INDIAN BROOK FLOW RESTORATION PLAN

MS4 General Permit Requirement (IV.C.1)

July 24th, 2015

In Partnership with:

Town of Essex, VT
Village of Essex Junction, VT
Vermont Department of Transportation

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I. Disclaimer

The intent of this plan is to present the data collected, evaluations, analysis, designs, and cost estimates for the Indian Brook Flow Restoration Plan (FRP) Project, completed under a contract between the Town of Essex and the hired consultant team, Watershed Consulting Associates, LLC and Aldrich & Elliott, PC. The Indian Brook FRP was prepared to meet the compliance requirement for the Indian Brook impervious surface owners, including the Town of Essex, Village of Essex Junction, and the Vermont Agency of Transportation (VTRANS), under the National Pollutant Discharge Elimination System (NPDES) General Permit 3-9014 (VTDEC 2012) for stormwater discharges to impaired waters. The presented plan is in draft form, and will be revised by the MS4 partners, as needed. **At this time, the MS4s are not bound in any way to the proposed BMP list.**

1 Executive Summary

Watershed Consulting Associates, LLC, and partners Aldrich and Elliott, PC (A+E) were commissioned to develop the following Flow Restoration Plan (FRP) for the Indian Brook watershed under contract with the Town of Essex, in partnership with the Village of Essex Junction, and the Vermont Department of Transportation (VTRANS). The plan was developed in accordance with the MS4 General Permit #3-9014 Subpart IV.C.1 as a part of the participating MS4's Stormwater Management Program (SWMP). The purpose of the FRP is to provide a planning tool for the MS4 entities to implement stormwater BMP's over a twenty (20) year timeframe, in the effort to return Indian Brook to its attainment condition.

As a part of the FRP development, an assessment was completed to determine to what extent current stormwater controls have reduced high flows (flows occurring less than 0.3% of the time) from the pre 2002 condition, as required by the Indian Brook Total Maximum Daily Load (TMDL) for stormwater. The Vermont Best Management Practice Decision Support System (BMPDSS) model, a GIS-based hydrologic model used to assess the impact of various stormwater Best Management Practice (BMP) scenarios, was used for the assessment.

The BMPDSS estimated **42%** of the high-flow target was met with existing BMPs designed to meet the Vermont 2002 Stormwater Design Standards, when compared to the condition before 2002. Therefore, additional BMPs are required to meet the actionable flow target.

Development of the FRP involved field inspection of all existing BMPs with an expired stormwater permit, followed by review and revision of the existing BMPDSS model scenarios. Several revisions to existing BMP drainage areas and BMP design configurations were identified during field inspection and accounted for in the revised models. After the existing model scenarios were reviewed, new BMPs were identified, inspected, and assessed in the BMPDSS.

The final evaluated BMP list includes 14 projects—four(4) retrofits of existing ponds, three(3) retrofits of existing natural detention areas to detention systems, three(3) new underground infiltration systems, two(2) new sand filters in the I-289 median, one(1) repaving project to increase capture to the Essex High School Rain Garden, and removal of 0.11 acres of existing impervious in the Briar Lane cul-de-sac. The proposed BMPs were assessed with the BMPDSS model, and determined to provide a –1.85% reduction in the high-flow which addresses 212% of the TMDL high-flow target (Q0.3%), through reduction of runoff from the 1-year design storm. While not an actionable target, the low-flow (baseflow) was estimated to increase by 0.6%, which addresses 58% of the low-flow target. The total planning level cost for the 14 projects is $2,899,000. Based on a calculation of the percent target mitigated by each project and cumulative percent addressed, only the top 2 of the 14 proposed projects are required to meet 100% of the TMDL high-flow target. The top two projects, in terms of high-flow reduction are the LDS North Pond Option 4 and the Fairview Dr. retrofit. The planning level cost for the top two projects (with LDS Option 5) is $1,230,000.

The projects were ranked using a comprehensive matrix. From the top projects, four(4) were selected for 30% engineering including:

1. **LDS North Pond:** Retrofit of the Church of Latter Day Saints (LDS) detention pond into an underground storage system
2. **Fairview Dr.:** Retrofit of an existing detention area into a terraced detention basin at the corner of Fairview Dr. and Main St.
3. **Brickyard Dr./Mansfield Ave.:** Retrofit of a natural detention area into a detention basin at the corner of Mansfield Dr. and Brickyard Dr.
4. **Woodlands/Sydney Dr:** Retrofit of a non-functioning detention pond into an underground infiltration basin with 48" perforated pipe for additional storage.

Preliminary 30% engineering plans were developed for the four (4) priority projects with itemized planning level cost estimates. Sketch plans were developed for all other proposed BMPs.

2 Background

Indian Brook, is currently on the State of Vermont's impaired waters (EPA 303(d)) list, determined to be primarily a result of stormwater runoff. In the effort to restore Indian Brook and lift its impaired designation, a flow-based Total Maximum Daily Load (TMDL) was developed for Indian 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 MS4s 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 Indian Brook Watershed 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, a construction and design (C&D) schedule, a financial plan, and a regulatory analysis.

Each MS4 is required to prepare an FRP for impaired waters. The three MS4's contributing impervious cover runoff to Indian Brook, including the Town Essex, Village of Essex Junction, and VTRANS agreed to prepare a joint FRP for the watershed, with consideration of the individual MS4s 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 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 (FDC) from which a normalized high flow and low flow per drainage area in square miles (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 ($Q_{95\%}$) of the curve and the "high" flow represented by the 5th percentile ($Q_{0.3\%}$). 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 target.

Future Growth

The VT DEC added a future growth factor to the TMDL flow targets to account for future non-jurisdictional impervious growth. Non-jurisdictional growth was defined as impervious area that is not subject to a state stormwater permit and is therefore not managed by a state permitted stormwater BMP. This type of growth is typical of a small project, which involves the addition of new impervious below the state threshold of 1 acre. This future growth factor was developed under the assumption that no local zoning or land use rules would be in place to require stormwater management for smaller projects. VT DEC used a future non-jurisdictional growth estimate of 18 acres, provided to VT DEC based on local development and projected growth. Documentation for this estimate was not provided to VT DEC.

To develop the TMDL target with future growth, the estimated future impervious growth (18 acres) was added to the watershed's existing impervious cover, to simulate the watershed conditions at the end of the FRP implementation timeframe (20 years), which at the time was projected to be 2025. With the projected non-jurisdictional future growth, the high-flow target reduction changed by -0.4% and the low-flow target increase changed by +0.6% (Table 1).

The approved TMDL flow targets are as follows:

Table 1: TMDL Flow Restoration Targets

Flow Target	Target High Flow Q 0.3 (± %) **Reduction**	Target Low Flow* Q 95 (± %) **Increase**
TMDL Targets (Stormwater allocation only)	-0.9%	0.4%
TMDL Targets with **18 acres** of Non-Jurisdictional Future Growth	-1.3%	1.1%
*The low flow target is not actionable under the TMDL, but is included because improving base flow in the watershed is still a water quality goal.		

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.

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 BMP which meets the Channel Protection Volume (CPv) design standard. This includes BMPs which detain the 1-year storm for 12-hours in cold-water fish habitat and 24-hours in warm-water fish habitat. 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 40.4% of the impervious cover in the Indian Brook watershed is within the Town of Essex, 51.3% within the Village of Essex Junction, and about 8.4% in the VTRANS Right-of-Way (Table 2).

Table 2: Indian Brook MS4 Impervious Breakdown

MS4 Impervious Owner	Total Area w/in Watershed (acres)	Impervious Cover (acres)	% of Watershed Impervious Cover
Town of Essex	3,492.39	171.85	40.4%
Village of Essex Junction	952.60	218.08	51.3%
VTrans	141.91	35.56	8.4%
Watershed Total	**4,586.90**	425.49	

The TMDL flow targets, including a -1.3% ***reduction***(-) in high flow across the watershed, and a 1.1% ***increase(+)*** in low flow, were then split between the three MS4's based on their percent share of the total impervious ownership in the watershed (Table 3).

Table 3: Indian Brook TMDL Flow Target Allocation by MS4

MS4 Impervious Owner	Target High Flow[1] **Reduction** (%)	Target Low Flow[2] **Increase** (%)
Town of Essex	-0.53%	0.44%
Village of Essex Junction	-0.67%	0.56%
VTrans	-0.11%	0.09%
Watershed Total[3]	**-1.3%**	**1.1%**
[1] The High Flow target is negative (-), indicating there needs to be a reduction in high flow from the baseline condition. The Low Flow target is positive (+), indicating there needs to be an increase in low flow from the baseline condition.		
[2] The low flow target is not actionable under the TMDL, but is included in the assessment because improving base flow in the watershed is still a water quality goal.		
[3] Watershed delineation from file: "Indian_watershed121614"		

3 BMPDSS Model Assessment

The Vermont DEC worked with an external consultant to develop a VT-specific hydrologic model, the VT BMPDSS, to predict progress toward the TMDL flow targets based on proposed BMP implementation scenarios. 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.

In order to complete the assessment, 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 extracted from Quickbird high-resolution satellite imagery. A "Post 2002" model scenario was then developed with all existing BMPs designed to the VT Stormwater standards, providing credit toward the flow target. Results from the BMPDSS model output are provided as unadjusted (cfs) and normalized flow (flow per drainage area, cfs/sq.mi). The unadjusted flow is used in the determination of progress towards the TMDL targets to eliminate the effect of watershed area in the percent change comparison.

3.1 Existing Condition Review

3.1.1 Permit Review

As per subpart IV.C.1 of the approved MS4 general permit, all expired stormwater permits in the watershed were acquired and reviewed for inclusion within the BMPDSS model assessment. The expired permits were sorted into two groups- Group 1) existing stormwater systems with a CPv BMP which provides extended detention of the 1-year design storm (Table 4), and Group 2) those without a CPv BMP (ie. system of catchbasins with no outfall management). The Group 1 list was

compared to the current BMP list included in the BMPDSS models to check for omissions. Only expired permit systems that include a BMP with CPv storage were included in the BMPDSS model, because only BMPs with CPv storage provide credit toward meeting the flow targets. Field assessments were then completed at each site with an existing CPv detention structure, to determine if the practice was operating according to the approved expired permit and if there was opportunity for an upgrade to the 2002 Vermont Stormwater Design Standards. A table of the expired stormwater permits within the Indian Brook impaired watershed is included in Appendix A-2-1.

Table 4: "Group 1" Expired Permit Stormwater BMPs

Permit #	Project/BMP Name	MS4	BMP Type in BMPDSS	Permit Renewal	Ownership
1-0775a	Lang Farm Parcel A- Phase 2- Essex Outlets	Town	Detention Pond	6262-9020 upgrades	Private
1-0775b	Lang Farm Parcel A- Phase 2,Essex Outlets	Town	Detention Pond	6262-9020 upgrades	Private
1-0775c	Lang Farm Parcel A- Phase 2, Essex Outlets	Town	Detention Pond	6262-9020 upgrades	Private
1-1307	Homestead Design, Inc.	Town	Detention Pond discharges 1-0775 pond b	4002-INDS.A upgrades	Private
1-1382	Essex Community Educational Ctr.	Village	Infiltration Basin	4119-INDS	Private
1-1074	Countryside II Fairview Farms: Locust lane, Chestnut Lane, Spruce Land, Walnut Lane	Village	Detention Pond (S/N 001) and natural detention area (S/N 002)	Upgrades completed	Public/ Private
1-1186	Woodlands II- Lang Farm Parcel	Town	Detention Pond		Public
1-1319_p1	Church of Jesus Christ of Latter Day Saints	Town	Detention Pond		Private
1-1319_p2	Church of Jesus Christ of Latter Day Saints	Town	Detention Pond		Private
1-1381_p1	The Commons at Essex Way Condominium Association	Town	Detention Pond		Private
1-1381_p2	The Commons at Essex Way Condominium Association	Town	Detention Pond		Private
2-0631	Essex Resort & Spa	Town	Detention Pond		Private
1081	Old Stage Rd/Rt-15 (Essex STP 030-1(17))	Town	Detention Pond		Essex
1-1409	Champlain Valley Exposition, Inc	Village	Detention Pond		Private
2-0289	East Creek Condominiums	Village	Detention Pond		Private
2-0835 p1	Village Glen Condos- CGPM, Inc.	Village	Dry well		Private
2-0835 p2	Village Glen Condos- CGPM, Inc.	Village	Dry well		Private
2-0952	North Creek, South Creek and East Creek Condominiums	Village	Natural Detention Area		Private

*Prepared by Emily Schelley (VT DEC, Jan. 2014). Revised by WCA (2014)

3.1.2 VTDEC BMPDSS Existing Model Review

The team field verified the drainage areas and design of the BMPs included in the Base and Post2002 model scenarios and compared the field observations to the DEC model inputs. Updated input files for the Base and Post2002 models were submitted to VT DEC to run the updated model scenarios. Input files included revised GIS shapefiles for subwatersheds, BMP locations, BMP drainage areas, as well as HydroCAD® (Version 10.0) model outputs used to model detention times and peak flows. Each BMP design was then converted to the equivalent system in the BMPDSS model, which has a slightly different interface for defining the BMP design than HydroCAD®. Adjustments were made to certain BMP designs, if the BMPs design in HydroCAD® was not directly transferrable to the BMPDSS format. A full list of existing BMPs in the base and Post2002 model scenarios is included in Appendix 2 (Table A-2-2).

- Permit #1-1409 Champlain Valley Exposition Historical Drainage:

  It was confirmed as a part of the model review process that the historical drainage changes implemented at the Sunderland Brook headwaters on the Champlain Valley Exposition (CVE) Property were accounted for in the baseline model. The permit 1-1409 was issued in August of 2000 followed by implementation later that fall. The drainage changes included routing an area from Sunderland *to* Indian Brook in an effort to mitigate localized flooding issues around the Essex Automotive Area and the Kinney Drug store.

3.1.2.1 Base model (Pre 2002 condition) Revisions

- Adjustments to subwatershed boundaries at Chestnut Lane to account for mapped storm infrastructure.
- Adjustments to the drainage area for the detention pond covered under #1-1409, at the Champlain Valley Exposition.
- Adjustments to subwatershed boundaries around Lincoln St/Grove St.
- Subwatershed adjustments at Brickyard and Mansfield Ave.
- Subwatershed adjustments along Essex Way.

Revisions were made to BMP design parameters (storage, outlet dimensions, etc) for several existing ponds to reflect field measurements, including:

- #1-1307 Homestead Design Pond, located in the Essex Shopping Center
- #1-1319 Church of LDS Ponds 1 and 2, along Essex Way
- #1-1381 The Commons at Essex Way Condominium Association Ponds 1 and 2, located off Essex Way.

- #1-1382 Pond located behind the Essex Community Educational Center.
- #2-0631 Pond located on the Essex Resort & Spa property
- #2-0289 East Creek Condominiums Pond, located off Brickyard Rd.

Existing detention storage not previously accounted for in the model was added for two locations:

- **Fairview Dr./Main St.**- A natural detention area was identified by the Village DPW, and added to the model. The outlet of the existing detention area is a permitted discharge under expired permit #1-1074 (S/N 002).
- **Brickyard Rd./ Mansfield Ave**- A man-made berm from past construction with an 18" culvert provides natural detention for runoff from the East, North, and South Creek Condominiums, covered under expired permit #2-0952.

3.1.2.2 Existing Condition (Post 2002) Model Revisions

The Existing condition model was revised as follows:

- Impervious cover mapping to reflect build out of several new projects including Handy Suites, and expected development at Thasha Lane (permit #7125-INDS).

Several new projects previously omitted from the model were added including:

- **#6262-9020** Essex Outlet Pond Upgrades
- **#4002-INDS.A** Essex Town Center Pond Upgrades to Pond B and Pond C
- **#3626-INDS.1** (upgrade to #1-1409) including new outlet structure, dry pond and grading plan
- **#5864-INDS** Lang Farm new parking and Wet Swale
- **#6713-INDS** Route 2A mini Storage Unit with detention pond.

Figure 1: WCA Staff, with Town of Essex Staff and Interns inspecting Essex Outlet Ponds (6/26/14).

- **#7125-INDS** new development at Thasha Lane with three detention ponds.

- Essex Union High School Rain Garden
- Handy Suites Apartments with Porous Asphalt parking lot

Additional revisions included removal of the upgrade to #1-1186 previously included as an existing upgrade. The design was based on the proposed design by Lamoureux & Dickinson. A new retrofit design was developed for this site and added to the Credit model scenario.

3.1.2.3 Existing Conditions Model Results

The existing condition (Post 2002) model was revised with two iterations resulting in an overall ***decrease*** in progress toward the targets from the previous model prepared by VT DEC (Table 5). This is primarily due to changes in the base condition model, improving the modeled condition from the previous model iterations. A full list of the existing BMPs in the Base and Post2002 models is included in Appendix 2 (Table A-2-2). The existing condition scenario includes 37 individual BMPs, each managing the 1-year design storm, and 8 of which also provide recharge to groundwater. The most up to date existing condition model scenario (as of 1/12/2015) was estimated to provide a -0.54% reduction in high flow, calculated as a percent change between the unadjusted flow in the baseline condition (pre 2002) and Post 2002 scenario, addressing **41.5%** of the TMDL high-flow(Q0.3%) target. The low-flow was estimated to increase by 0.6% over the baseline scenario, addressing **58.3%** of the non-actionable low-flow Q95% flow target. Based on the model results, additional CPv stormwater controls will be required to meet the required TMDL high-flow target. Biomonitoring of the streams will ultimately determine if the Indian Brook has reached attainment conditions in compliance with the Vermont Water Quality Standards.

Table 5: Existing Condition BMPDSS Model Assessment Results

Model Run	Description	High Flow **Reduction** (%)	Low Flow* **Increase** (%)	BMPDSS Model Run Date
TMDL Targets *Stormwater Allocation only		-1.3%	1.1%	----
DEC Existing Condition Model	DEC's existing model, includes all Post2002 BMPs	-1.14%	0.0%	1/31/2014
WCA Existing Condition Model (7/31/2014)	WCA revised subwatersheds and existing BMP design entries.	-1.49%	0.0%	7/31/2014
WCA Existing Condition Model (10/20/2014)	Additional revisions to BMP designs based on field assessment.	-1.40%	0.0%	10/20/2014
WCA Existing Condition Model (1/12/2015)	Changes to Base condition reduced high-flow % change	-0.54%	0.6%	1/12/2015
Percent of Target Managed (with Existing Condition Model 1/12/15)		**41.5%**	58.28%	----
* The low flow target is not actionable under the TMDL, but is included in the summary because improving base flow in the watershed is still a water quality goal.				

4 Required Controls Identification

The process of BMP identification was initiated with a field assessment on June 26th and 27th 2014, of existing CPv BMPs covered by an expired permit to assess the opportunity for upgrade potential to VT 2002 Stormwater design standards. During the initial field assessment with the Town and Village Staff, the team also visited several sites identified by the Town and Village as potential future retrofits. The team then conducted a desktop assessment of the watershed to identify additional open spaces ideal for BMP implementation with priority on municipally owned land. In addition, the distribution of BMPs was considered to provide storage throughout the watershed. Potential site selection focused on areas with a high-percentage of impervious coverage where flows were expected to be highest and where infiltration was possible as indicated by mapped Hydrologic Group A or B soils.

After an initial list of retrofits was identified, a follow-up field assessment was completed at each site documenting the preliminary engineering feasibility of each retrofit and mapped drainage area for the proposed BMPs. The BMPs were then designed using the HydroCAD® model to meet the CPv storage criteria for cold waters (12-hour detention standard).

BMP feasibility was determined based on available space, mapped NRCS soils, existing 1-ft topographic elevation contours derived from LIDAR, and mapped stormwater and wastewater infrastructure provided by the Town and VTRANS. Supplemental survey data was collected for the top 4 projects as needed. 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.

Once the final list of proposed BMPs was determined to meet the flow targets, the projects were ranked using a comprehensive ranking matrix, as detailed below in section 5-4. Four(4) projects were selected from the top ranked projects with a preference to include plans for Town and Village projects. The team prepared 30% preliminary engineering conceptual designs for the four projects and orthophoto-based sketch plans for all other projects, provided in Appendix 1. The top four projects include:

- **LDS North Pond:** Retrofit of the Church of Latter Day Saints (LDS) detention pond into an underground storage system
- **Fairview Dr.:** Retrofit of an existing detention area into a terraced detention basin at the corner of Fairview Dr. and Main St.
- **Brickyard Dr./Mansfield Ave.:** Retrofit of a natural detention area into a detention basin at the corner of Mansfield Dr. and Brickyard Dr.
- **Woodlands/Sydney Dr:** Retrofit of a non-functioning detention pond into an underground infiltration basin with 48” perforated pipe for additional storage.

4.1 BMPDSS Model Assessment Results

The final proposed BMP list was developed based on an iterative assessment using the BMPDSS model as follows; The first proposed "Credit" scenario (Credit1), included five(5) retrofits to existing detention ponds, two(2) sand filters in the I-289 Median, and one(1) proposed pavement regrade project to increase capture of the Rain Garden at the Essex High School. The 1st proposed scenario estimated a decrease in high flow of -1.85%, addressing **142%** of the target (Table 6). The low flow did not increase. Additional field work was completed at several sites and revisions were made to the Credit1 BMPs. In addition, three(3) infiltration BMPs were added (Densmore Dr, Grove St, and Countryside Dr.), as well as two(2) retrofits to existing BMPs (LDS P2, Commons P1 along Essex Way). Removal of 0.11 acres of impervious in the Briar Lane cul-de-sac was also included in the model. These revisions and additions constitute the Credit 2 model. The "Credit 2" scenario estimated a -2.75% decrease in the high-flow from the base condition, addressing **212%** of the high-flow and a 0.6% increase in baseflow, addressing 58% of the non-actionable low-flow target. A full modeling summary including all the model run results completed for Indian Brook, is provided in Appendix 3 (Table A-3-1), as well as a Table of BMPs sorted by the model run to which the BMP was first added (Table A-3-2). BMPs were maintained in each subsequent run.

Table 6: BMPDSS Model Runs Summary for Proposed FRP Scenario

Model Run	Description	High Flow **Reduction** (%)	Low Flow* **Increase** (%)	BMPDSS Model Run Date
TMDL Targets *Stormwater Allocation only		-1.3%	1.1%	----
Existing Condition Model (1/12/2015)	WCA revised additional subwatersheds and existing BMP design entries.	-0.54%	0.6%	1/12/2015
Percent of Target Managed (with Existing Condition Model 1/12/15)		**41.5%**	58.28%	----
Credit1 Model	Add 8 proposed retrofits.	-1.85%	0.0%	10/21/2014
Percent of Target Managed (with Credit1 run on 10/21/14)		142%	0%	----
Credit2 Model	Add 3 infiltration BMPs, two pond retrofits, and impervious removal.	-2.75%	0.6%	1/14/2015
Percent of Target Managed (with Credit2 run on 1/14/15)		**212%**	58%	----
Note: The High Flow target is negative(-), indicating there needs to be a reduction in high flow from the baseline condition. The Low Flow target is positive (+), indicating there needs to be an increase in low flow from the baseline condition.				
* The low flow target is not actionable under the TMDL, but is included in the summary because improving base flow in the watershed is still a water quality goal.				

4.2 Proposed FRP Model Scenario

The final recommended BMP list is represented in the "Credit2" model run, which includes 14 proposed BMPs (Table 7). The proposed FRP scenario addresses ***212%*** of the modified high-flow target providing a significant factor of safety (FOS). The additional FOS is included in the recommended BMP list to provide the MS4's additional options, in the event the list has to be modified or as conditions in the watershed change from what is present today.

The individual and cumulative percent of the high-flow target mitigated is also included in Table 7, calculated based on the CPv volume storage and the BMPDSS model run result (Credit 2 run). The individual and cumulative percent mitigated allows for a quick understanding of the relative benefit of each BMP toward meeting the high-flow target. The CPv volume is used as an indicator of the percent mitigated because it was determined by VT DEC that the high-flow (Q0.3%) is approximately equivalent to the 1-year storm peak discharge. Essentially, the high-flow is directly reduced in the model by mitigating the CPv volume.

The "Cumulative Percent of Target" addressed allows the MS4's flexibility in the event one of the top projects is determined infeasible and the projects need to be rearranged. The TMDL requires that 100% of the high-flow target be addressed. The ultimate determination for implementation of projects providing benefit beyond the high-flow target (> 100%) will be made by the State based on monitoring data or other relevant information (MS4 General Permit Sec. IV.J.3). Progress toward the TMDL flow targets with the proposed FRP scenario was allocated by MS4 to determine the extent to which the proposed BMPs addressed each MS4's allocated responsibility of the flow targets, summarized in Table A-3-3 (Appendix 3).

5 Proposed Implementation Plan

The proposed BMPs are summarized in Table 7, including the impervious cover treated, drainage area, and CPv volume storage estimated by the HydroCAD® model. A map of the proposed BMP locations is included in Appendix 4. The **individual and cumulative percent of the high-flow target mitigated** is also included in Table 7. An additional table is included in Appendix A-3-2, which separates the projects by the model run to which the project was first added (Credit 1 or Credit 2).

Table 7: Final Proposed BMPs for the Indian Brook FRP

Site Name (*Note)	MS4 Imp. Owner	Owner of BMP Land	BMP Type (*Key)	Permit #	Runoff Area (acres)	Impervious Acres Managed (ac)	Channel Protection Volume (CPv) Managed above Base Condition*		Percent of High-flow Target Managed, %	***Cumulative* Percent of High-Flow Target Managed %**	Retrofit Description
							CF	Ac-ft			
Existing Post2002 BMPs[1]	Varies	Varies	Varies	Varies	Varies	Varies	---	----	42%[1]	**42%**	Varies
LDS Church North Pond Retrofit (Outfall 204)- Option 5: Underground Storage with Perforated Pipe	Town	Private	USC	1-1319, 2-0631, 2-0613	29.59	12.00	44431	1.02	42%	**84%**	Route outfalls North and South of LDS pond to retrofit. Option 5: Convert pond to expanded underground stone gallery with 48" Perforated Pipe.
Fairview Dr./Main St.	Village/ Town VTRANS	Public	GW	1-1074 SN002	22.53	3.94	19384	0.45	18.4%	**102%**	Regrade existing detention area, add terraced WQ bays, and replace existing culvert. Stabilize eroded outfall on North side of Main St.
Fairview Dr. Add-on	Village/ Town VTRANS	Public	GW	1-1074 SN002	6.87	1.30	9583	0.22	9.1%	**111%[2]**	Install new culvert to direct North side of Main St. to basin.

1. See Table 6. The existing BMPDSS model run estimated 42% of the flow target is addressed with existing BMPs.
2. 100% of the High-flow Target is met with the top two projects ranked by CPv storage. The table is set up so projects can be rearranged to determine which set of projects meet the target

Site Name (*Note)	MS4 Imp. Owner	Owner of BMP Land	BMP Type (*Key)	Permit #	Runoff Area (acres)	Impervious Acres Managed (ac)	Channel Protection Volume (CPv) Managed above Base Condition*		Percent of High-flow Target Managed, %	**Cumulative Percent of High-Flow Target Managed %**	Retrofit Description
							CF	Ac-ft			
Brickyard/North, South, East Creek Condos	Village	Private	GW	2-0952	8.7	4.68	24960	0.57	23.7%	**135%**	Convert existing detention area at the corner of Mansfield/Brickyard to gravel wetland with CPv storage.
Woodlands (Detention Pond 139)	Town	Public	UIB	1-1186	32.80	4.04	15682	0.36	14.9%	**150%**	Retrofit existing detention pond to an underground stone gallery with 48" perforated pipe.
Densmore Dr.	Village	Private	UIB	2-1103	38.28	11.73	14985	0.34	14.2%	**164%**	Install StormTech Chamber System on Densmore Dr. Verify high groundwater elevation.
East Creek Condominiums	Village	Private	DB	2-0289/ 2-0317	48.2	14.40	13721	0.32	13.0%	**177%**	Retrofit outlet structure for CPv control. Armour spillway.
The Commons P1 (Outfall 131)	Town	Private	USC	1-1381	7.91	2.07	8668	0.20	8.2%	**185%**	Convert existing detention pond to StormTech chamber system. Improve aesthetics and landscaping.
Grove St.	Village	ROW	UIB	2-0187	23.39	8.71	5576	0.13	5.3%	**191%**	Install two underground storage basins in series for detention and infiltration of the CPv storm.
I-289/Route 15 North	VTrans	ROW	MF	NP	2.78	0.90	5271	0.12	5.0%	**196%**	Retrofit existing median swale with CPv volume control sand filter.
Countryside Dr Intersection	Village	ROW	USC	2-0155	5.25	1.95	4704	0.11	4.5%	**200%**	Stabilize outfall and bank. Install underground detention chamber at intersection of Countryside Dr./Brickyard. Add Stormwater planters in ROW on Countryside Dr.

Site Name (*Note)	MS4 Imp. Owner	Owner of BMP Land	BMP Type (*Key)	Permit #	Runoff Area (acres)	Impervious Acres Managed (ac)	Channel Protection Volume (CPv) Managed above Base Condition*		Percent of High-flow Target Managed, %	**Cumulative Percent of High-Flow Target Managed %**	Retrofit Description
							CF	Ac-ft			
LDS Church South P1 (Outfall 209)	Town	Private	DB	1-1319	1.34	1.01	4400	0.101	4.2%	**204%**	Retrofit existing detention pond to an underground stone gallery with 48" perforated pipe.
I-289/Route 15 South	VTrans	ROW	MF	NP	2.15	0.96	4443	0.10	4.2%	**209%**	Retrofit existing median swale with CPv volume control sand filter.
Essex Union High School-Rain Garden-Regrade Parking Lot	Village	School District	GSI	NP	1.61	1.07	2222	0.05	2.1%	**211%**	Regrade parking lot to increase capture. Garden has capacity for more runoff without expansion.
Briar Lane Cul-de-sac Impervious Removal	Village	No Practice	No Practice	2-0855 (Village Knoll)	NA	0.11	900	0.02	0.9%	**212%**	Eliminate cul-de-sac to reduce plowing needs. Small impact.
					Total:	**68.86**		**4.11**			

***Key :** BMP Type: DB: Detention Basin, USC = Underground Storage Chamber, UIB= Underground Infiltration Basin, GW = Gravel Wetland, GSI = Smaller-scale GSI practice DW= Dry Wells

***Note**: See Table A-3-2 for a list of the projects sorted by the BMPDSS Model run to which they were added. Summary: **Credit 1**- LDS Church North (Only Existing Drainage), Fairview Dr., Brickyard, Woodlands, East Creek Condos, I-289 N and S, EHS Rain Garden. **Credit 2**: Fairview Add-on, LDS Church Option 4, LDS Church South P1, The Commons P1, Countryside Dr., Grove St,. Densmore Dr, Briar Lane

* Channel Protection Volume Managed above Base condition = New Storage Volume - Existing Volume pre2002

5.1 Town of Essex Proposed BMPs

Church of Latter Day Saints (LDS) North Pond Retrofit

The Church of Latter Day Saints (LDS), located along Essex Way, is currently covered under an expired permit #1-1319. The permit covers two wetland ponds, one in the back of the property to the South (Pond 1), and one to the North in the front of the Church (Pond 2). Essex Way, a Town owned road, drains to a swale behind the Church property and is covered under an expired permit #2-0613. Options to route the roadway to an expanded retrofit of the North LDS pond was assessed. The North Pond (P2) was identified as a good site for retrofit primarily because of the availability of open space for expansion, visibility, and ease of access. Preliminary studies of the LDS ponds and Essex Way drainage completed by the UVM Civil Engineering Department in 2010 were reviewed and considered as a part of the FRP assessment.

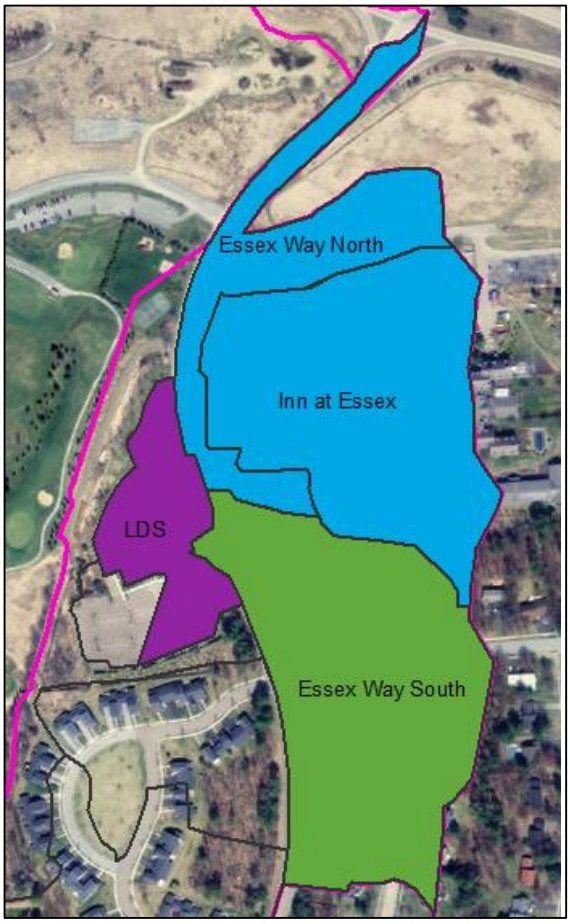


Figure 2: Drainage area map for LDS North Pond retrofit options. Each color represents the drainage to a separate inlet (3) to the proposed LDS retrofit.

