

Putney Road - Crosby Brook

RESTORATION STUDY PROJECT



February 2015

Prepared for:

Town of Brattleboro, VT

State of Vermont

Department of Environmental Conservation

Vermont Agency of Transportation (VTrans)

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TABLE OF CONTENTS

	Executive Summary	i
1.0	Introduction	1
1.1	Project Purpose	1
1.2	Project Background	2
1.3	Project Study Areas	6
2.0	STP Evaluation and Ranking Methodology	10
2.1	Watersheds & STP Evaluations	10
2.2	STP Selection & Justification	13
3.0	STP Selection	20
3.1	Selected Alternatives / STPs	20
3.2	STP Ranking Results	27
4.0	Recommendations	28
4.1	Recommended STPs	28
4.2	Implementation Phasing & Planning	33

List of Tables

Table 1.0 – STP Options - Ranking Summary	End of Section 4.0
Table 2.0 – STP Options - Ranking Results	End of Section 4.0
Table 2.1 – STP Options - Ranking Results by Area	End of Section 4.0
Table 3.0 – STP Options - Ranking Summary Top 10	End of Section 4.0
Table 3.1 – STP Options - Ranking Summary Top 4 by Area	End of Section 4.0
Table 4.0 – STP Options – Streambank Stabilization & Culvert Replacements	End of Section 4.0

List of Figures

Figure 1 – Watershed Map.....	End of Section 4.0
Figure 2 – Subwatershed Map & Drainage Components	End of Section 4.0
Figure 3 – Subwatershed Map & Drainage STP Locations	End of Section 4.0
Figure 4 – Crosby Brook Site 1.1 Proposed STPs	End of Section 4.0
Figure 5 – Crosby Brook Site 1.2 Proposed STPs	End of Section 4.0
Figure 6 – Crosby Brook Site 1.3 Proposed STPs	End of Section 4.0
Figure 7 – Crosby Brook Site 1.4 Proposed STPs	End of Section 4.0
Figure 8 – Crosby Brook Site 1.5 Proposed STPs	End of Section 4.0
Figure 9 – Crosby Brook Site 1.6 Proposed STPs	End of Section 4.0
Figure 10 – Crosby Brook Site 1.7 Proposed STPs	End of Section 4.0
Figure 11 – Crosby Brook Site 1.8 Proposed STPs	End of Section 4.0
Figure 12 – Crosby Brook Site 1.9 Proposed STPs	End of Section 4.0
Figure 13 – Crosby Brook Site 1.10 Proposed STPs	End of Section 4.0
Figure 14 – Crosby Brook Site 1.11 Proposed STPs	End of Section 4.0
Figure 15 – Crosby Brook Site 1.12 Proposed STPs	End of Section 4.0
Figure 16a – Crosby Brook Site 1.13 Proposed STPs	End of Section 4.0
Figure 16b – Crosby Brook Site 1.13 Proposed STPs	End of Section 4.0
Figure 17 – Crosby Brook Site 2.1 Proposed STPs	End of Section 4.0
Figure 18 – Crosby Brook Site 2.2 Proposed STPs	End of Section 4.0
Figure 19 – Crosby Brook Site 2.3 Proposed STPs	End of Section 4.0
Figure 20 – Crosby Brook Site 2.4 Proposed STPs	End of Section 4.0
Figure 21 – Crosby Brook Site 2.5 Proposed STPs	End of Section 4.0
Figure 22 – Crosby Brook Site 2.6 Proposed STPs	End of Section 4.0
Figure 23 – Crosby Brook Site 2.7 Proposed STPs	End of Section 4.0
Figure 24 –STP Treatment & Build-out Areas	End of Section 4.0
Figure 25 –Project Area 3 Crosby Brook STPs	End of Section 4.0

List of Appendices

Appendix A:	Preliminary Assessment of Environmental Permit Requirements
Appendix B:	Subwatershed Delineation Computations & Analysis Model Outputs
Appendix C:	STP Ranking Spreadsheet Outputs
Appendix D:	STP Costing Details
Appendix E:	Drainage & Stabilization Details

Putney Road - Crosby Brook

Restoration Study Project

Executive Summary

The Crosby Brook Stormwater Design Project is intended to identify Stormwater Treatment Practices (STPs) to protect Crosby Brook (identified as a Class B/Coldwater Fish Habitat) from non-point source pollution (NPS) associated with stormwater runoff that could enter storm drains within the Crosby Brook watershed. Under this study, STPs were selected to handle stormwater runoff and provide the most beneficial, cost effective and most protective alternatives for minimizing NPS pollution, in particular Total Suspended Solids (TSS) and sediment, associated with un-treated runoff into Crosby Brook. Additionally, STPs that provide bank stabilization and other sediment transport reduction techniques were identified for Crosby Brook to protect natural habitats and minimize the effects of sediment from changing the morphology of the brook.

For this project, CEI reviewed Town of Brattleboro, VTrans and VT DEC's existing information and went onsite to review watershed characteristics, inspect the catch basins, drainage features and outfalls. CEI also reviewed the contributing drainage areas and drainage pathways to the direct discharges to the brook.

As part of this review, CEI visited the following three project areas set forth in the project scope.

- Project Area 1 – Putney Road & Adjacent Private Properties
- Project Area 2 – Route 91 Limited Access Right of Way
- Project Area 3 – Upper Watershed Areas & Crosby Brook Corridor

Specific site constraints and potential STPs for each of the study areas were identified during a preliminary watershed evaluation. A ranking selection procedure was then completed as well as justification analysis to select the most beneficial and protective STP sites from all the potential sites that were identified during the watershed evaluation. This evaluation included field surveys and data review of information provided by both the Town of Brattleboro and VTrans. In order to identify all potential options, the collected data was used to generate potential STP locations and then several STP options were evaluated per location.

General conceptual STP options for each of the study areas were developed in order to identify and evaluate each of the specific STP sites. These general options were selected based on available property, existing drainage infrastructure, roadway grading, topography, potential utility conflicts, roadway structures, soil types, bedrock depths, waterways, wetland resources areas, public safety, aesthetics, land use and other site specific parameters.

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Town of Brattleboro, Vermont*



Once STPs were identified and conceptualized for Project Areas 1 and 2, a ranking system was utilized to prioritize STP sites. The ranking analyzed 22 total options which varied in STP/treatment type, total subwatershed area treatment combinations and volumes/storms treated which were then reduced down to the top 4 sites per area. Options were ranked as a lower priority based on maintenance concerns, constructability issues, STP sizing that did not optimize the stormwater volume provided when compared to the required target stormwater volume for a specific combination of handled subwatersheds and potential permitting issues.

This detailed ranking process utilized a series of twelve different criteria including:

- Proximity to Crosby Brook
- Direct / Indirect Discharge
- Impervious Area Handled
- Ease of Implementation
- Land Owner
- Land Use
- Potential STP Storm Size
- Potential STP Recharge
- Sediment Removal
- Permitting Requirements
- Maintenance Requirements

A detailed cost analysis for engineering, permitting, design, construction and maintenance of the potential STPs was completed and included in the ranking analysis. TSS load reductions were estimated for each STP over a ten year period and a cost per ton of TSS was predicted.

The STP ranking methodology produced preferred STP sites throughout the Crosby Brook watershed. This process ranked STPs higher that were located closest to the brook (targeting direct discharges), near the most impervious areas (providing the most treatment), at the busiest streets/intersections and handled the highest Water Quality Volume. From this analysis, a matrix of eight STP alternatives was developed with the top two preferred sites in each of the two project areas (Project Areas 1 and 2) selected overall based on the most cost effective reduction of TSS predictions. These final four STP alternatives were selected based on a potential ten year cost per ton of sediment removed with the lowest resultant STPs being recommended for implementation. These results can be used for both long-term planning and to prioritize immediate project funding and short-term budget planning.

A ranking selection process for Project Area 3 was note used based on the potential STPs being very similar in ranking criteria and sediment reduction benefits. Most of the potential STPs in this area were located in or direct adjacent to Crosby Brook, most addressed issues with similar magnitude and were nearly all located on or required access through private

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Town of Brattleboro, Vermont*



property. The upper watershed of Crosby Brook made up most of Project Area 3, which is a very large area made up of mainly undeveloped forest or agricultural land use with very minimal low-density residential areas. For these reasons, CEI only visited and identified potential STP locations that were cited in previously completed geomorphic assessments for Crosby Brook. Problem areas and recommended STPs were identified based on the severity of the issue. These STPs included potential recommendations to repair the following issues:

- Mass failures along Crosby Brook stream segments;
- Steep slopes or eroded banks along Crosby Brook stream segments;
- Undersized culvert replacements with associated roadway drainage issues.

Based on the STP selection process, CEI’s recommendations include combinations of several STPs which if all installed would provide treatment for several high impact direct discharges or identified potential problem areas covered under this study. These could be implemented in a phased manner based on future project planning and re-development by the Town of Brattleboro or the Vermont Agency of Transportation. Costs are provided as a ten year estimate which includes the principal engineering, permitting and construction costs plus a ten year estimated maintenance cost for treatment STPs. Our recommendations are as follows:

1. Complete STP Implementations (in priority order):

a. STP 1-1 – (STP behind America’s Best Inn).....	\$694,000
b. STP 1-4 – (STP near old Bickfords).....	\$236,000
c. STP 2-1 – (Rt. 91 STP near Black Mtn. Rd.).....	\$162,000
d. STP 2-4 – (Rt. 91 STP north of Exit 3).....	\$150,000
e. Streambank Stabilization STPs – (Repair 6 major eroded areas).....	\$370,000
f. Culvert & Drainage STPs – (Improve 4 stream crossings).....	<u>\$1,156,000</u>

Totals - \$2,768,000

2. It is anticipated that several of these options included in this report could be implemented to further protect Crosby Brook, but at a minimum, implement the previously noted STPs to provide the most effective stormwater treatment for the majority of direct discharges in the watersheds. If due to site constraints, land acquisition issues, utility conflicts, future permitting issues, funding constraints or other potential conflicts, a project cannot be completed, alternative parallel STPs can be selected from the top 22 potential STP locations to provide reduce stormwater runoff impacts.

Based on the recommendations listed above, treatment of several direct discharges in the Crosby Brook watershed area could be achieved for approximately \$2.8 million over a ten year period. These are costs are presented in 2014 dollars to plan, design, construct and maintain STPs over ten years, but do not include any estimated inflation costs for later phased projects that occur throughout the ten year time frame. Based on anticipated completion time frame,

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Town of Brattleboro, Vermont*



planners should apply contingencies to the planning budgets to cover any inflation or escalation of costs associated with these recommendations.

It is estimated that these recommended STPs could remove in excess of 60,000 pounds of Total Suspended Solids (TSS) on an annual basis or approximately 30 tons of TSS over a ten year period from entering Crosby Brook in addition to the replacement of four drastically undersized culverts and stabilization of approximately 25,000 square feet or approximately 550 linear feet of highly eroded stream banks along Crosby Brook.



Putney Road - Crosby Brook

Restoration Study

1.0 Introduction

1.1 Project Purpose

The purpose of the Crosby Brook Restoration Study Project is to protect Crosby Brook (identified as a Class B/Coldwater Fish Habitat) from polluted stormwater runoff that could enter storm drains within the three project areas identified by Town of Brattleboro, Vermont Agency of Transportation (VTTrans) and Vermont Department of Environmental Conservation (VT DEC).

Under this project, it is anticipated that STPs (Stormwater Treatment Practices) will be selected to handle stormwater runoff in three different project areas that will provide the most beneficial, cost effective and most protective alternatives for minimizing direct discharge of un-treated runoff and potential spills into the brook.

Protection of the brook would be provided by directing stormwater runoff that normally discharges un-treated into the brook to newly installed stormwater treatment STPs that are outfitted with specific non-point source (NPS) pollution treatment capabilities. These STPs will be conceptually sized and located to provide a balance of stormwater treatment for NPS pollution; peak flow attenuation for a wide range of storm events; stormwater recharge in accordance with State stormwater standards to maintain groundwater supplies; and pretreatment devices to capture sediment in easily accessible areas for maintenance.

Additional STPs would be provided for less developed areas where pollution sources include: soil erosion from un-armored roadways and drainage systems; bank and slope erosion along un-protected sections of the brook; sediment deposition and erosion caused by failing culvert crossings with gravel and paved roadways; and sediment and nutrient loading from a variety of land uses with little natural buffers to the brook.

The treatment STPs will be optimized based on subwatershed sizes, drainage characteristics and potential for pollutant removal. STPs will be sized to meet State of Vermont Stormwater Standards for Water Quality Volume, Recharge Volume, Pre-treatment Volume, Channel Protection Volume, Overbank Protection Volumes and to store peak volumes for certain larger sized storm events based on available space. Components within the STPs will also be properly sized to safely pass certain sized storm events and peak flows

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Town of Brattleboro, Vermont*



1.2 Project Background

The Town of Brattleboro received funding through a State of Vermont Federal Highway Transportation Enhancement (TE) Grant to complete the Crosby Brook Restoration Study Project. Tasks identified in this grant will include an evaluation of the watershed and conceptual designs for stormwater treatment practices (STPs) for discharges along the Route 5 / Putney Road corridor, Interstate 91 and the Exit 3 cloverleaf in the vicinity of Crosby Brook – a 303(d) impaired waterway listed for sediment pollution and habitat alterations due to sedimentation, channelization and buffer loss. The Town of Brattleboro intends to upgrade the Putney Road area; however, the continued deterioration of the Brook could interfere with that program. The project also intends to maintain good water quality in the brook to support the brook trout fishery. The proposed project will proactively address the impairment by identifying the best conceptual designs for stormwater control to be integrated with upcoming highway improvements by the Vermont Agency of Transportation (VTrans). It also integrates the proposed Brattleboro development plans as outlined in the Putney Road Master Plan.

Crosby Brook is made up of two tributaries, known as the North and South legs of Crosby Brook, that drain a largely rural yet steep area west of Interstate 91. The two tributaries are formed by several small tributaries that travel through a combination of low density residential areas and agricultural land prior to reaching very steep portions of the watershed. The two tributaries increase in size and velocity as they travel through this steep un-developed portion of the watershed prior to slowing and widening as both flow along the Route 91 right of way. These two tributaries eventually converge to the east of Interstate 91 between the Exit 3 ramps and the Putney Road round-about that connects State Routes 5 and 9. After this convergence, Crosby Brook flows through a highly developed impervious area prior to its ultimate discharge into the Connecticut River approximately ¼ mile south of the Route 9 (Franklin Pierce Highway Bridge). This highly developed area drains large parking lots and commercial businesses located along the Putney Road corridor with several direct runoff discharges to Crosby Brook.

The greater Crosby Brook Watershed covers in excess of 6 square miles and the project study area for the Crosby Brook Restoration Study Project covered approximately 735 acres of that total watershed area, and included in excess of 100 acres of impervious area. Throughout the upper subwatershed, which totaled approximately 385 acres of the study area, there are steep slopes, gravel roads and exposed terrain surrounding the brook and its smaller tributaries leading to erosion and resulting in sediment issues that are impacting water quality.

In the lower subwatershed, which totals approximately 350 acres of the study area, there are multiple stormwater outfalls to Crosby Brook along the Interstate 91 and Exit 3 right of way that have been identified as a source of sediment to the Brook. The Interstate 91 portion of the lower subwatershed makes up approximately 115 acres of the 350 acre study area with approximately 15 acres of impervious area.

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Town of Brattleboro, Vermont*



The remaining 235 acres of the lower subwatershed is made up of private commercial properties with a wide variety of land use and business types that have a lot of closed drainage systems and direct discharges into Crosby Brook. The lower subwatershed is also made up of right of ways owned and operated by the Town of Brattleboro including Black Mountain Rd., Bradford Drive and Hardwood Way, to name a few, and VTrans including State Routes 5 & 9 which contain portions of these closed drainage systems that discharge into the brook. This highly developed area contains a majority of the impervious area totaling approximately 85 acres that contributes large quantities of non-point source pollution that affect Crosby Brook including petroleum products, TSS and nutrients. The increased pavement area throughout this portion of the watershed also has impacts on the shrinking buffer zone and temperature effects on Crosby Brook and its natural inhabitants.

The main focus of the project is to provide conceptual designs that will provide enough capacity to carry projected flows from the 25-year design storm under build-out conditions, treating the water quality volume of the built-out drainage area to each discharge and providing recharge as allowable. Options that will be examined will include drainage re-routing options to direct runoff to the Connecticut River and proposed STPs that will meet the Channel Protection (CPv), Overbank Flood Protection (Qp10) and Extreme Flood Protection (Qp100) Treatment Standards of the VT Stormwater Manual. These STPs include but are not limited to:

- Diverting the Route 5 North stormwater to the existing Route 9 East drainage pipe to the Connecticut River through the existing box structure;
- A new trunk line that discharges directly to the Connecticut River;
- A combination of re-routing a portion of the flows to the Connecticut River and providing treatment of those discharges that are not re-routed;
- Installation of treatment STPs along portions of Interstate Route 91; State Routes 5 & 9; and in available open space on Town owned or private land including:
 - Wet swales
 - Stone infiltration trenches
 - Infiltration areas with sand filters
 - Extended detention basins
 - Bioretention systems
 - Catch basin inserts
 - Gravel wetlands
 - Wetlands with filtration berms
- Installation of STPs along portions of Crosby Brook main channel; along the Northern Fork; along the Southern Fork and in available open space on Town owned or private land including:

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Town of Brattleboro, Vermont*



- Repair of mass failures along Crosby Brook stream segments;
- Repair of steep slopes or eroded banks along Crosby Brook stream segments;
- Replacement of culverts and associated roadway drainage improvements for undersized stream crossings based on associated stream widths

For this project, CEI reviewed Town of Brattleboro, VTrans and VT DEC’s existing information and performed field visits to review watershed characteristics, inspect the catch basins, drainage features and outfalls.

CEI reviewed and organized several plan files provided from the Town of Brattleboro Planning Department. These plans provided details on drainage and utility infrastructure located along portions of Putney Road involving Town owned or private developments. CEI compiled this plan information to delineate subwatersheds, complete drainage computations and identify potential STP locations based on open space and existing utility infrastructure. CEI also reviewed the contributing drainage areas and drainage pathways to the direct discharges to the brook.

CEI utilized existing and proposed plans provided from VTrans for sections of Routes 5, 9 and 91 to identify infrastructure locations, existing / proposed roadway limits and drainage information to develop potential STPs located with VTrans right of ways. This information was used as a base map for most of the proposed STPs located within the Route 91 corridor. CEI also used example STPs that have recently been completed by VTrans on other portions of Route 91 as part of the proposed STP treatment designs.

Finally, CEI reviewed information included in the Phase 1 and Phase 2 Stream Geomorphic Assessment Summaries for Crosby Brook that were completed in 2008 by Fitzgerald Environmental Associates, LLC for the Windham County Conservation District. CEI utilized information in these reports to concentrate field efforts for the large upper watershed area of Crosby Brook. CEI visited potential problem areas cited in those reports and identified potential STPs along Crosby Brook based on that information and follow up field investigations.

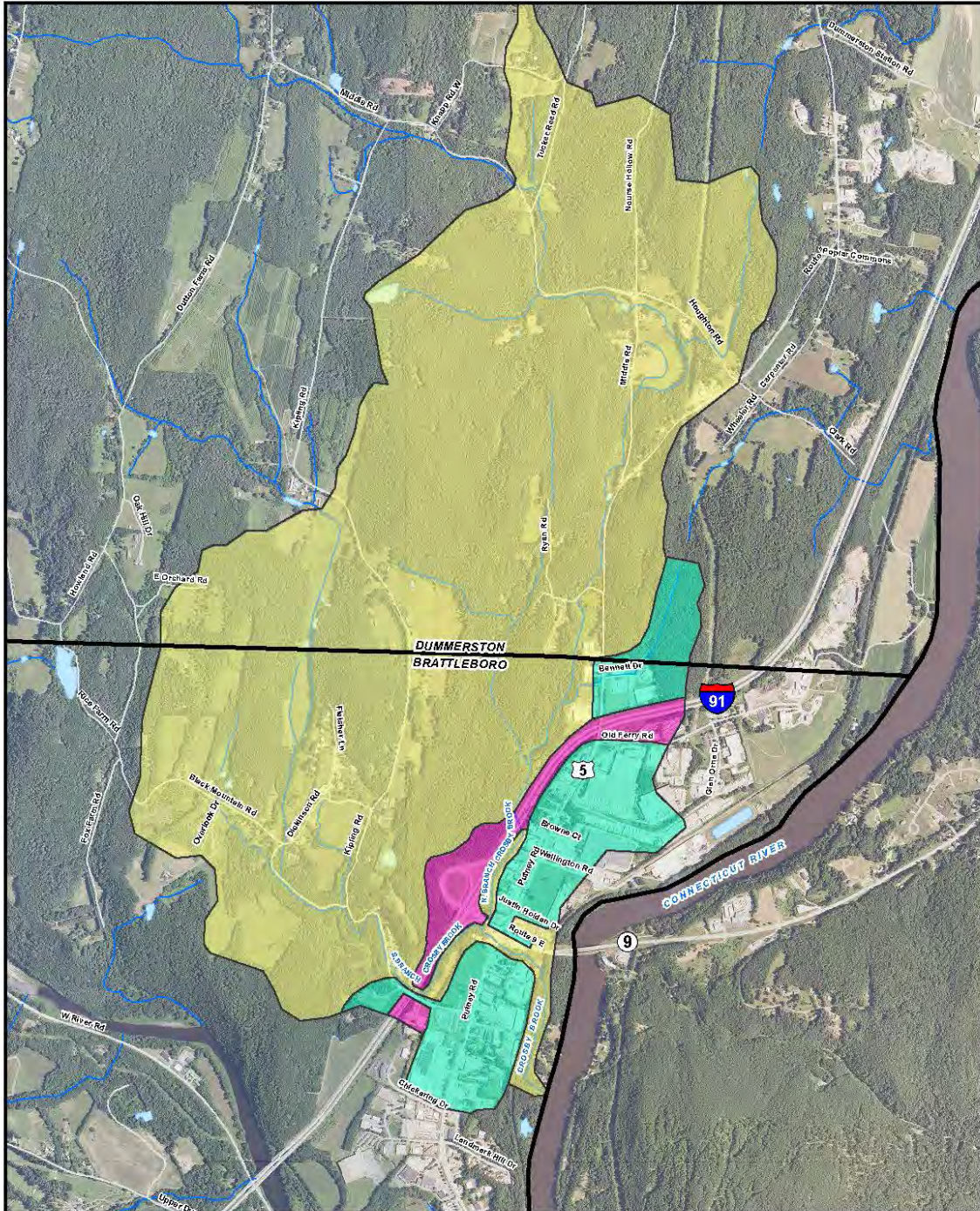
As part of the project review, CEI visited the following three project areas set forth in the project scope to confirm gathered information and field truth drainage and delineations prior to development of the proposed STPs:

- Project Area 1 – Putney Road & Adjacent Private Properties
- Project Area 2 – Route 91 Limited Access Right of Way
- Project Area 3 – Upper Watershed Areas & Crosby Brook Corridor

The following map details the project areas covered in this report and scope of field reviews:

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- Crosby Brook Project Areas**
- Project Area 1
 - Project Area 2
 - Project Area 3

PROJECT AREA MAP KEY

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During site reviews, CEI observed that for Project Areas 1 and 2 there are significant site constraints which will provide design challenges for either 1) redirecting the runoff from direct discharge to the brook, or 2) developing STP alternatives to treat stormwater runoff. Project Area 3, although subject to less site constraints than Project Areas 1 and 2, still has some design challenges associated with the type of STPs that could be utilized, large ledge outcroppings, access to the proposed work and the location of available land near the ultimate stormwater discharges and the brook.

CEI also revised drainage areas and subwatersheds based on the detailed record plan review and field investigations. Two specific drainage areas were not included in the STP analysis based on findings and revised watershed delineations. These areas are highlighted in Figure 1 located at the end of Section 4 along with the portion of Crosby Brook Watershed that was analyzed. In this figure, the lower portion of the watershed that was studied is highlighted in red, the upper watershed portion that was studied is highlighted in yellow and the two areas that were not included in the study are highlighted in green and cyan. The two excluded areas included:

- A portion of the original delineated watershed within Project Area 1 located between Wellington Rd and Route 9 and adjacent to the Connecticut River was found to drain directly to the Connecticut River rather than the Crosby Brook Watershed.
- A second portion located at the most southeastern corner of Project Area 1 along Putney Road and across from Chickering Drive was found to either drain directly to the Connecticut River or to Crosby Brook very near the confluence with the Connecticut River. It appears that this portion of the watershed drains under the railway right of way, but field visits could not confirm the location of the crossing and therefore the ultimate outfall location is currently unknown. If it is determined in the future that this area does drain under the railway and to Crosby Brook, there a number of potential locations to provide STPs and this area should be evaluated further.

As part of this study, Fitzgerald and Halliday, Inc. visited the potential STP sites and prepared a Preliminary Assessment of Environmental Permit Requirements to identify future permitting issues that may arise during the planning and implementation of larger STPs located through-out Project Areas 1 and 2. Potential permitting issues were used as part of the ranking process for selection of preferred alternatives and a copy of this assessment is provided in Appendix A.

1.3 Project Study Areas

Project Area 1

Project Area 1 is located at the eastern portion of the Crosby Brook watershed between Route 91 and the Connecticut River. The project area is made up of many commercial and industrial areas located along Routes 5 & 9 and consists of approximately

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Town of Brattleboro, Vermont*



7,000 feet of the two lane roadway with one bridge crossing over the brook. Portions of town owned rights of ways for Black Mountain Road, Bennett Road and Old Ferry Road plus adjacent residential and industrial areas are also included within this project area. Runoff discharges directly to the brook from approximately sixteen locations with several other indirect discharges that eventually drain to the brook. Design challenges include:

- The presence of multiple utilities in this area including, at a minimum, sewer, water and significant aerial utilities limit the area available for treatment within the road corridor. However, given the limited space for STPs, the inclusion of stormwater drainage and upgrades in this area during reconstruction of Putney Road could be more cost effective than installing STPs elsewhere;
- The presence of the bridge in the middle of the corridor spanning a portion of the brook near the east end of the watershed represents a challenge, since it would be difficult to cross the bridge with new drainage piping;
- The presence of heavy commercial and industrial development on either side of the major portion of this corridor limit the area available to provide STPs for treatment and/or storage and to install conveyances across the bridge;
- The presence of multiple utilities within this section of roadway also limits the ability to provide enhanced storage under the road.

While the opportunity to redirect runoff or provide treatment and storage within VTrans and Town owned right of ways may be limited, there appears to be contributing areas coming west along Routes 5 & 9 and most of Putney Road that collect in a few major drainage lines. This may provide the opportunity to redirect stormwater and/or create treatment and storage STPs to the east of Putney Road on private properties. Additionally, if there is future development within the Putney Road right of way or on private properties, both the Town and VTrans may have opportunities to tie in STPs with those changes. Despite tight utility corridors in these areas there could be opportunities to include improved stormwater management during construction or reconstruction of the State or Town owned infrastructure in the area. These opportunities will depend on how much the State or Town agencies plan to implement redevelopment in the area.

Project Area 2

Project Area 2 splits the Crosby Brook watershed in half, with the highly urbanized Route 5 and 9 (Putney Road) corridor located to the east and the large undeveloped upper watershed portion to the west. This area consists of the Route 91 turnpike right of way and consists of approximately 6,500 feet of four lane divided highway with three bridge crossings over Crosby Brook. This area also contains one major interchange with Route 5 and 9 (Exit 3 for Putney Road) and two overpasses; Route 5 on the northern end and Black Mountain Road on the southern end of the study area. These major features present both design challenges and potential locations for STPs throughout the study area. Runoff discharges directly to the brook from approximately fifteen locations with

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Town of Brattleboro, Vermont*



several other indirect discharges that eventually drain to the brook from the turnpike right of way.

Design challenges for this area include:

- A “tight” corridor along the turnpike bordered by guardrail to the east and steep slopes with potential ledge outcroppings to the west;
- Along one portion of the turnpike, a 3-4’ shoulder exists adjacent to the guardrail on the west side of the turnpike with a steep slope down to the brook allowing limited space for potential STPs;
- The lack of curbing along the eastern side of the turnpike could result in pollutants directly entering the brook via steep slopes;
- Existing wet areas within drainage swales and areas near designated wetlands located along portions of the eastern side of the turnpike provide some potential for STPs, however, options for infiltration STPs are limited, based on groundwater levels;
- The median of the turnpike contains most of the formal drainage for the paved surfaces and is wide (20 – 30 feet) and mostly flat, which provides some, however limited, opportunity for treatment STPs;
- Sections to the west of the turnpike and along the on/off ramps for Exit 3 provide ample space for STPs; however, existing drainage infrastructure and topography limit STP size and the capability of handling all turnpike drainage areas.

It appears there may be some opportunity on the western portion and possibly within the median of the turnpike to provide some locations for treatment and storage of runoff. However, the challenge will be to provide conveyance along the turnpike to these potential discharge/treatment areas.

Project Area 3

Project Area 3 makes up the remainder of the Crosby Brook watershed study area. It includes the main channel of Crosby Brook that runs through Project Area 1, the Northern and Southern upper forks of Crosby Brook, the land area directly abutting the brook and the upper watershed area for all of the Crosby Brook. This area consists mainly of banks and buffer areas to Crosby Brook including both forks and upper portions of the drainage area that contains very large sections of forest and undeveloped land to the west and northwest of the Route 91 right of way. This area consists of agricultural, forest and low density residential areas within the Towns of Brattleboro and Dummerston. This area includes approximately 9,000 feet of Black Mountain Road, Dickinson Road and portions of Kipling Road that drain to and/or border Crosby Brook along the Southern Fork. There is approximately 14,000 additional feet of Ryan Road, Middle Road, Houghton Road, Tucker Reed Road and Portions of Route 5

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Town of Brattleboro, Vermont*



that drain to and/or border Crosby Brook along the Northern Fork. These roadways consist of a mix of gravel and paved two lane roadways with approximately 10-12 roadway crossings over Crosby Brook. There are numerous discharges throughout this location, but limited formal drainage systems that would provide locations for potential STPs. Most discharges are via direct surface runoff or through open channels along roadway shoulders and at roadway crossings. Unlike Project Areas 1 and 2, there exists additional area adjacent to the roadways and smaller drainage areas to provide redirection and/or smaller treatment/storage STPs.

The challenges at this location include:

- Steep and inaccessible banks along the main channel of Crosby Brook as well as portions along both the Southern and Northern forks;
- Private properties and multiple locations with limited stream buffers border Crosby Brook throughout the upper watershed;
- Long, steep slopes to the east and west of Black Mountain Road are forested and not developed, but pose a challenge for handling large amounts of clean runoff that combine with the Black Mountain Road roadway runoff in closed drainage conduits prior to discharge into the South Fork. This increases the amount of runoff that must be handled when dealing with stormwater treatment for the relatively small portion of the watershed that is impervious;
- The long steep slopes along the Southern Fork also present substantial source of bank erosion and challenges with access to install stabilization STP techniques;
- There is evidence of significant ledge in the area as indicated by outcrops along the west side of Black Mountain Road and the South Fork at various locations;
- The proximity of the brook to Black Mountain Road and Dickinson Road in this area may limit the space available for redirection or STPs along the Southern Fork;
- Flatter terrain and larger roadway areas provide more opportunity for treating direct discharges along Route 5 and Middle Road along the Northern Fork, however, shoulders are narrow and space is limited where direct discharges occur;
- Multiple culvert crossings with limited formal drainage along the Northern Fork will require multiple treatment STPs and present design challenges with drainage conveyance;
- Shallower banks and easier access provide more options for bank stabilization along the Northern Fork, however, the presence of undersized and aging infrastructure within this area present design challenges and may lead to further issues with morphology of the stream in the future.



While there are limitations along this corridor, Project Area 3 appears to have the most available space within right of ways to redirect runoff from direct discharge to the brook through treatment and/or storage STPs. However, this project area is located in two different towns and has limited formal drainage that can be retrofitted and or improved. Additionally, it is evident that the roadway drainage and development poses less of a pollutant source issue in Project Area 3 compared to that in Project Areas 1 and 2. STPs that provide bank stabilization and sediment control along eroded sections of roadway or brook crossings present a more cost effective solution for this portion of the watershed. It should also be noted that a number of large bank mass failures/erosion areas and undersized culverts were identified in this area during previous geomorphic studies of Crosby Brook. The eroded banks leave the stream susceptible to further sedimentation and additional erosion during large storm events, which can become a larger issues and threaten nearby infrastructure if not stabilized or repaired. The undersized culverts limit flows through sections of Crosby Brook and cause erosion and sediment migration during large storm events. Correction of these deficiencies would help reduce stream instability, prevent stream bank erosion, minimize overtopping / flood damage and limit sedimentation of Crosby Brook. Corrective actions could be cost effective by combining deficient culvert replacement with streambank stabilization and erosion repairs if done during normal replacement schedules.

2.0 STP Evaluation & Ranking Methodology

2.1 Watersheds & STP Evaluations

Provided below is a description of the Stormwater Treatment Practices (STP) ranking selection procedures and justification that was used for the Crosby Brook Restoration Study Project. The purpose of this ranking was to select the most beneficial and protective STP sites from all the potential sites that were identified during a watershed evaluation conducted in the summer of 2011 at the three different project areas. This evaluation included field surveys and data collection provided by the Town of Brattleboro, State of Vermont Department of Environmental Conservation and Vermont Agency of Transportation. In order to identify all potential options, the collected data was used to generate potential STP locations and then several STP options were evaluated per location. To perform this evaluation, the following analysis was used:

1. Delineate subwatershed areas based on individual outfalls and potential STP locations;
2. Model subwatersheds to determine runoff volumes and peak flow rates for multiple storm events;
3. For each subwatershed, calculate required storage volumes for water



- quality, pre-treatment, recharge and multiple storm event scenarios based on Vermont Stormwater Standards;
4. Select STP options and determine available space and dimensions for multiple STP scenarios;
 - Drainage system re-routing;
 - Aboveground treatment areas;
 - Underground treatment systems;
 - Infiltration STPs,
 - Stabilization techniques;
 - Culvert Replacements
 5. Identify which subwatersheds can be diverted to each of the potential STP locations;
 6. Run multiple scenarios to determine which STP locations can be adequately sized to meet the required volumes based on diverting runoff from different subwatersheds;
 7. Determine required STP depths, sizes and spill containment capabilities under each scenario;
 8. Identify potential stream bank stabilization and culvert techniques and estimate a size of the problem area and potential repair for costing purposes;
 9. Estimate costs for each STP scenario and determine feasibility / benefits of implementation.

The following potential STP options and alternatives were conceptualized for each of the project areas in order to identify and evaluate each of the specific STP sites. Watershed delineations and conceptual STP locations are provided in Figures 2, 3, 4 and 25 for each of the Project Areas located at the end of this report. Model outputs for the watershed and subwatershed delineation and STP sizing computations are provided in Appendix B. The general alternatives were selected based on existing drainage infrastructure, roadway grading, topography, potential utility conflicts, roadway structures, soil types, bedrock depths, waterways, wetland resources areas, public safety, aesthetics, land use and other site specific parameters.

Project Area 1 – Putney Road

Alternatives - Capture stormwater from the roadways and divert runoff to STPs.

- Options to eliminate some direct discharges.
- Options to divert and treat with below-ground treatment trains or infiltration devices within VTrans right of ways.

*Crosby Brook Restoration Study Project
Town of Brattleboro, Vermont*



- Options to divert and treat at above-ground treatment trains located on Town owned or privately owned properties.

Project Area 2 –

Alternatives - Capture stormwater from the roadways and divert runoff to STPs.

- Options to divert & infiltrate within VTrans right of ways along highway shoulders and behind guardrails.
- Options to divert & infiltrate within the medians of highway and on/off ramps all within VTrans right of ways.
- Options to retrofit existing low lying areas located along right of way boundaries with above ground treatment trains.

Project Area 3 –

Alternatives – Stabilize roadways, steep slopes and provide stormwater treatment at roadway culvert crossings.

- Options to repair culverts and erosion at roadway crossings. Install small above-ground treatment systems with localized drainage controls at those crossings.
- Options to replace undersized culverts and stabilize stream banks.
- Options to repair eroded gravel roadways and drainage swales adjacent to the brook.
- Options to stabilize steep slopes and mass failures / eroded banks located along or adjacent to the brook.

Using these general options and taking into account the site constraints several potential locations were selected and the available space at each potential site was determined.

Once the potential STP sites were identified, CEI compiled the data and performed a ranking analysis or feasibility of implementation to determine the most beneficial STP sites for all of the project areas. Based on the ranking process for Project Areas 1 and 2 and the feasibility analysis for Project Area 3, some of these top sites will be selected as a recommendation for future implementation to assist in improving water quality and protecting the brook from NPS pollution and high velocity runoff. Attached to this narrative is map titled “Figure 3 – Crosby Brook Subwatershed Map and Drainage STP Locations,” that details the tributary subwatersheds and potential STP locations for Project Areas 1 and 2. Tables 1.0, 2.0 and 2.1 provide a summary of the potential STPs and some of the criteria used to rank sites in order to determine the most beneficial options for Project Areas 1 and 2. Figure 25 - “Project Area 3 - Crosby Brook STPs - Streambank Stabilization, Erosion Repairs and Culvert Replacements” provides details of the identified problem areas and potential STP locations for Project

*Crosby Brook Restoration Study Project
Town of Brattleboro, Vermont*



Areas 3. Table 4.0 provides an STP summary and associated cost for the recommended STPs located in Project Area 3.

2.2 STP Selection & Justification

A two phased ranking system was utilized to prioritize STP sites for Project Areas 1 and 2. The selection procedure ranked 35 total options which varied in treatment type, subwatershed area treatment combinations and volumes/storms treated, resulting in the top eight sites. These sites are summarized in Table 1.0, located at the end of this report. A detailed ranking process was performed to select the final STPs for each watershed area using a series of criteria. The ranking process utilized specific watershed data and results from the STP analysis. Results of the ranking are summarized in Tables 2.0 and 2.1 located at the end of Section 4 of this report. Below is a summary of the methods used for the STP ranking process:

Ranking Explanation

Potential STP volumes at all potential sites within Areas 1 and 2 were determined and compared to the required treatment volumes for each subwatershed that could potentially drain to the STP location. A total of 22 above ground locations were selected and the most effective STP was determined for each site based on Water Quality Volume Requirements. Underground / out-of-sight potential STP treatment locations were analyzed as part of the STP alternatives, but were avoided during this first prioritization/ranking process based on feedback from Town of Brattleboro, VTrans and VT DEC. It was determined that above ground alternatives would be preferred to any underground alternative, unless no other viable option could be identified for a particular area.

In all cases for the Project Areas, above ground STP options could be identified for all the subwatersheds by using new closed drainage systems and/or aboveground conveyance methods. The most effective options were based on the ability of each STP to handle the largest land area requiring treatment that could potentially drain to that STP with slight re-grading of drainage pathways and/or minimal adjustments to the existing closed drainage system. By optimizing these STPs for Water Quality Volumes, the largest area was treated in the smallest amount of space using the available land in the most effective manner while minimizing impacts and meeting several stormwater standards. Overall, a total of 22 options were analyzed and from those, the most effective options were selected for each of the project areas. Backup calculations and outputs for this STP alternative analysis are provided in Appendix B.

Twelve different criteria were used as justification for the first phase of the ranking system to determine the prioritization of the STPs, as seen in Tables 2.0 and 2.1. Backup for this methodology and ranking is also provided in Appendix C. This ranking method utilized a point system for each criterion that were specifically categorized

*Crosby Brook Restoration Study Project
Town of Brattleboro, Vermont*



and weighted to determine a total point score for each STP. The top ten STPs overall and the top four STPs for each project area with the highest number of points were selected to be analyzed and conceptualized for future evaluations as part of the second phase of the ranking system.

The twelve criteria used for ranking included: Proximity to Brook, Direct or In-direct Discharge to the Brook, Subwatershed Impervious Area Percentage, Ease of Implementation, Land Owner of STP Location, Subwatershed Land Use, Potential STP Storage Size, Potential STP Recharge Volume, Potential Sediment Removal, Potential STP Costs, Anticipated Permitting Requirements and Anticipated Maintenance Requirements. These criteria were assigned points based on a range of values for each STP site and then once the points were tallied, a multiplier was applied to each ranking number based on the location of the STP within a Project Area. Ranking criteria breakdowns and priority area multipliers can be seen under the notes for Tables 2.0 and 2.1 and are provided below:

- “Proximity to Brook”: Within 50 feet = 1 ; 51 feet - 100 feet = 2 ; 101 - 200 feet = 3 ; 201 - 300 feet = 4 ; 300+ feet = 5
- “Direct / Indirect Discharge”: Direct = 5 ; Indirect = 2
- “Impervious Area %”: 76% - 100% = 4; 51% - 75% = 3; 26% - 50% = 2; 0% - 25% = 1,
- “Ease of Implementation”: Easy, low number of issues = 5 ; Moderate, possible equipment maneuvering/ access issues = 3 ; Difficult, expensive equipment maneuvering/ road closures = 1
- “Land Owner”: Town / State = 3 ; Private = 1; Combined Town / State / Private = 2
- “Land Use”: Industrial/Commercial = 5 ; Mixed Use/Major Roadway = 3 ; Residential/Forested = 1
- “Potential STP Storm Size”: 100 yr plus = 5 ; 10yr - 100yr = 4 ; 5 yr - 10 yr = 3; 1yr - 5yr = 2; under 1yr = 1 ; No STP = 0
- “Potential STP Recharge”: 15,000 CF plus = 5 ; 10,000 - 14,999 CF = 4 ; 5,000 - 9,999 CF = 3 ; 2,000 - 4,999 CF = 2; <2,000 CF = 1 ; No STP = 0
- “Sediment Removal”: 250 CF plus = 6 ; 200 – 249 CF = 5 ; 150 – 199 CF = 4; 100 – 149 CF = 3; 50 – 99 CF = 2; 0 – 49 CF = 1 ; No STP = 0
- “STP Cost”: \$450,000 - \$549,999 = 1.5 ; \$350,000 - \$449,999 = 2 ; \$250,000 - \$349,999 = 2.5; \$150,000 - \$249,999 = 3; \$125,000 - \$149,999 = 3.5; \$75,000 - \$124,999 = 4; \$74,999 less = 4.5
- “Permitting Requirements”: No permits anticipated = 3 ; Possible permits anticipated = 2 ; Definitely permit anticipated = 1
- “Maintenance Requirements”: Low frequency, easy access, easy tasks = 5 ;



Moderate frequency, access issues, several tasks = 3 ; High frequency, difficult to access w/ equipment = 1

The second phase of the ranking system compared the potential TSS reduction with the estimated cost to determine a cost per ton of TSS removed per year. TSS loadings were calculated for the each subwatershed based on impervious area and potential winter maintenance loads. An assumed TSS removal rate was used for each STP to determine the total load reduction. Costs were estimated for each STP and a cost per ton of TSS was calculated. This was used to determine the most cost effective STP based on the lowest cost per ton removal. The top 2 sites for each area with the lowest associated cost per ton of TSS removal removed over a ten year period were selected for future watershed planning.

Ranking System Calculations

The ranking process first calculated an approximate subwatershed area for each STP based on GIS and CAD analysis and also where the STP was located within the specific subwatershed. This data was utilized to estimate an approximate impervious area and Water Quality Volume requirement using the Vermont Stormwater Manual guidance. This data, combined with the specific accidental spill volume calculations for each subwatershed, were also used to rank each potential STP. Based on each STP size, type, location and other implementation factors, an estimated construction and long term maintenance cost was determined. The STPs were then ranked from the highest number of ranking points down to the lowest number, as shown in Tables 2.0 and 2.1. Backup calculations and outputs for STP alternative ranking analysis are provided in Appendix C. Provided below is a detailed summary of the calculations used for this STP Ranking Methodology:

In order to evaluate each STP site for a large number of storms scenarios and water quality volumes, a model was used that calculates a specific rainfall amount to determine a runoff volume for each of the delineated subwatersheds. These different runoff volumes are compared to each STP volume that would be provided to determine how the STP will perform under different storm events and if it can meet certain treatment or accidental spill volume criteria. The STPs selected will have a specific pollutant removal efficiency based on this comparison, which will dictate how much of the pollutant loading going to the STP is actually removed/treated and how much of an accidental spill is actually stored. This methodology is reflected in the STP Matrix that was used to rank all the STPs.

The calculation for the STP performance and ranking is as follows:

*Crosby Brook Restoration Study Project
Town of Brattleboro, Vermont*



Several subwatershed areas for each project area are drawn in GIS/CAD to determine how much runoff (and associated pollutant) is received by a potential STP location. The subwatershed was then broken up into different land use types based on the six general land type categories using the same GIS layer information and aerial photography:

- Rural / Urban Mixed Use (High, Medium & Low Residential)
- Urban (Commercial & Industrial)
- Forest Land
- Open Land (Meadow & Low Density Residential)
- Agricultural Land
- Open Land (Bare soil, Mining, etc.)

Each of these land use types (LU) was assigned an average impervious area in the model. Using TR-55 methods, the land use areas (LUA) times the percent impervious were added together to determine a weighted average impervious area and average CN number per subwatershed ($\sum \text{LUA} \times \text{IMP}\% = \text{IMP AREA}$) and ($\sum \text{LUA} \times \text{CN} = \text{AVG CN value}$). These impervious areas and CN numbers were used in the model to estimate runoff volumes for multiple sized storm events and required treatment volumes like Pre-Treatment Volumes (PREv), Water Quality Volumes (WQv) and Recharge Volumes (REv). The TR-55 model was also used to estimate a time of concentrations for each subwatershed to determine a peak flows produced from multiple storm events occurring within each subwatershed.

The STP Water Quality Volume Required was determined using the weighted impervious areas and the following Vermont Stormwater Manual formula for each subwatershed: $(\text{WQv R}) = \text{IMP (sf)} * 1''/12$.

A Recharge Volume Required was also determined using this land use type breakdown, impervious area and specific soil type. Hydrologic Soil Type coefficients ($\text{SOIL}_{\text{coeff}}$) for each of soil types located under the subwatershed were determined from GIS data layers. These were multiplied by the impervious area in each STP subwatershed to determine a weighted recharge volume required for each individual subwatershed using Vermont Stormwater Manual requirements. The following equation was used from the Vermont stormwater Manual for each subwatershed: $(\text{REv R}) = \text{IMP (sf)} * \text{SOIL}_{\text{coeff}} (\text{in})/12$.

A STP Water Quality Volume Provided (STP WQv P) was estimated from GIS and Ortho plans based on the available space that was present to install the STP. These volume calculations used in the spreadsheet are all different based on available space, assumed depths, typical side slopes, typical STP widths, different tank materials and structural layouts. A STP Sizing Factor (STP SF) was determined using the available space information and volume provided compared to the STP Water Quality Volume Required so a ratio could be determined based on the following formula: $\text{STP SF} = \text{STP WQv P} / \text{STP WQv R}$. The STP Sizing Factor Ratio was then used to determine how many subwatershed areas and the associated WQv required could be handled

*Crosby Brook Restoration Study Project
Town of Brattleboro, Vermont*



by the estimated STP volumes provided to make the Sizing Factor Ratio roughly 1:1 (100% of WQv Required) or larger for each of the potential sites. Pre-Treatment Volumes and Recharge Volumes were compared in the same way, but Water Quality Volume Ratios were used as the deciding factor to complete the first round of ranking for each STP site.

The Pre-Treatment Volume was determined using the weighted impervious areas and the following Vermont Stormwater Manual formula for each subwatershed: $(PREv R) = IMP (sf) * 0.1''/12$. Once the STP sites were optimized for Water Quality Volume, the Pre-Treatment Volumes required were totaled and compared to the STP volumes provided. It was assumed that the forebay would make up roughly 10% of the total WQv provided in each pond and this volume would be used as the accidental spill storage area. The remaining area in each STP would be available for recharge to meet the treatment standards set forth in the Vermont Stormwater Manual and for additional controls for larger sized storm events.

In addition to the treatment volumes, the weighted CN numbers were used to calculate runoff volumes for different sized storms for comparison to the selected STPs locations and volumes provided. Runoff estimates and time of concentrations that were calculated in the model were used to determine unit peak discharges for each of the subwatersheds. A number of tables and nomographs were then used to determine the unit peak discharges and ratios of outflow to inflow for detention basins to safely pass specific storm events and store specific storm volumes. These ratios were used to determine a ratio of storage volume to runoff volume (Vs/Vr) using equations established by the Natural Resources Conservation Service (NRCS). Specific storm runoff volumes (Vr) included the Channel Protection Volume (CPv) and the Overbank Flood Volume (OBv or Q_{10}). The CPv was sized to provide 12 hours of extended detention for estimated peak flows of the 1 year-24 hour rainfall event. A 12 hour detention was used based on Crosby Brook being identified as a Class B / Coldwater Fish Habitat. The OBv was sized to control peak discharges for the 10 year-24 hour rainfall event to the maximum extent practicable since most of these STPs are being proposed as a redevelopment project rather than a new development project.

The storage volume (Vs) was calculated using that volume ratio, the subwatershed area (SA) and runoff estimates produced by each sized storm event. The following formula established by NRCS was used: $Vs = (Vs/Vr) * SA (sf) * Total\ Runoff (in) / 12$. Once the required storage volumes for each storm and subwatershed were determined, the volumes were totaled for each scenario and compared to the provided storage volume to determine what maximum size storm could be safely stored at each of the optimized locations and used for ranking criteria in the second round of ranking.

Most of these calculations were used in combination during ranking to optimize the STPs. A summary of these calculations for each subwatershed and STP can be found in Appendix B.

*Crosby Brook Restoration Study Project
Town of Brattleboro, Vermont*



Finally, an estimated conceptual construction cost for each STP was determined based on type, size, location and complexity of construction. Cost data was provided from published literature and historical construction costs from previously completed STP projects. Costs for piping, drainage structures, STP installations, excavation and additional components were carried in the construction costs. Contingencies were also carried for construction and project specific costs like potential rock/ledge excavation, stabilization techniques and special construction costs. Engineering, design, survey and permitting costs were added to these construction cost estimates to calculate total STP costs. It should be noted that these costs were presented for ranking purposes only and actual construction and engineering estimates should be refined once these STPs are selected for implementation and full scale design completed. A detailed cost breakdown for each of the 35 STPs is provided in table form in Appendix D. Assumptions for component costs are listed in that table and provided below:

- **Pipe Costs:** Linear feet of pipe times \$75/lf pipe between 0-500 ft; \$100/lf between 500 - 1000 ft; and \$150/lf for lengths over 1000 feet.
- **Structure Costs:** Number of drainage structures needed times \$2,500 per structure.
- **STP Installation Costs:** Cost to represent excavation, stabilization and installation of all standard stormwater treatment pond components: Pond Volume times \$1.50/ cu.ft. for ponds less than 100,000 cu.ft. and \$0.80 / cu.ft. for ponds larger than 100,000 cu.ft.
- **Additional Excavation Costs:** Cost per cubic yard to excavate existing terrain beyond the volume required for the pond. Estimated based on area of pond and approximate cut depths to level the area prior to pond installation.
- **Potential Rock/ Ledge Excavation Costs:** Cost per cubic foot to excavate rock and ledge that could be encountered during all excavations times \$5 per cubic foot of rock. Estimated based on volume of pond and volume of extra earth excavation assuming approximate ledge depths and percentage of total excavation depths.
- **Supplemental Costs:** Costs carried for supplemental work that would be required for a specific STP or location. Additional costs include liners for ponds close to brook, road re-grading, bridge retrofits, underground tanks, utility relocations and intercept swales to redirect additional runoff around STPs.
- **Survey Costs:** Based on estimates to obtain topographic survey for design and permitting. Cost includes a rough base price plus a cost per acre based on the footprint of the STP.
- **Permitting Costs:** Based on estimates to perform STP permitting for NOI and supplemental local permitting. Costs based on historical data and past experience and depend on potential impacts to the brook, wetland area, surface water resources and applicable buffers.



- **Engineering Costs:** Based on estimates to complete design, plans and specifications ready for bidding. Based on a combination of historical data, an approximate 20% of construction budget and previous design project experience. Costs do not include bidding and construction based services.
- **Annual Maintenance Costs:** Based on the type and size of STP, an annual operation and maintenance cost was estimated for each of the STPs and applied to each alternative over a ten year period to estimate a total long-term STP budget.

As a final step in the STP ranking calculation process for Project Areas 1 and 2, the estimated costs and estimated sediment removal capabilities of the higher prioritized STPs was used to determine a cost per ton of sediment removed over a ten year period. This was done by calculating potential sand loading from winter maintenance. Land use loadings were not used for this modeling and it should be noted that the potential TSS loading could be higher for some of the STPs based on additional land use factors and potential land erosion within the subwatershed. Winter maintenance was used for STP comparison purposes in Areas 1 and 2 based on the high percentage of impervious areas associated with commercial parking lots and busy roadways. It was assumed that TSS loading (TSS L) associated with winter maintenance was the same for all impervious areas; however it is more likely that parking lots and busy commercial areas are sanded even more heavily than some roadways.

The total impervious area (IMP in acres) was computed from the subwatershed analysis and totaled for each STP based on the amount of impervious land draining to that location. This impervious area was multiplied by typical total sand loading per acre per storm (SL) and then multiplied by the number of storms (#Storms) anticipated for this area that would require winter sanding in a given year. $TSS\ L = IMP\ (acre) * SL\ (lbs/acre) * \#storms\ (storms/year)$. It was assumed that there were approximately 10 storms per year (#Storms) and the typical sand loading per storm (TSS L) was 500 lbs of sand per acre, so that calculation for loading was $(TSS\ L)\ IMP\ (acre) * 500\ lbs/acre * 10\ storms\ per\ year$. This determined a total loading in pounds.

Each of the proposed STPs were then given an assumed removal percentage rate (Rem %), which was applied to the calculated sand loading (TSS L) to determine a total TSS reduction in pounds per year (TSS Rem). $TSS\ Rem = TSS\ L * Rem\%$. The TSS removal rate (Rem%) was assumed to be between 80% and 90% for STPs that are sized properly for pre-treatment (PREv R) and water quality volume (WQv R) requirements. Once the annual TSS removal in pounds was determined, it was normalized over a 10 year period and then converted to tons of TSS removed over a ten year period. $TSS\ Rem\ 10\ yr\ (tons) = TSS\ Rem\ (lbs/year) * 10\ Years / 2000\ lbs / ton$. For comparison



purposes, this report also refers to TSS loading (TSS L) and removals ((TSS Rem) in cubic feet and a density of 90 lbs per cubic foot was used to make this conversion.

Finally, the estimated costs to design, permit and build the project were added to the 10 year maintenance cost for each STP. This was done by calculating the anticipated annual maintenance cost in 2014 dollars and multiplying by ten. The total 10 year cost for each STP assumed that design, permitting and construction dollars were spent within the first 2-3 years of the project and 10 years of maintenance was applied to the principal costs following construction completion. This analysis was done to compare STP options for cost effectiveness and no inflation and escalation costs were applied to these numbers. It should be noted that if these projects are anticipated to be completed well into the future, planners should apply contingencies to the planning budgets to cover any inflation or escalation of costs.

The lowest cost per ton for each of the more feasible STPs was used to determine the highest priority STPs identified in the recommendations by dividing the total 10 year cost of the STP by the anticipated 10 year TSS reduction.

3.0 STP Selection

3.1 Selected Alternatives / STPs

For the purposes of this narrative, provided below is a detailed description of the top four priority sites in Project Areas 1 & 2. These top four STPs are not the highest priority STPs out of all the STPs identified; these details are provided for information purposes only to describe the top four STP sites for those project areas. It should be noted that some of the alternatives do overlap treatment areas within a watershed project area, so not all STPs would have to be constructed, rather one or a combination of these STPs could be implemented as the most cost effective solution for a specific location. Additionally, the top two nor top four STPs may not treat the entire subwatershed and additional STPs may be selected from the 22 to handle specific portions of the project area. Results of the top ten STPs overall and top four STPs per Area 1 and 2 can be found in Tables 3.0 and 3.1, respectively.

For Project Area 3, locations were selected where potential sediment or nutrient loadings could be significant and the site was readily accessible for repair or implementation of an STP. The upper watershed to Crosby Brook is very large and makes up the majority of Project Area 3. Project Area 3 is the largest of the project areas; however, it is the least developed. In general, the upper watershed is made up of forest, meadows, some agriculture and minimal low density residential land uses. Based on these land uses, the imperviousness of the watershed is very low and there are very limited potential

*Crosby Brook Restoration Study Project
Town of Brattleboro, Vermont*



locations where large cost effective stormwater treatment areas would be feasible. There are some minor paved roads and small gravel roads scattered throughout Area 3. Some portions of the upper watershed contain steep slopes where gravel roadways drain next to or cross Crosby Brook. Additionally, there are some culvert crossings that show signs of historical overtopping or have experienced erosion from roadway runoff. These locations would be the most viable to install treatment areas within Project Area 3.

Additionally, throughout the stream segments of Crosby Brook that run through Project Areas 1, 2 and 3, there are select locations with either steep slopes adjacent to the brook or portions of bank that have experienced historical erosion. These locations would provide viable opportunities to repair and provide stabilization techniques. The type of stabilization, associated cost and potential benefit would vary based on the severity of erosion.

