Town of Groton

Complete Streets

Bicycle and Pedestrian Masterplan

April, 2025

GROTON PARKS & RECREATION

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Acknowledgements

Special thanks to the following groups and individuals for their contributions to this plan:

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Contents

Appendix

1 INTRODUCTION

1.1 PURPOSE

This plan will provide the Town of Groton with guidance to improve bicycling and pedestrian conditions across the town with an emphasis on improving connections to and between parks, open spaces, schools, and existing bicycle and pedestrian facilities. This plan is one component of a Complete Streets approach to planning and designing transportation infrastructure to meet the needs of all users. Other components of Complete Streets such as transit facilities and services, traffic calming, access management, and streetscape design are not directly addressed by this plan, however the recommendations of this plan are fully compatible with the Complete Streets approach of accommodating all users and modes of travel.

1.2 COMPLETE STREETS APPROACH

1.2.1 COMPLETE STREETS POLICY

In August of 2022, the Town of Groton adopted a Complete Streets Policy with a vision to improve the accessibility and safety of Groton's streets for all users.

The Complete Streets Policy emphasizes the principles of All Users and All Modes, Network Connectivity, and Design. This plan seeks to fulfill that commitment by recommending bicycle and pedestrian improvements that are aimed at all levels of mobility across the entire town. This plan directly supports the following Complete Streets goals by prioritizing roads and areas for the improvement or development of bicycle and pedestrian facilities and by providing guidance for the design and construction of those facilities:

1. New construction projects and reconstruction/ retrofit projects shall incorporate wherever possible and warranted, the needs of all modes of transportation and all users of the road network. Focus on specific roadways and districts with existing demand and/or future potential for increased biking and walking. Projects such as road reconstruction, intersection improvements, and routes to schools and parks represent significant opportunities for Complete Streets improvements.

2. On an as-needed basis, incorporate Complete Street improvements in routine repairs and roadway maintenance. This may include crosswalk repainting, signage, lighting, sidewalk, and curb ramp repair. These minor activities may be addressed by staff review and not subject to Complete Streets Committee review.

1.2.2 COMPLETE STREETS ADVISORY COMMITTEE

As a part of the Complete Streets Policy, the Groton Town Council formed a Complete Streets Advisory Committee that is responsible for providing guidance for the implementation of Complete Streets within the community. The Committee served as the steering committee for the development of this plan, providing frequent and valuable guidance throughout the planning process.

1.2.3 LOCAL AND REGIONAL PLANS

The Complete Streets approach aims to accommodate all modes of transportation within a community and along as many roads as possible. This includes pedestrians, wheelchair users, bicyclists, transit users, and drivers. Many of Connecticut's towns and cities have adopted Complete Streets policies or have facilitated Complete Streets projects.

The Complete Streets approach has multiple objectives and benefits including making communities more equitable by improving mobility conditions for those without a driver's license or car, facilitating active movement and healthy lifestyles and improving roadway safety.

The Southeast Council of Governments (SECOG), of which Groton is a member community, developed a Regional Bike and Pedestrian Plan in 2019, which recommends Complete Streets improvements across the region including Groton.

1.2.4 CTDOT COMPLETE STREETS DESIGN CRITERIA

In 2023, the Connecticut Department of Transportation (CTDOT) expanded its Complete Streets Policy by adopting new complete streets design criteria. This criteria is to be incorporated into all CTDOT projects, with the goal of improving roadway safety and enhancing mobility for all users.

The criteria focuses on the three areas of pedestrian facilities, bicycle facilities, and transit provisions, to ensure that planned projects are designed to accommodate multi-modal transportation and safety.

COMPLETE STREETS

Image Source: CTDOT

Image Source: Bike Groton

2 THE COMMUNITY'S PERSPECTIVE

2.1 COMMUNITY ENGAGEMENT

Groton residents and frequent users of Groton's roads, sidewalk, and trail infrastructure have provided valuable input and feedback throughout the development of this plan. The community's perspective has served as a strong guiding force in identifying the needs, concerns, and desires of those using Groton's bicycle and pedestrian network and has played an important role in the development of the plan's recommendations.

The project team engaged with the community through stakeholder meetings, an online complete streets survey, focus group workshops, and a community workshop. The Town further engaged with members of the community by distributing surveys at Town of Groton events to reach more people and promote awareness about the plan.

2.1.1 COMPLETE STREETS SURVEY

The online complete streets survey was launched in the spring of 2024 with the aim of learning more about residents' thoughts and concerns about walking or bicycling in Groton. The survey received 624 responses and provides valuable insight from bicyclists and pedestrians with varying levels of experience and physical ability.

"I would LOVE to see a cross-town (east to west) bike or walking path that connects various open spaces".

"Expand sidewalks into multiuse trails in places where it is not practical to add buffered bike lanes".

"Improve signage along paths and trails".

"We need better maintenance of roadway shoulders and sidewalks".

FROM THE COMMUNITY

Responses to the survey indicate that the lack of sufficient infrastructure and concerns for personal safety are a challenge for Groton's bicyclists and pedestrians, and are reasons that many people choose not to bicycle or walk along roadways in Town. Through the survey, the community expressed that well maintained sidewalks and roadway shoulders, better bicycle and pedestrian connections, as well as more sidewalks, would improve bicycling and walking conditions and encourage bicyclists and pedestrians to travel along roadways in Town.

2.1.2 FOCUS GROUP MEETINGS

The project team conducted focus group meetings in the summer of 2024 to inform the project's existing conditions analysis. These meetings were topic based, small group discussions.

The first meeting was attended by bicycle commuters and recreational riders that frequently use Groton's roadways, paths, and trails. This group provided insight on frequently used routes, perception of safety and safety concerns, as well as an understanding about the bicycling culture within Town.

The second meeting, comprised of parks and open space stakeholders, focused on the recreational value of Groton's bicycle and pedestrian network. In this discussion, attendees identified opportunities to enhance Groton's trail facilities, and their connectivity, as well as the challenges that exist in doing so.

2.1.3 FOCUS GROUP WORKSHOPS

Two focus group workshops were conducted with the members of Groton's Complete Streets Advisory Committee, which also served as the Steering Committee for this Plan. The first workshop was held in the spring of 2024. The intent of the workshop was to review prior bicycle and pedestrian plans produced for the Town and to begin outlining a network of priority corridors for complete streets improvements.

The second focus group workshop was held in late fall, 2024 for the purpose of selecting corridors for concept plan development. The committee and project team reviewed multiple corridors that had been recommended for improvements and identified five segments that were a priority for developing conceptual designs for (**See Appendix 6 Concept Plans**).

2.1.4 COMMUNITY WORKSHOP

The project team conducted a community workshop at the Thrive 55 Community Center in early fall, 2024. The workshop included a presentation of existing conditions, survey results, bicycle and pedestrian facility types, and preliminary complete streets recommendations, followed by breakout sessions with the workshop attendees. Within the breakout sessions, participants identified roadways and types of improvements that should be prioritized within the plan. They also provided feedback on the preliminary complete streets network produced by the project team and identified additional areas and corridors for inclusion in the network.

September 2024 Public Workshop

2.2 KEY THEMES FROM COMMUNITY ENGAGEMENT

Summarized below are key themes that emerged from the community engagement process. The community expressed a need or desire to accomplish the following items.