Five options were explored for a retrofit of the North Pond, to assess the cost benefit of design alternatives. A summary of the five options and preliminary cost estimates is provided in Table 8 below. High flow (> 1 year storm) reduction would be provided and also potentially water quality benefit. Inflow areas would include the existing LDS North Lot, plus the CPv runoff via two new flow splitters from Essex Way North and Essex Way South, and the Essex Resort & Spa drainages (Figure 2).

Option #1 would involve expanding the present basin to a larger wet basin, while not encroaching on the existing swale along the bike path. The pond would provide the largest storage volume, of the four options. The preliminary cost estimate was the cheapest option (Table 8).

Option #2 would involve expanding and filling the existing pond area with stone to create a subsurface storage system. This option does not meet the target volume storage, but does reduce maintenance previously required for the open pond and improves aesthetics.

Option #3 is the same design alternative as Option #2 but with an expanded footprint that includes the existing swale adjacent to the bikepath, providing CPv control for all the add-on areas (Figure 2). Based on our initial review, eliminating the upper reaches of this swale might be acceptable from a natural resources standpoint, given that the wetland area is poor for habitat, is manmade, and that conditions downstream will be improved as a result of the project. The land required is approximately twice that of the other options, which increases the total project cost.

Option #4 involves StormTech MC-3500 Chambers which would fit in the expanded pond area footprint, eliminating the need to encroach on the existing swale. The chambers could potentially sit on a bed of sand, which would allow for extended filtration through a sand bed as well as detention. This would benefit both high flow and also future water quality goals. Option #4 is considerably more expensive, due to the cost of the chambers and added manifold structures, as compared to the stone gallery for Option #3 (Table 8). A 30% design plan was developed for this option (Appendix 1).

Option #5 was the final selected design alternative, involving a system of 48" perforated HDPE pipe arranged in a stone bed. This system avoids the use of prefabricated chambers, while providing more storage volume within the same footprint as Option #4 using StormTech chambers. The system would include 20' sections of pipe in 19 rows, each with a 30" manway and 18" vent at the end of each row. An 18" equalization outlet pipe with an 18" tee into each HPDE pipe will allow for an even discharge from the pipe system. Hydrodynamic separators, called Downstream Defenders, would be placed at each inlet for pretreatment. Option #5, while less expensive than option #4, is still more expensive than an open pond. However, the underground system would create a more usable space for passive use and will require less maintenance than a pond option. A 30% design plan was also developed for this option (Appendix 1).

Table 8: Preliminary Cost comparison for LDS North Pond 2 Retrofit Options

BMP ID	Storage Volume		Construction Cost	Land Cost	Design and Permitting Cost (30%)	Total Project Cost	Cost per Impervious Acre
	cft	acft					
Option 1: Expanded Open Pond	57,630	1.32	$172,890.00	$43,200.00	$51,867.00	$267,957.00	$22,329.75
Option 2: Expanded Gravel Wetland with Stone Gallery (CPv not met)	27,800	0.64	$288,150.00	$43,200.00	$86,445.00	$417,795.00	$34,816.25
Option 3: Additional Expansion of Gravel Wetland with Stone Gallery (CPv met)	49,875	1.14	30% Cost Estimate (Includes land cost)			$510,000.00	$42,500.00
Option 4: Expanded StormTech Chamber system with MC-3500 chambers	54,886	1.26	30% Cost Estimate (Includes land cost)			$1,100,000.00	$91,666.67
Option 5 (selected): Stone Gallery with 48" Perforated Pipe	54,886	1.26	30% Cost Estimate (Includes land cost)			$940,000.00	$78,333.33

Church of Latter Day Saints (LDS) South Pond Retrofit

The other pond on the LDS property, located behind the Church, is heavily overgrown and hard to access from the Church parking lot. Currently, a 1.0 acre portion of the back parking lot is routed to the pond. The proposed retrofit, would convert the existing pond to an underground storage similar to that proposed for the North Pond. The system would consist of a series of 48" HPDE perforated pipes placed in a bed of stone. A horizontal 18" equalization outlet pipe will connect the rows of perforated pipes via an 18" tee at each pipe outlet. The proposed system was sized to mitigate the CPv volume, and will provide water quality benefits from additional filtration through a sand subbase. An alternative option for the retrofit is to place the proposed chamber system under the parking lot, in the event access is an issue for the existing pond location.

Figure 3: LDS South Pond (P1), exhibiting significant overgrowth.

The Commons at Essex Condominium Association North Pond Retrofit

The Commons at Essex Condominiums, located just South of the LDS Church, has two stormwater ponds covered under permit #1-1381. The North pond (Figure 4), is in the backyard of one of the condominium units, limiting use of the backyard and is not aesthetically pleasing to the residents.

Figure 4: The Commons North Pond Outlet Structure

The proposed retrofit for this pond involves conversion of the pond to an underground storage chamber system, and leveling to ground level to provide additional backyard space. A less costly alternative option, is to convert the wet pond to an expanded gravel wetland with aesthetic improvements including a new outlet structure and landscaping features, sized to mitigate the CPv storm volume.

A design was first explored to combine the LDS South Pond drainage with The Commons North pond, into an expanded underground detention system located where The Commons North pond is currently. However, it was determined that the required footprint for a combined system, sized to treat the CPv volume would not fit within the available space behind the Condominiums, while still providing adequate passage of higher flows through the existing culvert downstream. A second combined system was assessed for a system located in the LDS Church back parking lot. However, it was determined the grade was not adequate to route The Common North Pond drainage to the parking lot system. Therefore, two separate retrofits were proposed for The Commons North Pond and the LDS Church South Pond. An alternative system with a decreased treatment volume and higher bypass flows is still an option if it is determined that a separate retrofit is not an acceptable alternative.

Woodlands/Sydney Drive Pond Retrofit

Figure 5: View of proposed retrofit site from roadway.

Detention pond 139, located in the wooded area, just off Syndey Drive is currently covered under permit #1-1186 for the Woodlands development. The detention pond was designed with a flow splitter from Sydney Drive, intended to route a majority of the flow to the detention pond, and overflow to an outfall behind The Commons Condos. The flow splitter has been observed to not function as designed, and most of the flow is diverted to the outfall, with direct discharge to the stream. A proposed retrofit study was completed by Lamoureux and Dickinson in 2007, resulting in a design to upgrade the existing pond, but maintain the system as an open basin. The Town would like to limit the amount of new detention ponds, due to the cost of maintenance and lack of aesthetic appeal and use in the landscape.

A retrofit was developed for the pond, which would convert the pond to an underground stone gallery with limited infiltration. The existing depression would be filled with stone and converted to an open space/passive recreation on grassed land (Figure 5). Existing piping would be utilized to bring flow into/out of the storage area from the road. Pretreatment of inflow would be provided by a hydrodynamic swirl Downstream Defender or similar structure. Additional water quality benefit could be provided by adding a sand filter layer below the storage. The project would meet high flow goals and potentially benefit water quality goals as well.

5.2 Village of Essex Junction Proposed BMPs

Fairview Dr./Main St. Retrofit (1-1074 S/N 001)

At the corner of Fairview Dr. and Route 15 (Main St), there is an existing natural detention area, controlled by a 12" culvert (Figure 6). The culvert captures runoff from the development above, covered under permit #1-1074, as well as Town land and Route 15, partially owned by VTRANS and the Village. The existing outfall on the North side of Route 15 is severely eroded due to high flows and runoff bypassing the catch basins and flowing over the bank, therefore capture of this runoff was assessed (Figure 7).

Figure 6: Fairview Dr. natural detention area (6/27/14)

The proposed retrofit is to convert the natural depression to a gravel wetland with water quality treatment bays. This retrofit will benefit the high flow target, as well as water quality treatment which will benefit future phosphorus TMDL goals. Runoff from the northwest side of Route 15 (Main St.) would be intercepted and directed into the system via a new culvert, represented as the "Fairview Add-on" drainage" in Figure 7. This would eliminate most runoff to the highly eroded outfall. Runoff would exit the system back under Route 15 via an upgraded pipe (12" to 30").

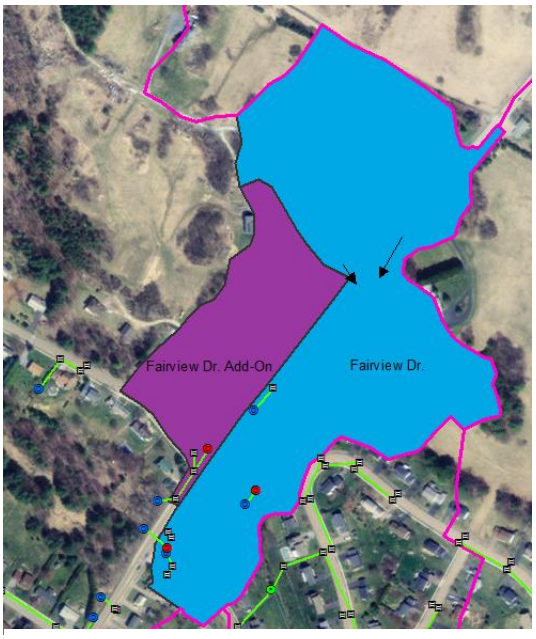


Figure 7: Drainage area map for Fairview Dr. Retrofit Options.

Brickyard Rd/North, East, South Creek Condos (# 2-0952)

The North, East, and South Creek Condominiums, located on Brickyard Road, drain to a natural detention area that was formed by a man-made berm before draining to a Class II Wetland. The existing detention area was identified as an ideal opportunity for retrofit, to provide CPv volume control for runoff from the North, East, and South Creek Condominiums, as well as a portion of the Village-owned road.

The proposed retrofit will convert the existing depression into a gravel wetland. There would be no permanent pool of water. The wetland will provide detention, benefitting the high flow target. Depending on confirmed groundwater elevation and duration of filtration time there could also be some low-flow benefit. Water quality treatment will be provided in a subsurface gravel layer potentially benefitting future phosphorus TMDL goals. A forebay could be installed at the inflow to the basin. As an alternative, a forebay could be created on the north side of Brickyard Road adjacent to the condominium complex entrance. Filling the depression with stone or chambers to create a level at-grade surface was contemplated for this site however it did not seem to be worth the cost for this particular location as it would not be expected to be a draw for local residents. The retrofit would not change the character of the area significantly. If anything, new plantings in the wetland could improve aesthetics.

Densmore Dr. Underground Infiltration Chamber System

A 38 acre residential area in the south east corner of the Indian Brook impaired watershed was identified as a good opportunity for retrofit because of the potential for infiltration and to mitigate runoff from a significant area. An underground infiltration system using SC-740 StormTech® chambers was proposed at the corner of Densmore Dr. and Sherwood Square, just up the pipe from the exiting outfall. The system would mitigate the CPv volume and 1-year design storm peak discharge, while providing water quality benefit through infiltration. Groundwater elevations will need to be verified, if the project is moved to implementation.

East Creek Condominiums Pond Retrofit (#2-0289)

The East Creek Condominiums, covered under permit #2-0289 drains to a dry pond controlled by a culvert and weir structure. The existing system provides minimal low-flow control. The proposed retrofit would involve retrofitting the dry pond to a wet pond with extended detention through addition of a low-flow orifice and overflow grate, as well as re-armoring of the spillway. No additional storage or regrading would be needed.

Grove St. Underground Infiltration Chamber System

A 23.4 acre subwatershed draining to an outfall just north of the North St./Grove St. intersection in downtown Essex Junction was identified as an opportunity for retrofit. The proposed retrofit would involve installation of a StormTech Chamber system in the Grove St. ROW. The footprint of the proposed practice would be within the Village-Owned ROW. A groundwater monitoring well installed for the Essex High School Pump System Retrofit project measured a high groundwater table of ~323' on the opposite side of the brook from the proposed retrofit. Upon initial design, there would be adequate head to allow infiltration. Confirmation of the high groundwater table will need to be verified.

Countryside Dr./Brickyard Rd. Underground Detention Chamber System

The lower portion of Countryside Dr., south of Beech Dr. was identified by the Village as a potential retrofit area for consideration primarily because the current roadway is wider than required and the outfall is significantly eroded. There is opportunity to install stormwater planters along the wide portion of Countryside Dr. with surface inlets to capture runoff from the roadway, providing water quality benefits and reducing impervious cover. A below-grade storage chamber system in the ROW is also proposed at the intersection of Countryside Dr and Brickyard Rd., sized to provide storage for the 1-year storm (CPv storage) from the existing catchment system.

Essex High School Parking Lot Improvements

A 1.28 acre area of the existing Essex High School parking lot drains to a rain garden, providing water quality and flow control benefits. Based on the 1-ft contours and field assessment, runoff from an additional 0.33 acres of impervious could be mitigated if the parking lot were regraded to provide positive flow to the east side of the parking lot. The proposed project would involve repaving approximately 0.5 acres of pavement. The existing rain garden has capacity for the additional runoff, and therefore would not require any retrofit to the garden itself, nor would the project increase maintenance demands.

Figure 8: Essex High School Rain Garden

Briar Lane Cul-de-sac Pavement Removal

An existing Cul-de-sac along Briar Lane was identified as an opportunity to reduce stormwater runoff, through the removal of the cul-de-sac. The removal of 0.11 acres of pavement was estimated to mitigate approximately 900 cft of stormwater runoff. An additional benefit of the project would be the reduction in plowing time, which currently takes the Village Plowing Staff an extra 30 min- 1 hour just to plow the cul-de-sac.

5.3 VTRANS Proposed BMPs

I-289/Route 15 North and South Exit Ramp Sand Filter Retrofits

The I-289/Route 15 Exit Ramp was identified as a potential opportunity to manage runoff from primarily VTRANS owned impervious. Two sand filter systems were proposed in the median on the North and South side of the Route 15 overpass (Figure 9). The proposed practice is an approximately 4' deep sand filter, with a 4" underdrain, and 1.5' surface ponding depth before passing over a weir. The system is designed to provide storage for the CPv volume. The low-flow orifice and sand filter provide extended filtration, which provides water quality benefit.

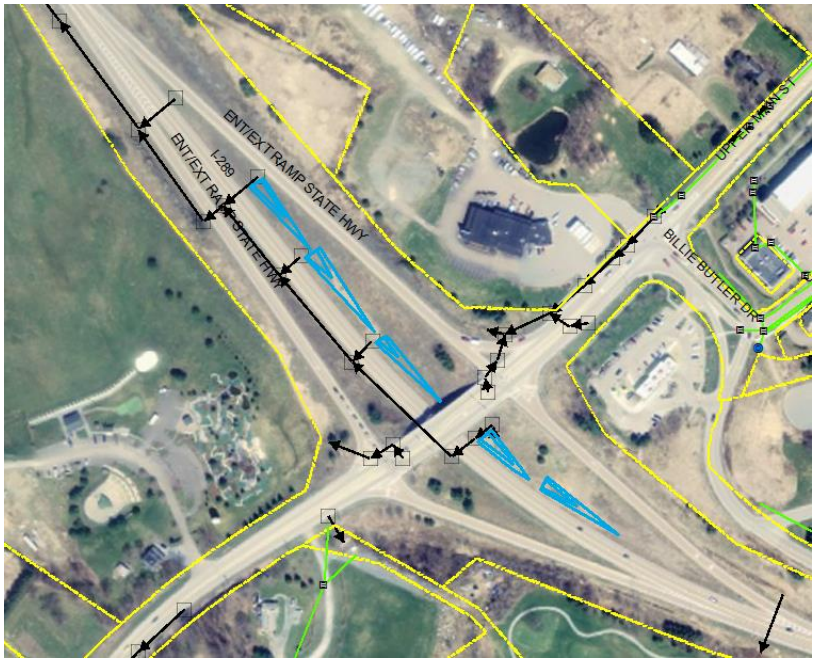


Figure 9: I-289 Exit Ramp with proposed retrofit.

5.4 Watershed-Wide Project Ranking

A comprehensive ranking matrix was developed in order to rank the proposed projects based on a multitude of criteria grouped into four general categories, as follows:

Category	ID	Criteria
Cost/Operations	A	Relative Project Cost
	B	Ease of O/M
Project Design Metrics	C	Impervious Acres Managed (ac)
	D	Channel Protection Volume (CPv) Mitigated, (ie. 1-year Storm)
	E	Volume Infiltrated (ac-ft)
	F	Water Quality (WQ) Volume Control
	G	Primary or Secondary BMP
Project Implementation	H	Permitabilty
	I	Land Availability
Other Project Benefits	J	Flood Mitigation (Is existing flooding issue mitigated by project?)
	K	TMDL Flow Target Addressed (Q03, Q95)
	L	Lake Champlain Phosphorus TMDL Metrics Met*
	M	Other Project Benefits/Constraints (Educational, Infrastructure Improvement, Unknown Feasibility)
*For now the Lake Champlain Phosphorus TMDL criteria is a placeholder, until the final TMDL is approved and the compliance metrics are outlined.		

Values for each criteria were identified and assigned a relative score so the projects could be ranked based on a total score. A secondary set of Water Quality criteria were added to the matrix, to rank the BMPs on water quality benefits, using the Source Loading & Management Model (WinSLAMM). WinSLAMM is a very robust, field verified and calibrated model that will accurately predict pollutant loading and BMP effectiveness. WCA modeled the BMPs within WinSLAMM and quantified the annual total suspended solids (TSS) and total phosphorus (TP) reductions in loads of pollutant per year. Ranges for the TSS and TP removals were identified, and assigned a score of 0-6 points, 6 being the greatest benefit. The final ranking of proposed projects is included in Table 9 below. The criteria key (Table A-5-1), scoring key (Table A-5-2) and the full matrix spreadsheet (A-5-3) are included in Appendix 5. A separate table with the phosphorus and TSS loading reductions for each proposed BMP is provided in Appendix A-5-4.

Table 9: Ranked Proposed FRP BMPs based on comprehensive ranking matrix

ID #	Site ID	BMP Type	Retrofit Description	Total Score
3	Fairview Dr./Main St. with Add-On	GW	Regrade existing detention area and add riser. Route outfall on North side of Fairfield Dr. to retrofit.	38.0
4	Woodlands (Detention Pond 139)	UIB	Retrofit existing detention pond to an underground infiltration practice with 48" perforated pipe.	38.0
1	Church LDS North P2 (Option 5)	USC	Retrofit existing Detention Pond in front of LDS Church. Convert pond to underground storage system with 48" perforated pipe. Route Essex Way and Inn at Essex runoff to retrofit.	34.0
2	Fairview Dr./Main St.	GW	Regrade existing detention area and add riser. Stabilize eroded outfall on North side of Fairfield Dr.	32.0
10	Densmore Dr.	UIB	StormTech Chamber System on Densmore Dr. Verify high groundwater elevation.	32.0
11	Grove St.	UIB	StormTech Chamber System in Grove St ROW. High groundwater table 323'.	31.0
6	Brickyard/North, South, East Creek Condos	DB	Retrofit existing detention area.	27.0
7	I-289/Route 15 North	MF	Retrofit existing median swale with CPv volume control sand filter.	27.0
8	I-289/Route 15 South	MF	Retrofit existing median swale with CPv volume control sand filter.	27.0
15	The Commons North Pond (P1)	USC	Convert existing detention pond to a Storm-Tech chamber system.	26.0
12	Countryside Dr Intersection	USC/GSI	Underground detention chamber at bottom of Countryside Dr is an option. Stabilize outfall and bank.	26.0

ID #	Site ID	BMP Type	Retrofit Description	Total Score
5	East Creek Condominiums	DB	Expand Existing Detention Pond and retrofit outlet structure for CPv control.	25.0
14	Church LDS South P1	USC	Convert to underground storage system with 48" perforated pipe.	23.0
9	Essex Union High School-Rain Garden- Regrade Parking Lot	GSI	Regrade parking lot to increase capture. Garden has capacity for more runoff without expansion.	19.0
13	Briar Lane Cul-de-sac Impervious Removal	No Practice	Eliminate Round-about to reduce Plowing needs. Small impact.	19.0

6 Design and Construction Schedule

A Design and Construction (D&C) schedule is a required element of the final approved Flow Restoration Plan, outlined for implementation of the proposed FRP over a 20-year timeframe. In Indian Brook, the TMDL high-flow target is currently met with existing BMPs, therefore no BMPs are required for implementation. While no new BMPs are required, the proposed BMPs would improve water quality in the watershed. Therefore, a D&C schedule will be prepared as a part of the final FRP, prioritizing the projects for implementation by their flow restoration benefits. Time for acquisition of necessary permits and/or regulatory approvals, as well as limitations of MS4s financial resources on an annual basis will be considered as well.

The flow restoration targets are subject to adjustment by the Secretary, as specified in section IV.C.1.e.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 schedule and full implementation of the proposed projects.

7 Financial Plan

Subject to the requirements of the MS4 permit, a financial plan is required as a part of the FRP which demonstrates the means by which the plan will be financed as well as 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. Most of the proposed retrofits have a sole MS4 owner, however there are few projects, like Fairview Dr., which have contributing runoff from impervious owned by all three MS4's. For joint ownership projects, the funding responsibility will be negotiated between the involved MS4's.

Town and Village of Essex Junction Stormwater Program Consolidation:

The Town of Essex and Village of Essex Junction Department of Public Works (DPW) decided to consolidate their Town and Village stormwater budgets, as a result of watershed-wide improvement efforts required under the MS4 permit and FRP implementation plans for Indian and Sunderland Brook. The Village and Town storm water activities budgets will be combined into the Town stormwater budget in the Town General Fund. The Town General Fund tax will be used to pay for the service to combine the programs. This merge will avoid duplication of effort and achieve cost savings. Furthermore, the Town and Village previously formed a Joint Storm Water Coordinating Committee (SWCC), in the effort to more easily work collectively to develop the watershed-wide FRPs for Indian and Sunderland Brook. The consolidation of the Village and Town budgets provides the SWCC with a financial framework to directly fund FRP projects with joint MS4 responsibility and address current and future permit compliance requirements. Costs will be less under the consolidated program, versus a separated program.

The SWCC will determine additional costs for FRP projects on an annual basis to be funded by the combined stormwater activities fund. In the future, the SWCC can also recommend to the Village Board of Trustees and the Town Selectboard that a separate charge or fee be developed to cover the costs for stormwater permit compliance and program management, in addition to the Town General Fund.

Funding Sources: The main funding source for Town and Village stormwater projects will be the Town General Fund Tax, paid by taxpayers within the Town and Village. VTRANS will utilize their budget funds for stormwater-related projects. Several additional funding sources that may be available for larger projects, which may need to be phased over several years, include the Clean Water State Revolving Fund (CWSRF) program and Municipal Bond bank funds.

7.1 BMP Cost Estimates:

Itemized cost estimates were developed for the top 4 priority projects based on 30% preliminary engineering plans, detailed below. For all other projects, a modified spreadsheet method was used as detailed in section 7.1.2.

7.1.1 Itemized Cost Estimates:

The itemized cost estimates for the top 4 projects were estimateed using a combination of the VTRANS estimator program, RS Means, and local values, based on 30% engineering plans. The full itemized cost estimates are included in Appendix 6. The cost estimates are based on the following criteria:

- **Construction Cost**: The construction costs were developed based on using both VTRANS 5 year average costs, VTRANS Estimator Program, and RS Means (where applicable) and vendor estimates as necessary for each of the itemized units.
- **Construction Contingency**: The construction contingency is calculated as 15% of the construction cost.
- **Final Design Engineering**: The final design engineering cost is estimated based on the State Fee Curve Allowance as developed by VT DEC. The equations used are as follows:
    - For construction costs less than $780,000
        - Construction cost = $1,950+(Construction cost *0.069)
    - For construction costs greater than $780,000,
        - Construction cost = (Construction cost^0.9206)*0.6788*0.30.
- **Construction Engineering**: The construction engineering cost is based on the State Fee Curve Allowance as developed by VT DEC. The equations used are as follows:
    - For construction costs less than $780,000
        - Construction cost = $3,575+(Construction cost *0.1265)
    - For construction costs greater than $780,000
        - Construction cost = (Construction cost^0.9206)*0.6788*0.55.
- **Other costs:** These costs are established based on simple percentages of the construction cost for the project as follows:
    - Administrative = 0.5%
    - Easement Assistance = 1.5%
    - Land Acquisition =$120,000 per acre for projects on private land (*Value estimated by local Town Assessor)
    - Legal = 5%
    - Bond Vote Assistance = 0.5%
    - Short Term Interest = 2.5%.

7.1.2 Cost Estimates Using Spreadsheet Method:

For projects not designed to the 30% level, a spreadsheet cost estimation tool was developed based on guidance from the US EPA and Center for Watershed Protection(CWP) for stormwater retrofit projects. All estimates were calculated as a base construction cost plus a 30% contingency factor for final design and permitting, site specific factors, and land cost, if applicable. The base cost was estimated on a unit cost basis, using a specified design volume (cu. ft) multiplied by a unit cost ($/cu.ft). Due to the variability in retrofit projects and application of general unit cost values, adjustment factors were applied, based on cost research by the CWP and professional engineering judgment. **The cost estimates presented are based on typical values, and may vary due to site specific challenges and unforeseen land acquisition costs.**

Unit Costs: Base construction costs were estimated using unit costs, summarized in Table 10 below. Unit costs for existing **pond retrofits, new storage retrofits, and Green Stormwater Infrastructure practices (planters, bioretention, etc.)** were acquired from cost research completed by the Center for Watershed Protection, derived from a synthesis of real retrofit practice construction costs [1] (Table 10). For **underground storage chambers**, a unit cost for StormTech MC-3500 chambers was used, accounting for the cost of the chambers and additional site work. The cost estimates are summarized in Table 10 below.

Table 10: Unit Costs for Different BMP Types

BMP Type	Unit Costs ($/cft)
Pond Retrofits	$3
New Storage Retrofits	$5
Underground Chamber Systems (StormTech MC-3500)	$11
Green Stormwater Practices (i.e. Bioretention)	$8

Adjustment factors were applied depending on the type of retrofit. An adjustment factor of 0.5 was used for a pond retrofit involving an upgrade to the outlet structure and basic site work[1]. The CWP found retrofits in developed areas to be 1.5 to 2 times more expensive than a new storage practice, and sometimes as great as 6 times more, due to the higher chance of utility conflicts, space restrictions, additional permitting costs, and/or sensitive site conditions. Engineering judgment and past project experience was used to assign the appropriate adjustment factors.

For the East Creek Condominiums Pond retrofit, an average cost per impervious acre managed was used instead of the unit cost approach, because the amount of work for the retrofit was not appropriately estimated based on the design volume[2]. For the Briar Lane imperious removal

[1] Schueler, T., Hirschman, D., Novotney, M., Zielinski, J. 2007. Urban Stormwater Retrofit Practices Appendices: Urban Subwatershed Restoration Manual Series. Center for Watershed Protection, Ellicott City, MD. Appendix E. Table E-4.
[2] Schueler, T., Hirschman, D., Novotney, M., Zielinski, J. 2007. Urban Stormwater Retrofit Practices Appendices: Urban Subwatershed Restoration Manual Series. Center for Watershed Protection, Ellicott City, MD. Appendix E. Table E-1.

project, a unit cost from the literature of $40,000 per acre removed was used[3]. For the Essex High School project, a unit cost of $30 per square yard to repave a portion of the parking lot was used, based on local construction experience.

Storage Volume: The unit costs were multiplied by a design volume (cu. ft), based on a storage volume required. The 100-year storm storage volume was used for above-ground detention and infiltration basins. The 1-year or 10-year storm (CPv) storage volume used for underground chamber systems. Underground chamber systems were designed as offline practices, which means only the 1-year or 10-year storm was routed to the practice. Higher flows were diverted from the system using a flow splitter. Storage volumes were estimated using the HydroCAD® model.

Design and Permitting Contingency: A 30% design and permitting contingency factor was applied, based on cost research provided by the EPA[4] , which found that a typical cost for design and permitting was approximately 30% of the base construction costs.

Land Acquisition Costs: For sites on private land, in which the Town or Village would need to acquire ownership of the land, and an estimate was included based on a general cost of $120,000 per acre. This is based on past local project experience.

Table 11, below, includes a summary of the project cost estimates.

[3] Schueler, T., Hirschman, D., Novotney, M., Zielinski, J. 2007. Urban Stormwater Retrofit Practices Appendices: Urban Subwatershed Restoration Manual Series. Center for Watershed Protection, Ellicott City, MD. Appendix E. Impervious Cover Conversion.

[4] U.S. Environmental Protection Agency (EPA). 2006. Preliminary Data Summary of Urban Stormwater Best Management Practices, Maryland, MD. Chapter 6. Costs and Benefits of Stormwater BMPs. EPA-821-R-99-012

Table 11: Proposed BMPs Cost Estimates

BMP ID	Design Storm	Impervious acres	Storage Volume		Unit Cost*	Retrofit Adjustment	Construction Cost	Land Owner	Land Cost	Design and Permitting Cost (30%)	Total Project Cost	Cost per Impervious Acre
			cft	acft								
LDS Church Option 5-Add On Essex Resort & Spa, Essex Way North, and Essex Way South	10 year	12.00	54886	1.26	30% Cost Estimate						$940,000.00	$78,330.00
Fairview Dr./Main St.	100 year	3.94	75185	1.73	$5	0.50	$187,961.40	Village	$0.00	$56,388.42	$244,350.00	$62,010.00
Fairview Dr. with Add-on	1 year	5.24	78887	1.81	30% Cost Estimate						$290,000.00	$55,340.00
Brickyard/North, South, East Creek Condos	100 year	4.68	65253	1.50	30% Cost Estimate						$130,000.00	$27,770.00
Woodlands (Detention Pond 139)	10 year	4.04	52838	1.21	30% Cost Estimate						$200,000.00	$49,490.00
East Creek Condominiums	100 year	14.40	161433	3.71	NA[1]	0.50	NA[1]	HOA	NA[1]	NA[1]	$79,920.00	$5,550.00
I-289/Route 15 North	1 year	0.90	5271	0.12	$5	1.00	$26,353.80	VTRANS	$0.00	$7,906.14	$34,260.00	$38,190.00
I-289/Route 15 South	1 year	0.96	4443	0.10	$5	1.00	$22,215.60	VTRANS	$0.00	$6,664.68	$28,880.00	$30,050.00
Densmore Dr.	1 year	11.73	14985	0.34	$11	1.00	$164,831.04	Private Owner	$27,600.00	$49,449.31	$241,880.00	$20,620.00

BMP ID	Design Storm	Impervious acres	Storage Volume		Unit Cost*	Retrofit Adjustment	Construction Cost	Land Owner	Land Cost	Design and Permitting Cost (30%)	Total Project Cost	Cost per Impervious Acre
			cft	acft								
Grove St.	1 year	8.71	5576	0.13	$11	1.50	$91,998.72	Village ROW	$0.00	$27,599.62	$119,600.00	$13,730.00
Countryside Dr.	1 year	1.95	7492	0.17	$19	1.50	$213,531.12	Village ROW	$0.00	$64,059.34	$277,590.00	$142,560.00
LDS Church South P1 (Outfall 209)	100 year	1.01	10500	0.24	$5	1.50	$78,750.00	Private Owner	$16,200.00	$23,625.00	$118,575.00	$117,400.00
The Commons P1 (Outfall 131)	100 year	2.07	23087	0.53	$11	1.00	$253,954.80	Private Owner	$18,360.00	$76,186.44	$348,500.00	$168,360.00
Essex Union High School-Rain Garden-Regrade Parking Lot	1 year	1.07	741	0.02	NA[2]	NA[2]	$72,600.00	School	NA[2]	NA[2]	$72,600.00	$145,200.00
Briar Lane Cul-de-sac Impervious Removal	Remove Impervious	0.11	---	---	NA[3]	NA[3]	$13,200.00	Village Road	NA[3]	$3,960.00	$17,160.00	$85,800.00
										Project Total:	**$2,899,000**	

* Unit Costs were derived from cost research completed by the CWP on stormwater retrofit projects. Pond Retrofits = $3/cft, New Storage Retrofits = $5/cft, Underground Storage systems = $11/cft, Green Stormwater Infrastructure (GSI) = $8/ cft (Schueler, T., Hirschman, D., Novotney, M., Zielinski, J. 2007. Urban Stormwater Retrofit Practices Appendices: Urban Subwatershed Restoration Manual Series. Center for Watershed Protection, Ellicott City, MD. Appendix E. Table E-4)

NA[1] Not Applicable. Estimate based on Cost per impervious acre managed of $11,100 times a 0.5 retrofit adjustment factor. Unit cost came from CWP cost research on pond retrofit projects (Schueler, T., Hirschman, D., Novotney, M., Zielinski, J. 2007. Urban Stormwater Retrofit Practices Appendices: Urban Subwatershed Restoration Manual Series. Center for Watershed Protection, Ellicott City, MD. Appendix E. Table E-1)

NA[2] Not Applicable. Estimate based on Unit cost for repaving of $30/ SYD, based on local construction costs.

