

LAKE STREET
Burlington, Vermont

PEDESTRIAN, STREETSCAPE, AND STORMWATER
FEASIBILITY STUDY



Prepared by:



Prepared for:



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1.0 INTRODUCTION

The City of Burlington obtained transportation planning assistance from the Chittenden County Regional Planning Commission (CCRPC) to complete a feasibility study for Lake Street. Stantec Consulting Services Inc. was retained by the CCRPC to develop this report. The feasibility study involves first quantifying and evaluating existing conditions. Potential strategies are then identified and evaluated leading to the recommended improvements.

The study process includes working closely with a project committee made up of representatives from the City of Burlington and the Chittenden County Regional Planning Commission.

Burlington City Staff
CCRPC Staff

James Sherrard, Laura Wheelock
Marshall Distel, Eleni Churchill

2.0 PROJECT BACKGROUND

Lake Street in Burlington is a shared use street that connects the City core to the northern waterfront. There are two mid-block pedestrian crossings on this segment. The road is landscaped with street trees and granite blocks. Stormwater runoff sheet flows across the road from east to west. Runoff from nearby properties drains over Lake Street at the driveway intersections. Most of the stormwater sheet flows into small swales or ponds in the nearest low spot.

The City with funding from the CCRPC will study possible pedestrian, streetscape and stormwater improvements for Lake Street in the project area.

This study evaluates alternatives for the specific issues identified by the City below:

- Stormwater runoff high in sediment from 102 Lake Street parking lot discharging across road
- Stormwater runoff from vacant lot discharging across Lake Street causing ponding on sidewalk and road
- No formalized pedestrian crossing over railroad or connection to the Waterfront North at the intersection of Lake Street with Penny Lane
 - Cyclists and pedestrians are unsafely crossing Lake Street and railroad at undesirable locations to access the Island Line Trail using the designated vehicle access to the Waterfront Park
- Existing mid-block crossings have poor sight distance due to the close vicinity of on-street parking

- Potential stormwater improvements are evaluated with focus on reducing sediment loads discharging from the system and reducing areas of ponding.

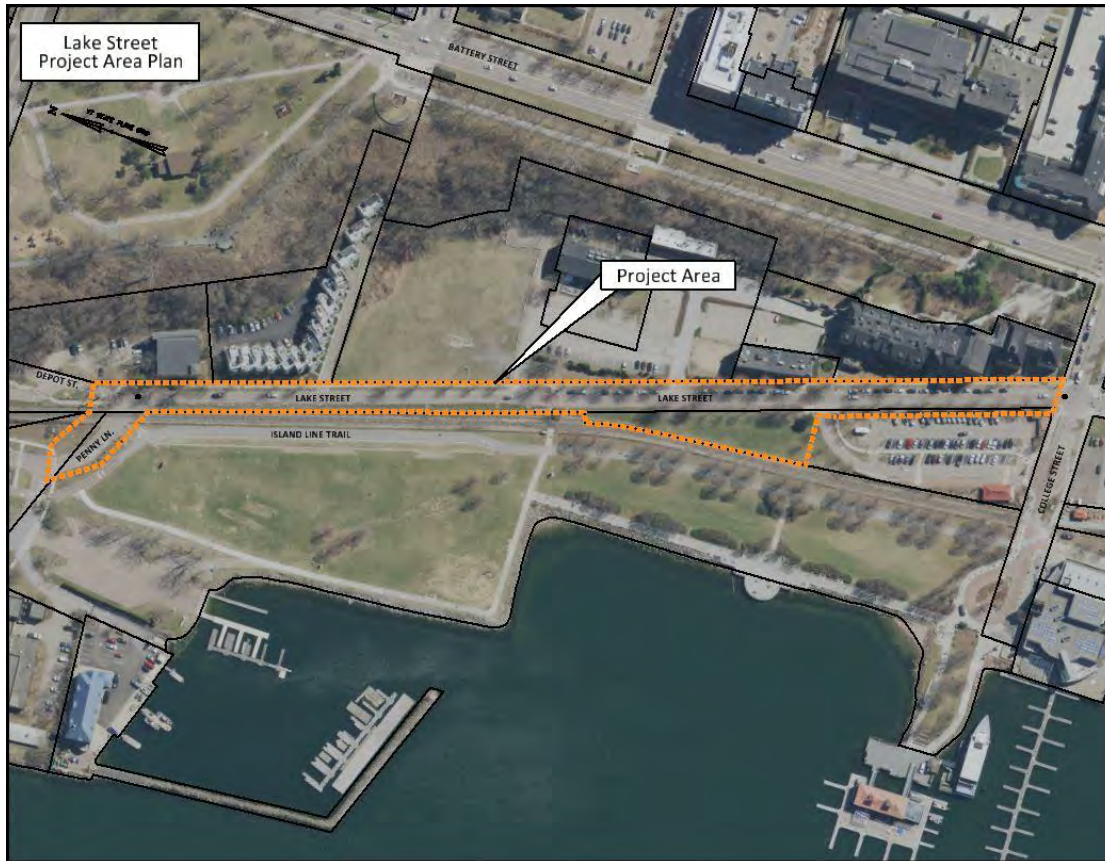


Figure 1: Project area plan

2.1 EXISTING PLAN AND STUDY REVIEW

Other studies and plans have been developed that considered traffic, pedestrian and stormwater concerns. These studies were reviewed in the preparation of this feasibility study and are listed below.

- *Comprehensive Transportation Plan, 2011* (City of Burlington/CCRPC) and Appendix 2: Street Design Guidelines
- *Burlington Great Streets Standards, 2018*
- *BTV Walk Bike Plan, 2015*
- *Waterfront Access North Scoping Study, 2009*

3.0 EXISTING CONDITIONS

3.1 ROADWAY CHARACTERISTICS

The project study area, identified in Figure 1 above, is located in Burlington, Vermont near the Waterfront Park. The study area is approximately 1,600' long and extends from the intersection with College Street to north of the intersection with Penny Lane. The pavement width is approximately 26' on the south end and 20' on the north end. There is a 5' wide concrete sidewalk with a 6-7' wide grass strip along the entire eastern side of the street. On-street parking exists from College Street to the point where the road narrows, just beyond the mid-block crossing to Waterfront Park. The road is in poor condition, especially along the shoulders on the west side as shown in Figure 2 below.



Figure 2: Weathering and alligator cracking along the shoulder on the west side of Lake Street.

3.2 STORMWATER

The general drainage pattern for Lake Street is from east to west and south to north. The grades are generally flat, ranging from 0 to 1.5%. There is a high point in the road just north of Skinny Pancake and a low point in front of the 200 Lake Street Apartments. There is an on-road closed drainage system from College Street to the entrance for the City Parking Area. Beyond that, runoff sheet flows off the pavement into swales and is collected by a system of inlets. The runoff collected by these swales discharge to inlets north and south of the Waterfront Park mid-block

pedestrian crossing as shown in Figure 3 and Figure 4 below. These inlets discharge to a system within the Waterfront Park and then to Lake Champlain.



Figure 3: Southern swale looking north to drainage inlet.



Figure 4: Northern swale looking south to drainage inlet.

Just south of Penny Lane on the west side of the road, there is an area where frequent flooding occurs. The flooding is related to a system of pipes connected by 15" pipe risers with 15" diameter plastic grates within a drainage swale. During the initial site visit it was noted that these grates had not been maintained and were severely clogged with vegetation, soil, and debris. As seen in Figure 4, this swale has recently been maintained. Flooding issues should be reassessed during a rainfall event. This system of grates and this swale eventually discharges to a structure with a large 2.5' grate. Runoff contributing to this swale includes runoff from the 200 Lake Street Apartments, which was noted by the City to flow "like a river" down the main driveway and across Lake Street during heavy rainstorms. The main driveway for the 200 Lake Street Apartments is shown below in Figure 5.



Figure 5: The driveway for 200 Lake Street Apartments looking east.

Another area of flooding occurs on the eastern side of Lake Street on the sidewalk along the empty lot. Small slots have been cut into the curb to help drain the sidewalk in this area. However, sediment has built up in the channels draining the sidewalk through the grass strip to the road. Some effort was made to repair these slots with aggregate.

At the northerly entrance to the Foam Brewers gravel parking lot, large amounts of sediment have deposited on the sidewalk and drive apron. There are significant signs of erosion from the parking lot including gulying. Large amounts of runoff with substantial sediment loading during rainfall events had been noted by the City in this area. Small repairs have been completed to stabilize the swale where this runoff likely discharges. The sediment and erosion found at the entrance to the Foam Brewers parking lot is shown in Figure 6 on the following page.



Figure 6: Northerly entrance to the Foam Brewers gravel parking lot.

At the entrance to Merrill Lynch, there are signs of runoff from this site flowing across the street and into an area of large stone fill as shown in Figure 7 below. Large flows crossing Lake Street during rain events was noted by the City.



Figure 7: Large stone fill across the 102 Lake Street parking lot.

3.3 HYDRAULICS

The drainage area to the discharge point is comprised of Hydrologic Soil Group A and categorized into four land use types to simplify the calculations. Impervious area incorporates all development including buildings, sidewalks, roads, parking lots, gravel lots, green belt, etc. The empty lot north of Foam was considered Grass in Poor Condition based on field observations. The steep slope was considered Woods in Fair Conditions. The remaining area was considered Grass in Good Condition. For purposes of this study, this is considered the post development condition. The pre-development condition considers the entire drainage area to be Woods in Good Condition. See Appendix A – Drainage Area Plan for a visual representation of these areas.

Using a combination of HydroCAD and ANR's **Standard Compliance Workbook**, drainage design parameters were determined. These parameters include pre-development peak flows, post-development peak flows and the required treatment volume for each of the design storms. These parameters were set based on assuming the pre-development condition were Woods in Good Conditions. Note that Woods in Good Condition on Type A soils typically yields zero runoff. Parameters are listed in Table 1 below.

Table 1: Hydraulic design parameters

Design Storm	Pre-Development Peak Flow Rate (cfs)	Post-Development Peak Flow Rate (cfs)	Treatment Volume Required (Acre-ft)
Recharge	N/A	N/A	0.23
Water Quality	N/A	8.35	0.39
1-year	0.00	8.61	0.62
10-year	0.00	16.17	1.10
100-year	0.00	26.63	1.74

Groundwater elevations are unknown. Due to the proximity to the lake and other nearby projects encountering groundwater, it is assumed that the seasonal high groundwater table elevation will restrict the use of infiltration practices along Lake Street. This should be confirmed prior to installing a filtering practice as infiltration is the most desirable form of stormwater treatment.