- Improve handicap accessibility throughout town
- Improve safety along roadways
- Improve roadway signage to promote awareness of bicyclists
- Fill gaps in the bicycle and pedestrian network and connect facilities
- Accommodate the many east/west commuters in Town by providing facilities along these routes
- Promote that roads are a public resource that should be shared and accessible
- Encourage bicycling at Groton's Public Schools
- Increase connections to Groton's extensive network of trails
- Improve wayfinding for trails
- Increase maintenance of roadway shoulders and sidewalks for both bicyclists and pedestrians
- Provide designated bicycle facilities where bicyclists have their own space
- Educate drivers about different types of bicycle facilities and the expectations and rules of each facility
- Reconfigure intersections to provide better pedestrian amenities
- Install amenities such as benches and lighting to improve pedestrian comfort and safety

See detailed notes for the community workshop in **Appendix 5 Community Workshop Summary**.

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3 EXISTING CONDITIONS

3.1 RELEVANT PLANS

There is a long history of planning for bicycle and pedestrian improvements across Town and the region. Relevant plans and studies include the following:

- **Tri-Town Trail Master Plan:** Master plan for a shared use path through the towns of Groton, Ledyard, and Preston.
- **SECOG Bicycle and Pedestrian Plan:** A regional plan for southeastern Connecticut that identifies bicycle networks, analyzes pedestrian environments, and provides recommendations for its twenty-two member towns.
- **Depot Road to Thomas Road Concept:** Conceptual level planning for a proposed bicycle facility along Industrial Drive, Depot Road, Route 1, South Road, and Tower Ave.
- **Cross Town Greenway:** A greenway master plan consisting of existing and proposed hiking trails and bicycling routes through public open space and on roadways in Groton.
- **Parks and Recreation Master Plan:** Master plan that provides foundational guidance and recommendations for the future of Groton's Parks and Recreation facilities and services.

Bike Lanes on Thomas Road, Image Source: Google Maps

3.2 EXISTING BICYCLE AND PEDESTRIAN FACILITIES

Groton's current bicycle and pedestrian network consists of:

- **Sidepaths:** Separated facility for the shared use of bicyclists and pedestrians. Found along segments of Route 12 and Route 1.
- **Bike Lanes:** An exclusive space on the roadway for bicycle travel, which is signified by pavement markings and signage. Found on Thomas Road and Groton Long Point Road (Brook Street to Esker Point).
- **Shared Use Paths:** A facility that is shared by bicyclists and pedestrians that is recreational in nature and often travels through open space areas. An example is the G&S Trolley Trail.
- **Trails:** Within Public Open Space.
- **Sidewalks:** The most complete segments of sidewalk in Town are found along the western segment of Route 1, the southern segment of Route 12, and the eastern segment of Route 215. In these locations, there are sidewalks on both sides of the roadway for continuous stretches. Other locations along these corridors and other roadways in Town lack sidewalks or contain gaps that disrupt sidewalk continuity and pose safety risks for pedestrians walking along the street. Groton lacks sidewalks on major north/south corridors, such as Route 117, Flanders Road, and Route 614 (Allyn Street and Cow Hill Road). The Gold Star Hwy (Rt 184) similarly lacks a complete sidewalk network.

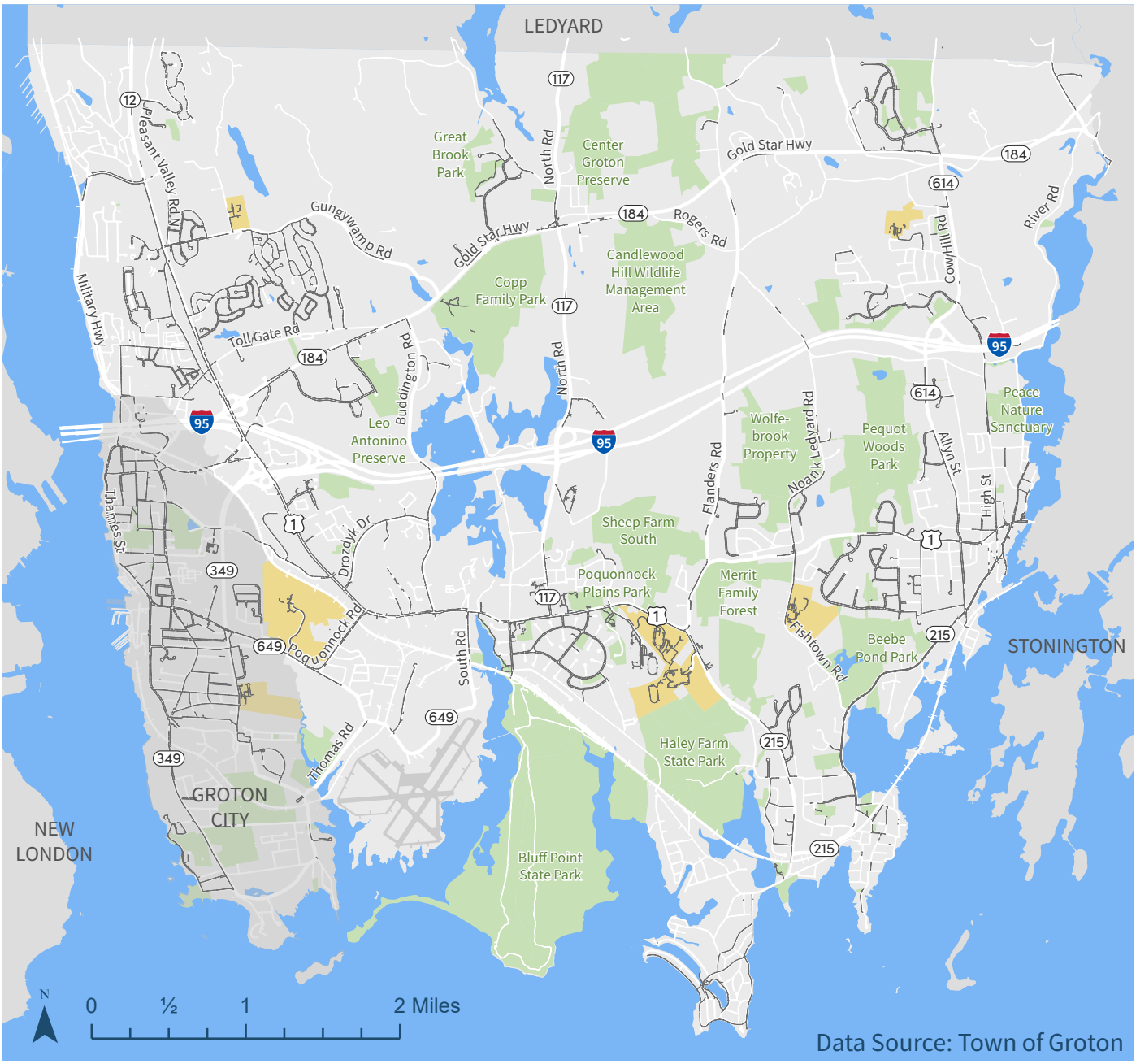
Marked bicycle routes that do not provide a designated facility for bicyclists are not included as existing facilities. For this reason, these routes have been identified as key priority areas throughout the development of this plan.