Project Area 1 STP Selections

The top four STPs selected for Project Area 1 are described below and shown on “Figure 3 – Crosby Brook Subwatershed Map and Drainage STP Locations”:

Site 1-1 would be located to the east of the Route 5 right of way on private property. Two different ponded areas could be constructed in series to handle and treat large storm volumes. The STP footprints could be shaped to meet existing topography and positioned adjacent to a paved parking area and gravel equipment storage area. The STPs would intercept stormwater flows and treat NPS pollution that could occur throughout the private developments to the east of the Route 5 right of way located near the intersection of Putney and Black Mountain Roads. Site access would be very easy, but the STP may require considerable tree removal and cut/fills. Drainage diversions and new piping would be required along Route 5 and on private properties to send stormwater runoff to this treatment area. This STP would treat a total of approximately 13 acres and nearly 9 acres of impervious area. It could provide in excess of 80,000 cubic feet of runoff storage volume which would far exceed the Water Quality, Recharge and overbank flood storm volume requirements. The cost of the STP could be in excess of \$694,000 and estimated to remove approximately 340 cubic feet of sediment on an annual basis. A detail of this STP is shown on “Figure 4 – Crosby Brook Site 1-1 Proposed STPs”.

Site 1-4 would be located to the east of the Route 5 right of way and south of the Route 9 right of way on private property. The STP footprint would be positioned at the end of a gravel parking area that was affiliated at one time with the Bickford’s restaurant. The STP would intercept stormwater flows, treat runoff and store potential spills that could occur throughout a portion of the subwatershed to the west, the Route 9 / 5 Putney Rd. round-about and portions of Route 5 and 9 to the north of the round-about. Drainage diversions, retrofits and new piping would be required to send stormwater runoff to this treatment area. Site access would be easy, although permission may be needed from the existing property owner, or the Town of Brattleboro, VTrans and VT



DEC could possibly make a land purchase. There would be minimal tree clearing and very little cuts / fills. This project would be located near recent flood plain restoration project and the proposed STPs and overflow components at this site would be designed to minimize any impacts to the restored floodplain as well as provide additional flood storage of runoff during extreme events further protecting the Crosby Brook channel and banks. This STP would treat a total of approximately 7 acres and 4 acres of impervious area. It could provide in excess of 25,000 cubic feet of runoff storage volume which would meet Water Quality, Recharge and up the overbank flood storm volume requirements. The cost of the STP could be in excess of \$215,000 and estimated to remove approximately 110 cubic feet of sediment on an annual basis. A detail of this STP is shown on “Figure 7 – Crosby Brook Site 1-4 Proposed STPs”.

Site 1-2 would be located to the west of the Route 5 right of way on private property. Two STP footprints would be long and narrow and positioned adjacent to the right of way in open meadow areas. These STPs would resemble large roadside treatment swales interconnected by drainage piping. The STPs would intercept stormwater flows, treat runoff and store potential spills that could occur throughout a portion of the subwatershed to the west, several privately owned commercial properties with large paved parking lots, a portion of Black Mountain Road and portions of Route 5 Putney Road to the south of the round-about and near the intersection of Black Mountain Rd. Drainage diversions, retrofits and new piping would be required to send stormwater runoff to this treatment area. Site access would be easy, although permission may be needed from the existing property owner, or the Town of Brattleboro, VTrans and VT DEC could possibly make a land purchase or obtain drainage easements. There would be minimal tree clearing and very little cuts / fills. This STP would treat a total of approximately 16 acres and nearly 6 acres of impervious area. It could provide in excess of 54,000 cubic feet of runoff storage volume which would meet Water Quality, Recharge and up the overbank flood storm volume requirements. The cost of the STP could be in excess of \$296,000 and estimated to remove approximately 135 cubic feet of sediment on an annual basis. A detail of this STP is shown on “Figure 5 – Crosby Brook Site 1-2 Proposed STPs”.

Site 1-8 would be located to the west of the Route 5 right of way on private property and adjacent to the north fork of Crosby Brook. One large ponded area could be constructed in series to handle and treat large storm volumes. The STP footprint could be shaped to meet existing topography and positioned in a low lying grassed area behind two privately owned buildings. The STP would intercept stormwater flows and treat NPS pollution that could occur throughout the private developments to the west of the Route 5 and 9 right of way and portions of Putney Road. The drainage area for this STP would include portions of adjacent private properties. Site access would be very easy, require minimal grading, but would be located within wetland and Streambank buffers of Crosby Brook. Drainage diversions and new piping would be required along Route 5 / 9 and on private properties to send stormwater runoff to this treatment area. Drainage diversion piping would cross a portion of the current 99 Restaurant private property, however, the STP would not treat portions of that property based on the existing infiltration system designed to treat runoff for that adjacent impervious parking area and building. This STP would



treat a total of approximately 9 acres and nearly 5 acres of impervious area. It could provide in excess of 48,000 cubic feet of runoff storage volume which would far exceed the Water Quality, Recharge and overbank flood storm volume requirements. The cost of the STP could be in excess of \$397,000 and estimated to remove approximately 125 cubic feet of sediment on an annual basis. A detail of this STP is shown on “Figure 11 – Crosby Brook Site 1-8 Proposed STPs”.

Project Area 2 STP Selections

The top four STPs selected for Project Area 2 are described below and shown on “Figure 3 – Crosby Brook Subwatershed Map and Drainage STP Locations”:

Site 2-1 would be located on VTrans property along a portion of Route 91 south of the Black Mountain Road overpass. A series of STPs would be located within the median and along the northbound shoulder in partly forested and partly flat open grass areas. The STP footprints could be very long and narrow allowing easy positioning adjacent to the Route 91 right of way and the discharge to Crosby Brook. The STPs would intercept stormwater flows, infiltrate runoff and treat NPS pollution via sand filter / under drains that could occur throughout a small subwatershed area located on private property to the southeast of Route 91 and portions of the turnpike to the south of Black Mountain Road that runs to the south of the brook and discharges at a culvert under Black Mountain Road. STPs would require new drainage installed along the median and portions of the Route 91 drainage system to the east. Site access would be easy within the median because there is a paved turn-around located nearby. Access to the STP located along the northbound would be more challenging due to steeper slopes and would require considerable tree removal and some minor cut and fills. The STPs would treat a total of approximately 6 acres and just over 3 acres of impervious area. It could provide in excess of 25,000 cubic feet of runoff storage volume which would far exceed the Water Quality, Recharge and the overbank flood storm volume requirements. The cost of the STP could be in excess of \$137,000 and estimated to remove approximately 87 cubic feet of sediment on an annual basis. A detail of this STP is shown on “Figure 17 – Crosby Brook Site 2-1 Proposed STPs”.

Site 2-3B would be located to the northwest of the Route 91 on VTrans property along the southbound on/off ramps for Exit 3 in a partly forested and flat open grass area. The STP footprint could be very large and easily positioned adjacent to the Route 91 right of way and existing drainage systems. It could also be tied to some existing drainage STPs previously installed by VTrans that handle the southern and western portions of the subwatershed. The STP would intercept stormwater flows, treat NPS pollution and store potential spills that could occur throughout nearly the entire on/off ramp at Exit 3, and a large portion of Route 91 southbound lanes that run to the north and south of the ramp overpass. It would require minimal new drainage installed along the ramps and portions of the Route 91 drainage system to the south. Site access would very easy, but the STP would require considerable tree removal, some work within wet areas and some major cut and fills. This STP would treat a total of approximately 13 acres and just



over 1.5 acres of impervious area. It could provide in excess of 48,000 cubic feet of runoff storage volume which would far exceed the Water Quality, Recharge and the overbank flood storm volume requirements. The cost of the STP could be in excess of \$223,000 and estimated to remove approximately 93 cubic feet of sediment on an annual basis. A detail of this STP is shown on “Figure 19 Crosby Brook Site 2-3 Proposed STPs”.

Site 2-4 would also be located to the northwest of the Route 91 on VTrans property along the southbound on/off ramps for Exit 3. A series of STPs would be located within the median and along the southbound shoulder of the off ramp in partly forested and partly flat open grass areas. The STP footprints could be long and narrow within the median and quite large positioned adjacent to the Route 91 southbound off-ramp right of way and steep wooded slopes located to the west. STPs would stabilize portions of eroded banks that are located near the Exit 3 southbound off ramp. The STPs would intercept stormwater flows; treat NPS pollution via sand filter / under drains and infiltrate runoff that could occur throughout the off ramp at Exit 3 and a large portion of Route 91 northbound and southbound lanes that run to the south of the Crosby Brook northern fork culvert crossing down to the southbound off ramp. These would require minimal new drainage installed along the ramps and portions of the Route 91 median. These would also require new curbing along portions of the off-ramp. Site access would be challenging with steep slopes and deep drainage systems but the STP would require minimal tree removal. Work within wet areas would be required within portions of the STPs located near the off-ramp and some minor cut and fills located at the toe-of-slope would be required to construct the gravel wetland or wetpond. These STPs would treat approximately a total of 5 acres and just less than 1.5 acres of impervious area. These could provide in excess of 21,000 cubic feet of runoff storage volume which would far exceed the Water Quality, Recharge and the overbank flood storm volume requirements. The cost of the STPs could be in excess of \$125,000 and estimated to remove approximately 68 cubic feet of sediment on an annual basis. A detail of this STP is shown on “Figure 20 Crosby Brook Site 2-4 Proposed STPs”.

Site 2-5 would be located on VTrans property along a portion of Route 91 to the north of the Crosby Brook north bank culvert. A series of STPs would be located within the median and along the northbound shoulder of Route 91 in partly forested and partly flat open grass areas. The STP footprints could be very long and narrow allowing easy positioning with medians and adjacent to the Route 91 right of way and forested areas to the east. The STPs would intercept stormwater flows, infiltrate runoff, treat NPS pollution via sand filter / under drains and store potential spills that could occur throughout a large portion of Route 91 northbound and southbound lanes that run to the north of the Crosby Brook culvert crossing. These would also require minimal new drainage installed along the median and portions of the Route 91 drainage system to the east. Site access would be easy and the STPs would require only minimal tree removal and some minor cut and fills. The drainage area for these STPs would include mainly the Route 91 corridor with some small portions of private properties that drain onto the VTrans right of way. Some of these private properties have existing



underground infiltration systems (Hampton / Quality Inn) which provide treatment and then overflow onto the VTrans right of way. The portions of associated treated private properties are small compared to the un-treated VTrans drainage and therefore STP sizing was not adjusted to take credit for the treated portions of associated private properties. These STPs would treat a total of approximately 8 acres and just over 2 acres of impervious area. They would provide in excess of 13,000 cubic feet of runoff storage volume which would far exceed the Water Quality, Recharge and the overbank flood storm volume requirements. The cost of the STPs could be in excess of \$129,000 and estimated to remove approximately 58 cubic feet of sediment on an annual basis. A detail of this STP is shown on “Figure 21 – Crosby Brook Site 2-5 Proposed STPs”.

Project Area 3 STP Selections

The STPs selected for Project Area 3 are described below and shown on Figure 25 - “Project Area 3 - Crosby Brook STPs - Streambank Stabilization, Erosion Repairs and Culvert Replacements”:

A ranking selection process was not used for Project Area 3 based on the potential STPs being very similar in ranking criteria and sediment reduction benefits. Most of the potential STPs in this area were located in or direct adjacent to Crosby Brook, most addressed issues with similar magnitude and were nearly all located on or required access through private property. The upper watershed of Crosby Brook made up most of Project Area 3, which is a very large area made up of mainly undeveloped forest or agricultural land use with very minimal low-density residential areas. For these reasons, CEI only visited and identified potential STP locations that were cited in previously completed geomorphic assessments for Crosby Brook. Problem areas were then identified and recommended STPs selected based on severity of the issue. Table 4.0 provides an STP summary and associated cost for the recommended STPs located in Project Area 3.

Twenty one potential locations were identified where a potential treatment or stabilization STP could be implemented. The approximate locations are identified on the above referenced map and are color coded based on the type and size of STP that could be implemented in the area. Typical details of culvert crossing treatments and various steep slope / bank stabilization methods were also identified. These details are provided in Appendix E and can be implemented at many different problem locations throughout the upper watershed as needed, including locations that may not be identified in the report.

Even though potential STPs were not ranked for Project Area 3, several locations along Crosby Brook that are more severe and may need more immediate attention were identified. These potential locations include:

- Steep slopes along Southern Fork near Black Mountain Road
- Steep / eroded gravel roadways and drainage ditches along Southern Fork

*Crosby Brook Restoration Study Project
Town of Brattleboro, Vermont*



- Mass slope failure along Southern Fork near Black Mountain Road
- Eroded culvert crossing / drainage issues along Southern Fork and Dickinson Road
- Steep slopes / mass slope failure along Southern Fork near Route 91 northbound shoulder
- Mass slope failure along Northern Fork (M02) along Route 91 southbound right of way
- Steep / eroded slopes along gulley near Pepsi Factory
- Mass slope failure along Main Channel near Route 9 eastbound shoulder
- Mass slope failure along Northern Fork near Houghton Road
- Eroded / steep banks near Dam along Northern Fork near Tucker Reed Road
- Eroded culvert crossing / drainage issues along Northern Fork and Houghton Road
- Perched culvert / drainage issues along Northern Fork and Ryan Road

In addition to identified slope failures, limited buffers, erosion and drainage issues, there are several undersized culverts located on both forks of Crosby Brook that can cause localized erosion, scouring and sediment transport during large storm events and overtopping occurrences during flooding events. The undersized culverts were identified during the Crosby Brook Phase 2 Stream Geomorphic Assessment completed in 2008 by Fitzgerald Environmental Associates, LLC. These culverts could be resized and replaced to reduce these impacts and stabilize Crosby Brook geomorphology. Replacement and widening or removal of perched culverts would also provide additional environmental benefits including improved fish and wildlife passage, stream bank stabilization and improved drainage. All of these benefits would be implemented on a more cost effective basis if completely correctly and concurrent with the associated culvert replacement. Major undersized culverts were identified in the Fitzgerald Report as being less than 75% of the associated stream width. Undersized culvert locations are also identified on Figure 25 - "Project Area 3 - Crosby Brook STPs - Streambank Stabilization, Erosion Repairs and Culvert Replacements." The major undersized culvert locations include:

- Culvert at Northern Fork crossing with Ryan Road (perched culvert) – 29% of stream segment width
- Culvert at Northern Fork crossing with Middle Road (north of Rt. 5) – 33% of stream segment width
- Culvert at Northern Fork crossing with Middle Road (south of Houghton Rd) – 44% of stream segment width
- Culvert at Northern Fork crossing with Houghton Road (south of Tucker Reed Rd) – 56% of stream segment width



- Culvert at Northern Fork crossing with Tucker Reed Road (east of Houghton Rd) – 34% of stream segment width
- Culvert at Northern Fork crossing with Houghton Road (northwest of Tucker Reed Rd) – 36% of stream segment width
- Culvert at Southern Fork crossing with Black Mountain Road (south of Crescent Drive) – 24% of stream segment width
- Culvert at Southern Fork crossing with the gravel portion of upper Black Mountain Road (west of Kipling Drive) – 40% of stream segment width
- Culvert at Southern Fork crossing with Dickinson Road (east of Black Mountain Rd) – 33% of stream segment width

3.2 STP Ranking Results

The two phased STP ranking methodology produced preferred STP sites from two of the three project areas (Projects Areas 1 & 2). This process ranked STPs higher that were located farthest from the brook, near the most impervious areas, at the busiest streets/intersections, handled the highest Water Quality Volume possible and provided the most cost effective removal of TSS as shown in Tables 2.0, 2.1 and Figures 2 & 3. In addition, a matrix of 22 STP alternatives with the top ten preferred sites overall summarized in Table 3.0 and provided as a ranking breakdown for individual Project Areas 1 and 2. The top four sites within each watershed are as discussed previously in this narrative and as shown in Table 3.1. These eight sites are not necessarily the top priority sites for the overall project and would not all have to be installed to solve all the stormwater, accidental spill and TSS loading issues throughout the watershed areas. Two different tables were provided detailing the top ten sites for the preferred alternative selection that were prioritized based on feedback from Town of Brattleboro, VTrans and VT DEC and the top four priority sites in each project area to provide Town of Brattleboro, VTrans and VT DEC with multiple means for future planning and alternatives for the final STP selection process. Potential STPs in Project Area 3 were not ranked, however, implementation of culvert repairs and structural stabilization techniques to minimize impacts from bank erosion, slope failures and minor roadway drainage issues can be implemented throughout the upper watershed to minimize sedimentation and adverse geomorphic changes to Crosby Brook in both the Northern and Southern forks.

The top ten STP sites from project areas 1 and 2 are estimated to treat over 115 acres of the watershed project areas and over 62 acres of impervious area which accounts for approximately 30% of the total subwatershed study area and over 60% of the impervious areas in the subwatersheds as shown in Table 3.0. With implementation of these STPs, there is some overlap with treatment areas throughout the watershed, but it is projected that the top 10 sites could remove approximately 1,555 cubic feet (140,000 pounds) of TSS per year from the watershed based on an estimated 80% removal efficiency for all the STPs. These top 10 STPs could provide approximately 203,000 cubic feet for water quality volumes and 20,000 cubic feet for pre-treatment volumes in total. It is anticipated that these top ten STP sites would cost approximately \$3,600,000 over

*Crosby Brook Restoration Study Project
Town of Brattleboro, Vermont*



a ten year period with annual maintenance included. These costs could vary based on implementation selection and size reductions based on which other STPs are implemented in the area and how big they are finally sized. It is recommended that, based on feedback from project partners, some of these STPs would be implemented taking care not to install STPs with overlapping treatment areas.

The top four STP sites from project areas 1 and 2 are estimated to treat 81 acres of the watershed project areas and approximately 27 acres of impervious area which accounts for approximately 23% of the total subwatershed project areas and nearly 30% of all the impervious areas in the subwatersheds as shown in Table 3.1. These STPs will provide approximately 114,000 cubic feet for water quality volumes and 11,000 cubic feet for pre-treatment volumes in total. These eight STPs will also remove approximately 1,046 cubic feet (94,000 pounds) of TSS per year from the watershed, based on an estimated 80% removal efficiency for all the STPs. It is anticipated that these top four STP sites for Project Areas 1 and 2 would cost approximately \$2,400,000 over a ten year period with annual maintenance included. These costs could vary based on implementation selection and size reductions based on which other STPs are implemented in the area and how big they are finally sized. It is recommended that, based on feedback from project partners, some of these STPs would be implemented taking care not to install STPs with overlapping treatment areas.

4.0 Recommendations

4.1 Recommended STPs

It is recommended that a combination of several STPs be installed in each of the Project Areas to treat or eliminate the majority of indirect and direct discharges covered under the project. These would be implemented in a phased manner to handle most of the direct discharges to the brook within each project area over several years. Provided below is a detailed recommendation plan for each project area based on the ranking results described in Section 3.2. This plan is designed to meet project goals in the most effective manner and begins with the highest priority area (Project Area 1) and proceeds in order down to the lowest priority area (Project Area 3).

Results of this recommendation plan are summarized in Table 4.0 located at the end of this section. Conceptual costs for construction, permitting and engineering were used for ranking each of the STPs relative to each other and are referenced in previous sections of the report. For planning and budgetary purposes, a contingency is carried for each of the recommended implementation plan costs in addition to supplemental costs for roadway enhancements and safety improvements that would go along with these recommended STPs. Recommended plan costs with these contingencies are provided below following a detailed description of the implementation plan for each project area.



Project Area 1 Recommendations – Priority #1

It is recommended that two of the highest priorities STPs are installed along the Putney Road corridor by VTrans and the Town of Brattleboro. These would include Site 1-1 and 1-4 as described above in Section 3.1. These sites were selected as the two highest priority sites based on available space, treatment capabilities, land owner, ease of access, size of watershed treated and potential cost per ton of sediment removed over a 10 year period. One STP would handle runoff from portions of Putney Road and associated private properties located to the south of the Putney Road crossing with Crosby Brook. The second STP would be designed to handle runoff from portions of Putney Road and associated private properties located near the Route 5 / 9 round-about and portions of Route 9 north of that intersection. This portion of the project would handle sections of existing Putney Road that is slotted for re-alignment and construction of several roundabouts. Additionally, the STPs were conceptually sized to handle runoff from undeveloped land that could potentially be developed and built-out in accordance with the Town of Brattleboro's Master Plan for the area. The implementation of these projects should be carefully planned with the re-alignment of Putney Road and any future planned redevelopment in that area by the Town of Brattleboro. It should be noted that most of the proposed STPs in this area would be sized to treat both VTrans / Town of Brattleboro drainage in addition to runoff from several private properties that is tied to existing drainage maintained by those agencies or flows overland onto those right of ways. If issues arise (e.g. access, permission and or environmental concerns) with the implementation of the two top STPs in Project Area 1, the alternative sites from the top 4 STP ranking could be implemented to provide treatment for those areas which include Sites 1-2 and 1-8

Based on the STP sizing and ranking analysis completed for STP 1-13 (STP integrated with future Putney Road re-alignment), it was determined that there would not be ample available above-ground space to provide adequate stormwater storage and treatment based on the proposed re-alignment project and round-about installation within the Crosby Brook watershed. Additionally, VTrans may have concerns with infiltrating runoff into the sub base of the newly replaced Route 5. For this reason, an alternative for providing treatment components within the new alignment would not be recommended. It should be noted that the recommended STPs for this area should be adequately sized to handle any new impervious area produced from the Putney Road re-alignment in addition to other potential build-out scenarios planned by the Town of Brattleboro. Any re-alignment project should incorporate new drainage design and part of that should include investigations of existing drainage connections from private properties within the impacted right of way. If new drainage is constructed for the re-alignment, this could be connected to the proposed STPs after they are built, however, the STPs could be cost effectively constructed as part of the roadway construction project and new drainage systems.

The recommended option selected for the proposed re-aligned section of Putney Road is sized based on an increase in impervious area due to future build-out and redevelopment along the Putney Road corridor. The proposed site could be

*Crosby Brook Restoration Study Project
Town of Brattleboro, Vermont*



constructed without influencing the proposed re-alignment of Putney Road and could be implemented prior to re-alignment work or during construction as a more cost effective solution. The STP proposed for the section of Putney Road not slated for redevelopment could also be constructed at any time, however, implementation during road construction could be more cost effective even if re-alignment is not proposed in that area.

The proposed STPs along Putney Road in Project Area 1 also handle stormwater runoff from private properties that are assumed to drain onto VTrans right of way or are connected to state owned drainage piping. The proposed STPs will be properly sized if implementation occurs prior to any re-alignment or re-development. If STPs are constructed during Putney Road re-alignment, the VTrans investigation of exiting drainage “tie-ins” will identify potential disconnects and VTrans will have to determine whether STPs will handle private property runoff and be sized accordingly. For cost effective installations on private property, the Town of Brattleboro should ensure that future STPs are proposed and implemented to the maximum extent practicable as part of future development. These should be identified by the Planning Department during their review of any re-development or new development projects in the area. This would reduce the volume of runoff handled by the proposed STPs identified under this study and decrease potential future construction costs for the Town of Brattleboro and VTrans.

The cost to install the two highest priority STPs in Project Area 1 would be approximately \$924,000. If implemented, the two STPs would potentially remove in excess of 40,000 pounds of sediment per year from entering Crosby Brook at an average cost of \$4,600 per ton of sediment removed over a ten year period.

Project Area 2 Recommendations – Priority #2

It is recommended that two of the highest priorities STP locations are implemented along the Route 91 corridor by VTrans. These would include Site 2-1 and 2-4 as described above in Section 3.1. These sites were selected as the two highest priority sites based on available space, treatment capabilities, land owner, ease of access, size of watershed treated and potential cost per ton of sediment removed over a 10 year period. One STP would be designed to handle runoff from portions of Route 91 around the Exit 3 on/off ramp and sections of Route 91 southbound traveled way. The second STP would handle runoff from portions of Route 91 south of the crossing with the Southern Fork of Crosby Brook and the Black Mountain Rd Bridge. Additionally, the STPs were conceptually sized to handle any future runoff from un-developed land that could potentially be developed within the subwatershed. The implementation of these projects should be carefully planned with any future construction or re-alignment on Route 91. It should be noted that most of the proposed STPs in this area would be sized to treat both VTrans drainage in addition to runoff from private properties that drain onto the Route 91 right of way within the associated subwatersheds.

The identified STP locations could employ several different design components to provide treatment including infiltration devices, sand filter devices and other stormwater treatment components (e.g. gravel wetlands, extended detention basins,



etc.). VTrans has recently successfully completed similar STPs along the Route 91 corridor and these high priority locations could be easily installed within the available space to provide excellent stormwater treatment prior to discharge into Crosby Brook.

The cost to install the two highest priority STPs in Project Area 2 would be approximately \$312,000. If implemented, the two STPs would potentially remove in excess of 16,000 pounds of sediment per year from entering Crosby Brook at an average cost of \$4,500 per ton of sediment removed over a ten year period.

Project Area 3 Recommendations – Priority #3

It is recommended that major stream bank erosion and mass failures be repaired / stabilized as the highest priority projects. Additionally, culvert replacement for some of the extremely undersized culverts identified in Section 3.1 above should be completed at a regular scheduled occurrence. The Town of Brattleboro and VTrans should develop of culvert inspection, maintenance and replacement schedule as a long-term plan for improving Crosby Brook. This schedule could propose a phased replacement for culverts based on the severity of the issue as well as how much the culvert is undersized. As an example, culverts under 33% of the associated stream width could be replaced first, followed by culverts under 66% of the associated stream width, followed by the remaining culverts needed to meet the minimum 75% width of the associated stream segment. All proposed culvert replacement would provide the minimum 75%, however, independent evaluations could determine which culverts should be replaced to full bank width to provide proper capacity, prevent flooding, minimize erosion / scour and improve wildlife stream passage.

The following locations were identified as the highest priority streambank / steep slope repairs:

- Mass slope failure along Southern Fork near Black Mountain Road
- Steep slopes / mass slope failure along Southern Fork near Route 91 northbound shoulder
- Mass slope failure along Northern Fork (M02) along Route 91 southbound right of way
- Steep / eroded slopes along gulley near Pepsi Factory
- Mass slope failure along Main Channel near Route 9 eastbound shoulder
- Mass slope failure along Northern Fork near Houghton Road

The following culvert locations were identified as the highest priority replacement projects (culverts under 33% of associated stream width):

- Culvert at Northern Fork crossing with Ryan Road (perched culvert) – 29% of stream segment width



- Culvert at Northern Fork crossing with Middle Road (north of Rt. 5) – 33% of stream segment width
- Culvert at Southern Fork crossing with Black Mountain Road (south of Crescent Drive) – 24% of stream segment width
- Culvert at Southern Fork crossing with Dickinson Road (east of Black Mountain Rd) – 33% of stream segment width

It should be noted that all stream bank and culvert projects will require careful engineering and permitting. Typical stabilization construction costs could range depending on the magnitude of the erosion. In general, small scale erosion repairs can cost \$5.00 / square foot of repaired bank. Medium to large scale streambank / slope stabilization measures can range from \$7.50 / square foot up to \$10.00 / square foot of repaired slope. On average, culvert replacement / installation costs can range from \$1,500/ linear foot for smaller culverts (under 10 foot wide opening) and up to \$3,500/ linear foot for large diameter pipes or box culverts (over 10 foot opening). These are costs for installation or replacement and do not include engineering, permitting or incidental construction costs associated with work in environmentally sensitive locations, as well as traffic control, water handling and other unforeseen items.

To complete the six major erosion sites it could cost approximately \$370,000. The cost assumes an approximate bank length and width for each of the identified sites and assumes engineering, permitting and contingencies are included, resulting in an average cost of \$15 per square foot of impacted bank. Typical streambank and steep slope details that can be used for implementing repairs are provided in Appendix E

To replace the four identified culverts that are under 33% of the stream width and expand them to meet the minimum 75% of stream width, it could cost approximately \$1,200,000. This cost assumes an approximate length and proposed opening of culvert to meet minimum requirements of the associated stream width. Costs also include repair of the impacted roadway and installation of improved drainage and stormwater runoff treatment (e.g. swales, checkdams, deep sump catch basins, etc.) to further protect Crosby Brook from NPS pollution associated with roadway drainage. These costs were prepared assuming engineering, permitting and contingencies are included in the total cost to replace the four highest priority culverts. These total project costs result in an average cost of approximately \$5,000 per linear foot of replaced culvert. Recommended culvert replacement alternatives are presented for planning purposes only and each culvert should be evaluated on site by site basis to determine a selected width, height, embedment, substrate type and additional design criteria prior to proceeding with full scale design and implementation.



4.2 Implementation Phasing & Planning

The implementation plans for each of the Project Areas should be strategically phased to provide treatment in the busier, high priority areas first and then continue to complete subsequent areas as funding becomes available. The following phasing plan is recommended based on the potential for negative impacts to Crosby Brook and known infrastructure plans at the time of this report:

1. Project Area 1 – STPs 1-1 and 1-4 (coincide with Putney Rd re-alignment)
2. Project Area 2 – STPs 2-1 and 2-4
3. Project Area 3 – Streambank / Mass Failure Repairs
4. Project Area 3 – Culvert Replacements

It is recommended that installation of STPs involved with the Putney Road drainage be installed as part of the proposed re-alignment project to be the most cost effective. STPs located on Route 91 should be constructed as funding becomes available or as proposed reconstruction in the area is planned to make installations more cost effective. Culvert replacements should be carefully planned to coincide with any future roadway construction projects as well. Culvert inspections and replacements should be on-going and the responsible parties should develop a long-term phased replacement schedule and budget to replace culverts prior damage or ultimate failure. Streambank repairs should also be continually monitored and a long-term repair schedule prepared to ensure that bank repairs take place before the erosion gets too large or starts to undermine / threaten the structural stability of nearby infrastructure.

It should be noted that STP costs referenced in this report were estimated for comparison of STP options to determine cost effectiveness and no inflation and escalation costs were applied to these numbers. If these projects are anticipated to be completed well into the future, planners should apply contingencies to the planning budgets to cover any inflation or escalation of costs.



TABLE 1.0 - STP OPTIONS - RANKING CRITERIA SUMMARY

STP ID	Sub-basins Handled (Outfall I.D.)	Sub-basin Areas (acres)	Impervious Areas (acres)	Percent Impervious (%)	WQv Target (cu.ft.)	REv Target (cu.ft.)	CPv Target (cu.ft.)	OBv Target (cu.ft.)	STP Max Volume (cu.ft.)	Percent Town (%)	Percent State (%)	Percent Private (%)	Available Build-Out (%)	TSS Removal (cu.ft.)	Property Owner	Proximity to Brook (ft)	Permitting Required	Design Storm Handled	Land Use Type	STP Construction Cost (\$)	Engineering Total Costs (\$)	STP Total Costs (\$)	STP Maintenance (\$)	STP Total 10 yr Costs (\$)
1-1	6, 6D, 6E, 6F, 15	13.4	9.0	67%	28,700	11,000	37,800	83,100	83,250	13%	0%	87%	24%	340	PRIVATE	375	NONE	OVER 10YR-24HR	COMMERCIAL	\$483,396	\$176,600	\$659,996	\$3,400	\$693,996
1-2	6, 6H, 6I, 6J	16.2	5.8	36%	19,650	6,200	23,300	54,400	54,800	3%	3%	93%	26%	135	PRIVATE / STATE	650	NONE	OVER 10YR-24HR	COMMERCIAL / RESIDENTIAL	\$214,659	\$82,200	\$296,900	\$3,100	\$327,900
1-3	1, 3, 5, 6, 6A, 6B, 6C, 8	13.0	7.3	56%	23,650	7,550	27,100	63,000	62,900	2%	10%	88%	29%	190	PRIVATE	75	POSSIBLE	10YR-24HR	COMMERCIAL / INDUSTRIAL	\$361,785	\$138,300	\$500,100	\$2,600	\$526,100
1-4	7, 7A	7.3	4.1	56%	13,200	5,900	9,100	26,200	26,400	0%	22%	78%	57%	110	PRIVATE / STATE	75	POSSIBLE	OVER 10YR-24HR	COMMERCIAL	\$151,259	\$64,000	\$215,300	\$2,000	\$235,300
1-5	8, 9	1.7	0.5	32%	1,900	800	2,000	5,650	5,640	0%	4%	96%	0%	18	PRIVATE	25	DEFINITE	10YR-24HR	COMMERCIAL	\$32,574	\$26,700	\$59,300	\$1,300	\$72,300
1-6	7	4.4	2.7	61%	8,500	3,900	6,300	17,700	26,800	1%	25%	74%	63%	84	PRIVATE	150	NONE	OVER 10YR-24HR	COMMERCIAL	\$144,820	\$57,100	\$201,900	\$2,400	\$225,900
1-7	7, 18, 19, 21, 23	9.5	6.6	69%	20,850	8,900	19,800	49,400	50,500	0%	13%	87%	41%	170	PRIVATE / STATE	500	NONE	OVER 10YR-24HR	COMMERCIAL / INDUSTRIAL	\$311,585	\$116,200	\$427,800	\$3,200	\$459,800
1-8	7, 18, 18A, 19	8.6	5.4	63%	17,300	7,900	12,800	35,300	48,750	0%	9%	91%	42%	125	PRIVATE	50	POSSIBLE	OVER 10YR-24HR	COMMERCIAL	\$285,102	\$111,900	\$397,000	\$3,100	\$428,000
1-9	23, 24, 26A, 26B	10.0	5.5	56%	18,000	4,800	16,300	39,500	38,000	0%	16%	84%	0%	138	PRIVATE / STATE	50	DEFINITE	UNDER 10YR-24HR	COMMERCIAL / HIGHWAY	\$224,419	\$94,700	\$319,100	\$2,100	\$340,100
1-10	33A, 33B	21.1	14.4	68%	45,800	13,200	56,200	130,600	94,500	1%	1%	98%	0%	170	PRIVATE / STATE	625	POSSIBLE	UNDER 10YR-24HR	COMMERCIAL / INDUSTRIAL	\$151,819	\$67,400	\$219,200	\$5,200	\$271,200
1-11A	37A, 40	20.5	3.9	19%	14,650	3,500	7,900	43,650	34,500	1%	0%	99%	2%	80	PRIVATE	225	DEFINITE	UNDER 10YR-24HR	COMMERCIAL / INDUSTRIAL	\$112,311	\$55,600	\$167,900	\$2,300	\$190,900
1-11B	37, A, 37B, 41A, 41B	19.3	6.1	32%	21,100	5,600	27,100	78,000	78,000	0%	4%	96%	7%	112	PRIVATE / TOWN	500	DEFINITE	10YR-24HR	COMMERCIAL / INDUSTRIAL	\$247,107	\$103,800	\$350,900	\$3,300	\$383,900
1-12	14	18.1	4.6	25%	16,500	6,600	1,300	17,800	17,800	2%	0%	98%	61%	87	PRIVATE / TOWN	50	POSSIBLE	10YR-24HR	RESIDENTIAL	\$128,456	\$56,100	\$184,600	\$2,100	\$205,600
1-13	6, 6H & 15C	16.4	8.8	54%	28,600	11,700	24,500	36,200	28,850	3%	70%	27%	6%	118	STATE	625	NONE	10YR-24HR	COMMERCIAL / HIGHWAY	\$308,619	\$120,900	\$429,500	\$3,900	\$468,500
2-1	13, 13B, 13C	5.6	3.1	56%	10,100	3,100	9,900	26,000	25,800	0%	62%	38%	2%	87	STATE	150	POSSIBLE	10YR-24HR	COMMERCIAL / HIGHWAY	\$93,607	\$44,100	\$137,700	\$2,400	\$161,700
2-2	12, 12A, 13A	22.5	3.5	16%	14,000	5,050	300	6,700	12,900	1%	46%	53%	7%	136	STATE	100	DEFINITE	OVER 10YR-24HR	RESIDENTIAL / HIGHWAY	\$82,846	\$46,000	\$128,800	\$3,000	\$158,800
2-3A	10, 11A, 16B, 17	6.5	1.6	25%	5,800	2,350	900	7,400	8,100	0%	100%	0%	0%	78	STATE	50	DEFINITE	OVER 10YR-24HR	HIGHWAY	\$109,874	\$55,100	\$165,000	\$2,600	\$191,000
2-3B	11B, 11C, 11D	13.3	1.9	14%	7,700	2,200	8,400	34,000	48,600	0%	100%	0%	0%	93	STATE	300	POSSIBLE	OVER 10YR-24HR	HIGHWAY	\$156,200	\$67,400	\$223,600	\$3,800	\$261,600
2-4	20A, 22A, 22B, 25A, 25B	5.9	1.5	25%	5,200	1,400	6,700	21,300	25,500	0%	77%	23%	23%	68	STATE	225	DEFINITE	OVER 10YR-24HR	HIGHWAY	\$81,130	\$44,800	\$125,900	\$2,400	\$149,900
2-5	27, 28A, 28B, 30	8.8	2.0	23%	7,400	3,000	3,800	13,300	15,200	0%	57%	43%	0%	58	STATE	100	DEFINITE	OVER 10YR-24HR	HIGHWAY	\$84,396	\$45,600	\$130,000	\$2,000	\$150,000
2-6	29, 32, 38, 39	15.6	7.6	49%	24,750	6,850	21,000	58,050	32,500	5%	41%	53%	0%	172	STATE	175	DEFINITE	UNDER 10YR-24HR	COMMERCIAL / HIGHWAY	\$110,641	\$55,800	\$166,400	\$3,100	\$197,400
2-7	35	9.5	2.8	29%	9,750	2,550	14,700	42,050	42,300	0%	100%	0%	0%	123	STATE	675	DEFINITE	10YR-24HR	HIGHWAY	\$194,620	\$85,400	\$280,000	\$3,300	\$313,000

Sub-basin & Impervious Total Area: Determined from sub-watershed delineation, analysis and calculations performed during first round of STP prioritization to optimize locations for meeting Water Quality Volume goals
WQv & REv: Based on State of Vermont Stormwater Standards and calculations performed during first round of STP analysis to optimize potential STP locations. WQv = (Area (acres) * P * Rv)/12 and REv = (Area (acres)*Impervious % * Weighted Soil Type Coefficient)/12
Maximum STP Volume: Determined from calculations performed during the first round of STP Analysis. STP size based on location, available space, minimum side slopes, maximum depths and site constraints like estimated depth to bedrock and groundwater
STP Construction Cost Estimate: Based on a combination of drainage piping, drainage structures, STP installation, additional excavation costs, potential rock excavation and supplemental costs. (See Appendix)
STP Engineering Cost Estimate: Based on a combination of survey, permitting and engineering/design cost estimates. (See Appendix)
STP Total Cost Estimate: Based on the combination of total construction costs plus engineering costs. (See Appendix)
Design Storm Handled: Comparison between maximum available volume and peak storm volumes that were determined from subwatershed delineation, analysis and calculations performed during first round of STP prioritization to optimize locations for meeting Water Quality Volume standards

Crosby Brook Stormwater Treatment Practices Study 2012
Town of Brattleboro, Vtrans and VTDEC

RANK	TABLE 2.0 - STP OPTIONS - RANKING SUMMARY RESULTS - ALL SITES															
	STP ID	Sub-basins Handled (Outfall I.D.)	Sub-basin Areas (acres)	Percent Impervious (%)	WQv Target (cu.ft.)	REv Target (cu.ft.)	CPv Target (cu.ft.)	OBv Target (cu.ft.)	STP Max Volume (cu.ft.)	TSS Removal (cu.ft.)	STP Const Cost (\$)	Engineering Total Costs (\$)	STP Total Costs (\$)	STP Maintenance (\$)	STP Total 10 yr Costs (\$)	Priority Points
1	1-1	6, 6D, 6E, 6F, 15	13.4	67%	28,700	11,000	37,800	83,100	83,250	340	\$483,396	\$176,600	\$659,996	\$3,400	\$693,996	38
2	1-4	7, 7A	7.3	56%	13,200	5,900	9,100	26,200	26,400	110	\$151,259	\$64,000	\$215,259	\$2,000	\$235,259	37
3	1-2	6, 6H, 6I, 6J	16.2	36%	19,650	6,200	23,300	54,400	54,800	135	\$214,659	\$82,200	\$296,859	\$3,100	\$327,859	35
4	2-1	13, 13B, 13C	5.6	56%	10,100	3,100	9,900	26,000	25,800	87	\$93,607	\$44,100	\$137,707	\$2,400	\$161,707	33.5
5	1-8*	7, 18, 18A, 19	8.6	63%	17,300	7,900	12,800	35,300	48,750	125	\$285,102	\$111,900	\$397,002	\$3,100	\$428,002	33
6	1-7	7, 18, 19, 21, 23	9.5	69%	20,850	8,900	19,800	49,400	50,500	170	\$311,585	\$116,200	\$427,785	\$3,200	\$459,785	32.5
7	1-10	33A, 33B	21.1	68%	45,800	13,200	56,200	130,600	94,500	170	\$151,819	\$67,400	\$219,219	\$5,200	\$271,219	32.5
8	1-6*	7	4.4	61%	8,500	3,900	6,300	17,700	26,800	84	\$144,820	\$57,100	\$201,920	\$2,400	\$225,920	32
9	2-3B	11B, 11C, 11D	13.3	14%	7,700	2,200	8,400	34,000	48,600	93	\$156,200	\$67,400	\$223,600	\$3,800	\$261,600	32
10	1-3	1, 3, 5, 6, 6A, 6B, 6C, 8	13.0	56%	23,650	7,550	27,100	63,000	62,900	190	\$361,785	\$138,300	\$500,085	\$2,600	\$526,085	31.5
11	1-13	6, 6H & 15C	16.4	54%	28,600	11,700	24,500	36,200	28,850	118	\$308,619	\$120,901	\$429,520	\$3,900	\$468,520	31.5
12	1-9	23, 24, 26A, 26B	10.0	56%	18,000	4,800	16,300	39,500	38,000	138	\$224,419	\$94,700	\$319,119	\$2,100	\$340,119	30.5
13	1-11B	37, A, 37B, 41A, 41B	19.3	32%	21,100	5,600	27,100	78,000	78,000	112	\$247,107	\$103,800	\$350,907	\$3,300	\$383,907	30.5
14	2-4	20A, 22A, 22B, 25A, 25B	5.9	25%	5,200	1,400	6,700	21,300	25,500	68	\$81,130	\$44,800	\$125,930	\$2,400	\$149,930	30.5
15	1-5	8, 9	1.7	32%	1,900	800	2,000	5,650	5,640	18	\$32,574	\$26,700	\$59,274	\$1,300	\$72,274	29.5
16	2-5**	27, 28A, 28B, 30	8.8	23%	7,400	3,000	3,800	13,300	15,200	58	\$84,396	\$45,600	\$129,996	\$2,000	\$149,996	29.5
17	2-7	35	9.5	29%	9,750	2,550	14,700	42,050	42,300	123	\$194,620	\$85,400	\$280,020	\$3,300	\$313,020	29.5
18	2-6	29, 32, 38, 39	15.6	49%	24,750	6,850	21,000	58,050	32,500	172	\$110,641	\$55,800	\$166,441	\$3,100	\$197,441	29
19	1-11A	37A, 40	20.5	19%	14,650	3,500	7,900	43,650	34,500	80	\$112,311	\$55,600	\$167,911	\$2,300	\$190,911	28.5
20	2-2	12, 12A, 13A	22.5	16%	14,000	5,050	300	6,700	12,900	136	\$82,846	\$46,000	\$128,846	\$3,000	\$158,846	28

Crosby Brook Stormwater Treatment Practices Study 2012
Town of Brattleboro, Vtrans and VTDEC

TABLE 2.0 - STP OPTIONS - RANKING SUMMARY RESULTS - ALL SITES																
RANK	STP ID	Sub-basins Handled (Outfall I.D.)	Sub-basin Areas (acres)	Percent Impervious (%)	WQv Target (cu.ft.)	REv Target (cu.ft.)	CPv Target (cu.ft.)	OBv Target (cu.ft.)	STP Max Volume (cu.ft.)	TSS Removal (cu.ft.)	STP Const Cost (\$)	Engineering Total Costs (\$)	STP Total Costs (\$)	STP Maintenance (\$)	STP Total 10 yr Costs (\$)	Priority Points
21	2-3A	10, 11A, 16B, 17	6.5	25%	5,800	2,350	900	7,400	8,100	78	\$109,874	\$55,100	\$164,974	\$2,600	\$190,974	27
22	1-12	14	18.1	25%	16,500	6,600	1,300	17,800	17,800	87	\$128,456	\$56,100	\$184,556	\$2,100	\$205,556	24

*Despite the proposed STP being located partially on the property, all of the existing facility associated with that property (subwatershed 7B) is currently treated by an underground infiltration system and therefore is not included in the analysis.

**Portions of Site 2-5 have some existing infiltration practices, however, the treated portion of that site is small compared to the untreated portion of watershed handled by the proposed STP.

Crosby Brook Stormwater Treatment Practices Study 2012
Town of Brattleboro, Vtrans and VTDEC

RANK	TABLE 2.1 - STP OPTIONS - RANKING SUMMARY RESULTS - BY AREA															
	STP ID	Sub-basins Handled (Outfall I.D.)	Sub-basin Areas (acres)	Percent Impervious (%)	WQv Target (cu.ft.)	REv Target (cu.ft.)	CPv Target (cu.ft.)	OBv Target (cu.ft.)	STP Max Volume (cu.ft.)	TSS Removal (cu.ft.)	STP Const Cost (\$)	Engineering Total Costs (\$)	STP Total Costs (\$)	STP Maintenance (\$)	STP Total 10 yr Costs (\$)	Priority Points
WATERSHED AREA #1																
1	1-1	6, 6D, 6E, 6F, 15	13.4	67%	28,700	11,000	37,800	83,100	83,250	340	\$483,396	\$176,600	\$659,996	\$3,400	\$693,996	38
2	1-4	7, 7A	7.3	56%	13,200	5,900	9,100	26,200	26,400	110	\$151,259	\$64,000	\$215,259	\$2,000	\$235,259	37
3	1-2	6, 6H, 6I, 6J	16.2	36%	19,650	6,200	23,300	54,400	54,800	135	\$214,659	\$82,200	\$296,859	\$3,100	\$327,859	35
4	1-8*	7, 18, 18A, 19	8.6	63%	17,300	7,900	12,800	35,300	48,750	125	\$285,102	\$111,900	\$397,002	\$3,100	\$428,002	33
5	1-7	7, 18, 19, 21, 23	9.5	69%	20,850	8,900	19,800	49,400	50,500	170	\$311,585	\$116,200	\$427,785	\$3,200	\$459,785	32.5
6	1-10	33A, 33B	21.1	68%	45,800	13,200	56,200	130,600	94,500	170	\$151,819	\$67,400	\$219,219	\$5,200	\$271,219	32.5
7	1-6*	7	4.4	61%	8,500	3,900	6,300	17,700	26,800	84	\$144,820	\$57,100	\$201,920	\$2,400	\$225,920	32
8	1-3	1, 3, 5, 6, 6A, 6B, 6C, 8	13.0	56%	23,650	7,550	27,100	63,000	62,900	190	\$361,785	\$138,300	\$500,085	\$2,600	\$526,085	31.5
9	1-13	6, 6H & 15C	16.4	54%	28,600	11,700	24,500	36,200	28,850	118	\$308,619	\$120,901	\$429,520	\$3,900	\$468,520	31.5
10	1-9	23, 24, 26A, 26B	10.0	56%	18,000	4,800	16,300	39,500	38,000	138	\$224,419	\$94,700	\$319,119	\$2,100	\$340,119	30.5
11	1-11B	37, A, 37B, 41A, 41B	19.3	32%	21,100	5,600	27,100	78,000	78,000	112	\$247,107	\$103,800	\$350,907	\$3,300	\$383,907	30.5
12	1-5	8, 9	1.7	32%	1,900	800	2,000	5,650	5,640	18	\$32,574	\$26,700	\$59,274	\$1,300	\$72,274	29.5
13	1-11A	37A, 40	20.5	19%	14,650	3,500	7,900	43,650	34,500	80	\$112,311	\$55,600	\$167,911	\$2,300	\$190,911	28.5
14	1-12	14	18.1	25%	16,500	6,600	1,300	17,800	17,800	87	\$128,456	\$56,100	\$184,556	\$2,100	\$205,556	24

Crosby Brook Stormwater Treatment Practices Study 2012
Town of Brattleboro, Vtrans and VTDEC

TABLE 2.1 - STP OPTIONS - RANKING SUMMARY RESULTS - BY AREA																
RANK	STP ID	Sub-basins Handled (Outfall I.D.)	Sub-basin Areas (acres)	Percent Impervious (%)	WQv Target (cu.ft.)	REv Target (cu.ft.)	CPv Target (cu.ft.)	OBv Target (cu.ft.)	STP Max Volume (cu.ft.)	TSS Removal (cu.ft.)	STP Const Cost (\$)	Engineering Total Costs (\$)	STP Total Costs (\$)	STP Maintenance (\$)	STP Total 10 yr Costs (\$)	Priority Points
WATERSHED AREA #2																
1	2-1	13, 13B, 13C	5.6	56%	10,100	3,100	9,900	26,000	25,800	87	\$93,607	\$44,100	\$137,707	\$2,400	\$161,707	33.5
2	2-3B	11B, 11C, 11D	13.3	14%	7,700	2,200	8,400	34,000	48,600	93	\$156,200	\$67,400	\$223,600	\$3,800	\$261,600	32
3	2-4	20A, 22A, 22B, 25A, 25B	5.9	25%	5,200	1,400	6,700	21,300	25,500	68	\$81,130	\$44,800	\$125,930	\$2,400	\$149,930	30.5
4	2-5**	27, 28A, 28B, 30	8.8	23%	7,400	3,000	3,800	13,300	15,200	58	\$84,396	\$45,600	\$129,996	\$2,000	\$149,996	29.5
5	2-7	35.00	9.5	29%	9,750	2,550	14,700	42,050	42,300	123	\$194,620	\$85,400	\$280,020	\$3,300	\$313,020	29.5
6	2-6	29, 32, 38, 39	15.6	49%	24,750	6,850	21,000	58,050	32,500	172	\$110,641	\$55,800	\$166,441	\$3,100	\$197,441	29
7	2-2	12, 12A, 13A	22.5	16%	14,000	5,050	300	6,700	12,900	136	\$82,846	\$46,000	\$128,846	\$3,000	\$158,846	28
8	2-3A	10, 11A, 16B, 17	6.5	25%	5,800	2,350	900	7,400	8,100	78	\$109,874	\$55,100	\$164,974	\$2,600	\$190,974	27

*Despite the proposed STP being located partially on the property, all of the existing facility associated with that property (subwatershed 7B) is currently treated by an underground infiltration system and therefore is not included in the analysis.

**Portions of Site 2-5 have some existing infiltration practices, however, the treated portion of that site is small compared to the untreated portion of watershed handled by the proposed STP.

RANK	TABLE 3.0 - STP OPTIONS - TOP 10 STP SITES OVERALL																		
	STP ID	Sub-basins Handled (Outfall I.D.)	Sub-basin Areas (acres)	Impervious Areas (acres)	Percent Impervious (%)	WQv Target (cu.ft.)	REv Target (cu.ft.)	CPv Target (cu.ft.)	OBv Target (cu.ft.)	STP Max Volume (cu.ft.)	TSS Removal (cu.ft.)	STP Const Cost (\$)	Engineering Total Costs (\$)	STP Total Costs (\$)	STP Maintenance (\$)	STP Total 10 yr Costs (\$)	TSS 10 yr Removal (lbs)*	TSS 10 yr Removal (tons)	Priority Points
1	1-1	6, 6D, 6E, 6F, 15	13.4	9.0	67%	28,700	11,000	37,800	83,100	83,250	340	\$483,396	\$176,600	\$659,996	\$3,400	\$693,996	30,600	15	38
2	1-4	7, 7A	7.3	4.1	56%	13,200	5,900	9,100	26,200	26,400	110	\$151,259	\$64,000	\$215,259	\$2,000	\$235,259	9,900	5	37
3	1-2	6, 6H, 6I, 6J	16.2	5.8	36%	19,650	6,200	23,300	54,400	54,800	135	\$214,659	\$82,200	\$296,859	\$3,100	\$327,859	12,150	6	35
4	2-1	13, 13B, 13C	5.6	3.1	56%	10,100	3,100	9,900	26,000	25,800	87	\$93,607	\$44,100	\$137,707	\$2,400	\$161,707	7,830	4	33.5
5	1-8**	7, 18, 18A, 19	8.6	5.4	63%	17,300	7,900	12,800	35,300	48,750	125	\$285,102	\$111,900	\$397,002	\$3,100	\$428,002	11,250	6	33
6	1-7	7, 18, 19, 21, 23	9.5	6.6	69%	20,850	8,900	19,800	49,400	50,500	170	\$311,585	\$116,200	\$427,785	\$3,200	\$459,785	15,300	8	32.5
7	1-10	33A, 33B	21.1	14.4	68%	45,800	13,200	56,200	130,600	94,500	170	\$151,819	\$67,400	\$219,219	\$5,200	\$271,219	15,300	8	32.5
8	1-6**	7	4.4	2.7	61%	8,500	3,900	6,300	17,700	26,800	84	\$144,820	\$57,100	\$201,920	\$2,400	\$225,920	7,560	4	32
9	2-3B	11B, 11C, 11D	13.3	1.9	14%	7,700	2,200	8,400	34,000	48,600	93	\$156,200	\$67,400	\$223,600	\$3,800	\$261,600	8,370	4	32
10	1-3	1, 3, 5, 6, 6A, 6B, 6C, 8	13.0	7.3	56%	23,650	7,550	27,100	63,000	62,900	190	\$361,785	\$138,300	\$500,085	\$2,600	\$526,085	17,100	9	31.5
TOTALS			112.3	60.3		195,450					1504.0			\$3,279,433		\$3,591,433	135,360	68	

*Assume sediment has a density of 90 lbs /cu.ft.

**Despite the proposed STPs being located partially on the property, all of the existing facility associated with that property (subwatershed 7B) is currently treated by an underground infiltration system and therefore is not included in the analysis.

TABLE 3.1 - STP OPTIONS - TOP 4 STP SITES BY AREA																				
RANK	STP	Sub-basins	Sub-basin	Impervious	Percent	WQv	REv	CPv	OBv	STP	TSS	STP Const	Engineering	STP	STP	STP	TSS 10 yr	TSS 10 yr	10 Yr Cost per ton	Priority Points
	ID	Handled (Outfall I.D.)	Areas (acres)	Areas (acres)	Impervious (%)	Target (cu.ft.)	Target (cu.ft.)	Target (cu.ft.)	Target (cu.ft.)	Max Volume (cu.ft.)	Removal (cu.ft.)	Cost (\$)	Total Costs (\$)	Total Costs (\$)	Maintenance (\$)	Total 10 yr Costs (\$)	Removal (lbs)*	Removal (tons)	TSS Removed (\$/lb)	
WATERSHED AREA #1																				
1	1-1	6, 6D, 6E, 6F, 15	13.4	9.0	67%	28,700	11,000	38,700	83,100	83,250	340	\$483,396	\$176,600	\$659,996	\$3,400	\$693,996	30,600	15	\$4,536	38
2	1-4	7, 7A	7.3	4.1	56%	13,200	5,900	8,600	26,200	26,400	110	\$151,259	\$64,000	\$215,259	\$2,000	\$235,259	9,900	5	\$4,753	37
3	1-2	6, 6H, 6I, 6J	16.2	5.8	36%	19,650	6,200	23,000	54,400	54,800	135	\$214,659	\$82,200	\$296,859	\$3,100	\$327,859	12,150	6	\$5,397	35
4	1-8**	7, 18, 18A, 19	8.6	5.4	63%	17,300	7,900	12,800	35,300	48,750	125	\$285,102	\$111,900	\$397,002	\$3,100	\$428,002	11,250	6	\$7,609	33
WATERSHED AREA 1 TOTALS			45.5	24		78,850			199,000		710.0			\$1,569,117		\$1,685,117	63,900	32	\$5,274.23	
WATERSHED AREA #2																				
1	2-1	13, 13B, 13C	5.6	3.1	56%	10,100	3,100	9,900	26,000	25,800	87	\$93,607	\$44,100	\$137,707	\$2,400	\$161,707	7,830	4	\$4,130	33.5
2	2-3B	11B, 11C, 11D	13.3	1.9	14%	7,700	2,200	8,700	34,000	48,600	93	\$156,200	\$67,400	\$223,600	\$3,800	\$261,600	8,370	4	\$6,251	32
3	2-4	20A, 22A, 22B, 25A, 25B	5.9	1.5	25%	5,200	1,400	6,700	21,300	25,500	68	\$81,130	\$44,800	\$125,930	\$2,400	\$149,930	6,120	3	\$4,900	30.5
4	2-5***	27, 28A, 28B, 30	8.8	2.0	23%	7,400	3,000	3,900	13,300	15,200	58	\$84,396	\$45,600	\$129,996	\$2,000	\$149,996	5,220	3	\$5,747	29.5
WATERSHED AREA 2 TOTALS			33.5	9		30,400			94,600		306.0			\$617,233		\$723,233	27,540	14	\$5,252.24	
TOTALS			79.0	26		109,250			293,600		1016.0			\$2,186,350		\$2,408,350		45.7	\$5,268	

*Assume sediment has a density of 90 lbs /cu.ft.

**Despite the proposed STP being located partially on the property, all of the existing facility associated with that property (subwatershed 7B) is currently treated by an underground infiltration system and therefore is not included in the analysis.

***Portions of Site 2-5 have some existing infiltration practices, however, the treated portion of that site is small compared to the untreated portion of watershed handled by the proposed STP.