3.4 BICYCLE/PEDESTRIAN

A sidewalk runs the entire length of Lake Street on the eastern side. This sidewalk does not connect to the existing sidewalk on Penny Lane. Lake Street is a relatively slow speed street with narrow lanes, on-street parking, and on-road cyclists share the lane with vehicles. For off-road cyclists, there is a bike path west of Lake Street. There is also an unofficial connection to the bike path just beyond the Lake Street railroad crossing used frequently by cyclists and pedestrians coming from Lake Street or Depot Street.

Along the project corridor there are two mid-block pedestrian crossings. Both crosswalks are painted brick crossings that have seen considerable weathering. One crossing leads to the Waterfront Park and the other to the City of Burlington parking area. There is limited site distance for both mid-block crossings due to the close vicinity of on-street parking. The existing mid-block railroad crossing to the Waterfront Park also does not have the required detectable warning surfaces as shown in Figure 8 below. At the intersection with Penny Lane and Depot Street, there is no formal ADA compliant pedestrian crossing to get people from Lake Street over the railroad tracks and to the Waterfront North as shown in Figure 9.



Figure 8: Mid-block pedestrian crossing over railroad to Waterfront Park.



Figure 9: Railroad crossing on Penny Lane with no formal pedestrian crossing.

Several grassed areas were noted by the City as “trampled down.” The main area of concern is in front of the Skinny Pancake between the sidewalk and Lake Street. There is no grass growth in this area as shown in Figure 10, and it was noted that pedestrians either walk or stand in this area.



Figure 10: Trampled down area in front of Skinny Pancake on Lake Street.

4.0 RECOMMENDED IMPROVEMENTS

Several recommended improvements are proposed to address the pedestrian, streetscape, and stormwater issues in this project area. These improvements include permeable hardscaping in front of Skinny Pancake, rain gardens to replace the parking spaces before both mid-block pedestrian crossings on Lake Street, a bioretention system across from the 102 Lake Street parking lot, improved crosswalk style, and two alternatives to address the railroad crossing on Penny Lane. These improvements can be seen in greater detail in the figures of Appendix E.

4.1 PERMEABLE PAVERS

The 6-7' wide grass strip on the eastern edge of Lake Street from Skinny Pancake to the entrance of the 60 Lake Street building is significantly trampled down with no grass growth. This recommended improvement proposes the use of permeable pavers along this grass strip. Permeable brick pavers would make the streetscape of Lake Street more aesthetically pleasing and allow pedestrians to walk or stand on them without drastically eroding the surface over time. In addition, permeable pavers will infiltrate stormwater runoff helping recharge groundwater and reduce flow to the existing drainage network.

The width of the 3" interlocking permeable pavers would be 5' and they would be placed directly adjacent to the existing 5' wide sidewalk. The pavers must adhere to the Great Street standards by being red clay or gray concrete. Notably, the red clay is found to have higher durability in environments with high salting during the winter. The cross-section layering of the Permeable pavers would include interlocking concrete pavers, a sand settling bed, compacted subgrade, and a base course from top to bottom. The three existing maple trees would remain with tree grates added for protection. There is also one existing catch basin on the southern end which would remain. This improvement is depicted in below in Figure 11: *Proposed hardscaping with permeable pavers along Lake Street.*, with additional details provided in Figure 1 of Appendix E.



Figure 11: *Proposed hardscaping with permeable pavers along Lake Street.*

4.2 RAIN GARDENS

This recommended improvement proposes two rain gardens to replace the parking spaces before both mid-block pedestrian crossings on Lake Street. The rain gardens (schematic in Figure 12) would treat stormwater runoff along Lake Street by grading the road towards the on-street parking which would reduce the amount of ponding. This grading work could be done during paving construction under the future planned project for Lake Street. In addition, the rain gardens would address pedestrian safety desires at the northern mid-block crossing to Waterfront Park by increasing site distance.

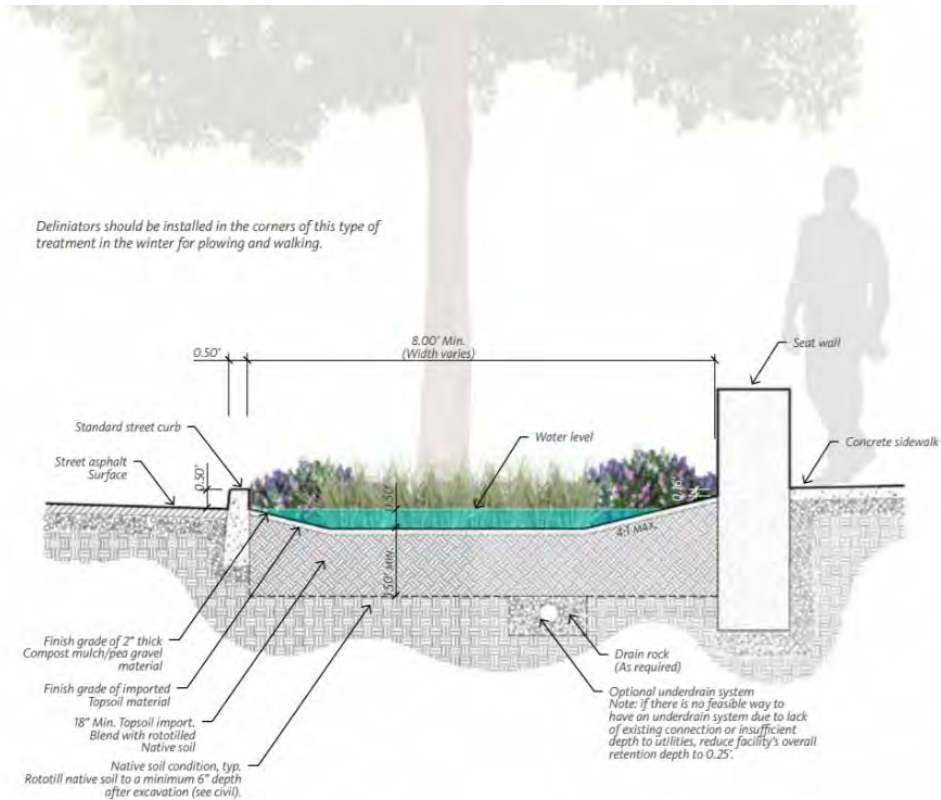


Figure 12: Profile diagram of a Rain Garden, from Burlington Great Streets.

The existing on-street parking width is 8' along Lake Street which would be graded towards the eastern curb at a 1 to 4% slope. Both existing maple trees north of each proposed rain garden would remain. At the mid-block crossing to the City of Burlington parking area, the existing parking space is designated for vehicles loading and unloading Monday through Friday from 8am to 5pm along with the existing parking space directly south. A rain garden in this space would require the elimination of one parking space on Lake Street in order for two vehicle loading and unloading parking spaces to remain. In addition, the existing **concrete** "carriage stop" for the parking space where the rain garden would be placed would need to be removed. At the mid-block crossing to Waterfront Park, a storm manhole exists along the western edge of the on-street parking where the rain garden is proposed. The rain garden could not extend past the edge of the storm manhole in order for it to remain accessible to the City of Burlington.

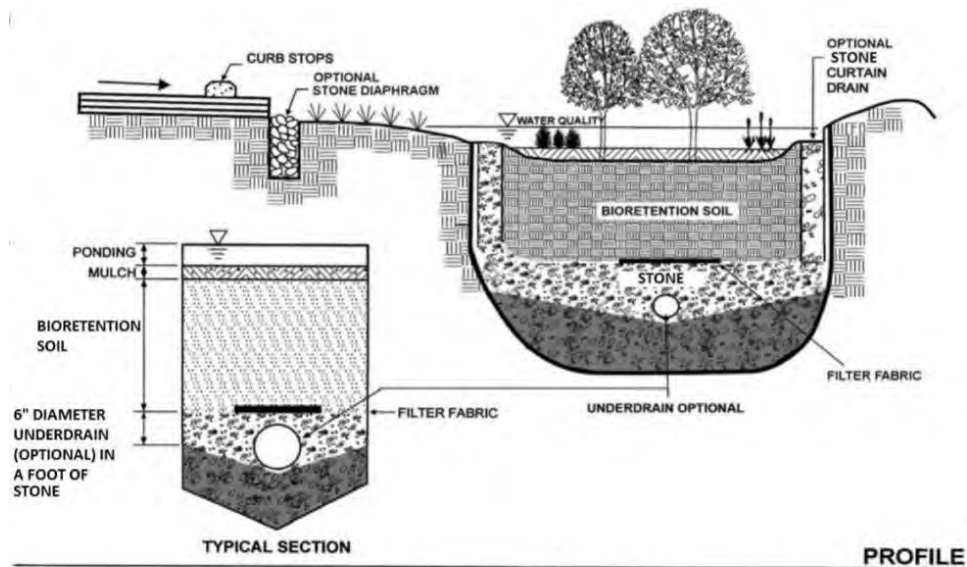
This improvement is depicted in Figure 13, with more detailed drawing provided in Figure 2 of Appendix E. Although this figure only shows the rain garden at the southern mid-block crossing to the City of Burlington parking area, the design for the rain garden at the northern mid-block crossing to the Waterfront Park would be nearly identical.



Figure 13: Location of the southern rain garden.

4.3 BIORETENTION

Due to the assumed depth to the seasonal high groundwater table, infiltration practices were excluded from this study. If a soil investigation is completed and depth to groundwater is deeper than anticipated, the use of an infiltration practice should be explored as it is the most desirable form of stormwater treatment. For purposes of this study, bioretention was selected as a sample practice but could be redesigned with a gravel wetland, a sand filter, or other proprietary treatment practices. An example of a bioretention schematic is pictured below in Figure 14.



Modified from: MDE, 2000 and RI DEM, 2010

Figure 14: Profile view of Bioretention Tanks, from the 2017 Vermont Stormwater Management Manual Rule and Design Guidance.

Stormwater runoff is high in sediment from the 102 Lake Street parking lot and discharges across the road from east to west. Large stone fill has been placed on the western end of Lake Street to slow down the stormwater runoff velocity before reaching the southern swale which drains north to the discharge area. This recommended improvement proposes two catch basins on the east side of the road which pipe into a bioretention system on the western edge of the road. This system would reduce the amount of sediment and stormwater runoff flowing across Lake Street and would treat the water quality volume for the area draining to the catch basins.