Sidewalks on Route 215 in Mystic, Image Source: Google Maps

Sidepath near Route 12, Image Source: Google Maps

Poquonnock River Boardwalk

MAP 3-1 EXISTING PUBLIC SIDEWALKS



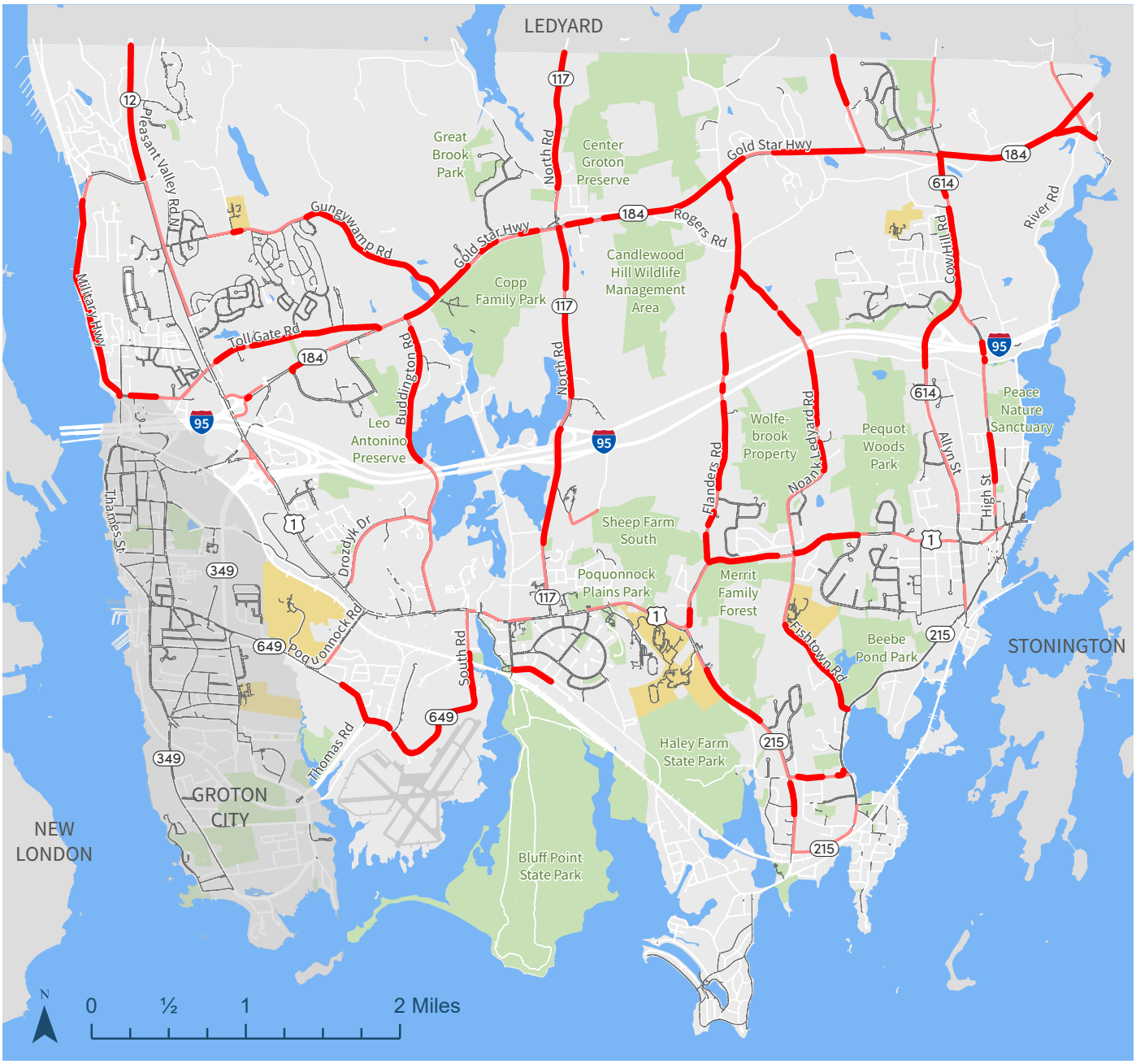
Key

Existing sidewalk

Public Open Space

Schools

MAP 3-2 SIDEWALK GAP ANALYSIS

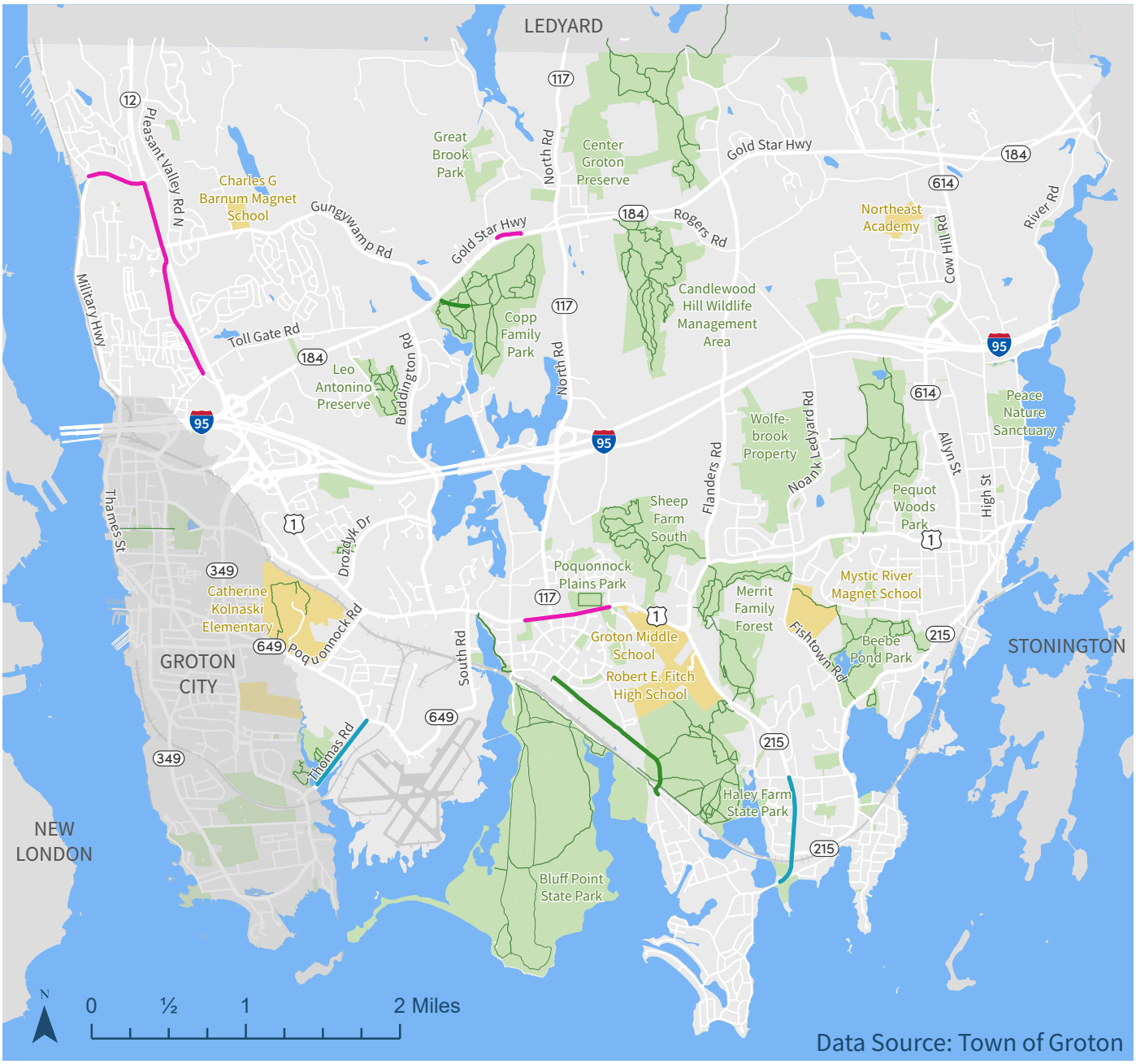


Key

- Sidewalk Gap* (one side of roadway)
- Sidewalk Gap* (both sides of roadway)
- Existing sidewalk
- Public Open Space
- Schools

*Sidewalk gaps were analyzed for arterial and collector roadways and for some local roads that provide important connections within the pedestrian network. See **Map 3-4** for a map of arterial and collector roadways.

MAP 3-3 EXISTING BICYCLE, PATH, AND TRAIL FACILITIES



Key

- Sidepath
- Bike Lane
- Shared Use Path
- Trail
- Public Open Space
- Schools

3.3 ROADWAY ANALYSIS

An understanding of roadway conditions is critical in ensuring the suitability of recommended facilities. Roadway classification, average daily traffic volumes, traffic speeds, and crash activity, are all important factors to consider when recommending bicycle and facility improvements for a roadway.

3.3.1 FUNCTIONAL CLASSIFICATION

Functional classification defines the role of a roadway within its network and the level of travel service that it provides. Groton's roadway network is classified by the Connecticut Department of Transportation as local roads, major collectors, principal and minor arterials, freeways and expressways, and Interstate 95 (which runs east to west through the center of Town).