NA[3] Not Applicable. Estimate based on cost research from Impervious removal including $40,000/ impervious acre removed plus $26,000/ac for site restoration. (Schueler, T., Hirschman, D., Novotney, M., Zielinski, J. 2007. Urban Stormwater Retrofit Practices Appendices: Urban Subwatershed Restoration Manual Series. Center for Watershed Protection, Ellicott City, MD. Appendix E. Impervious Cover Conversion)

8 Regulatory Analysis

Under the joint Storm Water Compliance Committee (SWCC), the Town and Village have developed an expired permit compliance ordinance. The latest update to the Town of Essex Title 10.20 Stormwater Ordinance is included in Appendix 7. The ordinance outlines the types of stormwater permits within Indian Brook based on varying ownership. For each permit type the corresponding procedure for how the Town and Village has dealt with that permit type in terms of permit responsibility and maintenance of the permitted stormwater infrastructure is included.

As part of this plan, retrofits are being proposed on sites tied to an expired State operational stormwater permit. The ordinance outlines the options for private permittees to either have their permit adopted under the MS4 permit, or to request coverage under a Residual Designation Authority (RDA) permit from the State. The decision as to how the responsibility for the proposed retrofit projects on private land are covered in the future will be subject to discussion and agreement with the private landowners and the MS4 according to the approved Stormwater Ordinance. A list of expired permits within the Indian Brook impaired watershed is included in Appendix A-2-1, including whether the existing BMP is proposed for a retrofit under the FRP.

9 Appendices

Table A-2-1: Indian Brook Expired Permit Discharges and Proposed BMP Retrofits

BMP in BMPDSS (Y/N?)	Permit Number	Project Name	RDA/ Other[1]	Owner	Existing Manner of Discharge	Proposed Retrofit (Y/N/E?)[2]	Proposed System Upgrades under FRP[3]
Town of Essex							
N- Not In Model	1-0667	Parcel H - Lang Farm	3557-9010	Private	No existing CPv BMP. Portion drains to Alder Brook.	Y	Paritial coverage by "LDS North" proposed BMP.
	2-0613	Lang Farm "Lot A" , Essex Way to the Inn at Essex		Private	No existing CPv BMP	E	Paritial coverage by "1-0775 Pond C", Essex Outlets Pond
	1-0491	The Center at Essex- Peter Edelman		Private	No existing CPv BMP	N	
	1-1371	Links @ Lang Farm, LLC Golf Course	6004-INDS	Private	No existing CPv BMP	N	See new permit
Y- Base Pre2002 Scenario - Channel Protection Volume (CPv) BMP covered under Permit	1-0775a	Lang Farm Parcel A- Phase 2- Essex Outlets	4002-INDS and 6262-9020	Private	Detention Pond A	E	Upgraded under 6262-9020 permit
	1-0775b	Lang Farm Parcel A- Phase 2,Essex Outlets	4002-INDS and 6262-9020	Private	Detention Pond B	E	Upgraded under 6262-9020 permit
	1-0775c	Lang Farm Parcel A- Phase 2, Essex Outlets	4002-INDS and 6262-9020	Private	Detention Pond C	E	Upgraded under 6262-9020 permit
	1-1307	Homestead Design, Inc.	4002-INDS.A	Private	Detention Pond	E	Detention Pond discharges to ponds covered by 1-0775
	1-1319_p1	Church of Jesus Christ of Latter Day Saints		Private	"South" Detention Pond	Y	"LDS South" proposed retrofit: Upgrade existing pond to detention chamber system.
	1-1319_p2	Church of Jesus Christ of Latter Day Saints		Private	"North" Detention Pond	Y	"LDS North" proposed retrofit: Upgrade existing pond to large detention chamber system.
	1-1381_p1	The Commons at Essex Way Condominium Association		Private	"North" Detention Pond	Y	"The Commons Pond" proposed retrofit: Upgrage existing pond to detention chamber system.
	2-0631	Inn at Essex		Private	Dry Pond	Y	Proposed to send runoff to "LDS North" proposed BMP.
	1-1381_p2	The Commons at Essex Way Condominium Association		Private	"South" Detention Pond	N	No retrofit proposed under FRP. Potential to convert pond to detention chamber system.
	1081	Essex STP 030-1(17)- Route 15 Reconstruction	Notice of Termination	Town	Detention Pond	N	

BMP in BMPDSS (Y/N?)	Permit Number	Project Name	RDA/ Other[1]	Owner	Existing Manner of Discharge	Proposed Retrofit (Y/N/E?)[2]	Proposed System Upgrades under FRP[3]
Village of Essex Junction							
N- Not in Model	2-0155	Essex Park Phase III & IV		Village	No existing CPv BMP	Y	Paritial coverage by "Countryside Dr." proposed detention Chamber BMP and GSI planters.
	2-0187	Grove Street- North Street		Village	No existing CPv BMP	Y	Paritial coverage by "Grove St" proposed infiltration chamber BMP.
	2-0952	North Creek, South Creek and East Creek Condominiums		Private	No existing CPv BMP	Y	Coverage by "Brickyard" proposed detention BMP
	2-1103	Pleasant Street & East Street		Village	No existing CPv BMP	Y	Paritial coverage by "Densmore Dr" proposed infiltration chamber BMP.
	1-0236	Brickyard		Private	System of Catch Basins	N	
	1-0771	Champlain Valley Exposition Inc.		Private	No existing CPv BMP	N	
	1-0953	Dury Drive & Meadow Village		Village	No existing CPv BMP	N	
	2-0769	Athens Drive		Village	System of Catch Basins	N	
	2-0855	Village Knoll-Woods End & Acorn		Village	System of Catch Basins	N	
	2-0961	Brookside Condominums		Village	No existing CPv BMP	N	
Y- Base Pre2002 Scenario - Channel Protection Volume (CPv) BMP covered under Permit	1-1074	Countryside II Fairview Farms: Locust lane, Chestnut Lane, Spruce Land, Walnut Lane	Upgraded	Private	Detention Pond	E	Pond upgrades included in Post 2002 model. No additional retrofit proposed.
	1-1382	Essex Community Educational Ctr.	renewed 4119-INDS.1	Private	Infiltration Basin- upgraded	E	Infiltration Basin
	1-1409	Champlain Valley Exposition, Inc		Private	Dry pond	E	Changes proposed under 3636-INDS.1 (TB constructed)
	2-0317/2-0289	East Creek Condominiums		Private	Dry pond	Y	Proposed upgrades to Detention pond to meet 2002 VT SWMM stds.
	2-0289/2-0317	Countryside in the Village/Essex Housing Partnership		Private	Dry pond	Y	Proposed upgrades to Detention pond to meet 2002 VT SWMM stds.
	2-0835 pt 1	Village Glen Condos- CGPM, Inc.		Private	Dry well	N	Meets CPv std. No retrofit proposed.
	2-0835 pt 2	Village Glen Condos- CGPM, Inc.		Private	Dry well	N	Meets CPv std. No retrofit proposed.

* Table Originally Prepared by Emily Schelley (VT DEC), Revised by WCA (2014).

[1] RDA: Residual Designation Authority- Private Permittees requests to have their expired stormwater system covered under an RDA permit, which overwrites their expired permit.

[2] Y - Yes, retrofit proposed, N- No retrofit proposed under FRP, E- Post 2002 Existing BMP addressses a portion of impervious under expired permit

[3] Expired permit retrofits were determined based on direct benefit to the Flow Restoration Targets. Expired pemits with a CPv(extended detention of the 1-year design storm) BMP were assesed for retrofit opportunity, and if the flow reduction benefit was determined neglible, a retrofit was not proposed. It was determined beneficial to route several expired permit systems to a larger retrofit project, rather than retrofit the existing system on-site.

Indian Brook Flow Restoration Plan
Existing Stormwater BMP List in BMPDSS Model
4/23/2015

Table A-2-2: Indian Brook Existing Stormwater BMP List in BMPDSS Model

Model	Permit #	Project/BMP Name	MS4	Ownership	BMP Type in BMPDSS	Permit Renewal	Proposed Retrofit
pre2002	1-0775a	Lang Farm Parcel A- Phase 2- Essex Outlets	Town	Private	Detention Pond	6262-9020 upgrades	No retrofit proposed under FRP
pre2002	1-0775b	Lang Farm Parcel A- Phase 2,Essex Outlets	Town	Private	Detention Pond	6262-9020 upgrades	No retrofit proposed under FRP
pre2002	1-0775c	Lang Farm Parcel A- Phase 2, Essex Outlets	Town	Private	Detention Pond	6262-9020 upgrades	No retrofit proposed under FRP
pre2002	1-1307	Homestead Design, Inc.	Town	Private	Detention Pond discharges 1-0775 pond b	4002-INDS.A upgrades	No retrofit proposed under FRP
pre2002	1-1382	Essex Community Educational Ctr.	Village	Private	Infiltration Basin	4119-INDS	No retrofit proposed under FRP
pre2002	1-1074 (SN 001)	Countryside II Fairview Farms: Locust lane, Chestnut Lane, Spruce Land, Walnut Lane	Village	Private	Detention Pond		No retrofit proposed under FRP
pre2002	1-1186	Woodlands II- Lang Farm Parcel	Town	Public	Detention Ponds (2)		Woodlands: Convert to underground infiltration gallery
pre2002	1-1319_p1_South	Church of Jesus Christ of Latter Day Saints	Town	Private	Detention Pond		LDS P1: Convert to underground detention system.
pre2002	1-1319_p2_North	Church of Jesus Christ of Latter Day Saints	Town	Private	Detention Pond		LDS P2: Convert to underground detention system.
pre2002	1-1381_p1_North	The Commons at Essex Way Condominium Association	Town	Private	Detention Pond		Commons P1: Convert to underground detention system.
pre2002	1-1381_p2_South	The Commons at Essex Way Condominium Association	Town	Private	Detention Pond		No retrofit proposed under FRP
pre2002	2-0631	Inn at Essex	Town	Private	Detention Pond		Route to LDS P1 Retrofit
pre2002	1081	Old Stage Rd/Rt-15 (Essex STP 030-1(17))	Town	Town	Detention Pond		No retrofit proposed under FRP
pre2002	Reservoir		Town	Town	On-stream Pond		No retrofit proposed under FRP
pre2002	1-1409	Champlain Valley Exposition, Inc	Village	Private	Detention Pond		No retrofit proposed under FRP
pre2002	2-0289/2-0317	East Creek Condominiums	Village	Private	Detention Pond		Retrofit outlet structure and armor spillway.
pre2002	2-0835 pt 1	Village Glen Condos- CGPM, Inc.	Village	Private	Dry well		No retrofit proposed under FRP
pre2002	2-0835 pt 2	Village Glen Condos- CGPM, Inc.	Village	Private	Dry well		No retrofit proposed under FRP
pre2002	1-1074 SN 002	Natural Detention area at Fairfield Dr/Mansfield Ave.	Village	Village	Existing Detention area		Fairview Dr: Proposed retrofit of existing detention area into terraced detention basin. New culvert under Main St. proposed to tie in Northside of Main St. to new basin.
pre2002	2-0952	North, East, and South Creek Condominiums on Brickyard Rd.	Village	Private	Existing Detention area		Brickyard: Proposed retrofit of existing detention area with new outlet structure and regrading.
post2002	7125-INDS	Thasha Lane Redevelopment	Village	Private	Detention Ponds (3)		Meeting VT 2002 Stormwater Design Standards
post2002	4002-INDS.A	Essex Town Center- Essex Outlets	Town	Private	Upgrades to #1-1307 and #1-0775 Ponds	See #1-1307	Meeting VT 2002 Stormwater Design Standards
post2002	6262-9020	Essex Outlets Pond A	Town	Private	Upgrades to #1-0775 Ponds	See #1-0775	Meeting VT 2002 Stormwater Design Standards
post2002	6262-9020	Essex Outlets Pond B	Town	Private	Upgrades to #1-0775 Ponds	See #1-0775	Meeting VT 2002 Stormwater Design Standards
post2002	6262-9020	Essex Outlets Pond C	Town	Private	Upgrades to #1-0775 Ponds	See #1-0775	Meeting VT 2002 Stormwater Design Standards
post2002	5864-INDS	Lang Family, LLC	Town	Private	Wet Swale		Meeting VT 2002 Stormwater Design Standards

Model	Permit #	Project/BMP Name	MS4	Ownership	BMP Type in BMPDSS	Permit Renewal	Proposed Retrofit
post2002	6713-INDS	Route 2A Mini Storage at 78 Lincoln Street	Town	Private	Detention Pond		Meeting VT 2002 Stormwater Design Standards
post2002	1-1382/4119-INDS.1	Essex Community Educational Ctr.	Village	Private	Infiltration Basin		Meeting VT 2002 Stormwater Design Standards
post2002	3626 1	Champlain Valley Exposition, Inc.	Village	Private	On-site Infiltration		Meeting VT 2002 Stormwater Design Standards
post2002	3626 2C	Champlain Valley Exposition, Inc.	Village	Private	On-site Infiltration		Meeting VT 2002 Stormwater Design Standards
post2002	4119 ice rink	Union 46 School District	Village	Village	Infiltration Basin		Meeting VT 2002 Stormwater Design Standards
post2002	4119 parking	Union 46 School District	Village	Essex School D	Detention Pond		Meeting VT 2002 Stormwater Design Standards
post2002	4989-INDO	5 Corners North	Village	Essex School D	Underground Storage System		Meeting VT 2002 Stormwater Design Standards
post2002	3626-INDS.1	Champlain Valley Exposition - multi-use area	Village	Private	Dry well		Meeting VT 2002 Stormwater Design Standards
post2002	1-1074 SN 001 upgrades	Countryside II Fairview Farms: Locust lane, Chestnut Lane, Spruce Land, Walnut Lane	Village	Private/ Village Road	Detention Pond		Meeting VT 2002 Stormwater Design Standards
post2002	Handy Suites	Handy Suites	Village	Private	Porous Asphalt (4 infiltration beds)		Meeting VT 2002 Stormwater Design Standards
post2002	EHS	Essex High School Rain Garden	Village	Essex School D	Rain Garden		Proposed repaving of parking lot to improve capture.

Indian Brook Flow Restoration Plan
BMPDSS Model Run Summary
As of January 26th, 2015

Table A-3-1: BMPDSS Model Run Summary

Indian Brook Model Runs Summary				
Model Run	Description	High Flow **Reduction** (%)	Low Flow* **Increase** (%)	BMPDSS Model Run Date
TMDL Targets *Stormwater Allocation only		-1.3%	1.1%	----
DEC Existing Condition Model	DEC's existing model, includes all Post2002 BMPs	-1.14%	0.0%	1/31/2014
WCA Revised Existing Condition Model (7/31/2014)	WCA revised subwatersheds and existing BMP design entries.	-1.49%	0.0%	7/31/2014
WCA Revised Existing Condition Model (10/20/2014)	WCA revised additional subwatersheds and existing BMP design entries.	-1.40%	0.0%	10/20/2014
WCA Revised Existing Condition Model (1/12/2015)	WCA revised additional subwatersheds and existing BMP design entries.	-0.54%	0.6%	1/12/2015
Percent of Target Managed (with Existing Condition Model 1/12/15)		**41.5%**	58.28%	----
Credit1 Model	Add 8 proposed retrofits.	-1.85%	0.0%	10/21/2014
Percent of Target Managed (with Credit1 run on 10/21/14)		142%	0%	----
Credit2 Model	Add 3 additional infiltration BMPs and two pond retrofits	-2.75%	0.6%	1/14/2015
Percent of Target Managed (with Credit2 run on 1/14/15)		**212%**	58%	----

Note: The High Flow target is negative(-), indicating there needs to be a reduction in high flow from the baseline condition. The Low Flow target is positive (+), indicating there needs to be an increase in low flow from the baseline condition. A positive(+) percent of target managed indicates progress toward the target, whereas a negative (-) percent of target managed indicates that the modeled scenario estimates low flow is below the baseline condition.

* The low flow target is not actionable under the TMDL, but is included in the summary because improving base flow in the watershed is still a water quality goal.

Indian Brook Flow Restoration Plan
BMP List by BMPDSS Model Scenario
July 23rd, 2015

Table A-3-2: BMP list by BMPDSS Model Scenario

Proposed BMP ID	MS4 owner of impervious draining to practice	Ownership where BMP is located	BMP Type (Key[1])	New or Existing Site?	Permit #[2] (if applicable)	Address	Drainage Area, DA (acres)	Impervious Acres Managed (ac)	Channel Protection Volume (CPv) Managed above Base Condition[3]		Retrofit Description
									cft	Ac-ft.	
Added to Credit 1 Scenario											
Existing Post2002 BMPs	Varies	Varies		Existing	Varies	Varies	Varies	Varies			Varies
LDS Church North Pond (P2-Outfall 204)	Town	Private	USC	Existing	1-1319	Essex Dr.	3.07	2.52	4312	0.10	Convert existing detention pond to a gravel wetland.
Fairview Dr./Main St.	Village/ VTRANS	Public	GW	Existing	1-1074 SN002	Fairview Dr. / Main St.	22.53	3.94	19384	0.45	Regrade existing detention area, add terraced WQ bays, and replace existing culvert. Stabilize eroded outfall on North side of Main St.
Brickyard/North, South, East Creek Condos	Village	Private	GW	Existing	2-0952	Brickyard/Mansfield Ave.	8.7	4.68	24960	0.57	Convert existing detention area at the corner of Mansfield/Brickyard to gravel wetland with CPv storage.
Woodlands (Detention Pond 139)	Town	Private	UIB	Existing	Public	Sydney Dr.	32.80	4.04	15682	0.36	Retrofit existing detention pond to an underground stone gallery with 48" perforated pipe.
East Creek Condominiums	Village	Private	DB	Existing	2-0289/ 2-0317	Countryside/ Brickyard	48.2	14.40	13721	0.32	Retrofit outlet structure for CPv control. Rearmour spillway.
I-289/Route 15 North	Vtrans	ROW	MF	New	NP	I-289/Route 15	2.78	0.90	5271	0.12	Retrofit existing median swale with CPv volume control sand filter.
I-289/Route 15 South	Vtrans	ROW	MF	New	NP	I-289/Route 15	2.15	0.96	4443	0.10	Retrofit existing median swale with CPv volume control sand filter.
Essex Union High School- Rain Garden- Regrade Parking Lot	Village	School District	GSI	Existing	NP	Educational Drive	1.61	1.07	2222	0.05	Regrade parking lot to increase capture. Garden has capacity for more runoff without expansion.
Added/Revised in Credit 2 Scenario											
Fairview Dr. Add-on	Village/ VTRANS	Public	GW	Existing	1-1074 SN002	Fairview Dr. / Main St.	6.87	1.30	9583	0.22	Add culvert under Main St. to direct Northside of Main St. to Basin.
LDS Church w/ Add On- Inn at Essex, Essex Way North and Essex Way South	Town/ VTRANS	Private	USC	Existing	2-0631, 2-0613	Essex Dr.	26.52	8.48	44431	1.02	Route outfalls North and South of LDS pond to retrofit. Option 5: Convert pond to expanded underground stone gallery with 48" Perforated Pipe.
LDS Church South P1 (Outfall 209)	Town	Private	USC	Existing	1-1319	Essex Dr.	1.34	1.01	4400	0.101	Retrofit existing detention pond to an underground stone gallery with 48" perforated pipe.
The Commons P1 (Outfall 131)	Town	Private	USC	Existing	1-1381	Essex Dr.	7.91	2.07	8668	0.20	Convert existing detention pond to StormTech chamber system. Improve aesthetics and landscaping.

Proposed BMP ID	MS4 owner of impervious draining to practice	Ownership where BMP is located	BMP Type (Key[1])	New or Existing Site?	Permit # (if applicable)	Address	Drainage Area, DA (acres)	Impervious Acres Managed (ac)	Channel Protection Volume (CPv) Managed above Base Condition[2]		Retrofit Description
									cft	Ac-ft.	
Countryside Dr Intersection	Village	ROW	USC	New	2-0155	Countryside Dr/Brickyard	5.25	1.95	4704	0.11	Stabilize outfall and bank. Install underground detention chamber at intersection of Countryside Dr./Brickyard. Add Stormwater planters in ROW on Countryside Dr.
Grove St.	Village/ VTRANS	ROW	UIB	New	2-0187	Grove St.	23.39	8.71	5576	0.13	Install two underground storage basins in series for detention and infiltration of the CPv storm.
Densmore Dr.	Village	Private (Sherwood Sq. Condos)	UIB	New	2-1103	Densmore Dr. / Police Station	38.28	11.73	14985	0.34	StormTech Chamber System on Densmore Dr. Verify high groundwater elevation.
Briar Lane Cul-de-sac Impervious Removal	Village	No Practice	No Practice	Existing	2-0855 (Village Knoll)	Briar Lane/ Woods End Dr.	na	0.11	900	0.02	Eliminate cul-de-sac to reduce plowing needs. Small impact.

1- BMP Type: DB: Detention Basin, USC = Underground Storage Chamber, UIB= Underground Infiltration Basin, GW = Gravel Wetland, GSI = Smaller-scale GSI practice DW= Dry Wells
2- Key: * NP = No permit
3- Channel Protection Volume Managed above Base condition = New Storage Volume - Existing Volume pre2002

Indian Brook Flow Restoration Plan
Tables A-3-3: MS4 Target Allocation and FRP Progress
As of January 26th, 2015

Table 1: Model Scenario Results Summary

Model Scenario	BMPDSS Model Run Date	High Flow Target, Q 0.3 (± %)	Low Flow Target, Q 95 (± %)
TMDL Targets for Indian Brook	---	-1.3%	1.1%
Existing Condition Post2002 Scenario	1/12/2015	-0.54%	0.64%
Proposed BMP Scenario "Credit2"	1/14/2015	-2.75%	0.64%

Table 2: TMDL Flow Target Allocation

MS4 Impervious Owner	Total Area w/in Watershed (acres)	Impervious Cover (acres)	% of Watershed Impervious Cover	Target High Flow **Reduction** (%)	Target Low Flow **Increase** (%)
Town of Essex	3492.39	171.85	40.4%	-0.5%	0.44%
Village of Essex Junction	952.6	218.08	51.3%	-0.7%	0.56%
VTrans	141.91	35.56	8.4%	-0.1%	0.09%
Watershed Total	**4586.90**	425.49		**-1.3%**	**1.1%**

* The low flow target is not actionable under the TMDL, but is included in the summary because improving base flow in the watershed is still a water quality goal.

*The High Flow target is negative(-), indicating there needs to be a reduction in high flow from the baseline condition. The Low Flow target is positive (+), indicating there needs to be an increase in low flow from the baseline condition.

*Watershed delineation from file: "Indian_watershed121614"

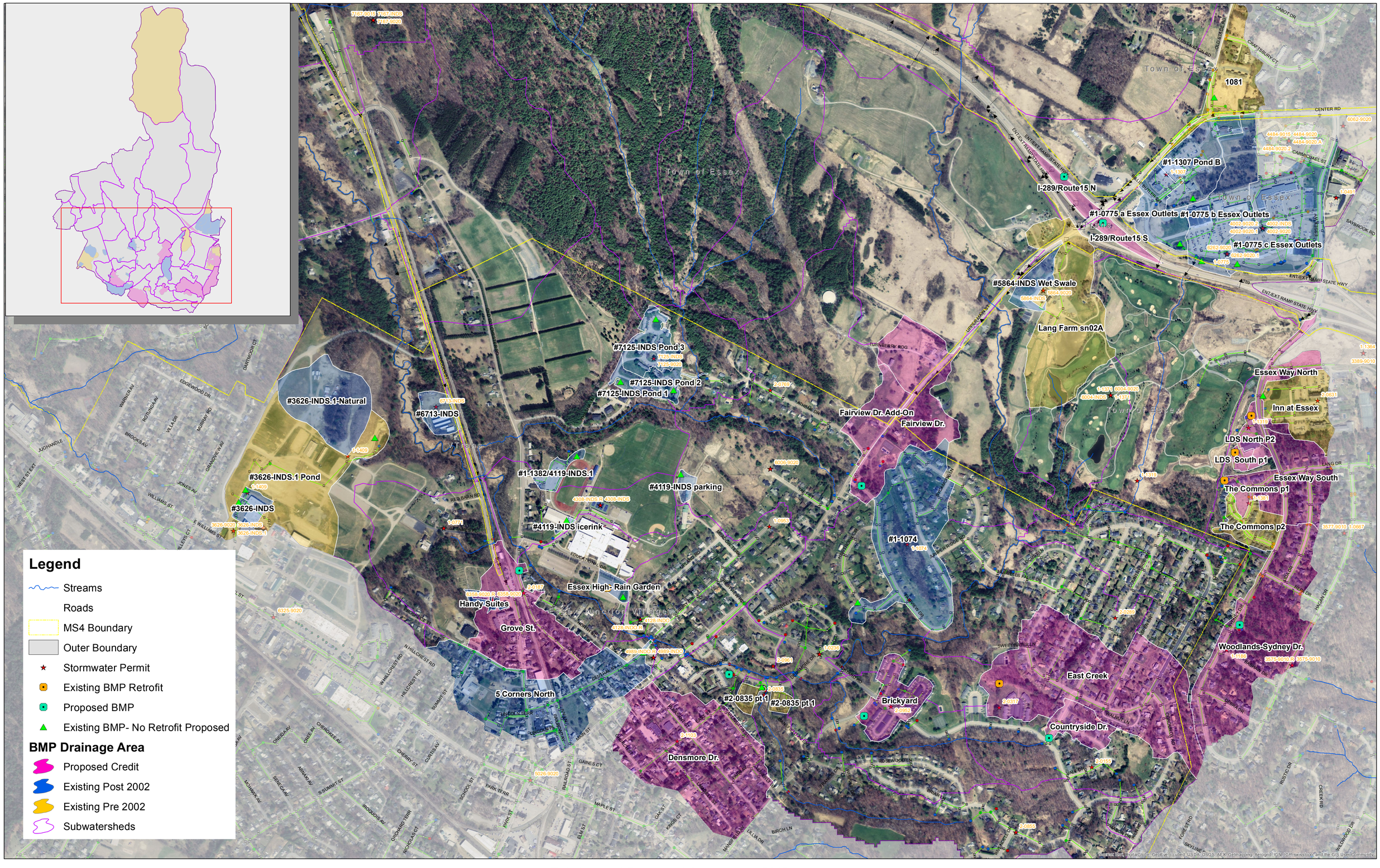
Table 3: Progress toward flow targets by model scenario

MS4 Impervious Owner	**Existing Condition "Post 2002"**						**Proposed BMP Scenario "Credit2"**					
	Managed Impervious Acres by DET or INF[1]	Target High Flow Q 0.3 (± %) Reduction Left [2]	**Percent of High-flow Target addressed, %**	Managed Impervious Acres INF	Target Low Flow Q 95 (± %) Increase Left[3]	Percent of Low-flow Target addressed, %	Managed Impervious Acres by DET or INF[1]	Target High Flow Q 0.3 (± %) Reduction Left [2]	**Percent of High-flow Target addressed, %**	Managed Impervious Acres INF	Target Low Flow Q 95 (± %) Increase Left[3]	Percent of Low-flow Target addressed, %
Village of Essex Junction	32.9	-0.28%	47.1%	0.0	0.44%	0.0%	53.1	0.00%	200.6%	0.0	0.44%	0.0%
Town of Colchester	38.6	-0.38%	43.5%	2.0	0.00%	113.5%	81.9	0.00%	243.5%	22.4	0.00%	112.4%
VTrans	0.4	-0.11%	2.4%	0.0	0.092%	0.0%	3.7	-0.03%	68.0%	0.2	0.086%	7.0%
Watershed Total		-0.76%	**41.5%**		0.5%	**58.2%**		1.45%	**211.5%**		0.5%	**58.2%**
	NOT MET						TARGET MET					

1- DET= Detention BMP providing CPv storage, INF= Infiltration BMP infiltrating the CPv volume

2-When the target was met, the" Q0.3 and Q95 LEFT to the managed" was changed to 0% in the table. There are still MS4's with a portion of their allocation left, even with the overall Watershed Target MET.

3-The low flow target is not actionable under the TMDL, but is included in the summary because improving base flow in the watershed is still a water quality goal.



Existing and Proposed Stormwater BMPs
Indian Brook Flow Restoration Plan
Essex, Vermont
as of 1-26-2015

N

0 215430 860 Feet

1 inch = 426 feet

Indian Brook Flow Restoration Plan(FRP) Project
BMP Ranking Criteria Key
January 26th, 2015

Table A-5-1 BMP Ranking Criteria Key

Category	ID	Criteria	Technical Description	Description
Cost/Operations	A	Project Cost	The project costs were grouped into categories from >$50,000 to >$1,000,000 based on the range of projects proposed. Cost estimates were developed using the latest unit costs from VTrans as well as local experience. More expensive projects are ranked lower.	Project Costs include additional engineering, permitting, and construction. Transportation and utility conflicts, as well as overall constructability is also reflected in the cost.
	B	Ease of O/M	This criteria is based on experience with the general ease of operation and maintenance for specific categories of practices.	This criteria is based on general knowledge of the ease of operation and maintenance for specific categories of practices. Most stormwater facilities require some amount of annual maintenance, with some BMP's requiring significantly more operational resources than others.
Project Design Metrics	C	Impervious Acres Managed (ac)	Natural groupings within the range of impervious managed for the proposed projects were identified. More impervious managed receives a higher score.	The more impervious managed by a project, the higher the potential pollutant reduction. Additionally, the goal of the FRP is to manage existing impervious surfaces.
	D	Channel Protection Volume (CPv) Mitigated, (i.e.. 1-year Storm)	Groupings within the range of CPv volume storage were identified. The largest grouping receives the highest score. The CPv was estimated in HydroCAD, using local rainfall data.	The Channel Protection Volume (CPv) is the volume of stormwater runoff generated from the 1-year design storm (1.96" in Essex). A BMP which provides CPv storage was determined to reduce the High-flow (Q0.3%), which is the flow rate exceeded 0.3% of the time (output from the State's BMPDSS model). Mitigating the CPv reduces channel erosion and excessive pollutant loading from streams.
	E	Volume Infiltrated (ac-ft)	Natural groupings within the range of volumes infiltrated for the BMPs were identified to which relative points were be assigned. The largest volume infiltrated was assigned the highest score. Volumes were calculated in HydroCAD.	The Volume Infiltrated indicates the amount of stormwater runoff that is infiltrated into the groundwater, and provides baseflow for the stream. The TMDL flow targets include a low-flow target, which is addressed by an infiltration-based BMP.
	F	Water Quality (WQ) Volume Mitigated	The WQ volume mitigated is defined as the runoff volume generated from the 0.9" rainfall that is stored in the BMP's permanent pool. Three categories were identified for the WQ volume 1) 100% WQ volume control which is the best-case standard for the EFA procedure. 2) >= 20% WQ volume as required for redevelopment projects, and 3) less than 20% WQ volume.	The WQ volume mitigated is an indicator of the reduction in pollutant runoff from 90% of annual storm events, approximated to be an 80% removal of the Total Suspended Solids (TSS) and 40% total phosphorus (TP) load.
	G	Primary or Secondary BMP	Primary BMP is the main control practice, whereas a secondary BMP drains to a primary BMP. Primary BMPs have a higher weighting.	A primary BMP is the main control practice, like a large end-of-pipe detention pond. A secondary BMP is located within the drainage area of a primary BMP, providing additional flow control and treatment. Secondary BMPs are weighted less than primary BMPs in terms of reducing stormwater runoff.
Project Implementation	H	Permitabilty	Permitabilty is simplified into two categories to reflect the common scenarios in permitting, as 1) minimal permitting 2) Complex permitting issues.	Permitabilty is a measure of the expected level of effort to permit the project, based on knowledge that each type of permit takes varying amounts of time. Some common permits include Stormwater Construction, Local Zoning, Act 250 amendments, VTRANS ROW, etc.
	I	Land Availability	Public land is preferred, followed by regulated private land, and private land where the owners are known to be open to participate. Private land, in which participation of the owner is unknown is lower priority.	Land availability is critical for BMPs requiring open space for detention and access for the Municipality involved. Properties owned by the Municipality (Public) are ranked the highest, followed by privately owned land with an expired permit, which provides leverage to retrofit the BMP. The next priority is private land with a land owner who is known to be cooperative. If a land owner is known to not be cooperative, points were subtracted from the ranking.