The northern catch basin would connect to the southern catch basin which would then connect under Lake Street into the bioretention system. Prior to laying down this pipe, it would need to be ensured that the existing underground utilities would not be impacted by the new stormwater pipe. Currently, underground electric, gas distribution, water main, sewer, and sewer pressurized main line run parallel to Lake Street. The stormwater pipe would enter the bottom of the pretreatment sediment forebay which would connect to the bioretention area via an earthen berm with 2:1 side slope. The depth of both the sediment forebay and the bioretention area would be 4' and 2', respectively. A hydraulic control structure would be installed on the northern end of the bioretention area to pipe above-design flows to the discharge area. In the event installing structures and pipes is not feasible, alternatively, the stormwater runoff could sheet flow across Lake Street as it currently does and would collect into the bioretention system through a pretreatment grass filter. However, the structures and pipes are important to prevent higher flows of runoff from weathering the pavement on Lake Street.



Figure 15: Drainage area to the bioretention system.

The delineated drainage area to the bioretention system is 1.66 acres which includes 1.09 acres of impervious area, shown above in Figure 15. Due to the drainage area of Lake Champlain being greater than 10 square miles, the channel protection standard, overbank flood protection standard, and extreme flood protection standard are waived. This leaves the groundwater recharge standard and the water quality treatment standard. To treat the required 0.088 ac-ft water quality volume (WQv) draining to the bioretention system, the pretreatment sediment forebay can store up to 25% of the WQv while the bioretention area can store up to 75% of the WQv. In order to treat 0.066 ac-ft WQv, the surface area of the bioretention filter bed would need to be 1,050 square feet. With an infiltrating bioretention system, this would also treat the 0.054 ac-ft groundwater recharge volume. In Appendix E, the delineated drainage area for the bioretention system is drawn in more detail in Figure 3a while the improvement is depicted to the required size in Figure 3b.

With the implementation of the bioretention area, the city would also like to integrate park features such as benches and plantings to make the area into a recreational space. The park would be designed to be accessible from the crosswalk by Gentleman's Top Option.

4.4 OTHER STORMWATER IMPROVEMENTS

The yard grates within the northern swale have been maintained and should be monitored to determine if this alone relieves flooding issues. In addition, this should be included in the Burlington inspection and maintenance program. If it is determined that maintenance alone does not relieve the flooding issues, it is recommended to install bigger structures such as beehive grates in the northern swale. Since the swale and drainage system do not extend along the entire length of Lake Street, a perimeter drain should be installed along the western edge of Lake Street from

the railroad tracks to the beginning of the swale. The perimeter drain would consist of a 2'-3' wide 3" layer of peastone at the surface followed by a minimum 1' of drainage aggregate surrounded by filter fabric. Within the drainage aggregate, install a 6"-8" perforated underdrain sloped towards the nearest inlet at a minimum 0.5% slope. Peastone should be inspected annually and replaced or maintained as required. This may help with ponding and roadway damage occurring in this area.

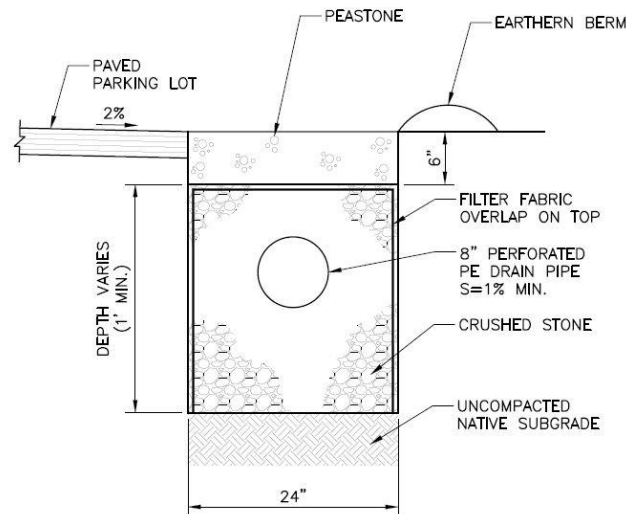


Figure 16: Perimeter Drain Detail

On the eastern side of Lake Street along the empty lot, the small slots in the curb needs to be inspected annually and maintained as necessary. Sediment needs to be removed from the channels draining the sidewalk through the grass strip to the road for them to do their job of helping drain the sidewalk in this area. In addition, sediment needs to be removed from the stone lining.

The stormwater issues at the entryways to Foam Brewers and the 200 Lake Street Apartments need to be addressed. A proposed solution would be to work with the property owners to assist in developing stormwater detention and treatment practices to reduce flows and sediment loads from their property onto Lake Street. At the entryway to Foam Brewers, it is suggested that the parking lot is paved and drains to a low spot where that drainage area will be collected into a structure. For the 200 Lake Street Apartments, it is suggested that the driveway is regraded for sheet flow to the south and a detention practice be installed south of the driveway on the existing lawn.

4.5 STREET CROSSING

The three existing crosswalks in front of Gentlemen's Top Option, Foam Brewers, and crossing Depot Street where it intersects with Lake Street. None of the three follow the standards of the

Great Street Initiative. The current printed bricks with red paint should be replaced. The preferred style of crosswalk is the Conventional Continental Crosswalk style pictured in Figure 17.



Figure 17: Conventional Continental Crosswalk

4.6 RAILROAD CROSSING

The intersection of Penny Lane, Depot Street, and Lake Street at the northern end of the project area presents a challenge for both pedestrians and cyclists to cross the road and railroad tracks safely to access the Island Line Trail and Waterfront Park. The first alternative to addressing this issue uses line striping and signage while the second alternative proposes a shared use path on top of the railroad tracks which connects to the existing infrastructure along with a bike path down Depot Street using minor curb work to improve safety and be ADA compliant.

The process for improving the railroad crossing typically involves a diagnostic team review to determine the level of control at the crossing. It is likely that this would be a passive crossing and only signs, markings, and detectable warning surfaces would be required. The diagnostic team may not include the Federal Railroad Administration (FRA) or the Federal Highway Administration (FHWA) unless their funding is used and would likely include the City of Burlington, the Vermont Agency of Transportation (VTrans), and railroad officials. The proposed improvements of this study focus on the pedestrian and cyclist issues and are for consideration during a diagnostic team review. After the diagnostic team review and before construction, an agreement with the railroad and VTrans outlining responsibilities and requirements such as allowable work windows would be needed. If there is an existing crossing agreement in place between the City of Burlington and the railroad, then it should be relatively easy to make upgrades. If there is not an existing agreement in place, the railroad may be amenable to improving pedestrian and cyclist safety.

4.6.1 Line Striping

For the Line Striping alternative, Penny Lane is converted into two 10' lanes with a 5' shoulder on the northern edge and additional stop measures are added on the eastern edge of Lake Street for vehicles and cyclists riding down Depot Street, shown below in . While not a formal railroad crossing, this alternative address pedestrian and cyclist safety by giving pedestrians a space to

walk on the northern edge of Penny Lane. This would not likely require a diagnostic team review, but VTrans and New England Central Railroad should be consulted.

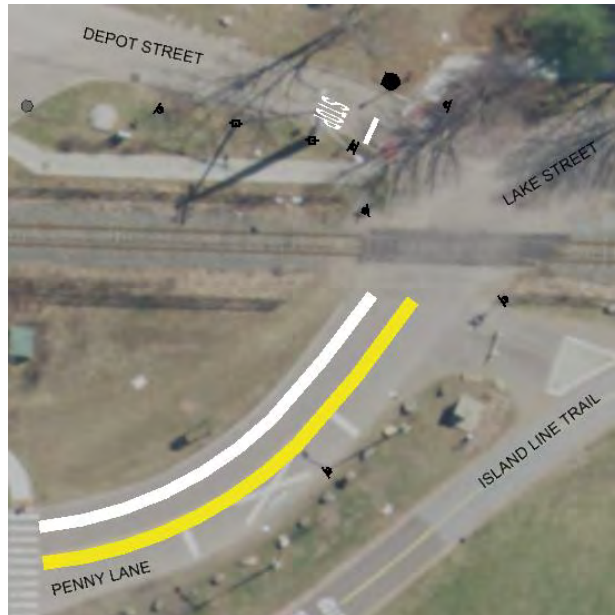


Figure 18: Railroad crossing with line striping alternative.



Figure 19: Rendering of the line striping alternative.

To slow cyclists traveling down Depot Street, a stop bar is proposed next to the existing stop sign for both vehicles and cyclists. **With the proposed fog line and 5' shoulder**, pedestrians and cyclists heading north to the Island Line Trail can move more safely along the northern edge of Penny Lane and connect to the existing sidewalk or crosswalk.

This alternative for the railroad crossing offers a cost-effective solution for this intersection and is depicted in further detail in Figure 4a of Appendix E.

4.6.2 Shared Use Path

For the Shared Use Path alternative, a 12' wide shared use path is proposed on top of a concrete railroad crossing platform, shown below. This would allow pedestrians and cyclists coming from both Depot Street and Lake Street to safely access the Waterfront Park and Island Line Trail.

Field observations of this intersection showed that both pedestrians and cyclists were crossing through the intersection in an unsafe manner via the designated vehicle access, indicating that infrastructure connecting Depot Street and Lake Street to the Waterfront Park and Island Line Trail is highly desirable. Pursuing this alternative would require a formal railroad crossing which offers a long-term solution for this intersection and is depicted in Figure 20, and the same intersection can be found in greater detail in Figure 4b of Appendix E.

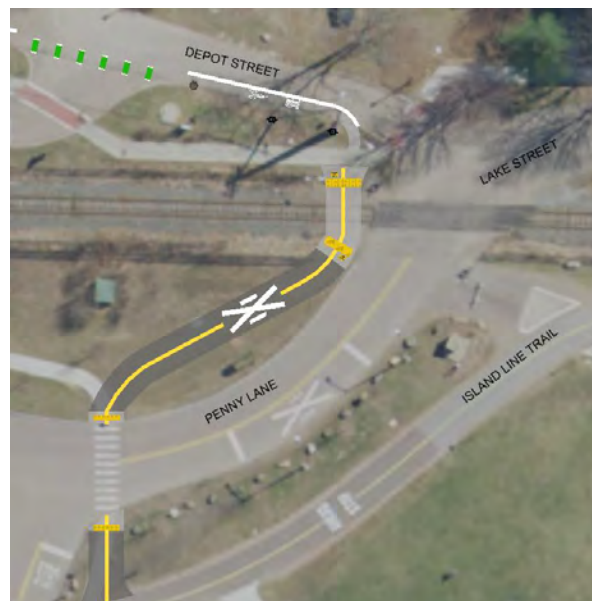


Figure 20: Railroad line with shared use path alternative.



Figure 21: Shared Use Path Rendering.