Most of the non-local roads in Town are either minor arterials or major collectors and many are designated as state roadways. When considering bicycle and pedestrian facilities, local and collector roads are generally preferred over arterial roads. This is because local and collector roadways typically have lower traffic volumes and carry less freight traffic.

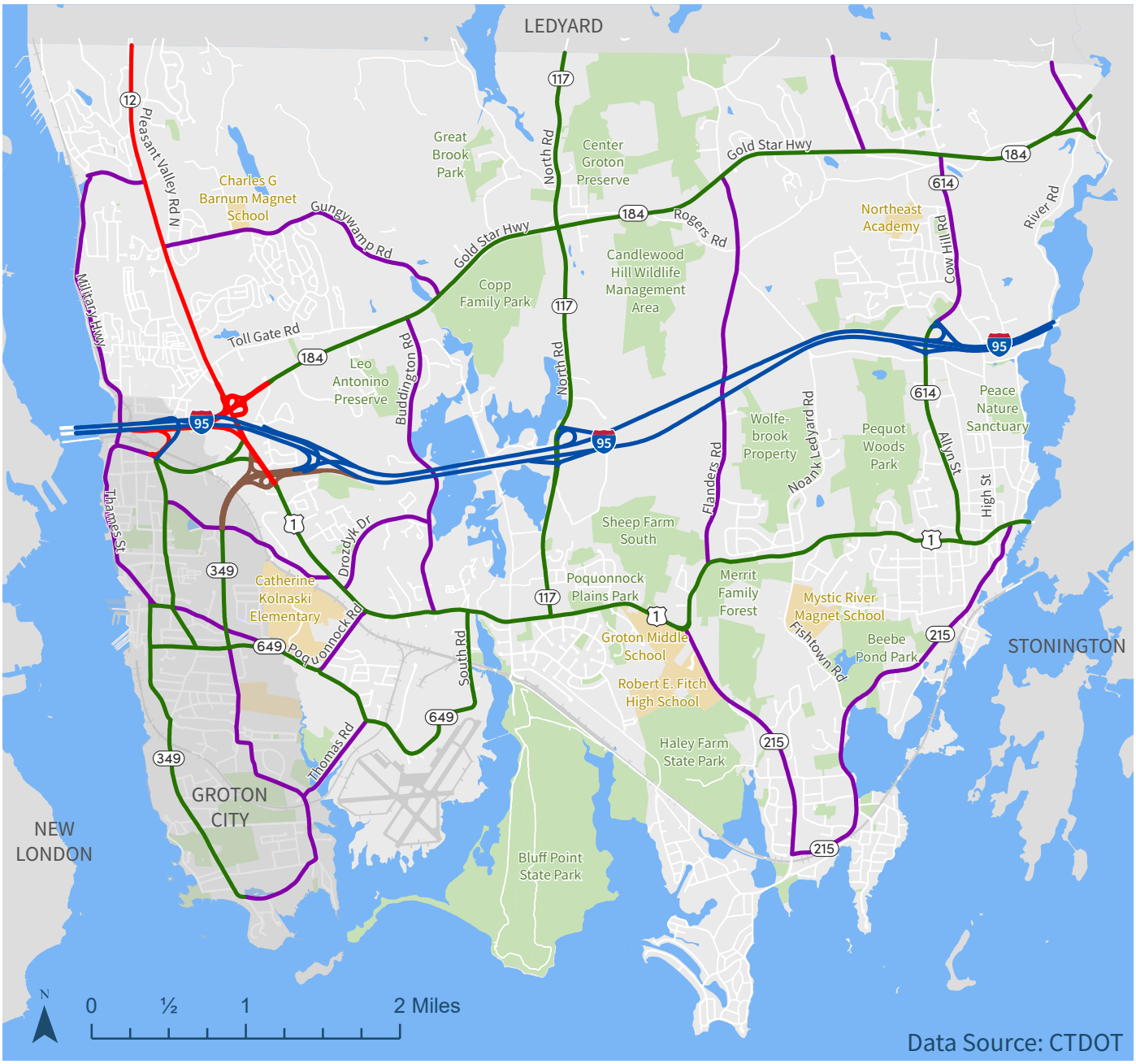
Table 3-1 Arterial and Collector Roadways (CTDOT Functional Classification)

Roadway Classification	Roads
Principal Arterial	Rt 12* Rt 1 (Kings Hwy to Rt 349)*
Minor Arterial	Rt 1 (Rt 349 to Stonington)* Rt 184 (Gold Star Hwy)* Rt 117* Rt 649 (South Rd/Tower Ave/ High Rock Rd/Poquonnock Rd)* Rt 614 (Allyn St)*
Major Collector	Rt 215* Rt 614 (Cow Hill Rd)* Flanders Rd Shewville Rd Colonel Ledyard Hwy Buddington Rd Drozdyk Dr Gungywamp Rd Meridian St Ext Poquonnock Rd Thomas Rd Crystal Lake Rd Military Hwy

*State roadways
Note: All roads not listed are classified as local

Source: CTDOT

MAP 3-4 ROADWAY FUNCTIONAL CLASSIFICATION (CTDOT)



Key*

- Interstate
- Other Freeway or Expressway
- Other Principle Arterial
- Minor Arterial
- Major Collector
- Public Open Space
- Schools

*See Groton Plan of Conservation and Development for roadway classifications specific to that plan.