TABLE 4.0 - PROJECT AREA 3 - STP OPTIONS SUMMARY

STP ID	STP Type	Location Description of STP	Environmental Permitting Required	STP Const. Cost (\$)	Survey Costs (\$)	Permit Costs (\$)	Engineering Costs (\$)	Bid / Construct Oversight (\$)	Engineering Total Costs (\$)	STP Total Costs (\$)
1	Stabilize Steep Slopes	Mass Slope Failure Southern Fork near Black Mtn. Rd - Repair erosion & stabilize slope	Definite	\$58,500	\$3,900	\$8,000	\$11,700	\$5,900	\$29,500	\$88,000
2	Streambank Stabilization	Steep Slope Failure Northern Fork near Route 91 northbound - Repair erosion & stabilize banks	Definite	\$33,200	\$3,300	\$8,000	\$6,600	\$3,300	\$21,200	\$54,400
3	Streambank Stabilization	Mass Slope Failure Northern Fork along Route 91 southbound right of way - Repair erosion & stabilize banks	Definite	\$41,475	\$3,400	\$8,000	\$8,300	\$4,100	\$23,800	\$65,300
4	Stabilize Steep Slopes	Steep Eroded Banks along Northern Fork near Pepsi - Repair erosion & stabilize slopes	Definite	\$19,500	\$3,300	\$8,000	\$3,000	\$2,500	\$16,800	\$36,300
5	Streambank Stabilization	Mass Slope Failure along Main Channel near Route 9 eastbound shoulder - Repair erosion & stabilize slope	Definite	\$49,750	\$3,500	\$8,000	\$10,000	\$5,000	\$26,500	\$76,300
6	Stabilize Steep Slopes	Mass Slope Failure Northern Fork near Houghton Rd - Repair erosion & stabilize slope	Definite	\$29,300	\$3,400	\$8,000	\$5,900	\$2,900	\$20,200	\$49,500
				\$231,725				Totals		\$369,800
1	Replace Culvert	Northern Fork / Ryan Rd (M03) - Install new culvert to meet min 75% stream width - Exist. Culvert = 7'x7'	Definite	\$247,825	\$3,100	\$8,000	\$49,600	\$24,800	\$85,500	\$333,300
2	Replace Culvert	Northern Fork / Middle Rd (M04) - Install new culvert to meet min 75% stream width & LCBs for paved drainage - Exist. Culvert = 7'x7'	Definite	\$322,750	\$3,300	\$8,000	\$64,600	\$32,300	\$108,200	\$431,000
3	Replace Culvert	Southern Fork / Black Mtn. Rd (T1.01) - Install new culvert to meet min 75% stream width LCBs for paved drainage - Exist. Culvert = 4'x4'	Definite	\$204,100	\$3,300	\$8,000	\$40,800	\$20,400	\$72,500	\$276,600
4	Replace Culvert	Southern Fork / Dickinson Rd (T1.02-D) - Install new culvert to meet min 75% stream width - Exist. Culvert = 3'x3'	Definite	\$98,325	\$3,100	\$8,000	\$19,700	\$9,800	\$40,600	\$138,900
				\$873,000				Totals		\$1,179,800

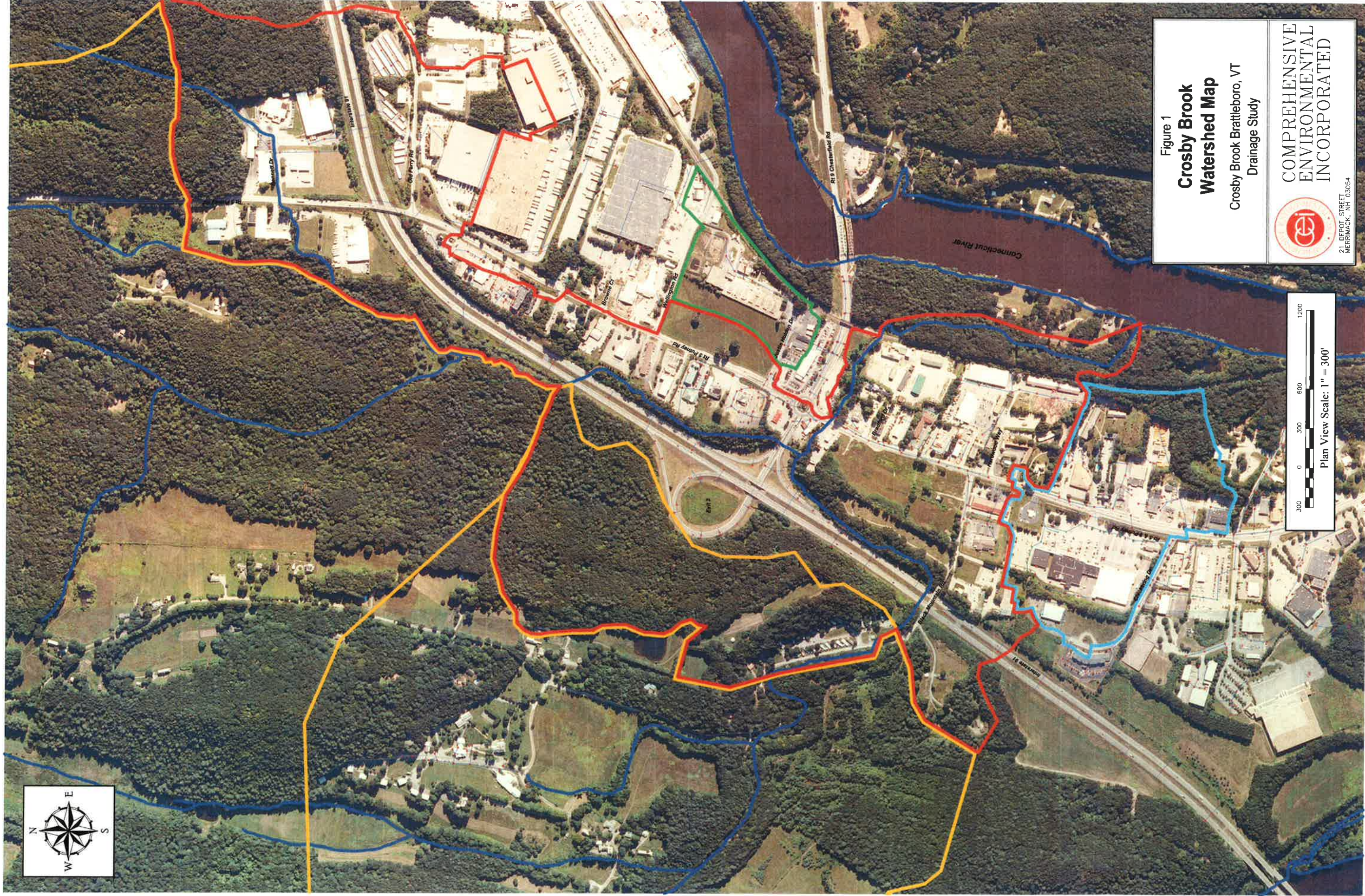


Figure 1

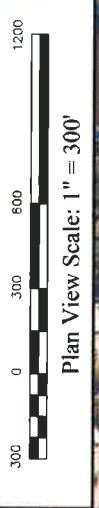
Crosby Brook Watershed Map

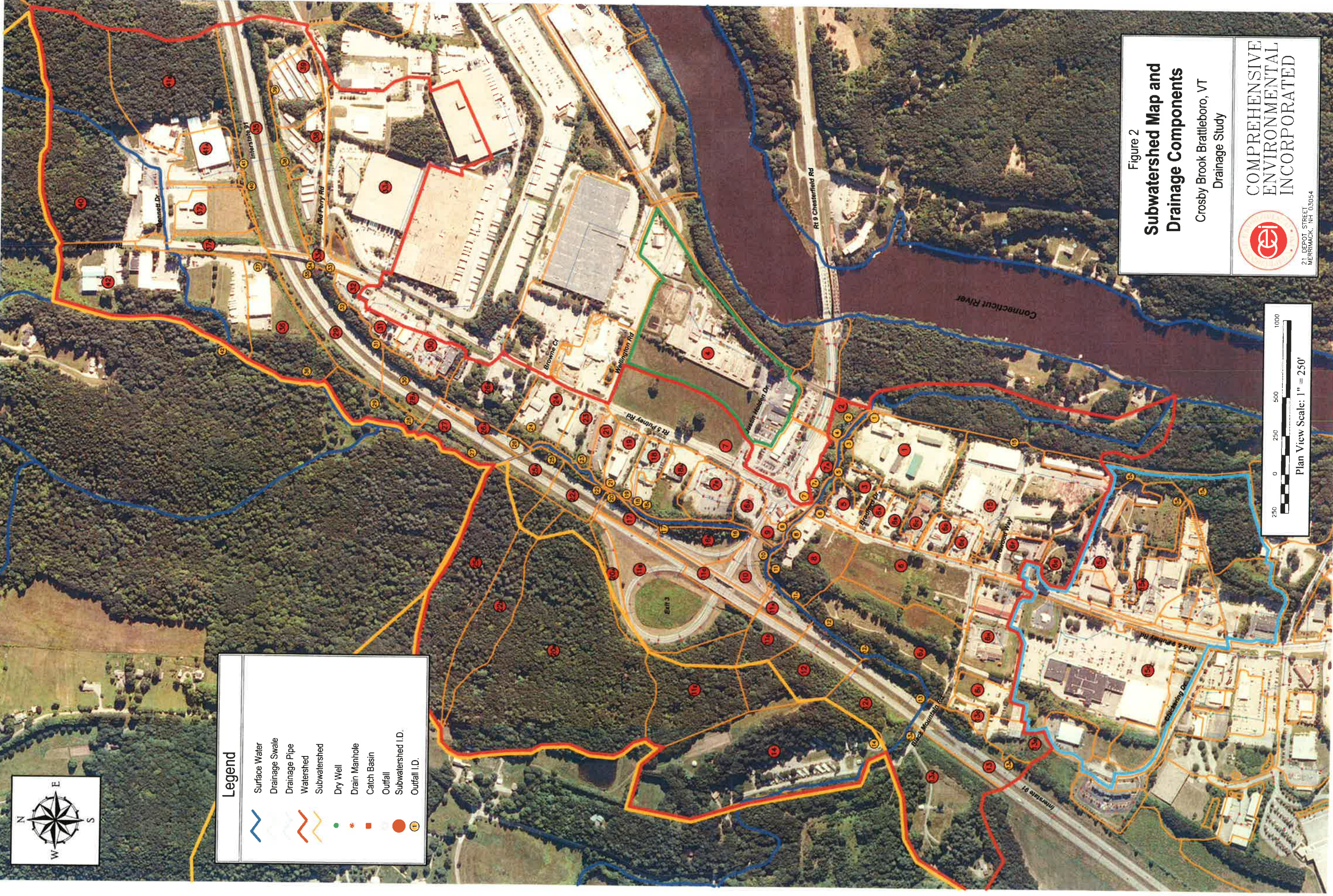
Crosby Brook Brattleboro, VT
Drainage Study



COMPREHENSIVE
ENVIRONMENTAL
INCORPORATED

21 DEPOT STREET
MERRIMACK, NH 03054





Legend

- Surface Water
- Drainage Swale
- Drainage Pipe
- Watershed
- Subwatershed
- Dry Well
- Drain Manhole
- Catch Basin
- Outfall
- Subwatershed I.D.
- Outfall I.D.

Figure 2
Subwatershed Map and
Drainage Components
 Crosby Brook Brattleboro, VT
 Drainage Study

COMPREHENSIVE ENVIRONMENTAL INCORPORATED

21 DEPOT STREET
 MERRIMACK, NH 03054





Legend

- Surface Water
- Drainage Swale
- Drainage Pipe
- Watershed
- Subwatershed
- Dry Well
- Drain Manhole
- Catch Basin
- Outfall
- BMP Location I.D.
- Outfall I.D.

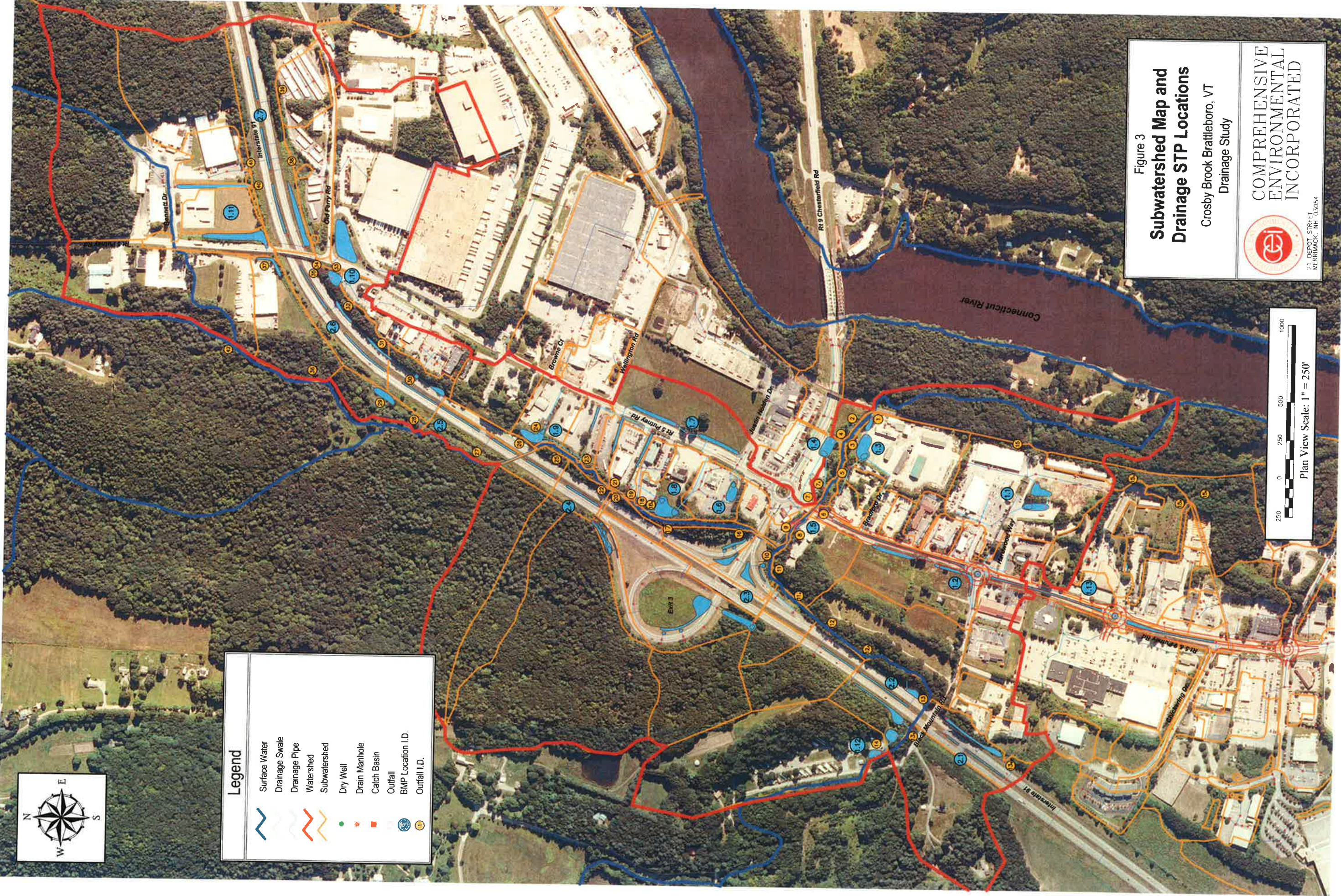


Figure 3
Subwatershed Map and
Drainage STP Locations
Crosby Brook Brattleboro, VT
Drainage Study

COMPREHENSIVE
ENVIRONMENTAL
INCORPORATED

24 DEPOT STREET
MERRIMACK, NH 03054

STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	3,300	3,300
WATER QUALITY VOLUME	28,700	28,700
RECHARGE VOLUME	11,000	11,000
CHANNEL PROTECTION VOLUME	37,800	37,800
OVERBANK FLOOD VOLUME	83,100	83,250
ANNUAL TSS LOADING / REMOVAL	380	340 (90%)

SITE 1.1 - MULTIPLE POND SYSTEM BEHIND McDONALDS, TACO BELL & AMERICA'S BEST INN

SUBWATERSHEDS: 6, 6D, 6E, 6F & 15
 TREATED AREA = 13.4 ACRES
 TOWN ROADS ~3%
 PRIVATE PROPERTY ~97%
 ASSUMED 25% BUILD-OUT CONDITION ON PRIVATE PROPERTY

NOTES: LOCATED ON PRIVATE LAND IN OPEN UN-PAVED AREAS. SEVERAL OPTIONS TO PROVIDE STORAGE AND TREATMENT FOR PORTIONS OF PUTNEY ROAD AND ADJACENT PRIVATE LOTS THAT ARE TIED INTO ROADWAY DRAINAGE. APPROX. POND DEPTH = 5.0 FEET. OPTION TO INCREASE DEPTHS & SIZE SPILLWAY TO STORE PORTION OF 100 YR-24 HR STORM EVENT. COMBINATION OF EXTENDED DETENTION, WETPONDS AND GRAVEL PONDS CAN BE USED TO CREATE A MULTIPLE POND SYSTEM. SEVERAL OPTIONS FOR CAPTURING LOCAL PARKING LOT RUNOFF. COULD BE SIZED FOR FUTURE DEVELOPMENT OF ABANDONED COMMERCIAL PROPERTIES. WOULD UTILIZE EXISTING DRAINAGE SYSTEM AND DISCHARGE AT SAME OUTFALL.

Legend

- Surface Water
- Existing Drainage Swale
- Existing Drainage Pipe
- Existing Sewer Pipe
- Existing Water Pipe
- Existing Gas Line
- Existing Power Line
- Parcel Boundary
- Right of Way
- Existing Dry Well
- Existing Drain Manhole
- Existing Catch Basin
- Existing Outfall
- Outfall I.D.
- Proposed STP Watershed
- Proposed Drainage Pipe
- Proposed Drain Manhole
- Proposed Catch Basin
- Proposed STP



Figure 4 - Crosby Brook Site 1-1 Proposed STPs

COMPREHENSIVE ENVIRONMENTAL INCORPORATED
 21 DEPOT STREET
 MERRIMACK, NH 03054

Not To Scale

**SITE 1.2 - TREATMENT/INFILTRATION SWALES
AT PUTNEY & BLACK MOUNTAIN ROADS**

SUBWATERSHEDS: 6, 6H, 6I & 6J
 TREATED AREA = 16.2 ACRES
 PUTNEY ROAD ~3%
 OTHER TOWN ROADS ~3%
 PRIVATE PROPERTY ~93%
 ASSUMED 28% BUILD-OUT CONDITION ON PRIVATE PROPERTY

NOTES: LOCATED ON PORTIONS OF BLACK MOUNTAIN AND
 PUTNEY ROAD R.O.W. AND PORTIONS ON PRIVATE LAND.
 SEVERAL OPTIONS TO PROVIDE STORAGE AND TREATMENT
 ALONG UN-USED ROADSIDE AREAS. PUTNEY ROAD DRAINAGE
 CAN BE USED AS OVERFLOW DURING LARGER STORMS.
 COULD BE INSTALLED AS PART OF PUTNEY ROAD
 IMPROVEMENTS. APPROX. PONDED DEPTH = 4.5 FEET.
 OPTION TO INCREASE DEPTHS TO SAFELY PASS 100 YR-24 HR
 STORM EVENT. WOULD NEED TO BE LARGER TO PROVIDE
 EXTENDED STORAGE FOR 100 YR STORM EVENT.
 SUBSURFACE STORAGE AND TREATMENT COULD BE USED TO
 REDUCE PONDED WATER DEPTHS BASED ON GROUNDWATER
 INFORMATION. SWALES INSTALLED OUTSIDE CLEARZONE
 FOR SAFETY CONCERNS.

Legend	
	Surface Water
	Existing Drainage Swale
	Existing Drainage Pipe
	Existing Sewer Pipe
	Existing Water Pipe
	Existing Gas Line
	Existing Power Line
	Parcel Boundary
	Right of Way
	Existing Dry Well
	Existing Drain Manhole
	Existing Catch Basin
	Existing Outfall
	Outfall I.D.
	Proposed STP Watershed
	Proposed Drainage Pipe
	Proposed Drain Manhole
	Proposed Catch Basin
	Proposed STP

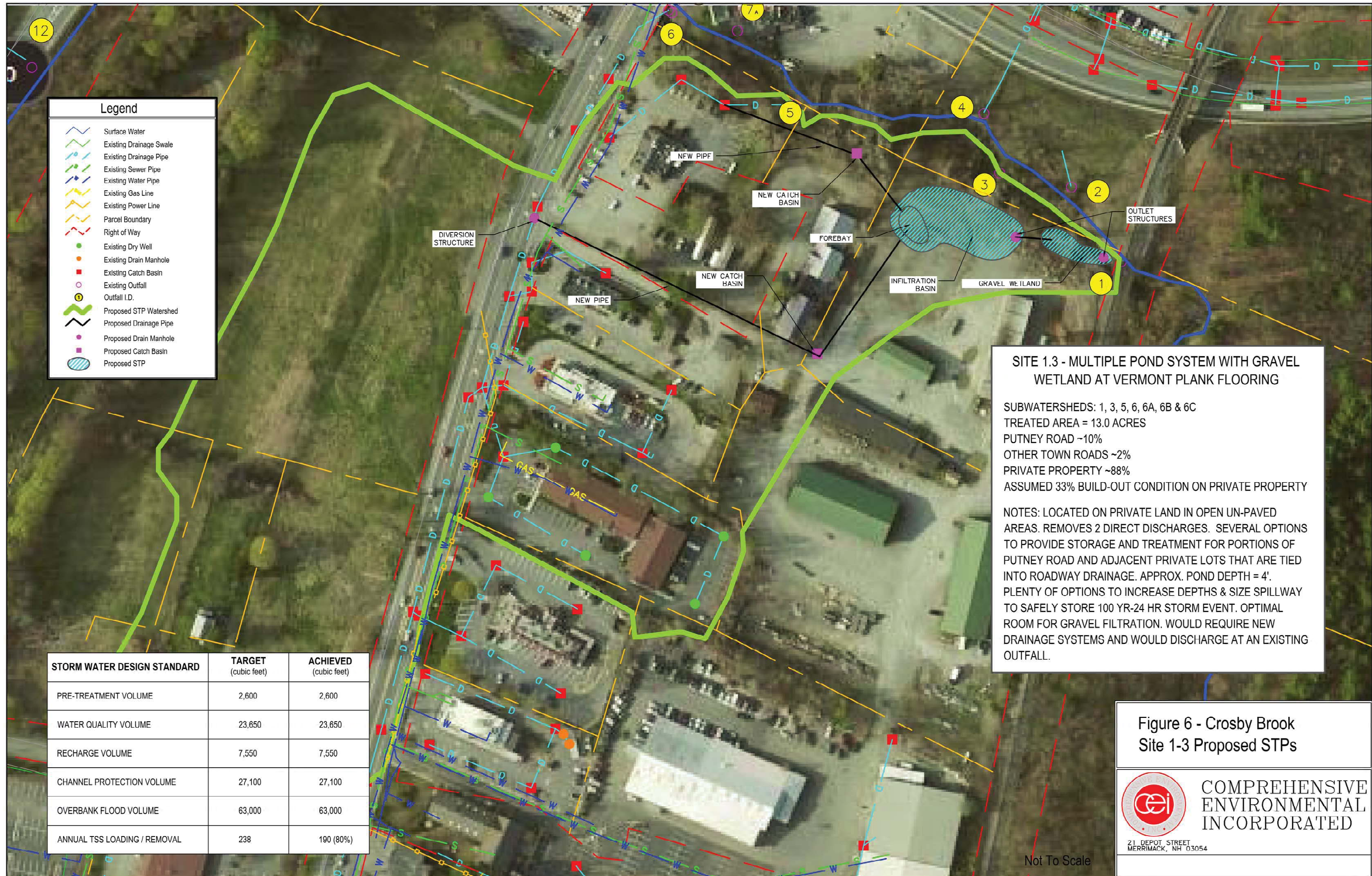


STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	2,100	2,100
WATER QUALITY VOLUME	19,650	19,650
RECHARGE VOLUME	6,200	6,200
CHANNEL PROTECTION VOLUME	23,000	23,000
OVERBANK FLOOD VOLUME	54,400	54,400
ANNUAL TSS LOADING / REMOVAL	195	135 (70%)

Figure 5 - Crosby Brook
Site 1-2 Proposed STPs

**COMPREHENSIVE ENVIRONMENTAL
INCORPORATED**
 21 DEPOT STREET
 MERRIMACK, NH 03054

Not To Scale



Legend

- Surface Water
- Existing Drainage Swale
- Existing Drainage Pipe
- Existing Sewer Pipe
- Existing Water Pipe
- Existing Gas Line
- Existing Power Line
- Parcel Boundary
- Right of Way
- Existing Dry Well
- Existing Drain Manhole
- Existing Catch Basin
- Existing Outfall
- Outfall I.D.
- Proposed STP Watershed
- Proposed Drainage Pipe
- Proposed Drain Manhole
- Proposed Catch Basin
- Proposed STP


STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	2,600	2,600
WATER QUALITY VOLUME	23,650	23,650
RECHARGE VOLUME	7,550	7,550
CHANNEL PROTECTION VOLUME	27,100	27,100
OVERBANK FLOOD VOLUME	63,000	63,000
ANNUAL TSS LOADING / REMOVAL	238	190 (80%)

SITE 1.3 - MULTIPLE POND SYSTEM WITH GRAVEL WETLAND AT VERMONT PLANK FLOORING

SUBWATERSHEDS: 1, 3, 5, 6, 6A, 6B & 6C
 TREATED AREA = 13.0 ACRES
 PUTNEY ROAD ~10%
 OTHER TOWN ROADS ~2%
 PRIVATE PROPERTY ~88%
 ASSUMED 33% BUILD-OUT CONDITION ON PRIVATE PROPERTY

NOTES: LOCATED ON PRIVATE LAND IN OPEN UN-PAVED AREAS. REMOVES 2 DIRECT DISCHARGES. SEVERAL OPTIONS TO PROVIDE STORAGE AND TREATMENT FOR PORTIONS OF PUTNEY ROAD AND ADJACENT PRIVATE LOTS THAT ARE TIED INTO ROADWAY DRAINAGE. APPROX. POND DEPTH = 4'. PLENTY OF OPTIONS TO INCREASE DEPTHS & SIZE SPILLWAY TO SAFELY STORE 100 YR-24 HR STORM EVENT. OPTIMAL ROOM FOR GRAVEL FILTRATION. WOULD REQUIRE NEW DRAINAGE SYSTEMS AND WOULD DISCHARGE AT AN EXISTING OUTFALL.

**Figure 6 - Crosby Brook
Site 1-3 Proposed STPs**



COMPREHENSIVE ENVIRONMENTAL INCORPORATED
 21 DEPOT STREET
 MERRIMACK, NH 03054

Not To Scale

STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	1,500	1,500
WATER QUALITY VOLUME	13,200	13,200
RECHARGE VOLUME	5,900	5,900
CHANNEL PROTECTION VOLUME	9,100	9,100
OVERBANK FLOOD VOLUME	26,200	26,200
ANNUAL TSS LOADING / REMOVAL	159	110 (70%)

**SITE 1.4 - INFILTRATION POND
AT ABANDONED BICKFORD'S LOT**

SUBWATERSHEDS: 7 & 7A
 TREATED AREA = 7.3 ACRES
 PUTNEY ROAD ~22%
 PRIVATE PROPERTY ~78%
 ASSUMED 73% BUILD-OUT CONDITION ON PRIVATE PROPERTY

NOTES: LOCATED ON PRIVATE LAND. REMOVES 2 UN-TREATED DISCHARGES. OPTIONS TO OUTLET FLOWS TO CROSBY BROOK OR CONNECTICUT RIVER. OUTLET TO CONNECTICUT WOULD REDUCE POND SIZE AND WOULD UTILIZE EXISTING DRAINAGE SWALE. WOULD REQUIRE NEW PIPING TO RE-DIRECT PUTNEY ROAD AND TRAFFIC CIRCLE DRAINAGE. APPROX. POND DEPTH = 3'. ROOM TO INCREASE DEPTHS/FOOTPRINT AND SIZE SPILLWAY TO SAFELY STORE 100 YR-24 HR STORM. ADDITIONAL OPTION TO INCREASE SIZE TO HANDLE RUNOFF FOR OUTLET #4.

Legend

- Surface Water
- Existing Drainage Swale
- Existing Drainage Pipe
- Existing Sewer Pipe
- Existing Water Pipe
- Existing Gas Line
- Existing Power Line
- Parcel Boundary
- Right of Way
- Existing Dry Well
- Existing Drain Manhole
- Existing Catch Basin
- Existing Outfall
- Outfall I.D.
- Proposed STP Watershed
- Proposed Drainage Pipe
- Proposed Drain Manhole
- Proposed Catch Basin
- Proposed STP



**Figure 7 - Crosby Brook
Site 1-4 Proposed STPs**

**COMPREHENSIVE ENVIRONMENTAL
INCORPORATED**

21 DEPOT STREET
MERRIMACK, NH 03054

Not To Scale

**SITE 1.5 - TREATMENT SWALES
AT CITGO EXPRESS & MOBILE GAS STATIONS**

SUBWATERSHEDS: 8 & 9
 TREATED AREA = 1.7 ACRES
 PUTNEY ROAD ~4%
 PRIVATE PROPERTY ~96%
 ASSUMED 0% BUILD-OUT CONDITION ON PRIVATE PROPERTY

NOTES: LOCATED ON PRIVATE LAND. WOULD REQUIRE PAVEMENT REMOVAL & INSTALLATION OF CURBING. REMOVES 3 DIRECT OVERLAND DISCHARGES. TREATMENT SWALE DEPTHS APPROX. 2.5 FEET WITH CONTROL STRUCTURES. OUTLET STRUCTURE AND SPILLWAY COULD BE PROVIDED TO SAFELY PASS 100-24HR STORM EVENT. IF DEPTH TO GROUNDWATER IS ADEQUATE COULD PROVIDE SUBSURFACE FILTER FOR GAS STATION RUNOFF.

STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	200	200
WATER QUALITY VOLUME	1,900	1,900
RECHARGE VOLUME	800	800
CHANNEL PROTECTION VOLUME	2,000	2,000
OVERBANK FLOOD VOLUME	5,650	5,650
ANNUAL TSS LOADING / REMOVAL	24	18 (74%)

Legend	
	Surface Water
	Existing Drainage Swale
	Existing Drainage Pipe
	Existing Sewer Pipe
	Existing Water Pipe
	Existing Gas Line
	Existing Power Line
	Parcel Boundary
	Right of Way
	Existing Dry Well
	Existing Drain Manhole
	Existing Catch Basin
	Existing Outfall
	Outfall I.D.
	Proposed STP Watershed
	Proposed Drainage Pipe
	Proposed Drain Manhole
	Proposed Catch Basin
	Proposed STP

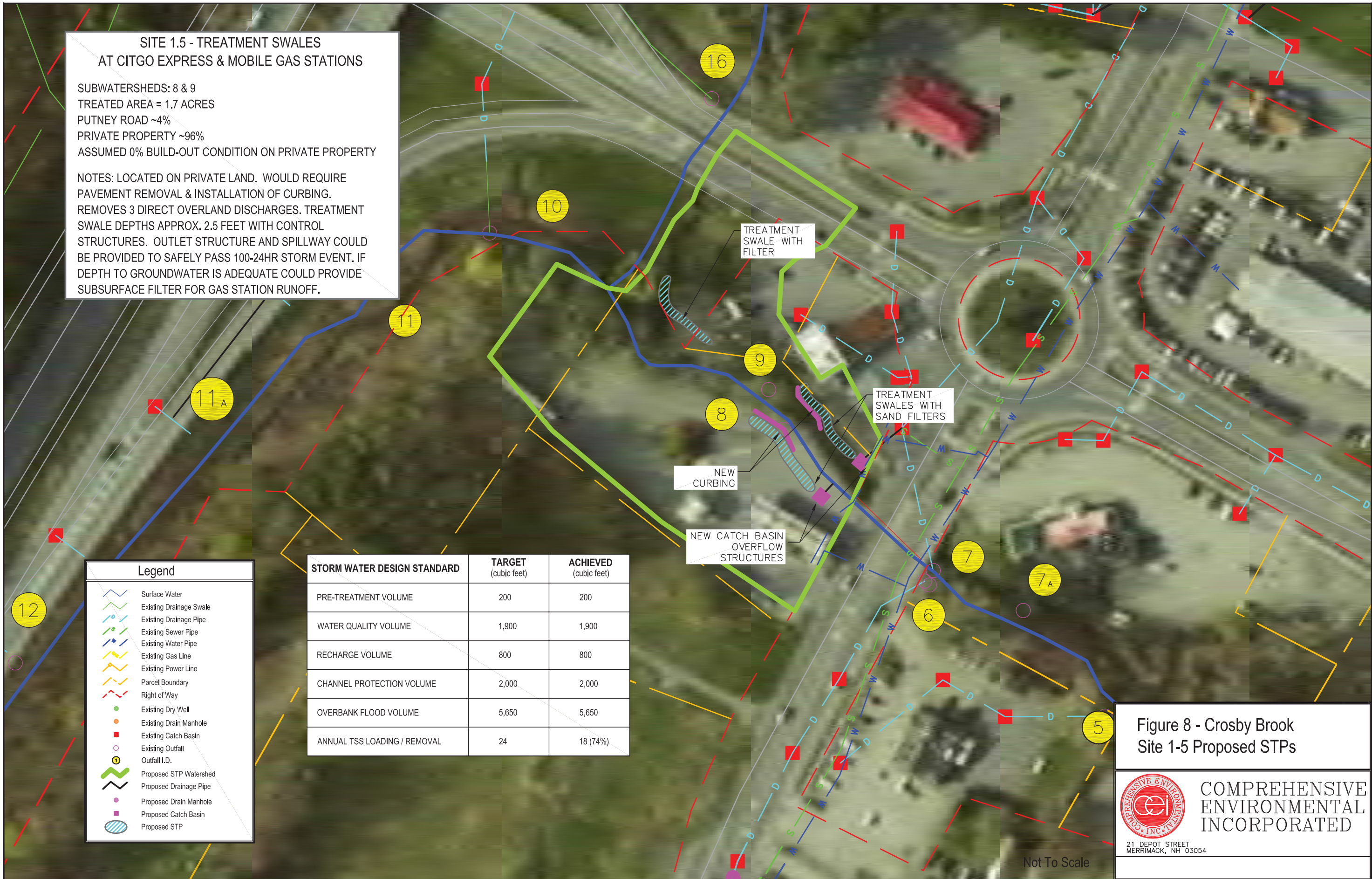


Figure 8 - Crosby Brook
Site 1-5 Proposed STPs



**COMPREHENSIVE ENVIRONMENTAL
INCORPORATED**

21 DEPOT STREET
MERRIMACK, NH 03054

Not To Scale

**SITE 1.6 - PEAK INFILTRATION POND
AT 99 RESTAURANT**

SUBWATERSHEDS: 7
 TREATED AREA = 4.4 ACRES
 PUTNEY ROAD ~25%
 OTHER TOWN ROADS ~0.5%
 PRIVATE PROPERTY ~74%
 ASSUMED 63% BUILD-OUT CONDITION ON PRIVATE PROPERTY

NOTES: LOCATED ON PRIVATE LAND. LOCATED IN UNUSED GRAVEL AREA OF RESTAURANT PARKING AREA. TREATS PORTIONS OF PUTNEY ROAD (APPROX. 40% OF ROADWAY RUNOFF DISCHARGING AT CROSBY BROOK OUTFALL #7). DISCHARGE FOR LOT IS UNKNOWN. APPROX. POND DEPTH = 3 FEET. SITE CONSTRAINTS AND ON-SITE UTILITIES REDUCE DEPTH AND STORAGE OPTIONS FOR 100YR-24 HR STORM EVENT. SPILLWAY COULD BE PROVIDED TO SAFELY PASS LARGER STORMS. IF PROPERTY OWNER WISHES TO EXPAND PARKING LOT, OPTIONS COULD BE EXPLORED FOR UNDERGROUND STORAGE TO BE TIED TO EXISTING UNDERGROUND SYSTEM CURRENTLY IN PLACE FOR THE LOT.

Legend	
	Surface Water
	Existing Drainage Swale
	Existing Drainage Pipe
	Existing Sewer Pipe
	Existing Water Pipe
	Existing Gas Line
	Existing Power Line
	Parcel Boundary
	Right of Way
	Existing Dry Well
	Existing Drain Manhole
	Existing Catch Basin
	Existing Outfall
	Outfall I.D.
	Proposed STP Watershed
	Proposed Drainage Pipe
	Proposed Drain Manhole
	Proposed Catch Basin
	Proposed STP

STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	1,000	1,000
WATER QUALITY VOLUME	8,500	8,500
RECHARGE VOLUME	3,900	3,900
CHANNEL PROTECTION VOLUME	6,300	6,300
OVERBANK FLOOD VOLUME	17,700	26,800
ANNUAL TSS LOADING / REMOVAL	105	84 (80%)

NEW PIPE
 INFILTRATION POND
 NEW PIPING
 FOREBAY
 NEW PIPING
 NEW OUTLET STRUCTURE

Figure 9 - Crosby Brook
Site 1-6 Proposed STP

**COMPREHENSIVE ENVIRONMENTAL
INCORPORATED**

21 DEPOT STREET
MERRIMACK, NH 03054

Not To Scale

Legend

- Surface Water
- Existing Drainage Swale
- Existing Drainage Pipe
- Existing Sewer Pipe
- Existing Water Pipe
- Existing Gas Line
- Existing Power Line
- Parcel Boundary
- Right of Way
- Existing Dry Well
- Existing Drain Manhole
- Existing Catch Basin
- Existing Outfall
- Outfall I.D.
- Proposed STP Watershed
- Proposed Drainage Pipe
- Proposed Drain Manhole
- Proposed Catch Basin
- Proposed STP

**SITE 1.7 - TREATMENT SWALES / WETPONDS
ON PUTNEY ROAD NORTH OF TRAFFIC CIRCLE**

SUBWATERSHEDS 7, 18, 19, 21 & 23
 TREATED AREA = 9.5 ACRES
 PUTNEY ROAD ~13%
 PRIVATE PROPERTY ~87%
 ASSUMED 47% BUILD-OUT CONDITION ON PRIVATE PROPERTY

NOTES: LOCATED PARTIALLY ON PUTNEY RIGHT-OF-WAY AND MOSTLY ON PRIVATE LAND. NOT LOCATED WITHIN PROPOSED PUTNEY ROAD IMPROVEMENTS. TREATS OVERLAND FLOW ON PUTNEY ROAD APPROX. 40% OF ROADWAY RUNOFF DISCHARGING AT CROSBY BROOK (OUTFALL #7) WITH OPTIONS TO HANDLE RUNOFF FROM PORTIONS OF ADJACENT PRIVATE PROPERTIES. COULD REMOVE THREE UN-TREATED DISCHARGES INTO CROSBY BROOK. APPROX. SWALE DEPTHS = 3.0'. OPTION TO INCREASE DEPTHS & FOOT PRINT TO SAFELY PASS 100 YR-24 HOUR STORM EVENT AND HANDLE RUNOFF FROM FULFLEX FACILITY THAT DISCHARGES AT CROSBY BROOK OUTFALL #4.

STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	2,400	2,400
WATER QUALITY VOLUME	20,850	20,850
RECHARGE VOLUME	8,900	8,900
CHANNEL PROTECTION VOLUME	19,800	19,800
OVERBANK FLOOD VOLUME	49,400	49,400
ANNUAL TSS LOADING / REMOVAL	214	170 (80%)

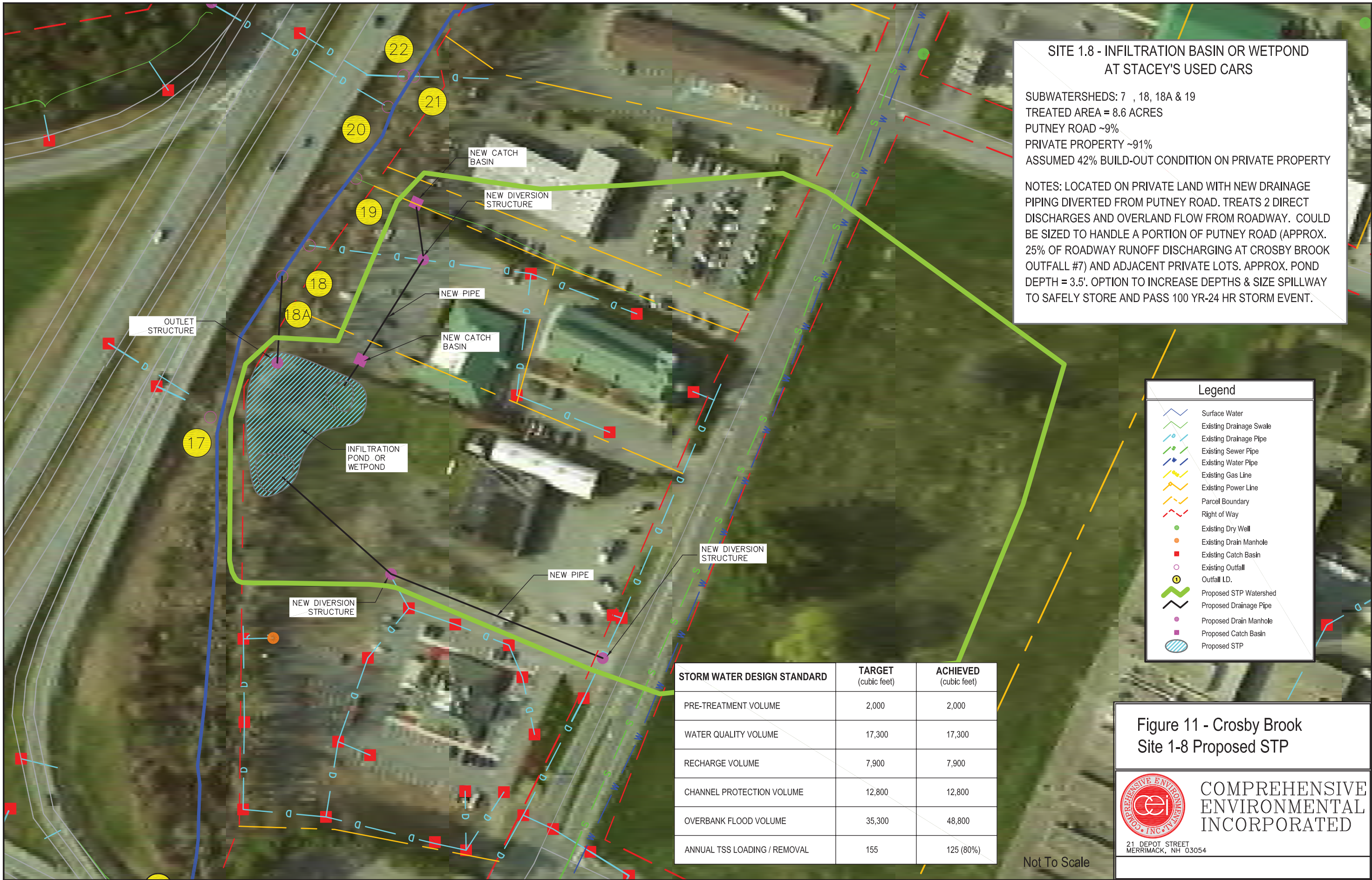


Figure 10 - Crosby Brook
Site 1-7 Proposed STP

COMPREHENSIVE ENVIRONMENTAL INCORPORATED

21 DEPOT STREET
MERRIMACK, NH 03054

Not To Scale



SITE 1.8 - INFILTRATION BASIN OR WETPOND AT STACEY'S USED CARS

SUBWATERSHEDS: 7 , 18, 18A & 19
 TREATED AREA = 8.6 ACRES
 PUTNEY ROAD ~9%
 PRIVATE PROPERTY ~91%
 ASSUMED 42% BUILD-OUT CONDITION ON PRIVATE PROPERTY

NOTES: LOCATED ON PRIVATE LAND WITH NEW DRAINAGE PIPING DIVERTED FROM PUTNEY ROAD. TREATS 2 DIRECT DISCHARGES AND OVERLAND FLOW FROM ROADWAY. COULD BE SIZED TO HANDLE A PORTION OF PUTNEY ROAD (APPROX. 25% OF ROADWAY RUNOFF DISCHARGING AT CROSBY BROOK OUTFALL #7) AND ADJACENT PRIVATE LOTS. APPROX. POND DEPTH = 3.5'. OPTION TO INCREASE DEPTHS & SIZE SPILLWAY TO SAFELY STORE AND PASS 100 YR-24 HR STORM EVENT.

Legend

- Surface Water
- Existing Drainage Swale
- Existing Drainage Pipe
- Existing Sewer Pipe
- Existing Water Pipe
- Existing Gas Line
- Existing Power Line
- Parcel Boundary
- Right of Way
- Existing Dry Well
- Existing Drain Manhole
- Existing Catch Basin
- Existing Outfall
- Outfall I.D.
- Proposed STP Watershed
- Proposed Drainage Pipe
- Proposed Drain Manhole
- Proposed Catch Basin
- Proposed STP

STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	2,000	2,000
WATER QUALITY VOLUME	17,300	17,300
RECHARGE VOLUME	7,900	7,900
CHANNEL PROTECTION VOLUME	12,800	12,800
OVERBANK FLOOD VOLUME	35,300	48,800
ANNUAL TSS LOADING / REMOVAL	155	125 (80%)

Figure 11 - Crosby Brook Site 1-8 Proposed STP

COMPREHENSIVE ENVIRONMENTAL INCORPORATED

21 DEPOT STREET
 MERRIMACK, NH 03054

Not To Scale

SITE 1.9 - EXTENDED WET DETENTION OR WETPOND AT COCOPLUM PLAZA & USED CAR LOT

SUBWATERSHEDS: 23, 24, 26 & 26B
 TREATED AREA = 9.9 ACRES
 PUTNEY ROAD ~10%
 ROUTE 91 ~6%
 PRIVATE PROPERTY ~84%
 ASSUMED 0% BUILD-OUT CONDITION ON PRIVATE PROPERTY

NOTES: LOCATED ON ROUTE 91 RIGHT OF WAY AND PRIVATE LAND. TREATS 2 DIRECT DISCHARGES AND COULD HANDLE PORTIONS OF PUTNEY ROAD DRAINAGE. WOULD REQUIRE PIPING AND STRUCTURES TO DIRECT RUNOFF FROM PUTNEY ROAD RIGHT OF WAY ACROSS PRIVATE PROPERTY. APPROX. POND DEPTH = 4.0'. OPTION TO INCREASE DEPTHS & SIZE SPILLWAY TO SAFELY PASS 100 YR-24 HR STORM EVENT. BASED ON DEPTH TO GROUNDWATER WOULD MOST LIKELY BE DESIGNED AS A WETPOND.

Legend	
	Surface Water
	Existing Drainage Swale
	Existing Drainage Pipe
	Existing Sewer Pipe
	Existing Water Pipe
	Existing Gas Line
	Existing Power Line
	Parcel Boundary
	Right of Way
	Existing Dry Well
	Existing Drain Manhole
	Existing Catch Basin
	Existing Outfall
	Outfall I.D.
	Proposed STP Watershed
	Proposed Drainage Pipe
	Proposed Drain Manhole
	Proposed Catch Basin
	Proposed STP

STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	2,050	2,050
WATER QUALITY VOLUME	18,000	18,000
RECHARGE VOLUME	4,800	4,800
CHANNEL PROTECTION VOLUME	16,300	16,300
OVERBANK FLOOD VOLUME	39,500	39,500
ANNUAL TSS LOADING / REMOVAL	173	138 (80%)

Figure 12 - Crosby Brook Site 1-9 Proposed STP



COMPREHENSIVE ENVIRONMENTAL INCORPORATED

21 DEPOT STREET
 MERRIMACK, NH 03054

Not To Scale

**SITE 1.10 - STORAGE POND & GRAVEL WETLAND
AT PUTNEY ROAD AND OLD FERRY INDUSTRIAL**

SUBWATERSHEDS: 32, 33A & 33B
 TREATED AREA = 21.1 ACRES
 PUTNEY ROAD ~1%
 TOWN ROAD ~1%
 PRIVATE PROPERTY ~98%
 ASSUMED 0% BUILD-OUT CONDITION ON PRIVATE PROPERTY

NOTES: LOCATED PARTIALLY ON RIGHT OF WAY AND ON PRIVATE LAND. TREATS DRAINAGE FROM PUTNEY ROAD DRAINAGE IN THE AREA AND A SMALL PORTION OF LARGE INDUSTRIAL AREA. ASSUMING POND ON OPPOSITE SIDE OF PUTNEY ROAD COULD BE SIZED TO HANDLE STORAGE FOR WATER QUALITY, RECHARGE, PEAK ONE AND TEN YEAR-24 HOUR VOLUMES, GRAVEL WETLAND COULD PROVIDE ADDITIONAL TREATMENT FOR SMALL IMPERVIOUS AREAS ADJACENT TO STP. RUNOFF FROM INDUSTRIAL AREA COULD BE STORED IN EXISTING STORAGE AREA AND FILTER THROUGH GRAVEL WETLAND PRIOR TO DISCHARGE ONTO ROUTE 91 PROPERTY.

STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	5,200	5,200
WATER QUALITY VOLUME	45,800	45,800
RECHARGE VOLUME	13,200	13,200
CHANNEL PROTECTION VOLUME	56,200	56,200
OVERBANK FLOOD VOLUME	130,600	95,000 (70%)
ANNUAL TSS LOADING / REMOVAL	409	170 (40%)

Legend

- Surface Water
- Existing Drainage Swale
- Existing Drainage Pipe
- Existing Sewer Pipe
- Existing Water Pipe
- Existing Gas Line
- Existing Power Line
- Parcel Boundary
- Right of Way
- Existing Dry Well
- Existing Drain Manhole
- Existing Catch Basin
- Existing Outfall
- Outfall I.D.
- Proposed STP Watershed
- Proposed Drainage Pipe
- Proposed Drain Manhole
- Proposed Catch Basin
- Proposed STP

**Figure 13 - Crosby Brook
Site 1-10 Proposed STPs**



**COMPREHENSIVE ENVIRONMENTAL
INCORPORATED**

21 DEPOT STREET
MERRIMACK, NH 03054

Not To Scale

SITE 1.11B - PEAK INFILTRATION BASIN & TREATMENT SWALE AT PUTNEY ROAD N. OF RT 91

SUBWATERSHEDS: 37A, 37B, 41A, & 41B
 TREATED AREA = 19.3 ACRES
 PUTNEY ROAD ~6%
 PRIVATE PROPERTY ~94%
 ASSUMED 8% BUILD-OUT CONDITION ON PRIVATE PROPERTY

NOTES: LOCATED ON A COMBINATION OF PRIVATE LAND & WITHIN RIGHT OF WAY. STORAGE AREAS WOULD BE LOCATED AT BASE OF PUTNEY ROAD SIDE SLOPES. TREATS PORTIONS OF PUTNEY ROAD DRAINAGE AND ADJACENT INDUSTRIAL AREAS. APPROX. SWALE AND POND DEPTHS = 3.5'. BASED ON DEPTH TO GROUNDWATER MAY NEED TO BE DESIGNED AS A WETPONDS. IT IS ASSUMED THAT AN OUTLET STRUCTURE CAN BE RETROFITTED ONTO THE EXISTING ROADWAY CULVERT UNDER PUTNEY ROAD. STRUCTURE WOULD BE DESIGNED TO SAFELY PASS 100 YEAR-24 HOUR STORM EVENT.

SITE 1.11A - TREATMENT SWALE AT BENNETT DRIVE INDUSTRIAL PARK

SUBWATERSHEDS: 37A & 40
 TREATED AREA = 20.5 ACRES
 TOWN ROADS ~1%
 PRIVATE PROPERTY ~99%
 ASSUMED 2% BUILD-OUT CONDITION ON PRIVATE PROPERTY

NOTES: LOCATED ON PRIVATE LAND TO TREAT RUNOFF FROM PRIVATELY OWNED INDUSTRIAL AREAS. DEPENDING ON PIPE DEPTHS MAY REQUIRE REMOVAL OF EXISTING PIPED DRAINAGE. BASED ON DEPTHS TO GROUNDWATER COULD ADD SUBSURFACE INFILTRATION AND ADDITIONAL STORAGE CAPACITY ABOVE OR ADJACENT TO PIPING. APPROX. PONDED DEPTH = 3 FEET. EXISTING DRAINAGE AT END OF SWALE WOULD BE USED TO SAFELY PASS 100 YEAR-24 HOUR STORM.

STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	1,380	1,380
WATER QUALITY VOLUME	14,650	14,650
RECHARGE VOLUME	3,500	3,500
CHANNEL PROTECTION VOLUME	7,900	7,900
OVERBANK FLOOD VOLUME	43,650	34,500 (80%)
ANNUAL TSS LOADING / REMOVAL	115	80 (70%)

STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	2,200	2,200
WATER QUALITY VOLUME	21,100	21,100
RECHARGE VOLUME	5,600	5,600
CHANNEL PROTECTION VOLUME	27,100	27,100
OVERBANK FLOOD VOLUME	78,000	78,000
ANNUAL TSS LOADING / REMOVAL	161	112 (70%)

Legend

- Surface Water
- Existing Drainage Swale
- Existing Drainage Pipe
- Existing Sewer Pipe
- Existing Water Pipe
- Existing Gas Line
- Existing Power Line
- Parcel Boundary
- Right of Way
- Existing Dry Well
- Existing Drain Manhole
- Existing Catch Basin
- Existing Outfall
- Outfall I.D.
- Proposed STP Watershed
- Proposed Drainage Pipe
- Proposed Drain Manhole
- Proposed Catch Basin
- Proposed STP



Figure 14 - Crosby Brook Site 1-11 Proposed STPs

COMPREHENSIVE ENVIRONMENTAL INCORPORATED
 21 DEPOT STREET
 MERRIMACK, NH 03054

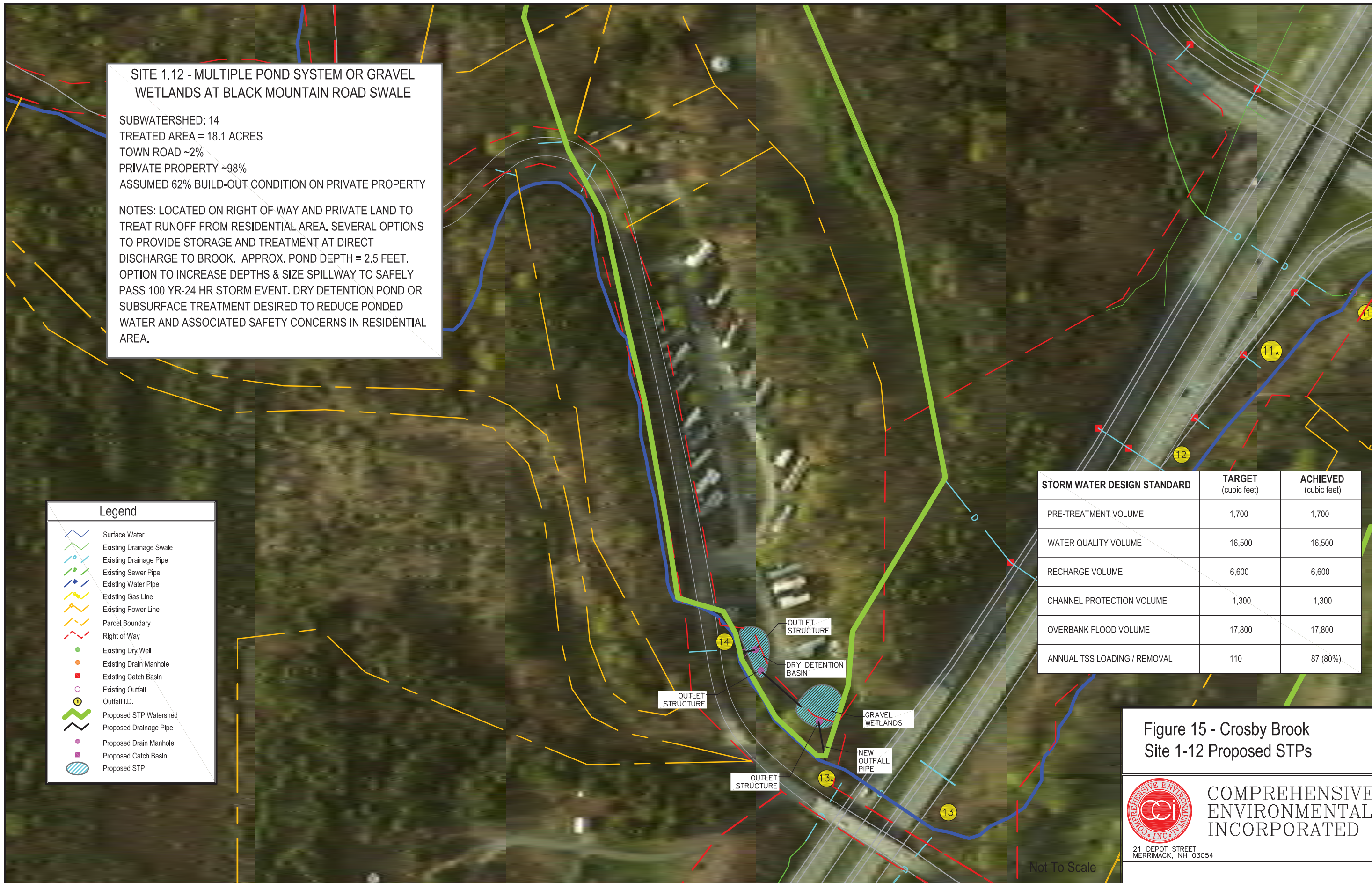
Not To Scale

SITE 1.12 - MULTIPLE POND SYSTEM OR GRAVEL WETLANDS AT BLACK MOUNTAIN ROAD SWALE

SUBWATERSHED: 14
 TREATED AREA = 18.1 ACRES
 TOWN ROAD ~2%
 PRIVATE PROPERTY ~98%
 ASSUMED 62% BUILD-OUT CONDITION ON PRIVATE PROPERTY

NOTES: LOCATED ON RIGHT OF WAY AND PRIVATE LAND TO TREAT RUNOFF FROM RESIDENTIAL AREA. SEVERAL OPTIONS TO PROVIDE STORAGE AND TREATMENT AT DIRECT DISCHARGE TO BROOK. APPROX. POND DEPTH = 2.5 FEET. OPTION TO INCREASE DEPTHS & SIZE SPILLWAY TO SAFELY PASS 100 YR-24 HR STORM EVENT. DRY DETENTION POND OR SUBSURFACE TREATMENT DESIRED TO REDUCE PONDED WATER AND ASSOCIATED SAFETY CONCERNS IN RESIDENTIAL AREA.