To slow cyclists traveling down Depot Street, a bike lane is proposed to guide downhill bike traffic into a specific area. A concrete bike lane connection to the shared use path is proposed which has a tight radius due to the existing utility pole. In order to fit a 12' wide shared use path across the railroad, one fence panel along the eastern side and western side of the railroad tracks would need to be removed. Prior to the railroad crossing platform, several detectable warning surfaces would be used along with signs and a railroad crossing marking on the path indicating the need to stop for trains ahead. This shared use path continues on the existing trampled down area along the northern edge of Penny Lane, connecting the formal railroad crossing to the 5' wide existing sidewalk. The elevation of two existing manholes along this path would need to be adjusted and slip-resistant covers would need to be added to both. This shared use path effectively moves pedestrians and cyclists safely to the existing 8.5' wide crosswalk on Penny Lane for access to the Waterfront Park and Island Line Trail. After the crosswalk, there is a short shared use path connection directly to the Island Line Trail. One existing boulder would need to be removed and the existing Penny Lane sign would need to be relocated slightly eastward.

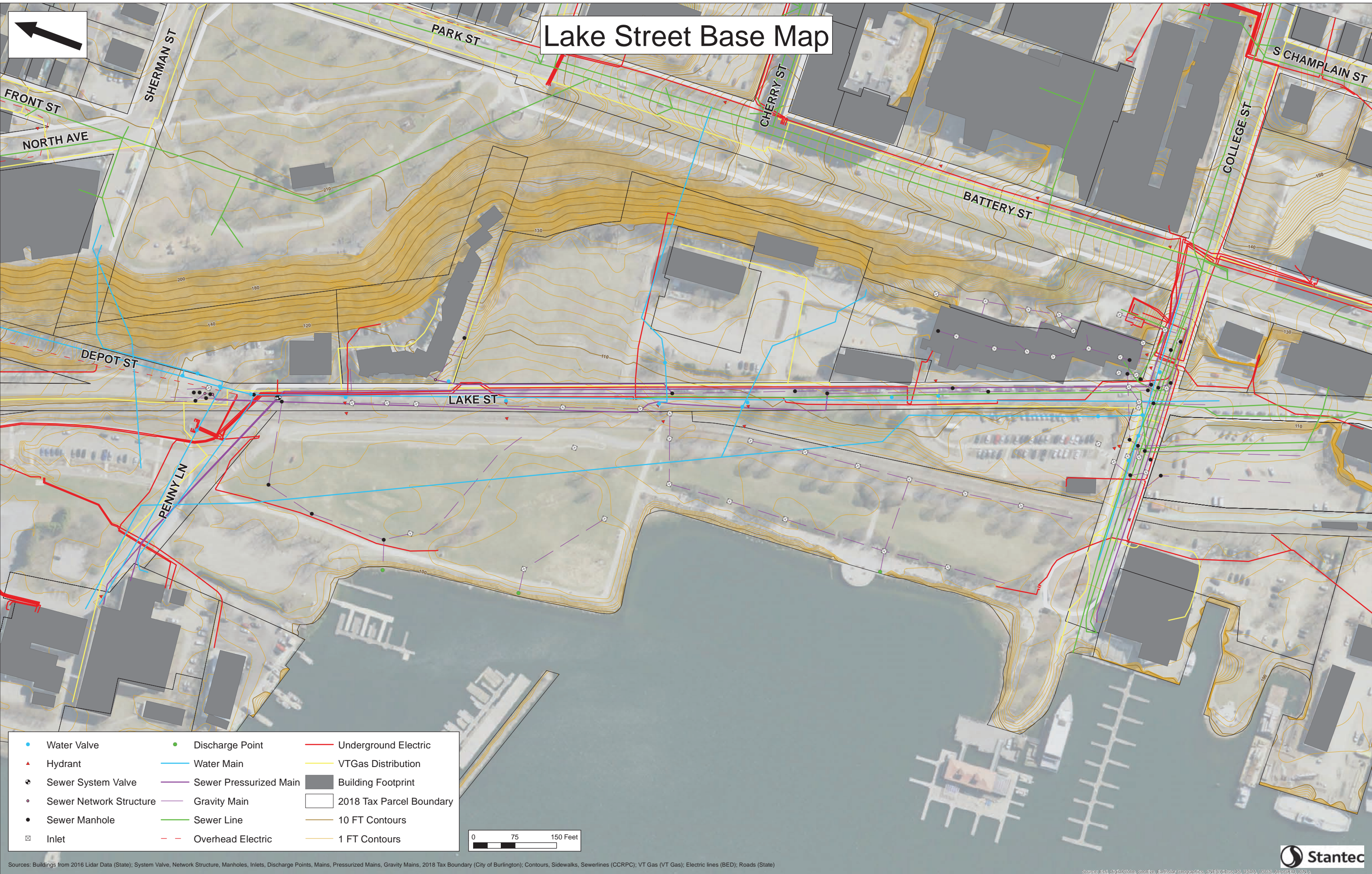
The city cited some expected challenges with the examination of the shared use path, including the following:

- Contaminated Soils
- Duct Banks
- Waterlines
- No-horn policy potentially requiring expensive railroad crossing equipment
- Need for a wider at grade crossing with enhanced signalization

5.0 PUBLIC OUTREACH

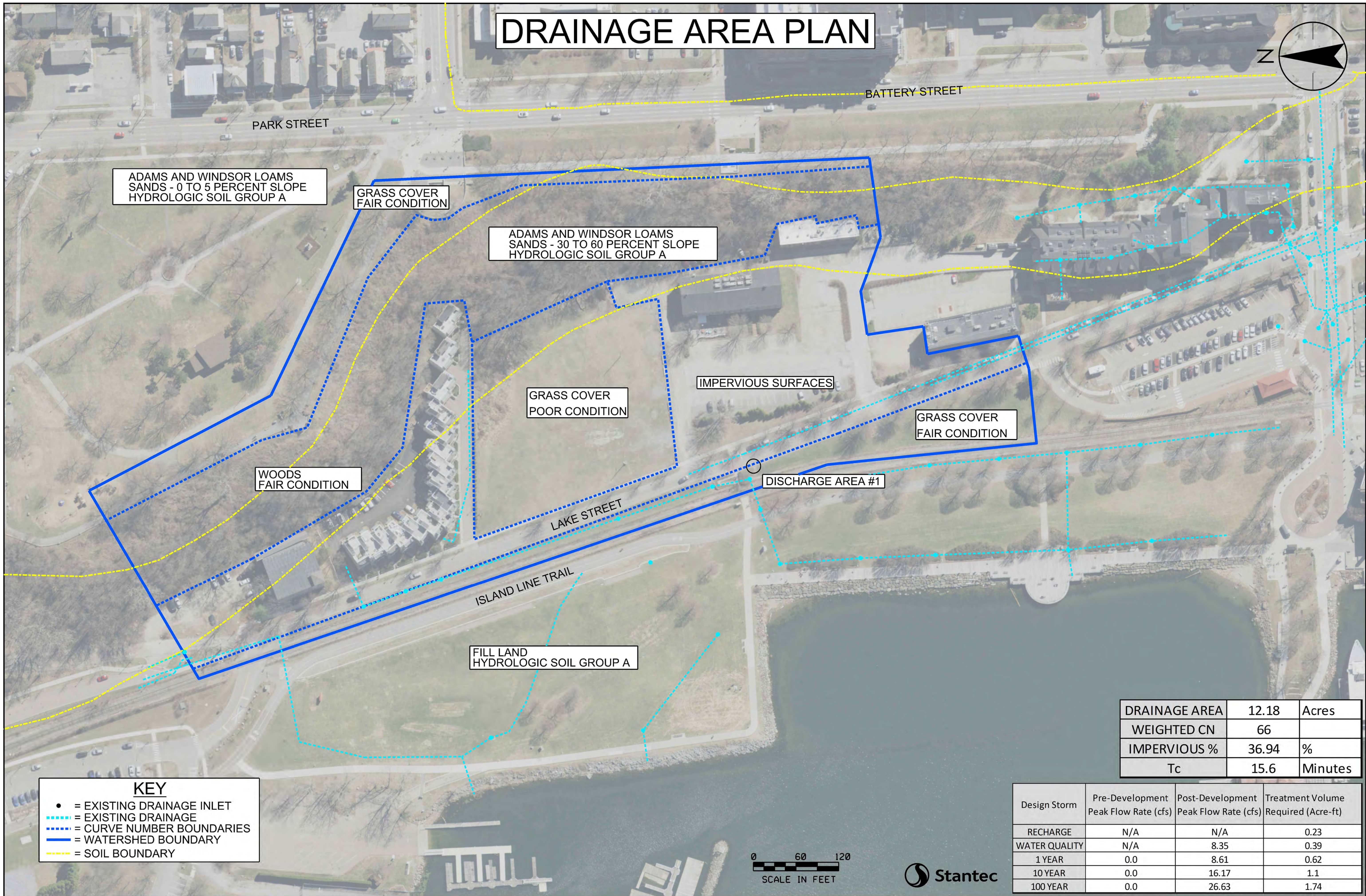
The project committee presented the preferred improvements to the Transportation, Energy, and Utilities Committee (TEUC) on June 23rd, which was well received. The TEUC and committee members expressed interest in seeing the recommendations further evaluated through a more focused scoping process. The TEUC showed strong support for all proposed improvements, noting that their highest priority item was the shared use path connection at the intersection with Penny Lane.