Category	ID	Criteria	Technical Description	Description
Other Project Benefits/Constraints	J	Flood Mitigation	Flood mitigation is categorized by the scale of the impact. A neighborhood flooding issue is weighed more heavily than a localized drainage issue.	Flood mitigation is categorized by the scale of the impact. A neighborhood flooding issue is weighed more heavily than a localized drainage issue.
	K	TMDL Flow Target Addressed (Q03, Q95)	More weight is on BMPs that address both TMDL targets- the high-flow (Q0.3%) and low-flow targets (Q95%). The high-flow target is addressed by detention BMPs which provide storage of the CP volume (1-year storm). The low-flow target is addressed by BMPs which infiltrate the 1-year storm volume.	The goal of the FRP is to implement projects which address the TMDL flow targets. The high-flow target is measured as a **reduction** in the stream flow rate exceeded 0.3% of the time, while the low-flow target is an **increase** in the stream flow rate exceeded 95% of the time (baseflow). Projects which address both targets through storage or infiltration of the 1-year design storm are weighted the highest, followed by projects which address just the high-flow. Projects which do not address the full 1-year storm volume are weighted the lowest.
	L	Lake Champlain Phosphorus TMDL	Yes or no whether the proposed practice will provide benefit toward the Lake Champlain Phosphorus TMDL. This will be determined once the TMDL compliance metrics are released.	The Lake Champlain Phosphorus TMDL has been developed in the effort to reduce nutrient loading and consequential toxic algal blooms in Lake Champlain. The TMDL will require stormwater BMPs to meet a certain level of Total Phosphorus reduction. Each BMP will be evaluated against the TMDL compliance metrics, and scored yes or no if the project meets the TMDL standards.
	M	Other Project Benefits/Constraints	This criteria is to account for indirect project benefits (+) like infrastructure improvements (e.g. aging infrastructure replacement, wetlands enhancement, and if it addresses an expired permit). This criteria also accounts for specific project constraints (-) due to potential erodible soils and bank destabilization.	This criteria is to account for indirect project benefits like infrastructure improvements, community benefits, habitat creation, etc., as well as additional project constraints like potential erodible soils causing bank destabilization concerns.
	N	Annual Total Suspended Solids (TSS) Yield Mitigated (lbs.) *WinSLAMM Model result	The annual TSS Yield mitigated by the proposed BMP was estimated with the Source Loading and Management Model (WinSLAMM), a continuous simulation urban runoff and water quality model. This criteria provides a metric for the WQ benefit of the project.	The annual TSS Yield mitigated by the proposed BMP was estimated with the Source Loading and Management Model (WinSLAMM), a continuous simulation urban runoff and water quality model. This criteria provides a metric for the WQ benefit of the project.
	O	Annual Total Phosphorus (TP) Yield Mitigated (lbs.) *WinSLAMM Model result	The annual TP Yield mitigated by the proposed BMP was estimated with the Source Loading and Management Model (WinSLAMM), a continuous simulation urban runoff and water quality model. This criteria provides a metric for the WQ benefit of the project.	The annual TP Yield mitigated by the proposed BMP was estimated with the Source Loading and Management Model (WinSLAMM), a continuous simulation urban runoff and water quality model. This criteria provides a metric for the WQ benefit of the project.

Indian Brook Flow Restoration Plan(FRP) Project
BMP Ranking Score Key
January 26th, 2015

Table A-5-2: Ranking Score Key

Category	ID	Criteria	Quality	Score
Cost/Operations	A	Relative Project Cost	Under $50,000	4
			$50,000-100,000	3
			$100,000-1,000,000	2
			Over $1,000,000	1
	B	Ease of O/M	Underground Storage/ Swirl Separator	2
			Bioretention/Rain Gardens/Tree Box Filters	1
			Ponds/Constructed Wetlands	0
Project Design Metrics	C	Impervious Acres Managed (ac)	> 10 acres	7
			5-10 acres	6
			4-5 acres	5
			2-4 acres	4
			1-2 acres	3
			0.5-1 acres	2
			< 0.5 acre	1
	D	Channel Protection Volume (CPv) Mitigated, (ie. 1-year Storm)	0.6-1.0 ac-ft	5
			0.4-0.6 ac-ft	4
			0.2-0.4 ac-ft	3
			0.05-0.2 ac-ft	2
			>0-0.05 ac-ft	1
	E	Volume Infiltrated (ac-ft)	>1 ac-ft	4
			0.5-1 ac-ft	3
			0.1- 0.5 ac-ft	2
			no infiltration	0
	F	Water Quality (WQ) Volume Control	>= 100% WQ volume controlled in permanent pool	2
			>= 20 % WQ volume controlled in permanent pool	1
			Under 20% WQ volume controlled in permanent pool	0
	G	Primary or Secondary BMP	Primary	2
			Secondary (Routed to Primary Control)	0
Project Implementation	H	Permitabilty	Minimal Issues/Concerns or no permits	2
			Complex issues/Potential permit denial	0
	I	Land Availability	MS4 owned	4
			Public	3
			Non MS4 owned regulated (expired permit)	3
			Non MS4 owned/Participatory Owner	2
			Unknown	0
			Not MS4 owned/Non participatory owner	-2
Other Project Benefits/Constraints	J	Flood Mitigation (Is existing flooding issue mitigated by project?)	Neighborhood Wide Flooding Issue	3
			Infrastructure damage (e.g. Wet Basement)/Single Property	2
			Nuisance Issue (ie. ponding, puddles, etc).	1
			None	0
	K	TMDL Flow Target Addressed (Q03, Q95)	High and Low Flow Targets	3
			High Flow Target	2
			No target addressed in BMPDSS (just WQ treatment)	1
	L	Lake Champlain Phosphorus TMDL*	Addressed TMDL	1
			Does not address TMDL	0
	M	Other Project Benefits (+) / Constraints (-)	Infrastructure Improvement (e.g. Culvert Replacement) (+)	1
			Educational/Functional Benefit (+)	1
			Recreational Benefit (+)	1
			Expired permit on site (+)	1
			Outfall Erosion Control (+)	1
			Potential Erodible soils/Bank Destabilization issues (-)	-1
			Access Issues (-)	-1
			Uncertainty in groundwater table/feasibility for infiltration (-)	-3
			Loss of Habitat (-)	-1
	N	Annual Total Suspended Solids (TSS) Yield Mitigated (lbs.) *WinSLAMM Model result	>2000	5
			1500-2000	4
			1000-1500	3
			500-1000	2
			<500	1
			<50	0
	O	Annual Total Phosphorus (TP) Yield Mitigated (lbs.) *WinSLAMM Model result	<5	6
			4-5	5
			3-4	4
			2-3	3
			1-2	2
			<1	1
	*Lake Champlain Phosphorus TMDL compliance metrics TBD. All projects which address > 20%of the WQ volume are considered meeting this standard.			

Indian Brook Flow Restoration Plan(FRP) Project
BMP Ranking Criteria Key
January 26th, 2015

Table A-5-1 BMP Ranking Criteria Key

Category	ID	Criteria	Technical Description
Cost/Operations	A	Project Cost	The project costs were grouped into categories from >$50,000 to >$1,000,000 based on the range of projects proposed. Cost estimates were developed using the latest unit costs from VTrans as well as local experience. More expensive projects are ranked lower.
	B	Ease of O/M	This criteria is based on experience with the general ease of operation and maintenance for specific categories of practices.
Project Design Metrics	C	Impervious Acres Managed (ac)	Natural groupings within the range of impervious managed for the proposed projects were identified. More impervious managed receives a higher score.
	D	Channel Protection Volume (CPv) Mitigated, (i.e.. 1-year Storm)	Groupings within the range of CPv volume storage were identified. The largest grouping receives the highest score. The CPv was estimated in HydroCAD, using local rainfall data.
	E	Volume Infiltrated (ac-ft)	Natural groupings within the range of volumes infiltrated for the BMPs were identified to which relative points were be assigned. The largest volume infiltrated was assigned the highest score. Volumes were calculated in HydroCAD.
	F	Water Quality (WQ) Volume Mitigated	The WQ volume mitigated is defined as the runoff volume generated from the 0.9" rainfall that is stored in the BMP's permanent pool. Three categories were identified for the WQ volume 1) 100% WQ volume control which is the best-case standard for the EFA procedure. 2) >= 20% WQ volume as required for redevelopment projects, and 3) less than 20% WQ volume.
	G	Primary or Secondary BMP	Primary BMP is the main control practice, whereas a secondary BMP drains to a primary BMP. Primary BMPs have a higher weighting.
Project Implementation	H	Permitabilty	Permitabilty is simplified into two categories to reflect the common scenarios in permitting, as 1) minimal permitting 2) Complex permitting issues.
	I	Land Availability	Public land is preferred, followed by regulated private land, and private land where the owners are known to be open to participate. Private land, in which participation of the owner is unknown is lower priority.

Category	ID	Criteria	Technical Description
Other Project Benefits/Constraints	J	Flood Mitigation	Flood mitigation is categorized by the scale of the impact. A neighborhood flooding issue is weighed more heavily than a localized drainage issue.
	K	TMDL Flow Target Addressed (Q03, Q95)	More weight is on BMPs that address both TMDL targets- the high-flow (Q0.3%) and low-flow targets (Q95%). The high-flow target is addressed by detention BMPs which provide storage of the CP volume (1-year storm). The low-flow target is addressed by BMPs which infiltrate the 1-year storm volume.
	L	Lake Champlain Phosphorus TMDL	Yes or no whether the proposed practice will provide benefit toward the Lake Champlain Phosphorus TMDL. This will be determined once the TMDL compliance metrics are released.
	M	Other Project Benefits/Constraints	This criteria is to account for indirect project benefits (+) like infrastructure improvements (e.g. aging infrastructure replacement, wetlands enhancement, and if it addresses an expired permit). This criteria also accounts for specific project constraints (-) due to potential erodible soils and bank destabilization.
	N	Annual Total Suspended Solids (TSS) Yield Mitigated (lbs.) *WinSLAMM Model result	The annual TSS Yield mitigated by the proposed BMP was estimated with the Source Loading and Management Model (WinSLAMM), a continuous simulation urban runoff and water quality model. This criteria provides a metric for the WQ benefit of the project.
	O	Annual Total Phosphorus (TP) Yield Mitigated (lbs.) *WinSLAMM Model result	The annual TP Yield mitigated by the proposed BMP was estimated with the Source Loading and Management Model (WinSLAMM), a continuous simulation urban runoff and water quality model. This criteria provides a metric for the WQ benefit of the project.

Description
Project Costs include additional engineering, permitting, and construction. Transportation and utility conflicts, as well as overall constructability is also reflected in the cost.
This criteria is based on general knowledge of the ease of operation and maintenance for specific categories of practices. Most stormwater facilities require some amount of annual maintenance, with some BMP's requiring significantly more operational resources than others.
The more impervious managed by a project, the higher the potential pollutant reduction. Additionally, the goal of the FRP is to manage existing impervious surfaces.
The Channel Protection Volume (CPv) is the volume of stormwater runoff generated from the 1-year design storm (1.96" in Essex). A BMP which provides CPv storage was determined to reduce the High-flow (Q0.3%), which is the flow rate exceeded 0.3% of the time (output from the State's BMPDSS model). Mitigating the CPv reduces channel erosion and excessive pollutant loading from streams.
The Volume Infiltrated indicates the amount of stormwater runoff that is infiltrated into the groundwater, and provides baseflow for the stream. The TMDL flow targets include a low-flow target, which is addressed by an infiltration-based BMP.
The WQ volume mitigated is an indicator of the reduction in pollutant runoff from 90% of annual storm events, approximated to be an 80% removal of the Total Suspended Solids (TSS) and 40% total phosphorus (TP) load.
A primary BMP is the main control practice, like a large end-of-pipe detention pond. A secondary BMP is located within the drainage area of a primary BMP, providing additional flow control and treatment. Secondary BMPs are weighted less than primary BMPs in terms of reducing stormwater runoff.
Permitabilty is a measure of the expected level of effort to permit the project, based on knowledge that each type of permit takes varying amounts of time. Some common permits include Stormwater Construction, Local Zoning, Act 250 amendments, VTRANS ROW, etc.
Land availability is critical for BMPs requiring open space for detention and access for the Municipality involved. Properties owned by the Municipality (Public) are ranked the highest, followed by privately owned land with an expired permit, which provides leverage to retrofit the BMP. The next priority is private land with a land owner who is known to be cooperative. If a land owner is known to not be cooperative, points were subtracted from the ranking.

Description
Flood mitigation is categorized by the scale of the impact. A neighborhood flooding issue is weighed more heavily than a localized drainage issue.
The goal of the FRP is to implement projects which address the TMDL flow targets. The high-flow target is measured as a **reduction** in the stream flow rate exceeded 0.3% of the time, while the low-flow target is an **increase** in the stream flow rate exceeded 95% of the time (baseflow). Projects which address both targets through storage or infiltration of the 1-year design storm are weighted the highest, followed by projects which address just the high-flow. Projects which do not address the full 1-year storm volume are weighted the lowest.
The Lake Champlain Phosphorus TMDL has been developed in the effort to reduce nutrient loading and consequential toxic algal blooms in Lake Champlain. The TMDL will require stormwater BMPs to meet a certain level of Total Phosphorus reduction. Each BMP will be evaluated against the TMDL compliance metrics, and scored yes or no if the project meets the TMDL standards.
This criteria is to account for indirect project benefits like infrastructure improvements, community benefits, habitat creation, etc., as well as additional project constraints like potential erodible soils causing bank destabilization concerns.
The annual TSS Yield mitigated by the proposed BMP was estimated with the Source Loading and Management Model (WinSLAMM), a continuous simulation urban runoff and water quality model. This criteria provides a metric for the WQ benefit of the project.
The annual TP Yield mitigated by the proposed BMP was estimated with the Source Loading and Management Model (WinSLAMM), a continuous simulation urban runoff and water quality model. This criteria provides a metric for the WQ benefit of the project.

Indian Brook Flow Restoration Plan(FRP) Project
BMP Ranking Score Key
January 26th, 2015

Table A-5-2: Ranking Score Key

Category	ID	Criteria	Quality	Score
Cost/Operations	A	Relative Project Cost	Under $50,000	4
			$50,000-100,000	3
			$100,000-1,000,000	2
			Over $1,000,000	1
	B	Ease of O/M	Underground Storage/ Swirl Separator	2
			Bioretention/Rain Gardens/Tree Box Filters	1
			Ponds/Constructed Wetlands	0
Project Design Metrics	C	Impervious Acres Managed (ac)	> 10 acres	7
			5-10 acres	6
			4-5 acres	5
			2-4 acres	4
			1-2 acres	3
			0.5-1 acres	2
			< 0.5 acre	1
	D	Channel Protection Volume (CPv) Mitigated, (ie. 1-year Storm)	0.6-1.0 ac-ft	5
			0.4-0.6 ac-ft	4
			0.2-0.4 ac-ft	3
			0.05-0.2 ac-ft	2
			>0-0.05 ac-ft	1
	E	Volume Infiltrated (ac-ft)	>1 ac-ft	4
			0.5-1 ac-ft	3
			0.1- 0.5 ac-ft	2
			no infiltration	0
	F	Water Quality (WQ) Volume Control	>= 100% WQ volume controlled in permanent pool	2
			>= 20 % WQ volume controlled in permanent pool	1
			Under 20% WQ volume controlled in permanent pool	0
	G	Primary or Secondary BMP	Primary	2
			Secondary (Routed to Primary Control)	0
Project Implementation	H	Permitabilty	Minimal Issues/Concerns or no permits	2
			Complex issues/Potential permit denial	0
	I	Land Availability	MS4 owned	4
			Public	3
			Non MS4 owned regulated (expired permit)	3
			Non MS4 owned/Participatory Owner	2
			Unknown	0
			Not MS4 owned/Non participatory owner	-2
Other Project Benefits/Constraints	J	Flood Mitigation (Is existing flooding issue mitigated by project?)	Neighborhood Wide Flooding Issue	3
			Infrastructure damage (e.g. Wet Basement)/Single Property	2
			Nuisance Issue (ie. ponding, puddles, etc).	1
			None	0
	K	TMDL Flow Target Addressed (Q03, Q95)	High and Low Flow Targets	3
			High Flow Target	2
			No target addressed in BMPDSS (just WQ treatment)	1
	L	Lake Champlain Phosphorus TMDL*	Addressed TMDL	1
			Does not address TMDL	0
	M	Other Project Benefits (+) / Constraints (-)	Infrastructure Improvement (e.g. Culvert Replacement) (+)	1
			Educational/Functional Benefit (+)	1
			Recreational Benefit (+)	1
			Expired permit on site (+)	1
			Outfall Erosion Control (+)	1
			Potential Erodible soils/Bank Destabilization issues (-)	-1
			Access Issues (-)	-1
			Uncertainty in groundwater table/feasibility for infiltration (-)	-3
			Loss of Habitat (-)	-1
	N	Annual Total Suspended Solids (TSS) Yield Mitigated (lbs.) *WinSLAMM Model result	>2000	5
			1500-2000	4
			1000-1500	3
			500-1000	2
			<500	1
			<50	0
	O	Annual Total Phosphorus (TP) Yield Mitigated (lbs.) *WinSLAMM Model result	<5	6
			4-5	5
			3-4	4
			2-3	3
			1-2	2
			<1	1
	*Lake Champlain Phosphorus TMDL compliance metrics TBD. All projects which address > 20%of the WQ volume are considered meeting this standard.			

Indian Brook Flow Restoration Plan(FRP) Project
BMP Ranking Matrix

Site ID	BMP Type	Retrofit Description	Cost/Operations				Project Design Metrics								Project Implementation				Other Project Benefits/Constraints										Total Score
			A		B		C		D		E		F		G		H		I		J		K		L		M		N		O		
			Project Cost		Ease of O/M		Impervious Acres Managed (ac)		Channel Protection Volume (CPv)		Volume Infiltrated (ac-ft)		WQ Volume controlled (%)		Primary or Secondary BMP		Permitting Restrictions		Land Availability where BMP is located		Flood Mitigation		TMDL Flow Target Addressed (Q03, Q95)		Lake Champlain P TMDL addressed?		Other Benefits/Constraints		Annual Total Suspended Solids (TSS) Yield Mitigated (lbs.)		Annual Total Phosphorus (TP) Yield Mitigated (lbs.)		
			Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	
Church LDS North P2 (Option 5)	USC	Retrofit existing D	$ 1,100,000.00	1	Underground Stora	2	12.00	7	1.02	5			>= 100% W	2	Primary	2	Minimal Issu	2	Non City owne	3			High	2	Addressed	1	Functional B	2	576	2	2.69	3	34
Fairview Dr./Main St.	GW	Regrade existing	$ 244,400.00	2	Ponds/Constructed	0	3.94	5	0.45	4			>= 100% W	2	Primary	2	Minimal Issu	2	MS4 owned	4			High	2	Addressed	1	Outfall Erosi	2	887	2	3.21	4	32
Fairview Dr./Main St. with Add-On	GW	Regrade existing	$ 290,000.00	2	Ponds/Constructed	0	5.24	6	0.67	5			>= 100% W	2	Primary	2	Minimal Issu	2	MS4 owned	4			High	2	Addressed	1	Infrastructu	3	1847	4	4.01	5	38
Woodlands (Detention Pond 139)	UIB	Retrofit existing d	$ 200,400.00	2	Underground Stora	2	4.04	5	0.36	3			>= 100% W	2	Primary	2	Minimal Issu	2	MS4 owned	4			High	2	Addressed	1	Potential re	3	1502	4	5.79	6	38
East Creek Condominiums	DB	Expand Existing D	$ 80,000.00	3	Ponds/Constructed	0	14.40	6	0.32	3			>= 100% W	2	Primary	2	Minimal Issu	2	Non MS4 owne	3			High	2	Addressed	1	Expired Perr	1	0	0	0	0	25
Brickyard/North, South, East Creek C	DB	Retrofit existing	$ 130,000.00	2	Ponds/Constructed	0	4.68	5	0.57	4			>= 100% W	2	Primary	2	Minimal Issu	2	Non MS4 owne	3			High	2	Addressed	1	HOA willingr	2	234	1	0.49	1	27
I-289/Route 15 North	MF	Retrofit existing n	$ 34,000.00	4	Underground Stora	2	0.90	2	0.12	2			>= 100% W	2	Primary	2	Minimal Issu	2	MS4 owned	4			High	2	Addressed	1			879	2	1.99	2	27
I-289/Route 15 South	MF	Retrofit existing n	$ 29,000.00	4	Underground Stora	2	0.96	2	0.10	2			>= 100% W	2	Primary	2	Minimal Issu	2	MS4 owned	4			High	2	Addressed	1			650	2	1.82	2	27
Essex Union High School-Rain Garde	GSI	Regrade parking l	$ 72,600.00	3	Bioretention/Rain G	1	0.72	2	0.05	1			>= 100% W	2	Primary	2	Minimal Issu	2	Public	3			High	2	Addressed	1			13	0	0.04	0	19
Densmore Dr.	UIB	StormTech Chami	$ 241,900.00	2	Underground Stora	2	11.73	6	0.34	3	0.34	1	>= 100% W	2	Primary	2	Minimal Issu	2	Unknown	0			High/Low	3	Addressed	1	GW Table U	-3	2126	5	6.29	6	32
Grove St.	UIB	StormTech Chami	$ 119,600.00	2	Underground Stora	2	8.71	6	0.13	2	0.13	1	>= 100% W	2	Primary	2	Minimal Issu	2	MS4 owned	4			High/Low	3	Addressed	1	GW Table U	-3	1595	4	2.34	3	31
Countryside Dr Intersection	USC/GSI	Underground det	$ 263,000.00	2	Bioretention/Rain G	1	1.95	3	0.11	2			>= 100% W	2	Primary	2	Minimal Issu	2	MS4 owned	4			High	2	Addressed	1	Outfall Erosi	2	411	1	1.86	2	26
Briar Lane Cul-de-sac Impervious Re	No Practice	Eliminate Round-	$ 277,600.00	4	Decreased Plowing	2	0.11	1	0.02	1			>= 100% W	2	Secondary	0	Minimal Issu	2	MS4 owned	4			WQ	1	Addressed	1	Functional B	1	<20	0	0	0	19
Church LDS South P1	USC	Convert to underg	$ 135,400.00	2	Underground Stora	2	1.01	3	0.10	2			>= 100% W	2	Primary	2	Minimal Issu	2	Non MS4 owne	3			High	2	Addressed	1	Access issue	-1	494	2	0.65	1	23
The Commons North Pond (P1)	USC	Convert existing	$ 348,500.00	2	Underground Stora	2	2.07	3	0.20	2			>= 100% W	2	Primary	2	Minimal Issu	2	Non MS4 owne	3			High	2	Addressed	1	Access issue	0	681	2	2.67	3	26

BMP Type: **DB**: Detention Basin, **USC**: Underground/Covered Storage Chamber, **UIB**= Underground Infiltration Basin, **IB**= Vegetated Infiltration Basin **GSI** = Smaller-scale GSI practice **DW**= Dry Wells, **GW**= Gravel Wetland *WQ = Addresses WQ issue (i.e. excessive erosion but not flow targets)

Project Cost		Ease of O/M		Impervious Acres Managed (ac)		Channel Protection Volume (CPv)		Volume Infiltrated (ac-ft)		WQ Volume controlled (%)		Primary or Secondary BMP		Permitting Restrictions		Land Availability where BMP is located		Flood Mitigation		TMDL Flow Target Addressed (Q03, Q95)		Lake Champlain P TMDL addressed?		Other Benefits/Constraints		Annual Total Suspended Solids (TSS) Yield Mitigated (lbs.)		Annual Total Phosphorus (TP) Yield Mitigated (lbs.)	
Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
< $50	4	Underground	2	>10 acres	7	0.6-1.0 ac-f	5	>1 ac-ft.	3	>= 100% W	2	Primary	2	Minimal Issu	2	MS4 owned	4	Neighb	3	High/Low	3	Addressed	1	Infrastructu	1	>2000	5	<5	6
$50-100	3	Bioretention/Rain	1	5-10 acres	6	0.4-0.6 ac-f	4	0.5-1 ac-	2	>= 20 % W	1	Secondary	0	Complex issu	0	Public	3	Infrastr	2	High	2	Does not a	0	Provides tre	1	1500-2000	4	4-5	5
$100-1000	2	Ponds/Constructe	0	4-5 acres	5	0.2-0.4 ac-f	3	0.1- 0.5 a	1	Under 20%	0					Non MS4 owne	3	Nuisan	1	WQ	1			Educational,	1	1000-1500	3	3-4	4
> $1000	1			2-4 acres	4	>0.05-0.2 a	2	0	0							Non MS4 owne	2	None	0					Community	1	500-1000	2	2-3	3
				1-2 acres	3	>0-0.05 ac-	1									Unknown	0							Recreationa	1	<500	1	1-2	2
				0.5- 1 acre	2	0	0									Not City owned	-2							Natural Hab	1	<50	0	<1	1
				< 0.5 acre	1																			Outfall Erosi	1				
*in 1,000ths																								Erodible Soi	-1				
																								Uncertainty	-3				
																								High	-1				
																								Access Issue	-1				
																								Habitat loss	-1				

Ascending

ID #	Site ID	BMP Type
3	Fairview Dr./Main St. with Add-On	GW
4	Woodlands (Detention Pond 139)	UIB
1	Church LDS North P2 (Option 5)	USC
2	Fairview Dr./Main St.	GW
10	Densmore Dr.	UIB
11	Grove St.	UIB
6	Brickyard/North, South, East Creek Condos	DB
7	I-289/Route 15 North	MF
8	I-289/Route 15 South	MF
15	The Commons North Pond (P1)	USC
12	Countryside Dr Intersection	USC/GSI
5	East Creek Condominiums	DB
14	Church LDS South P1	USC
9	Essex Union High School-Rain Garden- Regrade Parking Lot	GSI
13	Briar Lane Cul-de-sac Impervious Removal	No Practice

	Decending
Retrofit Description	**Total Score**
Regrade existing detention area and add riser. Route outfall on North side of Fairfield Dr. to retrofit.	38.0
Retrofit existing detention pond to an infiltration practice if determined feasible.	38.0
Retrofit existing Detention Pond in front of LDS Church. Convert pond to underground detention chamber system. Route Essex Way and Inn at Essex runoff to retrofit.	34.0
Regrade existing detention area and add riser. Stabilize eroded outfall on North side of Fairfield Dr.	32.0
StormTech Chamber System on Densmore Dr. Verify high groundwater elevation.	32.0
StormTech Chamber System in Grove St ROW. High groundwater table 323'.	31.0
Retrofit existing detention area	27.0
Retrofit existing median swale with CPv volume control sand filter.	27.0
Retrofit existing median swale with CPv volume control sand filter.	27.0
Convert existing detention pond to a Storm-Tech chamber system.	26.0
Underground detention chamber at bottom of Countryside Dr is an option. Stabilize outfall and bank.	26.0
Expand Existing Detention Pond and retrofit outlet structure for CPv control.	25.0
Convert to underground detention system.	23.0
Regrade parking lot to increase capture. Garden has capacity for more runoff without expansion.	19.0
Eliminate Round-about to reduce Plowing needs. Small impact.	19.0

Indian Brook Flow Restoration Plan(FRP) Project
Task 4: Ranked BMPs Table
BMPs Ranked watershed-wide based on matrix of criteria

ID #	Site ID	BMP Type	Retrofit Description	Total Score
3	Fairview Dr./Main St. with Add-On	GW	Regrade existing detention area and add riser. Route outfall on North side of Fairfield Dr. to retrofit.	38
4	Woodlands (Detention Pond 139)	UIB	Retrofit existing detention pond to an infiltration practice if determined feasible.	38
1	Church LDS North P2 (Option 5)	USC	Retrofit existing Detention Pond in front of LDS Church. Convert pond to underground detention chamber system. Route Essex Way and Inn at Essex runoff to retrofit.	34
2	Fairview Dr./Main St.	GW	Regrade existing detention area and add riser. Stabilize eroded outfall on North side of Fairfield Dr.	32
10	Densmore Dr.	UIB	StormTech Chamber System on Densmore Dr. Verify high groundwater elevation.	32
11	Grove St.	UIB	StormTech Chamber System in Grove St ROW. High groundwater table 323'.	31
6	Brickyard/North, South, East Creek Condos	DB	Retrofit existing detention area	27
7	I-289/Route 15 North	MF	Retrofit existing median swale with CPv volume control sand filter.	27
8	I-289/Route 15 South	MF	Retrofit existing median swale with CPv volume control sand filter.	27
15	The Commons North Pond (P1)	USC	Convert existing detention pond to a Storm-Tech chamber system.	26
12	Countryside Dr Intersection	USC/GSI	Underground detention chamber at bottom of Countryside Dr is an option. Stabilize outfall and bank.	26
5	East Creek Condominiums	DB	Expand Existing Detention Pond and retrofit outlet structure for CPv control.	25
14	Church LDS South P1	USC	Convert to underground detention system.	23
9	Essex Union High School-Rain Garden-Regrade Parking Lot	GSI	Regrade parking lot to increase capture. Garden has capacity for more runoff without expansion.	19
13	Briar Lane Cul-de-sac Impervious Removal	No Practice	Eliminate Round-about to reduce Plowing needs. Small impact.	19

BMP Type: **DB**: Detention Basin, **USC**: Underground/Covered Storage Chamber, **UIB**= Underground Infiltration Basin, **IB**= Vegetated Infiltration Basin **GSI** = Smaller-scale GSI practice **DW=** Dry Wells, **GW=** Gravel Wetland *WQ = Addresses WQ issue (i.e. excessive erosion but not flow targets)

Table A-5-4 Total Phosphorus and TSS Reduction Benefits from Proposed BMPs

Site Name	MS4 Imp. Owner	Owner of BMP Land	BMP Type (Key[1])	Permit #[2]	Runoff Area (acres)	Impervious Acres Managed (ac)	Channel Protection Volume (CPv) Managed above Base Condition[3]		WQ Results				Retrofit Description
							CF	Ac-ft	Annual TSS Yield Mitigated w/ control (lbs)	% TSS reduction	Annual TP Yield Mitigated w/ control (lbs)	% TP Reduction	
LDS Church North Pond Retrofit (Outfall 204)- Option 5: Underground Storage with Perforated Pipe System	Town	Private	USC	1-1319, 2-0631, 2-0613	29.59	12.00	44431	1.02	576.00	20.7%	2.69	27.1%	Route outfalls North and South of LDS pond to retrofit. Option 5: Convert pond to expanded underground stone gallery with 48" Perforated Pipe.
Fairview Dr./Main St. w/ Add-On	Village/ VTRANS	Public	GW	1-1074 SN002	22.53	3.94	19384	0.45	887.00	30.2%	3.21	26.3%	Regrade existing detention area, add terraced WQ bays, and replace existing culvert. Stabilize eroded outfall on North side of Main St.
Fairview Dr. Add-on	Village/ VTRANS	Public	GW	1-1074 SN002	6.87	1.30	9583	0.22	1847.00	46.5%	4.01	41.3%	Install new culvert under Main St. to direct North side of Main St. to basin.
Brickyard/North, South, East Creek Condos	Village	Private	GW	2-0952	8.7	4.68	24960	0.57	234.00	8.6%	0.49	6.5%	Convert existing detention area at the corner of Mansfield/Brickyard to gravel wetland with CPv storage.
Woodlands (Detention Pond 139)	Town	Public	UIB	1-1186	32.80	4.04	15682	0.36	1502.00	86.0%	5.79	80.6%	Retrofit existing detention pond to an underground stone gallery with 48" perforated pipe.
Densmore Dr.	Village	Private	UIB	2-1103	38.28	11.73	14985	0.34	2126.00	100%	6.29	100%	Install StormTech Chamber System on Densmore Dr. Verify high groundwater elevation.
East Creek Condominiums	Village	Private	DB	2-0289/ 2-0317	48.2	14.40	13721	0.32	0.00	0.0%	0*	0.0%	Retrofit outlet structure for CPv control. Rearmour spillway.
The Commons P1 (Outfall 131)	Town	Private	USC	1-1381	7.91	2.07	8668	0.199	680.89	88.53	2.67	87%	Convert existing detention pond to StormTech chamber system. Improve aesthetics and landscaping.
Grove St.	Village/ VTRANS	ROW	UIB	2-0187	23.39	8.71	5576	0.13	1595.30	92%	2.34	80%	Install two underground storage basins in series for detention and infiltration of the CPv storm.
I-289/Route 15 North	Vtrans	ROW	MF	NP	2.78	0.90	5271	0.12	879.00	100%	1.99	100%	Retrofit existing median swale with CPv volume control sand filter.
Countryside Dr Intersection	Village	ROW	USC	2-0155	5.25	1.95	4704	0.11	411.31	88%	1.86	87%	Stabilize outfall and bank. Install underground detention chamber at intersection of Countryside Dr./Brickyard. Add Stormwater planters in ROW on Countryside Dr.
LDS Church South P1 (Outfall 209)	Town	Private	DB	1-1319	1.34	1.01	4400	0.101	494.07	92.07	0.65	92%	Retrofit existing detention pond to an underground stone gallery with 48" perforated pipe.
I-289/Route 15 South	Vtrans	ROW	MF	NP	2.15	0.96	4443	0.10	649.90	100%	1.82	100%	Retrofit existing median swale with CPv volume control sand filter.
Essex Union High School-Rain Garden- Regrade Parking Lot	Village	School District	GSI	NP	1.61	1.07	2222	0.05	13.34	99%	0.04	98%	Regrade parking lot to increase capture. Garden has capacity for more runoff without expansion.
Briar Lane Cul-de-sac Impervious Removal	Village	No Practic	No Practice	2-0855 (Village Knoll)	na	0.11	900	0.02	<20	----	0.00	----	Eliminate cul-de-sac to reduce plowing needs. Small impact.
					Total:	**68.86**		**4.11**					

1- BMP Type: DB: Detention Basin, USC = Underground Storage Chamber, UIB= Underground Inf
2- Key: * NP = No permit
3- Channel Protection Volume Managed above Base condition = New Storage Volume - Existing Volume pre2002
* WinSLAMM model result showed export of TP from wet pond (negative TP mitigated). Value was changed to 0, as there is "0" TP mitigated.