Legend	
	Surface Water
	Existing Drainage Swale
	Existing Drainage Pipe
	Existing Sewer Pipe
	Existing Water Pipe
	Existing Gas Line
	Existing Power Line
	Parcel Boundary
	Right of Way
	Existing Dry Well
	Existing Drain Manhole
	Existing Catch Basin
	Existing Outfall
	Outfall I.D.
	Proposed STP Watershed
	Proposed Drainage Pipe
	Proposed Drain Manhole
	Proposed Catch Basin
	Proposed STP



STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	1,700	1,700
WATER QUALITY VOLUME	16,500	16,500
RECHARGE VOLUME	6,600	6,600
CHANNEL PROTECTION VOLUME	1,300	1,300
OVERBANK FLOOD VOLUME	17,800	17,800
ANNUAL TSS LOADING / REMOVAL	110	87 (80%)

Figure 15 - Crosby Brook Site 1-12 Proposed STPs

COMPREHENSIVE ENVIRONMENTAL INCORPORATED
 21 DEPOT STREET
 MERRIMACK, NH 03054

Not To Scale

SITE 1.13 - MULTIPLE INFILTRATION SYSTEM FOR ROUTE 5 (PUTNEY ROAD) RE-ALIGNMENT PROJECT

SUBWATERSHED: 6.6H & PORTION OF 15C
 TREATED AREA = 16.4 ACRES
 PUTNEY RD ~70%
 TOWN ROAD ~3%
 PRIVATE PROPERTY ~27%
 ASSUMED 6% BUILD-OUT CONDITION ON PRIVATE PROPERTY

NOTES: BASED ON VTRANS PROPOSED PUTNEY RD ROADWAY IMPROVEMENTS, INFILTRATION / BIORETENTION BMPs WOULD BE CONSTRUCTED IN THE PROPOSED MEDIANS AND TRAFFIC CIRCLES TO HANDLE ROADWAY DRAINAGE. BMPs COULD ALSO HANDLE PORTIONS OF PRIVATE PROPERTIES LOCATED ADJACENT TO PUTNEY AND BLACK MOUNTAIN ROADS. BMPs WOULD OUTFALL TO EITHER CROSBY BROOK OR CONNECTICUT RIVER FOLLOWING TREATMENT. THESE BMPs WOULD HANDLE RUNOFF FROM PORTIONS OF PUTNEY ROAD THAT ARE OUTSIDE CROSBY BROOK WATERSHED BASED ON EXISTING DRAINAGE PATTERNS. WOULD BE LOCATED IN PROPOSED RIGHT OF WAY OF RE-ALIGNED ROUTE 5. EXISTING DRAINAGE COULD BE UTILIZED, BUT NEW DRAINAGE SYSTEMS WOULD BE REQUIRED TO COLLECT ROADWAY RUNOFF AND CONNECT TO PROPOSED MEDIANS. APPROX. STORAGE DEPTHS = 3.5 FEET. OVERFLOWS AND BYPASSES WOULD BE REQUIRED TO SAFELY PASS LARGER THAN 100 YR-24 HR STORM EVENT.



STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	3,200	3,200
WATER QUALITY VOLUME	28,600	28,600
RECHARGE VOLUME	11,700	11,700
CHANNEL PROTECTION VOLUME	24,500	24,500
OVERBANK FLOOD VOLUME	36,200	28,900
ANNUAL TSS LOADING / REMOVAL	169	118 (70%)

STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	3,200	3,200
WATER QUALITY VOLUME	28,600	28,600
RECHARGE VOLUME	11,700	11,700
CHANNEL PROTECTION VOLUME	24,500	24,500
OVERBANK FLOOD VOLUME	36,200	28,900
ANNUAL TSS LOADING / REMOVAL	169	118 (70%)

Figure 16a - Crosby Brook Site 1-13 Proposed STPs



COMPREHENSIVE ENVIRONMENTAL INCORPORATED

21 DEPOT STREET
 MERRIMACK, NH 03054

Not To Scale

SITE 1.13 - MULTIPLE INFILTRATION SYSTEM FOR ROUTE 5 (PUTNEY ROAD) RE-ALIGNMENT PROJECT

SUBWATERSHED: 6.6H & PORTION OF 15C
 TREATED AREA = 16.4 ACRES
 PUTNEY RD ~70%
 TOWN ROAD ~3%
 PRIVATE PROPERTY ~27%
 ASSUMED 6% BUILD-OUT CONDITION ON PRIVATE PROPERTY

NOTES: BASED ON VTRANS PROPOSED PUTNEY RD ROADWAY IMPROVEMENTS, INFILTRATION / BIORETENTION BMPs WOULD BE CONSTRUCTED IN THE PROPOSED MEDIANS AND TRAFFIC CIRCLES TO HANDLE ROADWAY DRAINAGE. BMPs COULD ALSO HANDLE PORTIONS OF PRIVATE PROPERTIES LOCATED ADJACENT TO PUTNEY AND BLACK MOUNTAIN ROADS. BMPs WOULD OUTFALL TO EITHER CROSBY BROOK OR CONNECTICUT RIVER FOLLOWING TREATMENT. THESE BMPs WOULD HANDLE RUNOFF FROM PORTIONS OF PUTNEY ROAD THAT ARE OUTSIDE CROSBY BROOK WATERSHED BASED ON EXISTING DRAINAGE PATTERNS. WOULD BE LOCATED IN PROPOSED RIGHT OF WAY OF RE-ALIGNED ROUTE 5. EXISTING DRAINAGE COULD BE UTILIZED, BUT NEW DRAINAGE SYSTEMS WOULD BE REQUIRED TO COLLECT ROADWAY RUNOFF AND CONNECT TO PROPOSED MEDIANS. APPROX. STORAGE DEPTHS = 3.5 FEET. OVERFLOWS AND BYPASSES WOULD BE REQUIRED TO SAFELY PASS LARGER THAN 100 YR-24 HR STORM EVENT.

Legend

- Surface Water
- Existing Drainage Swale
- Existing Drainage Pipe
- Existing Sewer Pipe
- Existing Water Pipe
- Existing Gas Line
- Existing Power Line
- Parcel Boundary
- Right of Way
- Existing Dry Well
- Existing Drathn Manhole
- Existing Catch Basin
- Existing Outfall
- Outfall I.D.
- Proposed STP Watershed
- Proposed Drainage Pipe
- Proposed Drain Manhole
- Proposed Catch Basin
- Proposed STP

STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	3,200	3,200
WATER QUALITY VOLUME	28,600	28,600
RECHARGE VOLUME	11,700	11,700
CHANNEL PROTECTION VOLUME	24,500	24,500
OVERBANK FLOOD VOLUME	36,200	28,900
ANNUAL TSS LOADING / REMOVAL	169	118 (70%)

Figure 16b - Crosby Brook Site 1-13 Proposed STPs



COMPREHENSIVE ENVIRONMENTAL INCORPORATED

21 DEPOT STREET
 MERRIMACK, NH 03054

Not To Scale

SITE 2.1 - INFILTRATION TRENCHES & TREATMENT SWALES AT RT 91 S.OF BLACK MT RD OVERPASS

SUBWATERSHEDS: 13, 13B & 13C
 TREATED AREA = 5.6 ACRES
 ROUTE 91 ~62%
 PRIVATE PROPERTY ~38%
 ASSUMED 6% BUILD-OUT CONDITION ON PRIVATE PROPERTY

NOTES: LOCATED WITHIN ROUTE 91 L.A.R.O.W. HANDLES ROUTE 91 AND ADJACENT PRIVATE PROPERTY DRAINAGE. RETROFIT EXISTING SWALES WITH PRE-TREATMENT DEVICES AND SUBSURFACE INFILTRATION / STORAGE CAPABILITIES. INCREASE CAPACITY OF EXISTING ROADSIDE DRAINAGE SWALES. TREATMENT SWALE DEPTH = 1-2 FEET. APPROX. STONE DEPTH = 3 FEET. IT IS ASSUMED THAT ROADSIDE SWALES CAN BE RE-GRADED IN AREAS WHERE THERE IS NO GUARDRAIL.

STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	1,100	1,100
WATER QUALITY VOLUME	10,100	10,100
RECHARGE VOLUME	3,100	3,100
CHANNEL PROTECTION VOLUME	9,900	9,900
OVERBANK FLOOD VOLUME	26,000	26,000
ANNUAL TSS LOADING / REMOVAL	127	87 (70%)

Legend

- Surface Water
- Existing Drainage Swale
- Existing Drainage Pipe
- Existing Sewer Pipe
- Existing Water Pipe
- Existing Gas Line
- Existing Power Line
- Parcel Boundary
- Right of Way
- Existing Dry Well
- Existing Drain Manhole
- Existing Catch Basin
- Existing Outfall
- Outfall I.D.
- Proposed STP Watershed
- Proposed Drainage Pipe
- Proposed Drain Manhole
- Proposed Catch Basin
- Proposed STP



Figure 17 - Crosby Brook Site 2-1 Proposed STPs

COMPREHENSIVE ENVIRONMENTAL INCORPORATED
 21 DEPOT STREET
 MERRIMACK, NH 03054

Not To Scale

**SITE 2.2 - INFILTRATION TRENCHES & WETPONDS
AT RT 91 NORTH OF BLACK MT RD OVERPASS**

SUBWATERSHEDS: 12, 12A & 13A
 TREATED AREA = 22.5 ACRES
 ROUTE 91 ~46%
 TOWN ROADS ~ 1%
 PRIVATE PROPERTY ~53%
 ASSUMED 12% BUILD-OUT CONDITION ON PRIVATE PROPERTY

NOTES: LOCATED WITHIN ROUTE 91 L.A.R.O.W. AND SOME PRIVATE LAND. HANDLES ROUTE 91 DRAINAGE. RETROFIT EXISTING SWALES WITH PRE-TREATMENT DEVICES AND SUBSURFACE INFILTRATION / STORAGE CAPABILITIES. INCREASE CAPACITY OF EXISTING ROADSIDE DRAINAGE SWALES AND PROVIDE TREATMENT USING GRAVEL WETLANDS OR WETPONDS. TREATMENT SWALE DEPTH = 1 FEET. APPROX. STONE DEPTH = 2 FEET. WETPOND DEPTHS = 1-2 FEET. OPTIMAL SPACE FOR STORAGE AND SAFE PASSING OF 100 YEAR - 24 HOUR STORM EVENT. WILL REQUIRE WORK ON TURNPIKE SIDE SLOPES AND THE INSTALLATION OF NEW DISCHARGES TO CROSBY BROOK. IT IS ASSUMED THAT ROADSIDE SWALES AND AREAS OUTSIDE CLEAR ZONE CAN BE RE-GRADED IN AREAS WHERE THERE IS NO GUARDRAIL.

Legend

- Surface Water
- Existing Drainage Swale
- Existing Drainage Pipe
- Existing Sewer Pipe
- Existing Water Pipe
- Existing Gas Line
- Existing Power Line
- Parcel Boundary
- Right of Way
- Existing Dry Well
- Existing Drain Manhole
- Existing Catch Basin
- Existing Outfall
- Outfall I.D.
- Proposed STP Watershed
- Proposed Drainage Pipe
- Proposed Drain Manhole
- Proposed Catch Basin
- Proposed STP

STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	1,250	1,250
WATER QUALITY VOLUME	14,000	14,000
RECHARGE VOLUME	5,050	5,050
CHANNEL PROTECTION VOLUME	300	300
OVERBANK FLOOD VOLUME	6,700	14,000
ANNUAL TSS LOADING / REMOVAL	170	136 (80%)

**Figure 18 - Crosby Brook
Site 2-2 Proposed STPs**



**COMPREHENSIVE
ENVIRONMENTAL
INCORPORATED**

21 DEPOT STREET
MERRIMACK, NH 03054

Not To Scale

**SITE 2.3B - MULTIPLE WETPOND SYSTEM
AT ROUTE 91 EXIT 3 SB RAMPS**

SUBWATERSHEDS: 11B, 11C & 11D
TREATED AREA = 13.3 ACRES
ROUTE 91 ~100%
ASSUMED 0% BUILD-OUT CONDITION

NOTES: LOCATED WITHIN ROUTE 91 L.A.R.O.W. HANDLES ROUTE 91 DRAINAGE. RETROFIT EXISTING SWALES WITH PRE-TREATMENT DEVICES AND INCREASE CAPACITY. PROVIDE TREATMENT THROUGH MULTIPLE TREATMENT SWALES AND WETPONDS. SWALE WETPOND DEPTHS = 1 TO 2 FEET. FOOTPRINT AND DEPTHS CAN BE INCREASED TO SAFELY STORE 100 YEAR-24 HOUR STORM EVENT. WILL REQUIRE SOME BANK STABILIZATION AND TURNPIKE DRAINAGE ADJUSTMENT. IT IS ASSUMED THAT OUTLET STRUCTURES CAN BE RETROFITTED ONTO THE EXISTING TURNPIKE CULVERTS.

**SITE 2.3A - WETLAND POCKETS
AT ROUTE 91 EXIT 3 NB RAMPS**

SUBWATERSHEDS: 10, 11A, 16B & 17
TREATED AREA = 6.5 ACRES
ROUTE 91 ~100%
ASSUMED 0% BUILD-OUT CONDITION

NOTES: LOCATED WITHIN ROUTE 91 L.A.R.O.W. HANDLES ROUTE 91 DRAINAGE. RETROFIT EXISTING SWALES WITH PRE-TREATMENT DEVICES AND SUBSURFACE INFILTRATION / STORAGE CAPABILITIES. INCREASE CAPACITY OF GRASSED AREAS BETWEEN ON/OFF RAMPS. TREATMENT SWALE DEPTH = 1-2 FEET. DETENTION AREA = 1 FOOT OR LESS. ADDITIONAL STORAGE PROVIDED BY RAISING RIMS OF EXISTING CATCH BASINS LOCATED IN MEDIANS.

Legend	
	Surface Water
	Existing Drainage Swale
	Existing Drainage Pipe
	Existing Sewer Pipe
	Existing Water Pipe
	Existing Gas Line
	Existing Power Line
	Parcel Boundary
	Right of Way
	Existing Dry Well
	Existing Drain Manhole
	Existing Catch Basin
	Existing Outfall
	Outfall I.D.
	Proposed STP Watershed
	Proposed Drainage Pipe
	Proposed Drain Manhole
	Proposed Catch Basin
	Proposed STP

STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	690	690
WATER QUALITY VOLUME	7,700	7,700
RECHARGE VOLUME	2,200	2,200
CHANNEL PROTECTION VOLUME	8,400	8,400
OVERBANK FLOOD VOLUME	34,000	48,600
ANNUAL TSS LOADING / REMOVAL	103	93 (90%)

STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	580	580
WATER QUALITY VOLUME	5,800	5,800
RECHARGE VOLUME	2,350	2,350
CHANNEL PROTECTION VOLUME	900	900
OVERBANK FLOOD VOLUME	7,400	8,000
ANNUAL TSS LOADING / REMOVAL	98	78 (80%)



Figure 19 - Crosby Brook Site 2-3 Proposed STPs

**COMPREHENSIVE ENVIRONMENTAL
INCORPORATED**
21 DEPOT STREET
MERRIMACK, NH 03054

Not To Scale

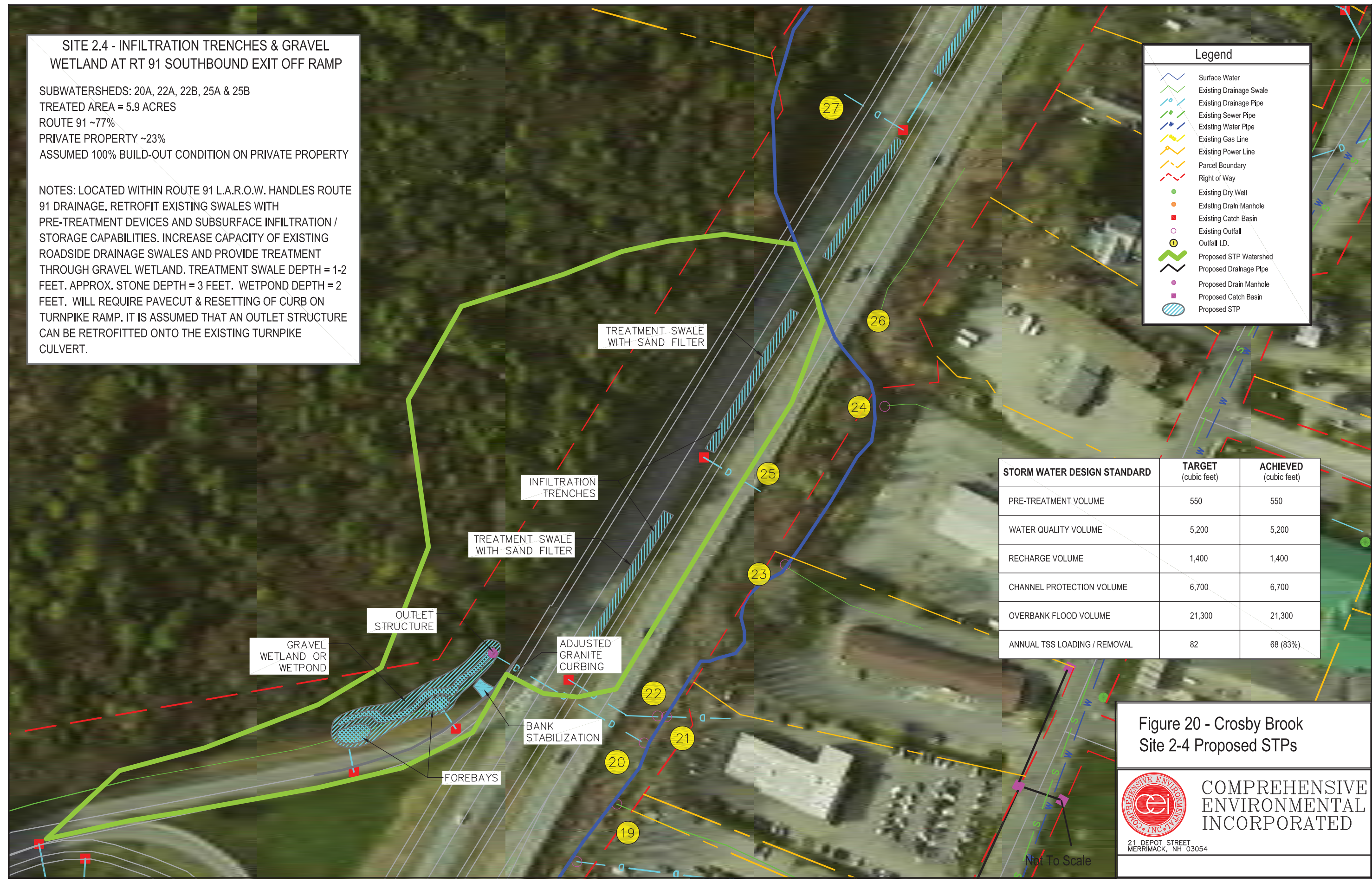
SITE 2.4 - INFILTRATION TRENCHES & GRAVEL WETLAND AT RT 91 SOUTHBOUND EXIT OFF RAMP

SUBWATERSHEDS: 20A, 22A, 22B, 25A & 25B
 TREATED AREA = 5.9 ACRES
 ROUTE 91 ~77%
 PRIVATE PROPERTY ~23%
 ASSUMED 100% BUILD-OUT CONDITION ON PRIVATE PROPERTY

NOTES: LOCATED WITHIN ROUTE 91 L.A.R.O.W. HANDLES ROUTE 91 DRAINAGE. RETROFIT EXISTING SWALES WITH PRE-TREATMENT DEVICES AND SUBSURFACE INFILTRATION / STORAGE CAPABILITIES. INCREASE CAPACITY OF EXISTING ROADSIDE DRAINAGE SWALES AND PROVIDE TREATMENT THROUGH GRAVEL WETLAND. TREATMENT SWALE DEPTH = 1-2 FEET. APPROX. STONE DEPTH = 3 FEET. WETPOND DEPTH = 2 FEET. WILL REQUIRE PAVECUT & RESETTING OF CURB ON TURNPIKE RAMP. IT IS ASSUMED THAT AN OUTLET STRUCTURE CAN BE RETROFITTED ONTO THE EXISTING TURNPIKE CULVERT.

Legend

- Surface Water
- Existing Drainage Swale
- Existing Drainage Pipe
- Existing Sewer Pipe
- Existing Water Pipe
- Existing Gas Line
- Existing Power Line
- Parcel Boundary
- Right of Way
- Existing Dry Well
- Existing Drain Manhole
- Existing Catch Basin
- Existing Outfall
- Outfall I.D.
- Proposed STP Watershed
- Proposed Drainage Pipe
- Proposed Drain Manhole
- Proposed Catch Basin
- Proposed STP



STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	550	550
WATER QUALITY VOLUME	5,200	5,200
RECHARGE VOLUME	1,400	1,400
CHANNEL PROTECTION VOLUME	6,700	6,700
OVERBANK FLOOD VOLUME	21,300	21,300
ANNUAL TSS LOADING / REMOVAL	82	68 (83%)

Figure 20 - Crosby Brook Site 2-4 Proposed STPs

COMPREHENSIVE ENVIRONMENTAL INCORPORATED
 21 DEPOT STREET
 MERRIMACK, NH 03054

Not To Scale

**SITE 2.5 - INFILTRATION AREAS
ON ROUTE 91 NEAR HAMPTON INN**

SUBWATERSHEDS: 27, 28A, 28B & 30
 TREATED AREA = 8.8 ACRES
 ROUTE 91 ~57%
 PRIVATE PROPERTY ~43%
 ASSUMED 0% BUILD-OUT CONDITION ON PRIVATE PROPERTY

NOTES: LOCATED WITHIN ROUTE 91 L.A.R.O.W. HANDLES ROUTE 91 DRAINAGE AND PORTIONS OF HAMPTON / QUALITY INN DRAINAGE. NEED TO CONFIRM DRAINAGE AT HAMPTON INN BECAUSE OUTFALL ONTO ROUTE 91 MIGHT BE ABANDONED. RETROFIT EXISTING SWALES WITH PRE-TREATMENT DEVICES AND SUBSURFACE INFILTRATION / STORAGE CAPABILITIES. INCREASE CAPACITY OF EXISTING ROADSIDE DRAINAGE SWALES. WETPOND AND TREATMENT SWALE DEPTH = 2 FEET. APPROX. STONE DEPTH = 3 FEET. ASSUMED ACCESS TO TURNPIKE SHOULDERS IN AREAS WITH NO GUARDRAIL. MAY REQUIRE BANK STABILIZATION AND RIPRAP LINING AT SPECIFIC LOCATIONS.

STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	750	750
WATER QUALITY VOLUME	7,400	7,400
RECHARGE VOLUME	3,000	3,000
CHANNEL PROTECTION VOLUME	3,800	3,800
OVERBANK FLOOD VOLUME	13,300	13,300
ANNUAL TSS LOADING / REMOVAL	83	58 (70%)

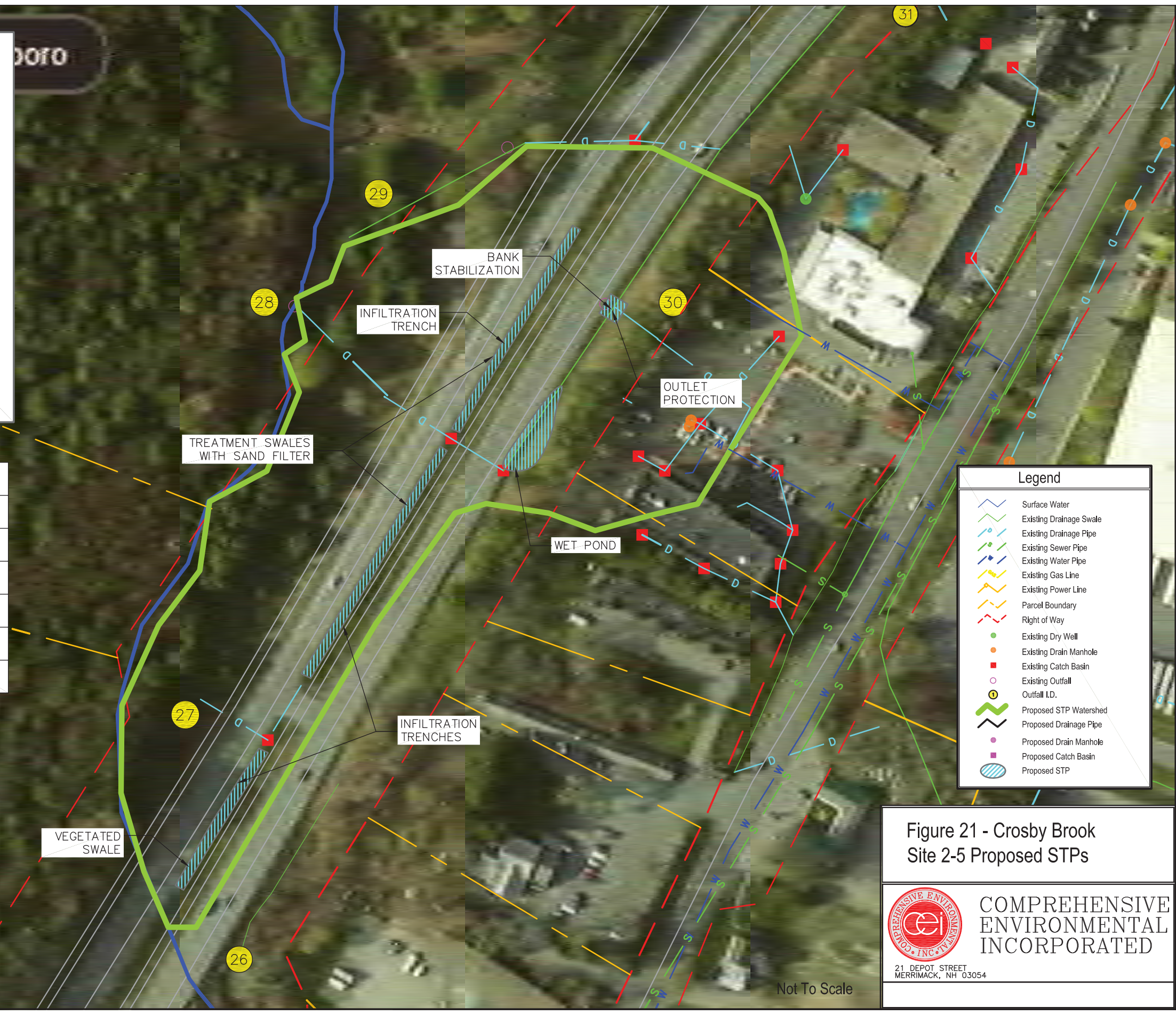


Figure 21 - Crosby Brook Site 2-5 Proposed STPs

Not To Scale

SITE 2.6 - INFILTRATION TRENCHES & TREATMENT SWALES AT RT 91 SW OF PUTNEY BRIDGE

SUBWATERSHEDS: 29, 32, 38 & 39
 TREATED AREA = 15.6 ACRES
 TOWN ROADS ~5%
 ROUTE 91 ~41%
 PRIVATE PROPERTY ~54%
 ASSUMED 0% BUILD-OUT CONDITION ON PRIVATE PROPERTY

NOTES: LOCATED WITHIN ROUTE 91 L.A.R.O.W. HANDLES ROUTE 91 DRAINAGE AND PORTIONS OF PRIVATE DRAINAGE. RETROFIT EXISTING SWALES WITH PRE-TREATMENT DEVICES AND SUBSURFACE INFILTRATION / STORAGE CAPABILITIES. TREATMENT SWALE DEPTH = 1-2 FEET. APPROX. STONE DEPTH = 3 FEET. ADDITIONAL OVERBANK FLOOD VOLUME AND LARGER STORMS CAN BE HANDLED BY INCREASING DETENTION POND FOOTPRINT AND SPILLWAY, BUT ADJACENT WETLAND RESOURCE AREAS LIMIT POND SIZE. (IT IS ASSUMED THAT SOME PRIVATE DRAINAGE IS ATTENUATED ON-SITE PRIOR TO DISCHARGE ONTO RT 91.)

STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	2,750	2,750
WATER QUALITY VOLUME	24,750	24,750
RECHARGE VOLUME	6,850	6,850
CHANNEL PROTECTION VOLUME	21,000	21,000
OVERBANK FLOOD VOLUME	58,050	32,500 (56%)
ANNUAL TSS LOADING / REMOVAL	246	172 (70%)

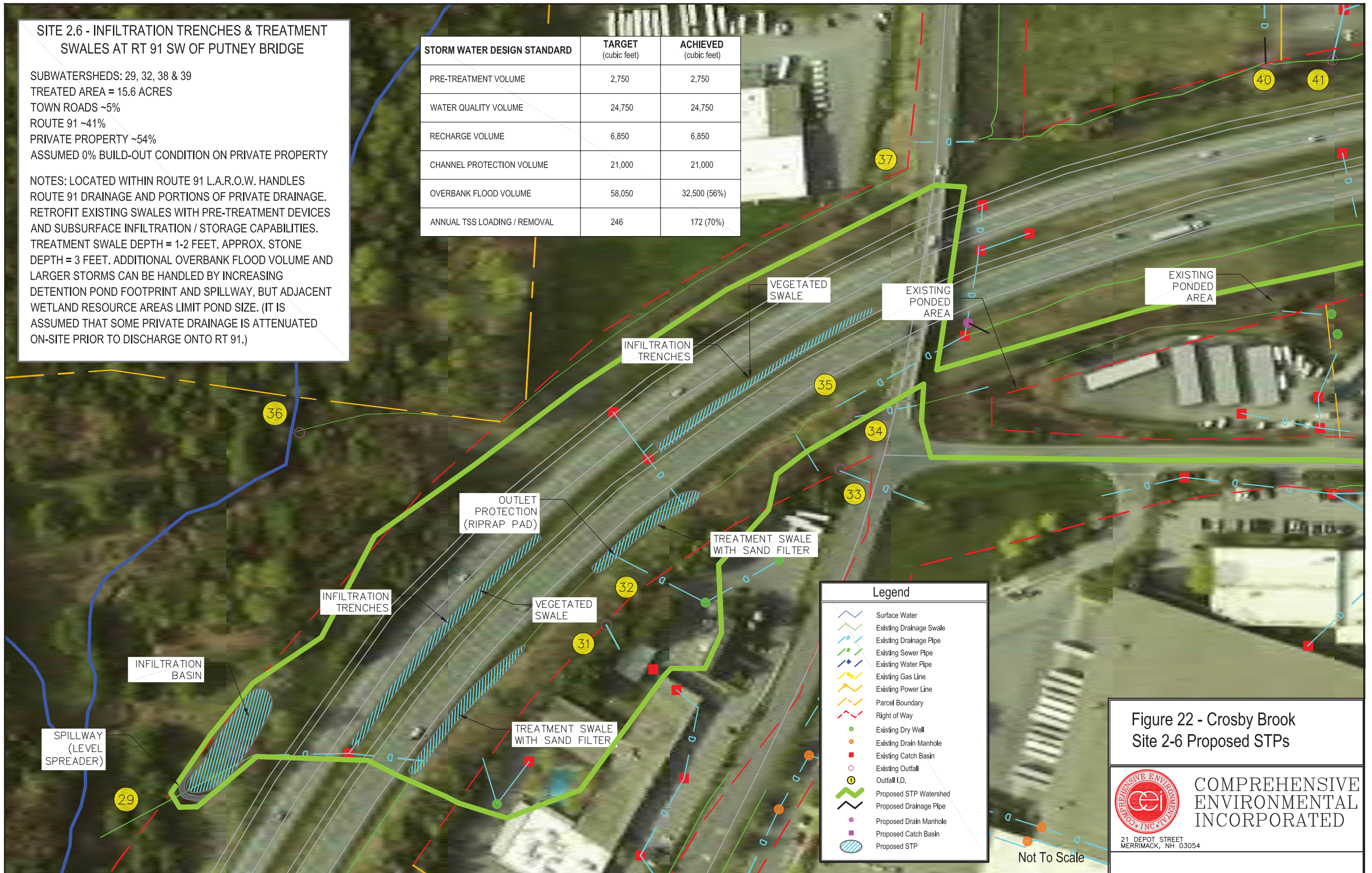


Figure 22 - Crosby Brook Site 2-6 Proposed STPs

Not To Scale

**SITE 2.7 - INFILTRATION TRENCHES & WETPOND
AT ROUTE 91 NE OF PUTNEY BRIDGE**

SUBWATERSHED: 35
TREATED AREA = 9.5 ACRES
ROUTE 91 ~100%
ASSUMED 0% BUILD-OUT CONDITION

NOTES: LOCATED WITHIN ROUTE 91 L.A.R.O.W. HANDLES ROUTE 91 DRAINAGE. RETROFIT EXISTING SWALES WITH PRE-TREATMENT DEVICES AND SUBSURFACE INFILTRATION / STORAGE CAPABILITIES. TREATMENT SWALE DEPTH = 1-2 FEET. APPROX. INCREASE CAPACITY OF DRAINAGE SWALES BY DIVERTING FLOWS AND INSTALLING OUTLET CONTROL STRUCTURES ADJACENT TO WETLAND AREAS. SWALE DEPTHS 1-2 FEET .STONE DEPTH = 3 FEET. WETPOND DEPTHS = 2 FEET. OVERBANK FLOOD VOLUMES AND LARGER STORMS CAN BE HANDLED WITH PROPERLY SIZED SPILLWAY THAT DISCHARGES TO EXISTING ADJACENT WETLANDS.

Legend	
	Surface Water
	Existing Drainage Swale
	Existing Drainage Pipe
	Existing Sewer Pipe
	Existing Water Pipe
	Existing Gas Line
	Existing Power Line
	Parcel Boundary
	Right of Way
	Existing Dry Well
	Existing Drain Manhole
	Existing Catch Basin
	Existing Outfall
	Outfall I.D.
	Proposed STP Watershed
	Proposed Drainage Pipe
	Proposed Drain Manhole
	Proposed Catch Basin
	Proposed STP

STORM WATER DESIGN STANDARD	TARGET (cubic feet)	ACHIEVED (cubic feet)
PRE-TREATMENT VOLUME	1,010	1,010
WATER QUALITY VOLUME	9,750	9,750
RECHARGE VOLUME	2,550	2,550
CHANNEL PROTECTION VOLUME	14,700	14,700
OVERBANK FLOOD VOLUME	42,050	42,050
ANNUAL TSS LOADING / REMOVAL	154	123 (80%)

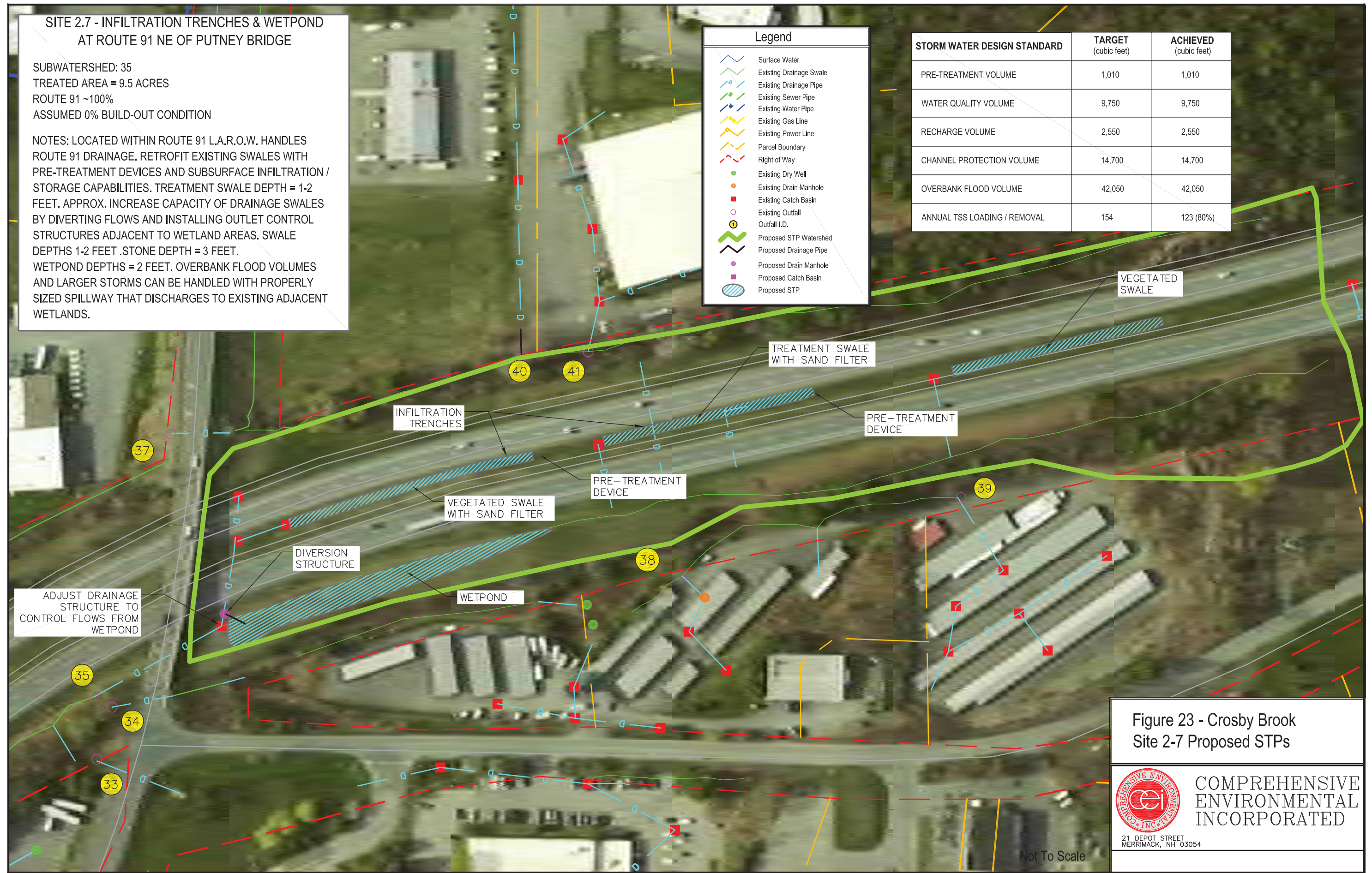


Figure 23 - Crosby Brook
Site 2-7 Proposed STPs



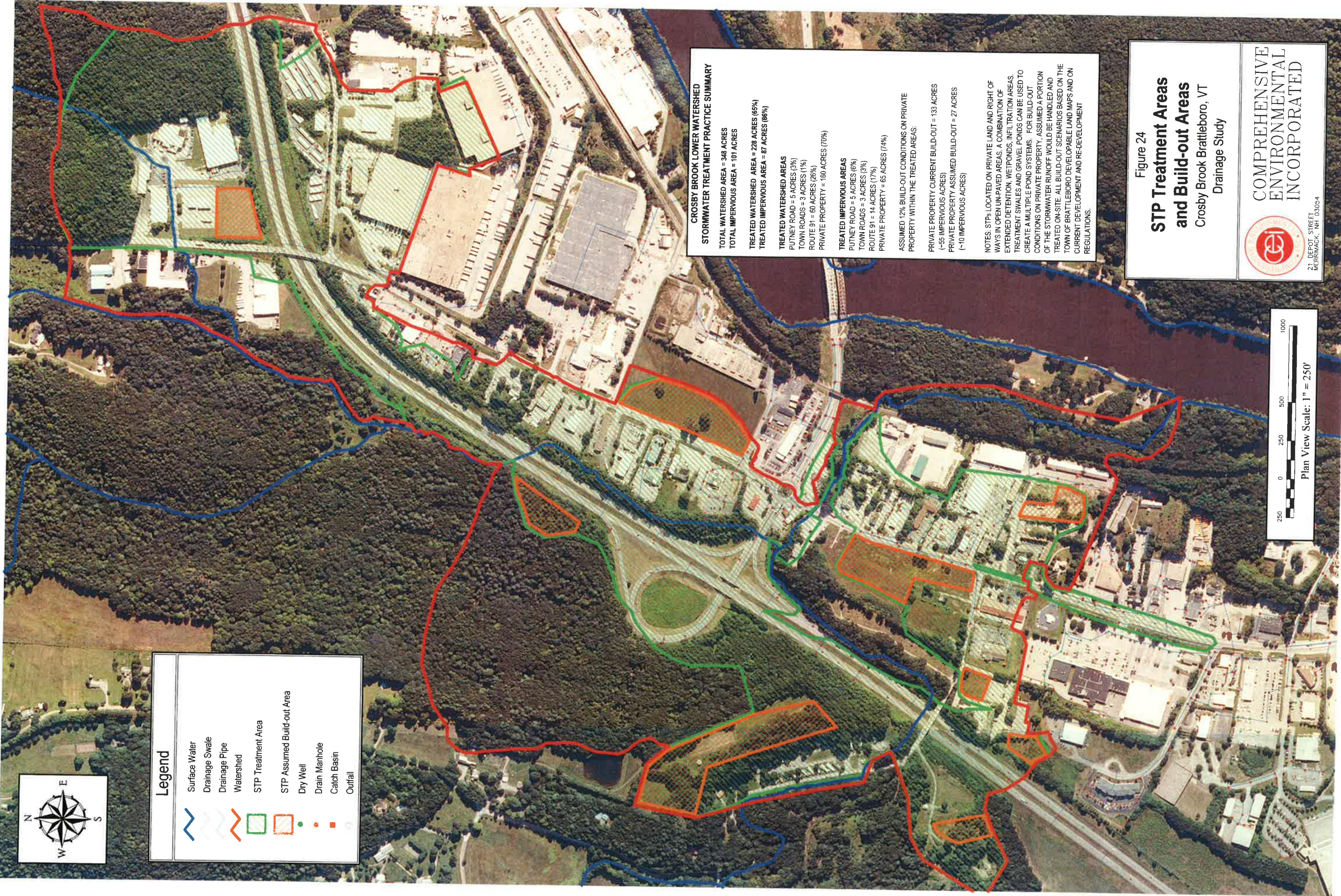
**COMPREHENSIVE ENVIRONMENTAL
INCORPORATED**
21 DEPOT STREET
MERRIMACK, NH 03054

Not To Scale



Legend

- Surface Water
- Drainage Swale
- Drainage Pipe
- Watershed
- STP Treatment Area
- STP Assumed Build-out Area
- Dry Well
- Drain Manhole
- Catch Basin
- Outfall



**CROSBY BROOK LOWER WATERSHED
STORMWATER TREATMENT PRACTICE SUMMARY**

TOTAL WATERSHED AREA = 348 ACRES
TOTAL IMPERVIOUS AREA = 101 ACRES

TREATED WATERSHED AREA = 228 ACRES (65%)
TREATED IMPERVIOUS AREA = 87 ACRES (86%)

TREATED WATERSHED AREAS
PUTNEY ROAD = 5 ACRES (3%)
TOWN ROADS = 3 ACRES (1%)
ROUTE 91 = 60 ACRES (26%)
PRIVATE PROPERTY = 160 ACRES (70%)

TREATED IMPERVIOUS AREAS
PUTNEY ROAD = 5 ACRES (6%)
TOWN ROADS = 3 ACRES (3%)
ROUTE 91 = 14 ACRES (17%)
PRIVATE PROPERTY = 65 ACRES (74%)

ASSUMED 12% BUILD-OUT CONDITIONS ON PRIVATE PROPERTY WITHIN THE TREATED AREAS.

PRIVATE PROPERTY CURRENT BUILD-OUT = 133 ACRES (~55 IMPERVIOUS ACRES)
PRIVATE PROPERTY ASSUMED BUILD-OUT = 27 ACRES (~10 IMPERVIOUS ACRES)

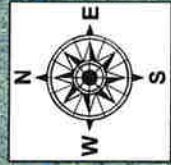
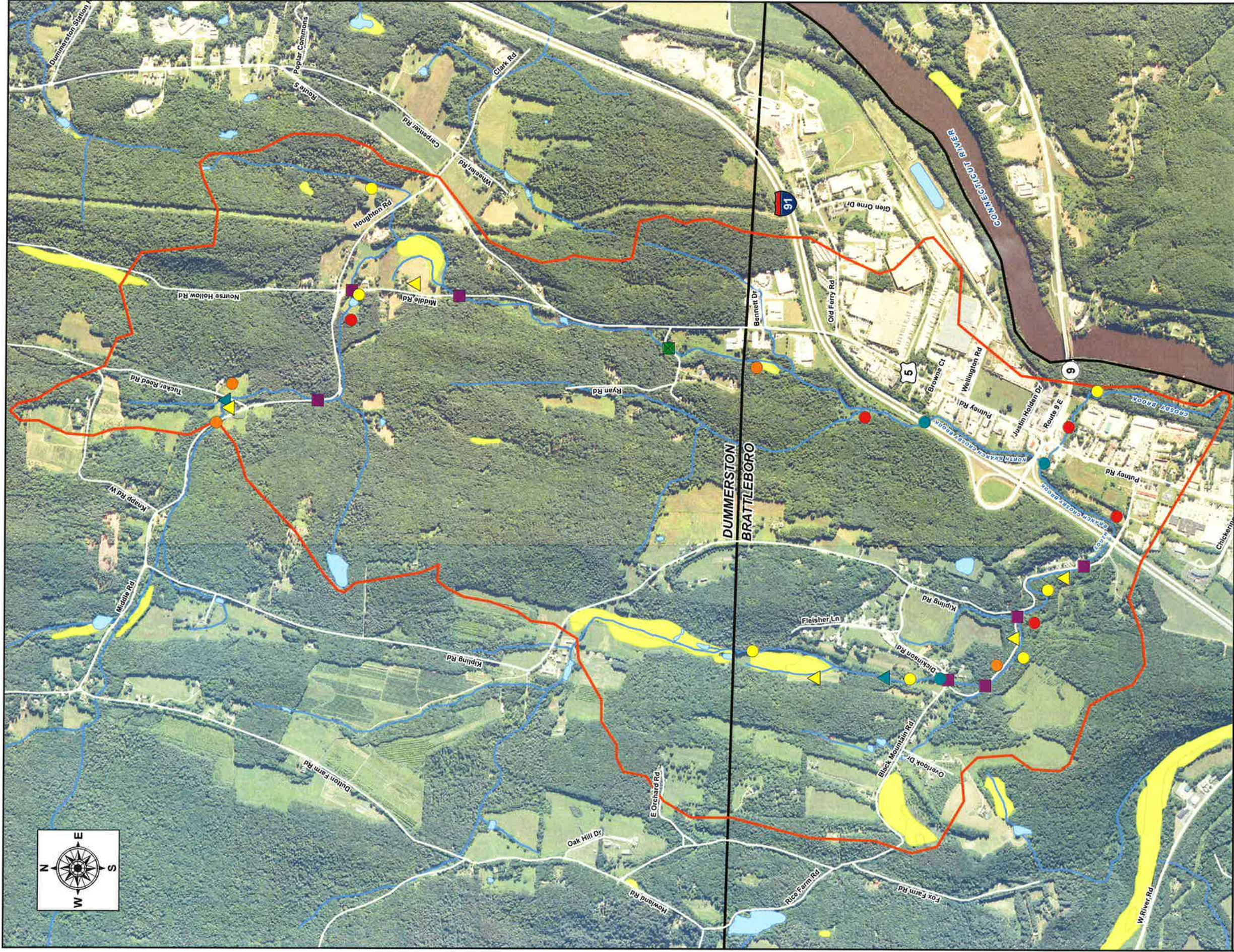
NOTES: STPs LOCATED ON PRIVATE LAND AND RIGHT OF WAYS IN OPEN UN-PAVED AREAS. A COMBINATION OF EXTENDED DETENTION, WETPONDS, INFILTRATION AREAS, TREATMENT SWALES AND GRAVEL PONDS CAN BE USED TO CREATE A MULTIPLE POND SYSTEMS. FOR BUILD-OUT CONDITIONS ON PRIVATE PROPERTY, ASSUMED A PORTION OF THE STORMWATER RUNOFF WOULD BE HANDLED AND TREATED ON-SITE. ALL BUILD-OUT SCENARIOS BASED ON THE TOWN OF BRATTLEBORO DEVELOPABLE LAND MAPS AND ON CURRENT DEVELOPMENT AND RE-DEVELOPMENT REGULATIONS.

Figure 24
**STP Treatment Areas
and Build-out Areas**
Crosby Brook Brattleboro, VT
Drainage Study

COMPREHENSIVE
ENVIRONMENTAL
INCORPORATED

21 DEPOT STREET
MERRIMACK, NH 03054





Legend

- Bank Erosion (minor streambank stabilization)
- Steep Slope (medium streambank stabilization)
- Mass Failure (major streambank stabilization)
- Sediment Accumulation (dredge sediment, stabilize streambed)
- Undersized Culvert (replace culvert)
- Undersized Culvert/Perched (replace culvert)
- ▲ Limited Buffer (install stream buffer)
- ▲ Dam Location

- Crosby Brook Watershed
- Town Boundary
- Hydrography**
- Lake, Pond
- Wetlands
- Stream

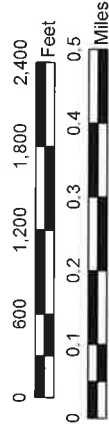


Figure 25

Putney Road - Crosby Brook
Stormwater Design Project

Project Area 3 Crosby Brook STPs

Streambank Stabilization, Erosion Repairs
and Culvert Replacement



Comprehensive Environmental Inc.

Appendix A
Preliminary Assessment of Environmental
Permit Requirements



FITZGERALD & HALLIDAY, INC.
72 Cedar Street, Hartford, Connecticut 06106
Tel. (860) 247-7200
Fax (860) 247-7206

Memorandum

Project: Crosby Brook Stormwater Best Management Practices

To: Matthew Lundsted, P.E., CFM, Comprehensive Environmental Inc.

Date: May 16, 2012

Report By: Daniel A. Hageman, PSS

Purpose: Preliminary Assessment of Environmental Permit Requirements

Introduction

The Town of Brattleboro, Vermont has received funding through a State of Vermont Federal Highway Transportation Enhancement (TE) Grant to evaluate and conceptually design stormwater treatment practices (STPs) for discharges along the Route 5 corridor, Interstate 91, and the Exit 3 cloverleaf in the vicinity of Crosby Brook. Crosby Brook is currently on the State of Vermont 303(d) impaired waters list for sediment pollution and habitat alterations due to sedimentation, channelization and buffer loss.

The proposed project will proactively address the impairment by identifying the best conceptual designs for stormwater control to be integrated with upcoming highway improvements by the Vermont Agency of Transportation (VTrans). It also integrates the proposed Brattleboro development plans as outlined in the Putney Road Master Plan. The project involves working closely with the Town of Brattleboro, Vermont Department of Environmental Conservation (DEC), and VTrans to identify the best conceptual designs that meet multiple objectives. Major objectives of this project include:

- Improving the water quality of Crosby Brook
- Accommodating stormwater runoff from existing and full build-out conditions
- Ease of maintenance

Fitzgerald & Halliday, Inc. (FHI) was retained by Comprehensive Environmental Inc. (CEI) to investigate the presence and extent of wetlands and perennial watercourses within the limits of the proposed alternative project areas in Brattleboro, Vermont. FHI was also tasked with conducting a preliminary assessment of environmental permit requirements.

Methodology

On January 4, 2012 David Laiuppa (FHI Soil Scientist) investigated the nineteen (19) different alternative sites, as defined by CEI project mapping, for the presence of wetlands and watercourses. Mr. Laiuppa utilized a handheld Garmin Oregon 550t GPS unit to document the approximate perimeter of wetlands and watercourses within the project area at a planning level. Hand sketches and field notes were recorded during the field investigation (see Attachment A). Table 1 provides a summary of the mapping in Attachment A for the various alternative sites with recorded observations. Additionally, georeferenced photographs were taken of wetland areas, watercourses, and surrounding upland areas (see Attachment B).

The wetland investigation was conducted in accordance to both federal and State of Vermont definitions. Criteria used to support the wetland determinations included: Natural Resources Conservation Service (NRCS) mapping; *Field Indicators of Hydric Soils in the United States – Version 6.0* (NRCS, 2006); *Field Indicators for Identifying Hydric Soils in New England – Version 3* (New England Hydric Soils Technical Committee, 2004); the U.S. Army Corps of Engineers (ACOE) 1987 *Wetland Delineation Manual* and the ACOE 2009 *Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region*; the Vermont Wetlands Protection and Water Resources Management Act (10 V.S.A Chapter 37, Section 905(a) (7-9)); and *2010 Vermont Wetland Rules*.

Since the field work was based on observation, due to the time of year (January), and did not include wetland and watercourse delineations, the regulatory guidelines were utilized in order to determine the presence and general locations of wetlands and watercourses. A formal wetland delineation was not conducted as part of this study. Any future delineation will need to take place during the growing season (as per state and federal guidelines).

Results

A summary of recorded observations can be found in Table 1. The GIS maps for each of the nineteen (19) alternative site observations can be found in Attachment A. Observations were recorded for observed wetlands and perennial watercourses within or directly adjacent to each of the alternative sites.

Table 1: Summary of Observed Wetlands & Perennial Watercourses for Site Alternatives in the Crosby Brook-Brattleboro, Vermont Study Area

Site Alternative		Site Alternative Contains Wetlands Only		Site Alternative Contains Wetlands & Perennial Watercourses	
Sheet #	Site ID	Within Site	Directly Adjacent to Site	Within Site	Directly Adjacent to Site
1	1-1	No	No	No	No
2	1-2	No	No	No	No
3	1-3	No	No	Yes	Yes
4	1-4	No	No	No	Yes
5	1-5	No	Yes	Yes	Yes
6	1-6	No	No	No	No
7	1-7	No	No	No	No
8	1-8	No	No	No	Yes
9	1-9	Yes	No	Yes	Yes
10	1-10	Yes	No	No	No
11	1-11	Yes	Yes	Yes*	Yes*
12	1-12	No	No	Yes	Yes
13	2-1	Yes	No	No	No
14	2-2	Yes	Yes	Yes	Yes
15	2-3	Yes	No	Yes	Yes
16	2-4	No	No	Yes	Yes
17	2-5	Yes	Yes	Yes	Yes
18	2-6	Yes	Yes	Yes	Yes
19	2-7	Yes	Yes	No	No

* Area not investigated during field study as investigator was not able to gain access to the northern part of Site 1-11. Based on GIS-layer identified presence of a watercourse, it is anticipated that there are wetlands and perennial watercourse(s) there.

Preliminary Environmental Permit Assessment

Since the project will involve improvements to stormwater facilities, there is a potential for impacts to adjacent wetlands and/or watercourses. Since the full extent of potential work within regulated areas is currently unknown, this preliminary permit assessment should be used as a guide for planning purposes only. The permit assessment will need to be finalized as the design progresses and site-specific engineering information is generated. Assuming all wetlands within the project area fall under Class 2 or 3 wetland resources, the following permits may be required:

Wetland Permits

- Wetland General Permit (3-9025)
- Wetland Permit Application

- Supplement for Additional Wetlands Form
- U.S. Army Corps of Engineers Section 404 PGP

Stormwater Permits

- General Permit (3-9015) – this is for New Development and Redevelopment Discharges to Waters that are Not Principally Impaired by Collected Stormwater Runoff
- General Permit (3-9010) – this is for Previously Permitted Discharges to Waters that are Not Principally Impaired by Collected Stormwater Runoff
- MSGP Permit – this is for Stormwater Discharges Associated with Industrial Activity

River Management Permits - Most in-channel management activities and new projects like bridges, culverts or utility crossings require regulatory action by the River Management Program (jurisdictional determination is required in order to decide which of the two following permits are required)

- Individual Stream Alteration Permit – Same as below but under DEC
- Stream Alteration General Permit - Placement or construction of Stream Crossing Structures within or over streams

Summary

FHI investigated the nineteen (19) different alternative sites, as defined by CEI project mapping, for the presence of wetlands and watercourses. Since the field work was based on observation, due to the time of year (January), and did not include wetland and watercourse delineations, the regulatory guidelines were utilized in order to determine the presence and general locations of wetlands and watercourses. A formal wetland delineation was not conducted as part of this study.