3.3.2 AVERAGE DAILY TRAFFIC VOLUMES

Average daily traffic (ADT) volume is the average number of cars traveling along a roadway on any given day. Higher traffic volumes typically correlate with greater levels of stress for bicyclists and pedestrians that share the roadway. In locations where ADT volumes are greater than 25,000, it is recommended to separate bicycle traffic from motor vehicle traffic. In locations where ADT volumes are lower, such 10,000 and below, bicyclists are generally more comfortable sharing the road with motor vehicles (assuming traffic speeds are not too high).

The highest volumes in Town, excluding I-95, are along Route 12 and the western segments of Route 1. The lowest volumes are found on local roadways, collector roads such as Buddington Road, Flanders Road, and Gungywamp Road, and the eastern segments of Route 215 and Route 1.

3.3.3 TRAFFIC SPEEDS

Speed plays a large role in the selection of appropriate bicycle facilities. While bicyclist comfort generally declines with higher traffic volumes and heavy vehicles, bicyclist safety is most impacted by traffic speed. As traffic speed increases, the severity of collision increases.

Traffic speed data was collected from CTDOT in the form of 85th percentile speeds, which is the speed at which 85% of drivers travel at or below.

In locations where speeds are greater than 45 mph, CTDOT recommends to separate bicycle traffic from vehicular traffic. Bicyclist comfort and safety on higher speed roads can be improved using traffic calming techniques that reduce traffic speed and/or providing adequate separation between bicyclists and vehicles.

The highest speeds in Town are found along Routes 117, 614 (Allyn Street and Cow Hill Road), 184, 215, 1, and 12.

3.3.4 CRASH ACTIVITY

Higher crash concentrations may be correlated with higher user stress levels and increased safety risk. The greatest concentrations of crashes over the 5-year period from 2019-2023 were located along Route 12 and Route 1, specifically near the on- and off-ramps of Route 184 and under the I-95 overpass. Other notable locations include; the intersection of Route 117 and Route 184; the on and off ramps to I-95 from Allyn St; and West Main Street along Route 1.

Bicycle and pedestrian involved crashes follow a similar pattern, with most crashes occurring along Route 12 and Route 1. There are also instances of bicycle or pedestrian involved crashes on Toll Gate Road, Route 184, Crystal Lake Road, and other locations.

3.3.5 ROADWAY STRESS

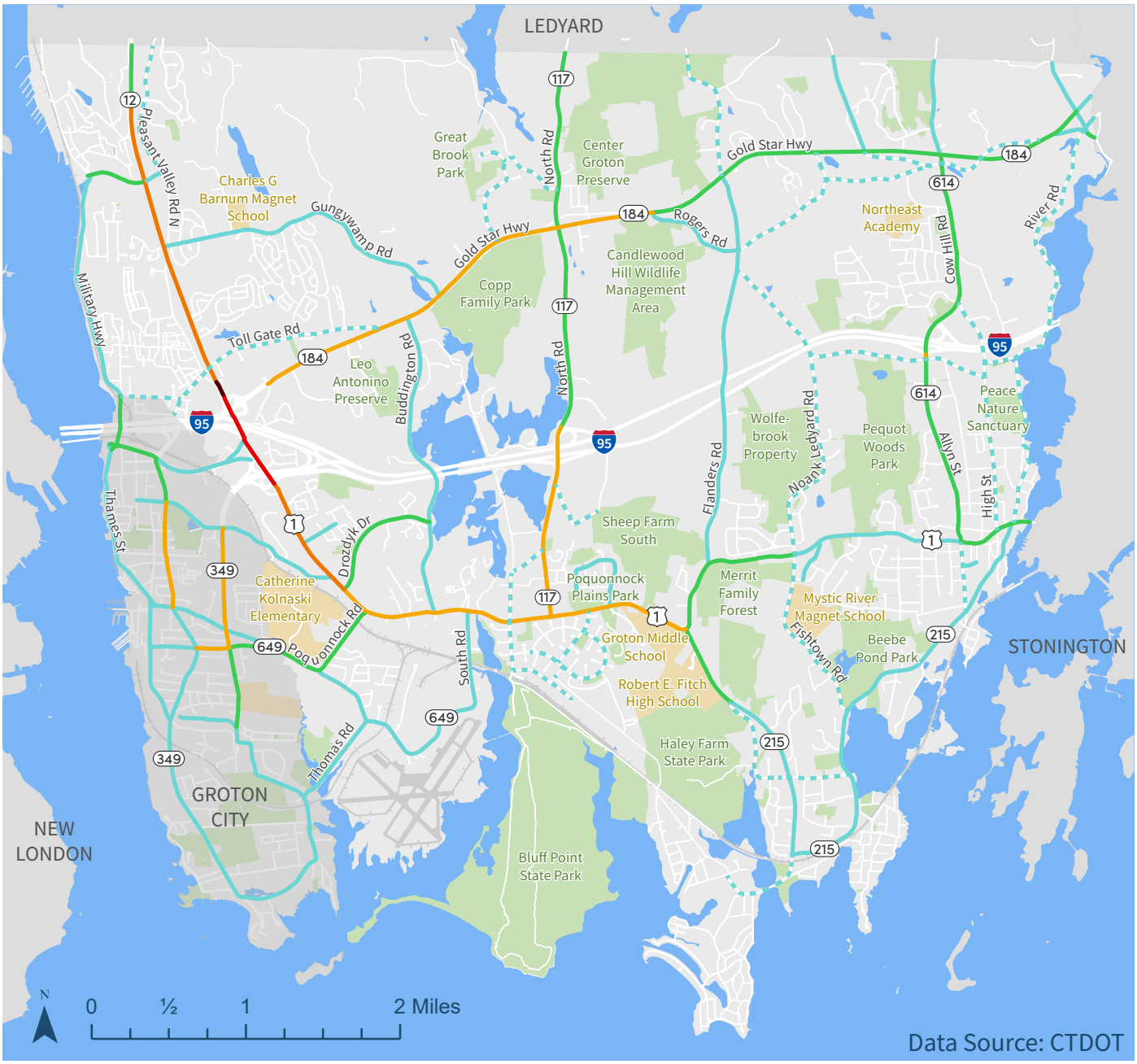
The level of stress for a bicyclist or pedestrian sharing the roadway can be gauged by traffic volume, traffic speed, and crash activity. The roadway stress map (**Map 3-8**) was created by collective analysis of ADT and speed values, which were then layered beneath the crash activity heat map. Some roads, while having lower traffic speeds and volumes, may have high crash rates, which should be factored into the selection of an appropriate facility.

Higher stress corridors have higher traffic volumes, speeds, *or* crash activity, while lower stress corridors have low traffic volumes, speeds *and* crash activity.