APPENDIX A – EXISTING CONDITIONS PLAN



APPENDIX B – DRAINAGE AREA PLAN

DRAINAGE AREA PLAN



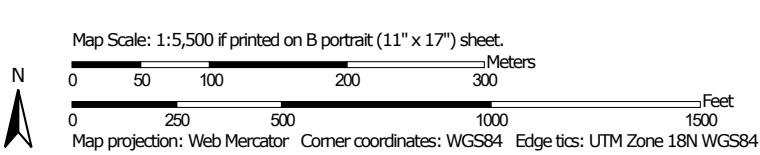
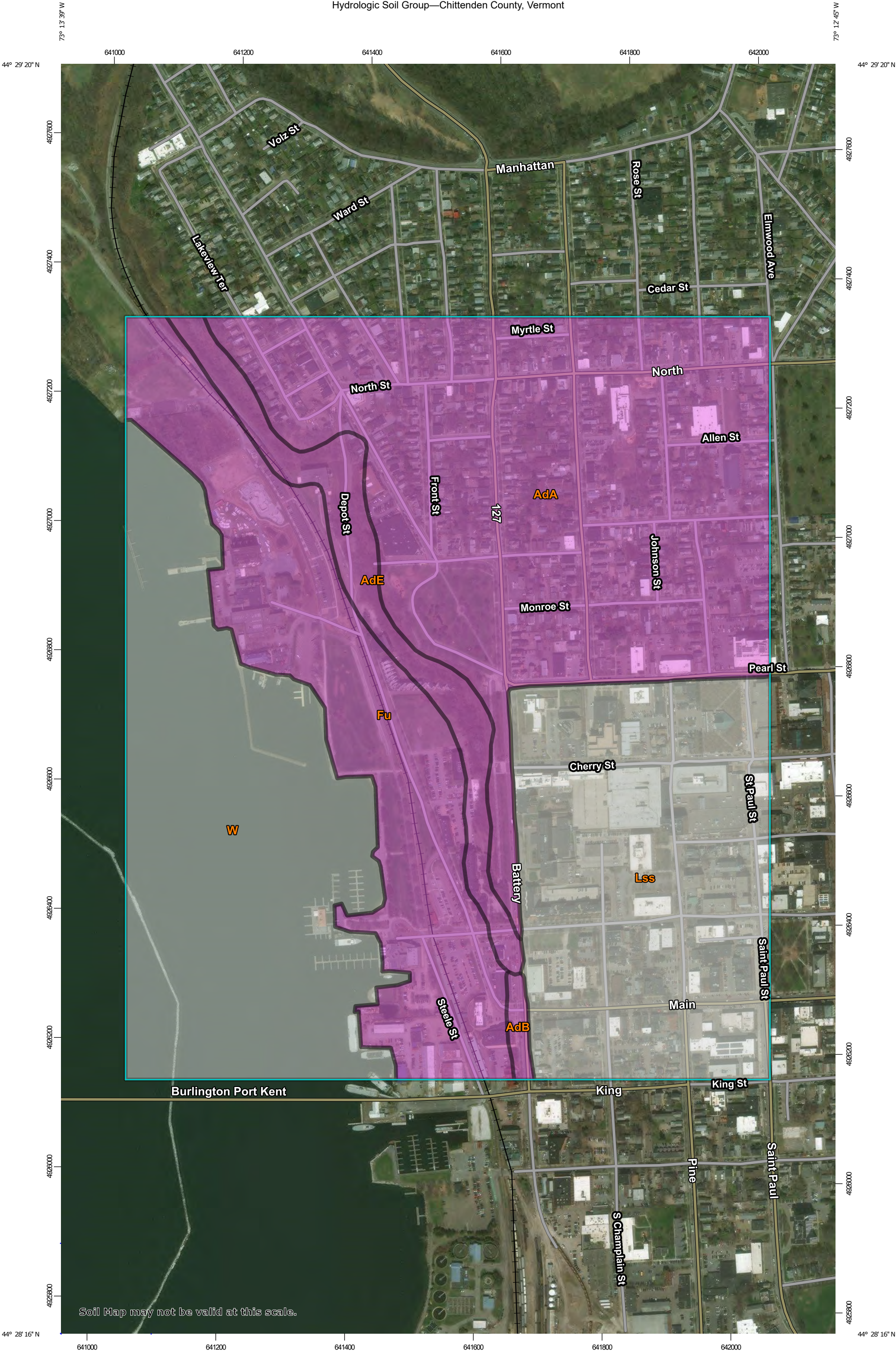
KEY

- = EXISTING DRAINAGE INLET
- = EXISTING DRAINAGE
- = CURVE NUMBER BOUNDARIES
- = WATERSHED BOUNDARY
- = SOIL BOUNDARY

DRAINAGE AREA	12.18	Acres
WEIGHTED CN	66	
IMPERVIOUS %	36.94	%
Tc	15.6	Minutes

Design Storm	Pre-Development Peak Flow Rate (cfs)	Post-Development Peak Flow Rate (cfs)	Treatment Volume Required (Acre-ft)
RECHARGE	N/A	N/A	0.23
WATER QUALITY	N/A	8.35	0.39
1 YEAR	0.0	8.61	0.62
10 YEAR	0.0	16.17	1.1
100 YEAR	0.0	26.63	1.74

APPENDIX C – USGS SOILS MAP



MAP LEGEND

Area of Interest (AOI)









 Area of Interest (AOI)

Soils

Soil Rating Polygons





 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Lines

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Points




 A
 A/D
 B
 B/D

 C
 C/D
 D
 Not rated or not available


Water Features

 Streams and Canals

Transportation

 Rails
 Interstate Highways
 US Routes
 Major Roads
 Local Roads

Background

 Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
 Web Soil Survey URL:
 Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Chittenden County, Vermont
 Survey Area Data: Version 22, Sep 16, 2019

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 28, 2012—Mar 29, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AdA	Adams and Windsor loamy sands, 0 to 5 percent slopes	A	97.6	33.3%
AdB	Adams and Windsor loamy sands, 5 to 12 percent slopes	A	1.3	0.4%
AdE	Adams and Windsor loamy sands, 30 to 60 percent slopes	A	14.6	5.0%
Fu	Fill land	A	50.4	17.2%
Lss	Limit of detailed soil survey		59.4	20.3%
W	Water		69.5	23.7%
Totals for Area of Interest			292.8	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

APPENDIX D – ANR RESOURCE MAP



LEGEND




Stormwater Permits (Issued)








-  Operational
-  Construction
-  Industrial - NOI
-  Industrial - NOX
-  Other

Stormwater Permits (Pending)

-  Operational
-  Construction
-  Industrial - NOI
-  Industrial - NOX
-  Other

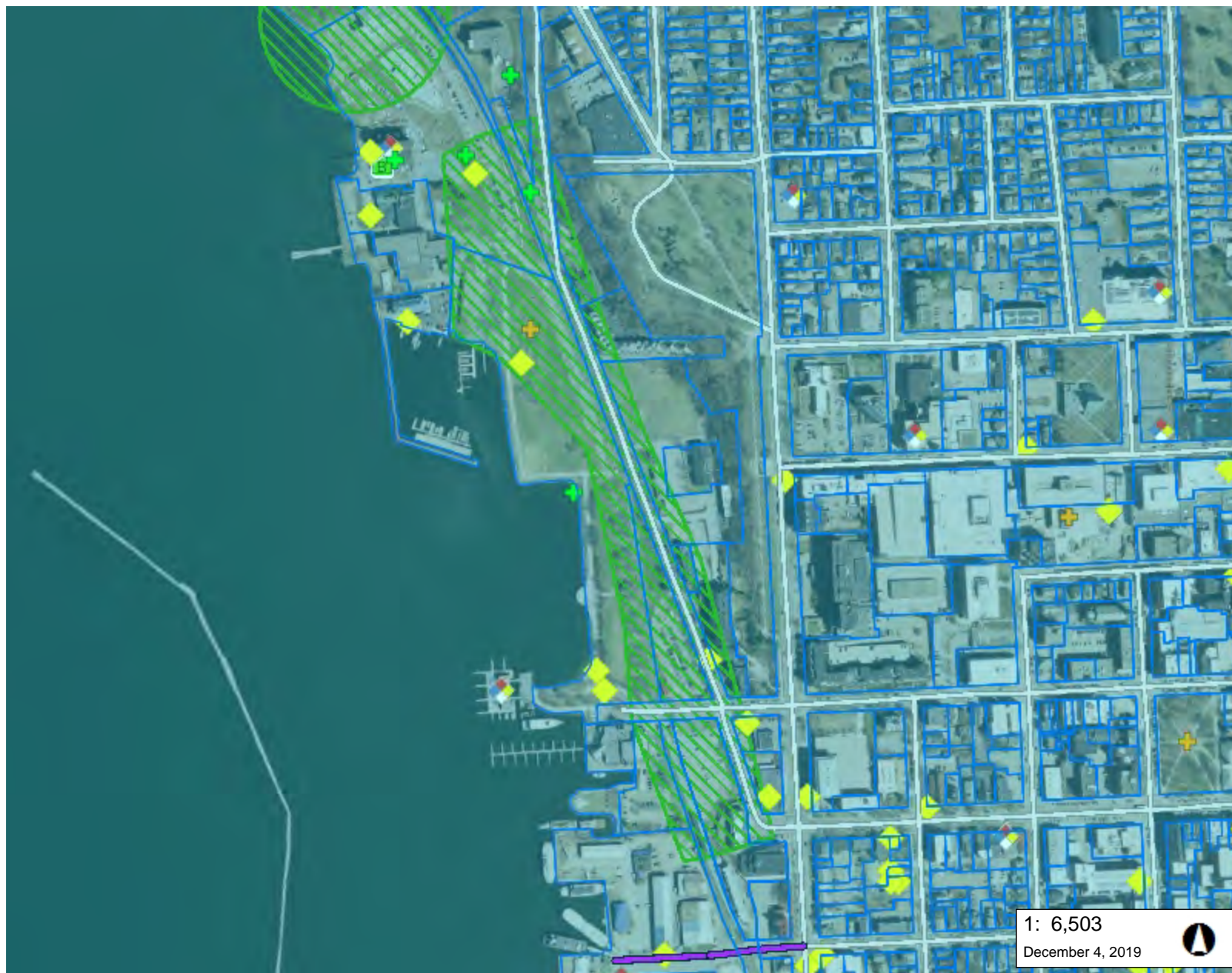
Hydrologically Connected Road (MRGP)

-  Yes
-  Yes (Catch Basin)
-  No

-  Hazardous Site
-  Hazardous Waste Generators
-  Brownfields
- Rare Threatened Endangered**
 -  Threatened or Endangered
 -  Rare
-  Parcels (standardized)
-  Parcels (non-standardized)