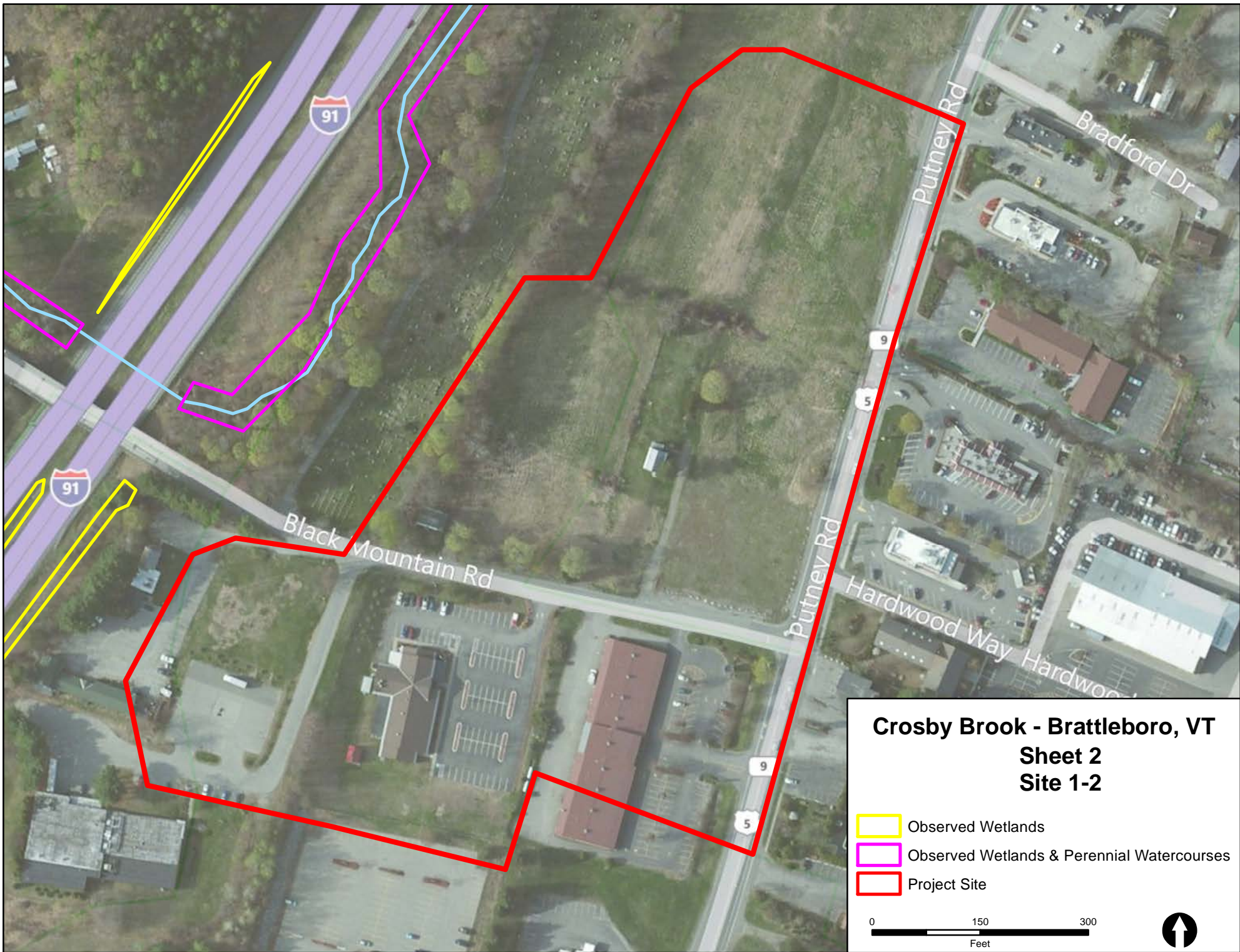
All but four of the nineteen alternative sites contained, or were directly adjacent to, wetland and/or watercourse resources, as presented in Table 1. Of the remaining fifteen sites, twelve contained, or were directly adjacent to, both wetlands and watercourses. Only two contained, or were directly adjacent to, only wetlands. The GIS maps for each of the nineteen (19) alternative site observations can be found in Attachment A.

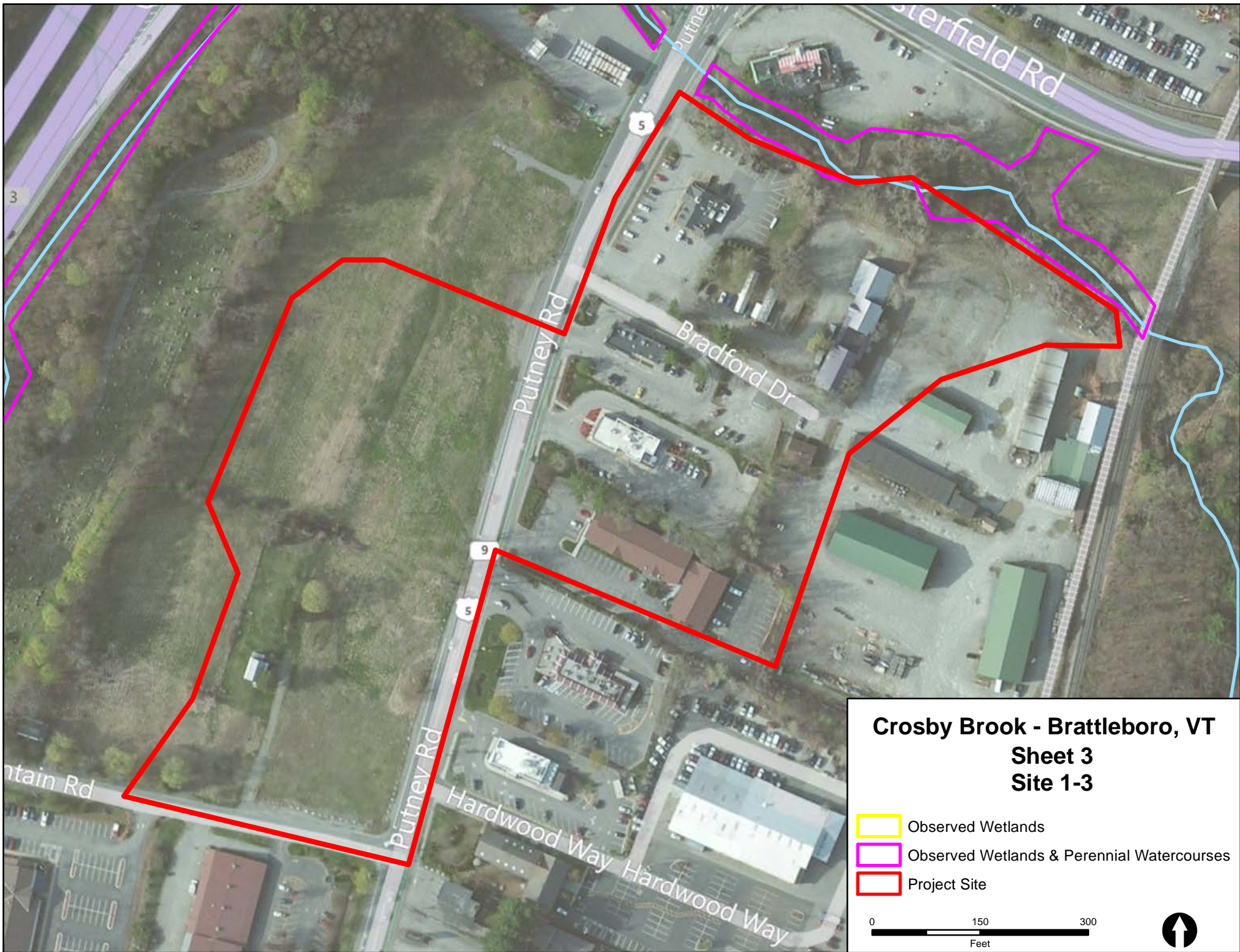
Since the project will involve improvements to stormwater facilities, there is a potential for impacts to adjacent wetlands and/or watercourses. As a result, it is anticipated that state and federal permits may be required, including wetland permits, stormwater permits, and river management permits. Since the full extent of potential work within regulated areas is currently unknown, this preliminary permit assessment should be used as a guide for planning purposes only. The permit assessment will need to be finalized as the design progresses and site-specific engineering information is generated.

Attachment A

Alternative Sites Wetlands/Watercourses Map Sheets 1-19

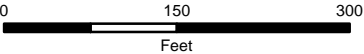


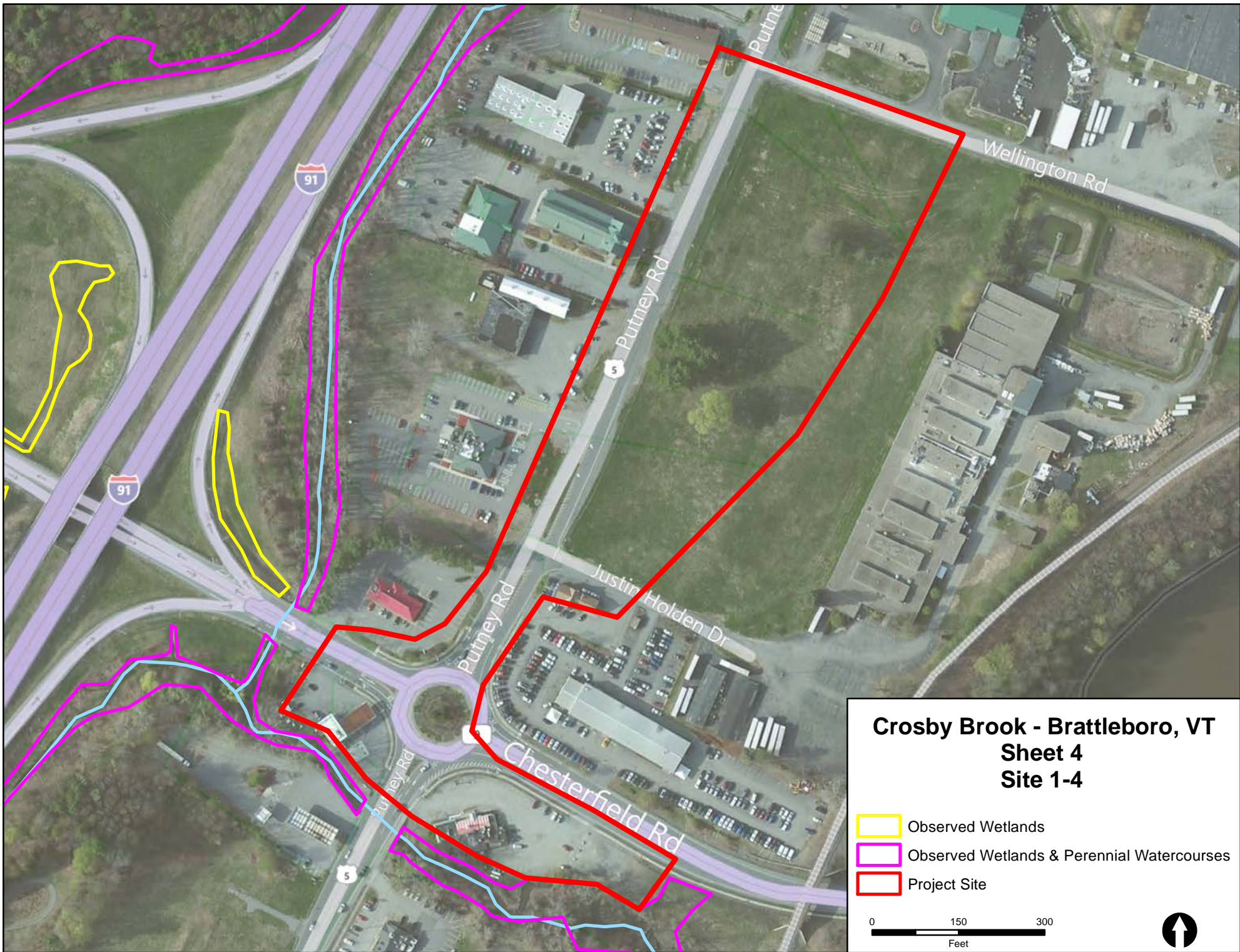


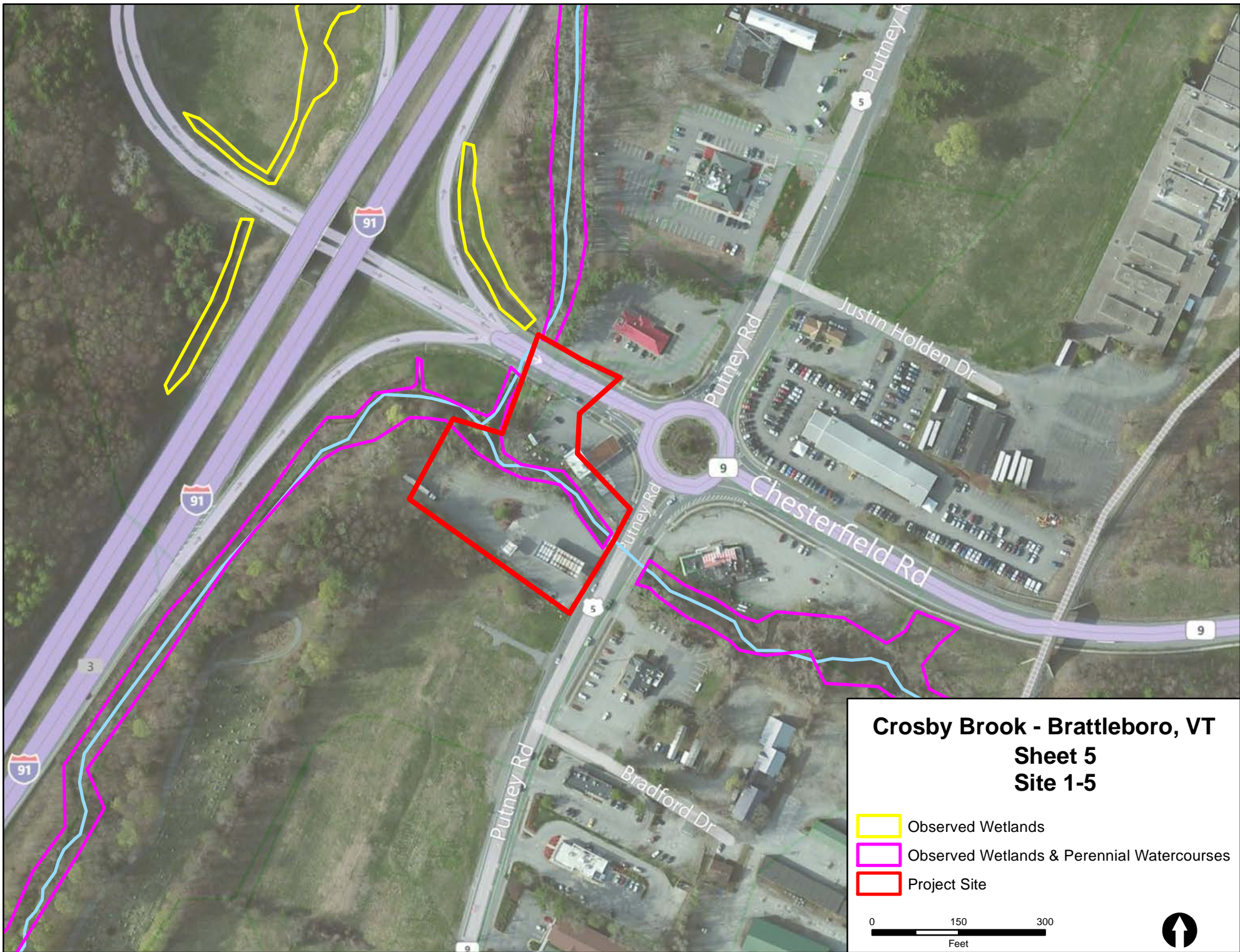


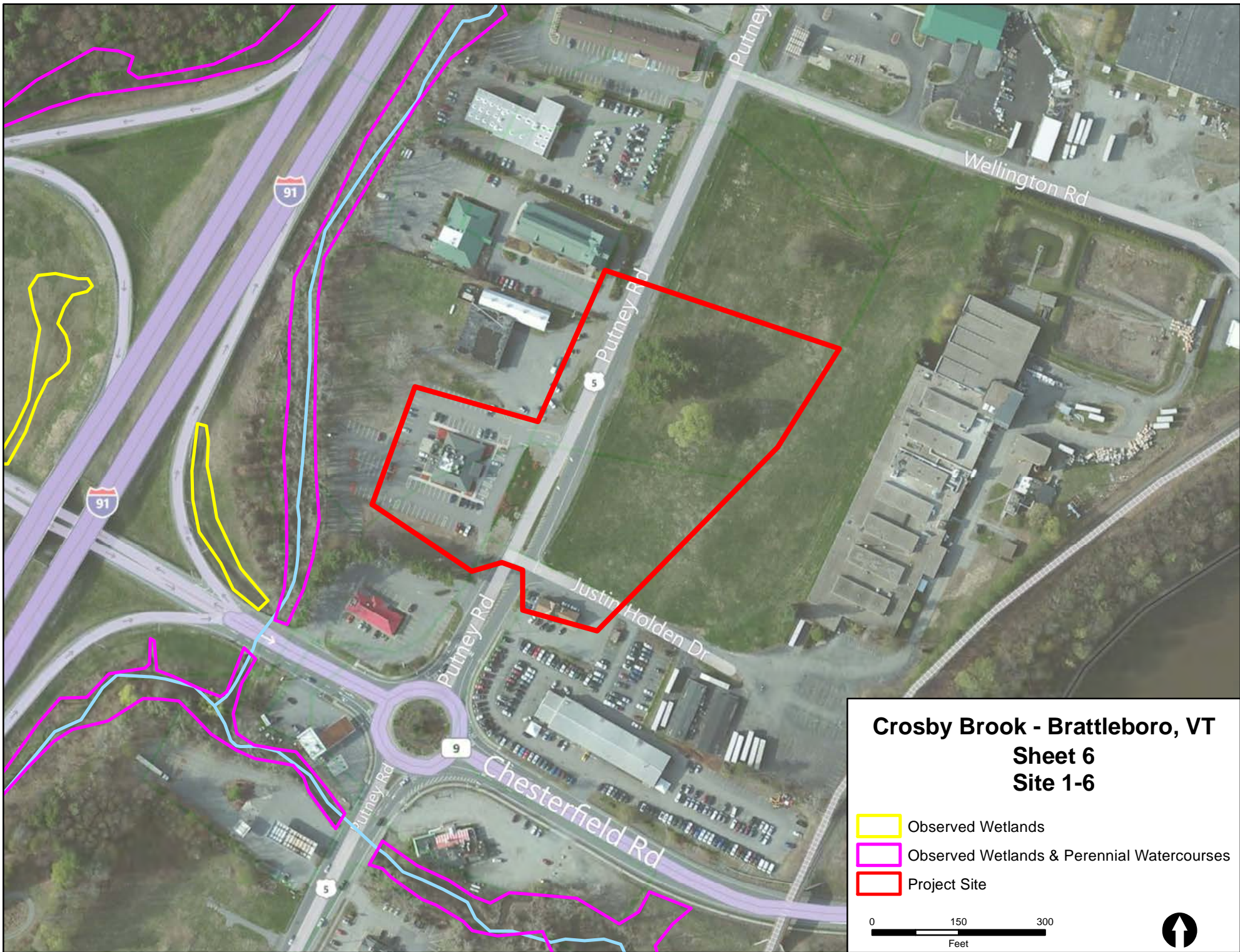
Crosby Brook - Brattleboro, VT
Sheet 3
Site 1-3

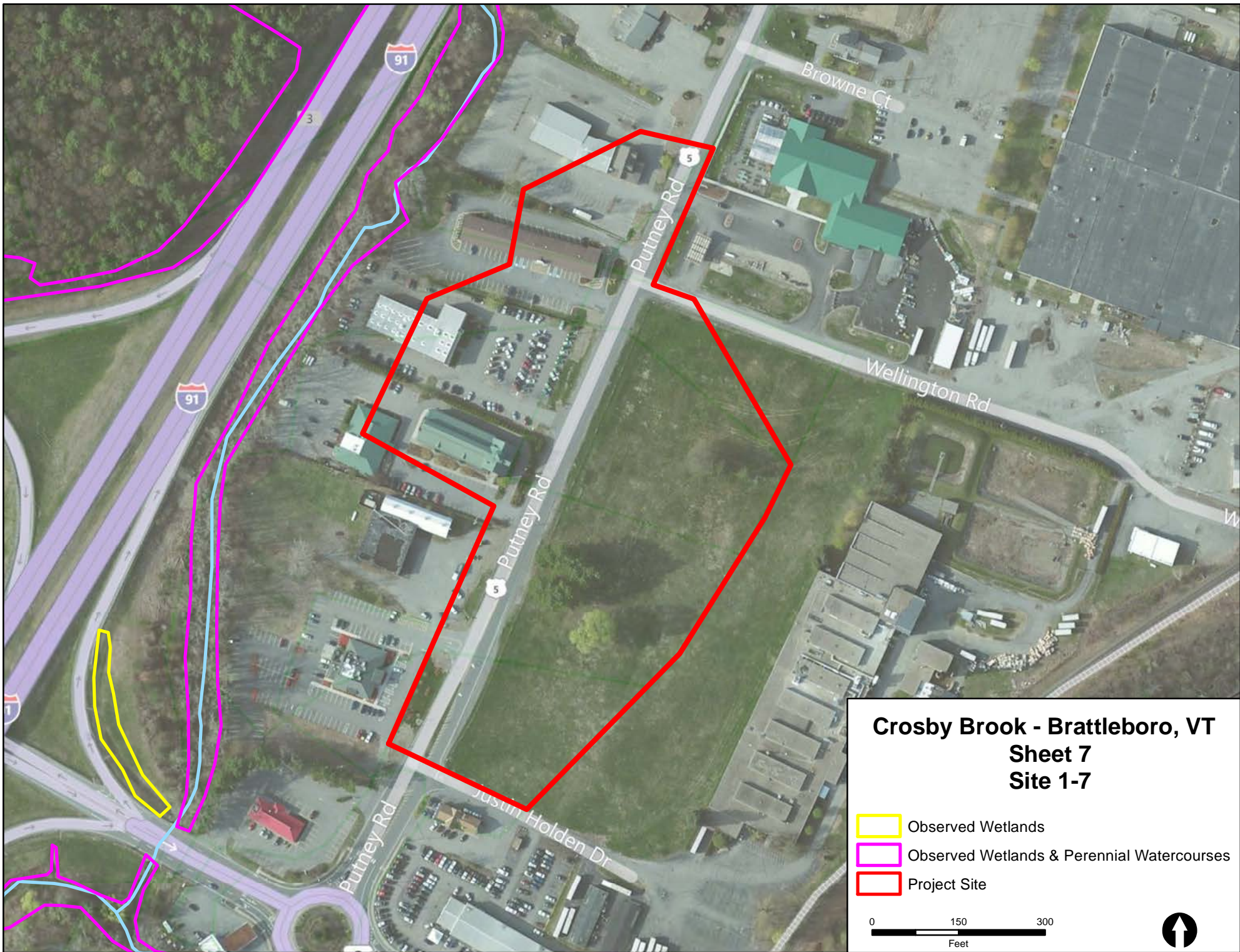
- Observed Wetlands
- Observed Wetlands & Perennial Watercourses
- Project Site

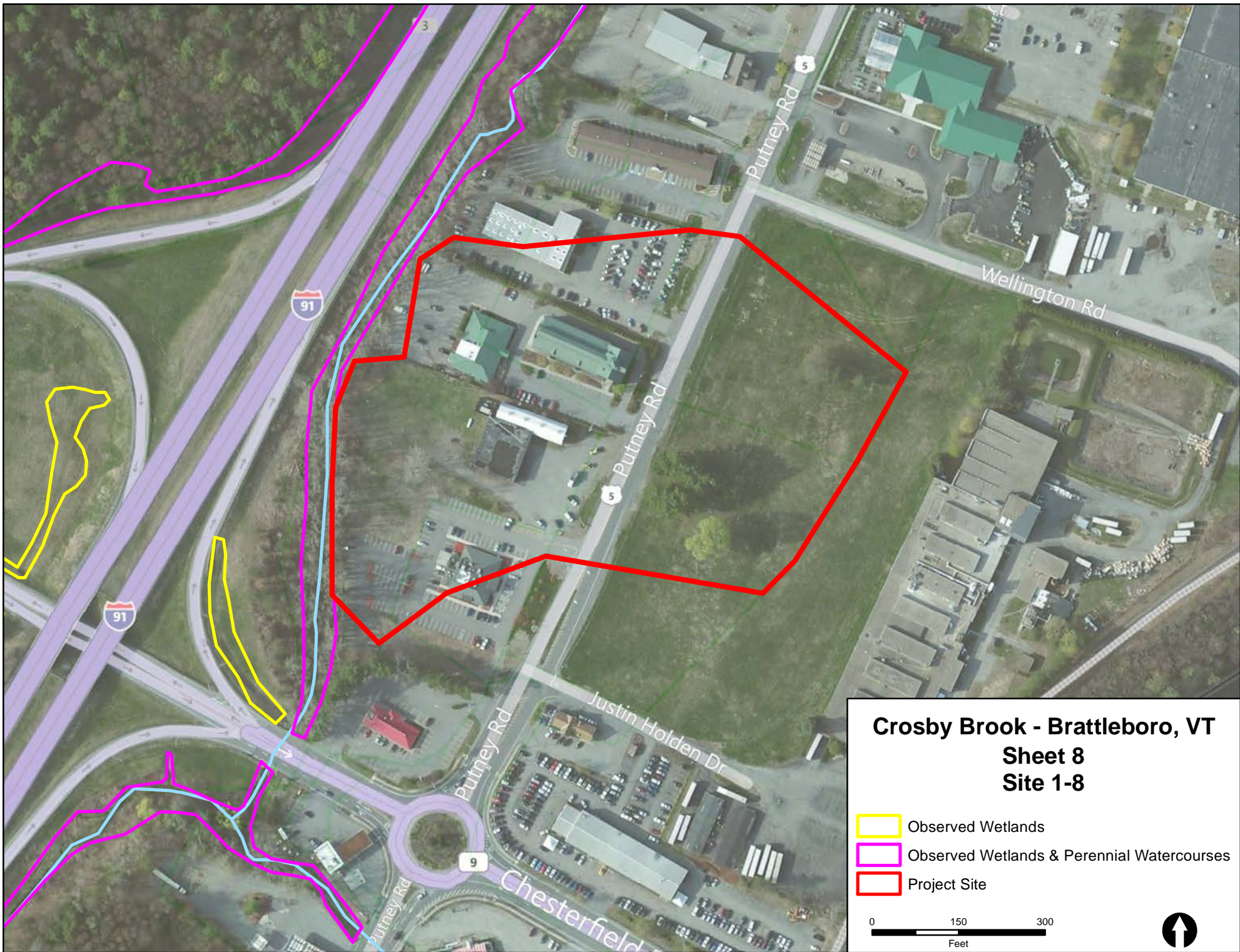


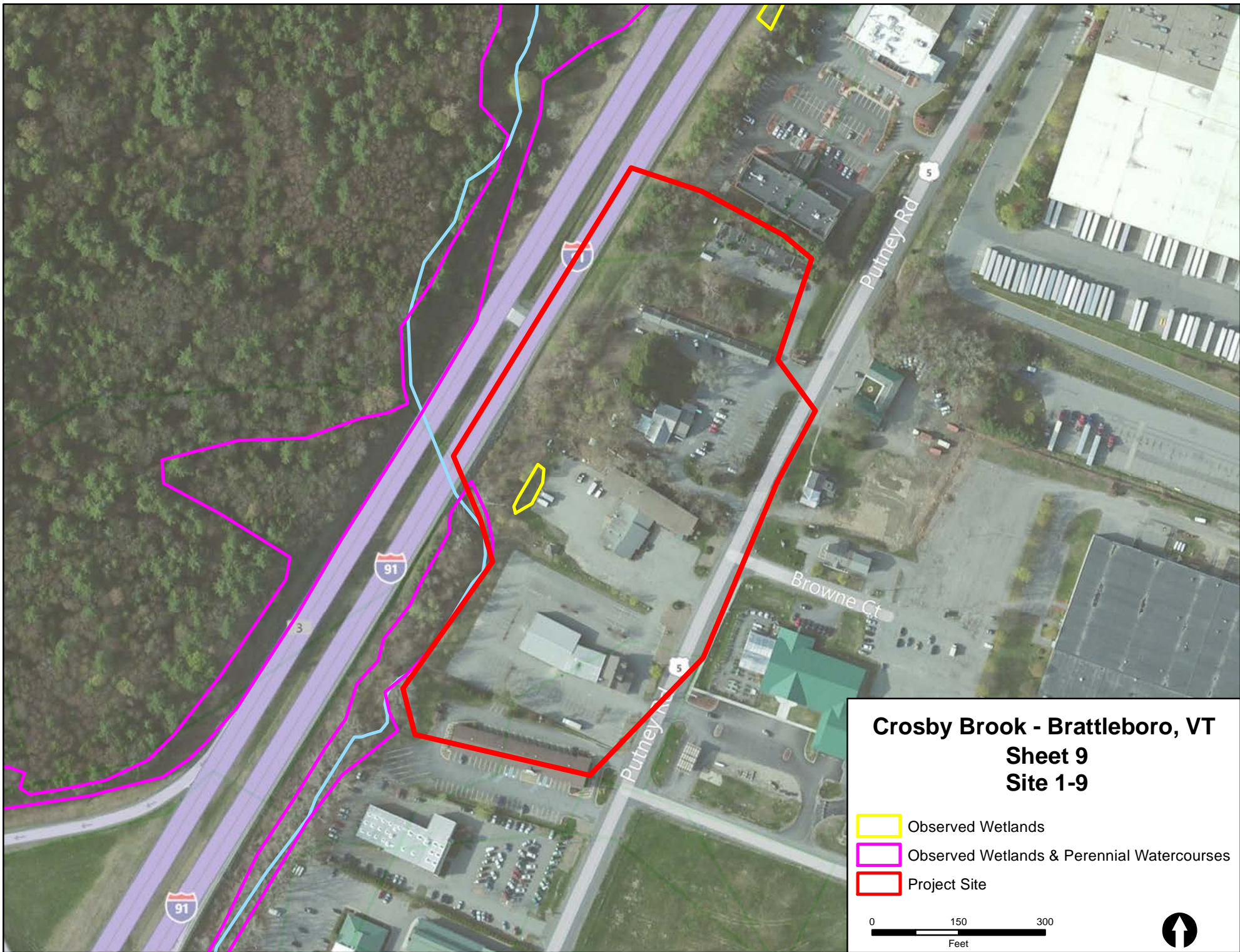




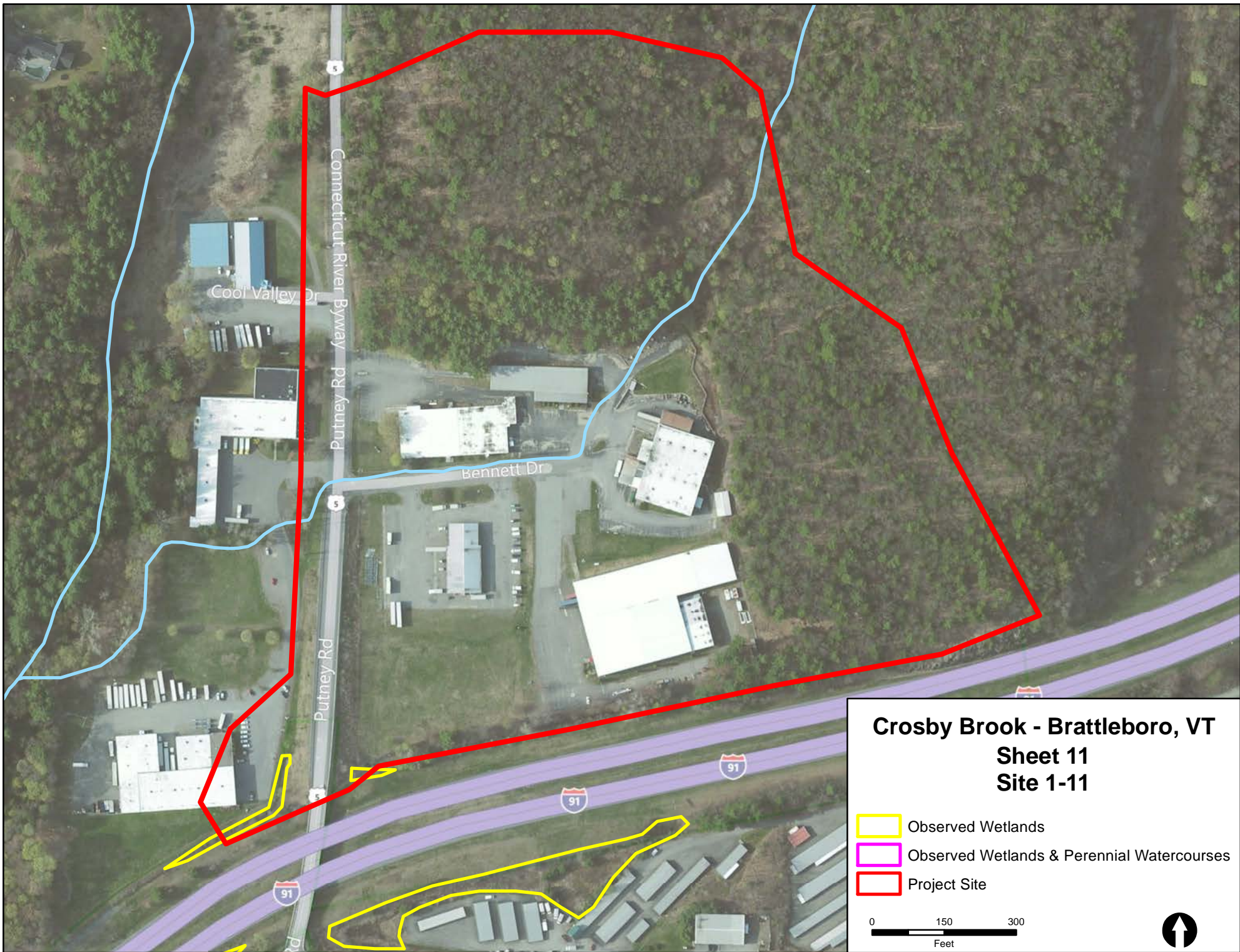






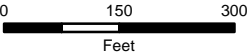


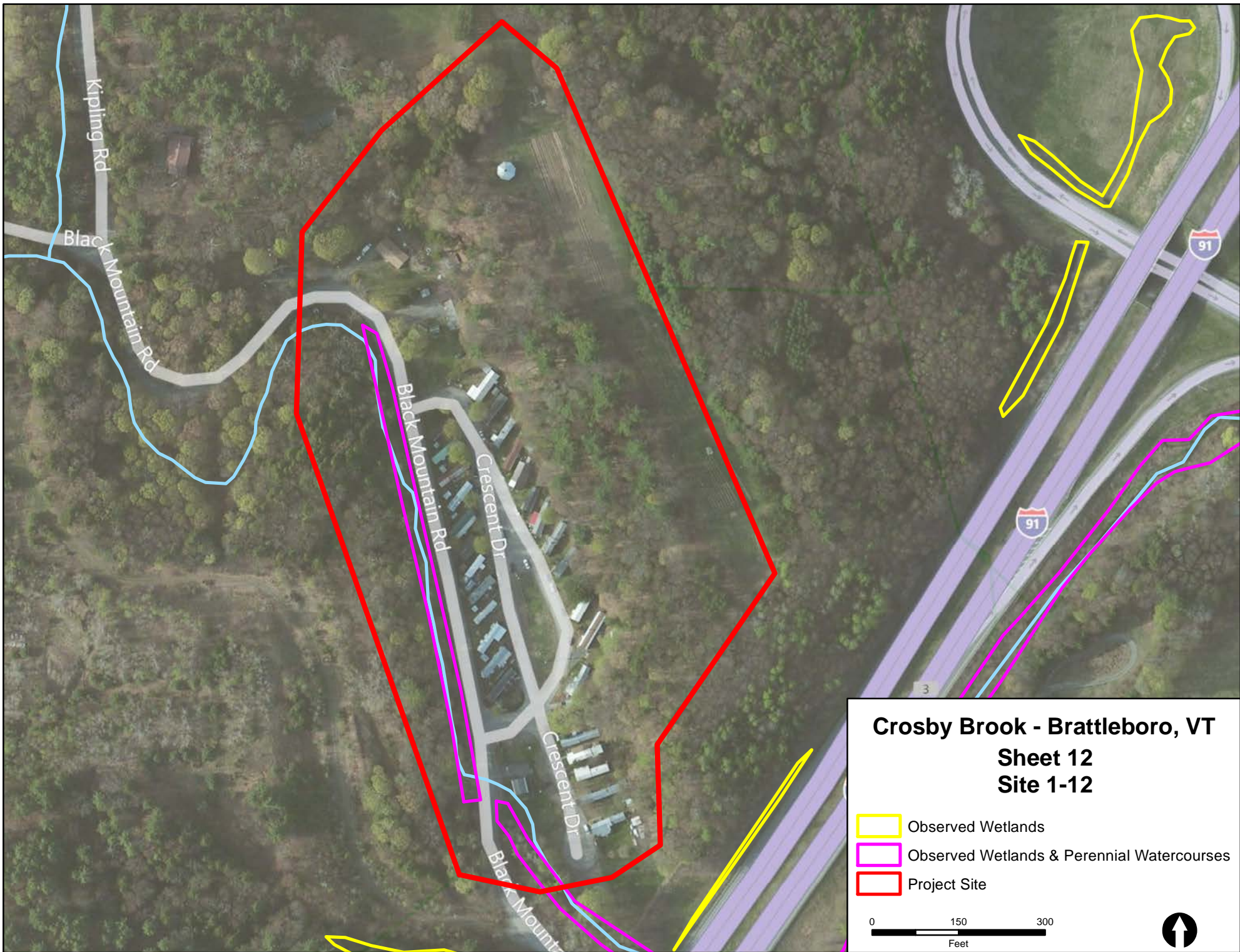




Crosby Brook - Brattleboro, VT
Sheet 11
Site 1-11

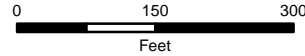
- Observed Wetlands
- Observed Wetlands & Perennial Watercourses
- Project Site

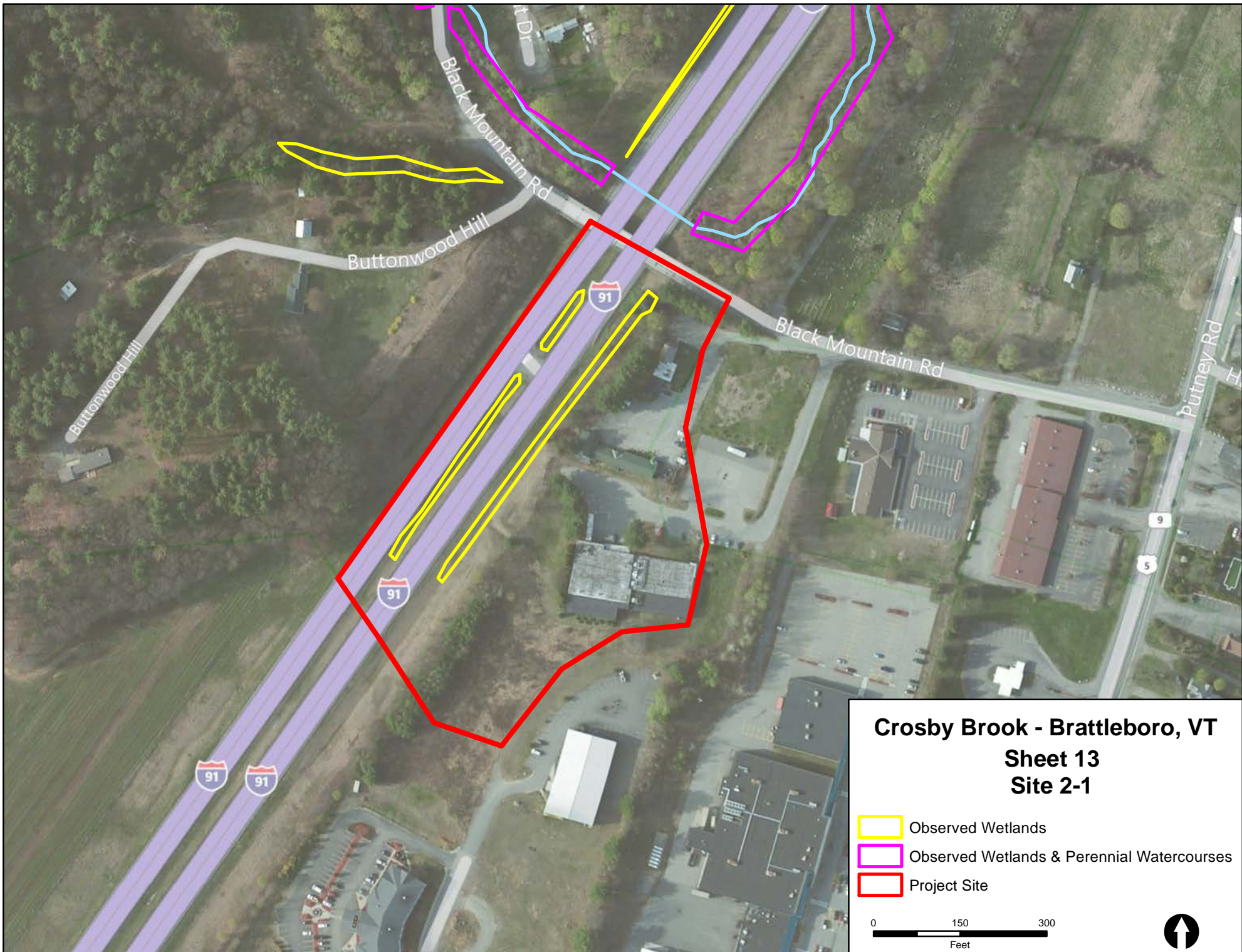




Crosby Brook - Brattleboro, VT
Sheet 12
Site 1-12

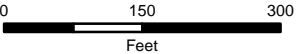
- Observed Wetlands
- Observed Wetlands & Perennial Watercourses
- Project Site

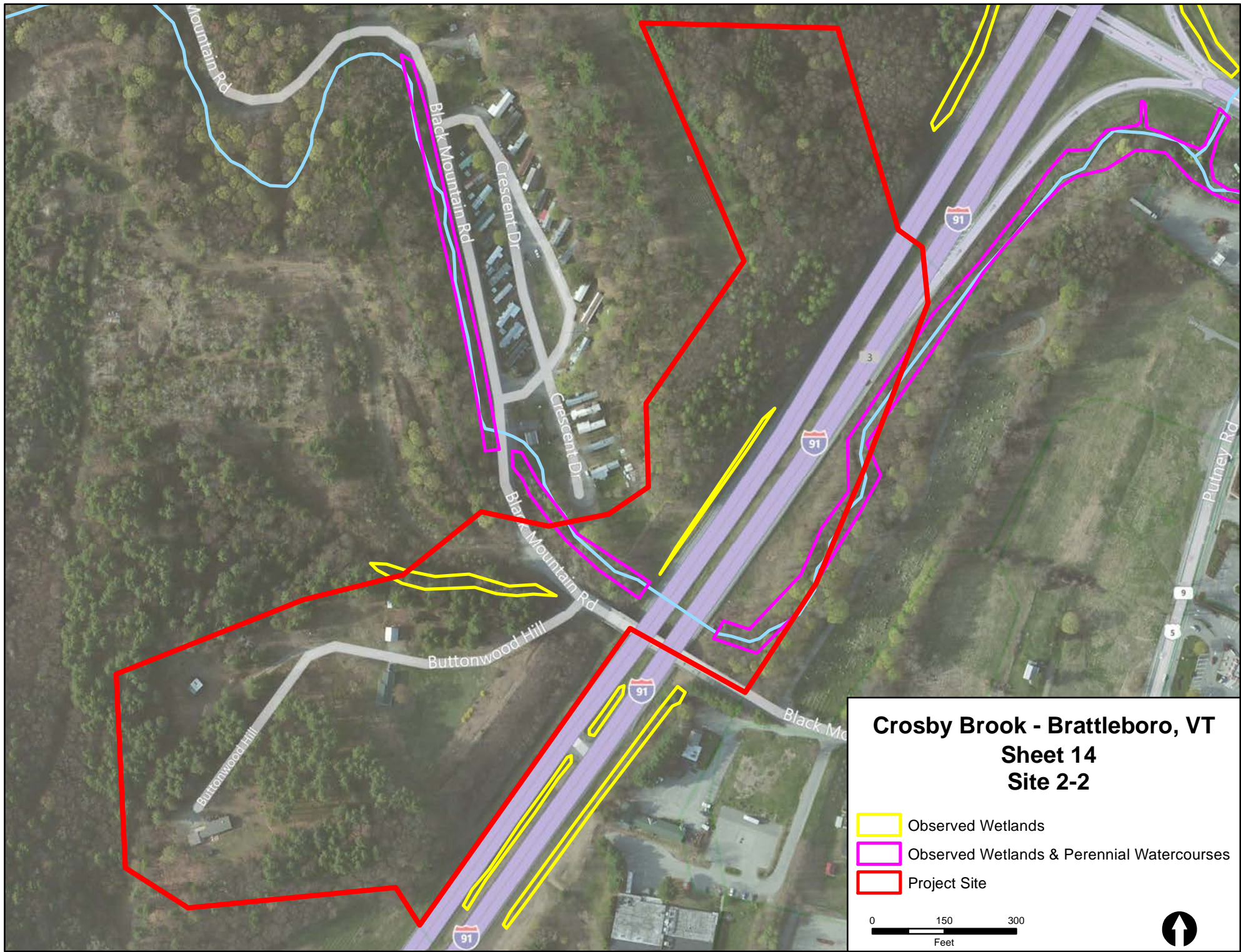




Crosby Brook - Brattleboro, VT
Sheet 13
Site 2-1

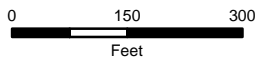
- Observed Wetlands
- Observed Wetlands & Perennial Watercourses
- Project Site

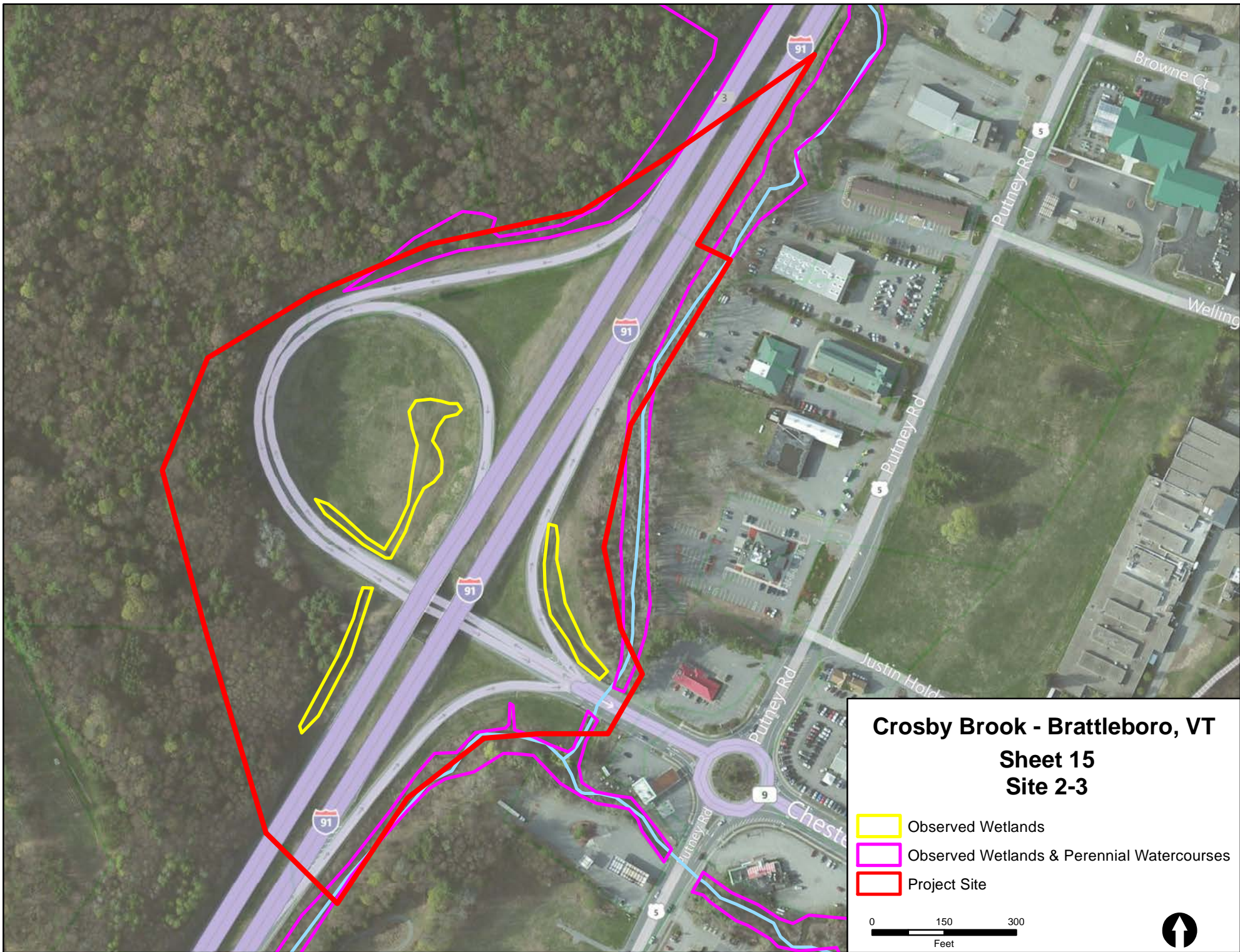


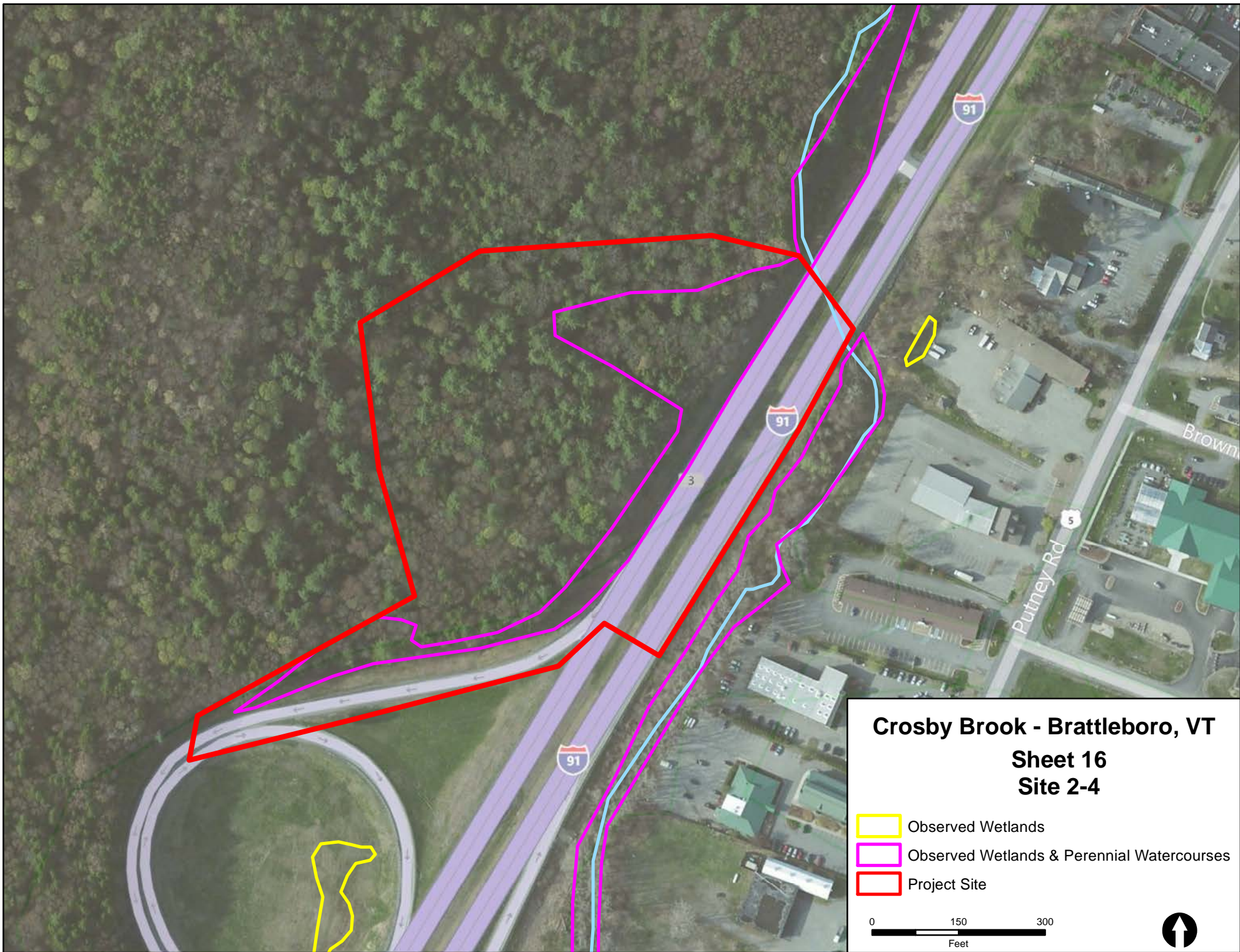


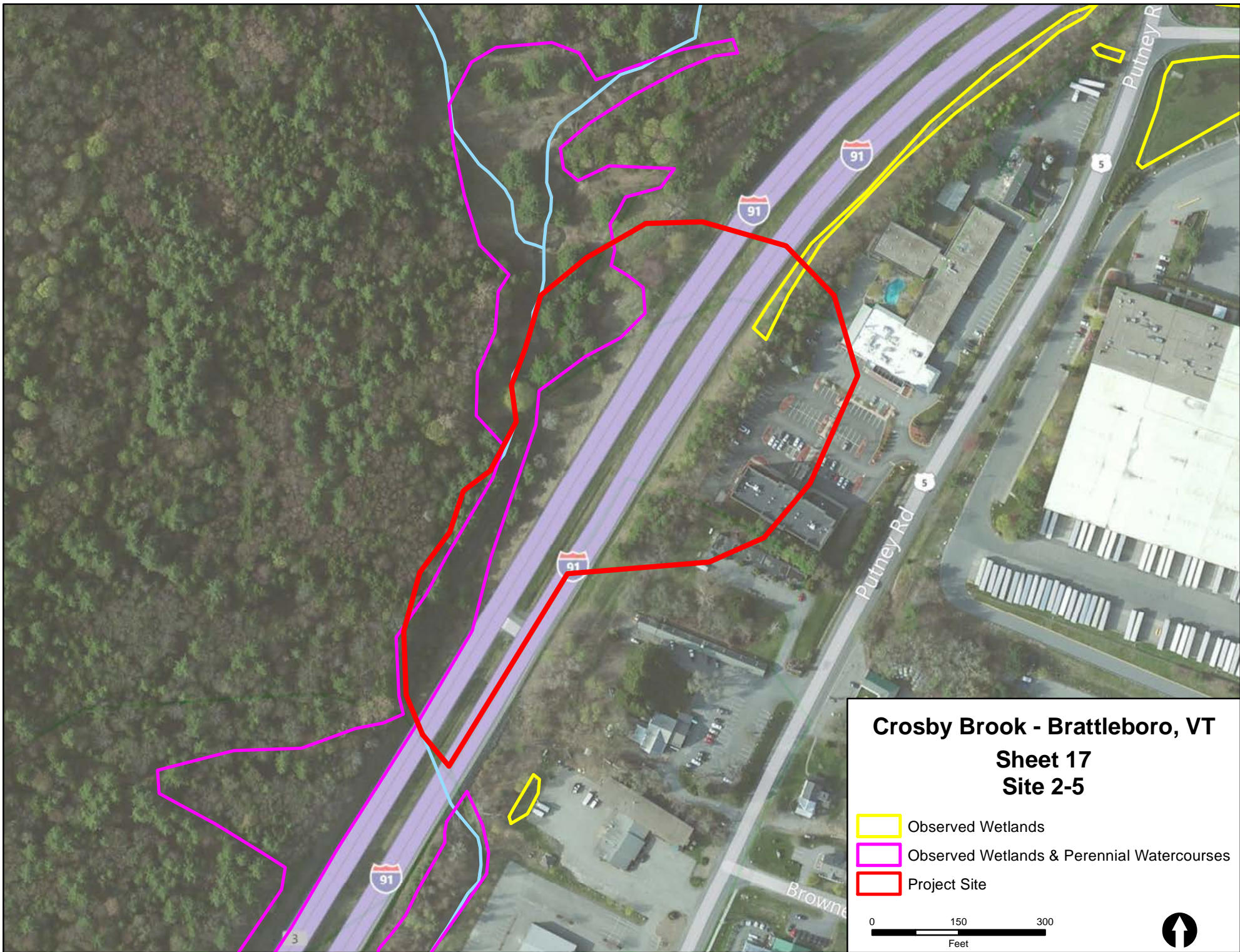
Crosby Brook - Brattleboro, VT
Sheet 14
Site 2-2

-  Observed Wetlands
-  Observed Wetlands & Perennial Watercourses
-  Project Site