TOWN OF ESSEX SELECTBOARD
CHANGES TO TITLE 10.20, STORM WATER ORDINANCE

The Selectboard of the Town of Essex hereby ordains that the following changes be made to the Municipal Ordinance, Title 10.20, Storm Water Ordinance. Added material is underlined, with the exception that entire added chapter sub-sections shall be noted in the heading as "**added in entirety**". Deleted material is in brackets and struck through.

Add the following to Section 10.20.015, Definitions:

Added in Entirety:

"*Authorization to Discharge Permits*" means permits issued by the State of Vermont to discharge storm water into receiving water bodies, which may or may not be valid permits at time of adoption of Section 10.20.090 of this Ordinance.

"*Expired storm water permits*" means storm water permits previously issued by the State of Vermont that are no longer current.

"*Flow Restoration Plan (s)*" means a stream flow plan required by the State of Vermont designed to implement storm water runoff controls producing runoff characteristics that return stream flows to compliant, stable flow conditions as required to meet the water-quality based TMDL requirements for a particular impaired waterway.

"*Impaired waterways*" means rivers, lakes, or streams that do not meet one or more water-quality standards, and therefore are considered too polluted for their intended uses.

Non-impaired waterways" means rivers, lakes, or streams that currently meet the designated water-quality standards for the water body.

"*Non-public contributing storm water permittee*" means a current storm water permit holder, including homeowner associations and any successors or assigns, of either a valid or expired storm water permit that is not a public entity.

"*Non-public storm water infrastructure*" means storm water infrastructure not owned, operated or maintained by the Town.

"*Private (storm water) system owner*" means the non-public owner of a storm water system, including homeowner associations and any successors or assigns, consisting of, but not limited to, culverts, pipes, catch basins, treatment ponds, treatment devices, and/or storm water infiltration systems.

"*Public storm water infrastructure*" means storm water infrastructure such as, but not limited to, culverts, pipes, catch basins, treatment ponds, treatment devices, and/or storm water infiltration systems, all of which is under Town ownership or within Town

easements, and which infrastructure has been accepted by the Town as a component of the Town storm water system or systems.

"Residual Designation Authority (RDA) " means the authority granted to the United States Environmental Protection Agency and delegated to the State of Vermont to issue a permit directly to a party or parties discharging storm water to a water body where a TMDL supports such a determination and where discharges are contributing to water quality violations.

"Shared storm water system" means a storm water system such as, but not limited to, culverts, pipes, catch basins, treatment ponds, treatment devices, and/or storm water infiltration systems which consist of both public and non-public storm water infrastructure.

"*Unpermitted (storm water) discharges*" means a system discharging storm water to a stream or watercourse that has never been issued any type of authorization to discharge storm water by either the Town or the State of Vermont.

"Valid storm water system" means a system which has been issued a storm water permit by the Town or the State of Vermont that is current with respect to the issuance and expiration dates of the permit.

Revise Section 10.20.090 to delete reference to (~~Riparian Buffer Zones (Reserved for Future~~) and rename): Establishment and Transfer of Responsibility for State of Vermont issued Department of Environmental Conservation Authorization to Discharge Permits under General Storm Water Permits and for Unpermitted Discharges to Impaired Waterways within the Town of Essex, Inclusive of the Village of Essex Junction

Add Section 10.20.90: (**added in entirety**):

10.20.090 Establishment and Transfer of Responsibility for State of Vermont issued Department of Environmental Conservation Authorization to Discharge Permits under General Storm Water Permits and for Unpermitted Discharges to Impaired Waterways within the Town of Essex, Inclusive of the Village of Essex Junction (the "Town") to NPDES MS4 General Permit 3-9014.

A. The Vermont Agency of Natural Resources Department of Environmental Conservation ("DEC") issues Authorization to Discharge Permits under General Permits for area or site-specific storm water discharges to applicants, including municipalities, private parties, and shared storm water systems involving both privately-owned and publicly-owned components.

B. Valid storm water system discharge permits have been issued by the DEC for projects in the non-impaired and impaired waterways within the Town, and the Town has either accepted full responsibility for such permits in these waterways or shared permit responsibility based upon the percentage of impervious area contributed by the

publicly-owned component of the system in comparison to the impervious area contributed by the privately-owned component.

C. As of the adoption of this Ordinance, valid storm water system discharge permits have not been issued to expired storm water permit holders in the impaired waterways due to the inability to legally authorize, under State law, renewal of the previously issued Authorization to Discharge Permits.

D. Current responsibility for previously issued expired storm water permits and valid storm water system discharge permits in the impaired watersheds in the MS4 area varies widely. In some cases, there is a well-defined chain of responsibility from the "owner" of the original permit to the current permit holder. In other cases, permit responsibility is either poorly defined or non-existent notwithstanding that permit responsibility runs with the land. Some expired and valid (permit) discharges are defined in the original permit as directly to a stream or water body; in others, they are defined as being directed to or connected into a shared storm water system.

E. Pre-existing unpermitted storm water discharges occur within the impaired and non-impaired waterways. These discharges were either never issued permits or the discharges occurred before DEC began issuing discharge permits. Pre-existing unpermitted storm water discharges into impaired waterways may obtain legal coverage under the MS4 general permit in the manner outlined in this Ordinance.

F. The Village of Essex Junction ("Village") regulates storm water discharges through its Land Development Code. The Village intends to amend its Ordinances to incorporate the terms of this Town Ordinance, which is intended to apply to storm water discharges in the Town, inclusive of the Village. To the extent the terms of this Ordinance conflict with the Village Ordinance, the Town Ordinance governs.

G. For purposes of this Ordinance, the "appropriate legislative body" for the Town outside the Village shall be the Selectboard, and for the Village, the Board of Trustees. Either appropriate legislative body may delegate its authority under this Ordinance to an appropriate municipal panel.

10.20.091 General Approach and Purpose

A. The Town seeks to develop consistent policy and procedures for determination of storm water permit responsibility for both valid storm water system discharge permits and expired storm water permits, and to establish minimum requirements for transfer of expired and future new permit responsibility by and between the appropriate parties.

B. MS4 responsibility for operation, repair and maintenance of storm water infrastructure extends only to public storm water infrastructure and proportional shared

responsibility on shared storm water systems, and is separate and distinct from permit responsibility. The Town may accept permit responsibility if determined by the appropriate legislative body to be in the Town's best interests. Factors to be considered when determining whether acceptance of permit responsibility is in the Town's "best interests" include, but are not limited to, whether improved water quality is not otherwise obtainable without additional Town participation, potential cost savings to the Town, or provision of land or easements for treatment or storage of storm water for shared systems. The non-public contributing storm water permittee shall be responsible for the operation, maintenance, repair, replacement and upgrade of the non-public infrastructure, unless the Town determines that accepting some or all of this responsibility to be in its best interests as defined above.

10.20.092 NPDES Phase 2 MS4 Requirement for Expired Authorization to Discharge Permits

A. The Vermont Agency of Natural Resources (VANR) Authorization to Discharge Permit Number 7025-9014 issued to the Town and Authorization to Discharge Permit Number 7024-9014 issued to the Village under NPDES MS4 General Permit 3-9014 requires the Town and the Village, separately as MS4 permittees, to submit to the Secretary of VANR a plan for addressing expired storm water permits discharging to the MS4 permittee's system, which was accomplished through the proposed adoption of this Ordinance.

B. A compliance date of October 2015 is set within the Authorization to Discharge Permits for verification of the condition of all public and non-public storm water infrastructure identified in and approved under each original expired permit.

C. On expired permits within the impaired waterways or with regard to discharges that have no permits in the impaired waterways, it is the intent of the VANR to either have these permits ultimately come under the umbrella of the Town MS4 Permit or issue Residual Designation Authority (RDA) permits directly to each permittee or party responsible for the storm water discharge not covered under the MS4 umbrella permit.

10.20.093 Classification of Storm Water Systems within the Town as relates to Authorization to Discharge Permits

A. Due to the complexity and variety of existing permit "ownership" and types of permits, the Town has classified all valid storm water system discharge permits and all expired storm water permits into one of the following four types for purposes of determining permit responsibility:

1. Type 1 Storm Water System:

    a. A Type 1 storm water system consists of a system of storm water infrastructure that is entirely on public land (public rights of

way, municipally-owned property or on public storm water easements) and owned by the Town, including residential subdivisions or groups of houses with no non-public storm water infrastructure, such as privately-owned catch basins or privately-owned storm water pipelines connected into storm water systems on public land (excluding private underdrain systems). For purposes of this Ordinance, a "private underdrain system" is storm water infrastructure serving individual private lots or buildings from the private lot or building to the point of interconnection with public storm water infrastructure.

b. Examples of Type 1 storm water systems include:

1) Public buildings such as municipal offices, police stations, fire stations, municipal highway garage complexes, schools or other educational facilities with no on-site storm water infrastructure (other than underdrains connected with public storm water infrastructure) which do not discharge directly into a stream, and/or similar facilities.

2) Residential subdivisions with valid or expired permits in the Town. Those residential subdivisions presently identified by the Town as meeting the Type 1 criterion are listed in Table 1 in the Appendix to this Ordinance. Table 1 may be revised by the Town, acting through its Municipal Manager or their designee(s) as such additional systems are identified.

c. Type 1 storm water systems do not include any private lot, residential subdivision or groups of housing covered under an expired storm water permit that has non-public storm water infrastructure such as catch basins and pipelines (excluding private underdrain systems) connected into public storm water infrastructure.

2. Type 2 Storm Water System:

a. A Type 2 storm water system consists of a system of storm water infrastructure that is entirely contained on private property, discharges directly or indirectly to a stream or other recognized water body and is not directly connected by piping to a Type 1 or Type 3 storm water system.

b. Examples of Type 2 of storm water systems include:

1) Private residential, commercial or industrial systems that retain all storm water flows onsite as originally designed and

have valid or expired permits for such discharge, and private residential, commercial or industrial systems that discharge some or all of their storm water flows to a stream or other recognized water body.

2) Select storm water systems in the Town. Those private residential, commercial or industrial systems presently identified by the Town as meeting the Type 2 criterion are listed in Table 1 in the Appendix to this Ordinance. Table 1 may be revised by the Town, acting through its Municipal Manager or their designee(s) as such additional systems are identified.

3. Type 3 Storm Water System:

a. A Type 3 storm water system consists of a shared storm water system covered under either valid and/or expired storm water permits that combines storm water flow from both public and non-public storm water infrastructure before discharging storm water directly or indirectly into a stream, swale or other method of water conveyance to waters of the State.

b. Examples of Type 3 storm water systems include:

1) Non-public storm water infrastructure systems that discharge directly to public storm water infrastructure; public storm water infrastructure systems that discharge to non-public storm water infrastructure; public and non-public infrastructure systems that discharge to a common storm water pond or open swale on public or private property or to an outfall pipe leading to a stream, swale or other conveyance to a recognized water body; other systems that combine storm water flow from both public and non-public storm water infrastructure; prior valid storm water permits involving both public and non-public components covered under one issued permit with responsibility defined in the permit between public and non-public contributors to a storm water system.

2) Those combined public-private systems in the Town presently identified by the Town as meeting the Type 3 criterion are listed in Table 1 in the Appendix to this Ordinance. Table 1 may be revised by the Town, acting through its Municipal Manager or their designee(s) as such additional systems are identified.

4. Type 4 Storm Water System:

a. Any other type of storm water system not covered under Types 1 through 3.

b. Unique storm water systems with valid or expired storm water permits not included in Types 1 through 3 have not been identified as of the date of adoption of this Ordinance. This category is reserved for such systems.

c. Storm water systems involving both Town and Vermont Agency of Transportation (VTRANS) infrastructure.

d. Those combined public-private systems in the Town that are identified by the Town as meeting the Type 4 criterion will be listed in Table 1 in the Appendix to this Ordinance created by the Town, acting through its Municipal Manager. Table 1 may be revised by the Town, acting through its Municipal Manager or their designee(s) as additional systems are identified.

B. Prior to adoption of this section, the Town has not accepted full or shared permit responsibility for Authorization to Discharge permits within the impaired watersheds.

10.20.094 Methodology for Establishment of Permit Responsibility for Each Type of Storm Water System

A. Type 1 Storm Water Systems

1. The Town accepts responsibility for all valid Type 1 storm water system permits in the non-impaired waterways, all expired Type 1 storm water system permits in the impaired waterways, and all future Type 1 storm water system permits. These permits will be consolidated under the Town's NPDES MS4 General Permit 3-9014.

2. The Town accepts responsibility for the operation, maintenance, repair, replacement and upgrade of all public storm water infrastructure included in Type 1 storm water systems, with the exception of private underdrain systems and overland storm water flow systems from private lands such as driveways, open swales, and vegetated land. Such private underdrain systems and overland flow systems shall remain the responsibility of the property owner.

3. Acceptance of storm water permit responsibility by the Town does not relieve individual property owner(s) or housing and/or homeowner association(s), or any successor(s) and assign(s), from compliance with other sections of the Town's storm water ordinance or State

environmental regulations, including but not limited to sections dealing with illicit discharges, offsite discharge of sediment, site erosion, fertilizer application with respect to phosphorous and overall compliance with best storm water management practices as defined in adopted regulations or ordinances.

B. Type 2 Storm Water Systems

1. The Town shall have no responsibility for the operation, maintenance, repair, replacement or upgrade of non-public storm water infrastructure identified in a valid or expired storm water permit, or non-public storm water infrastructure added subsequent to the original version of a valid or expired permit, to meet an approved Flow Restoration Plan (FRP) unless it is determined by the appropriate legislative body, in its sole discretion, to be in the Town's best interests, as defined in Section 10.20.091.B above, to accept some or all of this responsibility.

2. The Town may accept MS4 permit responsibility for valid or expired Type 2 storm water system permits if requested by the current private storm water system owner and provided the following conditions are satisfied:

a. The private storm water system owner under an original valid or expired permit enters into a written agreement with the Town prior to January 1, 2015, which includes, at a minimum, the requirements set forth in section 10.20.094.b, below. A form of the Type 2 Storm Water System Agreement is provided in Appendix B to this Ordinance. If the private storm water system owner has not entered into a written agreement with the Town by January 1, 2015, the Town will request the State to use its RDA to require permit compliance by the holder of the expired Type 2 storm water permit.

b. The written agreement specified in section 10.20.094.a shall, at a minimum, require the following:

i. All applicable permit fees, including initial fees and all future renewal fees, if any such fees are required, shall be paid by the Type 2 private storm water system owner;

ii. The Type 2 private storm water system owner shall allow the Town to hire a professional engineer, at no cost to the holder of the Type 2 storm water permit, to inspect and certify that the Type 2 non-public storm water infrastructure is in compliance with the infrastructure requirements as contained in the expired permit. The certification shall occur prior to August 1, 2015. Alternatively, the

current holder of the expired non-public storm water permit may hire a professional engineer, acceptable to the Town, to perform the necessary inspection and certification. Future inspections that occur after the initial certification inspection of Type 2 non-public storm water infrastructure shall be conducted by the Town at no charge to the private storm water system owner;

iii. The Type 2 non-public contributing storm water permittee shall correct any deficiencies noted as a result of the engineer's inspection at their own expense prior to the August 1, 2015 date for system certification;

iv. The Type 2 non-public contributing storm water system permittee shall be responsible for permanent maintenance, repair, replacement and upgrade if necessary of all elements covered under the Type 2 storm water system permit. The Town shall conduct annual system compliance inspections to verify the condition and maintenance of the Type 2 storm water system and report findings to the State and the responsible party identified under the Type 2 storm water system permit;

v. The Type 2 non-public contributing storm water system permittee shall sweep clean all paved private roadways or parking lots at least twice per year and clean out all private catch basins whenever the depth of deposited material exceeds 50% of the depth of the catch basin sump, or enter into an agreement with the Town to perform the services for a fee;

vi. The failure of the Type 2 non-public contributing storm water system permittee to perform the required actions under b. iv. and v. shall be deemed a violation of this Ordinance and shall subject the non-public contributing storm water system permittee to penalties under section 10.20.112. The Town has the right but not the obligation to take the necessary actions to insure that the required maintenance is performed and otherwise correct any violation of this Ordinance. The provisions of section 10.20.116 of this Ordinance shall apply in the event the costs for the maintenance or correcting the violation are not paid by the non-public contributing storm water system permittee; and

vii. The cost of required storm water system upgrades to the Type 2 storm water system to meet the Town's adopted and State approved FRP shall be borne by the non-public contributing storm water system permittee unless it is determined by the Town to be in

its best interests as defined in Section 10.20.091.B above to participate in some or all of the system upgrade project or project costs.

3. Any prior written agreements entered into by the Town and non-public contributing storm water system permittees shall remain in full force with respect to cost sharing and operation, maintenance, repair and replacement of existing storm water infrastructure.

a. Permit responsibility and upgrades to meet the FRP are separate elements of storm water responsibility not defined in previous agreements and therefore this Ordinance is the controlling document relative to permitting.
b. In the event of any conflict between pre-existing agreements and the ordinance, the pre-existing agreements shall control.

4. Acceptance of partial storm water permit responsibility by the Town shall not relieve non-public contributing storm water system permittees from compliance with all other elements of the storm water ordinance or State environmental regulations, including but not limited to sections dealing with illicit discharges, offsite discharge of sediment, site erosion, fertilizer application with respect to phosphorous and overall compliance with best storm water management practices as defined in adopted regulations or ordinances.

C. Type 3 Storm Water Systems

1. The Town will <u>not</u> accept responsibility for operation, maintenance, repair, replacement and upgrade to meet an approved FRP of <u>non-public storm water infrastructure</u> identified in a valid or expired storm water permit or <u>non-public storm water infrastructure added subsequent to the original version of the valid or expired permit,</u> unless it is determined by the appropriate legislative body, in its sole discretion, to be in the best interests of the Town, as defined in Section 10.20.091.B above, to accept some or all of this responsibility.

2. The Town will accept MS4 permit responsibility on a proportional basis by relative impervious area contributed within the permitted area of the shared storm water system for the valid or expired Type 3 storm water system permit if requested by the non-public contributing storm water system permittee <u>and</u> provided the following conditions are satisfied:

a. The Type 3 non-public contributing storm water permittee shall enter into a written agreement with the Town prior to January 1, 2015, which includes, at a minimum, the requirements set forth in

section 10.20.094.b.i-vii above. A form of the Type 3 Storm Water System Agreement is provided in Appendix C to this Ordinance. If the non-public contributing storm water system permittee has not entered into a written agreement by January 1, 2015, the Town will request the State to use its RDA to require permit compliance by the Type 3 non-public contributing storm water system permittee.

b. If the Type 3 non-public contributing storm water system permittee elects not to enter into a shared agreement with the Town on MS4 permit responsibility, the Town shall comply with the requirements pertaining to the public storm water infrastructure, and may request the State to use its RDA over that portion of the shared storm water system not included within an agreement with the Town.

c. All applicable permit fees, including initial fees and all future renewals, if such fees are required, shall be shared between the municipality and the non-public contributing storm water permittee on the basis of relative impervious area, unless the appropriate legislative body determines that it is in the Town's best interests, as defined in Section 10.20.091.B above, that such fees shall be paid either on a larger percentage than relative impervious area or in full by the Town. If the Town accepts permit responsibility, then the intent is to consolidate the permit under the municipal NPDES MS4 General Permit 3-9014.

3. Any prior written agreements entered into by the Town and the Type 3 non-public contributing storm water system permittee shall remain in full force with respect to cost sharing and operation, maintenance, repair and replacement of existing storm water infrastructure.

a. Permit responsibilities and upgrades to meet the FRP are separate elements of storm water responsibility not defined in previous agreements and therefore this Ordinance is the controlling document relative to these issues.

b. In the event of any conflict between executed pre-existing agreements and this Ordinance, the pre-existing agreements shall control.

4. Acceptance of MS4 Permit responsibility by the Town does not relieve non-public contributing storm water system permittees from compliance with other elements of the Town's storm water ordinance or State environmental

regulations, including but not limited to sections dealing with illicit discharges, offsite discharge of sediment, site erosion, fertilizer application with respect to phosphorous and overall compliance with best storm water management practices as defined in adopted regulations or ordinances.

D. Type 4 Storm Water Systems

1. Other storm water systems with valid or expired storm water permits that do not qualify as a Type 1, 2, or 3 storm water system.

2. These systems shall be managed on a case by case basis, using the general procedures and methods as applicable from the three system types.

3. Permits involving the Town and VTRANS shall fall under this category. VTRANS is a separate MS4 permittee. Under a future adopted FRP for each impaired waterway, the Town will negotiate an agreement with VTRANS on the level of shared responsibility and costs for meeting the TMDL requirement of each impaired waterway. In the event an agreement cannot be negotiated with VTRANS, the Town will request VANR to use its RDA with respect to those VTRANS direct or indirect discharges contributing storm water flow to the impaired watersheds under the VTRANS MS4 permit.

APPENDIX A

Table 1: Valid and Expired Storm Water Permits in the Village of Essex Junction and the Town of Essex outside the Village as of the Date of Ordinance Adoption

Permit #	Old Permit #	Village or Town	Project Name	Valid (V) or Expired (E)	Ordinance Type	Watershed
2-0855		Village	Village Knoll-Woods End & Acorn	Valid	Type 1	Indian Brook
2-1103		Village	Pleasant Street & East Street	Valid	Type 1	Indian Brook
1-1074		Village	Countryside II Fairview Farms: Chestnut Lane	Expired	Type 2	Indian Brook
1-1074		Village	Countryside II Fairview Farms: Spruce Lane	Expired	Type 2	Indian Brook
1-1074		Village	Countryside II Fairview Farms: Walnut Lane	Expired	Type 2	Indian Brook
2-0835		Village	Village Glen Condos	Expired	Type 2	Indian Brook
1.1527.0111		Village	Highland Village	Expired	Type 2	Sunderland Brook
1-0236		Village	Brickyard	Expired	Type 2 & 3	Indian Brook
1-1074		Village	Countryside II Fairview Farms: Locust Lane	Expired	Type 3	Indian Brook
2-0863		Village	167 Pearl Street (McEwing)	Expired	TBD	Sunderland Brook
2-0633		Town	Shillingford Crossing	Expired	Type 1	Sunderland Brook
3575-9010.R	1-1186	Town	Woodlands I	Valid	Type 1	Alder Brook
1-0667		Town	Woodlands I	Expired	Type 1	Indian Brook
3577-9010.R	1-0667	Town	Woodlands II/Lang Farm Parcel H	Valid	Type 1	Alder Brook

1-0250		Town	Kimberly Drive	Expired	Type 1	Sunderland Brook
3578-9010.R	1-0612 2-0752	Town	Pinewood Development	Valid	Type 1	Winooski River /Alder Brook
3581-9010.R		Town	Heritage Phase II	Valid	Type 1	Alder Brook
3579-9010.R		Town	Old Stage Village	Valid	Type 1	Alder Brook
3580-9010.R		Town	Rivers Bend	Valid	Type 1	Winooski River
3201-9010.R		Town	Pinewood Section G	Valid	Type 1	Winooski River
3267-9010.R		Town	Saybrook	Valid	Type 1	Alder Brook
4367-9010.R		Town	Autumn Knoll	Valid	Type 1	Browns River
3996-9010		Town	Town Swimming Pool Complex	Valid	Type 1	Alder Brook
2-0631		Town	Essex Resort and Spa	Expired	Type 2	Indian Brook
1-1463		Town	VT Systems, Inc.	Expired	Type 2	Sunderland Brook
1-0965		Town	#7 Ewing Place	Expired	Type 2	Sunderland Brook
1-0518		Town	#3 Ewing Place	Expired	Type 2	Sunderland Brook
1-0619		Town	#26 Susie Wilson Road	Expired	Type 2	Sunderland Brook
2-0634		Town	#26 Susie Wilson Road	Expired	Type 2	Sunderland Brook
1-1319		Town	Church of Latter Day Saints	Expired	Type 2	Indian Brook
1-1371		Town	Why Not LLC (Lang Farm Golf Course)	Expired	Type 2	Indian Brook
3324-9010.R		Town	Meadows Edge	Valid	Type 3	Alder Brook
3574-9010.R	1-0730	Town	Forestdale	Valid	Type 3	Winooski River /Alder Brook
3081-9010.R		Town	Perkins Bend	Valid	Type 3	Winooski River

1-1381		Town	The Commons at Essex Way	Expired	Type 3	Indian Brook
1-1307		Town	Homestead Design	Expired	Type 3	Indian Brook
1-0775		Town	The Outlets and Hannafords	Expired	Type 3	Indian Brook
2-0613		Town	The Outlets and Hannafords	Expired	Type 3	Indian Brook
1-1469		Town	Mainstay Suites	Expired	Type 3	Sunderland Brook
1-0552		Town	The Market Place	Expired	Type 3	Sunderland Brook
1-0896		Town	Yankee Enterprises, Oil #1 LLC, Bradley, Oil Annex, Patco Properties	Expired	Type 3	Sunderland Brook
1-0761		Town	Ewing	Expired	Type 3	Sunderland Brook
1-0694		Town	Ewing	Expired	Type 3	Sunderland Brook

Appendix B

TYPE 2 STORM WATER SYSTEM AGREEMENT

This STORM WATER SYSTEM AGREEMENT ("Agreement") is made this _____ day of _____ 20___ by and between the [Village of Essex Junction] [Town of Essex], a Vermont municipal corporation with a principal place of business at [Village address] [81 Main Street], Essex, Vermont 05452 (the ["Town"] ["Village"]), and _____ with a principal place of business at _____ ("Permittee"). The [Town] [Village] and Permittee are sometimes each referred to in this Agreement as a "Party" or collectively as the "Parties."

WITNESSETH:

WHEREAS, the [Town has adopted an amendment to its Storm Water Ordinance] [Village has adopted an amendment to its Village Ordinance , incorporating Section 10.20.90 of the Town Storm Water Ordinance] entitled Establishment and Transfer of Responsibility for State of Vermont issued Department of Environmental Conservation Authorization to Discharge Permits under General Storm Water Permits and for Unpermitted Discharges to Impaired Waterways within the Town of Essex, Inclusive of the Village of Essex Junction; and

WHEREAS, the Storm Water Ordinance amendment identifies the requirements under section 10.20.094.B necessary for the [Town] [Village] to accept storm water permit responsibility for a valid or expired Type 2 storm water permit, as such type is defined in the Ordinance Amendment; and

WHEREAS, Permittee has identified that it is in their best interests to have the [Town] Village] accept storm water permit responsibility by entering into this Agreement; and

WHEREAS, it is in the best interests of the Parties to work together to achieve State of Vermont storm water permit compliance; and

WHEREAS, the Parties agree that the [Town] [Village] has no responsibility for the operation, maintenance, repair, replacement or upgrade of all non-public storm water or storm water–related infrastructure, or non-public storm water infrastructure added to the original version of a valid or expired storm water permit; and

WHEREAS, the [Town] [Village] may in its sole discretion, if determined by the legislative body to be in its best interests, to accept some or all of the operation, maintenance, repair, replacement or upgrade of all non-public storm water or storm water–related infrastructure, at some future date;

NOW, THEREFORE, in consideration of the matters described above, and of the mutual benefits and obligations set forth in this Agreement, and on the express condition that all conditions precedent described below are satisfied, the Parties agree as follows:

SECTION ONE
[TOWN] [VILLAGE] OBLIGATIONS

The [Town] [Village] agrees to accept full or shared permit responsibility for valid or expired storm water system permits as follows and also shall:

1. Hire a professional engineer, at no cost to Permittee, to inspect and certify that the Type 2 storm water system, including but not limited to catch basins, storm pipes, and treatment facilities, is in compliance with the infrastructure requirements as contained in the expired permit, unless such work is undertaken at no cost to the [Town] [Village] by Permittee. The certification shall occur prior to August 1, 2015.

2. Conduct future inspections that occur after the initial certification inspection of Type 2 storm water systems at no charge to the Permittee.

3. Conduct annual system compliance inspections to verify the condition and maintenance of the Type 2 storm water system and report findings to the State and the Permittee.

4. Inspect and prepare an annual structural condition survey and extent of debris capture in all catch basins contributing storm water flow within the permitted area.

5. At the request of Permittee, arrange for cleaning of non-public catch basins, and to bill such cleaning costs to the Permittee.

6. Make best efforts to minimize the impact on the Permittee's property and their business operations thereon in performing its obligations under this Agreement.

SECTION TWO
PERMITTEE OBLIGATIONS

Permittee shall:

1. Accept all responsibility for the operation, maintenance, repair, replacement or upgrade of non-public storm water infrastructure identified in a valid or expired storm water permit, or non-public storm water infrastructure added subsequent to

the original version of a valid or expired permit, to meet an approved Flow Restoration Plan (FRP) unless it is determined by the appropriate legislative body, in its sole discretion, to be in the [Town's] [Village's] best interests, as defined in Section 10.20.091.B above, to accept some or all of this responsibility.

2. To pay all applicable permit fees, including initial fees and all future renewal fees, if any such fees are required of the Type 2 storm water system.

3. Hire a professional engineer, at no cost to the [Town] [Village], to inspect and certify that the Type 2 storm water system, including but not limited to catch basins, storm pipes, and treatment facilities, is in compliance with the infrastructure requirements as contained in the expired permit, unless Permittee requests such work be performed by the [Town] [Village]. The certification shall occur prior to August 1, 2015.

4. Correct any deficiencies identified in the engineer's storm water system inspection at their own expense prior to the August 1, 2015 date for system certification.

5. Maintain, repair, replace and upgrade as necessary all storm water infrastructure covered under the Type 2 storm water system permit.

6. Sweep clean all paved private roadways or parking lots at least twice per year and clean out all private catch basins whenever the depth of deposited material exceeds 50% of the depth of the catch basin sump, or enter into an agreement with the Town to perform the services for a fee.

7. Bear all costs of required storm water system upgrades (if needed) to the Type 2 storm water system to meet the [Town's] [Village's] adopted and State approved FRP unless it is determined by the [Town] [Village] to be in its best interests as defined in Section 10.20.091.B of the Town's Storm Water Ordinance [as adopted by Village's Land Development Code] to participate in some or all of the system upgrade project or project costs.

8. Comply with all other elements of the Storm Water Ordinance or State environmental regulations, including but not limited to sections dealing with illicit discharges, offsite discharge of sediment, site erosion, fertilizer application with respect to phosphorous and overall compliance with best storm water management practices as defined in adopted regulations or ordinances.