NOTES

Map created using ANR's Natural Resources Atlas



1: 6,503

December 4, 2019



330.0 0 165.00 330.0 Meters

WGS_1984_Web_Mercator_Auxiliary_Sphere

© Vermont Agency of Natural Resources

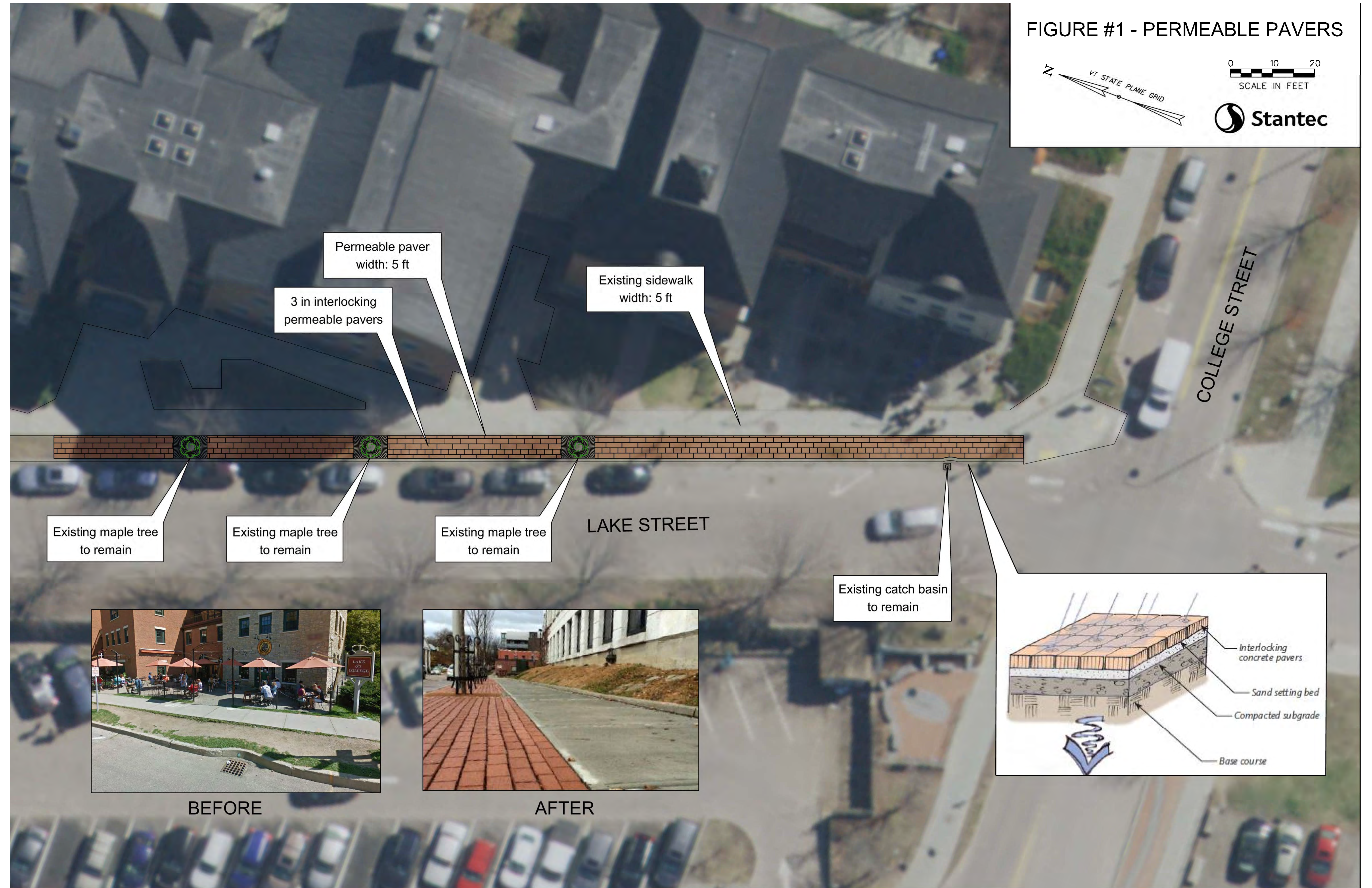
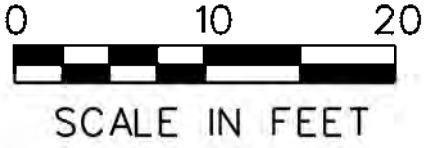
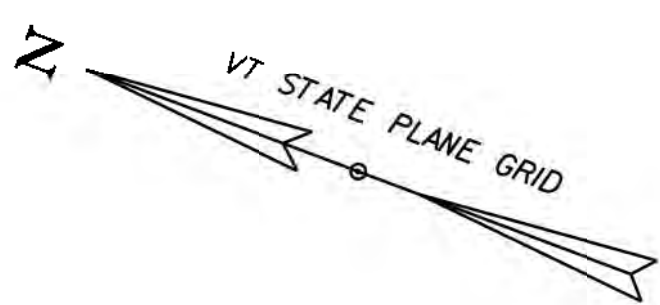
1" = 542 Ft. 1cm = 65 Meters

THIS MAP IS NOT TO BE USED FOR NAVIGATION

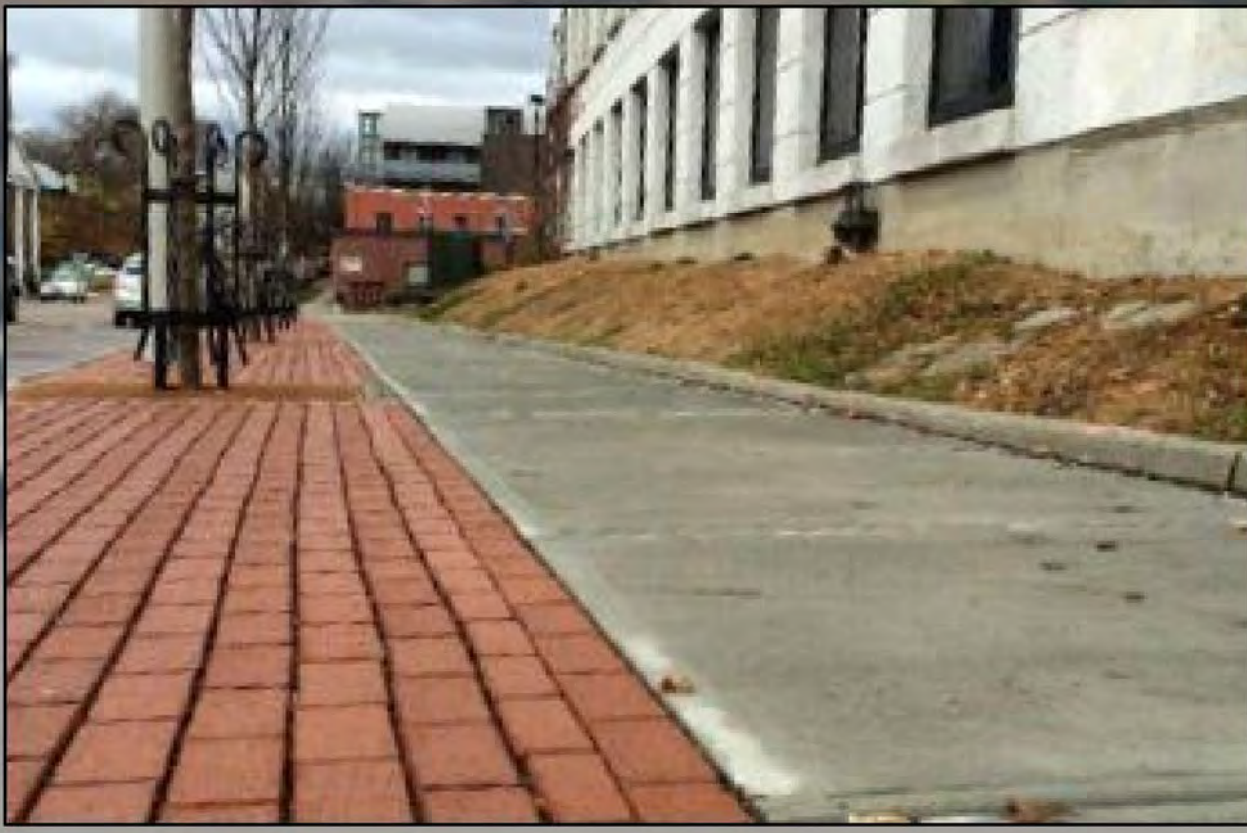
DISCLAIMER: This map is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. ANR and the State of Vermont make no representations of any kind, including but not limited to, the warranties of merchantability, or fitness for a particular use, nor are any such warranties to be implied with respect to the data on this map.

APPENDIX E – RECOMMENDED IMPROVEMENTS FIGURES

FIGURE #1 - PERMEABLE PAVERS



BEFORE



AFTER

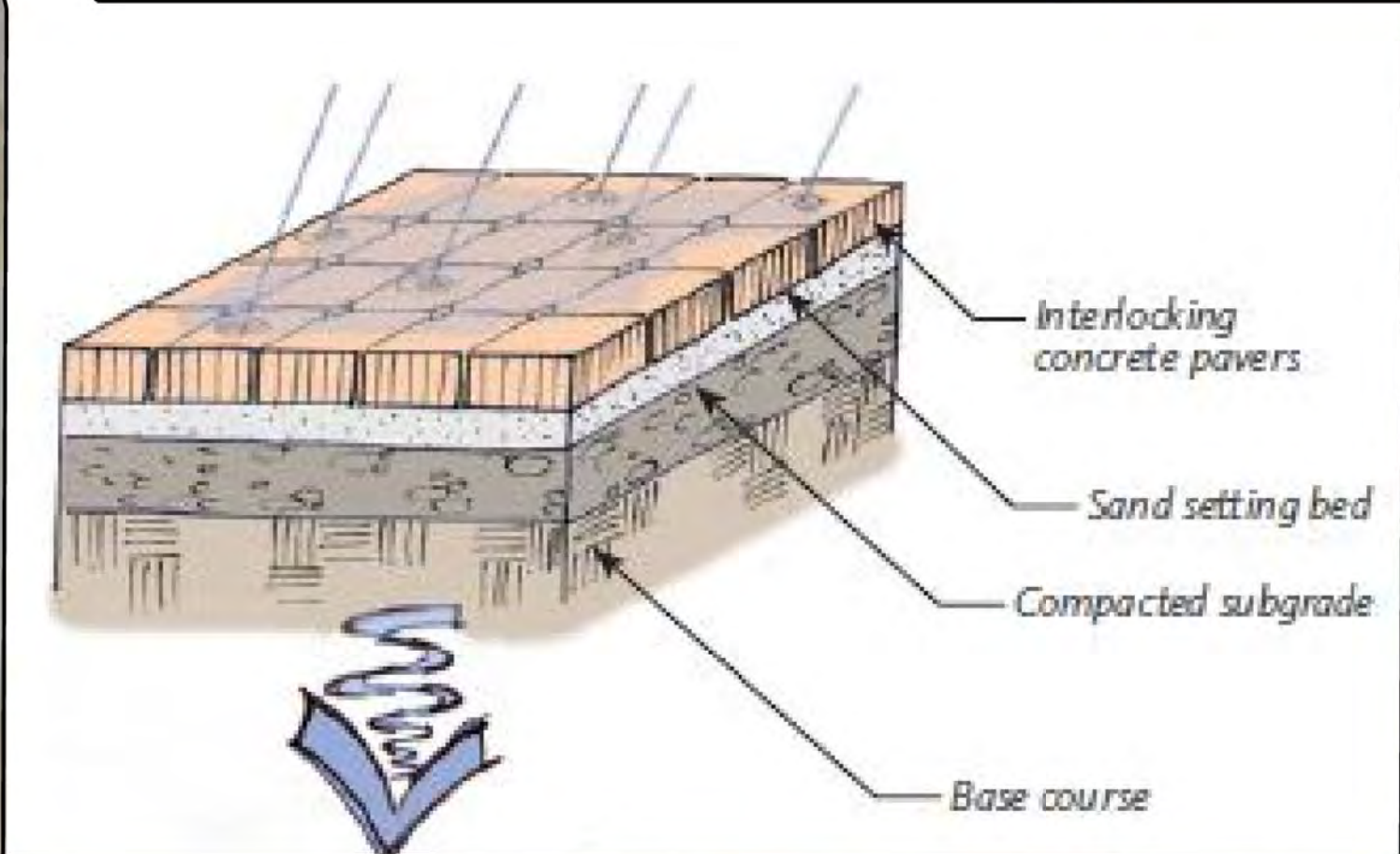
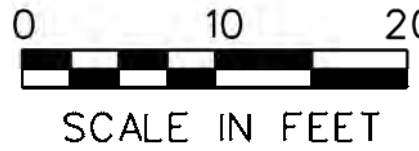
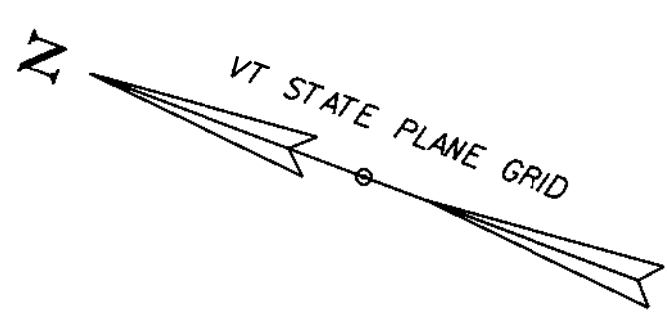