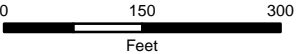


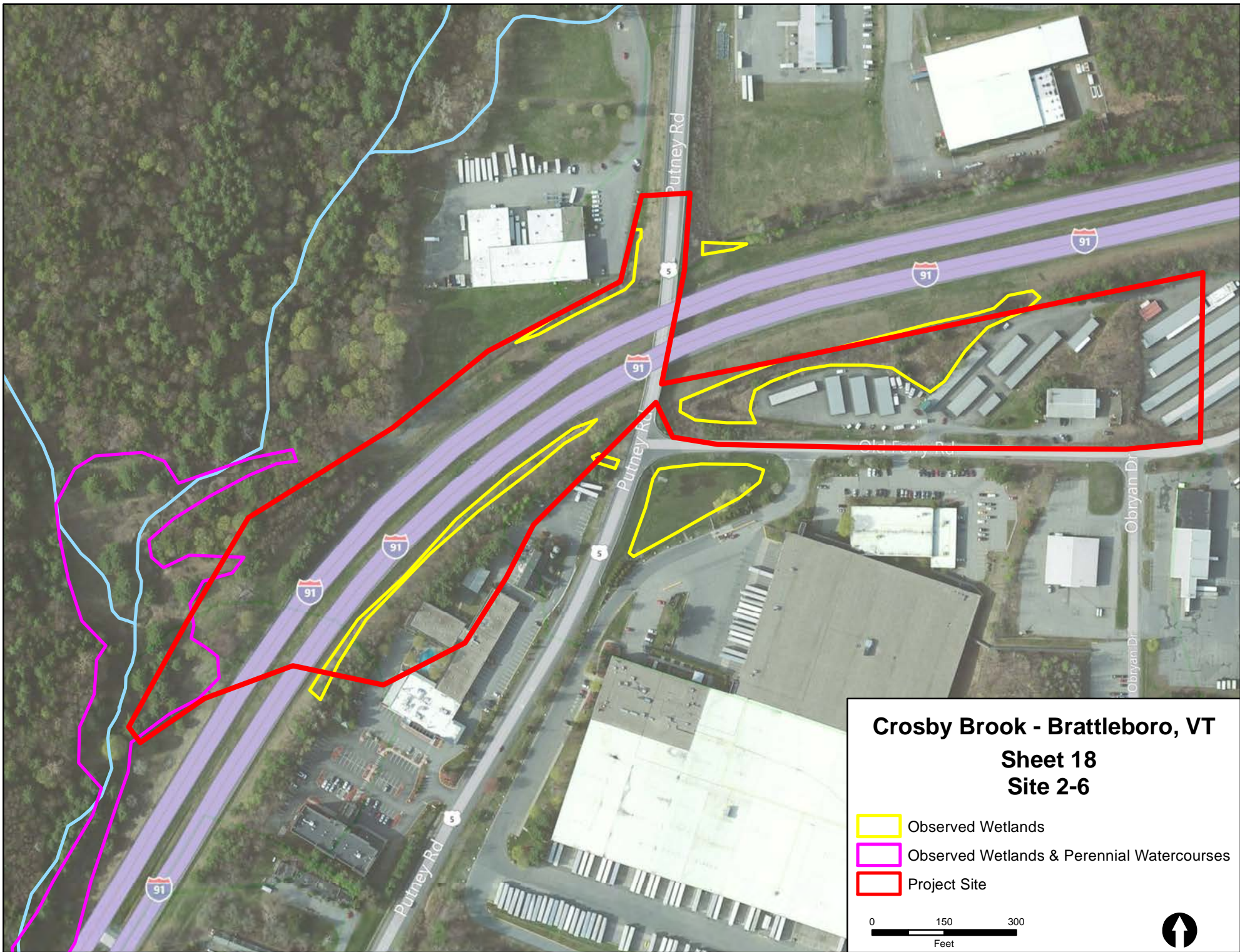


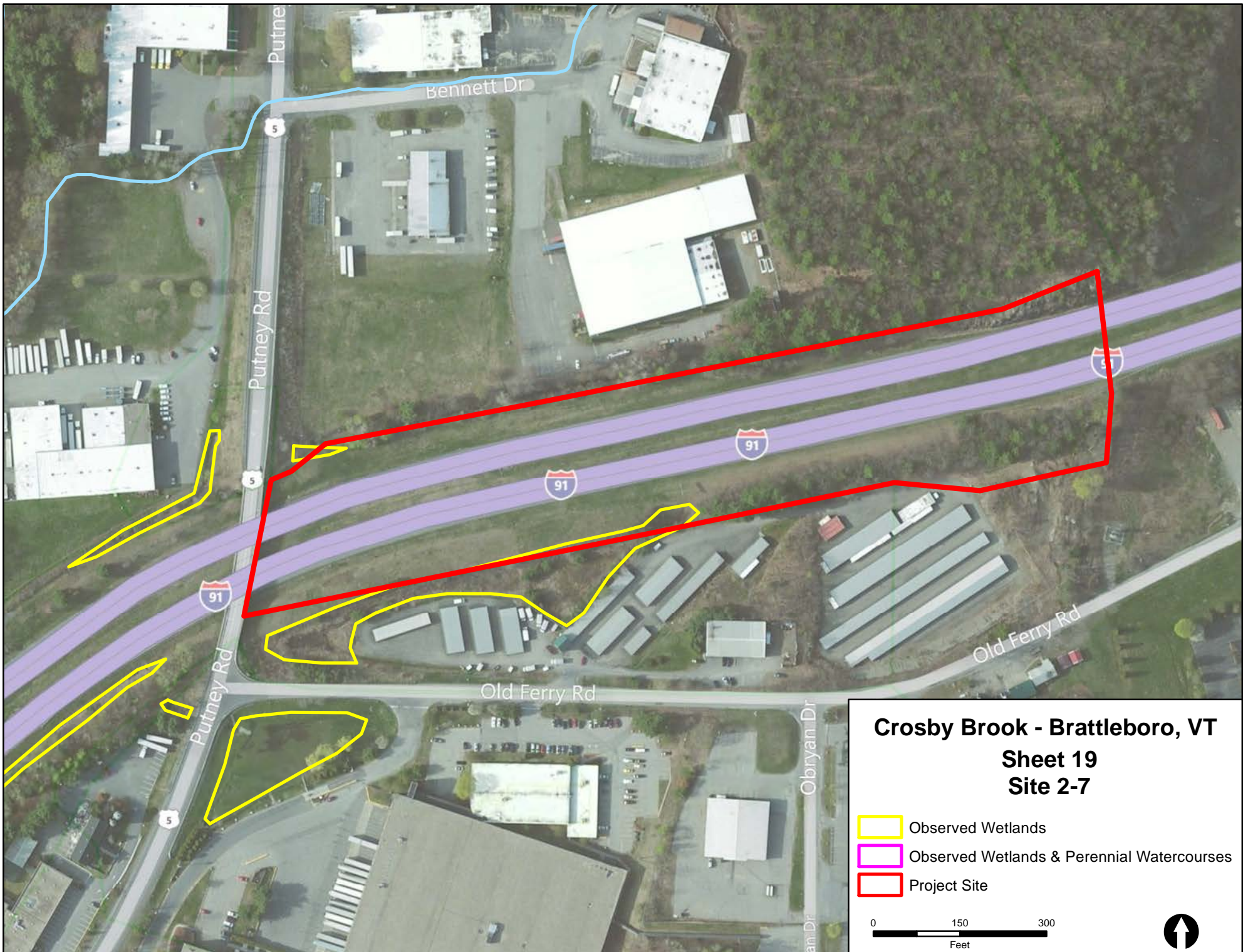


Crosby Brook - Brattleboro, VT
Sheet 17
Site 2-5

-  Observed Wetlands
-  Observed Wetlands & Perennial Watercourses
-  Project Site







Attachment B

Photographs



Northeast corner of Black Mountain Road and I-91 – facing northeast



Northwest corner of Black Mountain Road and Buttonwood Hill – facing east



West of Black Mountain Road (near Crescent Drive) – facing north



West of Black Mountain Road (near Crescent Drive) – facing east



Northwest corner of Black Mountain Road and I-91 – facing northeast



West of Putney Road (north of Black Mountain Road) – facing east



West of Putney Road (south of Black Mountain Road) – facing south



Southwest corner of Putney Road and Chesterfield Road – facing east



Southwest corner of Putney Road and Chesterfield Road – facing west



Southwest corner of Putney Road and Chesterfield Road – facing north



Southwest corner of I-91 and I-91 Chesterfield Road southbound ramps – facing south



I-91 Chesterfield Road southbound ramps infield area – facing north



Northwest corner of I-91 and I-91 Chesterfield Road southbound ramps – facing northeast



Northeast corner of Chesterfield Road and I-91 Chesterfield Road northbound onramp – facing southeast



Northeast corner of Chesterfield Road and I-91 Chesterfield Road northbound onramp – facing north



Southeast corner of Putney Road and Chesterfield Road – facing northwest



Southwest corner of Chesterfield Road and rail tracks – facing northwest



Northwest of Putney Road and Chesterfield Road – facing northwest



Northwest of Putney Road and Chesterfield Road – facing west



Northeast corner of Putney Road and Justin Holden Drive – facing north



West of Putney Road between Justin Holden Drive and Wellington Road – facing west



West of Putney Road near Wellington Road – facing south



West of Putney Road near Browne Court – facing west



West of Putney Road near Browne Court – facing north



Southwest corner of Putney Road and I-91 near Old Ferry Road – facing east



Southwest corner of Putney Road and I-91 near Old Ferry Road – facing west



Southeast corner of Putney Road and Old Ferry Road – facing east



Southeast corner of Putney Road and I-91 – facing west



Northeast corner of Putney Road and I-91 – facing south



Northeast corner of Putney Road and I-91 – facing east



Northwest corner of Putney Road and I-91 – facing southwest



West side of I-91 (between Putney Road and I-91 Chesterfield Road ramps) – facing west



West side of I-91 (between Putney Road and I-91 Chesterfield Road ramps) – facing northeast

Appendix B
Watershed Analysis
Model Outputs

STP #1.1		Area	Imp Area					
Subwatersheds	(acres)	(acres)						
BO-OF-6 Current House	0.528	0.03						
BO-OF-6 New Development 1	0.630	0.34						
BO-OF-6 New Development 2	1.328	0.72						
BO-OF-6-Current Putney Road	1.372	1.08						
OF-6D McDonalds	0.965	0.80						
OF-6E KFC Taco Bell	0.249	0.22						
OF-6F Americas Best Inn	1.832	1.26						
BO-OF-15 Current Commercial / Industrial	5.236	3.86						
BO-OF-15 New Development 15	1.289	0.70						
Total =	13.43	9.00						
Area Breakdown	Area	Area	% Total Area		% Imp Area			
Putney Rd	1.37	1.08	Putney Rd	10%		12%		
Other Town Roads	0.35	0.35	Other Town Roads	3%		4%		
Route 91	0.00	0.00	Route 91	0%		0%		
Total Private	11.71	7.57	Total Private	87%		84%		
					% Private		% Private	
Private - Currently Developed	8.46	5.82	Current	63%	72%	65%	77%	
Private - Potential Buildout	3.25	1.76	Potential Buildout	24%	28%	19%	23%	

STP #1.2		Area	Imp Area					
Subwatersheds	(acres)	(acres)						
BO-OF-6 Current House	2.114	0.12						
BO-OF-6 New Development 1	1.260	0.68						
BO-OF-6 New Development 2	2.390	1.30						
BO-OF-6-Current Putney Road	1.372	1.08						
BO-OF-6I Front Newspaper	1.142	0.60						
BO-OF-6I New Development 5	0.545	0.29						
OF-6H VFW & Strip Mall	2.935	1.54						
OF-6J Cemetary	4.446	0.18						
Total =	16.20	5.79						
Area Breakdown	Area	Area	% Total Area		% Imp Area			
Putney Rd	0.54	0.54	Putney Rd	3%		9%		
Other Town Roads	0.54	0.54	Other Town Roads	3%		9%		
Route 91	0.00	0.00	Route 91	0%		0%		
Total Private	15.12	4.71	Total Private	93%		81%		
					% Private		% Private	
Private - Currently Developed	10.93	2.44	Current	67%	72%	42%	52%	
Private - Potential Buildout	4.20	2.27	Potential Buildout	26%	28%	39%	48%	

STP #1.3		Area	Imp Area					
Subwatersheds	(acres)	(acres)						
OF-1 Floor Plank	0.998	0.74						
OF-3 Residential	0.936	0.48						
OF-5 Friendlys	0.880	0.68						
BO-OF-8 New Development 3	0.879	0.47						
BO-OF-6 Current House	2.114	0.12						
BO-OF-6 New Development 1	0.945	0.51						
BO-OF-6 New Development 2	1.992	1.08						
BO-OF-6-Current Putney Road	1.715	1.35						
OF-6A Dunkin Donuts	0.818	0.77						
OF-6B Wendy's	1.020	0.70						
OF-6C Motel 8	0.686	0.42						
Total =	12.98	7.32						
Area Breakdown	Area	Area	% Total Area		% Imp Area			
Putney Rd	1.36	1.35	Putney Rd	10%		18%		
Other Town Roads	0.21	0.21	Other Town Roads	2%		3%		
Route 91	0.00	0.00	Route 91	0%		0%		
Total Private	11.42	5.76	Total Private	88%		79%		
					% Private		% Private	
Private - Currently Developed	7.60	3.70	Current	59%	67%	51%	64%	
Private - Potential Buildout	3.82	2.06	Potential Buildout	29%	33%	28%	36%	

STP #1.4		Area	Imp Area				
Subwatersheds		(acres)	(acres)				
BO-OF-7 Current Putney Road		2,331	1,60				
BO-OF-7 New Development 4		4,168	2,25				
OF-7A Bickfords Old Parking		0,803	0,22				
Total =		7.30	4.07				
Area Breakdown		Area	Area	% Total Area		% Imp Area	
Putney Rd		1.58	1.58	Putney Rd	22%		39%
Other Town Roads		0.02	0.02	Other Town Roads	0%		0%
Route 91		0.00	0.00	Route 91	0%		0%
Total Private		5.73	2.49	Total Private	78%		61%
				% Private		% Private	
Private - Currently Developed		1.56	0.24	Current	21%	27%	6%
Private - Potential Buildout		4.17	2.25	Potential Buildout	57%	73%	55%

STP #1.5		Area	Imp Area				
Subwatersheds		(acres)	(acres)				
BO-OF-8 Current Citgo Green Light Package		1,149	0,38				
OF-9 Mobile Gas Rear		0,528	0,16				
Total =		1.68	0.54				
Area Breakdown		Area	Area	% Total Area		% Imp Area	
Putney Rd		0.06	0.06	Putney Rd	4%		11%
Other Town Roads		0.00	0.00	Other Town Roads	0%		0%
Route 91		0.00	0.00	Route 91	0%		0%
Total Private		1.61	0.48	Total Private	96%		89%
				% Private		% Private	
Private - Currently Developed		1.61	0.48	Current	96%	100%	89%
Private - Potential Buildout		0.00	0.00	Potential Buildout	0%	0%	0%

STP #1.6		Area	Imp Area				
Subwatersheds		(acres)	(acres)				
BO-OF-7 Current Putney Road		1,665	1,15				
BO-OF-7 New Development 4		2,779	1,50				
OF-7B Ninety Nine Rest		0,000	0,00				
Total =		4.44	2.65				
Area Breakdown		Area	Area	% Total Area		% Imp Area	
Putney Rd		1.11	1.12	Putney Rd	25%		42%
Other Town Roads		0.03	0.03	Other Town Roads	1%		1%
Route 91		0.00	0.00	Route 91	0%		0%
Total Private		3.33	1.53	Total Private	75%		58%
				% Private		% Private	
Private - Currently Developed		0.55	0.02	Current	12%	17%	1%
Private - Potential Buildout		2.78	1.50	Potential Buildout	63%	83%	57%

STP #1.7		Area	Imp Area				
Subwatersheds		(acres)	(acres)				
BO-OF-7 Current Putney Road		1,665	1,15				
BO-OF-7 New Development 4		3,890	2,10				
OF-18 Steak Out / Mall		1,075	1,08				
OF-19 Brattleboro Subaru		1,356	1,12				
OF-21 Motel 6		0,561	0,35				
OF-23 Motel 6 / Used Car Parking		0,957	0,77				
Total =		9.50	6.56				
Area Breakdown		Area	Area	% Total Area		% Imp Area	
Putney Rd		1.24	1.15	Putney Rd	13%		18%
Other Town Roads		0.00	0.00	Other Town Roads	0%		0%
Route 91		0.00	0.00	Route 91	0%		0%
Total Private		8.27	5.41	Total Private	87%		82%
				% Private		% Private	
Private - Currently Developed		4.38	3.31	Current	46%	53%	50%
Private - Potential Buildout		3.89	2.10	Potential Buildout	41%	47%	32%

STP #1.8		Area	Imp Area				
Subwatersheds	(acres)	(acres)					
BO-OF-7 Current Putney Road	1.165	0.80					
BO-OF-7 New Development 4	3.612	1.95					
OF-7B Ninety Nine Rest	0.000	0.00					
OF-18 Steak Out / Mall	0.806	0.81					
OF-18A Staceys Used Cars	2.105	1.10					
OF-19 Brattleboro Subaru	0.904	0.75					
Total =	8.59	5.40					
Area Breakdown	Area	Area	% Total Area		% Imp Area		
Putney Rd	0.80	0.80	Putney Rd	9%	15%		
Other Town Roads	0.00	0.00	Other Town Roads	0%	0%		
Route 91	0.00	0.00	Route 91	0%	0%		
Total Private	7.79	4.60	Total Private	91%	85%		
			% Private		% Private		
Private - Currently Developed	4.18	2.65	Current	49%	54%	49%	58%
Private - Potential Buildout	3.61	1.95	Potential Buildout	42%	46%	36%	42%

STP #1.9		Area	Imp Area				
Subwatersheds	(acres)	(acres)					
OF-23 Motel 6 / Used Car Parking	1.913	1.53					
OF-26A Rt 91 N of Crosby Cross	0.617	0.36					
OF-24 Cocoplum / Used Car	3.190	2.29					
OF-26B China Buffet / Motel	4.234	1.35					
Total =	9.95	5.53					
Area Breakdown	Area	Area	% Total Area		% Imp Area		
Putney Rd	0.99	0.99	Putney Rd	10%	18%		
Other Town Roads	0.00	0.00	Other Town Roads	0%	0%		
Route 91	0.62	0.36	Route 91	6%	7%		
Total Private	8.35	4.18	Total Private	84%	76%		
			% Private		% Private		
Private - Currently Developed	8.35	4.18	Current	84%	100%	76%	100%
Private - Potential Buildout	0.00	0.00	Potential Buildout	0%	0%	0%	0%

STP #1.10		Area	Imp Area				
Subwatersheds	(acres)	(acres)					
OF-33A Old Ferry Industrial	20.872	14.21					
OF-33B Putney Rd / Old Ferry Intersection	0.198	0.20					
Total =	21.07	14.41					
Area Breakdown	Area	Area	% Total Area		% Imp Area		
Putney Rd	0.20	0.20	Putney Rd	1%	1.4%		
Other Town Roads	0.21	0.21	Other Town Roads	1%	1.5%		
Route 91	0.00	0.00	Route 91	0%	0%		
Total Private	20.66	14.00	Total Private	98%	97%		
			% Private		% Private		
Private - Currently Developed	20.66	14.00	Current	98%	100%	97%	100%
Private - Potential Buildout	0.00	0.00	Potential Buildout	0%	0%	0%	0%

STP #1.11 -A		Area	Imp Area				
Subwatersheds	(acres)	(acres)					
OF-40 Bennett Drive Industrial Park	20.098	3.62					
BO-OF-37A New Development 10	0.387	0.23					
Total =	20.48	3.85					
Area Breakdown	Area	Area	% Total Area		% Imp Area		
Putney Rd	0.00	0.00	Putney Rd	0%	0%		
Other Town Roads	0.30	0.30	Other Town Roads	1%	8%		
Route 91	0.00	0.00	Route 91	0%	0%		
Total Private	20.18	3.55	Total Private	99%	92%		
			% Private		% Private		
Private - Currently Developed	19.80	3.32	Current	97%	98%	86%	94%
Private - Potential Buildout	0.39	0.23	Potential Buildout	2%	2%	6%	6%

STP #1.11 -B		Area	Imp Area				
Subwatersheds	(acres)	(acres)					
BO-OF-37A Current Industrial Area	1.130	1.13					
BO-OF-37A New Development 11	1.360	0.82					
OF-37B Putney Rd N of RT 91	2.590	0.79					
OF-41A ROV Tech	3.277	2.62					
OF-41B Upper Watershed ROV Tech	10.898	0.74					
Total =	19.26	6.10					
Area Breakdown	Area	Area	% Total Area		% Imp Area		
Putney Rd	0.79	0.79	Putney Rd	4%		13%	
Other Town Roads	0.00	0.00	Other Town Roads	0%		0%	
Route 91	0.00	0.00	Route 91	0%		0%	
Total Private	18.47	5.31	Total Private	96%		87%	
			% Private		% Private		
Private - Currently Developed	17.11	4.49	Current	89%	93%	74%	85%
Private - Potential Buildout	1.36	0.82	Potential Buildout	7%	7%	13%	15%

STP #1.12		Area	Imp Area				
Subwatersheds	(acres)	(acres)					
BO-OF-14 Current Black Mountain Rd Swale	7.050	2.39					
BO-OF-14 New Development 8	4.945	0.98					
BO-OF-14 New Development 9	6.123	1.22					
Total =	18.12	4.59					
Area Breakdown	Area	Area	% Total Area		% Imp Area		
Putney Rd	0.00	0.00	Putney Rd	0%		0%	
Other Town Roads	0.28	0.28	Other Town Roads	2%		6%	
Route 91	0.00	0.00	Route 91	0%		0%	
Total Private	17.84	4.31	Total Private	98%		94%	
			% Private		% Private		
Private - Currently Developed	6.77	2.11	Current	37%	38%	46%	49%
Private - Potential Buildout	11.07	2.20	Potential Buildout	61%	62%	48%	51%

STP #1.13		Area	Imp Area				
Subwatersheds	(acres)	(acres)					
OF-6H VFW & Strip Mall	2.935	1.54					
BO-OF-6 Current House	1.057	0.06					
BO-OF-6 New Development 1	0.945	0.51					
BO-OF-6-Current Putney Road	2.287	1.80					
BO-OF-15C Current Putney / Chickering Road	9.171	4.93					
Total =	16.39	8.84					
Area Breakdown	Area	Area	% Total Area		% Imp Area		
Putney Rd	11.46	6.73	Putney Rd	70%		76%	
Other Town Roads	0.46	0.46	Other Town Roads	3%		5%	
Route 91	0.00	0.00	Route 91	0%		0%	
Total Private	15.93	8.38	Total Private	97%		95%	
			% Private		% Private		
Private - Currently Developed	14.99	7.87	Current	91%	94%	89%	94%
Private - Potential Buildout	0.95	0.51	Potential Buildout	6%	6%	6%	6%

STP #2.1		Area	Imp Area				
Subwatersheds	(acres)	(acres)					
OF-13 Rt 91 S Black Mt Rd Overpass	3.499	2.11					
BO-OF-13B Current Rear Newspaper	1.471	0.49					
BO-OF-13B New Development 13	0.127	0.07					
OF-13C Comcast	0.501	0.46					
Total =	5.60	3.13					
Area Breakdown	Area	Area	% Total Area		% Imp Area		
Putney Rd	0.00	0.00	Putney Rd	0%		0%	
Other Town Roads	0.00	0.00	Other Town Roads	0%		0%	
Route 91	3.50	2.11	Route 91	62%		67%	
Total Private	2.10	1.02	Total Private	38%		33%	
			% Private		% Private		
Private - Currently Developed	1.97	0.95	Current	35%	94%	30%	93%
Private - Potential Buildout	0.13	0.07	Potential Buildout	2%	6%	2%	7%

STP #2.2		Area	Imp Area				
Subwatersheds		(acres)	(acres)				
OF-12 Rt 91 S of Exit 3		5.472	0.69				
OF-12A Rt 91 N of Black MT Rd Overpass		4.868	0.88				
BO-OF-13A Current Buttonwood Hill Rd		10.677	1.65				
BO-OF-13A New Development 7		1.497	0.29				
Total =		22.51	3.51				
Area Breakdown		Area	Area	% Total Area		% Imp Area	
Putney Rd		0.00	0.00	Putney Rd	0%	0%	
Other Town Roads		0.30	0.30	Other Town Roads	1%	9%	
Route 91		10.34	1.57	Route 91	46%	45%	
Total Private		11.87	1.64	Total Private	53%	47%	
				% Private		% Private	
Private - Currently Developed		10.38	1.35	Current	46%	87%	38% 82%
Private - Potential Buildout		1.50	0.29	Potential Buildout	7%	13%	8% 18%

STP #2.3 A		Area	Imp Area				
Subwatersheds		(acres)	(acres)				
OF-10 Rt 91 Exit 3 NB Off ramp		2.112	0.54				
OF-11A Rt 91 NB / S Exit 3 Off ramp		0.992	0.37				
OF-17 Rt 91 N Exit 3 / Steakout		0.991	0.33				
OF-16B Rt 91 Exit 3 NB On ramp		2.435	0.38				
Total =		6.53	1.62				
Area Breakdown		Area	Area	% Total Area		% Imp Area	
Putney Rd		0.00	0.00	Putney Rd	0%	0%	
Other Town Roads		0.00	0.00	Other Town Roads	0%	0%	
Route 91		6.53	1.62	Route 91	100%	100%	
Total Private		0.00	0.00	Total Private	0%	0%	
				% Private		% Private	
Private - Currently Developed		0.00	0.00	Current	0%	0%	0% 0%
Private - Potential Buildout		0.00	0.00	Potential Buildout	0%	0%	0% 0%

STP #2.3 B		Area	Imp Area				
Subwatersheds		(acres)	(acres)				
OF-11B Rt 91 Exit 3 SB On/Off Clover Leaf		9.290	1.06				
OF-11C Rt 91 Exit 3 SB Overpass		1.849	0.56				
OF-11D Rt 91 SB / S Exit 3		2.123	0.27				
Total =		13.26	1.89				
Area Breakdown		Area	Area	% Total Area		% Imp Area	
Putney Rd		0.00	0.00	Putney Rd	0%	0%	
Other Town Roads		0.00	0.00	Other Town Roads	0%	0%	
Route 91		13.26	1.89	Route 91	100%	100%	
Total Private		0.00	0.00	Total Private	0%	0%	
				% Private		% Private	
Private - Currently Developed		0.00	0.00	Current	0%	0%	0% 0%
Private - Potential Buildout		0.00	0.00	Potential Buildout	0%	0%	0% 0%

STP #2.4		Area	Imp Area				
Subwatersheds		(acres)	(acres)				
OF-20A Rt 91 SB Exit Offramp		1.318	0.31				
BO-OF-22B Upper Watershed Rt 91		0.622	0.06				
BO-OF-25B Upper Watershed Rt 91		0.730	0.07				
OF-22A Rt 91 N of Exit 3		1.799	0.59				
OF-25A Rt 91 S of Crosby Crossing		1.420	0.43				
Total =		5.89	1.46				
Area Breakdown		Area	Area	% Total Area		% Imp Area	
Putney Rd		0.00	0.00	Putney Rd	0%	0%	
Other Town Roads		0.00	0.00	Other Town Roads	0%	0%	
Route 91		4.54	1.33	Route 91	77%	91%	
Total Private		1.35	0.14	Total Private	23%	9%	
				% Private		% Private	
Private - Currently Developed		0.00	0.00	Current	0%	0%	0% 0%
Private - Potential Buildout		1.35	0.14	Potential Buildout	23%	100%	9% 100%

STP #2.5		Area	Imp Area				
Subwatersheds		(acres)	(acres)				
OF-27 Rt 91 N of Crosby Cross		2,389	0.49				
OF-28A Rt 91 N Exit 3 / E Hampton		2,640	0.67				
OF-28B Upper Watershed Rt 91		2,670	0.00				
OF-30 Hampton Inn		1,056	0.88				
Total =		8.76	2.04				
Area Breakdown		Area	Area	% Total Area		% Imp Area	
Putney Rd		0.00	0.00	Putney Rd	0%	0%	0%
Other Town Roads		0.00	0.00	Other Town Roads	0%	0%	0%
Route 91		5.03	1.16	Route 91	57%	57%	57%
Total Private		3.73	0.88	Total Private	43%	43%	43%
				% Private		% Private	
Private - Currently Developed		3.73	0.88	Current	43%	100%	43%
Private - Potential Buildout		0.00	0.00	Potential Buildout	0%	0%	0%

STP #2.6		Area	Imp Area				
Subwatersheds		(acres)	(acres)				
OF-29 Rt 91 SW of Putney Bridge		6,417	1.69				
OF-32 Quality Inn Parking		0,795	0.58				
OF-38 Casey Storage Solutions / Old Ferry		5,357	2.99				
OF-39 Casey Storage Solutions		2,982	2.29				
Total =		15.55	7.55				
Area Breakdown		Area	Area	% Total Area		% Imp Area	
Putney Rd		0.00	0.00	Putney Rd	0%	0%	0%
Other Town Roads		0.83	0.83	Other Town Roads	5%	11%	11%
Route 91		6.42	1.69	Route 91	41%	22%	22%
Total Private		8.30	5.03	Total Private	53%	67%	67%
				% Private		% Private	
Private - Currently Developed		8.30	5.03	Current	53%	100%	67%
Private - Potential Buildout		0.00	0.00	Potential Buildout	0%	0%	0%

STP #2.7		Area	Imp Area				
Subwatersheds		(acres)	(acres)				
OF-35 Rt 91 NE of Putney Bridge		9,488	2.78				
Total =		9.49	2.78				
Area Breakdown		Area	Area	% Total Area		% Imp Area	
Putney Rd		0.00	0.00	Putney Rd	0%	0%	0%
Other Town Roads		0.00	0.00	Other Town Roads	0%	0%	0%
Route 91		9.49	2.78	Route 91	100%	100%	100%
Total Private		0.00	0.00	Total Private	0%	0%	0%
				% Private		% Private	
Private - Currently Developed		0.00	0.00	Current	0%	0%	0%
Private - Potential Buildout		0.00	0.00	Potential Buildout	0%	0%	0%

	Area	% Total Area		Imp Area	% Imp Area
Total Treated Watershed	224.80			84.75	
Putney Rd	4.97	3%		4.97	6%
Other Town Roads	3.07	1%		3.07	4%
Route 91	59.72	27%		14.51	17%
Total Private	157.04	70%		62.20	73%
Private - Currently Developed	129.47	58%		52.10	61%
Private - Potential Buildout	27.57	12%		10.10	12%

STP #1.1	Total Area (acre)	Treated Percent	Treated Area (acre)	12 hr- CPV Volume (cu.ft.)	Total Imp Area (acre)	Treated Imp Area (acre)	WQ Volume (cu.ft.)	Soils Group	Re Volume (cu.ft.)	Pre-Treat Volume (cu.ft.)	Sanded Area (acre)	Sand Load (cu.ft.)	24 hr-OB Volume (cu.ft.)	Assumed Weir Ht. (ft)	Peak Flow (cfs)	Weir Length (ft)
59-OF-6D McDonalds	0.97	100%	0.965	3593	0.8	0.80	2510	B	726	290	0.00	27	7364	1.0	9.0	3
60-OF-6E KFC Taco Bell	1.00	25%	0.249	928	0.87	0.22	680	B	197	79	0.04	7	1902	1.0	2.3	1
61-OF-6F Americas Best Inn	1.83	100%	1.832	6820	1.26	1.26	4004	B	1143	457	0.15	46	13979	1.0	17.0	5
22-BO-OF-6 Current House	2.11	25%	0.528	19	0.12	0.03	175	A	44	11	0.00	0	263	1.0	0.6	0
23-BO-OF-6 New Development 1	1.26	50%	0.630	608	0.68	0.34	1103	B	309	123	0.00	9	2126	1.0	3.4	1
24-BO-OF-6 New Development 2	2.66	50%	1.328	1281	1.44	0.72	2334	A	1045	261	0.00	20	4480	1.0	7.1	2
25-BO-OF-6 Current Putney Road	2.29	50%	1.372	3791	1.80	1.08	3400	B	980	392	1.08	60	8705	1.0	11.8	4
8-BO-OF-15 Current Commercial / Indus	8.73	60%	5.236	19491	6.43	3.86	12199	A	5602	1400	0.16	191	39953	1.0	47.9	15
9-BO-OF-15 New Development 15	2.58	50%	1.289	1244	1.39	0.70	2254	A	1009	252	0.00	19	4351	1.0	6.9	2
15-OF-15 Commercial / Industrial	11.31	0%	0.000	0	7.36	0.00	0	B	0	0	0.00	0	0	1.0	0.0	0
STP #1.1	34.73		13.43	37773	22.15	9.00	28658		11055	3267	1.43	380	83123		106.1	34

BMP	Description	TYPE	Length	Width	Area	Area	Depth	Volume	Pre (cu.ft.)	WQv (cu.ft.)	REv (cu.ft.)	CPv (cu.ft.)	Obv (cu.ft.)	100 YR Peak (cfs)	Spillway Length (ft)
BMP 1	Infiltration Pond	POND	0.00	0.00	7500.00	4.50	33750								
BMP 2	Wetpond	POND	0.00	0.00	9300.00	5.00	46500								
BMP 3	Gravel Wetland	TRENCH	100.00	50.00	5000.00	2.00	3000								
BMP 4			0.00	0.00	0.00		0								
Total Area								83250	2548%	290%	753%	220%	100%		

STP #1.2	%	Area	12 hr- CPV	Imp Area	Imp Area	WQv	REV	Pre-Treat	Sand	24 hr-OBv	Weir Ht.	Peak Flow	Weir Length
55-OF-6 Putney Rd & Field	7.75	0%	0.000	1.83	0.00	0	0	0	0	0	1.0	0.0	0
22-BO-OF-6 Current House	2.11	100%	2.114	0	0.12	0.12	698	A	174	44	1.0	2.5	1
23-BO-OF-6 New Development 1	1.26	100%	1.260	1335	0.68	0.68	2205	A	617	247	1.0	6.8	2
24-BO-OF-6 New Development 2	2.66	90%	2.390	2532	1.44	1.30	4201	A	1882	470	1.0	12.8	4
25-BO-OF-6 Current Putney Road	2.29	60%	1.372	4036	1.80	1.08	3400	B	980	392	1.08	11.8	4
26-BO-OF-6I Front Newspaper	1.14	100%	1.142	3867	0.60	0.60	1951	B	545	218	1.0	10.1	3
27-BO-OF-6I New Development 5	0.55	100%	0.545	578	0.29	0.29	942	A	421	105	1.0	2.9	1
63-OF-6H VFW & Strip Mall	4.89	60%	2.935	10926	2.29	1.54	5013	B	1399	560	1.0	26.5	9
64-OF-6I Front Newspaper	1.71	0%	0.000	0	0.61	0.00	0	B	0	0	1.0	0.0	0
65-OF-6J Cemetary	8.89	50%	4.446	0	0.36	0.18	1256	B	163	65	1.0	1.0	0
STP #1.2	33.25		16.20	23274	10.30	5.79	19665		6182	2101	1.08	74.4	24

BMP	Description	TYPE	Length	Width	Area	Area	Depth	Volume	Pre (cu.ft.)	WQv (cu.ft.)	REv (cu.ft.)	CPv (cu.ft.)	Obv (cu.ft.)	100 YR Peak (cfs)	Spillway Length (ft)
BMP 1	Treatment / Infiltration Swale	SWALE	325.00	15.00	4875.00	4.50	21938								
BMP 2	Treatment / Infiltration Swale	SWALE	425.00	15.00	6375.00	4.50	28688								
BMP 3	Underground Storage	TRENCH	300.00	10.00	3000.00	2.00	1800								
BMP 4	Underground Storage	TRENCH	400.00	10.00	4000.00	2.00	2400								
Total Area								54825	2609%	279%	887%	23274	54384	74.4	24

STP #1.3	%	Area	12 hr- CPV	Imp Area	Imp Area	WQv	REV	Pre-Treat	Sand	24 hr-OBv	Weir Ht.	Peak Flow	Weir Length		
1-OF-1 Floor Plank	6.66	15%	0.998	2947	4.95	0.74	2346	B	674	270	0.01	13	6689		
38-OF-3 Residential	0.25	75%	0.936	2387	0.64	0.48	1564	B	436	174	0.00	7	5658		
54-OF-5 Friendlys	0.88	100%	0.880	3275	0.68	0.68	2143	B	617	247	0.06	23	6714		
55-OF-6 Putney Rd & Field	7.75	0%	0.000	0	1.83	0.00	0	B	0	0	0.00	0	0		
31-BO-OF-6 New Development 3	2.20	40%	0.879	931	1.18	0.47	1531	A	685	171	0.00	13	2965		
22-BO-OF-6 Current House	2.11	100%	2.114	0	0.12	0.12	698	A	174	44	0.00	0	1053		
23-BO-OF-6 New Development 1	1.26	75%	0.945	1001	0.68	0.51	1654	B	463	185	0.00	14	3188		
24-BO-OF-6 New Development 2	2.66	75%	1.992	2110	1.44	1.08	3501	A	1568	392	0.00	30	6720		
25-BO-OF-6 Current Putney Road	2.29	75%	1.718	5045	1.80	1.35	4250	B	1225	490	1.36	75	10811		
56-OF-6A Dunkin Donuts	0.82	100%	0.818	3045	0.77	0.77	2398	B	699	280	0.14	26	6242		
57-OF-6B Wendy's	1.02	100%	1.020	3799	0.7	0.70	2225	B	635	254	0.00	23	7786		
58-OF-6C Motel 8	1.37	50%	0.686	2552	0.83	0.42	1332	B	377	151	0.00	14	5232		
STP #1.3	30.25		12.98	27097	15.62	7.32	23642		7553	2657	1.56	238	63129	85.9	28

BMP	Description	TYPE	Length	Width	Area	Area	Depth	Volume	Pre (cu.ft.)	WQv (cu.ft.)	REv (cu.ft.)	CPv (cu.ft.)	Obv (cu.ft.)	100 YR Peak (cfs)	Spillway Length (ft)
BMP 1	Infiltration Pond	POND	0.00	0.00	11675.00	4.50	52538								
BMP 2	Wetpond	POND	0.00	0.00	2300.00	4.50	10350								
BMP 3			0.00	0.00	0.00		0								
BMP 4			0.00	0.00	0.00		0								
Total Area								62888	2657	23642	7553	27097	63129	85.9	28

STP #1.4	%	Area	12 hr- CPV	Imp Area	Imp Area	WQv	REV	Pre-Treat	Sand	24 hr-OBv	Weir Ht.	Peak Flow	Weir Length		
66-OF-7 Rt 5 & 9 Roundabout Access	9.14	0%	0.000	0	2.56	0.00	0	A	0	0	0.00	0	0		
28-BO-OF-7 Current Putney Road	3.33	70%	2.331	4616	2.29	1.60	5094	A	2328	582	1.60	89	11576		
29-BO-OF-7 New Development 4	5.56	75%	4.168	4416	3.00	2.25	7257	A	3267	817	0.00	63	14063		
67-OF-7A Bickfords Old Parking	0.80	100%	0.803	3	0.22	0.22	778	A	319	80	0.00	7	575		
STP #1.4	18.83		7.30	9036	8.07	4.07	13169		5914	1478	1.60	159	26213	41.8	13

BMP	Description	TYPE	Length	Width	Area	Area	Depth	Volume	Pre (cu.ft.)	WQv (cu.ft.)	REv (cu.ft.)	CPv (cu.ft.)	Obv (cu.ft.)	100 YR Peak (cfs)	Spillway Length (ft)
BMP 1	Infiltration Pond	POND	0.00	0.00	8800.00	3.00	26400								
BMP 2			0.00	0.00	0.00		0								
BMP 3			0.00	0.00	0.00		0								
BMP 4			0.00	0.00	0.00		0								
Total Area								26400	1478	13169	5914	9036	26213	41.8	13

STP #1.5	%	Area	12 hr- CPV	Imp Area	Imp Area	WQv	REV	Pre-Treat	Sand	24 hr-OBv	Weir Ht.	Peak Flow	Weir Length		
69-OF-8 Citgo Green Light Package Expre	4.49	0%	0.000	0	0.76	0.00	0	A	0	0	0.00	0	0		
30-BO-OF-8 Current Citgo Green Light P	2.30	50%	1.144	333	0.76	0.38	1305	A	552	138	0.00	17	1992		
70-OF-9 Mobile Gas Rear	0.66	80%	0.528	1677	0.2	0.16	557	A	232	58	0.06	7	3655		
STP #1.5	7.45		1.68	2010	1.72	0.54	1862		784	196	0.06	24	5646	9.5	9

BMP	Description	TYPE	Length	Width	Area	Area	Depth	Volume	Pre (cu.ft.)	WQv (cu.ft.)	REv (cu.ft.)	CPv (cu.ft.)	Obv (cu.ft.)	100 YR Peak (cfs)	Spillway Length (ft)
BMP 1	Treatment / Infiltration Swale	SWALE	100.00	6.00	600.00	2.50	1500								
BMP 2	Treatment / Infiltration Swale	SWALE	105.00	6.00	630.00	2.50	1575								
BMP 3	Treatment / Infiltration Swale	SWALE	110.00	6.00	660.00	3.00	1980								
BMP 4	Underground Storage	TRENCH	325.00	3.00	975.00	2.00	585								
Total Area								5640	196	1862	784	2010	5646	9.5	9

STP #1.6	%	Area	12 hr- CPV	Imp Area	Imp Area	WQv	REV	Pre-Treat	Sand	24 hr-OBv	Weir Ht.	Peak Flow	Weir Length
66-OF-7 Rt 5 & 9 Roundabout Access	9.14	0%	0.000	0	2.56	0.00	0	A	0	0	0.00	0	0
28-BO-OF-7 Current Putney Road	3.33	50%	1.665	3297	2.29	1.15	3639	A	1663				

STP #1.8	%	Area	12 hr- CPv	Imp Area	Imp Area	WQv	Rev	Pre-Treat	Sand	24 hr-OBv	Weir Ht.	Peak Flow	Weir Length
66:OF-7 Rt 5 & 9 Roundabout Access	9.14	0.00	0	2.56	0.00	0	A	0	0	0	1.0	0.0	0
28:BO-OF-7 Current Putney Road	3.33	1.165	2308	2.29	0.80	2547	A	1064	291	44	5788	1.0	8.8
29:BO-OF-7 New Development 4	5.56	3.612	3828	3.00	1.95	6324	A	2831	708	0	12183	1.0	19.4
68:OF-7B Ninety Nine Rest	2.63	0.000	0	1.96	0.00	0	A	0	0	0	1.0	0.0	0
19:OF-18 Steak Out / Mall	1.08	0.806	2565	1.08	0.81	2513	A	1176	294	23	5584	1.0	7.2
20:OF-18A Staceys Used Cars	2.63	2.105	1230	1.37	1.10	3566	A	1591	398	12	5443	1.0	11.1
21:OF-19 Brattleboro Subaru	1.81	0.904	2875	1.49	0.75	2338	A	1082	270	21	6261	1.0	8.0
STP #1.8	26.17	8.59	12806	13.75	5.40	17289		7844	1961	80	35263		54.4

STP #1.8	Description	TYPE	Length	Width	Area	Area	Depth	Volume	Pre	WQv	Rev	CPv	Obv	100 YR Peak	Spillway Length
BMP 1	Wetpond	POND	0.00	0.00	13500.00	3.50	47250								
BMP 2	Gravel Wetland	TRENCH	100.00	50.00	5000.00	1.00	1500		(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cfs)	(ft)
BMP 3			0.00	0.00	0.00	0.00	0								
BMP 4			0.00	0.00	0.00	0.00	0								
					Total Area	Avg Depth	2.25	Volume	2486%	17289	7844	12806	35263	54.4	18

STP #1.9	%	Area	12 hr- CPv	Imp Area	Imp Area	WQv	Rev	Pre-Treat	Sand	24 hr-OBv	Weir Ht.	Peak Flow	Weir Length
42:OF-23 Motel 6 / Used Car Parking	1.91	100%	1.913	7012	1.53	4811	B	1388	555	0.19	44	14464	1.0
32:OF-26A Rt 91 N of Crosby Cross	0.95	65%	0.617	288	0.56	1171	A	529	132	0.26	20	1439	1.0
29:OF-24 Cocoplum / Used Car	3.19	100%	3.190	8894	2.29	7254	C	831	831	0.54	78	20359	1.0
33:OF-26B China Buffet / Motel	4.23	100%	4.234	70	1.35	4661	A	1960	490	0.25	31	3160	1.0
STP #1.9	10.29	9.95	16263	5.73	5.53	17898		4708	2009	1.35	170	39423	

STP #1.9	Description	TYPE	Length	Width	Area	Area	Depth	Volume	Pre	WQv	Rev	CPv	Obv	100 YR Peak	Spillway Length
BMP 1	Wetpond	POND	0.00	0.00	9500.00	4.00	38000								
BMP 2			0.00	0.00	0.00	0.00	0								
BMP 3			0.00	0.00	0.00	0.00	0								
BMP 4			0.00	0.00	0.00	0.00	0								
					Total Area	Avg Depth	4.00	Volume	1892%	17898	4708	16263	39423	58.1	19

STP #1.10	%	Area	12 hr- CPv	Imp Area	Imp Area	WQv	Rev	Pre-Treat	Sand	24 hr-OBv	Weir Ht.	Peak Flow	Weir Length
42:OF-33A Old Ferry Industrial	20.87	100%	20.872	55132	14.21	45191	B	12896	5158	0.21	398	128791	1.5
43:OF-33B Putney Rd / Old Ferry Intersec	0.20	100%	0.198	997	0.20	614	A	287	72	0.20	11	1812	1.5
STP #1.10	21.07	21.07	56129	14.41	14.41	45805		13183	5230	0.41	409	130603	

STP #1.10	Description	TYPE	Length	Width	Area	Area	Depth	Volume	Pre	WQv	Rev	CPv	Obv	100 YR Peak	Spillway Length
BMP 1	Existing Storage Area (Add outlet cont)	POND	0.00	0.00	25500.00	3.00	76500								
BMP 2	Wetpond	POND	0.00	0.00	6000.00	2.50	15000								
BMP 3	Gravel Wetland	TRENCH	50.00	100.00	5000.00	2.00	3000		(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cfs)	(ft)
BMP 4			0.00	0.00	0.00	0.00	0								
					Total Area	Avg Depth	2.50	Volume	1807%	45805	13183	56129	130603	173.4	30

STP #1.11 -A	%	Area	12 hr- CPv	Imp Area	Imp Area	WQv	Rev	Pre-Treat	Sand	24 hr-OBv	Weir Ht.	Peak Flow	Weir Length
50:OF-40 Bennett Drive Industrial Park	21.16	95%	20.098	7123	3.81	13925	B	3285	1314	0.30	109	41467	1.0
18:BO-OF-37A New Development 10	0.77	50%	0.387	805	0.46	739	B	209	83	0.00	6	1980	1.0
STP #1.11 -A	21.93	20.48	7928	4.27	3.85	14665		3493	1397	0.30	116	43446	

STP #1.11 -A	Description	TYPE	Length	Width	Area	Area	Depth	Volume	Pre	WQv	Rev	CPv	Obv	100 YR Peak	Spillway Length
BMP 1	Treatment / Infiltration Swale	SWALE	480.00	20.00	9600.00	3.50	33600								
BMP 2	Underground Storage	TRENCH	150.00	10.00	1500.00	2.00	900		(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cfs)	(ft)
BMP 3			0.00	0.00	0.00	0.00	0								
BMP 4			0.00	0.00	0.00	0.00	0								
					Total Area	Avg Depth	2.75	Volume	2469%	14665	3493	7928	43446	77.4	25

STP #1.11 -B	%	Area	12 hr- CPv	Imp Area	Imp Area	WQv	Rev	Pre-Treat	Sand	24 hr-OBv	Weir Ht.	Peak Flow	Weir Length
46:OF-37A Industrial Area	3.27	0%	0.000	0	1.13	0.00	A	0	0	0.00	0	0.0	0
17:BO-OF-37A Current Industrial Area	1.13	100%	3625	1.13	0.38	8179	B	1025	410	0.00	111	14670	1.0
19:BO-OF-37A New Development 11	1.36	100%	1.360	2832	0.82	2633	B	744	298	0.00	23	6967	1.0
47:OF-37B Putney Rd N of RT 91	2.59	100%	2.590	201	0.79	2746	A	1147	287	0.79	44	2866	1.0
51:OF-41A ROV Tech	3.28	100%	3.277	9875	2.62	8239	B	2378	951	0.00	52	21956	1.0
52:OF-41B Upper Watershed ROV Tech	11.98	91%	10.898	10551	0.81	3947	C	268	268	0.00	4	38577	1.0
STP #1.11 -B	23.61	19.26	27085	7.30	6.10	21073		5562	2213	0.79	161	77936	

STP #1.11 -B	Description	TYPE	Length	Width	Area	Area	Depth	Volume	Pre	WQv	Rev	CPv	Obv	100 YR Peak	Spillway Length
BMP 1	Wetpond	POND	0.00	0.00	18000.00	4.00	72000								
BMP 2	Treatment / Infiltration Swale	SWALE	200.00	10.00	2000.00	3.00	6000		(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cfs)	(ft)
BMP 3			0.00	0.00	0.00	0.00	0								
BMP 4			0.00	0.00	0.00	0.00	0								
					Total Area	Avg Depth	3.50	Volume	3524%	21073	5562	27085	77936	95.0	31

STP #1.12	%	Area	12 hr- CPv	Imp Area	Imp Area	WQv	Rev	Pre-Treat	Sand	24 hr-OBv	Weir Ht.	Peak Flow	Weir Length
14:OF-14 Black Mountain Rd Swale	17.88	0%	0.000	0	3.14	0.00	A	0	0	0.00	0	0.0	0
5:BO-OF-14 Current Black Mountain Rd	0.05	100%	0.053	663	0.38	8179	A	3470	868	0.28	67	7705	1.0
6:BO-OF-14 New Development 8	4.94	100%	4.945	282	0.98	3689	A	1423	356	0.25	19	4538	1.0
7:BO-OF-14 New Development 9	6.12	100%	6.123	349	1.22	4587	A	1771	443	0.31	24	5620	1.0
STP #1.12	36.00	18.12	1293	7.73	4.59	16456		6665	1666	0.84	110	17863	

STP #1.12	Description	TYPE	Length	Width	Area	Area	Depth	Volume	Pre	WQv	Rev	CPv	Obv	100 YR Peak	Spillway Length
BMP 1	Infiltration Pond	POND	0.00	0.00	3400.00	2.00	6800								
BMP 2	Infiltration Pond	POND	0.00	0.00	5200.00	2.00	10400								
BMP 3		TRENCH	20.00	50.00	1000.00	2.00	600		(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cfs)	(ft)
BMP 4			0.00	0.00	0.00	0.00	0								
					Total Area	Avg Depth	2.00	Volume	1068%	16456	6665	1293	17863	44.8	14

STP #1.13	%	Area	12 hr- CPv	Imp Area	Imp Area	WQv	Rev	Pre-Treat	Sand	24 hr-OBv	Weir Ht.	Peak Flow	Weir Length	
63:OF-6H VFW & Strip Mall	4.89	60%	2.935	10926	2.57	1.54	5013	B	1399	560	0.00	51	22396	1.0
22:BO-OF-6 Current House	2.11	50%	1.057	0	0.12	0.06	349	A	87	22	0.00	0	527	1.0
23:BO-OF-6 New Development 1	1.26	75%	0.945	1001	0.68	0.51	1654	B	463	185	0.00	14	3188	1.0
25:BO-OF-6 Current Putney Road	2.29	100%	2.287	6726	1.89	1.80	5666	B	2614	653	0.00	50	8960	1.0
13:BO-OF-15C Current Putney / Chickerin	36.68	25%	9.171	5790	19.70	4.93	15979	A	7151	1788	0.46	53	1135	1.0
STP #1.13	47.24	16.39	24443	24.87	8.84	28662		11714	3208	0.46	169	36206		

STP #1.13	Description	TYPE	Length	Width	Area	Area	Depth	Volume	Pre	WQv	Rev	CPv	Obv	100 YR Peak	Spillway Length
BMP 1	Infiltration Pond	POND	0.00	0.00	1100.00	3.50	3850								
BMP 2	Infiltration Pond	POND	0.00	0.00	1100.00	3.50	3850								
BMP 3	Infiltration Trench	TRENCH	4700.00	5.00	23500.00	3.00	21150		(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cfs)	(ft)
BMP 4			0.00	0.00	0.00	0.00	0								

STP #2.2	%	Area	12 hr- CPv	Imp Area	Imp Area	WQv	REv	Pre-Treat	Sand	24 hr-OBv	Weir Ht.	Peak Flow	Weir Length			
8:OF-12 Rt 91 S of Exit 3	5.47	100%	5.472	0	0.69	0.69	2923	A	1002	250	0.68	38	968	0.5	6.1	6
9:OF-12A Rt 91 N of Black Mt Rd Overgr	4.87	100%	4.868	130	0.88	0.88	3383	A	1278	319	0.88	49	4086	0.5	12.2	11
1:BO-OF-13A Current Buttonwood Hill R	10.68	100%	10.677	0	1.65	1.65	6596	A	2396	599	0.21	71	288	0.5	2.5	2
2:BO-OF-13A New Development 7	1.50	100%	1.497	85	0.29	0.29	1097	A	421	105	0.00	2	1374	0.5	3.3	3
12:OF-13A Buttonwood Hill Rd	12.45	0%	0.000	0	1.91	0.00	0	A	0	0	0.00	0	0		0.0	0
STP #2.2	34.96		22.51	216	5.42	3.51	13998		5097	1274	1.77	160	6717		24.2	22

STP #2.2		Description	TYPE	Length	Width	Area	Area	Depth	Volume	Pre	WQv	REv	CPv	Obv	100 YR Peak	Spillway Length
BMP 1	Infiltration Pond	POND	0.00	0.00		8500.00	1.00	8500								
BMP 2	Treatment / Infiltration Swale	POND	0.00	0.00		3200.00	0.50	1600								
BMP 3	Underground Storage	SWALE	660.00	6.00		3960.00	0.50	1980	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cfs)	(ft)	
BMP 4	Treatment / Infiltration Swale	TRENCH	660.00	2.00		1320.00	2.00	792	1274	13998	5097	216	6717	24.2	22	
Total Area								12872	1010%	92%	253%	5969%	192%			

STP #2.3 A	%	Area	12 hr- CPv	Imp Area	Imp Area	WQv	REv	Pre-Treat	Sand	24 hr-OBv	Weir Ht.	Peak Flow	Weir Length			
2:OF-10 Rt 91 Exit 3 NB Off ramp	2.11	100%	2.112	239	0.54	0.54	1933	A	784	196	0.55	31	2630	1.0	7.2	2
3:OF-11A Rt 91 NB / S Exit 3 Off ramp	1.32	75%	0.992	348	0.49	0.37	1243	A	534	133	0.37	20	2016	1.0	4.6	1
18:OF-17 Rt 91 N Exit 3 / Steakout	1.32	75%	0.991	254	0.44	0.33	1132	A	479	120	0.33	18	1748	1.0	4.0	1
17:OF-16B Rt 91 Exit 3 NB On ramp	2.44	100%	2.435	0	0.38	0.38	1515	A	552	138	0.52	29	983	1.0	4.1	1
STP #2.3 A	7.19		6.53	841	1.85	1.62	5823		2349	587	1.77	98	7377		19.8	6

STP #2.3 A		Description	TYPE	Length	Width	Area	Area	Depth	Volume	Pre	WQv	REv	CPv	Obv	100 YR Peak	Spillway Length
BMP 1	Wetpond / Infiltration Pond	POND	0.00	0.00		5770.00	0.50	2885								
BMP 2	Treatment / Infiltration Swale	SWALE	150.00	5.00		750.00	1.00	750	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cfs)	(ft)	
BMP 3	Wetpond / Infiltration Pond	POND	0.00	0.00		5385.00	0.50	2693								
BMP 4	Treatment / Infiltration Swale	SWALE	175.00	10.00		1750.00	1.00	1750	587	5823	2349	841	7377	19.8	6	
Total Area								8078	1376%	139%	344%	961%	109%			

STP #2.3 B	%	Area	12 hr- CPv	Imp Area	Imp Area	WQv	REv	Pre-Treat	Sand	24 hr-OBv	Weir Ht.	Peak Flow	Weir Length			
4:OF-11B Rt 91 Exit 3 SB On/Off Clover	9.29	100%	9.290	6826	1.06	1.06	4634	B	962	385	1.02	57	27128	1.0	47.0	15
5:OF-11C Rt 91 Exit 3 SB Overpass	1.85	100%	1.849	1525	0.56	0.56	1949	A	813	203	0.55	31	5758	1.0	10.7	3
6:OF-11D Rt 91 SB / S Exit 3	2.12	100%	2.123	0	0.27	0.27	1141	A	392	98	0.28	15	413	1.0	2.5	1
STP #2.3 B	13.26		13.26	8351	1.89	1.89	7723		2167	686	1.85	103	33299		60.1	19

STP #2.3 B		Description	TYPE	Length	Width	Area	Area	Depth	Volume	Pre	WQv	REv	CPv	Obv	100 YR Peak	Spillway Length
BMP 1	Wetpond / Infiltration Pond	POND	0.00	0.00		14800.00	2.00	29600								
BMP 2	Wetpond / Infiltration Pond	POND	0.00	0.00		9500.00	2.00	19000	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cfs)	(ft)	
BMP 3			0.00	0.00		0.00	0.00	0								
BMP 4			0.00	0.00		0.00	0.00	0	686	7723	2167	8351	33299	60.1	19	
Total Area								48600	7084%	629%	2243%	582%	146%			