9. Perform any necessary structural repairs to any non-public storm water infrastructure beyond the annual routine maintenance within at least six (6) months of discovery of such needed structural repair or, if not repaired within six months of discovery, reimburse the [Town] [Village] for all its costs for such catch basin repair plus a ten percent (10%) surcharge for associated administrative expenses relating to such repair.

10. Indemnify, defend and hold harmless the [Town] [Village] and its officers, employees, agents, and representatives for and from any claims for liability and or damages arising out of the [Town's] [Village's] performance of the required annual operations and maintenance and required testing of the storm water infrastructure, including all catch basins and pipes, that may occur on Permittee's property, except to the extent such claims (a) arise from the gross negligence or intentional misconduct of the [Town] [Village] or its employees, agents or contractors, or (b) are covered by insurance carried by the [Town] [Village], its agents or contractors.

SECTION THREE
MISCELLANEOUS

1. The [Town] [Village] will notify Permittee at such time as the FRP for the watershed in which the property lies is adopted as to any obligations of Permittee to make on-site storm water improvements as required under the FRP.

2. All payments required under this Agreement shall be due upon receipt of an invoice. Any payments not made within thirty (30) days of their due date shall accrue interest at a rate of one percent (1%) per month on the past due amount until paid in full.

3. The Parties covenant and agree that the conditions and obligations under this Agreement shall run with the land, and shall accrue to the benefit of and be binding upon their respective successors and assigns as if they were parties to this Agreement. Any payments required under this Agreement not made when due shall constitute a lien on property of the Party failing to make payment, and shall be collectible in the same fashion as unpaid property taxes.

4. In the event a Party resorts to the judicial process to enforce another Party's obligations hereunder, the prevailing Party shall be entitled to recover its reasonable attorneys' fees.

5. This Agreement shall be interpreted consistent with and governed by the laws of the State of Vermont.

6. This Agreement consists of the entire understanding between the Parties relative to its subject matter, and may not be modified orally, but only by a written instrument signed by all Parties.

IN WITNESS WHEREOF, the Parties have caused their corporate seal to be affixed hereto and these premises to be signed in its name and on its behalf by its duly authorized agent as of the day and date first written above.

_____, VERMONT

_____ BY: _____
Witness Duly Authorized Agent

_____

_____ BY: _____
Witness Duly Authorized Agent

STATE OF VERMONT)
) **SS.**
COUNTY OF CHITTENDEN)

At Essex in said County this ____ day of _____, A.D., ____, personally appeared _____ duly authorized officer of _____, and he acknowledged this instrument, by him sealed and subscribed to be his free act and deed and the free act and deed of the [Town of Essex] [Village of Essex Junction].

Before me,

_____
Notary Public
My Commission Expires: _____

STATE OF VERMONT)
)
COUNTY OF CHITTENDEN)

SS.

At Essex in said County this ____ day of _____, A.D., ____, personally appeared _____ duly authorized officer of _____, and he/she acknowledged this instrument, by him/her sealed and subscribed to be his/her free act and deed and the free act and deed of _____.

Before me,

_____
Notary Public
My Commission Expires: _____

Appendix C

TYPE 3 STORM WATER SYSTEM AGREEMENT

This STORM WATER SYSTEM AGREEMENT ("Agreement") is made this _____ day of _____ 20___ by and between the [Village of Essex Junction] [Town of Essex], a Vermont municipal corporation with a principal place of business at [Village address] [81 Main Street], Essex, Vermont 05452 (the ["Town"] ["Village"]), and _____ with a principal place of business at _____("Permittee"). The Town and Permittee are sometimes each referred to in this Agreement as a "Party" or collectively as the "Parties." (***NOTE: May be multiple parties to sign***)

WITNESSETH:

WHEREAS, the [Town has adopted an amendment to its Storm Water Ordinance] [Village has adopted an amendment to its Village Ordinance , incorporating Section 10.20.90 of the Town Storm Water Ordinance] entitled Establishment and Transfer of Responsibility for State of Vermont issued Department of Environmental Conservation Authorization to Discharge Permits under General Storm Water Permits and for Unpermitted Discharges to Impaired Waterways within the Town of Essex, Inclusive of the Village of Essex Junction; and

WHEREAS, the Storm Water Ordinance amendment identifies the requirements in section 10.20.094.C necessary for the [Town] [Village] to accept shared or full storm water permit responsibility for a valid or expired Type 3 storm water permit, as such type is defined in the Ordinance Amendment; and

WHEREAS, Permittee (***NOTE: May be multiple parties)*** has identified that it is in their best interests to have the [Town] [Village] accept storm water permit responsibility by entering into this agreement; and

WHEREAS, it is in the best interests of the Parties to work together to achieve State of Vermont storm water permit compliance; and

WHEREAS, the Parties agree that the [Town] [Village] has no responsibility for the operation, maintenance, repair, replacement or upgrade of all non-public storm water or storm water–related infrastructure, or non-public storm water infrastructure added to the original version of a valid or expired storm water permit and shared responsibility on storm water systems consisting of both public and non-public infrastructure; and

WHEREAS, the [Town] [Village] may in its sole discretion, if determined by its legislative body to be in the [Town's] [Village's] best interests, to accept some or all of the operation, maintenance, repair, replacement or upgrade of all non-public storm water or storm water–related infrastructure, at some future date;

NOW, THEREFORE, in consideration of the matters described above, and of the mutual benefits and obligations set forth in this Agreement, and on the express condition that all conditions precedent described below are satisfied, the Parties agree as follows:

SECTION ONE.
[TOWN] [VILLAGE] OBLIGATIONS

The Town agrees to accept full or shared permit responsibility on a proportional basis by relative impervious area contributed by the public and non-public storm water infrastructure within the permitted area for valid or expired storm water system permits. The relative impervious area has been agreed as follows: [Town] [Village] __%; Permittee __%. The [Town] [Village] also shall:

1. Hire a professional engineer, at no cost to the Permittee, to inspect and certify that the Type 3 storm water system, including but not limited to catch basins, storm pipes, and treatment facilities, is in compliance with the infrastructure requirements as contained in the expired permit, unless such work is undertaken at no cost to the [Town] [Village] on non-public storm water infrastructure by Permittee. The certification shall occur prior to August 1, 2015.

2. Conduct future inspections that occur after the initial certification inspection of Type 3 storm water systems at no charge to the Permittee.

3. Conduct annual system compliance inspections to verify the condition and maintenance of the Type 3 storm water system and report findings to the State and the Permittee.

4. Inspect and prepare a structural condition survey and extent of debris capture in all catch basins contributing storm water flow within the permitted area.

5. At the request of Permittee, arrange for cleaning of non-public catch basins, and to bill such cleaning costs to the Permittee.

6. Make best efforts to minimize the impact on any Permittee's property and their business operations thereon in performing its obligations under this Agreement.

SECTION TWO
PERMITTEE OBLIGATIONS

Permittee (***NOTE: May be multiple parties)*** shall:

1. Accept all responsibility for the operation, maintenance, repair, replacement or upgrade of non-public storm water infrastructure identified in a valid or expired storm water permit, or non-public storm water infrastructure added subsequent to the original version of a valid or expired permit, or their portion of a shared storm water system to meet an approved Flow Restoration Plan (FRP) unless it is determined by the appropriate legislative body, in its sole discretion, to be in the [Town's] [Village's] best interests, as defined in Section 10.20.091.B of the Storm Water Ordinance to accept some or all of this responsibility.

2. Pay their proportionate share of all applicable permit fees, including initial fees and all future renewal fees, if any such fees are required of the Type 3 storm water system, and

3. Hire a professional engineer, at no cost to the [Town] [Village], to inspect and certify that the non-public or shared portion of the Type 3 storm water system, including but not limited to catch basins, storm pipes, and treatment facilities, is in compliance with the infrastructure requirements as contained in the expired permit, unless Permittee requests such work be performed by the [Town] [Village]. The certification shall occur prior to August 1, 2015.

4. Correct any deficiencies on the non-public portion of the storm water system identified by the engineer's storm water system inspection at their own expense prior to the August 1, 2015 date for system certification.

5. Maintain, repair, replace and upgrade as necessary all non-public storm water infrastructure and to share responsibility for portions of shared storm water systems covered under the Type 3 storm water system permit according to the percentages identified above.

6. Sweep clean all paved private roadways or parking lots at least twice per year and clean out all private catch basins whenever the depth of deposited material exceeds 50% of the depth of the catch basin sump on non-public private storm water infrastructure or enter into an agreement with the [Town] [Village] to perform such services for a fee.

7. Bear the cost of required storm water system upgrades on non-public portions of the shared storm water systems and to share in the costs of all shared elements of the storm water system (if needed) to the Type 3 storm water system to meet the [Town's] [Village's] adopted and State approved FRP according to the percentages identified above unless it is determined by the [Town] [Village] to be in its best interests as defined in Section 10.20.091.B of the Town's Stormwater

Ordinance to participate in some or all of the system upgrade project or project costs.

8. Comply with all other elements of the Storm Water Ordinance or State environmental regulations, including but not limited to sections dealing with illicit discharges, offsite discharge of sediment, site erosion, fertilizer application with respect to phosphorous and overall compliance with best storm water management practices as defined in adopted regulations or ordinances.

9. Perform any necessary structural repairs to any non-public storm water infrastructure beyond the annual routine maintenance within at least six (6) months of discovery of such needed structural repair or, if not repaired within six (months) of discovery, reimburse the [Town] [Village] for all its costs for such catch basin repair plus a ten percent (10%) surcharge for associated administrative expenses relating to such repair; and share in such costs on shared elements of the storm water system according to the percentages identified above.

10. To indemnify, defend and hold harmless the [Town] [Village] and its officers, employees, agents, and representatives for and from any claims for liability and or damages arising out of the [Town's] [Village's] performance of the required annual operations and maintenance and required testing of the storm water infrastructure, including all catch basins and pipes, that may occur on Permittee's property, except to the extent such claims (a) arise from the gross negligence or intentional misconduct of the [Town] [Village]or its employees, agents or contractors, or (b) are covered by insurance carried by the [Town] [Village], its agents or contractors.

SECTION THREE
MISCELLANEOUS

1. The [Town] [Village] will notify Permittee at such time as the FRP for the watershed in which the property lies is adopted as to any obligations of Permittee to make on-site storm water improvements as required under the FRP.

2. All payments required under this Agreement shall be due upon receipt of an invoice. Any payments not made within thirty (30) days of their due date shall accrue interest at a rate of one percent (1%) per month on the past due amount until paid in full.

3. The Parties covenant and agree that the conditions and obligations under this Agreement shall run with the land, and shall accrue to the benefit of and be binding upon their respective successors and assigns as if they were parties to this

Agreement. Any payments required under this Agreement not made when due shall constitute a lien on property of the Party failing to make payment, and shall be collectible in the same fashion as unpaid property taxes.

4. In the event a Party resorts to the judicial process to enforce another Party's obligations hereunder, the prevailing Party shall be entitled to recover its reasonable attorneys' fees.

5. This Agreement shall be interpreted consistent with and governed by the laws of the State of Vermont.

6. This Agreement consists of the entire understanding between the Parties relative to its subject matter, and may not be modified orally, but only by a written instrument signed by all Parties.

IN WITNESS WHEREOF, the Parties have caused their corporate seal to be affixed hereto and these premises to be signed in its name and on its behalf by its duly authorized agent as of the day and date first written above.

[VILLAGE OF ESSEX JUNCTION] [TOWN OF ESSEX], VERMONT

_____
Witness

BY:_____
Duly Authorized Agent

PERMITTEE

_____
Witness

BY:_____
Duly Authorized Agent

STATE OF VERMONT)
) **SS.**
COUNTY OF CHITTENDEN)

At Essex in said County this ____ day of _____, A.D., ____, personally appeared _____ duly authorized officer of _____, and he

acknowledged this instrument, by him sealed and subscribed to be his free act and deed and the free act and deed of the [Town of Essex] [Village of Essex Junction].

Before me,

_____

Notary Public
My Commission Expires: _____

TOWN OF ESSEX SELECTBOARD
CHANGES TO TITLE 10.20, STORM WATER ORDINANCE
Inclusive of Appendix A, B and C:

Adopted this 18th day of August 2014 by the Town of Essex Selectboard.

Max Levy , Chair

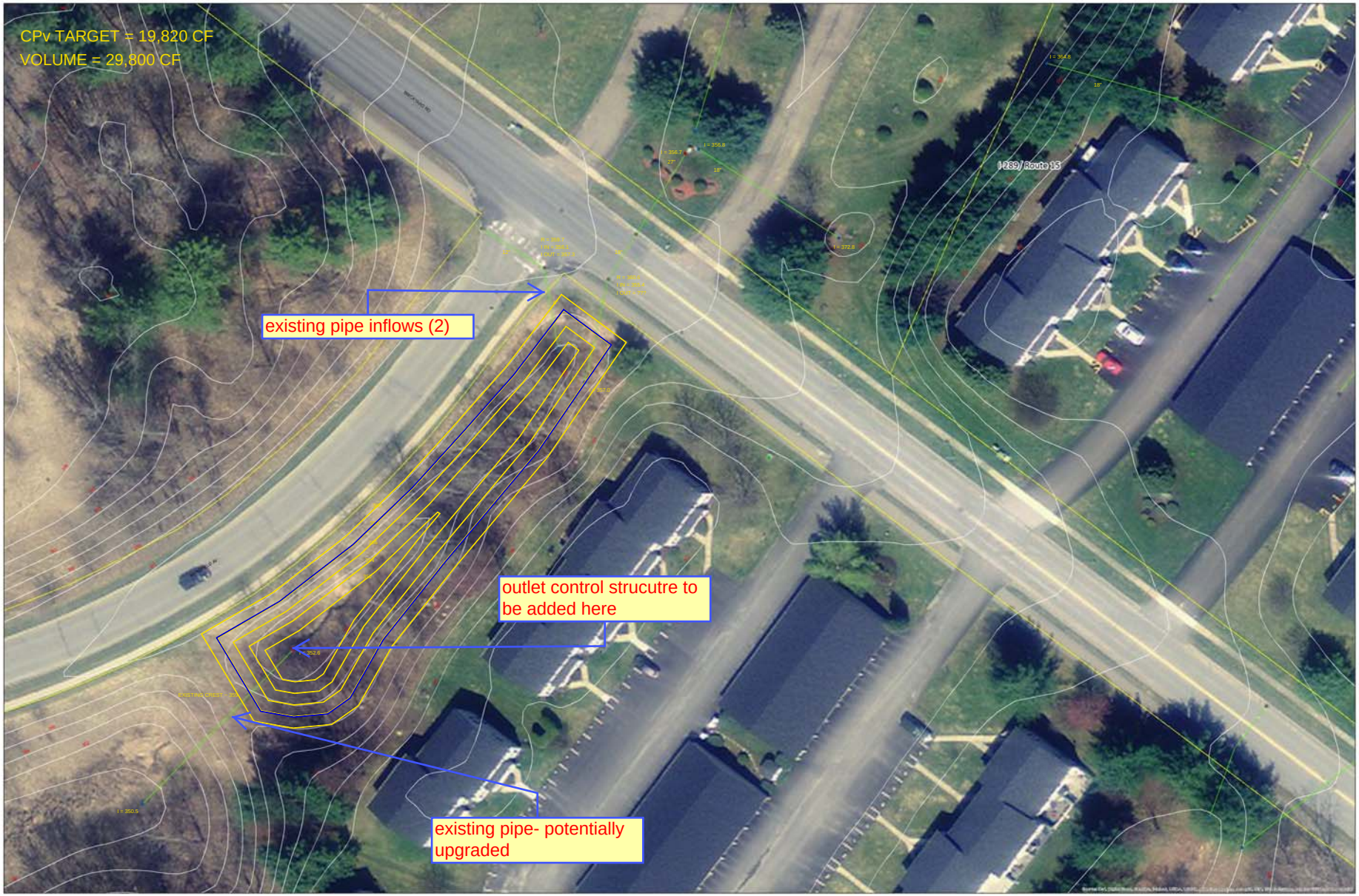
Brad M. Luck, Vice Chair

Andy J. Watts, Clerk

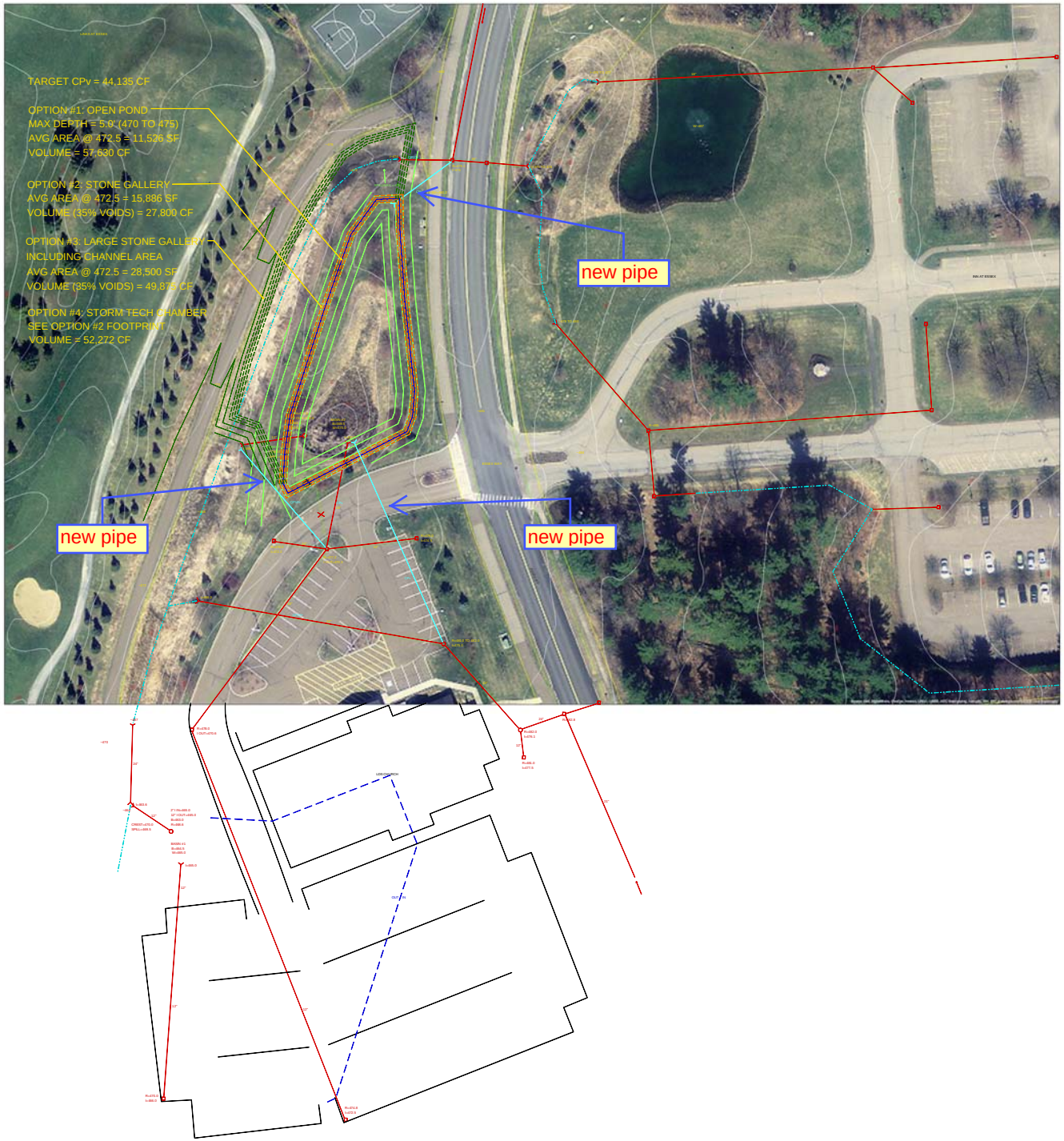
Irene Wrenner

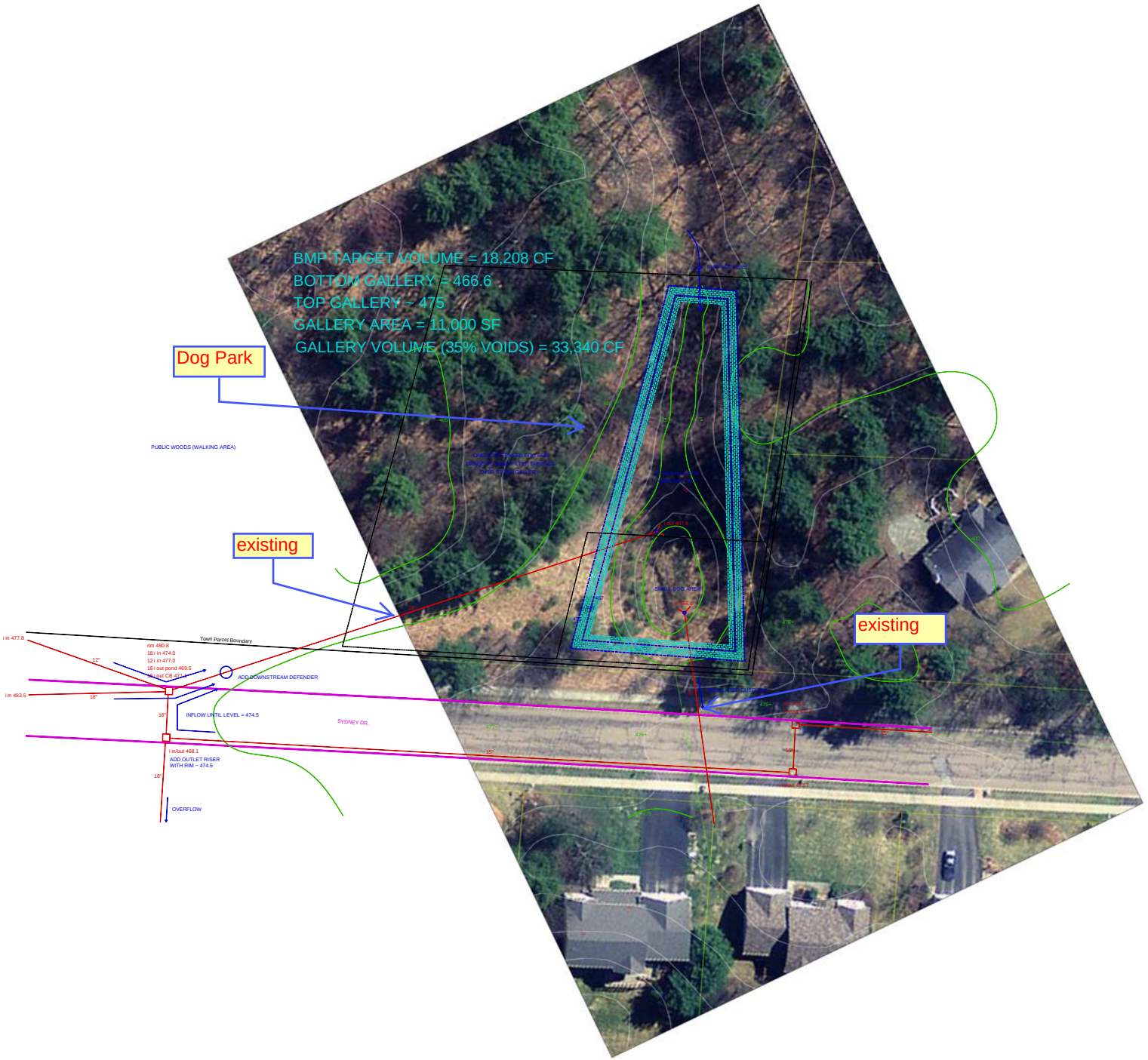
R. Michael Plageman

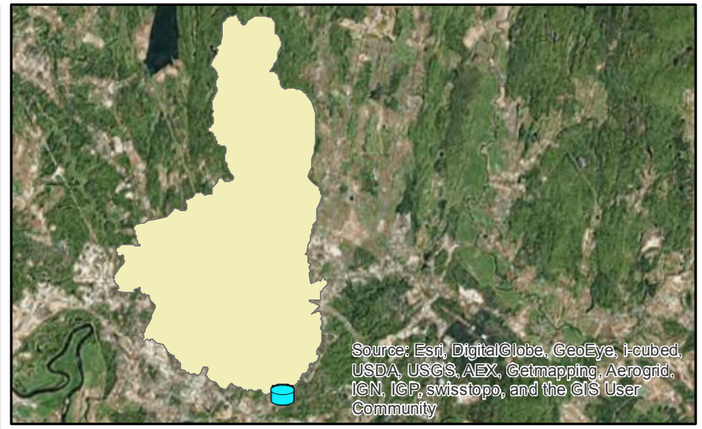
Received for Record by Essex Town Clerk this 22nd day of Oct 2014.


CPv TARGET = 19,820 CF
VOLUME = 29,800 CF
existing pipe inflows (2)
outlet control strucutre to be added here
existing pipe- potentially upgraded
I 289/ Route 15


CPv Target = 27,748 CF
5.0 Depth (381.2 to 386.2)
37,900 CF SHOWN
QP100 Target = 110,250 CF
With 30" Outlet Pipe &
Maximum Basin w/ 3:1 Slopes
5.0 Depth (381.2 to 386.2)
83,000 CF Possible
16,600 SF @384
new pipe
existing pipe upgrade
Rim=399.0
i out=394.5
Rim=392.7
i out=390.3
i out=388.7
Rim=381.2
i out=381.8
Rim=387.2
12"
30"
WQv
CPv & QP10
3:1
SECTION
I-289/Route 13
ROAD
OUTLET
BASIN
WQ TERRACE
PATH
400
390
380


TARGET CPv = 44,135 CF
OPTION #1: OPEN POND
MAX DEPTH = 5.0' (470 TO 475)
AVG AREA @ 472.5 = 11,526 SF
VOLUME = 57,630 CF
OPTION #2: STONE GALLERY
AVG AREA @ 472.5 = 15,886 SF
VOLUME (35% VOIDS) = 27,800 CF
OPTION #3: LARGE STONE GALLERY
INCLUDING CHANNEL AREA
AVG AREA @ 472.5 = 28,500 SF
VOLUME (35% VOIDS) = 49,875 CF
OPTION #4: STORM TECH CHAMBER
SEE OPTION #2 FOOTPRINT
VOLUME = 52,272 CF
new pipe
new pipe
new pipe


BMP TARGET VOLUME = 18,208 CF
BOTTOM GALLERY = 466.6
TOP GALLERY = 475
GALLERY AREA = 11,000 SF
GALLERY VOLUME (35% VOIDS) = 33,340 CF
Dog Park
existing
existing
PUBLIC WOODS (WALKING AREA)
Town Parcel Boundary
ADD DOWNSTREAM DEFENDER
INFLOW UNTIL LEVEL = 474.5
ADD OUTLET RISER WITH RIM = 474.5
OVERFLOW
SYDNEY DR.



LEGEND

- Proposed Retrofit
- PROPERTY LINE
- EXISTING 2' CONTOUR
- IssuedPermits_Indian
- Watershed Boundary

NOTES:

The existing cul-de-sac at Briar lane/Woods End Dr. is unnecessary, and was identified as a good opportunity to remove approximately 0.11 acres of excess impervious. The project will also reduce the time required for plowing by Village Staff.

WATERSHED CONSULTING ASSOCIATES, LLC

0 40 80 Feet

N S

INDIAN BROOK FLOW RESTORATION STUDY ***ESSEX, VERMONT***		
Briar Lane Cul-de-sac Impervious Removal		
DATE: 1-26-15	***DRAWN BY:JS***	***SCALE:NOTED***

COUNTRYSIDE DR

VALE DR

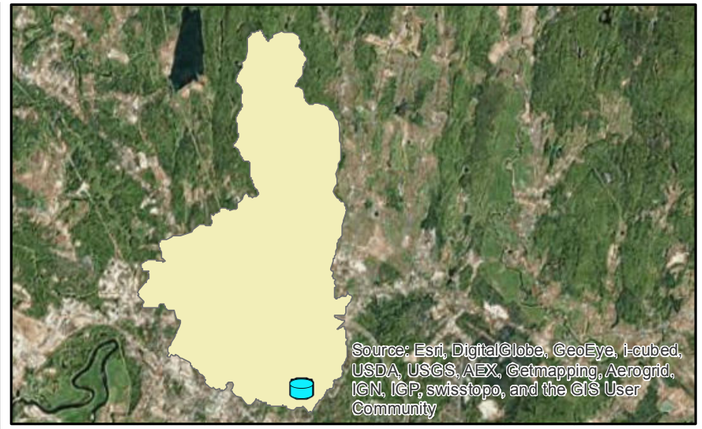
BRICKYARD RD

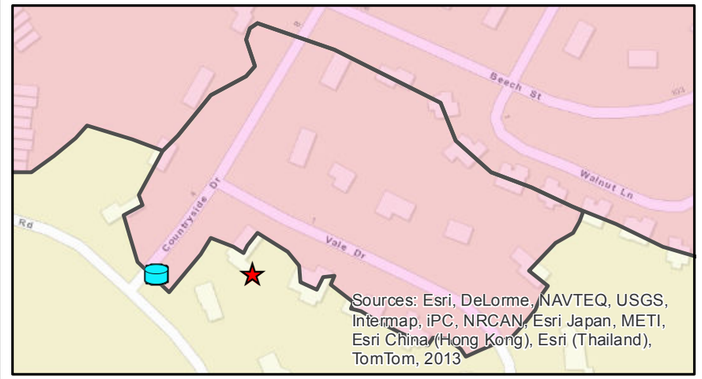
New CPv Flow splitter with high flow bypass

2-0155

412 410 408 406 404 402 400 398 396 394 414 416 418 420

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community





LEGEND

- Proposed Retrofit
- PROPOSED STORM STRUCTURE
- PROPOSED STORM PIPE
- PROPOSED STORMWATER PLANTERS
- Proposed Underground Chamber System
- PROPERTY LINE
- EXISTING 2' CONTOUR
- Indian Brook
- IssuedPermits_Indian

BMP Drainage Area

- Existing Post 2002
- Existing Pre 2002
- Proposed

NOTES:

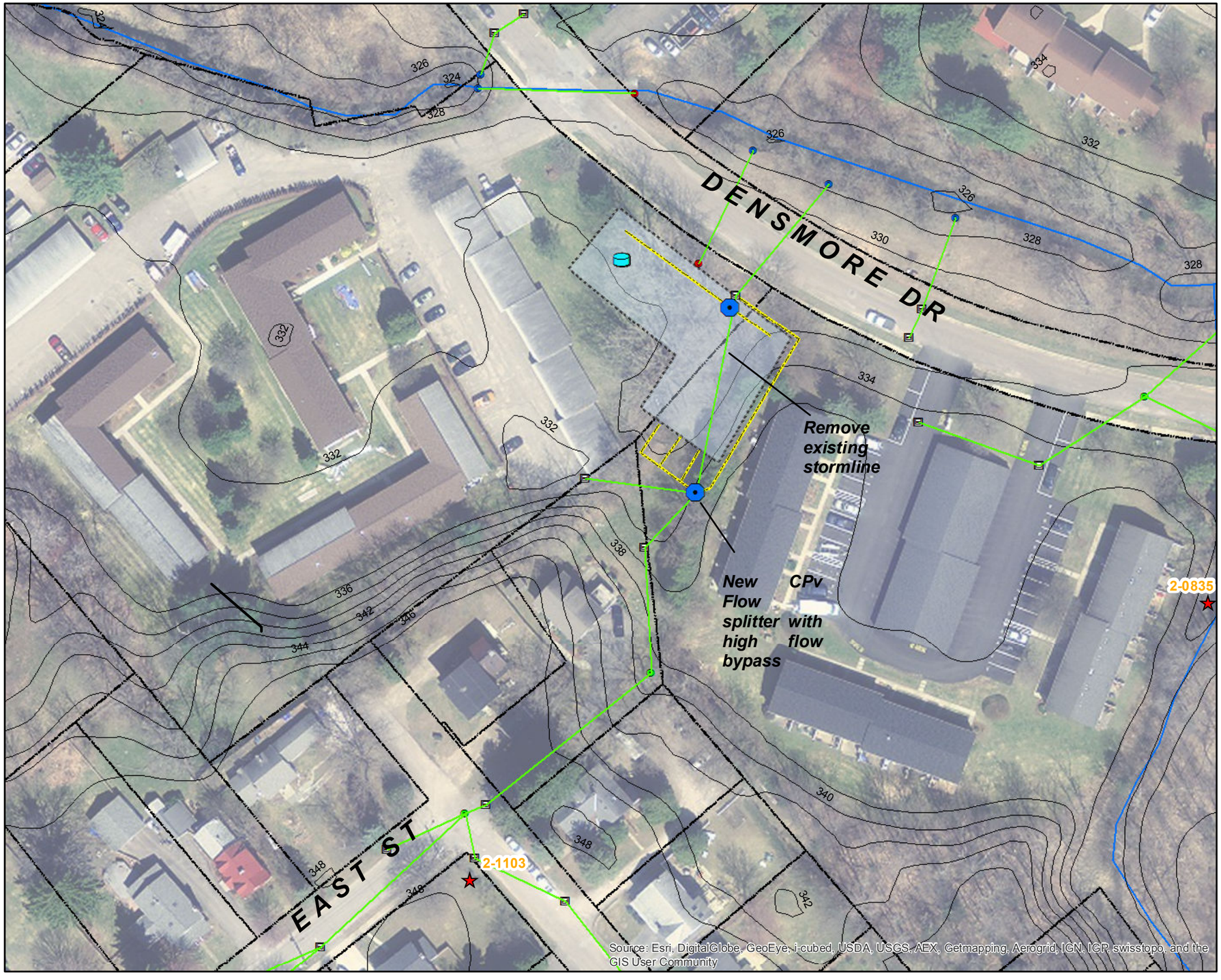
The proposed retrofit project would involve installation of a system of StormTech Chambers in the ROW to mitigate the CPv storm. All high flows will bypass the system and drain to the existing outfall. The eroded outfall will be stabilized to reduce excess sediment loading and minimize the risk of bank failure. In addition, 6' wide stormwater planters are proposed for the ROW of Countryside Dr. to provide water quality treatment.

