table. Additional soils investigation would be needed during the design phase.

An open area next to Piedmont Pond off Stratton Road was also reviewed for potential treatment practices. A hydrodynamic separator was selected as the best fit treatment practice due to space constraints and regulatory considerations related to the floodplain, river corridor, and wetlands.

City Selection of BMPs

The City identified a subset of the BMPs evaluated as most likely to be implemented to meet the City's PCP requirements. The full list of BMPs evaluated is presented in Appendix C. The BMPs under consideration for implementation to meet PCP requirements are summarized in Appendix D. The iterative effect of the Proposed BMPs on the City P-reduction requirement and baseload associated with planned CSS disconnections is summarized in Table 8.

7.2 Natural Resources BMP Opportunities

We assessed the approximate floodplain P storage credit for floodplain restoration project on Moon and Mussey Brook identified in the Moon Brook River Corridor Plan (Bear Creek Environmental) and from discussion with Nani McGuire (RNRCD) and Shannon Pytlik (VTDEC Rivers Program). The Moon Brook site considered is the parcel behind the Tire Warehouse. The Mussey Brook site considered is on the Vermont State Fairgrounds property. Additional information is provided in Appendix D.

Table 8: Projection of City baseload and P-reduction remaining with sequential and cumulative implementation of BMPs and associated CSS area disconnections. Negative values indicate excess P credits.

Site Name	BMP Type	MS4 P Reduction Credit (kg)	CSS Area Baseload (kg/yr)	CSS Area Reduction Requirement (kg/yr)	Net P-Credit** (kg/yr)	Cumulative Baseload (kg/yr)	Cumulative Reduction Requirement (kg/yr)	Cumulative MS4 P Credit (kg/yr)	Reduction Requirement Remaining (kg/yr)	Estimated Implementation Year
Baseload (Table 3)*						**279.2**	**43.3**	**34.6**	8.74	N/A
Charter Hills/ Combination Pond	Hydrodynamic Separator	**0.97**				279.2	43.3	35.5	7.77	2023
	Native Revegetation	**0.22**				279.2	43.3	35.8	7.55	2023
Main Street	Hydrodynamic Separator	**1.28**	5.70	0.86	0.43	284.9	44.2	37.0	7.12	2025
Meadow Street	Hydrodynamic Separator	**0.84**	1.92	0.29	0.55	286.8	44.4	37.9	6.57	2026
Rutland Recreation Center	Infiltration Feature	**6.16**				286.8	44.4	44.0	0.41	2027
Vermont Achievement Center	Gravel Wetland	**3.55**				286.8	44.4	47.6	-3.14	2030
Stratton Road	Hydrodynamic Separator	**0.68**				286.8	44.4	48.3	-3.82	TBD
Allen Street Infiltration	Infiltration Feature	**7.03**				286.8	44.4	55.3	-10.85	TBD
Tire Warehouse (3 acres)	Floodplain Restoration	**10.34**				286.8	44.4	65.6	-21.19	TBD
Fairgrounds (1 acre)	Floodplain Restoration	**2.72**				286.8	44.4	68.4	-23.91	TBD

* Existing credits are from MRGP improvements, Structural BMPs, and the Dunklee Pond Dam Removal project.
**Net benefit to the MS4 of installing a hydrodynamic separator to treat CSS areas with planned disconnections. Municipally owned developed lands reduction requirement minus the MS4 P-credit. MS4 receives the full MS4 P-Credit.

7.3 Cost-Effectiveness and Municipal Planning Considerations for Proposed BMPs

Approximate capital costs and maintenance costs were developed for the proposed practices described above. The structural BMP capital costs were based on research completed by the Charles River Watershed Association and the Center for Watershed Protection (US EPA, 2016b) and ballpark cost estimates in the Moon Brook SWMP (WCA, 2017). The floodplain restoration costs were estimated using the median unitized cost from past projects in Vermont. Maintenance costs were estimated for a 20-year period, with a base cost assumption of $1,000/year for a small BMP and $2,000/year for a large BMP. Typical BMP "useful life" estimates range from 20-50 years with proper maintenance. The cost estimates shown in Table 9 are preliminary for planning purposes only and should not be included in Municipal budget planning without further scoping.

Table 9: Planning level cost estimates and P-credits for candidate BMPs to meet remaining PCP target.