STP #2.4	%	Area	12 hr- CPv	Imp Area	Imp Area	WQv	REv	Pre-Treat	Sand	24 hr-OBv	Weir Ht.	Peak Flow	Weir Length			
23:OF-20A Rt 91 SB Exit Offramp	1.76	75%	1.318	966	0.41	0.31	1119	B	279	112	0.31	17	3840	1.0	7.5	2
15:BO-OF-22B Upper Watershed Rt 91	6.22	10%	0.622	883	0.62	0.06	284	B	56	23	0.03	2	2468	1.0	3.4	1
16:BO-OF-25B Upper Watershed Rt 91	7.30	10%	0.730	1036	0.73	0.07	334	B	66	26	0.04	2	2897	1.0	3.9	1
26:OF-22A Rt 91 N of Exit 3	1.80	100%	1.799	2149	0.59	0.59	2029	B	535	214	0.59	33	6873	1.0	11.7	4
30:OF-25A Rt 91 S of Crosby Crossing	1.58	90%	1.420	1608	0.43	0.43	1502	B	392	157	0.43	24	5220	1.0	9.1	3
STP #2.4	18.66		5.89	6641	2.83	1.46	5268		1329	532	1.40	78	21298		35.6	11

STP #2.4		Description	TYPE	Length	Width	Area	Area	Depth	Volume	Pre	WQv	REv	CPv	Obv	100 YR Peak	Spillway Length
BMP 1	Wetpond / Infiltration Pond	POND	0.00	0.00		8900.00	2.50	22250								
BMP 2	Treatment / Infiltration Swale	SWALE	250.00	6.00		1500.00	1.00	1500	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cfs)	(ft)	
BMP 3	Treatment / Infiltration Swale	SWALE	200.00	6.00		1200.00	1.00	1200								
BMP 4	Underground Storage	TRENCH	450.00	2.00		900.00	2.00	540	532	5268	1329	6641	21298	35.6	11	
Total Area								25490	4795%	484%	1918%	384%	120%			

STP #2.5	%	Area	12 hr- CPv	Imp Area	Imp Area	WQv	REv	Pre-Treat	Sand	24 hr-OBv	Weir Ht.	Peak Flow	Weir Length			
34:OF-27 Rt 91 N of Crosby Cross	2.39	100%	2.389	113	0.49	0.49	1831	A	711	178	0.49	27	2284	1.0	6.6	2
35:OF-28A Rt 91 N Exit 3 / E Hampton	2.64	100%	2.640	288	0.67	0.67	2401	A	973	243	0.66	37	3291	1.0	8.6	3
36:OF-28B Upper Watershed Rt 91	2.67	100%	2.670	0	0	0.00	436	A	0	0	0.00	0	333	1.0	1.1	0
39:OF-30 Hampton Inn	2.11	50%	1.056	3360	1.75	0.88	2745	A	1271	318	0.00	19	7316	1.0	9.5	3
STP #2.5	9.81		8.76	3761	2.91	2.04	7414		2955	739	1.15	83	13224		25.8	8

STP #2.5		Description	TYPE	Length	Width	Area	Area	Depth	Volume	Pre	WQv	REv	CPv	Obv	100 YR Peak	Spillway Length
BMP 1	Wetpond / Infiltration Pond	POND	0.00	0.00		2700.00	2.50	6750								
BMP 2	Treatment / Infiltration Swale	SWALE	180.00	6.00		1080.00	1.50	1620	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cfs)	(ft)	
BMP 3	Treatment / Infiltration Swale	SWALE	600.00	6.00		3600.00	1.50	5400								
BMP 4	Underground Storage	TRENCH	780.00	2.00		1560.00	3.00	1404	739	7414	2955	3761	13224	25.8	8	
Total Area								15174	2054%	205%	514%	403%	115%			

STP #2.6	%	Area	12 hr- CPv	Imp Area	Imp Area	WQv	REv	Pre-Treat	Sand	24 hr-OBv	Weir Ht.	Peak Flow	Weir Length			
37:OF-29 Rt 91 SW of Putney Bridge	6.42	100%	6.417	794	1.69	1.69	6017	A	2454	613	1.69	94	8380	1.0	21.9	7
41:OF-32 Quality Inn Parking	0.79	100%	0.795	2526	0.58	0.58	1835	A	842	211	0.00	32	5503	1.0	7.1	2
48:OF-38 Casey Storage Solutions / Old F	5.36	100%	5.357	8184	2.99	2.99	9667	B	2713	1085	0.83	82	23582	1.0	38.0	12
49:OF-39 Casey Storage Solutions	2.98	100%	2.982	9431	2.29	2.29	7220	C	831	831	0.00	38	20577	1.0	26.7	9
STP #2.6	15.55		15.55	20935	7.55	7.55	24740		6841	2741	2.52	246	58042		93.6	30

STP #2.6		Description	TYPE	Length	Width	Area	Area	Depth	Volume	Pre	WQv	REv	CPv	Obv	100 YR Peak	Spillway Length
BMP 1	Wetpond / Infiltration Pond	POND	0.00	0.00		6300.00	1.50	9450								
BMP 2	Treatment Swale	POND	0.00	0.00		6150.00	2.50	15375	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cu.ft.)	(cfs)	(ft)	
BMP 3	Treatment / Infiltration Swale	SWALE	710.00	6.00		4260.00	1.50	6390								
BMP 4	Underground Storage	TRENCH	710.00	2.00		1420.00	3.00	1278	2741	24740	6841	20935	58042	93.6	30	
Total Area								32493	1186%	131%	475%	155%	56%			

STP #2.7	%	Area	12 hr- CPv	Imp Area	Imp Area	WQv	REv	Pre-Treat	Sand	24 hr-OBv	Weir Ht.	Peak Flow	Weir Length

Subbasin Summary - 1 Year - 24 Storm

SN	Subbasin ID	Area	Weighted Curve Number	Total Rainfall	Total Runoff	Total Runoff Volume	Peak Runoff	Time of Concentration
		(ac)		(in)	(in)	(ac-in)	(cfs)	(days hh:mm:ss)
1	BO-OF-13A Current Buttonwood Hill Rd	10.68	35.63	2.40	0.00	0.00	0.00	0 00:18:51
2	BO-OF-13A New Development 7	1.50	51.00	2.40	0.02	0.03	0.00	0 00:11:39
3	BO-OF-13B Current Rear Newspaper	1.47	81.12	2.40	0.88	1.29	2.15	0 00:02:57
4	BO-OF-13B New Development 13	0.42	81.42	2.40	0.89	0.38	0.54	0 00:07:57
5	BO-OF-14 Current Black Mountain Rd Swale	7.05	52.68	2.40	0.04	0.27	0.03	0 00:07:21
6	BO-OF-14 New Development 8	4.94	51.00	2.40	0.02	0.11	0.01	0 00:08:17
7	BO-OF-14 New Development 9	6.12	51.00	2.40	0.02	0.14	0.02	0 00:08:17
8	BO-OF-15 Current Commercial / Industrial	8.73	92.00	2.40	1.60	13.97	22.78	0 00:03:27
9	BO-OF-15 New Development 15	2.58	70.60	2.40	0.43	1.10	1.39	0 00:07:57
10	BO-OF-15B Current Bowling Alley	7.91	72.82	2.40	0.51	4.02	5.87	0 00:03:28
11	BO-OF-15B New Development 14	2.19	70.60	2.40	0.43	0.94	1.19	0 00:07:57
12	BO-OF-15C Current Chickering Drive Upper	0.85	95.60	2.40	1.92	1.63	2.57	0 00:03:00
13	BO-OF-15C Current Putney / Chickering Roads	36.68	64.78	2.40	0.26	9.35	10.20	0 00:06:12
14	BO-OF-15C New Development 6	1.79	81.42	2.40	0.89	1.60	2.29	0 00:07:57
15	BO-OF-22B Upper Watershed Rt 91	6.22	74.50	2.40	0.57	3.57	4.32	0 00:12:21
16	BO-OF-25B Upper Watershed Rt 91	7.30	74.50	2.40	0.57	4.18	5.08	0 00:12:21
17	BO-OF-37A Current Industrial Area	1.13	88.00	2.40	1.30	1.46	2.40	0 00:03:59
18	BO-OF-37A New Development 10	0.77	80.40	2.40	0.84	0.65	0.92	0 00:07:57
19	BO-OF-37A New Development 11	1.36	80.40	2.40	0.84	1.14	1.63	0 00:07:57
20	BO-OF-43 Lower Crosby Current Residential	9.00	40.50	2.40	0.00	0.00	0.00	0 00:08:04
21	BO-OF-43 New Development 12	7.05	51.00	2.40	0.02	0.16	0.02	0 00:08:17
22	BO-OF-6 Current House	2.11	46.00	2.40	0.00	0.00	0.00	0 00:19:50
23	BO-OF-6 New Development 1	1.26	70.60	2.40	0.43	0.54	0.68	0 00:07:57
24	BO-OF-6 New Development 2	2.66	70.60	2.40	0.43	1.14	1.44	0 00:07:57
25	BO-OF-6-Current Putney Road	2.29	86.39	2.40	1.19	2.72	4.58	0 00:02:51
26	BO-OF-6I Front Newspaper	1.14	89.00	2.40	1.37	1.56	2.58	0 00:03:25
27	BO-OF-6I New Development 5	0.55	70.60	2.40	0.43	0.23	0.29	0 00:07:57
28	BO-OF-7 Current Putney Road	3.33	79.59	2.40	0.80	2.66	4.26	0 00:03:51
29	BO-OF-7 New Development 4	5.56	70.60	2.40	0.43	2.38	3.00	0 00:07:57
30	BO-OF-8 Current Citgo Green Light Package Express	2.30	58.40	2.40	0.12	0.27	0.16	0 00:02:25
31	BO-OF-8 New Development 3	2.20	70.60	2.40	0.43	0.94	1.19	0 00:07:57
32	OF-1 Floor Plank	6.66	88.00	2.40	1.30	8.63	14.64	0 00:02:32
33	OF-10 Rt 91 Exit 3 NB Off ramp	2.11	54.08	2.40	0.05	0.11	0.01	0 00:02:12
34	OF-11A Rt 91 NB / S Exit 3 Off ramp	1.32	60.86	2.40	0.16	0.22	0.23	0 00:01:55
35	OF-11B Rt 91 Exit 3 SB On/Off Clover Leaf	9.29	67.37	2.40	0.33	3.03	3.65	0 00:06:36
36	OF-11C Rt 91 Exit 3 SB Overpass	1.85	68.68	2.40	0.37	0.68	0.91	0 00:03:40
37	OF-11D Rt 91 SB / S Exit 3	2.12	40.70	2.40	0.00	0.00	0.00	0 00:03:30
38	OF-11E Upper Watershed RT 91 Clover Leaf	8.13	30.00	2.40	0.00	0.00	0.00	0 00:20:25
39	OF-12 Rt 91 S of Exit 3	5.47	40.32	2.40	0.00	0.00	0.00	0 00:03:33
40	OF-12A Rt 91 N of Black Mt Rd Overpass	4.87	49.90	2.40	0.02	0.07	0.01	0 00:03:35
41	OF-13 Rt 91 S Black Mt Rd Overpass	3.50	74.96	2.40	0.59	2.07	3.16	0 00:03:33
42	OF-13C Comcast	0.67	89.00	2.40	1.37	0.91	1.53	0 00:02:51
43	OF-15A True Value Hardware / Motel	3.10	73.99	2.40	0.55	1.71	2.61	0 00:03:07
44	OF-16A Pizza Hut	1.18	89.00	2.40	1.37	1.61	2.72	0 00:02:40
45	OF-16B Rt 91 Exit 3 NB On ramp	2.44	44.42	2.40	0.00	0.00	0.00	0 00:02:20
46	OF-17 Rt 91 N Exit 3 / Steakout	1.32	58.65	2.40	0.12	0.16	0.09	0 00:03:33
47	OF-18 Steak Out / Mall	1.08	89.00	2.40	1.37	1.47	2.48	0 00:02:39
48	OF-18A Staceys Used Cars	2.63	65.03	2.40	0.26	0.69	0.88	0 00:02:48
49	OF-19 Brattleboro Subaru	1.81	89.00	2.40	1.37	2.47	4.10	0 00:03:31
50	OF-2 Open Space Railroad Bridge	0.87	39.00	2.40	0.00	0.00	0.00	0 00:02:37
51	OF-20A Rt 91 SB Exit Offramp	1.76	67.33	2.40	0.33	0.57	0.78	0 00:02:45
52	OF-20B Upper Watershed Rt 91 Exit 3	29.54	70.00	2.40	0.41	12.05	9.18	0 00:23:42
53	OF-21 Motel 6	1.12	89.00	2.40	1.37	1.53	2.55	0 00:03:16
54	OF-22A Rt 91 N of Exit 3	1.80	73.13	2.40	0.52	0.93	1.37	0 00:03:35
55	OF-23 Motel 6 / Used Car Parking	1.91	91.70	2.40	1.58	3.02	5.00	0 00:02:41
56	OF-24 Cocoplum / Used Car	3.19	86.56	2.40	1.20	3.82	6.43	0 00:03:00
57	OF-25A Rt 91 S of Crosby Crossing	1.58	72.25	2.40	0.49	0.77	1.10	0 00:03:37
58	OF-26A Rt 91 N of Crosby Cross	0.95	63.18	2.40	0.22	0.20	0.24	0 00:03:03
59	OF-26B China Buffet / Motel	4.23	48.81	2.40	0.01	0.03	0.01	0 00:03:19
60	OF-27 Rt 91 N of Crosby Cross	2.39	51.10	2.40	0.02	0.05	0.01	0 00:02:59
61	OF-28A Rt 91 N Exit 3 / E Hampton	2.64	53.97	2.40	0.05	0.14	0.01	0 00:03:06
62	OF-28B Upper Watershed Rt 91	2.67	39.00	2.40	0.00	0.00	0.00	0 00:25:43
63	OF-29 Rt 91 SW of Putney Bridge	6.42	54.54	2.40	0.06	0.38	0.04	0 00:02:45
64	OF-3 Residential	1.25	85.00	2.40	1.10	1.37	2.32	0 00:02:51
65	OF-30 Hampton Inn	2.11	89.00	2.40	1.37	2.89	4.90	0 00:02:20
66	OF-31 Quality Inn	0.88	89.00	2.40	1.37	1.20	2.05	0 00:02:01
67	OF-32 Quality Inn Parking	0.79	89.00	2.40	1.37	1.09	1.84	0 00:02:18
68	OF-33A Old Ferry Industrial	20.87	85.58	2.40	1.14	23.71	38.15	0 00:04:34
69	OF-33B Putney Rd / Old Ferry Intersection	0.20	98.00	2.40	2.17	0.43	0.64	0 00:01:51
70	OF-35 Rt 91 NE of Putney Bridge	9.49	76.68	2.40	0.66	6.30	10.38	0 00:02:15
71	OF-36 Dewett Beverage Rear	6.29	49.76	2.40	0.01	0.09	0.01	0 00:06:00
72	OF-37B Putney Rd N of RT 91	2.59	52.59	2.40	0.04	0.10	0.01	0 00:04:01
73	OF-38 Casey Storage Solutions / Old Ferry	5.36	76.51	2.40	0.66	3.52	5.51	0 00:03:32
74	OF-39 Casey Storage Solutions	2.98	88.89	2.40	1.36	4.06	6.84	0 00:02:38
75	OF-4 Fullflex Building	18.12	70.52	2.40	0.43	7.72	10.51	0 00:04:13
76	OF-40 Bennett Drive Industrial Park	21.16	61.10	2.40	0.17	3.58	2.10	0 00:10:07
77	OF-41A ROV Tech	3.28	88.00	2.40	1.30	4.25	7.15	0 00:02:53
78	OF-41B Upper Watershed ROV Tech	11.98	71.42	2.40	0.46	5.47	4.13	0 00:25:58
79	OF-42 Dewett Beverage Trib	13.21	48.37	2.40	0.01	0.08	0.02	0 00:03:52
80	OF-43 Lower Crosby	16.29	35.80	2.40	0.00	0.00	0.00	0 00:15:05

Subbasin Summary - 1 Year - 24 Storm

SN Subbasin ID	Area	Weighted Curve Number	Total Rainfall	Total Runoff	Total Runoff Volume	Peak Runoff	Time of Concentration
	(ac)		(in)	(in)	(ac-in)	(cfs)	(days hh:mm:ss)
81 OF-5 Friendlys	0.88	92.00	2.40	1.60	1.41	2.33	0 00:02:29
82 OF-50 Route 9 to CT River	3.84	72.69	2.40	0.50	1.93	2.82	0 00:03:27
83 OF-51 Bickfords Parking Lot to CT River	0.76	98.00	2.40	2.17	1.66	2.49	0 00:02:33
84 OF-52 Brattleboro Ford to CT River	2.34	89.00	2.40	1.37	3.20	5.43	0 00:02:17
85 OF-6A Dunkin Donuts	0.82	92.00	2.40	1.60	1.31	2.17	0 00:02:39
86 OF-6B Wendy's	1.02	92.00	2.40	1.60	1.63	2.69	0 00:02:45
87 OF-6C Motel 8	1.37	92.00	2.40	1.60	2.20	3.62	0 00:02:50
88 OF-6D McDonalds	0.97	92.00	2.40	1.60	1.55	2.58	0 00:02:12
89 OF-6E KFC Taco Bell	1.00	92.00	2.40	1.60	1.60	2.67	0 00:02:07
90 OF-6F Americas Best Inn	1.83	92.00	2.40	1.60	2.93	4.87	0 00:02:25
91 OF-6G Tourist Shops	2.67	66.10	2.40	0.29	0.77	1.04	0 00:02:25
92 OF-6H VFW & Strip Mall	4.89	92.00	2.40	1.60	7.83	12.57	0 00:04:04
93 OF-6J Cemetary	8.89	36.20	2.40	0.00	0.00	0.00	0 00:27:40
94 OF-7A Bickfords Old Parking	0.80	48.54	2.40	0.00	0.00	0.00	0 00:02:07
95 OF-7B Ninety Nine Rest	2.63	89.00	2.40	1.37	3.60	6.02	0 00:03:01
96 OF-9 Mobile Gas Rear	0.66	89.00	2.40	1.37	0.90	1.54	0 00:02:01

Subbasin Summary - 10 Year - 24 Storm

SN	Subbasin ID	Area	Weighted Curve Number	Total Rainfall	Total Runoff	Total Runoff Volume	Peak Runoff	Time of Concentration
		(ac)		(in)	(in)	(ac-in)	(cfs)	(days hh:mm:ss)
1	BO-OF-13A Current Buttonwood Hill Rd	10.68	35.63	4.10	0.01	0.14	0.02	0 00:18:51
2	BO-OF-13A New Development 7	1.50	51.00	4.10	0.40	0.60	0.48	0 00:11:39
3	BO-OF-13B Current Rear Newspaper	1.47	81.12	4.10	2.22	3.26	5.49	0 00:02:57
4	BO-OF-13B New Development 13	0.42	81.42	4.10	2.24	0.95	1.38	0 00:07:57
5	BO-OF-14 Current Black Mountain Rd Swale	7.05	52.68	4.10	0.47	3.31	3.57	0 00:07:21
6	BO-OF-14 New Development 8	4.94	51.00	4.10	0.40	1.99	1.85	0 00:08:17
7	BO-OF-14 New Development 9	6.12	51.00	4.10	0.40	2.47	2.29	0 00:08:17
8	BO-OF-15 Current Commercial / Industrial	8.73	92.00	4.10	3.21	28.05	44.10	0 00:03:27
9	BO-OF-15 New Development 15	2.58	70.60	4.10	1.44	3.70	5.26	0 00:07:57
10	BO-OF-15B Current Bowling Alley	7.91	72.82	4.10	1.59	12.55	20.66	0 00:03:28
11	BO-OF-15B New Development 14	2.19	70.60	4.10	1.44	3.15	4.47	0 00:07:57
12	BO-OF-15C Current Chickering Drive Upper	0.85	95.60	4.10	3.60	3.05	4.63	0 00:03:00
13	BO-OF-15C Current Putney / Chickering Roads	36.68	64.78	4.10	1.07	39.40	55.64	0 00:06:12
14	BO-OF-15C New Development 6	1.79	81.42	4.10	2.24	4.02	5.85	0 00:07:57
15	BO-OF-22B Upper Watershed Rt 91	6.22	74.50	4.10	1.71	10.61	13.94	0 00:12:21
16	BO-OF-25B Upper Watershed Rt 91	7.30	74.50	4.10	1.71	12.46	16.37	0 00:12:21
17	BO-OF-37A Current Industrial Area	1.13	88.00	4.10	2.82	3.19	5.12	0 00:03:59
18	BO-OF-37A New Development 10	0.77	80.40	4.10	2.16	1.67	2.43	0 00:07:57
19	BO-OF-37A New Development 11	1.36	80.40	4.10	2.16	2.93	4.28	0 00:07:57
20	BO-OF-43 Lower Crosby Current Residential	9.00	40.50	4.10	0.09	0.76	0.08	0 00:08:04
21	BO-OF-43 New Development 12	7.05	51.00	4.10	0.40	2.84	2.64	0 00:08:17
22	BO-OF-6 Current House	2.11	46.00	4.10	0.23	0.48	0.13	0 00:19:50
23	BO-OF-6 New Development 1	1.26	70.60	4.10	1.44	1.81	2.57	0 00:07:57
24	BO-OF-6 New Development 2	2.66	70.60	4.10	1.44	3.81	5.41	0 00:07:57
25	BO-OF-6-Current Putney Road	2.29	86.39	4.10	2.67	6.11	10.11	0 00:02:51
26	BO-OF-6I Front Newspaper	1.14	89.00	4.10	2.92	3.33	5.36	0 00:03:25
27	BO-OF-6I New Development 5	0.55	70.60	4.10	1.44	0.78	1.11	0 00:07:57
28	BO-OF-7 Current Putney Road	3.33	79.59	4.10	2.09	6.97	11.46	0 00:03:51
29	BO-OF-7 New Development 4	5.56	70.60	4.10	1.44	7.98	11.32	0 00:07:57
30	BO-OF-8 Current Citgo Green Light Package Express	2.30	58.40	4.10	0.73	1.68	2.41	0 00:02:25
31	BO-OF-8 New Development 3	2.20	70.60	4.10	1.44	3.16	4.47	0 00:07:57
32	OF-1 Floor Plank	6.66	88.00	4.10	2.82	18.78	30.97	0 00:02:32
33	OF-10 Rt 91 Exit 3 NB Off ramp	2.11	54.08	4.10	0.53	1.12	1.54	0 00:02:12
34	OF-11A Rt 91 NB / S Exit 3 Off ramp	1.32	60.86	4.10	0.86	1.13	1.77	0 00:01:55
35	OF-11B Rt 91 Exit 3 SB On/Off Clover Leaf	9.29	67.37	4.10	1.23	11.43	16.41	0 00:06:36
36	OF-11C Rt 91 Exit 3 SB Overpass	1.85	68.68	4.10	1.31	2.43	3.89	0 00:03:40
37	OF-11D Rt 91 SB / S Exit 3	2.12	40.70	4.10	0.09	0.19	0.02	0 00:03:30
38	OF-11E Upper Watershed RT 91 Clover Leaf	8.13	30.00	4.10	0.00	0.00	0.00	0 00:20:25
39	OF-12 Rt 91 S of Exit 3	5.47	40.32	4.10	0.08	0.44	0.05	0 00:03:33
40	OF-12A Rt 91 N of Black Mt Rd Overpass	4.87	49.90	4.10	0.36	1.76	1.96	0 00:03:35
41	OF-13 Rt 91 S Black Mt Rd Overpass	3.50	74.96	4.10	1.74	6.08	10.07	0 00:03:33
42	OF-13C Comcast	0.67	89.00	4.10	2.92	1.95	3.16	0 00:02:51
43	OF-15A True Value Hardware / Motel	3.10	73.99	4.10	1.67	5.18	8.64	0 00:03:07
44	OF-16A Pizza Hut	1.18	89.00	4.10	2.92	3.44	5.61	0 00:02:40
45	OF-16B Rt 91 Exit 3 NB On ramp	2.44	44.42	4.10	0.18	0.44	0.20	0 00:02:20
46	OF-17 Rt 91 N Exit 3 / Steakout	1.32	58.65	4.10	0.74	0.98	1.36	0 00:03:33
47	OF-18 Steak Out / Mall	1.08	89.00	4.10	2.92	3.14	5.13	0 00:02:39
48	OF-18A Staceys Used Cars	2.63	65.03	4.10	1.09	2.87	4.58	0 00:02:48
49	OF-19 Brattleboro Subaru	1.81	89.00	4.10	2.92	5.27	8.50	0 00:03:31
50	OF-2 Open Space Railroad Bridge	0.87	39.00	4.10	0.06	0.05	0.01	0 00:02:37
51	OF-20A Rt 91 SB Exit Offramp	1.76	67.33	4.10	1.23	2.16	3.54	0 00:02:45
52	OF-20B Upper Watershed Rt 91 Exit 3	29.54	70.00	4.10	1.40	41.27	39.85	0 00:23:42
53	OF-21 Motel 6	1.12	89.00	4.10	2.92	3.27	5.28	0 00:03:16
54	OF-22A Rt 91 N of Exit 3	1.80	73.13	4.10	1.61	2.89	4.76	0 00:03:35
55	OF-23 Motel 6 / Used Car Parking	1.91	91.70	4.10	3.18	6.09	9.72	0 00:02:41
56	OF-24 Cocoplum / Used Car	3.19	86.56	4.10	2.69	8.58	14.13	0 00:03:00
57	OF-25A Rt 91 S of Crosby Crossing	1.58	72.25	4.10	1.55	2.44	4.00	0 00:03:37
58	OF-26A Rt 91 N of Crosby Cross	0.95	63.18	4.10	0.98	0.93	1.44	0 00:03:03
59	OF-26B China Buffet / Motel	4.23	48.81	4.10	0.32	1.36	1.43	0 00:03:19
60	OF-27 Rt 91 N of Crosby Cross	2.39	51.10	4.10	0.41	0.97	1.19	0 00:02:59
61	OF-28A Rt 91 N Exit 3 / E Hampton	2.64	53.97	4.10	0.53	1.39	1.84	0 00:03:06
62	OF-28B Upper Watershed Rt 91	2.67	39.00	4.10	0.06	0.15	0.02	0 00:25:43
63	OF-29 Rt 91 SW of Putney Bridge	6.42	54.54	4.10	0.55	3.53	4.79	0 00:02:45
64	OF-3 Residential	1.25	85.00	4.10	2.55	3.18	5.30	0 00:02:51
65	OF-30 Hampton Inn	2.11	89.00	4.10	2.92	6.16	10.11	0 00:02:20
66	OF-31 Quality Inn	0.88	89.00	4.10	2.92	2.55	4.21	0 00:02:01
67	OF-32 Quality Inn Parking	0.79	89.00	4.10	2.92	2.32	3.80	0 00:02:18
68	OF-33A Old Ferry Industrial	20.87	85.58	4.10	2.60	54.25	86.51	0 00:04:34
69	OF-33B Putney Rd / Old Ferry Intersection	0.20	98.00	4.10	3.86	0.76	1.12	0 00:01:51
70	OF-35 Rt 91 NE of Putney Bridge	9.49	76.68	4.10	1.87	17.71	30.37	0 00:02:15
71	OF-36 Dewett Beverage Rear	6.29	49.76	4.10	0.36	2.24	2.13	0 00:06:00
72	OF-37B Putney Rd N of RT 91	2.59	52.59	4.10	0.47	1.21	1.49	0 00:04:01
73	OF-38 Casey Storage Solutions / Old Ferry	5.36	76.51	4.10	1.85	9.93	16.47	0 00:03:32
74	OF-39 Casey Storage Solutions	2.98	88.89	4.10	2.91	8.67	14.18	0 00:02:38
75	OF-4 Fullflex Building	18.12	70.52	4.10	1.43	25.93	41.24	0 00:04:13
76	OF-40 Bennett Drive Industrial Park	21.16	61.10	4.10	0.87	18.38	23.03	0 00:10:07
77	OF-41A ROV Tech	3.28	88.00	4.10	2.82	9.25	15.16	0 00:02:53
78	OF-41B Upper Watershed ROV Tech	11.98	71.42	4.10	1.49	17.86	16.53	0 00:25:58
79	OF-42 Dewett Beverage Trib	13.21	48.37	4.10	0.31	4.04	3.90	0 00:03:52
80	OF-43 Lower Crosby	16.29	35.80	4.10	0.01	0.23	0.04	0 00:15:05

Subbasin Summary - 10 Year - 24 Storm

SN Subbasin ID	Area	Weighted Curve Number	Total Rainfall	Total Runoff	Total Runoff Volume	Peak Runoff	Time of Concentration
	(ac)		(in)	(in)	(ac-in)	(cfs)	(days hh:mm:ss)
81 OF-5 Friendlys	0.88	92.00	4.10	3.21	2.83	4.49	0 00:02:29
82 OF-50 Route 9 to CT River	3.84	72.69	4.10	1.58	6.06	9.98	0 00:03:27
83 OF-51 Bickfords Parking Lot to CT River	0.76	98.00	4.10	3.87	2.96	4.31	0 00:02:33
84 OF-52 Brattleboro Ford to CT River	2.34	89.00	4.10	2.92	6.82	11.19	0 00:02:17
85 OF-6A Dunkin Donuts	0.82	92.00	4.10	3.21	2.63	4.19	0 00:02:39
86 OF-6B Wendy's	1.02	92.00	4.10	3.21	3.28	5.20	0 00:02:45
87 OF-6C Motel 8	1.37	92.00	4.10	3.21	4.41	6.99	0 00:02:50
88 OF-6D McDonalds	0.97	92.00	4.10	3.21	3.10	4.97	0 00:02:12
89 OF-6E KFC Taco Bell	1.00	92.00	4.10	3.21	3.20	5.14	0 00:02:07
90 OF-6F Americas Best Inn	1.83	92.00	4.10	3.21	5.89	9.39	0 00:02:25
91 OF-6G Tourist Shops	2.67	66.10	4.10	1.15	3.07	5.04	0 00:02:25
92 OF-6H VFW & Strip Mall	4.89	92.00	4.10	3.21	15.72	24.36	0 00:04:04
93 OF-6J Cemetary	8.89	36.20	4.10	0.02	0.16	0.02	0 00:27:40
94 OF-7A Bickfords Old Parking	0.80	48.54	4.10	0.31	0.25	0.28	0 00:02:07
95 OF-7B Ninety Nine Rest	2.63	89.00	4.10	2.92	7.67	12.47	0 00:03:01
96 OF-9 Mobile Gas Rear	0.66	89.00	4.10	2.92	1.92	3.17	0 00:02:01

Subbasin Summary - 100 Year - 24 Storm

SN Subbasin ID	Area (ac)	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
32 OF-1 Floor Plank	6.66	88.00	7.00	5.59	37.23	58.94	0 00:02:32
50 OF-2 Open Space Railroad Bridge	0.87	39.00	7.00	0.77	0.67	0.87	0 00:02:37
64 OF-3 Residential	1.25	85.00	7.00	5.25	6.55	10.54	0 00:02:51
81 OF-5 Friendlys	0.88	92.00	7.00	6.06	5.33	8.13	0 00:02:29
85 OF-6A Small Buisness	0.82	92.00	7.00	6.06	4.95	7.58	0 00:02:39
86 OF-6B Dunkin Donuts	1.02	92.00	7.00	6.06	6.18	9.41	0 00:02:45
87 OF-6C Motel 8	1.37	92.00	7.00	6.06	8.30	12.65	0 00:02:50
88 OF-6D McDonalds	0.97	92.00	7.00	6.06	5.84	8.98	0 00:02:12
89 OF-6E KFC Taco Bell	1.00	92.00	7.00	6.06	6.04	9.28	0 00:02:07
90 OF-6F Americas Best Inn	1.83	92.00	7.00	6.06	11.09	16.97	0 00:02:25
91 OF-6G Tourist Shops	2.67	66.10	7.00	3.22	8.57	14.65	0 00:02:25
92 OF-6H VFW & Strip Mall	4.89	92.00	7.00	6.06	29.62	44.18	0 00:04:04
93 OF-6J Cemetary	8.89	36.20	7.00	0.57	5.09	1.95	0 00:27:40
94 OF-7A Bickfords Old Parking	0.80	48.54	7.00	1.54	1.24	1.95	0 00:02:07
95 OF-7B Ninety Nine Rest	2.63	89.00	7.00	5.71	15.01	23.45	0 00:03:01
96 OF-9 Mobile Gas Rear	0.66	89.00	7.00	5.71	3.77	5.94	0 00:02:01
33 OF-10 Rt 91 Exit 3 NB Off ramp	2.11	54.08	7.00	2.04	4.30	7.15	0 00:02:12
34 OF-11A Rt 91 NB / S Exit 3 Off ramp	1.32	60.86	7.00	2.69	3.55	6.13	0 00:01:55
35 OF-11B Rt 91 Exit 3 SB On/Off Clover Leaf	9.29	67.37	7.00	3.35	31.07	47.00	0 00:06:36
36 OF-11C Rt 91 Exit 3 SB Overpass	1.85	68.68	7.00	3.48	6.43	10.65	0 00:03:40
37 OF-11D Rt 91 SB / S Exit 3	2.12	40.70	7.00	0.90	1.90	2.49	0 00:03:30
38 OF-11E Upper Watershed RT 91 Clover Leaf	8.13	30.00	7.00	0.21	1.72	0.21	0 00:20:25
39 OF-12 Rt 91 S of Exit 3	5.47	40.32	7.00	0.87	4.74	6.13	0 00:03:33
40 OF-12A Rt 91 N of Black MT Rd Overpass	4.87	49.90	7.00	1.66	8.07	12.19	0 00:03:35
41 OF-13 Rt 91 S Black Mt Rd Overpass	3.50	74.96	7.00	4.15	14.50	23.91	0 00:03:33
42 OF-13C Comcast	0.67	89.00	7.00	5.71	3.82	5.95	0 00:02:51
43 OF-15 Commercial / Industrial	3.10	73.99	7.00	4.04	12.53	20.88	0 00:03:07
44 OF-16A Pizza Hut	1.18	89.00	7.00	5.71	6.72	10.54	0 00:02:40
45 OF-16B Rt 91 Exit 3 NB On ramp	2.44	44.42	7.00	1.19	2.90	4.10	0 00:02:20
46 OF-17 Rt 91 N Exit 3 / Steakout	1.32	58.65	7.00	2.47	3.27	5.31	0 00:03:33
47 OF-18 Steak Out / Mall	1.08	89.00	7.00	5.71	6.14	9.63	0 00:02:39
48 OF-18A Staceys Used Cars	2.63	65.03	7.00	3.11	8.17	13.82	0 00:02:48
49 OF-19 Brattleboro Subaru	1.81	89.00	7.00	5.71	10.32	16.01	0 00:03:31
51 OF-20A Rt 91 SB Exit Offramp	1.76	67.33	7.00	3.34	5.87	9.97	0 00:02:45
52 OF-20B Upper Watershed Rt 91 Exit 3	29.54	70.00	7.00	3.62	106.89	108.09	0 00:23:42
53 OF-21 Motel 6	1.12	89.00	7.00	5.71	6.40	9.94	0 00:03:16
54 OF-22A Rt 91 N of Exit 3	1.80	73.13	7.00	3.95	7.10	11.73	0 00:03:35
55 OF-23 Motel 6 / Used Car Parking	1.91	91.70	7.00	6.02	11.52	17.65	0 00:02:41
56 OF-24 Cocoplum / Used Car	3.19	86.56	7.00	5.43	17.32	27.50	0 00:03:00
57 OF-25A Rt 91 S of Crosby Crossing	1.58	72.25	7.00	3.86	6.09	10.07	0 00:03:37
58 OF-26A Rt 91 N of Crosby Cross	0.95	63.18	7.00	2.92	2.77	4.64	0 00:03:03
59 OF-26B China Buffet / Motel	4.23	48.81	7.00	1.56	6.61	9.92	0 00:03:19
60 OF-27 Rt 91 N of Crosby Cross	2.39	51.10	7.00	1.77	4.22	6.62	0 00:02:59
61 OF-28A Rt 91 N Exit 3 / E Hampton	2.64	53.97	7.00	2.03	5.35	8.62	0 00:03:06
62 OF-28B Upper Watershed Rt 91	2.67	39.00	7.00	0.77	2.05	1.09	0 00:25:43
63 OF-29 Rt 91 SW of Putney Bridge	6.42	54.54	7.00	2.08	13.35	21.86	0 00:02:45
65 OF-30 Hampton Inn	2.11	89.00	7.00	5.71	12.06	18.98	0 00:02:20
66 OF-31 Quality Inn	0.88	89.00	7.00	5.71	5.00	7.90	0 00:02:01
67 OF-32 Quality Inn Parking	0.79	89.00	7.00	5.71	4.54	7.13	0 00:02:18
68 OF-33A Old Ferry Industrial	20.87	85.58	7.00	5.32	111.00	171.52	0 00:04:34
69 OF-33B Putney Rd / Old Ferry Intersection	0.20	98.00	7.00	6.76	1.34	1.91	0 00:01:51
70 OF-35 Rt 91 NE of Putney Bridge	9.49	76.68	7.00	4.33	41.09	69.23	0 00:02:15
71 OF-36 Dewett Beverage Rear	6.29	49.76	7.00	1.65	10.34	14.28	0 00:06:00
72 OF-37B Putney Rd N of RT 91	2.59	52.59	7.00	1.90	4.92	7.56	0 00:04:01
73 OF-38 Casey Storage Solutions / Old Ferry	5.36	76.51	7.00	4.31	23.11	37.97	0 00:03:32
74 OF-39 Casey Storage Solutions	2.98	88.89	7.00	5.70	16.99	26.68	0 00:02:38
76 OF-40 Bennett Drive Industrial Park	21.16	61.10	7.00	2.71	57.38	78.68	0 00:10:07
77 OF-41A ROV Tech	3.28	88.00	7.00	5.59	18.33	28.89	0 00:02:53
78 OF-41B Upper Watershed ROV Tech	11.98	71.42	7.00	3.77	45.12	43.39	0 00:25:58
79 OF-42 Dewett Beverage Trib	13.21	48.37	7.00	1.52	20.12	29.24	0 00:03:52
80 OF-43 Lower Crosby	16.29	35.80	7.00	0.55	8.90	4.67	0 00:15:05
75 OF-4 Fulflex Building	18.12	70.52	7.00	3.67	66.55	108.37	0 00:04:13

Subbasin Summary - 100 Year - 24 Storm

SN Subbasin ID	Area (ac)	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
82 OF-50 Route 9 to CT River	3.84	72.69	7.00	3.90	14.99	24.84	0 00:03:27
83 OF-51 Bickfords Parking Lot to CT River	0.76	98.00	7.00	6.76	5.17	7.39	0 00:02:33
84 OF-52 Brattleboro Ford to CT River	2.34	89.00	7.00	5.71	13.35	21.00	0 00:02:17
1 BO-OF-13A Current Buttonwood Hill Rd	10.68	35.63	7.00	0.54	5.71	2.54	0 00:18:51
2 BO-OF-13A New Development 7	1.50	51.00	7.00	1.76	2.63	3.29	0 00:11:39
3 BO-OF-13B Current Rear Newspaper	1.47	81.12	7.00	4.82	7.09	11.62	0 00:02:57
4 BO-OF-13B New Development 13	0.42	81.42	7.00	4.85	2.06	2.93	0 00:07:57
5 BO-OF-14 Current Black Mountain Rd Swale	7.05	52.68	7.00	1.91	13.46	18.63	0 00:07:21
6 BO-OF-14 New Development 8	4.94	51.00	7.00	1.76	8.68	11.71	0 00:08:17
7 BO-OF-14 New Development 9	6.12	51.00	7.00	1.76	10.75	14.50	0 00:08:17
8 BO-OF-15 Current Commercial / Industrial	8.73	92.00	7.00	6.06	52.84	79.89	0 00:03:27
9 BO-OF-15 New Development 15	2.58	70.60	7.00	3.68	9.49	13.83	0 00:07:57
10 BO-OF-15B Current Bowling Alley	7.91	72.82	7.00	3.92	30.96	51.30	0 00:03:28
11 BO-OF-15B New Development 14	2.19	70.60	7.00	3.68	8.08	11.77	0 00:07:57
12 BO-OF-15C Current Chickering Drive Upper	0.85	95.60	7.00	6.48	5.50	8.07	0 00:03:00
13 BO-OF-15C Current Putney / Chickering Roads	36.68	64.78	7.00	3.08	112.99	172.09	0 00:06:12
14 BO-OF-15C New Development 6	1.79	81.42	7.00	4.85	8.71	12.45	0 00:07:57
15 BO-OF-22B Upper Watershed Rt 91	6.22	74.50	7.00	4.10	25.49	33.53	0 00:12:21
16 BO-OF-25B Upper Watershed Rt 91	7.30	74.50	7.00	4.10	29.91	39.36	0 00:12:21
17 BO-OF-37A Current Industrial Area	1.13	88.00	7.00	5.59	6.32	9.78	0 00:03:59
18 BO-OF-37A New Development 10	0.77	80.40	7.00	4.74	3.66	5.27	0 00:07:57
19 BO-OF-37A New Development 11	1.36	80.40	7.00	4.74	6.45	9.28	0 00:07:57
20 BO-OF-43 Lower Crosby Current Residential	9.00	40.50	7.00	0.88	7.92	8.69	0 00:08:04
21 BO-OF-43 New Development 12	7.05	51.00	7.00	1.76	12.39	16.70	0 00:08:17
22 BO-OF-6 Current House	2.11	46.00	7.00	1.32	2.79	2.50	0 00:19:50
23 BO-OF-6 New Development 1	1.26	70.60	7.00	3.68	4.64	6.76	0 00:07:57
24 BO-OF-6 New Development 2	2.66	70.60	7.00	3.68	9.77	14.24	0 00:07:57
25 BO-OF-6-Current Putney Road	2.29	86.39	7.00	5.41	12.37	19.71	0 00:02:51
26 BO-OF-6I Front Newspaper	1.14	89.00	7.00	5.71	6.52	10.08	0 00:03:25
27 BO-OF-6I New Development 5	0.55	70.60	7.00	3.68	2.01	2.92	0 00:07:57
28 BO-OF-7 Current Putney Road	3.33	79.59	7.00	4.65	15.48	25.01	0 00:03:51
29 BO-OF-7 New Development 4	5.56	70.60	7.00	3.68	20.46	29.78	0 00:07:57
30 BO-OF-8 Current Citgo Green Light Package Express	2.30	58.40	7.00	2.45	5.63	9.49	0 00:02:25
31 BO-OF-8 New Development 3	2.20	70.60	7.00	3.68	8.09	11.77	0 00:07:57

Appendix C
STP Ranking Analysis
Spreadsheet Outputs

APPENDIX C - STP OPTIONS - RANKING SUMMARY TABLE																													
STP ID	Sub-basins Handled (Outfall I.D.)	Sub-basin Areas (acres)	Percent Impervious (%)	WQv Target (cu.ft.)	Rev Target (cu.ft.)	CPv Target (cu.ft.)	OBv Target (cu.ft.)	STP Max Volume (cu.ft.)	TSS Removal (cu.ft.)	STP Total Costs (\$)	STP Maintenance (\$)	STP Total 10 yr Costs (\$)	Proximity to Brook	Direct / Indirect Discharge	Impervious Area %	Ease of Implementation	Land Owner	Land Use	Potential STP Storm Size	Potential STP Recharge	Sediment Removal	STP Costs	Permit Requirements	Maintenance Requirements / Access	Priority Points	RANK	TSS Removal (lbs)	10 Yr TSS Removal (tons)	Cost / TSS Removal (\$/ton)
1-1	6, 6D, 6E, 6F, 15	13.4	67%	28,700	11,000	37,800	83,100	83,250	340	\$659,996	\$3,400	\$693,996	5	2	3	3	1	4	3	4	6	1	3	3	38	1	30,600	153	\$4,536
1-4	7, 7A	7.3	56%	13,200	5,900	9,100	26,200	26,400	110	\$215,259	\$2,000	\$235,259	2	4	3	5	2	4	3	3	3	3	2	3	37	2	9,900	50	\$4,753
1-2	6, 6H, 6I, 6J	16.2	36%	19,650	6,200	23,300	54,400	54,800	135	\$296,859	\$3,100	\$327,859	5	2	2	5	2	2.5	3	3	3	2.5	3	2	35	3	12,150	61	\$5,397
2-1	13, 13B, 13C	5.6	56%	10,100	3,100	9,900	26,000	25,800	87	\$137,707	\$2,400	\$161,707	3	4	3	5	3	3	2	2	2	3.5	2	1	33.5	4	7,830	39	\$4,130
1-8	7, 18, 18A, 19	8.6	63%	17,300	7,900	12,800	35,300	48,750	125	\$397,002	\$3,100	\$428,002	1	4	3	5	1	4	3	3	3	2	2	2	33	5	11,250	56	\$7,609
1-7	7, 18, 19, 21, 23	9.5	69%	20,850	8,900	19,800	49,400	50,500	170	\$427,785	\$3,200	\$459,785	5	2	3	1	2	3.5	3	3	4	2	3	1	32.5	6	15,300	77	\$6,010
1-10	33A, 33B	21.1	68%	45,800	13,200	56,200	130,600	94,500	170	\$219,219	\$5,200	\$271,219	5	2	3	1	2	3.5	1	4	4	3	2	2	32.5	7	15,300	77	\$3,545
1-6	7	4.4	61%	8,500	3,900	6,300	17,700	26,800	84	\$201,920	\$2,400	\$225,920	3	2	3	3	1	4	3	2	2	3	3	3	32	8	7,560	38	\$5,977
2-3B	11B, 11C, 11D	13.3	14%	7,700	2,200	8,400	34,000	48,600	93	\$223,600	\$3,800	\$261,600	4	2	1	5	3	2	3	2	2	3	2	3	32	9	8,370	42	\$6,251
1-3	1, 3, 5, 6, 6A, 6B, 6C, 8	13.0	56%	23,650	7,550	27,100	63,000	62,900	190	\$500,085	\$2,600	\$526,085	2	4	3	3	1	3.5	2	3	4	1	2	3	31.5	10	17,100	86	\$6,153
1-13	6, 6H & 15C	16.4	54%	28,600	11,700	24,500	36,200	28,850	118	\$429,500	\$3,900	\$468,500	5	2	3	1	3	3	1	4	3	1.5	3	2	31.5	11	10,620	53	\$8,823
1-9	23, 24, 26A, 26B	10.0	56%	18,000	4,800	16,300	39,500	38,000	138	\$319,119	\$2,100	\$340,119	1	4	3	5	2	3	1	2	3	2.5	1	3	30.5	12	12,420	62	\$5,477
1-11B	37, A, 37B, 41A, 41B	19.3	32%	21,100	5,600	27,100	78,000	78,000	112	\$350,907	\$3,300	\$383,907	5	2	2	3	2	3.5	2	3	3	2	1	2	30.5	13	10,080	50	\$7,617
2-4	20A, 22A, 22B, 25A, 25B	5.9	25%	5,200	1,400	6,700	21,300	25,500	68	\$125,930	\$2,400	\$149,930	4	4	1	5	3	2	3	1	2	3.5	1	1	30.5	14	6,120	31	\$4,900
1-5	8, 9	1.7	32%	1,900	800	2,000	5,650	5,640	18	\$59,274	\$1,300	\$72,274	1	4	2	5	1	4	2	1	1	4.5	1	3	29.5	15	1,620	8	\$8,923
2-5	27, 28A, 28B, 30	8.8	23%	7,400	3,000	3,800	13,300	15,200	58	\$129,996	\$2,000	\$149,996	2	4	1	3	3	2	3	2	2	3.5	1	3	29.5	16	5,220	26	\$5,747
2-7	35	9.5	29%	9,750	2,550	14,700	42,050	42,300	123	\$280,020	\$3,300	\$313,020	5	2	2	3	3	2	2	2	3	2.5	1	2	29.5	17	11,070	55	\$5,655
2-6	29, 32, 38, 39	15.6	49%	24,750	6,850	21,000	58,050	32,500	172	\$166,441	\$3,100	\$197,441	3	2	2	3	3	3	1	3	4	3	1	1	29	18	15,480	77	\$2,551
1-11A	37A, 40	20.5	19%	14,650	3,500	7,900	43,650	34,500	80	\$167,911	\$2,300	\$190,911	4	2	1	5	1	3.5	1	2	2	3	1	3	28.5	19	7,200	36	\$5,303
2-2	12, 12A, 13A	22.5	16%	14,000	5,050	300	6,700	12,900	136	\$128,846	\$3,000	\$158,846	2	2	1	3	3	1.5	3	3	3	3.5	1	2	28	20	12,240	61	\$2,596
2-3A	10, 11A, 16B, 17	6.5	25%	5,800	2,350	900	7,400	8,100	78	\$164,974	\$2,600	\$190,974	1	4	1	3	3	2	3	2	2	3	1	2	27	21	7,020	35	\$5,441
1-12	14	18.1	25%	16,500	6,600	1,300	17,800	17,800	87	\$184,556	\$2,100	\$205,556	1	4	1	1	2	1	2	3	2	3	2	2	24	22	7,830	39	\$5,250

Explanation of Ranking:
Proximity to Brook: Within 50 feet = 1 ; 51 feet - 100 feet = 2 ; 101 - 200 feet = 3 ; 201 - 300 feet = 4 ; 300+ feet = 5
Direct / Indirect Discharge: Direct = 4 ; Indirect = 2
Impervious Area %: 76% - 100% = 4 ; 51% - 75% = 3 ; 26% - 50% = 2 ; 0% - 25% = 1
Ease of Implementation: Easy, low number of issues = 5 ; Moderate, possible equipment maneuvering/ access issues = 3 ; Difficult, expensive equipment maneuvering/ road closures = 1
Land Owner: Town / State Owned (no easements) = 3 ; Partially Town / State / Private Owned (potential easement) = 2 ; Private only (easement needed) = 1
Land Use: Commercial / Industrial = 3.5 ; Commercial / Highway = 3 ; Industrial / Highway = 2.5 ; Commercial / Residential = 2.5 ; Residential / Highway = 1.5 ; Commercial = 4 ; Industrial = 3 ; Highway = 2 ; Residential/Forested = 1
Potential STP Storm Size: 10yr -24hr plus = 3 ; 10yr -24hr = 2 ; under 10yr -24hr = 1 ; No STP = 0
Potential STP Recharge: 15,000 CF plus = 5 ; 10,000 - 14,999 CF = 4 ; 5,000 - 9,999 CF = 3 ; 2,000 - 4,999 CF = 2 ; <2,000 CF = 1 ; No STP = 0
Sediment Removal: 250 cf plus = 6 ; 200 - 249 cf = 5 ; 150 - 199 cf = 4 ; 100 - 149 = 3 ; 50 - 99 = 2 ; 0 - 49 = 1 ; No STP = 0
STP Cost: \$550,000 plus = 1 ; \$450,000 - \$549,999 = 1.5 ; \$350,000 - \$449,999 = 2 ; \$250,000 - \$349,999 = 2.5 ; \$150,000 - \$249,999 = 3 ; \$125,000 - \$149,999 = 3.5 ; \$75,000 - \$124,999 = 4 ; \$74,999 and less = 4.5
Permit Requirements: No Permit Needed = 3 ; Possible Permit Needed = 2 ; Definitely Permit Needed = 1
Maintenance Requirements: Low frequency, easy access, easy tasks = 3 ; Moderate frequency, access issues, several tasks = 2 ; High frequency, difficult to access w/ equipment = 1

APPENDIX C - STP OPTIONS - RANKING SUMMARY TABLE BY AREA

STP ID	Sub-basins Handled (Outfall I.D.)	Sub-basin Areas (acres)	Percent Impervious (%)	WQV Target (cu.ft.)	REV Target (cu.ft.)	CPV Target (cu.ft.)	OBV Target (cu.ft.)	STP Max Volume (cu.ft.)	TSS Removal (cu.ft.)	STP Total Costs (\$)	STP Maintenance (\$)	STP Total 10 yr Costs (\$)	Proximity to Brook	Direct / Indirect Discharge	Impervious Area %	Ease of Implementation	Land Owner	Land Use	Potential STP Storm Size	Potential STP Recharge	Sediment Removal	STP Costs	Permit Requirements	Maintenance Requirements / Access	Priority Points	RANK	TSS Removal (lbs)	10 Yr TSS Removal (tons)	Cost / TSS Removal (\$/ton)
1-1	6, 6D, 6E, 6F, 15	13.4	67%	28,700	11,000	37,800	83,100	83,250	340	\$659,996	\$3,400	\$693,996	5	2	3	3	1	4	3	4	6	1	3	3	38	1	30,600	153	\$4,536
1-4	7, 7A	7.3	56%	13,200	5,900	9,100	26,200	26,400	110	\$215,259	\$2,000	\$235,259	2	4	3	5	2	4	3	3	3	3	2	3	37	2	9,900	50	\$4,753
1-2	6, 6H, 6I, 6J	16.2	36%	19,650	6,200	23,300	54,400	54,800	135	\$296,859	\$3,100	\$327,859	5	2	2	5	2	2.5	3	3	3	2.5	3	2	35	3	12,150	61	\$5,397
1-8	7, 18, 18A, 19	8.6	63%	17,300	7,900	12,800	35,300	48,750	125	\$397,002	\$3,100	\$428,002	1	4	3	5	1	4	3	3	3	2	2	2	33	4	11,250	56	\$7,609
1-7	7, 18, 19, 21, 23	9.5	69%	20,850	8,900	19,800	49,400	50,500	170	\$427,785	\$3,200	\$459,785	5	2	3	1	2	3.5	3	3	4	2	3	1	32.5	5	15,300	77	\$6,010
1-10	33A, 33B	21.1	68%	45,800	13,200	56,200	130,600	94,500	170	\$219,219	\$5,200	\$271,219	5	2	3	1	2	3.5	1	4	4	3	2	2	32.5	6	15,300	77	\$3,545
1-6	7	4.4	61%	8,500	3,900	6,300	17,700	26,800	84	\$201,920	\$2,400	\$225,920	3	2	3	3	1	4	3	2	2	3	3	3	32	7	7,560	38	\$5,977
1-3	1, 3, 5, 6, 6A, 6B, 6C, 8	13.0	56%	23,650	7,550	27,100	63,000	62,900	190	\$500,085	\$2,600	\$526,085	2	4	3	3	1	3.5	2	3	4	1	2	3	31.5	8	17,100	86	\$6,153
1-13	6, 6H & 15C	16.4	54%	28,600	11,700	24,500	36,200	28,850	118	\$429,500	\$3,900	\$468,500	5	2	3	1	3	3	1	4	3	1.5	3	2	31.5	9	10,620	53	\$8,823
1-9	23, 24, 26A, 26B	10.0	56%	18,000	4,800	16,300	39,500	38,000	138	\$319,119	\$2,100	\$340,119	1	4	3	5	2	3	1	2	3	2.5	1	3	30.5	10	12,420	62	\$5,477
1-11B	37, A, 37B, 41A, 41B	19.3	32%	21,100	5,600	27,100	78,000	78,000	112	\$350,907	\$3,300	\$383,907	5	2	2	3	2	3.5	2	3	3	2	1	2	30.5	11	10,080	50	\$7,617
1-5	8, 9	1.7	32%	1,900	800	2,000	5,650	5,640	18	\$59,274	\$1,300	\$72,274	1	4	2	5	1	4	2	1	1	4.5	1	3	29.5	12	1,620	8	\$8,923
1-11A	37A, 40	20.5	19%	14,650	3,500	7,900	43,650	34,500	80	\$167,911	\$2,300	\$190,911	4	2	1	5	1	3.5	1	2	2	3	1	3	28.5	13	7,200	36	\$5,303
1-12	14	18.1	25%	16,500	6,600	1,300	17,800	17,800	87	\$184,556	\$2,100	\$205,556	1	4	1	1	2	1	2	3	2	3	2	2	24	14	7,830	39	\$5,250
2-1	13, 13B, 13C	5.6	56%	10,100	3,100	9,900	26,000	25,800	87	\$137,707	\$2,400	\$161,707	3	4	3	5	3	3	2	2	2	3.5	2	1	33.5	1	7,830	39	\$4,130
2-3B	11B, 11C, 11D	13.3	14%	7,700	2,200	8,400	34,000	48,600	93	\$223,600	\$3,800	\$261,600	4	2	1	5	3	2	3	2	2	3	2	3	32	2	8,370	42	\$6,251
2-4	20A, 22A, 22B, 25A, 25B	5.9	25%	5,200	1,400	6,700	21,300	25,500	68	\$125,930	\$2,400	\$149,930	4	4	1	5	3	2	3	1	2	3.5	1	1	30.5	3	6,120	31	\$4,900
2-5	27, 28A, 28B, 30	8.8	23%	7,400	3,000	3,800	13,300	15,200	58	\$129,996	\$2,000	\$149,996	2	4	1	3	3	2	3	2	2	3.5	1	3	29.5	4	5,220	26	\$5,747
2-7	35	9.5	29%	9,750	2,550	14,700	42,050	42,300	123	\$280,020	\$3,300	\$313,020	5	2	2	3	3	2	2	2	3	2.5	1	2	29.5	5	11,070	55	\$5,655
2-6	29, 32, 38, 39	15.6	49%	24,750	6,850	21,000	58,050	32,500	172	\$166,441	\$3,100	\$197,441	3	2	2	3	3	3	1	3	4	3	1	1	29	6	15,480	77	\$2,551
2-2	12, 12A, 13A	22.5	16%	14,000	5,050	300	6,700	12,900	136	\$128,846	\$3,000	\$158,846	2	2	1	3	3	1.5	3	3	3	3.5	1	2	28	7	12,240	61	\$2,596
2-3A	10, 11A, 16B, 17	6.5	25%	5,800	2,350	900	7,400	8,100	78	\$164,974	\$2,600	\$190,974	1	4	1	3	3	2	3	2	2	3	1	2	27	8	7,020	35	\$5,441