Generally, the preferred recommendations for bicycle facilities are as follows:

- **Higher Stress:** Sidepath
- **Moderate/High Stress:** Buffered Bike Lanes
- **Low/Moderate Stress:** Bike Lanes
- **Low Stress:** Shared Roadway

MAP 3-5 AVERAGE DAILY TRAFFIC VOLUME



Key

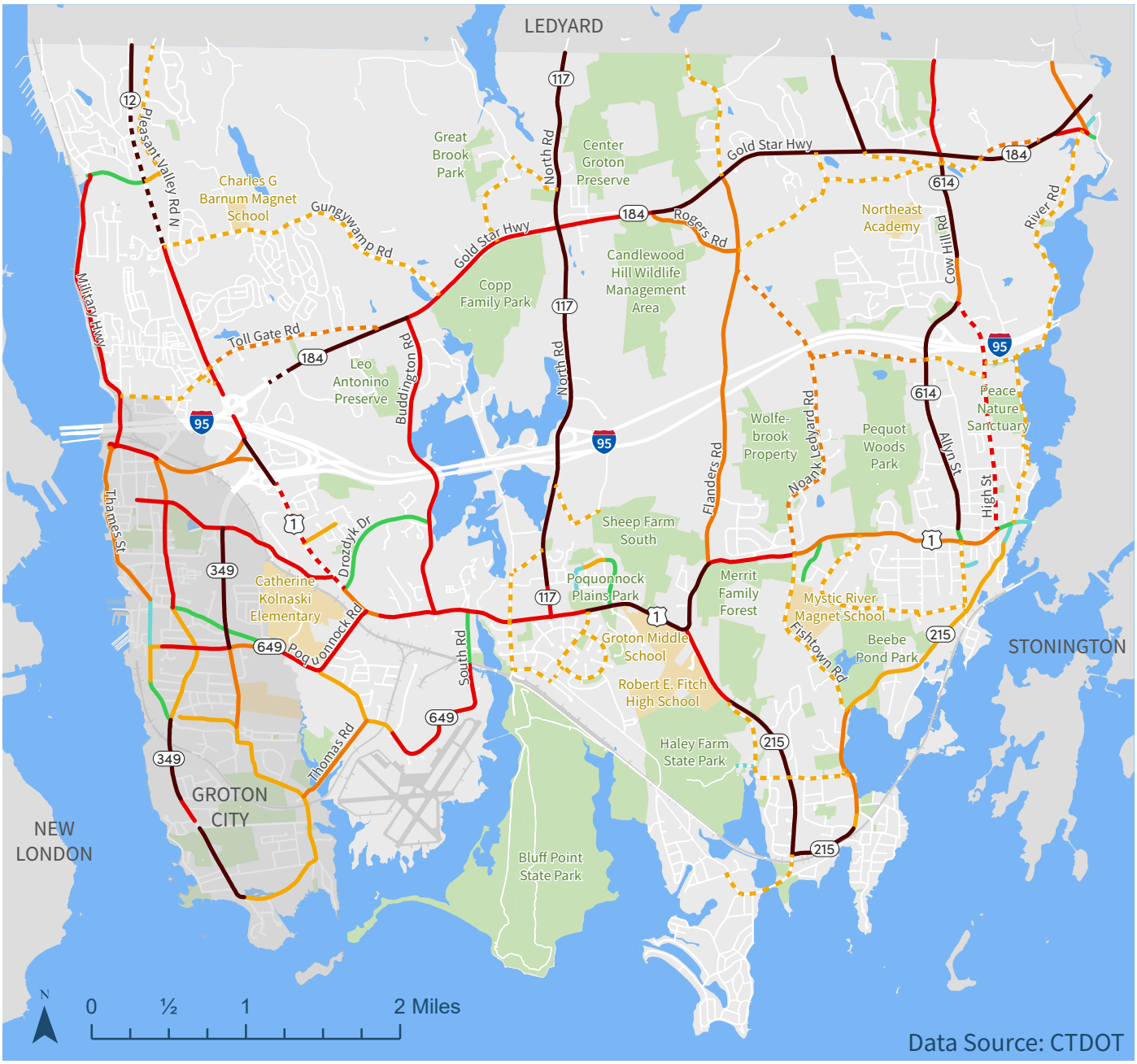
- > 25,000
- 20,001 - 25,000
- 15,001 - 20,000
- 10,001 - 15,000
- 5,001 - 10,000
- ≤ 5,000*

- Public Open Space
- Schools

Traffic volume data shown on this map is based upon and limited to data available from CTDOT.

*Dashed segments indicate areas where ADT data is estimated using UConn's *Connecticut AADT Visualization Tool*

MAP 3-6 85TH PERCENTILE TRAFFIC SPEED



Key

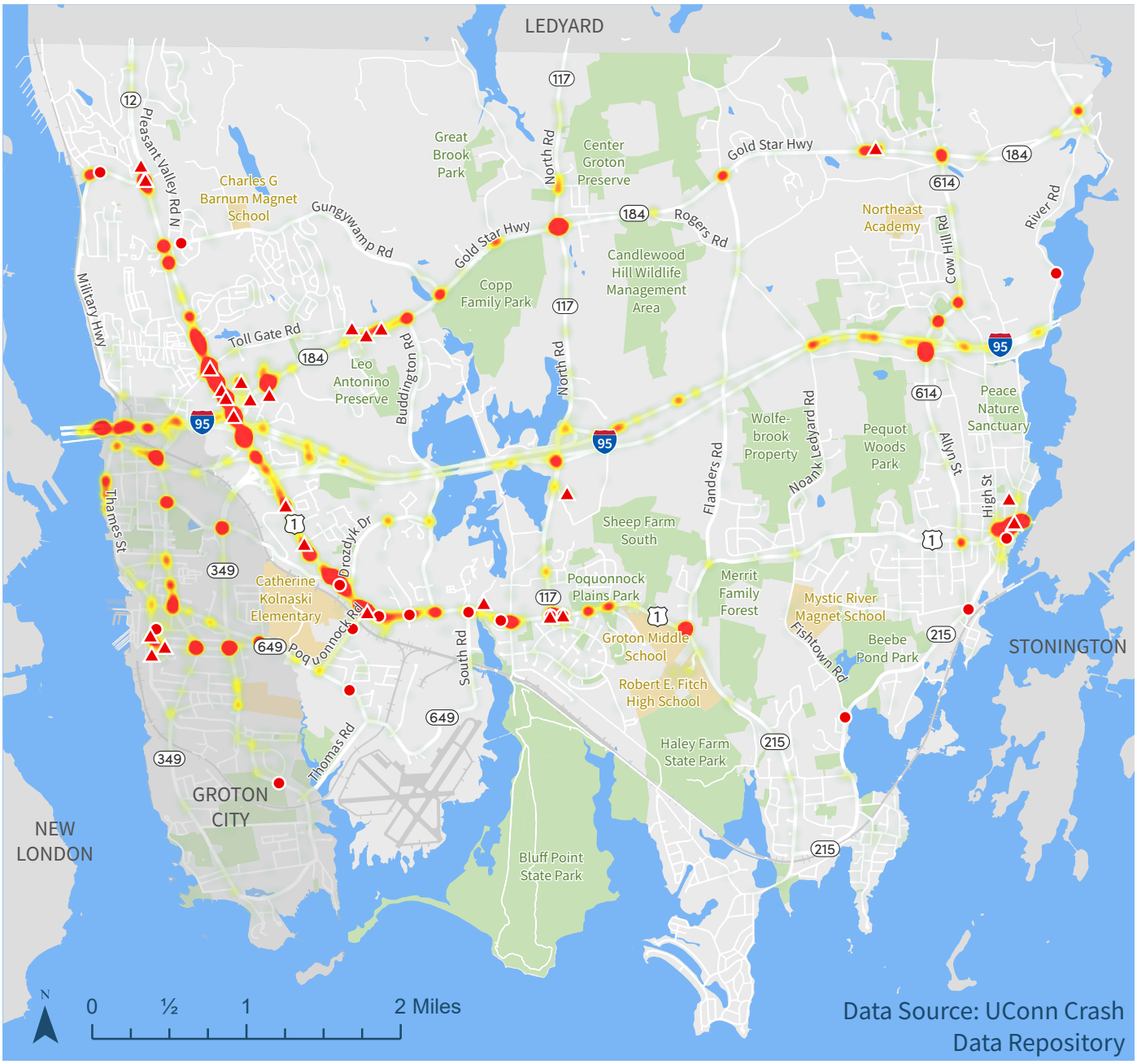
- > 45 mph
- 40.1 - 45 mph
- 35.1 - 40 mph*
- 30.1 - 35 mph*
- 25.1 - 30 mph*
- ≤ 25 mph*