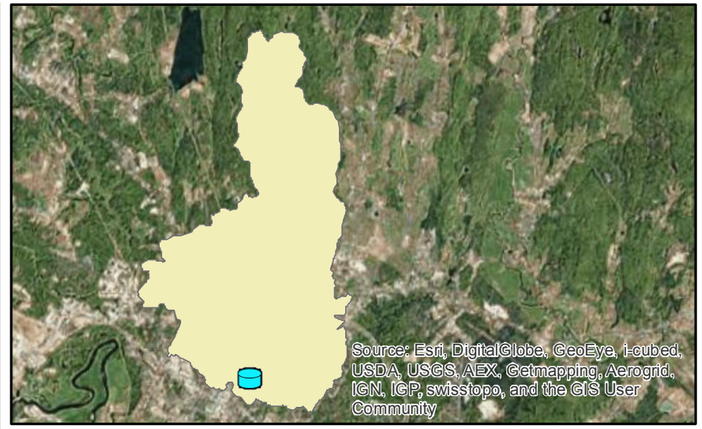
WATERSHED CONSULTING ASSOCIATES, LLC

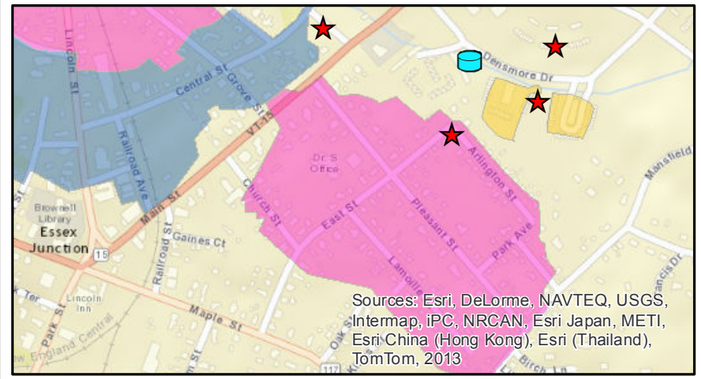
0 40 80 160 Feet

N S

INDIAN BROOK FLOW RESTORATION STUDY		
ESSEX, VERMONT		
Countryside Dr. Stormwater Improvements		
DATE: 1-26-15	***DRAWN BY:JS***	***SCALE:NOTED***







LEGEND

- Proposed Retrofit
- PROPOSED STORM STRUCTURE
- PROPOSED STORM PIPE
- Proposed Underground Chamber System
- PROPERTY LINE
- EXISTING 2' CONTOUR
- Indian Brook
- IssuedPermits_Indian

BMP Drainage Area

- Existing Post 2002
- Existing Pre 2002
- Proposed

NOTES:

The proposed retrofit at Densmore Dr. involves installation of an underground chamber system, using StormTech SC-740 chambers to mitigate runoff from a 23 acre residential area. A flow splitter will route the CPv (1-year flow) to the chamber sytem and all high flow will bypass the chamber via a new stormline to the existing outfall. An additional outfall will be removed. Verification of the groundwater table is necessary to determine feasibility for infiltration on site.

WATERSHED CONSULTING ASSOCIATES, LLC

0 40 80 160 240 Feet

N

S

INDIAN BROOK FLOW RESTORATION STUDY		
ESSEX, VERMONT		
Densmore Dr. Underground Infiltration Basin		
DATE: 1-26-15	***DRAWN BY:JS***	***SCALE:NOTED***

SWEETWATER LN

TAMARACK DR

BEECH ST

BRICKYARD RD

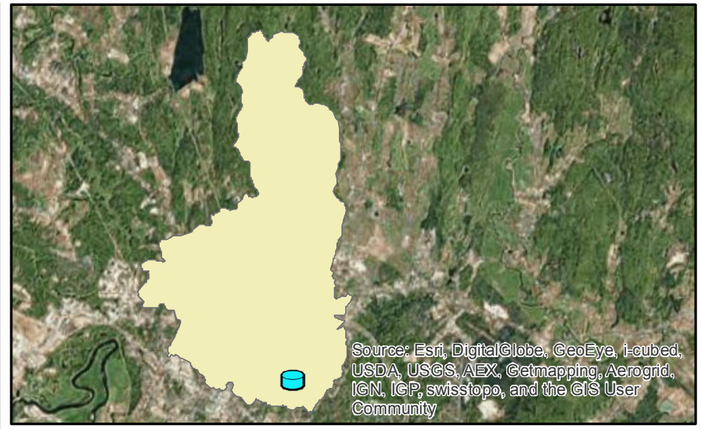
Rearmour spillway

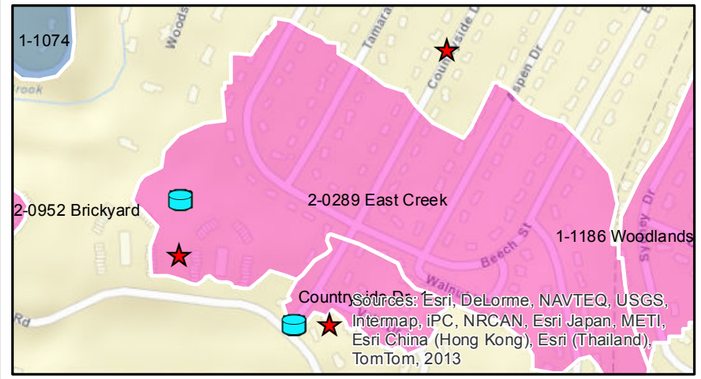
Reset section of existing culvert and connect to new overflow riser.

Proposed new outlet riser with 2.5" low-flow orifice.

2-0317

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community





LEGEND

- Proposed Retrofit
- PROPOSED STORM STRUCTURE
- PROPOSED STORM PIPE
- Existing Detention Pond
- PROPERTY LINE
- EXISTING 2' CONTOUR
- IssuedPermits_Indian

BMP Drainage Area

- Existing Post 2002
- Existing Pre 2002
- Proposed

NOTES:

The proposed project will involve retrofitting the existing dry pond's 36" culvert with a riser structure and 2.5" low-flow orifice. A permanent pool will be established for water quality volume storage. Rearmouring of the spillway is proposed. No regrading or expansion is necessary.

WATERSHED CONSULTING ASSOCIATES, LLC

0 40 80 160 240 320 400 Feet

N S

INDIAN BROOK FLOW RESTORATION STUDY ESSEX, VERMONT		
East Creek Condominiums Pond Retrofit		
DATE: 1-26-15	DRAWN BY:JS	SCALE:NOTED

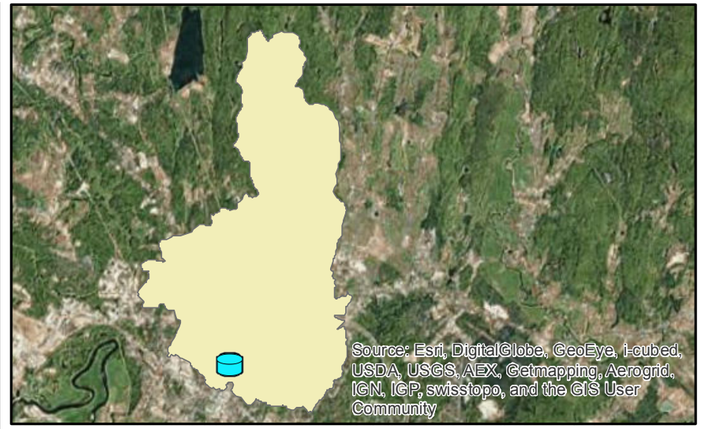
EDUCATIONAL DR

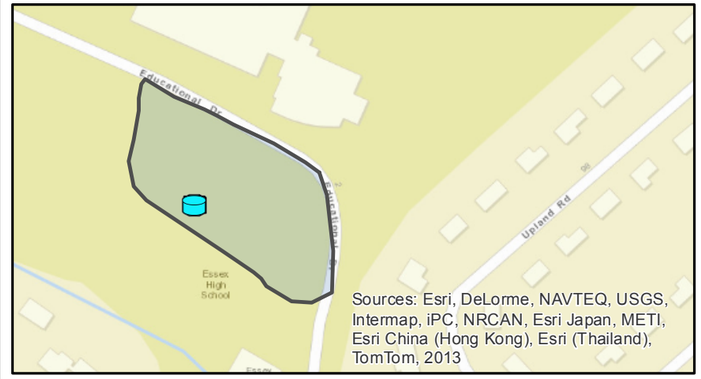
Repave approximately 0.5 acres of parking lot to improve capture by the existing rain garden.

Existing Rain Garden (no change proposed)

342 340 338 336 334 332 330 328 326 324 322 320

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community





LEGEND

- Proposed Retrofit
- PROPERTY LINE
- EXISTING 2' CONTOUR
- Indian Brook
- IssuedPermits_Indian

BMP Drainage Area

- Existing Post 2002
- Existing Pre 2002
- Proposed

NOTES:

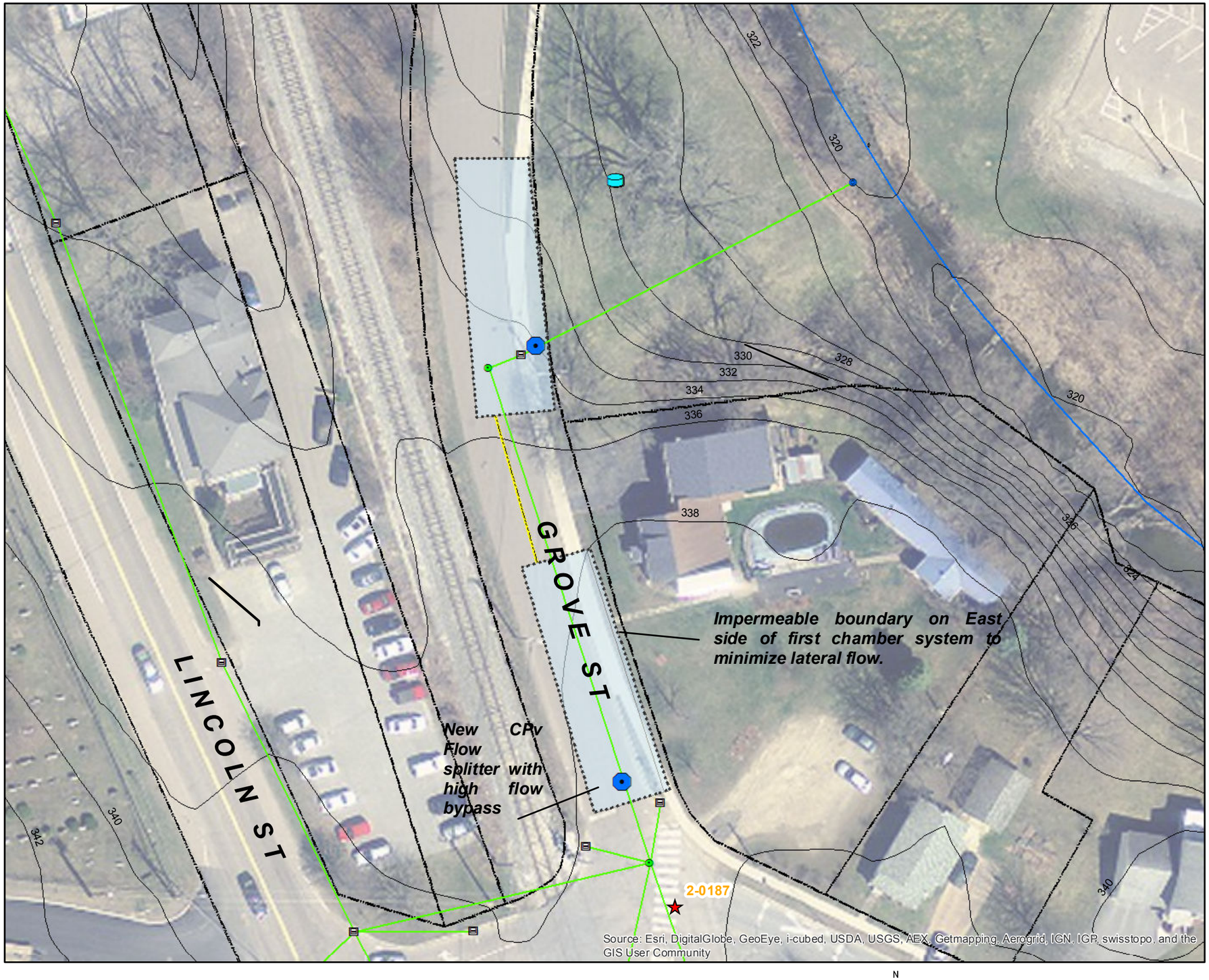
A portion of the Essex High School parking lot runoff was observed to bypass the rain garden. The proposed project involves regrading and paving of approximately 0.5 acres of the parking lot to increase capture by the existing rain garden. The project would divert approximately 900 cft more stormwater runoff than is currently managed.

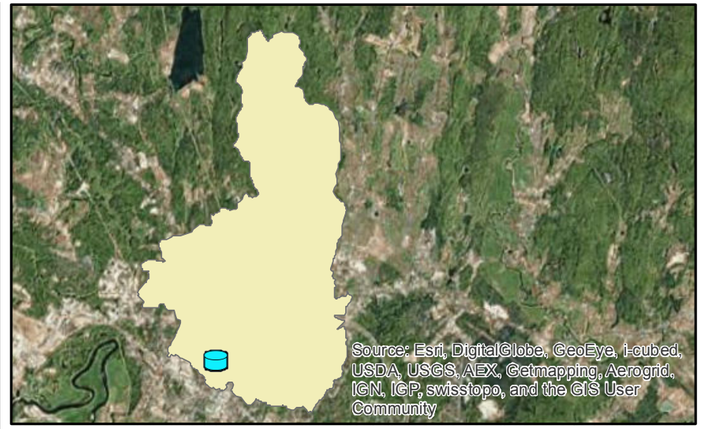
WATERSHED CONSULTING ASSOCIATES, LLC

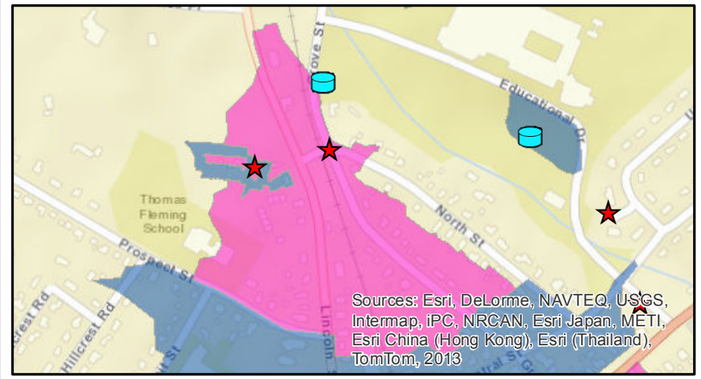
0 40 80 160 Feet

N S

INDIAN BROOK FLOW RESTORATION STUDY		
ESSEX, VERMONT		
Essex High School Parking Lot Improvements		
DATE: 1-26-15	***DRAWN BY:JS***	***SCALE:NOTED***







LEGEND

- Proposed Retrofit
- PROPOSED STORM STRUCTURE
- PROPOSED STORM PIPE
- Proposed Underground Chamber System
- PROPERTY LINE
- EXISTING 2' CONTOUR
- Indian Brook
- IssuedPermits_Indian

BMP Drainage Area

- Existing Post 2002
- Existing Pre 2002
- Proposed

NOTES:

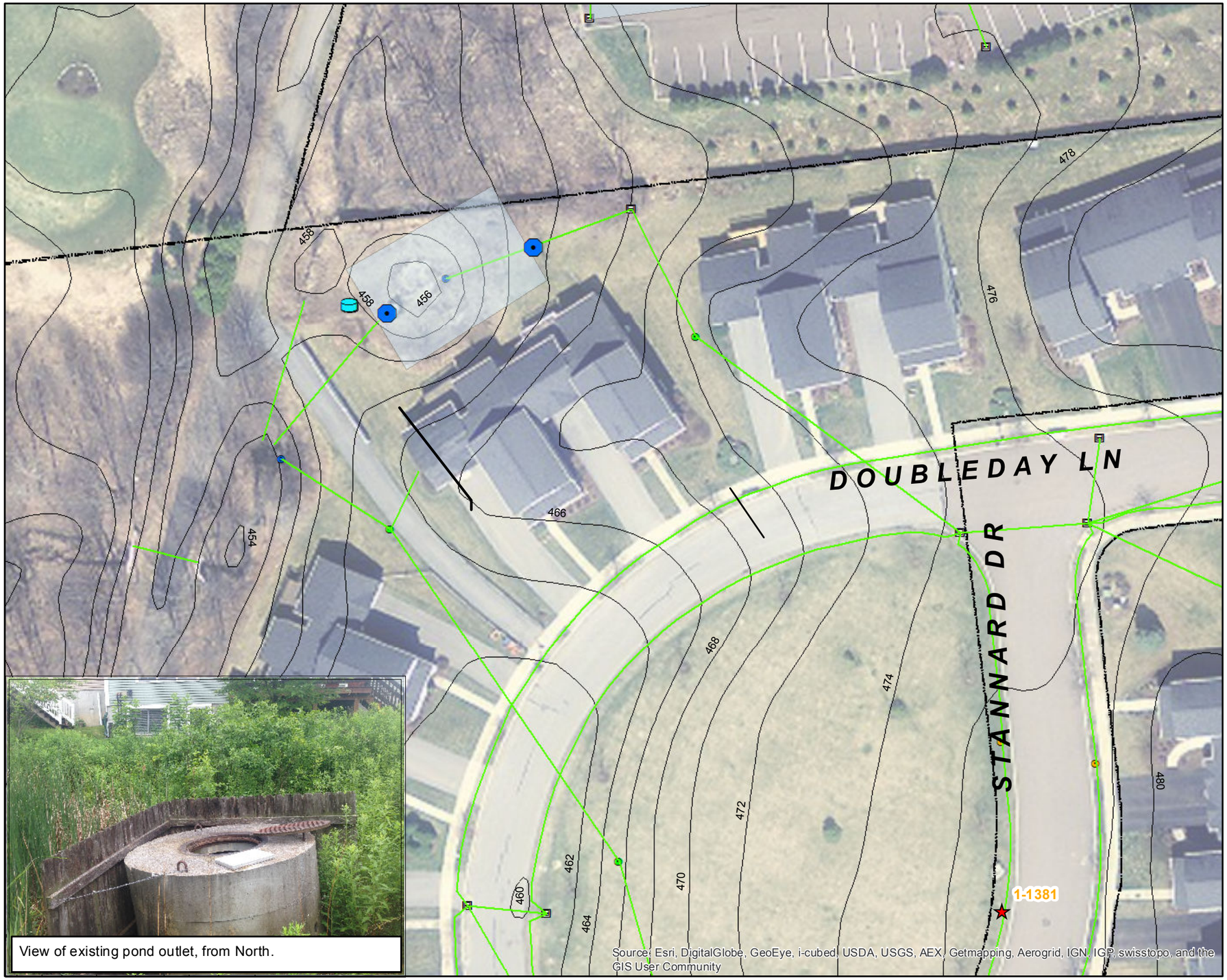
The proposed retrofit for the Grove St. outfall, is to install two connected chamber systems in the Village ROW, sized to mitigate the CPv volume and bypass high flows. The system would use StormTech SC-740 chambers. The first system of chambers would be impermeable on the east side to protect the home foundation to the east. The second system would allow infiltration. Feasibilty was based on existing groundwater table data from a monitoring well near the Village Pump Station.

WATERSHED CONSULTING ASSOCIATES, LLC

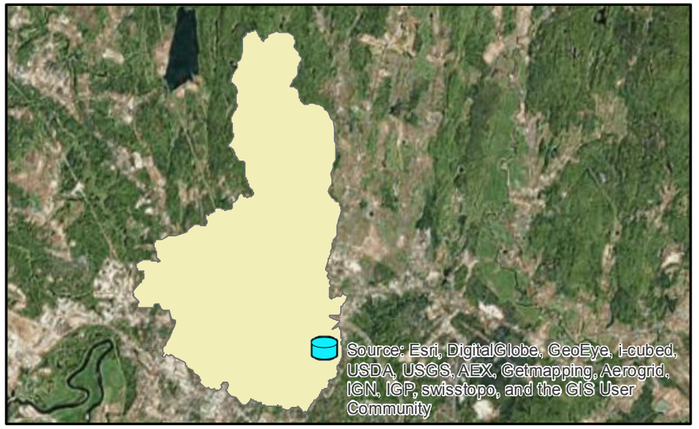
0 40 80 160 Feet

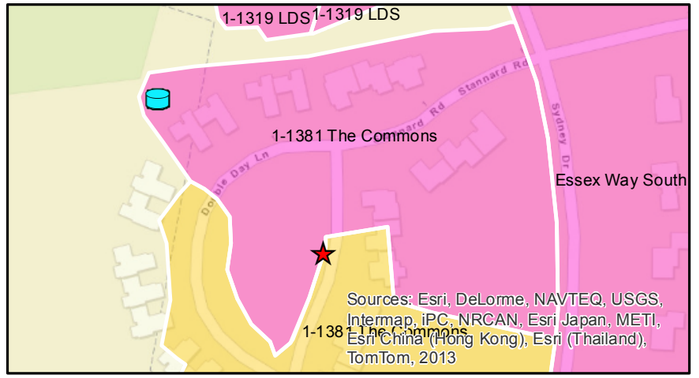
N S

INDIAN BROOK FLOW RESTORATION STUDY ***ESSEX, VERMONT***		
Grove St. Underground Detention/Infiltration Chamber System		
DATE: 1-26-15	***DRAWN BY:JS***	***SCALE:NOTED***



View of existing pond outlet, from North.





LEGEND

- Proposed Retrofit
- PROPOSED STORM STRUCTURE
- Underground Chamber System
- PROPERTY LINE
- EXISTING 2' CONTOUR
- IssuedPermits_Indian

BMP Drainage Area

- Existing Post 2002
- Existing Pre 2002
- Proposed

NOTES:

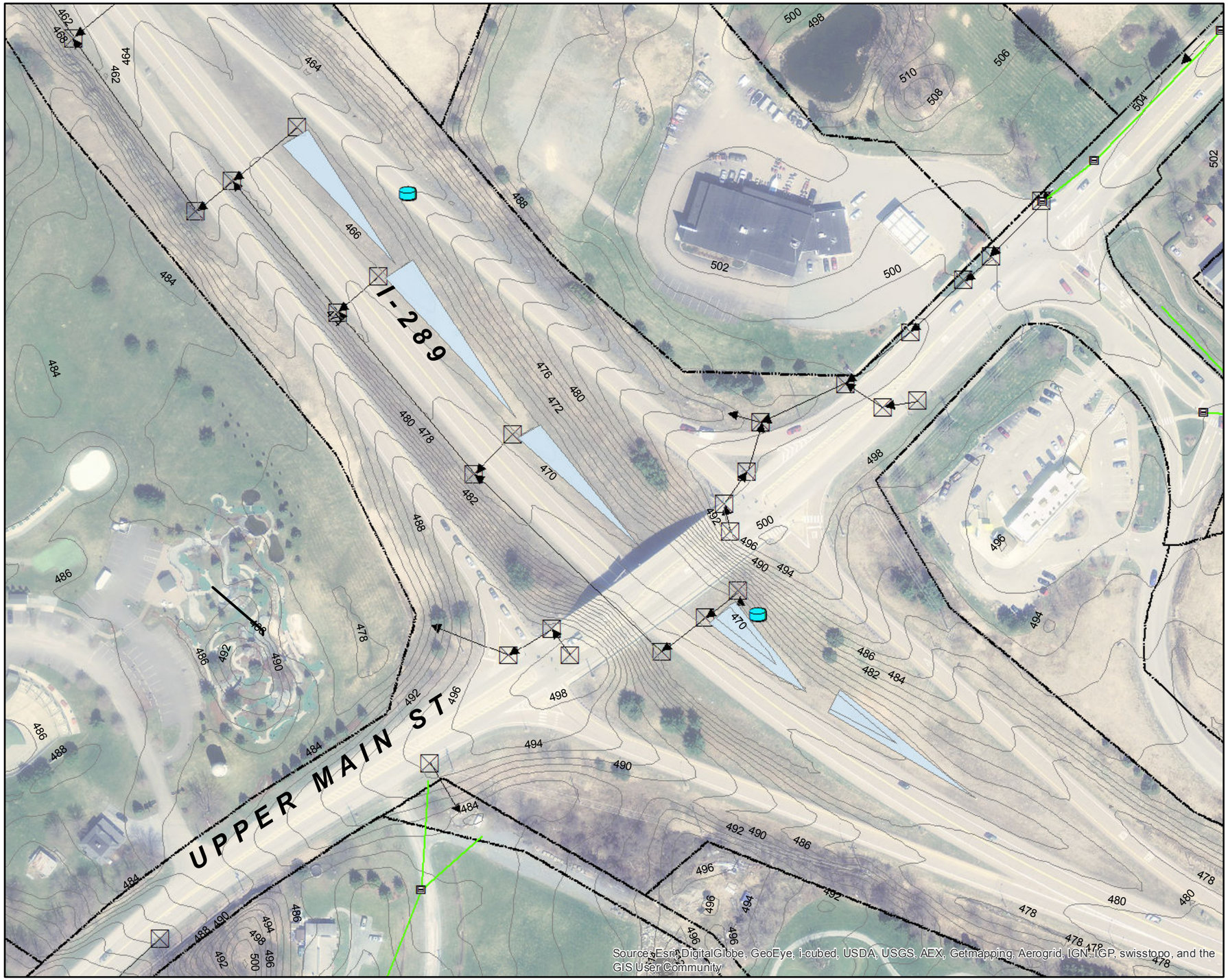
The proposed retrofit will involve converting the existing detention pond to an underground chamber system, using StormTech SC-740 chambers. The existing pond is located behind the Condos and occupies a large portion of the resident's backyard. An underground chamber system will expand the usable space and improve aesthetics of the site.

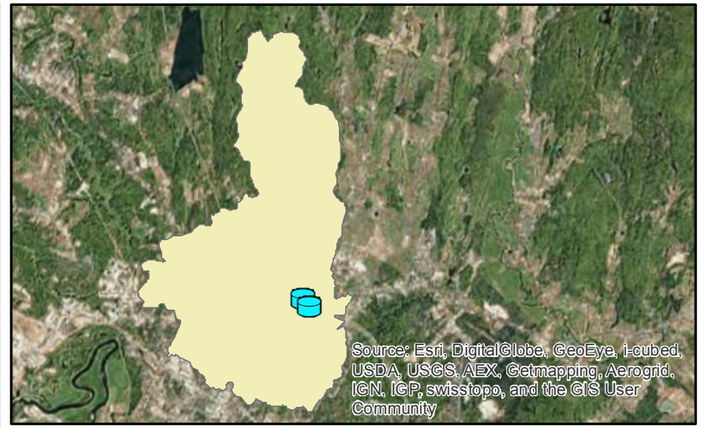
WATERSHED CONSULTING ASSOCIATES, LLC

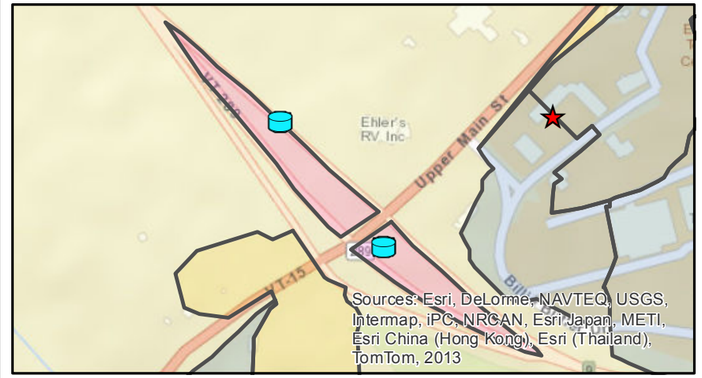
0 40 80 160 Feet

N S

INDIAN BROOK FLOW RESTORATION STUDY		
ESSEX, VERMONT		
#1-1381 The Commons North Pond Retrofit		
DATE: 1-26-15	***DRAWN BY:JS***	***SCALE:NOTED***







LEGEND

- Proposed Retrofit
- Proposed Stormwater Sand Filter
- PROPERTY LINE
- EXISTING 2' CONTOUR
- DropInlets
- Culverts
- IssuedPermits_Indian

BMP Drainage Area

- Existing Post 2002
- Existing Pre 2002
- Proposed

NOTES:

The proposed improvements include the installation of terraced sand filters, designed to provide surface ponding for the CPv storm and filtration through a 4' sand bed. A 4" underdrain controls flow from the filter. This type of filter has been installed in I-89 medians in St. Albans.

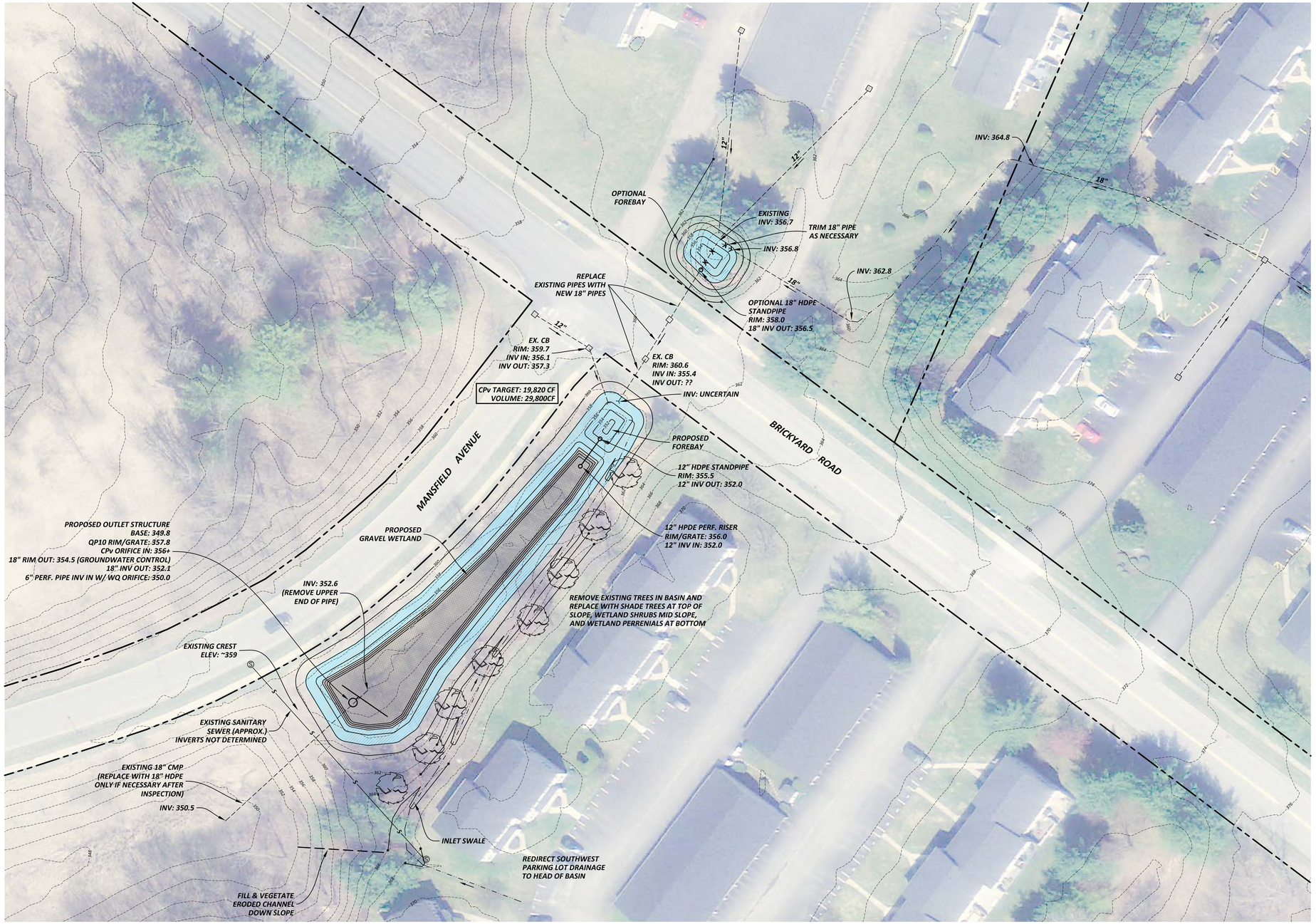
WATERSHED CONSULTING ASSOCIATES, LLC

0 40 80 160 240 320 400 480 Feet

N

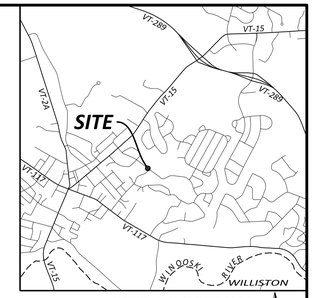
S

INDIAN BROOK FLOW RESTORATION STUDY		
ESSEX, VERMONT		
VTRANS I-289 Exit Ramp Stormwater Improvements		
DATE: 1-26-15	***DRAWN BY:JS***	***SCALE:NOTED***



30 0 15 30 60 120

(IN FEET)
1 inch = 30 ft.