Explanation of Ranking:
Proximity to Brook: Within 50 feet = 1; 51 feet - 100 feet = 2; 101 - 200 feet = 3; 201 - 300 feet = 4; 300+ feet = 5
Direct / Indirect Discharge: Direct = 4; Indirect = 2
Impervious Area %: 76% - 100% = 4; 51% - 75% = 3; 26% - 50% = 2; 0% - 25% = 1
Ease of Implementation: Easy, low number of issues = 5; Moderate, possible equipment maneuvering/ access issues = 3; Difficult, expensive equipment maneuvering/ road closures = 1
Land Owner: Town / State Owned (no easements) = 3; Partially Town / State / Private Owned (potential easement) = 2; Private only (easement needed) = 1
Land Use: Commercial / Industrial = 3.5; Commercial / Highway = 3; Industrial / Highway = 2.5; Commercial / Residential = 2.5; Residential / Highway = 1.5; Commercial = 4; Industrial = 3; Highway = 2; Residential/Forested = 1
Potential STP Storm Size: 10yr -24hr plus = 3; 10yr -24hr = 2; under 10yr -24hr = 1; No STP = 0
Potential STP Recharge: 15,000 CF plus = 5; 10,000 - 14,999 CF = 4; 5,000 - 9,999 CF = 3; 2,000 - 4,999 CF = 2; <2,000 CF = 1; No STP = 0
Sediment Removal: 250 cf plus = 6; 200 - 249 cf = 5; 150 - 199 cf = 4; 100 - 149 = 3; 50 - 99 = 2; 0 - 49 = 1; No STP = 0
STP Cost: \$550,000 plus = 1; \$450,000 - \$549,999 = 1.5; \$350,000 - \$449,999 = 2; \$250,000 - \$349,999 = 2.5; \$150,000 - \$249,999 = 3; \$125,000 - \$149,999 = 3.5; \$75,000 - \$124,999 = 4; \$74,999 and less = 4.5
Permit Requirements: No Permit Needed = 3; Possible Permit Needed = 2; Definitely Permit Needed = 1
Maintenance Requirements: Low frequency, easy access, easy tasks = 3; Moderate frequency, access issues, several tasks = 2; High frequency, difficult to access w/ equipment = 1

Appendix D
STP Costing Details

APPENDIX D - STP OPTIONS - COST SUMMARY TABLE																					
STP ID	Sub-basins Handled (Outfall I.D.)	Sub-basin Areas (acres)	STP Max Volume (cu.ft.)	STP Area	Pipe Length	Pipe Cost	Number of Structures	Structure Cost	Pond Install	Add Excavation	Excav Cost	Added Costs	STP Const Cost (\$)	Survey	Permitting	Engineering	Bid / Construction	Engineering Total Costs (\$)	STP Total Costs (\$)	STP Maintenance (\$)	STP Total 10 yr Costs (\$)
1-1	6, 6D, 6E, 6F, 15	13.4	83,250	20,500	1,200	\$180,000	15	\$52,500	\$166,500	5,125	\$3,796	\$80,600	\$483,396	\$7,400	\$0	\$96,700	\$72,500	\$176,600	\$659,996	\$3,400	\$693,996
1-2	6, 6H, 6I, 6J	16.2	54,800	18,250	300	\$45,000	5	\$17,500	\$109,600	9,125	\$6,759	\$35,800	\$214,659	\$7,100	\$0	\$42,900	\$32,200	\$82,200	\$296,859	\$3,100	\$327,859
1-3	1, 3, 5, 6, 6A, 6B, 6C, 8	13.0	62,900	14,000	950	\$142,500	8	\$28,000	\$125,800	7,000	\$5,185	\$60,300	\$361,785	\$6,600	\$5,000	\$72,400	\$54,300	\$138,300	\$500,085	\$2,600	\$526,085
1-4	7, 7A	7.3	26,400	8,800	350	\$52,500	5	\$17,500	\$52,800	4,400	\$3,259	\$25,200	\$151,259	\$6,000	\$5,000	\$30,300	\$22,700	\$64,000	\$215,259	\$2,000	\$235,259
1-5	8, 9	1.7	5,640	2,900	50	\$5,000	2	\$7,000	\$14,100	1,450	\$1,074	\$5,400	\$32,574	\$5,300	\$10,000	\$6,500	\$4,900	\$26,700	\$59,274	\$1,300	\$72,274
1-6	7	4.4	26,800	11,800	325	\$48,750	4	\$14,000	\$53,600	5,900	\$4,370	\$24,100	\$144,820	\$6,400	\$0	\$29,000	\$21,700	\$57,100	\$201,920	\$2,400	\$225,920
1-7	7, 18, 19, 21, 23	9.5	50,500	19,400	800	\$120,000	9	\$31,500	\$101,000	9,700	\$7,185	\$51,900	\$311,585	\$7,200	\$0	\$62,300	\$46,700	\$116,200	\$427,785	\$3,200	\$459,785
1-8	7, 18, 18A, 19	8.6	48,750	18,500	725	\$108,750	7	\$24,500	\$97,500	9,250	\$6,852	\$47,500	\$285,102	\$7,100	\$5,000	\$57,000	\$42,800	\$111,900	\$397,002	\$3,100	\$428,002
1-9	23, 24, 26A, 26B	10.0	38,000	9,500	600	\$90,000	5	\$17,500	\$76,000	4,750	\$3,519	\$37,400	\$224,419	\$6,100	\$10,000	\$44,900	\$33,700	\$94,700	\$319,119	\$2,100	\$340,119
1-10	33A, 33B	21.1	94,500	36,500	100	\$10,000	4	\$14,000	\$89,000	18,250	\$13,519	\$25,300	\$151,819	\$9,200	\$5,000	\$30,400	\$22,800	\$67,400	\$219,219	\$5,200	\$271,219
1-11A	37A, 40	20.5	34,500	11,100	100	\$10,000	3	\$10,500	\$69,000	5,550	\$4,111	\$18,700	\$112,311	\$6,300	\$10,000	\$22,500	\$16,800	\$55,600	\$167,911	\$2,300	\$190,911
1-11B	37, A, 37B, 41A, 41B	19.3	78,000	20,000	250	\$25,000	5	\$17,500	\$156,000	10,000	\$7,407	\$41,200	\$247,107	\$7,300	\$10,000	\$49,400	\$37,100	\$103,800	\$350,907	\$3,300	\$383,907
1-12	14	18.1	17,800	9,600	300	\$45,000	4	\$14,000	\$44,500	4,800	\$3,556	\$21,400	\$128,456	\$6,100	\$5,000	\$25,700	\$19,300	\$56,100	\$184,556	\$2,100	\$205,556
1-13	6, 6H & 15C	16.4	28,850	25,700	800	\$120,000	20	\$70,000	\$57,700	12,850	\$9,519	\$51,400	\$308,619	\$7,900	\$5,000	\$61,700	\$46,300	\$120,900	\$429,500	\$3,900	\$468,500
2-1	13, 13B, 13C	5.6	25,800	11,900	150	\$15,000	2	\$7,000	\$51,600	5,950	\$4,407	\$15,600	\$93,607	\$6,400	\$5,000	\$18,700	\$14,000	\$44,100	\$137,707	\$2,400	\$161,707
2-2	12, 12A, 13A	22.5	12,900	17,000	200	\$20,000	3	\$10,500	\$32,250	8,500	\$6,296	\$13,800	\$82,846	\$7,000	\$10,000	\$16,600	\$12,400	\$46,000	\$128,846	\$3,000	\$158,846
2-3A	10, 11A, 16B, 17	6.5	8,100	13,700	325	\$48,750	5	\$17,500	\$20,250	6,850	\$5,074	\$18,300	\$109,874	\$6,600	\$10,000	\$22,000	\$16,500	\$55,100	\$164,974	\$2,600	\$190,974
2-3B	11B, 11C, 11D	13.3	48,600	24,300	100	\$10,000	4	\$14,000	\$97,200	12,150	\$9,000	\$26,000	\$156,200	\$7,800	\$5,000	\$31,200	\$23,400	\$67,400	\$223,600	\$3,800	\$261,600
2-4	20A, 22A, 22B, 25A, 25B	5.9	25,500	12,500	50	\$5,000	2	\$7,000	\$51,000	6,250	\$4,630	\$13,500	\$81,130	\$6,400	\$10,000	\$16,200	\$12,200	\$44,800	\$125,930	\$2,400	\$149,930
2-5	27, 28A, 28B, 30	8.8	15,200	8,900	150	\$15,000	4	\$14,000	\$38,000	4,450	\$3,296	\$14,100	\$84,396	\$6,000	\$10,000	\$16,900	\$12,700	\$45,600	\$129,996	\$2,000	\$149,996
2-6	29, 32, 38, 39	15.6	32,500	18,200	100	\$10,000	3	\$10,500	\$65,000	9,100	\$6,741	\$18,400	\$110,641	\$7,100	\$10,000	\$22,100	\$16,600	\$55,800	\$166,441	\$3,100	\$197,441
2-7	35	9.5	42,300	19,900	375	\$56,250	4	\$14,000	\$84,600	9,950	\$7,370	\$32,400	\$194,620	\$7,300	\$10,000	\$38,900	\$29,200	\$85,400	\$280,020	\$3,300	\$313,020

Explanation of Calculations:

STP Construction Cost Estimate: Based on a combination of drainage piping, drainage structures, STP installation, additional excavation costs, potential rock excavation and supplemental costs

Pipe Costs: Linear feet of pipe times \$75/lf pipe between 0-500 ft; \$100/lf between 500 - 1000 ft; and \$150/lf for lengths over 1000 feet

Structure Costs: Number of drainage structures needed times \$2,500 per structure

STP Installation Costs: Cost to represent excavation, stabilization and installation of all standard stormwater treatment pond components: Pond Volume times \$1.50/ cu.ft. for ponds less than 100,000 cu.ft. and \$0.80 / cu.ft. for ponds larger than 100,000 cu.ft.

Additional Excavation Costs: Cost per cubic yard to excavate existing terrain beyond the volume required for the pond. Estimated based on area of pond and approximate cut depths to level the area prior to pond installation

Potential Rock/ Ledge Excavation Costs: Cost per cubic foot to excavate rock and ledge that could be encountered during all excavations times \$5 per cubic foot of rock. Estimated based on volume of pond and volume of extra earth excavation assuming approximate ledge depths and percentage of total excavation depths

Supplemental Costs: Costs carried for supplemental work that would be required for a specific STP or location. Additional costs include liners for ponds close to reservoir, road re-grading, bridge retrofits, underground tanks, utility relocations and intercept swales to redirect additional runoff around STPs

STP Engineering Cost Estimate: Based on a combination of survey, permitting and engineering/design cost estimates

Survey Costs: Based on estimates to obtain topographic survey for design and permitting. Cost includes a rough base price plus a cost per acre based on the footprint of the STP

Permitting Costs: Based on estimates to perform STP permitting for NOI and supplemental local permitting. Costs based on historical data and past experience and depend on potential impacts to the reservoir, wetland area, surface water resources and applicable buffers.

Engineering Costs: Based on estimates to complete design, plans and specifications ready for bidding. Based on a combination of historical data, an approximate 20% of construction budget and previous design project experience. Costs do not include bidding and construction based services.

STP Total Cost Estimate: Based on the combination of total construction costs plus engineering costs

APPENDIX D - PROJECT AREA 3 - STP OPTIONS - COST SUMMARY																									
STP ID	STP Type	Location Description of STP	Environmental Permitting Required	Road or Slope Length (ft.)	Road or Slope Width (ft.)	Road or Slope Area (sq.ft.)	Culvert Length (ft.)	Culvert Opening (ft. x ft.)	Culvert Cost (\$)	Number of Structures (#)	Structure Cost (\$)	STP Install (\$)	STP Materials (\$)	Additional Excav / Prep/ Clearing (\$)	Construction Contingency Costs (30%) (\$)	STP Const. Cost (\$)	Survey Costs (\$)	Permit Costs (\$)	Engineering Costs (\$)	Bid / Construct Oversight (\$)	Engineering Total Costs (\$)	STP Total Costs (\$)			
1	Stabilize Steep Slopes	Mass Slope Failure Southern Fork near Black Mtn. Rd - Repair erosion & stabilize slope	Definite	100.0	75.0	7500.0			\$0		\$0	\$15,000	\$22,500	\$7,500	\$13,500	\$58,500	\$3,900	\$8,000	\$11,700	\$5,900	\$29,500	\$88,000			
2	Streambank Stabilization	Steep Slope Failure Northern Fork near Route 91 northbound - Repair erosion & stabilize banks	Definite	100.0	30.0	3000.0			\$0		\$0	\$9,000	\$13,500	\$3,000	\$7,700	\$33,200	\$3,300	\$8,000	\$6,600	\$3,300	\$21,200	\$54,400			
3	Streambank Stabilization	Mass Slope Failure Northern Fork along Route 91 southbound right of way - Repair erosion & stabilize banks	Definite	75.0	50.0	3750.0			\$0		\$0	\$11,250	\$16,875	\$3,750	\$9,600	\$41,475	\$3,400	\$8,000	\$8,300	\$4,100	\$23,800	\$65,300			
4	Stabilize Steep Slopes	Steep Eroded Banks along Northern Fork near Pepsi - Repair erosion & stabilize slopes	Definite	50.0	50.0	2500.0			\$0		\$0	\$5,000	\$7,500	\$2,500	\$4,500	\$19,500	\$3,300	\$8,000	\$3,000	\$2,500	\$16,800	\$36,300			
5	Streambank Stabilization	Mass Slope Failure along Main Channel near Route 9 eastbound shoulder - Repair erosion & stabilize slope	Definite	150.0	30.0	4500.0			\$0		\$0	\$13,500	\$20,250	\$4,500	\$11,500	\$49,750	\$3,500	\$8,000	\$10,000	\$5,000	\$26,500	\$76,300			
6	Stabilize Steep Slopes	Mass Slope Failure Northern Fork near Houghton Rd - Repair erosion & stabilize slope	Definite	75.0	50.0	3750.0			\$0		\$0	\$7,500	\$11,250	\$3,750	\$6,800	\$29,300	\$3,400	\$8,000	\$5,900	\$2,900	\$20,200	\$49,500			
						25,000							Totals				\$231,725					Totals		\$369,800	
1	Replace Culvert	Northern Fork / Ryan Rd (M03) - Install new culvert to meet min 75% stream width - Exist. Culvert = 7'x7'	Definite	50.0	25.0	1250.0	50	7 x 18	\$175,000		\$0	\$3,750	\$5,625	\$6,250	\$57,200	\$247,825	\$3,100	\$8,000	\$49,600	\$24,800	\$85,500	\$333,300			
2	Replace Culvert	Northern Fork / Middle Rd (M04) - Install new culvert to meet min 75% stream width & LCBs for paved drainage - Exist. Culvert = 7'x7'	Definite	100.0	25.0	2500.0	60	7 x 16	\$210,000	2	\$7,000	\$7,500	\$11,250	\$12,500	\$74,500	\$322,750	\$3,300	\$8,000	\$64,600	\$32,300	\$108,200	\$431,000			
3	Replace Culvert	Southern Fork / Black Mtn. Rd (T1.01) - Install new culvert to meet min 75% stream width LCBs for paved drainage - Exist. Culvert = 4'x4'	Definite	100.0	30.0	3000.0	75	4 x 12	\$112,500	2	\$7,000	\$9,000	\$13,500	\$15,000	\$47,100	\$204,100	\$3,300	\$8,000	\$40,800	\$20,400	\$72,500	\$276,600			
4	Replace Culvert	Southern Fork / Dickinson Rd (T1.02-D) - Install new culvert to meet min 75% stream width - Exist. Culvert = 3'x3'	Definite	50.0	25.0	1250.0	40	3 x 7	\$60,000		\$0	\$3,750	\$5,625	\$6,250	\$22,700	\$98,325	\$3,100	\$8,000	\$19,700	\$9,800	\$40,600	\$138,900			
							225							Totals				\$873,000					Totals		\$1,179,800

Explanation of Calculations:

STP Construction Cost Estimate: Based on a combination of drainage piping, drainage structures, STP installation, additional excavation costs, potential rock excavation and supplemental costs

Pipe Costs: Linear feet of pipe times \$75/lf pipe between 0-500 ft.; \$100/lf between 500 - 1000 ft.; and \$150/lf for lengths over 1000 feet

Structure Costs: Number of drainage structures needed times \$2,500 per structure

STP Installation Costs: Cost to represent excavation, stabilization and installation of all standard stormwater treatment STP components:

STP Material Costs: Cost to represent the required materials for stabilization and installation of all standard stormwater treatment STP components:

Excavation/ Prep/ Clearing Costs: Cost per cubic yard to excavate existing terrain beyond the volume required for the STP construction. Estimated based on area of STP and approximate cut depths to clear, grub, level the area and provide access prior to STP installation

Contingency / Supplemental Costs: Costs carried for supplemental work that would be required for a specific STP or location. Additional costs include liners for ponds, road re-grading, infrastructure retrofits, utility relocations, traffic control and grading required to control water and runoff during construction

STP Engineering Cost Estimate: Based on a combination of survey, permitting and engineering/design cost estimates

Survey Costs: Based on estimates to obtain topographic survey for design and permitting. Cost includes a rough base price plus a cost per acre based on the footprint of the STP

Permitting Costs: Based on estimates to perform STP permitting for local, state and supplemental permitting. Costs based on historical data and past experience and depend on potential impacts to the brook, wetland area, surface water resources and applicable buffers.

Engineering Costs: Based on estimates to complete design, plans and specifications ready for bidding. Based on a combination of historical data, an approximate 20% of construction budget and previous design project experience. Costs do not include bidding and construction based services.

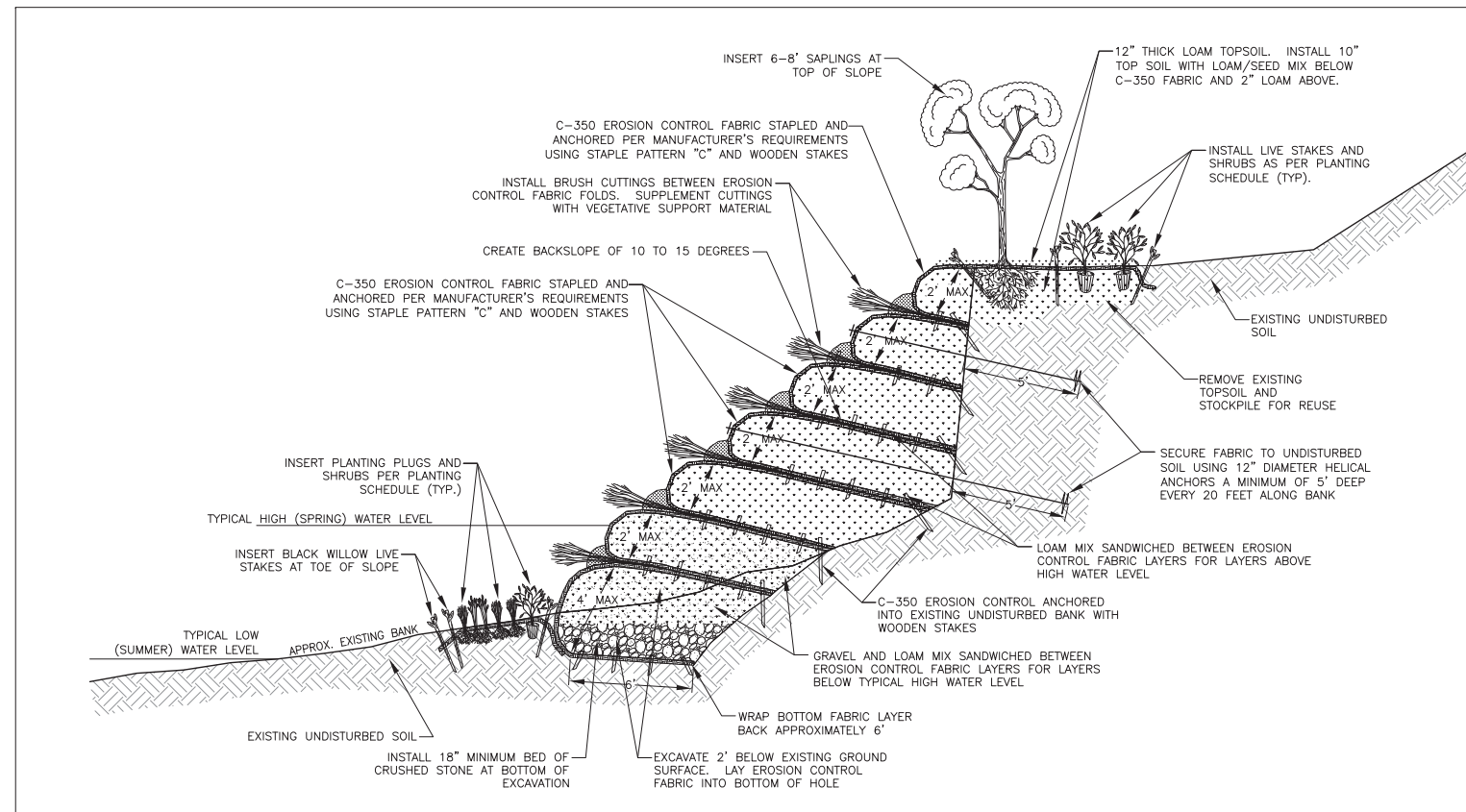
Bid & Construction Oversight: Based on estimates to complete bid and construction services including administrative services, construction oversight and inspection. Based on a combination of historical data and previous design project experience.

STP Total Cost Estimate: Based on the combination of total construction costs plus engineering costs

STP Cost Summary:

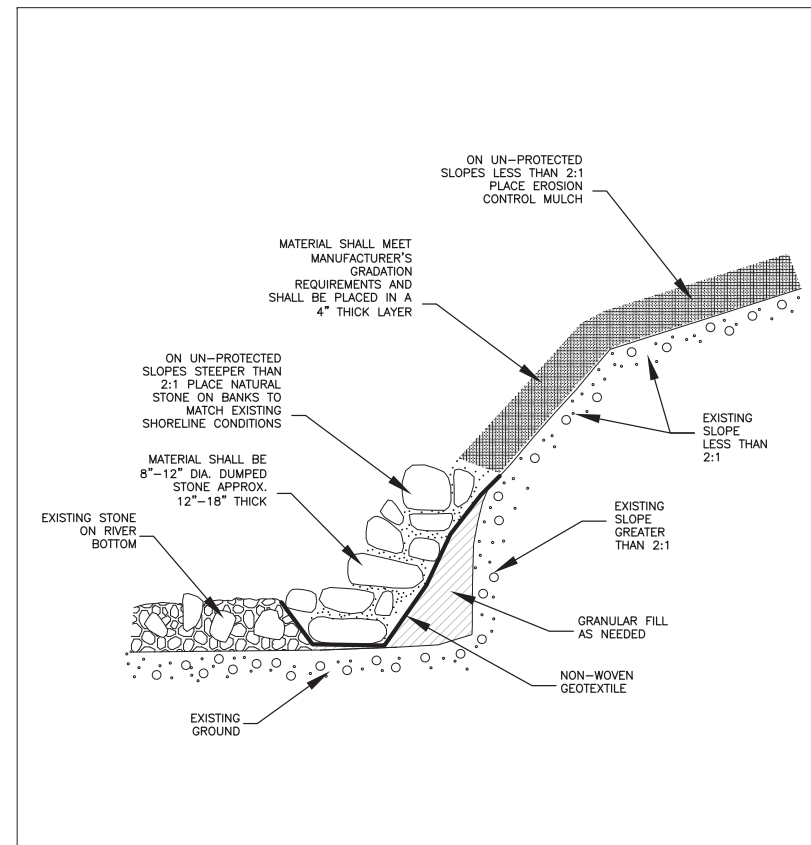
	Install	Material	Total	Unit
Treatment STP	\$2.00	\$1.00	\$3.00	per CF
Stilling Basin	\$2.00	\$1.50	\$3.50	per CF
Sediment Forebay STP	\$1.50	\$1.00	\$2.50	per CF
Roadside Swales & STPs	\$1.50	\$3.00	\$4.50	per SF
Maintenance Level Spreader	\$5.00	\$15.00	\$20.00	per SF
Riprap Spillway	\$5.00	\$10.00	\$15.00	per SF
Riprap Infiltration STP	\$3.00	\$8.00	\$11.00	per SF
Filter Media STP	\$10.00	\$20.00	\$30.00	per SF
Streambank Stabilization	\$3.00	\$4.50	\$7.50	per SF
Naturalized Bank Erosion Stabilization	\$4.00	\$6.00	\$10.00	per SF
Steep Slope Stabilization	\$2.00	\$3.00	\$5.00	per SF
Erosion Repair	\$0.50	\$1.00	\$1.50	per SF
Vegetated Buffer	\$2.00	\$4.00	\$6.00	per SF
Dredge	\$1.50	\$0.00	\$1.50	per CF
Small Culvert Replacement	\$1,000.00	\$500.00	\$1,500.00	per LF
Large Culvert Replacement	\$3,000.00	\$500.00	\$3,500.00	per LF

Appendix E
Drainage & Stabilization Details



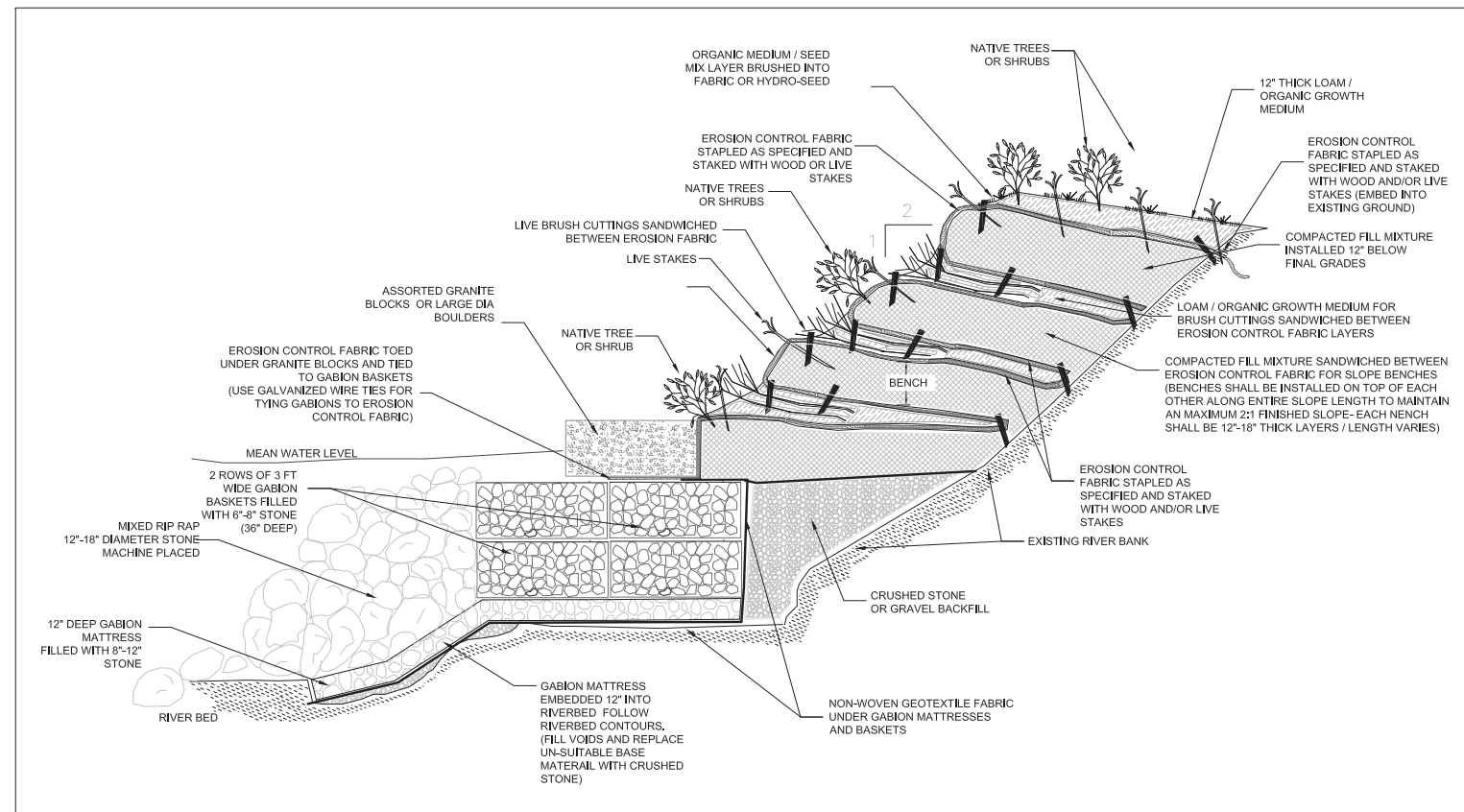
STREAM BANK SLOPE TREATMENT - FABRIC & BRUSH LAYERS (NATURAL BASE)

NOT TO SCALE



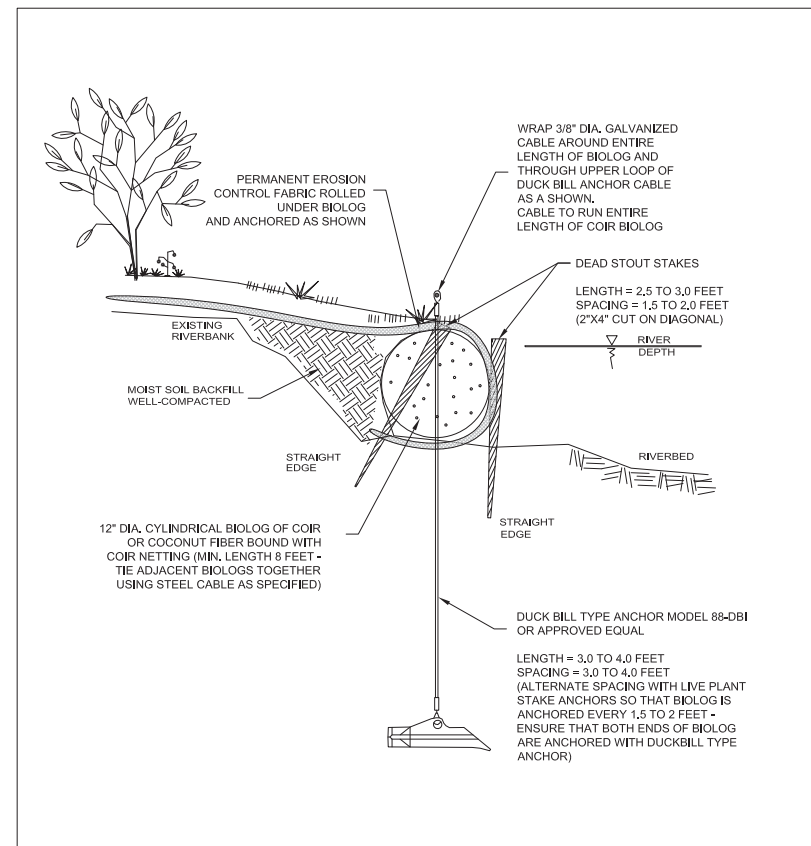
STREAM BANK SLOPE TREATMENT - E.C. MULCH & STONE

NOT TO SCALE



STREAM BANK SLOPE TREATMENT - FABRIC & BRUSH LAYERS (STRUCTURAL BASE)

NOT TO SCALE



STREAM BANK SLOPE TREATMENT - COIR LOG W/ ANCHOR

NOT TO SCALE

General Notes

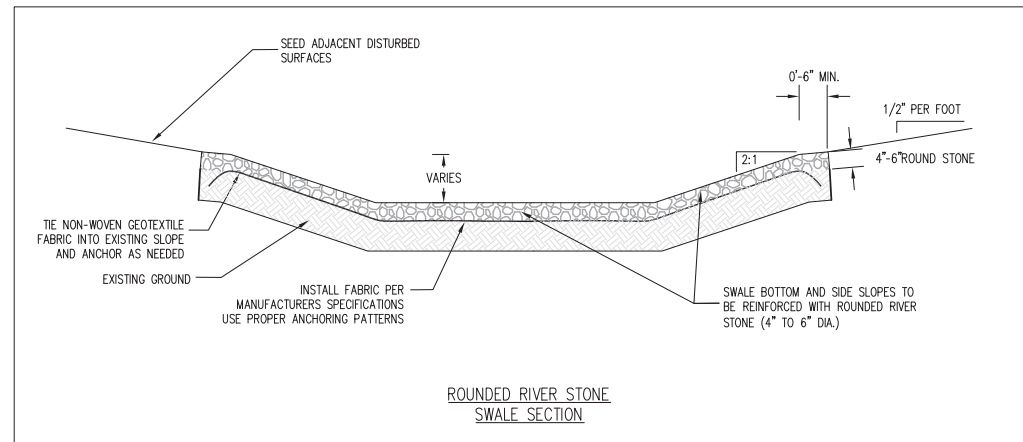
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No.	Revision/Issue	Date

**COMPREHENSIVE ENVIRONMENTAL
INCORPORATED**
21 DEPOT STREET
MERRIMACK, NH 03054

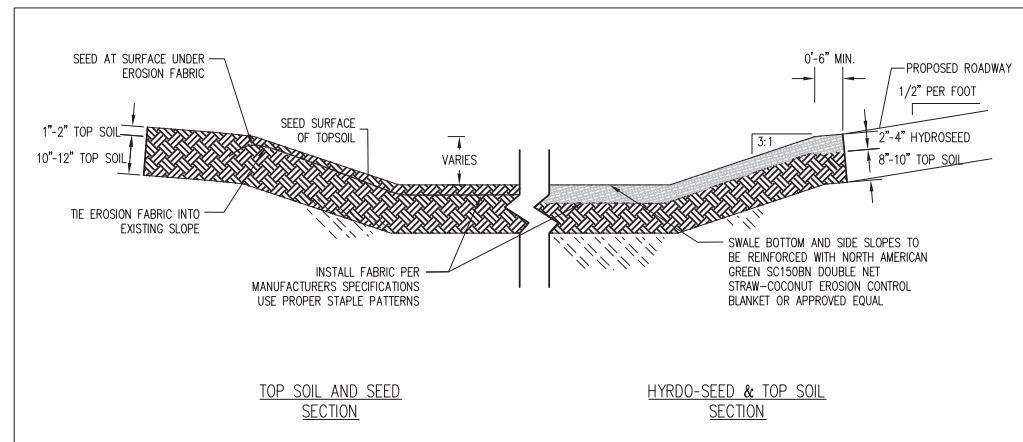
**GENERAL
DETAILS**

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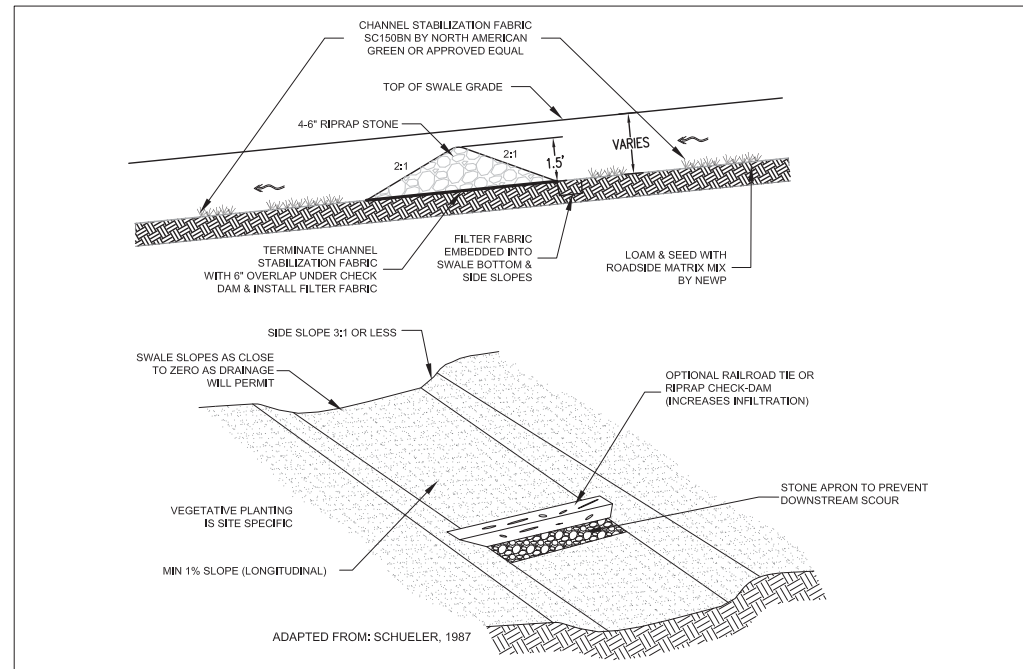
SWALE STABILIZATION WITH STONE TYP. DETAIL

NOT TO SCALE



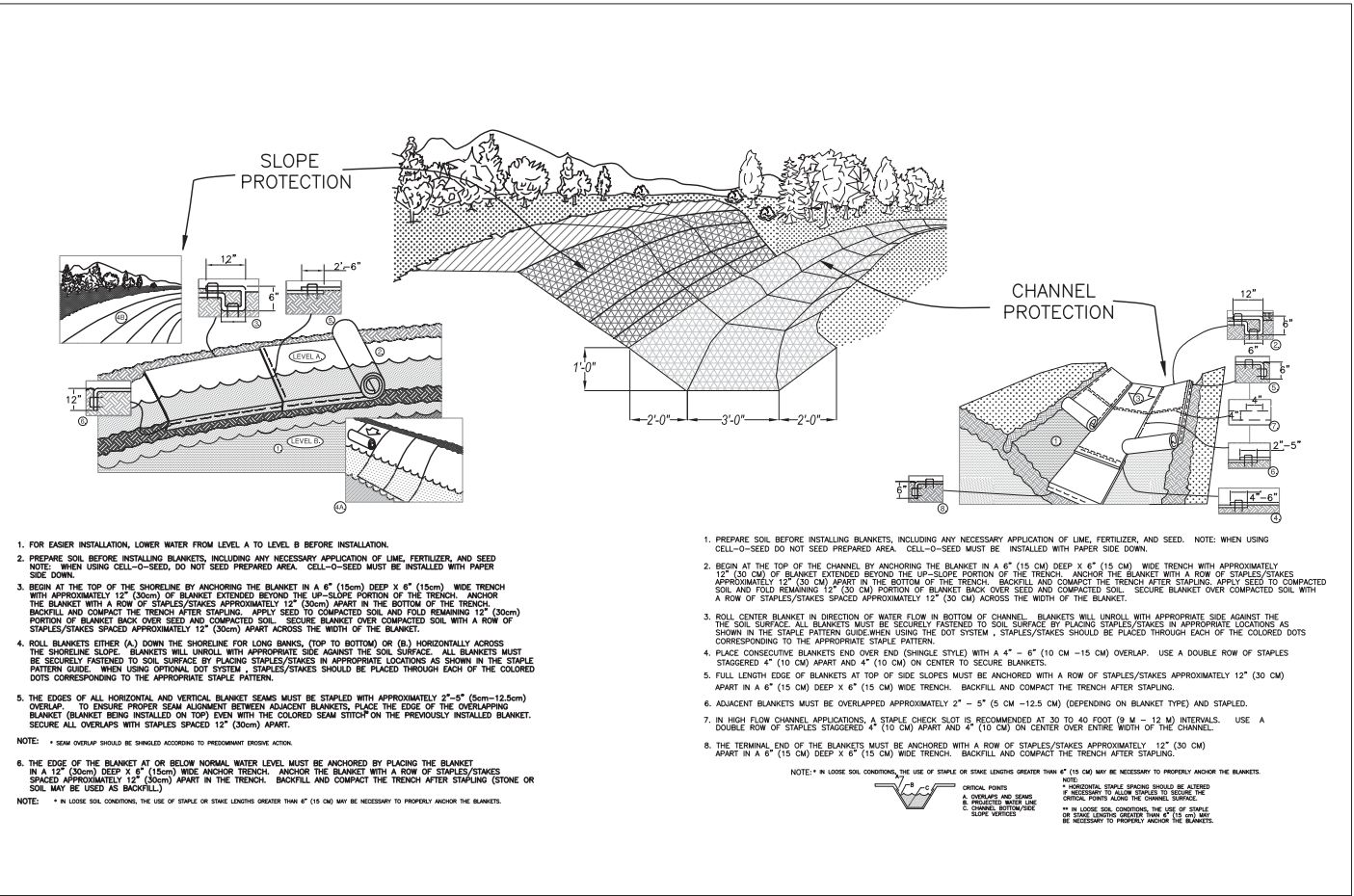
SWALE STABILIZATION WITH VEGETATION TYP. DETAIL

NOT TO SCALE



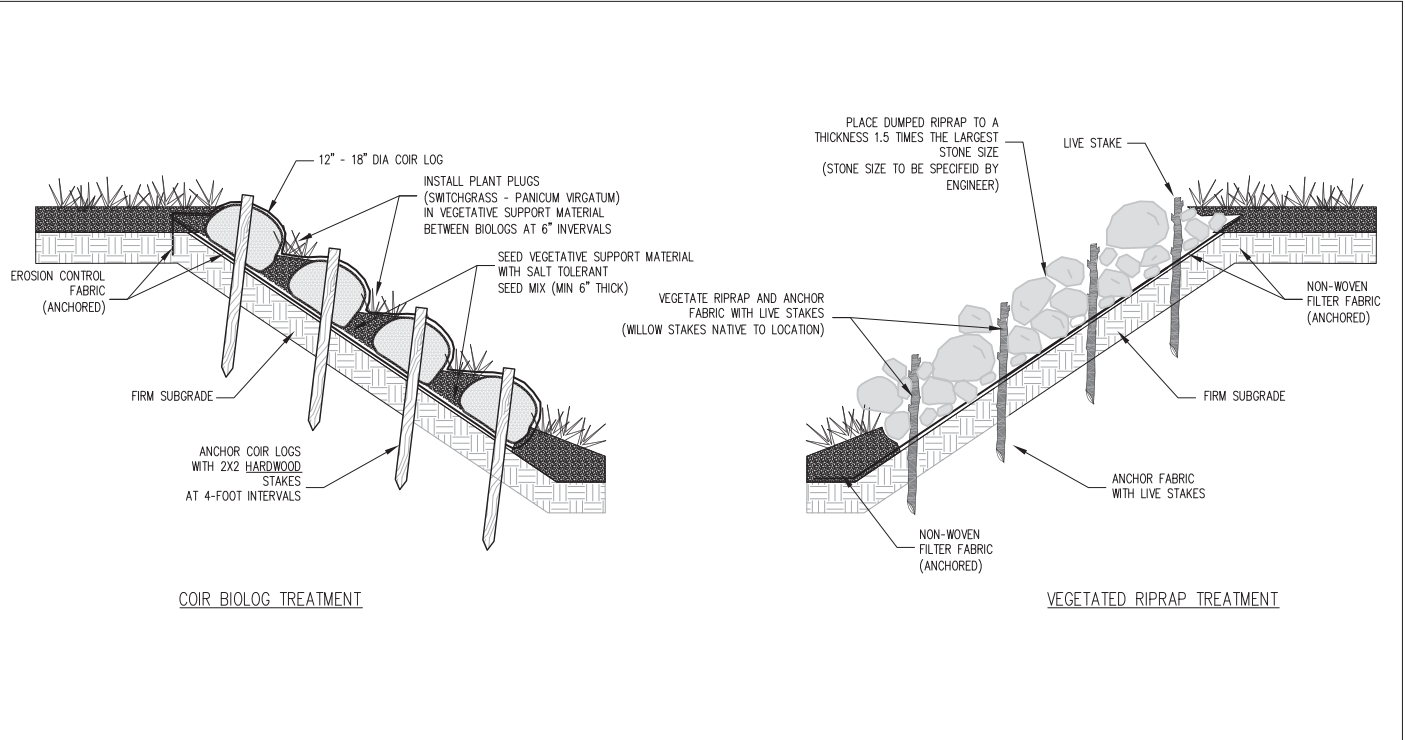
SWALE WITH CHECK DAMS TYP. DETAIL

NOT TO SCALE



TYP. SLOPE OR SWALE STABILIZATION

NOT TO SCALE



STEEP SLOPE STABILIZATION DETAILS

NOT TO SCALE

General Notes

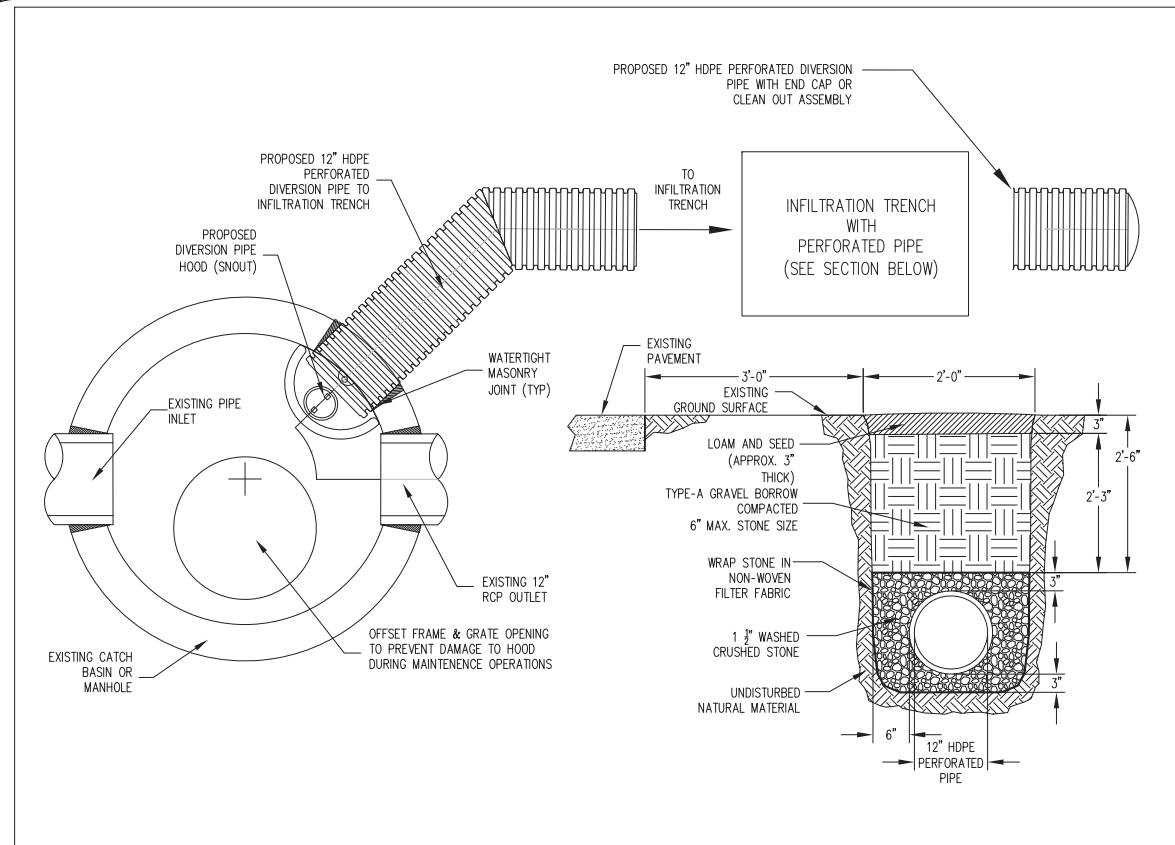
**PRELIMINARY PLANS
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No.	Revision/Issue	Date

**COMPREHENSIVE ENVIRONMENTAL
INCORPORATED**
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MERRIMACK, NH 03054

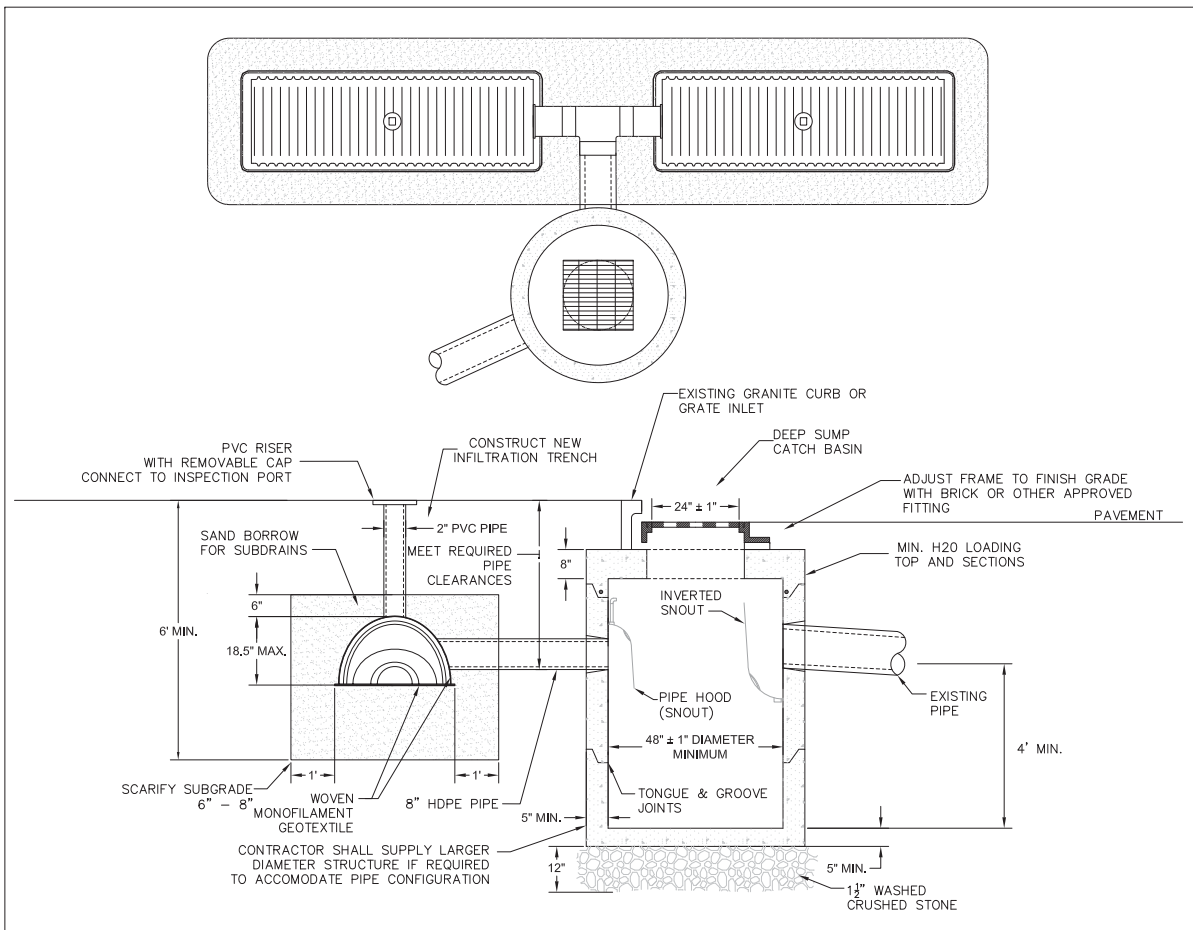
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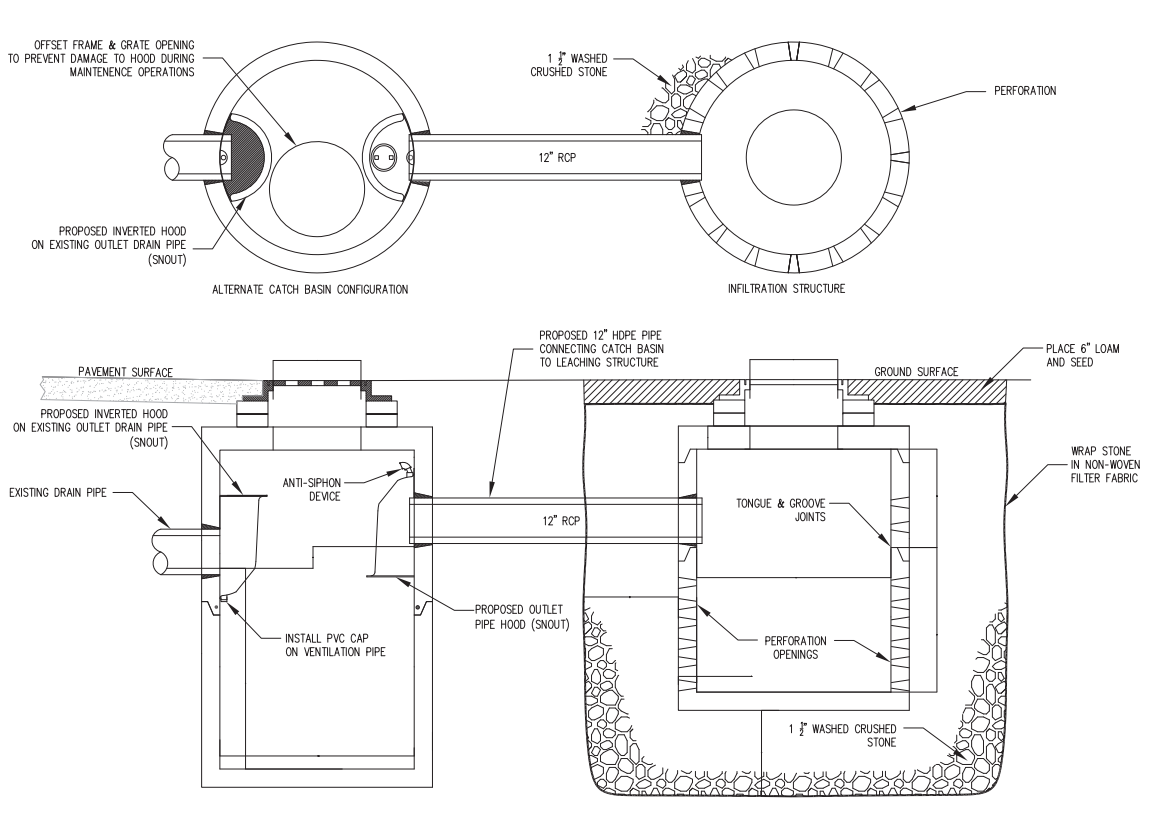
INFILTRATION TRENCH DETAIL

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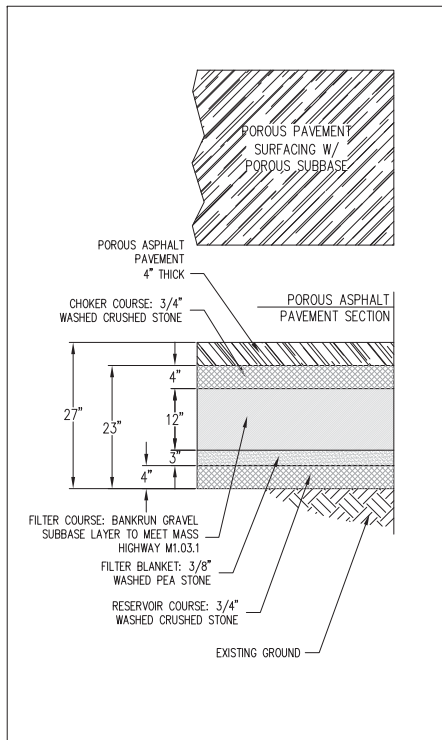
UNDERGROUND INFILTRATION CHAMBER DETAIL

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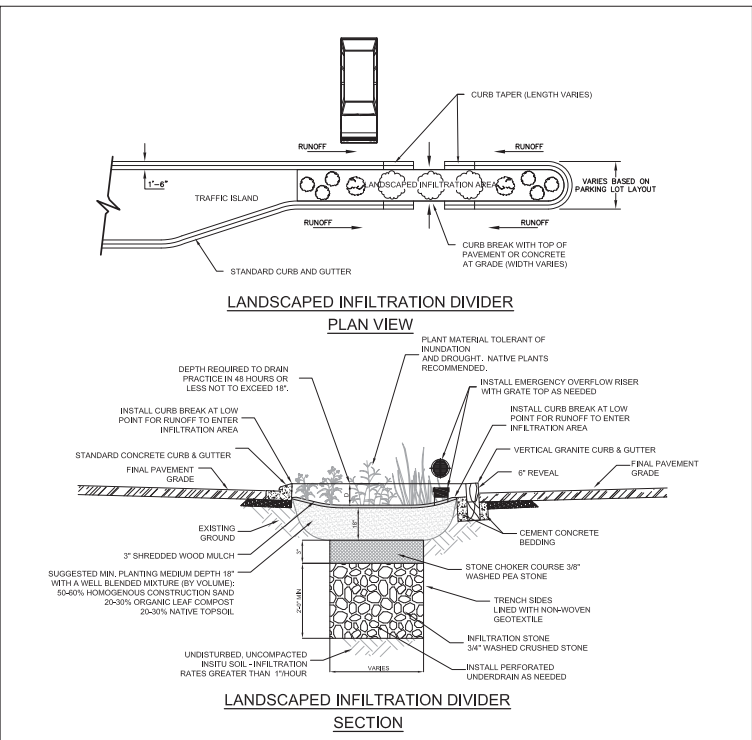
LEACHING CATCH BASIN TYP. DETAIL

NOT TO SCALE



POROUS PAVEMENT DETAIL

NOT TO SCALE



INFILTRATION DIVIDER DETAIL

NOT TO SCALE

General Notes

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