- Public Open Space
- Schools

Traffic speed data shown on this map is based upon and limited to data available from CTDOT.

*Dashed segments indicate areas where speed data is estimated using posted speed limits + 5 mph. Actual 85th percentile speeds may vary.

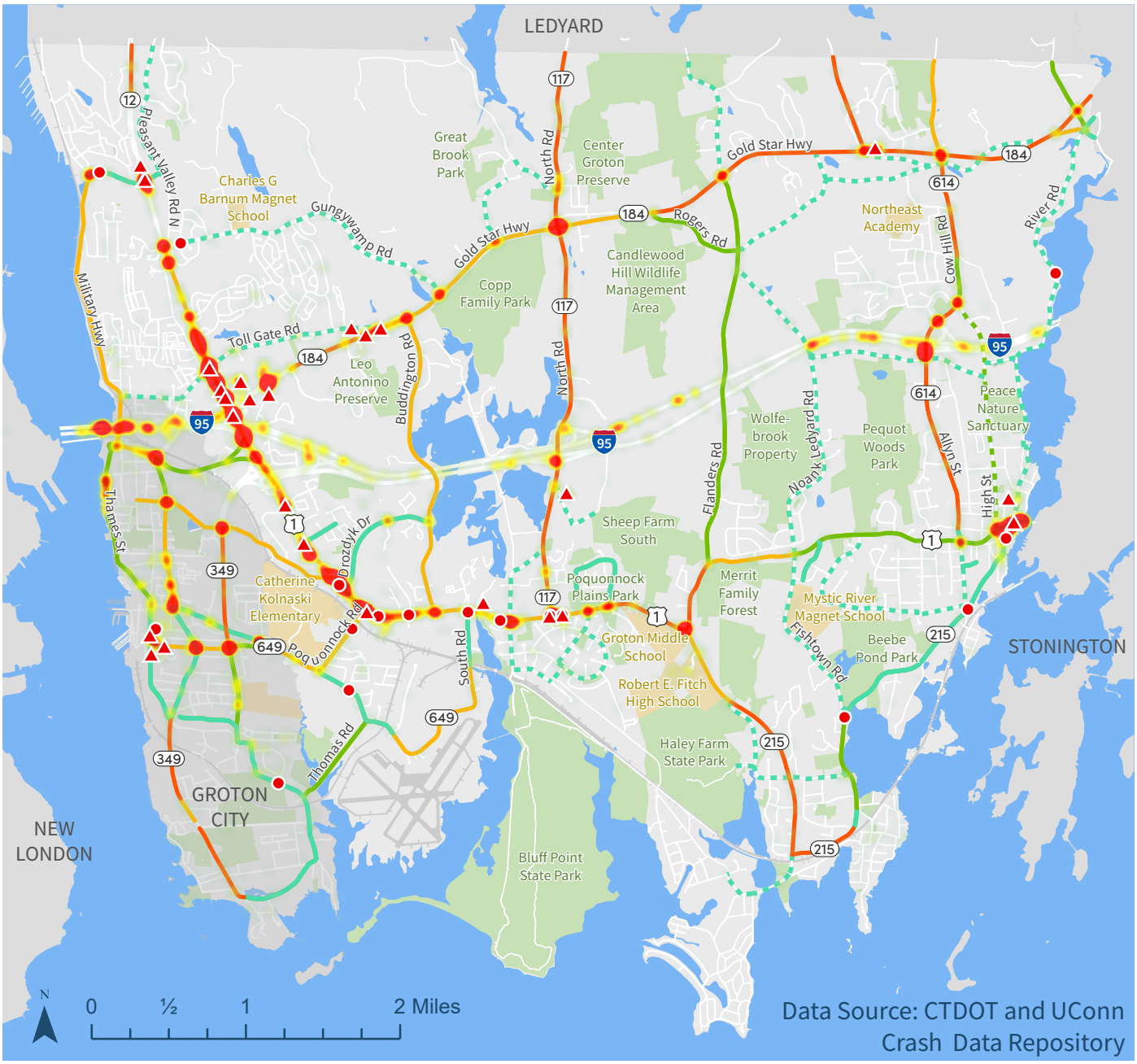
MAP 3-7 CRASH ACTIVITY (2019-2023)



Key

- Higher Concentration
- Lower Concentration
- Pedestrian Involved Crash
- Bicyclist Involved Crash
- Public Open Space
- Schools

MAP 3-8 ROADWAY STRESS



Key

- High Stress
- Moderate/High Stress
- Low/Moderate Stress*
- Low Stress*

Crash Activity

- Higher Concentration
- Lower Concentration
- Pedestrian Involved Crash
- Bicyclist Involved Crash

- Public Open Space
- Schools

*Dashed segments indicate areas where data is estimated using posted speed limits + 5 mph and/or ADT data from UConn's *Connecticut AADT Visualization Tool*

Data not available for roads not shown on this map.

3.4 ORIGINS AND DESTINATIONS ANALYSIS

An origins and destinations analysis was conducted to determine priority areas for bicycle and pedestrian connectivity. A heat map was produced by mapping the following resources:

- K-12 schools
- Universities
- Parks and Open Space
- Community Centers (such as Town Hall, community centers, senior centers, libraries, and major healthcare facilities)
- Major Employment Locations
- High Density Residential Areas
- Retail Corridors

The heat map generated depicts areas in Town where people are traveling to or from and indicates areas where there may be a need for increased bicycle and pedestrian infrastructure. The goal is not only to provide connections within areas of high demand, but also between areas of high demand. For example, much of Route 184 is not shown as a high demand area but is known to be a popular east/west bicycle commuter route. This route is still considered a priority because it connects origin and destination points on either end of Town.