FIGURE #2 - RAIN GARDEN



RAIN GARDEN DRAINAGE AREA

Remove existing carriage stop

Existing maple tree to remain

Proposed rain garden



CROSS-SECTION OF ON-STREET PARKING

Existing on-street parking width: 8 ft

LAKE STREET

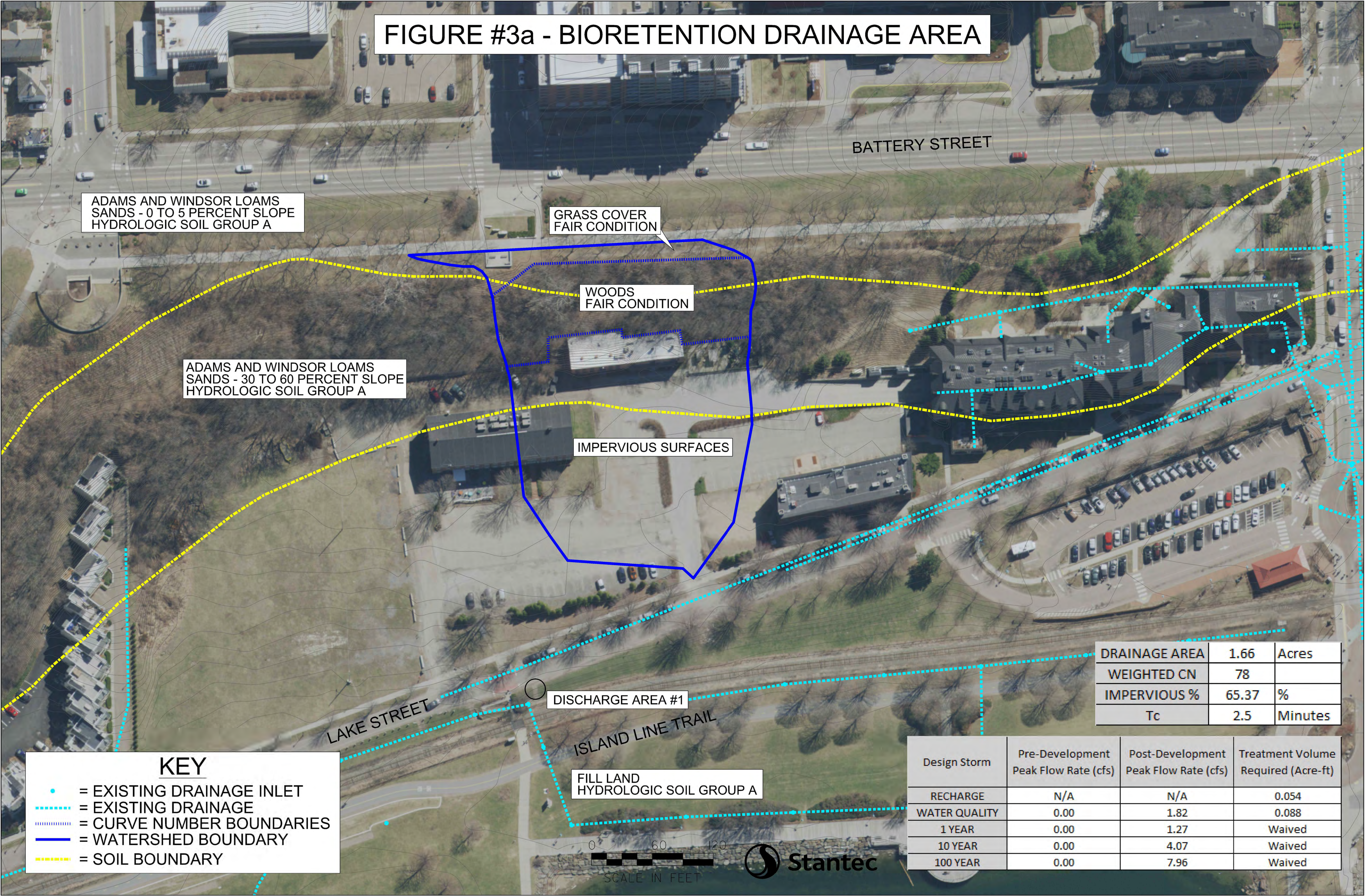


EXISTING PARKING SPOT



RAIN GARDEN

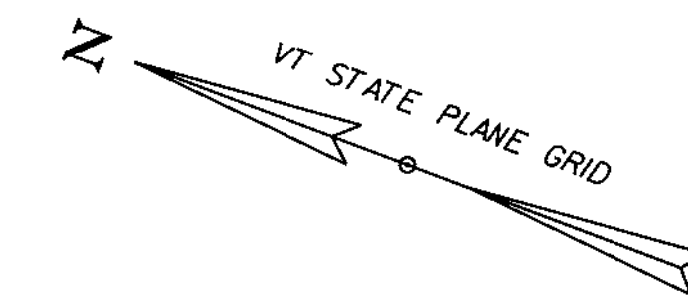
FIGURE #3a - BIORETENTION DRAINAGE AREA



DRAINAGE AREA	1.66	Acres
WEIGHTED CN	78	
IMPERVIOUS %	65.37	%
Tc	2.5	Minutes

Design Storm	Pre-Development Peak Flow Rate (cfs)	Post-Development Peak Flow Rate (cfs)	Treatment Volume Required (Acre-ft)
RECHARGE	N/A	N/A	0.054
WATER QUALITY	0.00	1.82	0.088
1 YEAR	0.00	1.27	Waived
10 YEAR	0.00	4.07	Waived
100 YEAR	0.00	7.96	Waived

FIGURE #3b - BIORETENTION



0 10 20
SCALE IN FEET



LEGEND	
	Water Main
	VT Gas Distribution
	Underground Electric
	Sewer Pressurized Main
	Sewer Line

Proposed pipe connection

Proposed catch basin

Proposed catch basin

Existing maple tree to remain

Existing maple tree to remain

Existing maple tree to remain

LAKE STREET

Sediment forebay holds 25% WQv

Earthen berm connects forebay to bioretention

Pipe inlet to forebay

Pipe outlet to existing inlet

Hydraulic outlet structure

Bioretention area: 1050 ft²

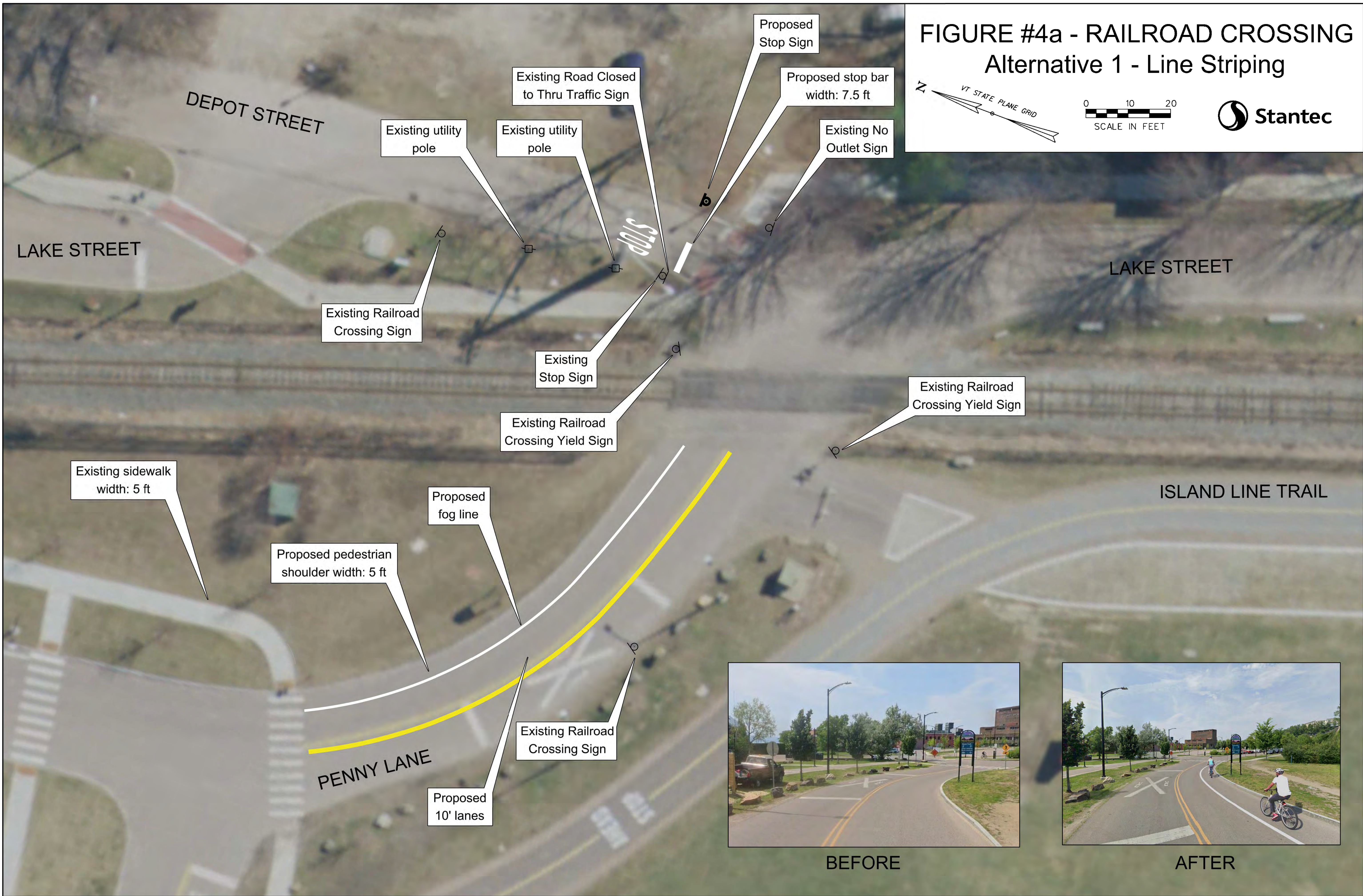
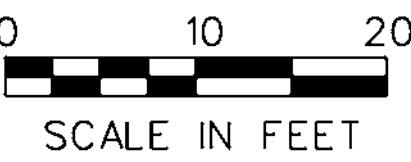
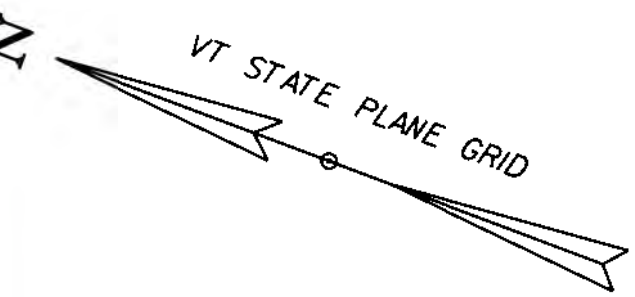