SITE LOCATION
NTS

LEGEND

- PROPERTY LINE
- EXISTING CONTOUR
- PROPOSED CONTOUR
- EXISTING STORM LINE
- PROPOSED STORM LINE
- DRAINAGE COURSE

NOTES

1. THIS IS NOT A BOUNDARY SURVEY. BOUNDARY INFORMATION IS FROM TOWN TAX MAPS.
2. EXISTING TOPOGRAPHY WAS CREATED FROM CHITTENDEN COUNTY LiDAR (2004).

CONCEPT

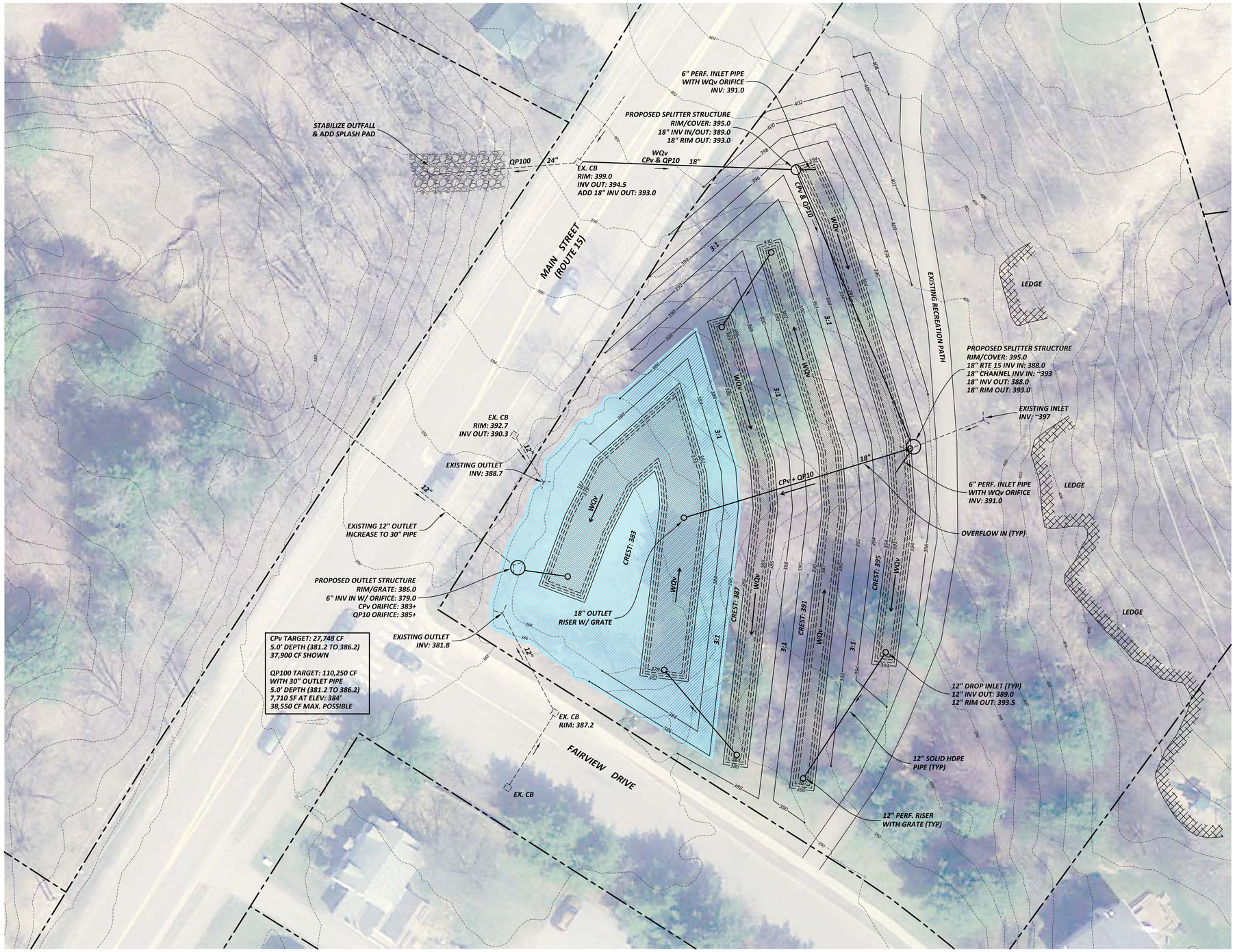
INDIAN BROOK FLOW RESTORATION PLAN

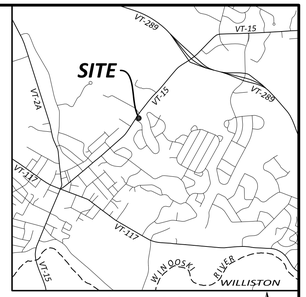
ESSEX, VERMONT

BRICKYARD CONDOMINIUMS STORMWATER IMPROVEMENT PLAN

WATERSHED CONSULTING ASSOCIATES, LLC
Stormwater Management | Water Quality | Erosion Control
430 Shelburne Road P.O. Box 4413
Burlington, VT 05406
Mobile: 802.922.4871 | Main: 802.497.2367
www.watershedca.com

APPROVED BY:	AT	DRAWN BY:	SMS/ATS	SCALE:	NOTED
DATE:	1-28-15	CHECKED BY:	AT	SHEET:	1 OF 1





SITE LOCATION
NTS

LEGEND

- PROPERTY LINE
- EXISTING CONTOUR
- PROPOSED CONTOUR
- EXISTING STORM LINE
- PROPOSED STORM LINE
- DRAINAGE COURSE

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20 0 10 20 40 80
(IN FEET)
1 inch = 20 ft.

CONCEPT

INDIAN BROOK FLOW RESTORATION PLAN

ESSEX, VERMONT

FAIRVIEW DRIVE STORMWATER IMPROVEMENT PLAN

WATERSHED CONSULTING ASSOCIATES, LLC
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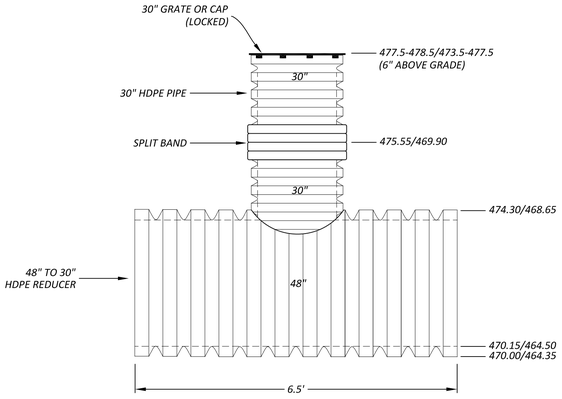
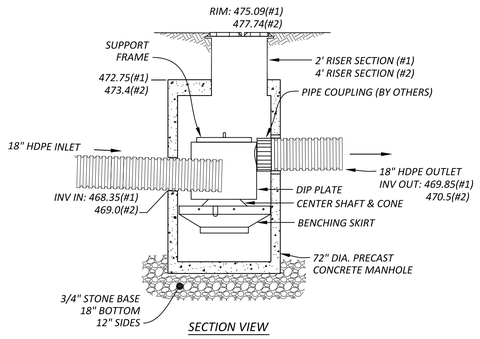


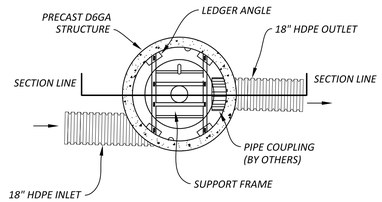
(NORTH SYSTEM/SOUTH SYSTEM)

MANWAY DETAIL

NTS



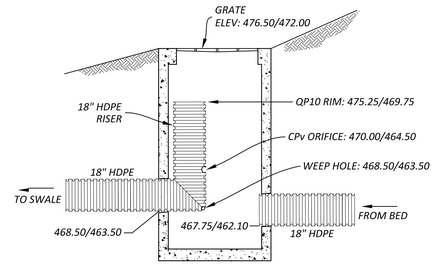
SECTION VIEW



PLAN VIEW

HYDRO INT'L MODEL D6GA DOWNSTREAM DEFENDER DETAIL

NTS

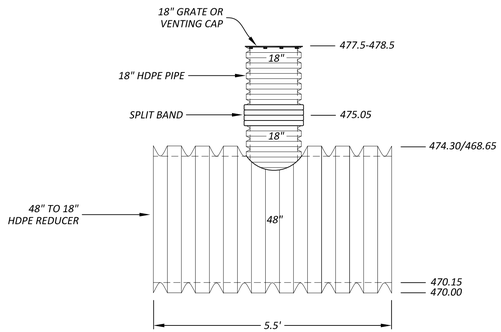


SECTION VIEW

(NORTH SYSTEM/SOUTH SYSTEM)

OUTLET STRUCTURE DETAIL

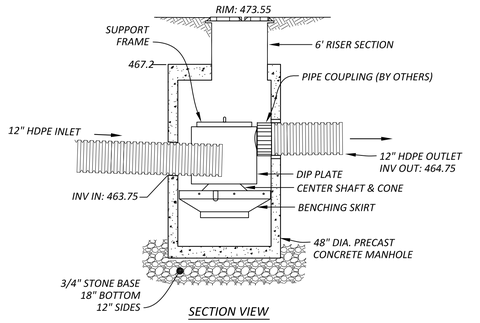
NTS



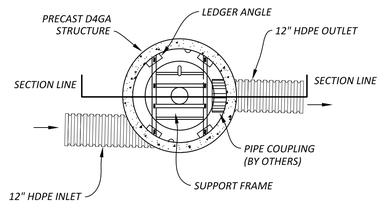
(NORTH SYSTEM ONLY)

VENT DETAIL

NTS



SECTION VIEW

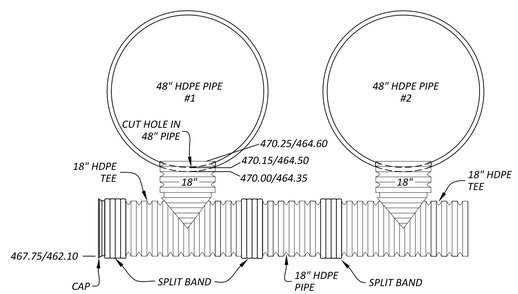


PLAN VIEW

HYDRO INT'L MODEL D4GA DOWNSTREAM DEFENDER DETAIL

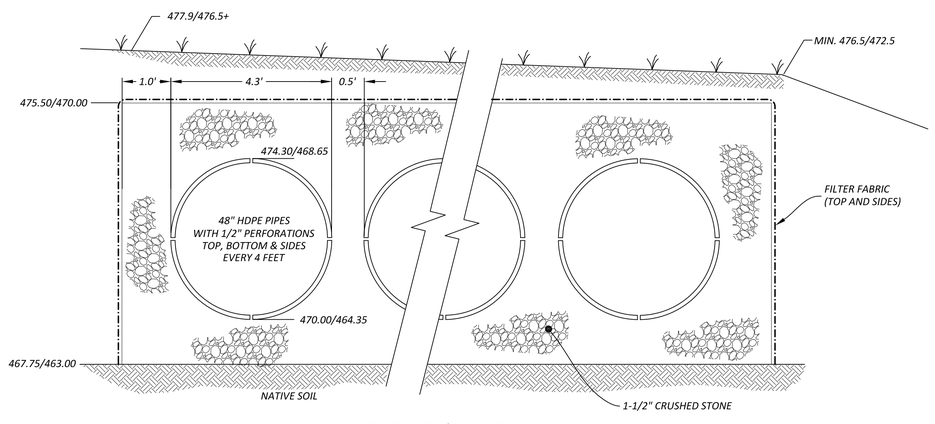
NTS

Indian Brook Storm						
LDS CPv Detention in 48" Pipes						
ADS Pipe Materials List (btween downstream defenders and outlet structure)						
	ADS #		North		South	
48" x 20' N-12 double wall storm pipe, straight ends	48950020		128		21	
48" x 13' N-12 double wall storm pipe, straight ends	?		19		0	
48" to 30" N-12 double wall reducer, straight ends	4868AN		19		7	
48" to 18" N-12 double wall reducer, straight ends	4866AN		19		0	
48" N-12 double wall end cap, straight end	4801AN		36		13	
48" to 12" N-12 double wall reducer, straight ends	4874AN		1	north inlet	1	
48" to 18" N-12 double wall reducer, straight ends	4876AN		1	south inlet	0	
48" N-12 split bands, no gasget	4865AA		204		35	
30" x 20' N-12 double wall storm pipe, straigt ends	30950020		3		2	
30" H20 drop in grate, lockable	3099CGC		19		7	
30" N-12 split bands, no gasget	3065AA		19		7	
18" x 20' N-12 double wall pipe, straight ends	18950020		6		1	
18" N-12 double wall end cap, straight end	1801AN		1		1	
18" N-12 split bands, no gasget	1865AA		39		8	
12" x 20' N-12 double wall storm pipe, one bell end	12950020IB		2		1	
12" N-12 double wall 30 degree elbow	?		1		0	
1-1/2" crushed stone	n/a		2695	cy	414	cy
fabric	n/a		19403	sf	4159	sf
other inlet and outlet structures, pipes, corings, replacement pavement, etc. need to be estimated separately from plan.						



EQUALIZER/OUTLET PIPE DETAIL

NTS



(NORTH SYSTEM/SOUTH SYSTEM)

BED DETAIL

NTS

FINAL CONCEPT

INDIAN BROOK FLOW RESTORATION PLAN

ESSEX, VERMONT

LDS CHURCH STORMWATER IMPROVEMENT DETAILS

VERSHED CONSULTING ASSOCIATES, LLC

Stormwater Management | Water Quality | Erosion Control
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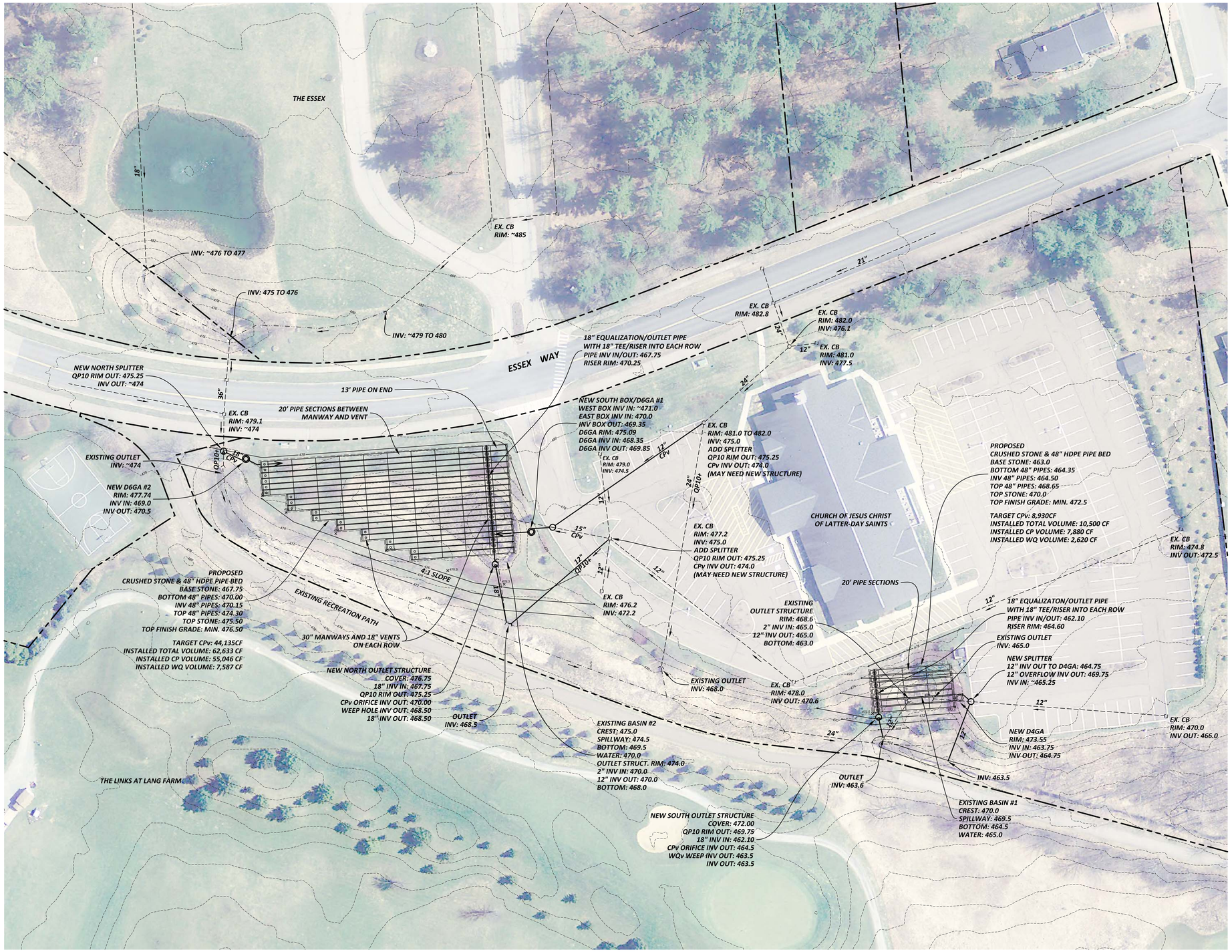

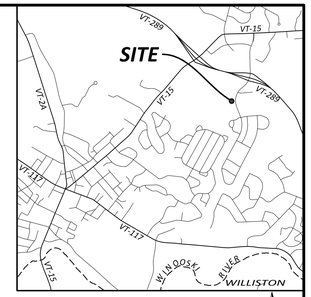

SITE LOCATION
NTS

LEGEND

- PROPERTY LINE
- EXISTING CONTOUR
- PROPOSED CONTOUR
- EXISTING STORM LINE
- PROPOSED STORM LINE
- DRAINAGE COURSE

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40 0 20 40 80 160
(IN FEET)
1 inch = 40 ft.

FINAL CONCEPT

INDIAN BROOK FLOW RESTORATION PLAN

ESSEX, VERMONT

LDS CHURCH STORMWATER IMPROVEMENT PLAN

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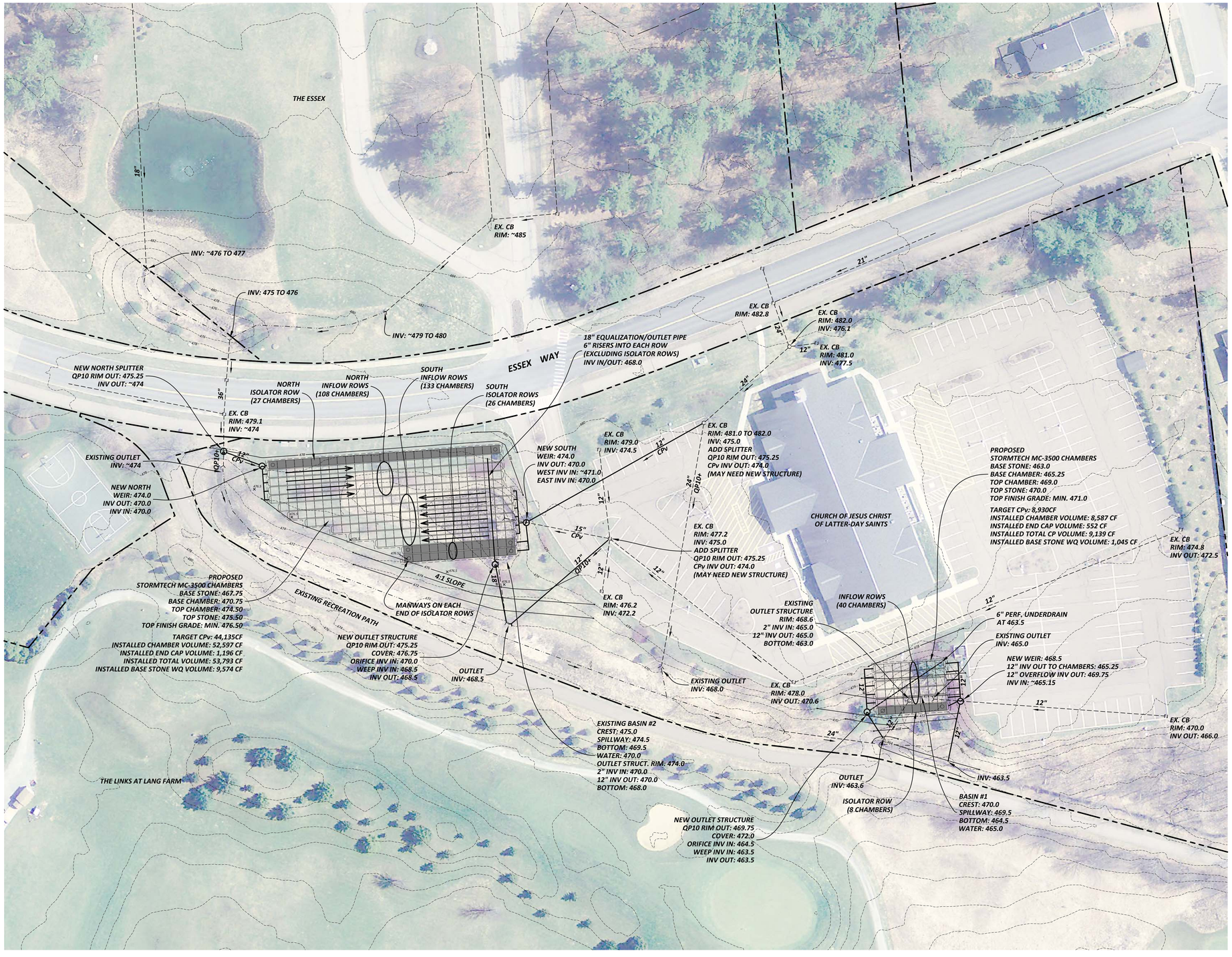

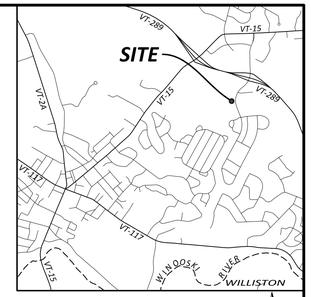

SITE LOCATION
NTS

N

LEGEND

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CONCEPT

INDIAN BROOK FLOW RESTORATION PLAN

ESSEX, VERMONT

LDS CHURCH STORMWATER IMPROVEMENT PLAN

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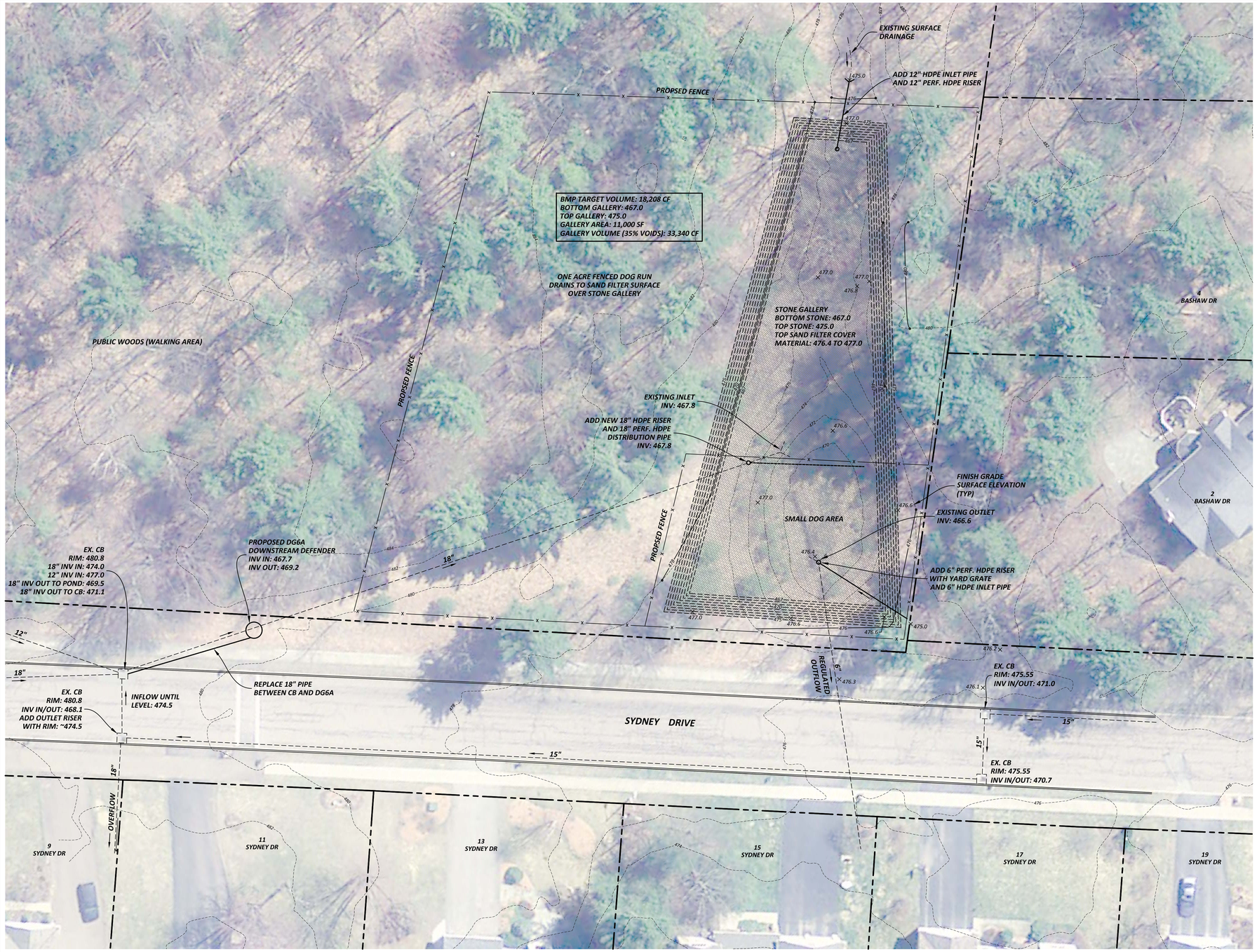

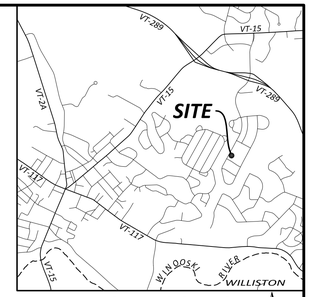

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NTS

N

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CONCEPT

INDIAN BROOK FLOW RESTORATION PLAN

ESSEX, VERMONT

WOODLANDS SUBDIVISION STORMWATER IMPROVEMENT PLAN

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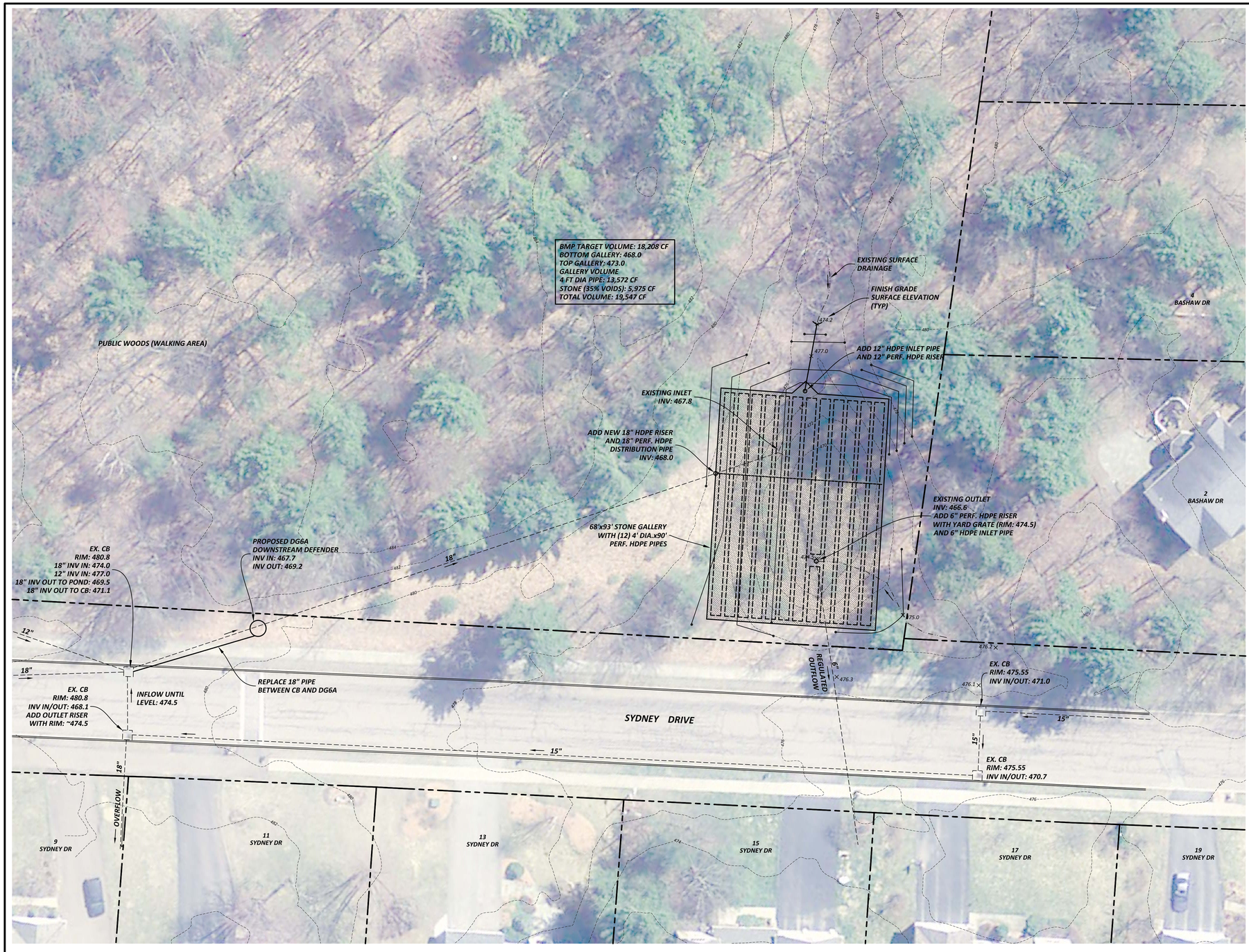

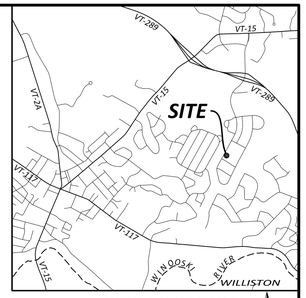

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