BMP Data					Ballpark BMP Cost				Maintenance		Ballpark Cost Summary			
Site Name	BMP Type	BMP Volume (cf)	BMP P Reduction (kg-P/ year)	MS4 P Reduction Credit (kg-P/year)	Inflation Adjusted BMPDSS/ WCA ($/cf)	BMPDSS Capital Cost	Additional Costs	Total Ballpark Capital Cost	Maintenance Effort	Ballpark Maintenance Cost (Over 20 Years)	Total Ballpark Cost	$/kg-P/ year credit	$/kg-P credit (Over 20 years)	$/lb-P credit (Over 20 years)***
Charter Hills/ Combination Pond	Hydrodynamic Separator	N/A	0.97	0.97	N/A	N/A	N/A	$ 75,000	Moderate	$ 20,000	$ 95,000	$ 4,897	$ 97,938	$ 44,424
	Native Revegetation	N/A	0.22	0.22	N/A	N/A	N/A	$146,500	Moderate	$ 20,000	$166,500	$ 37,500	$750,000	$340,198
Main Street	Hydrodynamic Separator	N/A	1.28	1.28	N/A	N/A	N/A	$ 75,000	Moderate	$ 20,000	$ 95,000	$ 3,711	$ 74,219	$ 33,665
Meadow Street	Hydrodynamic Separator	N/A	0.84	0.84	N/A	N/A	N/A	$ 60,000	Moderate	$ 20,000	$ 80,000	$ 4,762	$ 95,238	$ 43,200
Rutland Recreation Center	Infiltration Feature	6,850	6.38	6.16	$ 6.76	$ 46,306	$ 50,000	$ 96,306	High	$ 40,000	$136,306	$ 1,106	$ 22,128	$ 10,037
Vermont Achievement Center	Gravel Wetland	20,438	3.65	3.55	*			$230,003	High	$ 40,000	$270,003	$ 3,803	$ 76,057	$ 34,499
Stratton Road	Hydrodynamic Separator	N/A	0.68	0.68	N/A	N/A	N/A	$ 60,000	Moderate	$ 20,000	$ 80,000	$ 5,882	$117,647	$ 53,364
Allen Street Infiltration	Infiltration Feature	9,963	7.03	7.03	*			$235,963	High	$ 40,000	$275,963	$ 1,963	$ 39,255	$ 17,806
Tire Warehouse (3 acres)	Floodplain Restoration	N/A	14.71	10.34	**			$465,000	Low	$ 20,000	$485,000	$ 1,649	$ 32,971	$ 14,955
Fairgrounds (1 acre)	Floodplain Restoration	N/A	5.44	2.72	**			$232,500	Low	$ 20,000	$252,500	$ 2,321	$ 46,415	$ 21,054

* See Moon Brook SWMP (2019) for details on ballpark cost estimate. A 20% contigency was added to Moon Brook SWMP costs due to recent inflation.

** Based on median cost of $155,000 per acre. A 50% contingency was applied to the Fairgrounds project to account for potential utility relocation.

*** Floodplain restoration cost effectiveness based on total potential credit to MS4 and partner, including storage and stream stability credits.

7.4 Remaining Actions to Meet the MS4 PCP Requirements

The City of Rutland 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 this plan will require significant capital expenditures (BMP construction and MRGP upgrades) and ongoing costs and effort (BMP maintenance and road practices). Based on the analysis described in this report, the City will be required to obtain a minimum of 8.7 kg/year (19.3 lb/year) of additional P-credits. The structural BMP opportunities described in Appendices B, C and D include over 40 kg/year of potential P-credits. The proposed practices have a wide range of cost-effectiveness. Costs increase significantly if new BMP construction is required, however some of these projects may be required to meet the Moon Brook flow restoration targets. The next 15 years will be busy for Municipal stormwater management; however, the City of Rutland is in a strong position to meet the phosphorus reduction targets and do their part to improve water quality in the Lake Champlain Basin.

7.5 PCP Next Steps

This PCP presents multiple pathways for the City of Rutland to meet its remaining required phosphorus reduction. A draft implementation schedule is provided in Table 8. This is intended to demonstrate the City can meet their P-reduction target within a reasonable timeframe and can be adapted as needed.

Following submission of this PCP to VTDEC to meet its obligations under the City's MS4 Permit, we expect the City will continue reviewing and exploring the alternatives summarized in Tables 8 and 9. Additional design, engineering, and permitting will be required for new and retrofit structural BMPs. The City of Rutland will report progress on advancing projects toward the PCP target each year to VTDEC in the Annual PCP Report.

8.0 Literature Cited

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