EXISTING TREATMENT LOOKING SOUTH

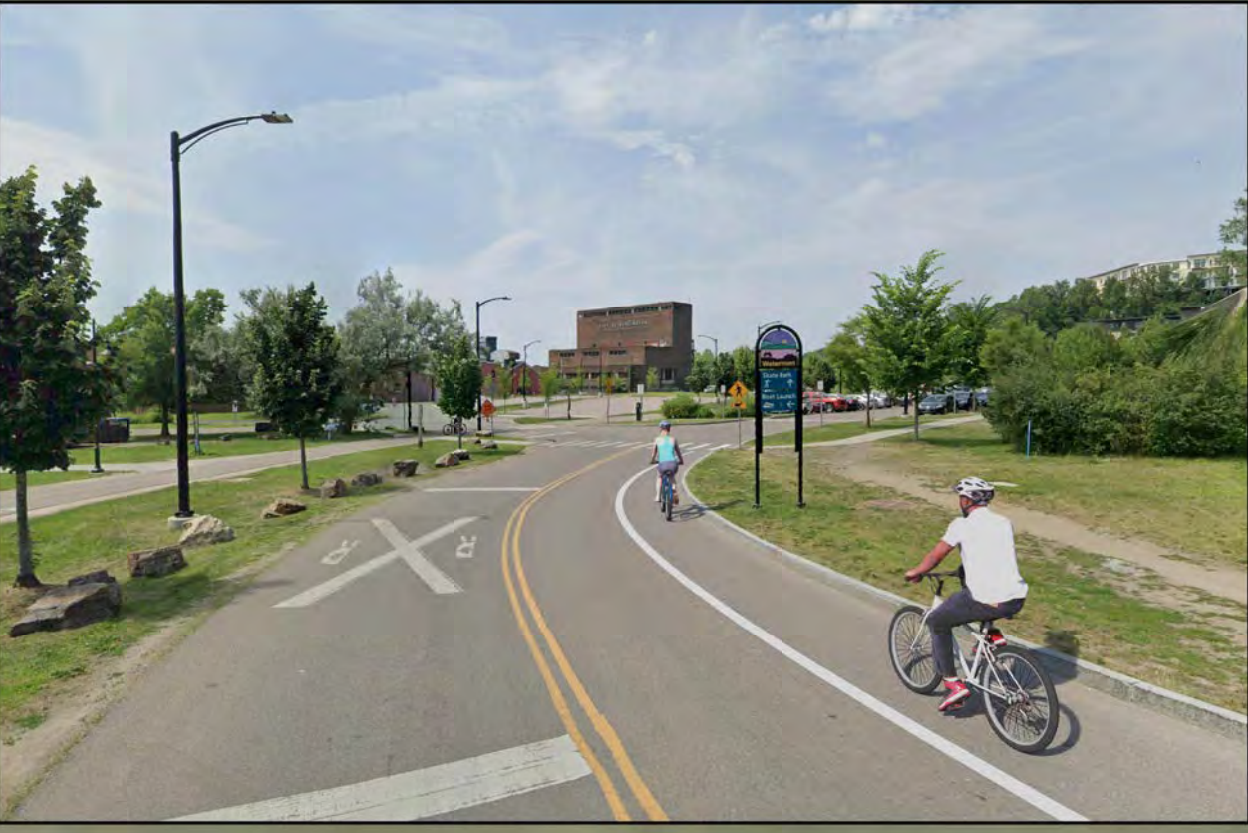


PROPOSED TREATMENT

FIGURE #4a - RAILROAD CROSSING
Alternative 1 - Line Striping

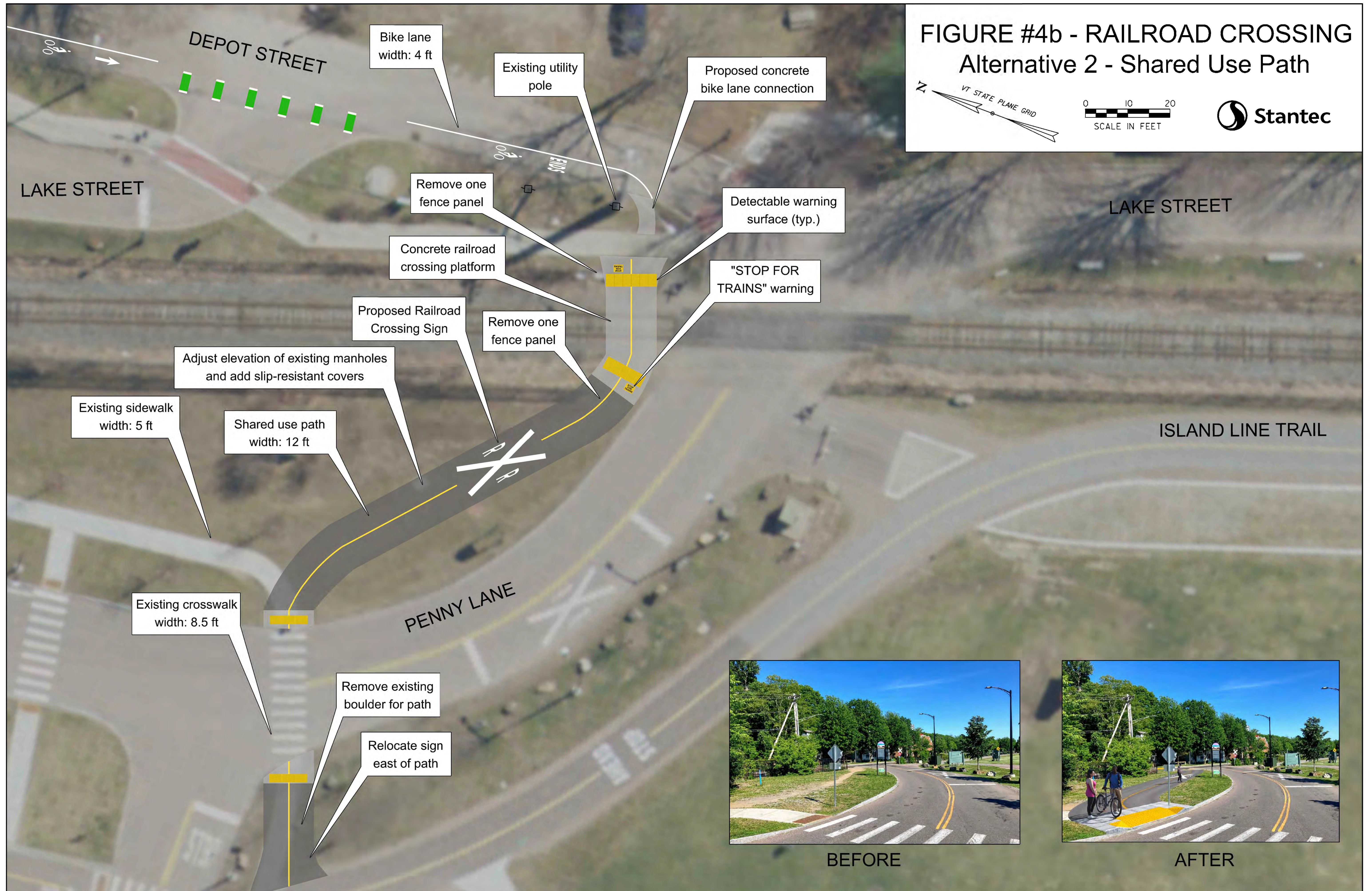
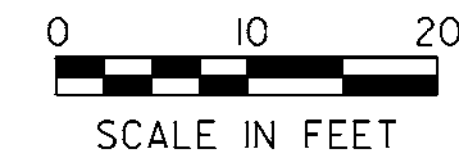
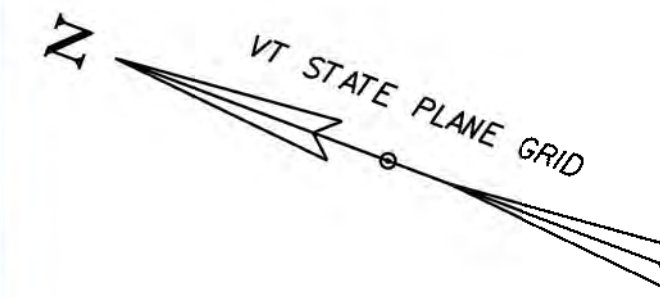


BEFORE



AFTER

FIGURE #4b - RAILROAD CROSSING
Alternative 2 - Shared Use Path



BEFORE



AFTER