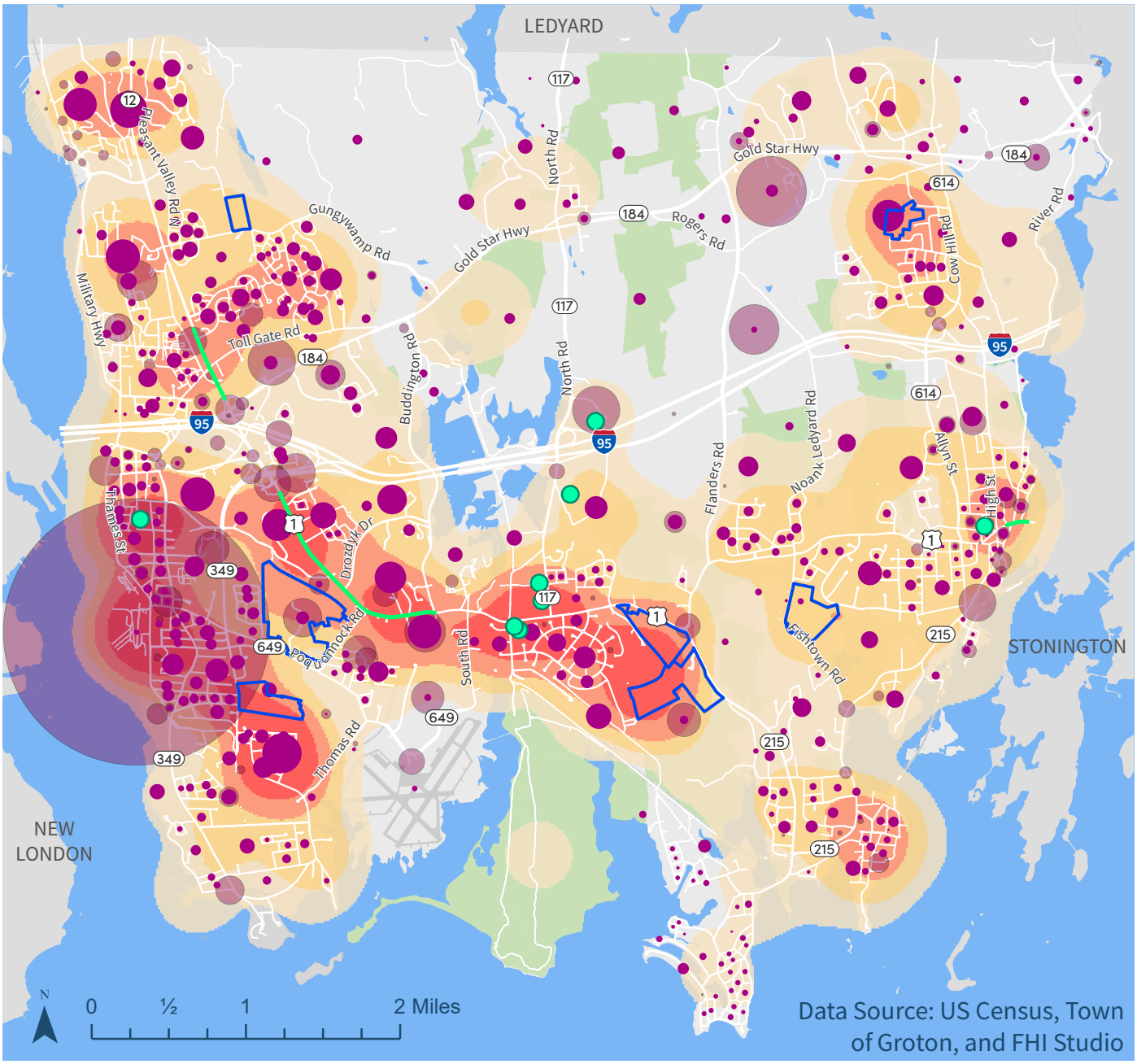
This analysis suggests that locations along and adjacent to Route 12, Route 1, Gungywamp Road, Toll Gate Road, Route 614 (Allyn Street and Cow Hill Road), and Route 215 have high bicycle and pedestrian demand as compared to other areas of Town. This analysis serves a baseline for understanding priority linkages within Town and was further informed by community members and the Complete Streets Committee.

Groton Middle School, Image Source: Homes.com

Electric Boat City of Groton, Image Source: General Dynamics

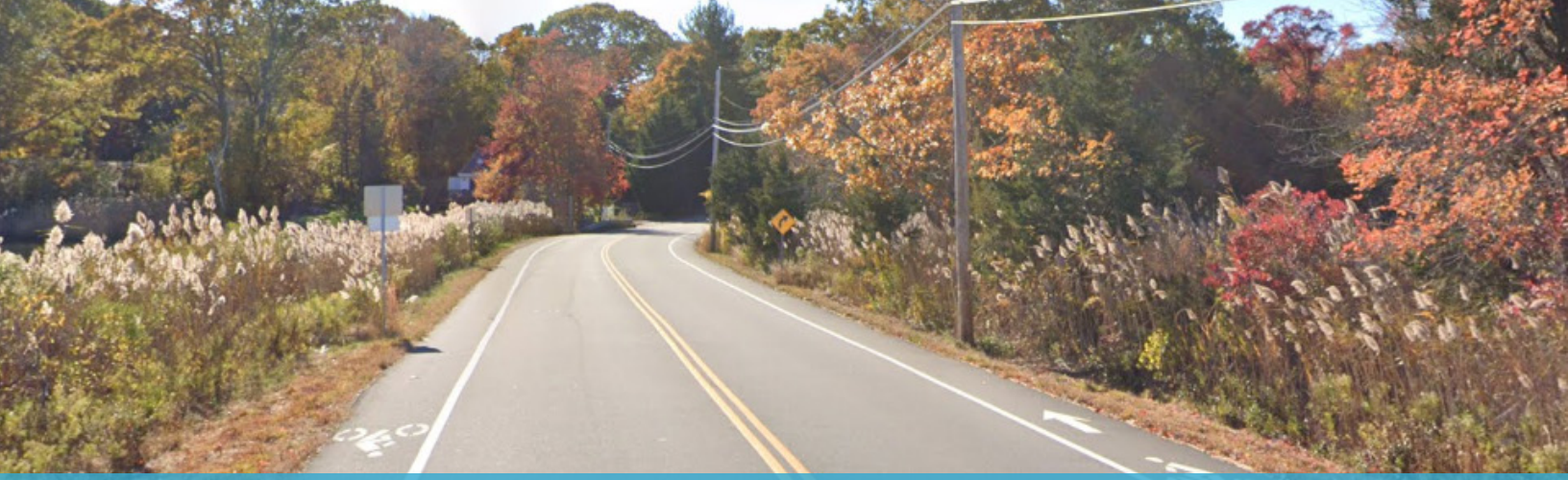
Trail at Haley Farm State Park,
Image Source: Groton Open Space Association

MAP 3-9 ORIGINS AND DESTINATIONS ANALYSIS



Key

- Higher Demand
- Lower Demand
- Community Resources
- Schools
- Retail Corridors
- High Density Residential Areas
- Major Employment Locations



4 BICYCLE AND PEDESTRIAN NETWORK

This plan provides a strategic approach to the improvement of State and local roadways to better accommodate both bicyclists and pedestrians by recommending improvements that are feasible and that will provide the greatest user comfort and safety relative to the conditions and constraints. This plan does not recommend the improvement of every roadway in Groton, rather it focuses on roadways that have the highest bicycle and pedestrian demand, the greatest need for improvement to provide comfort and safety, and that will provide the greatest value relative to the investment.

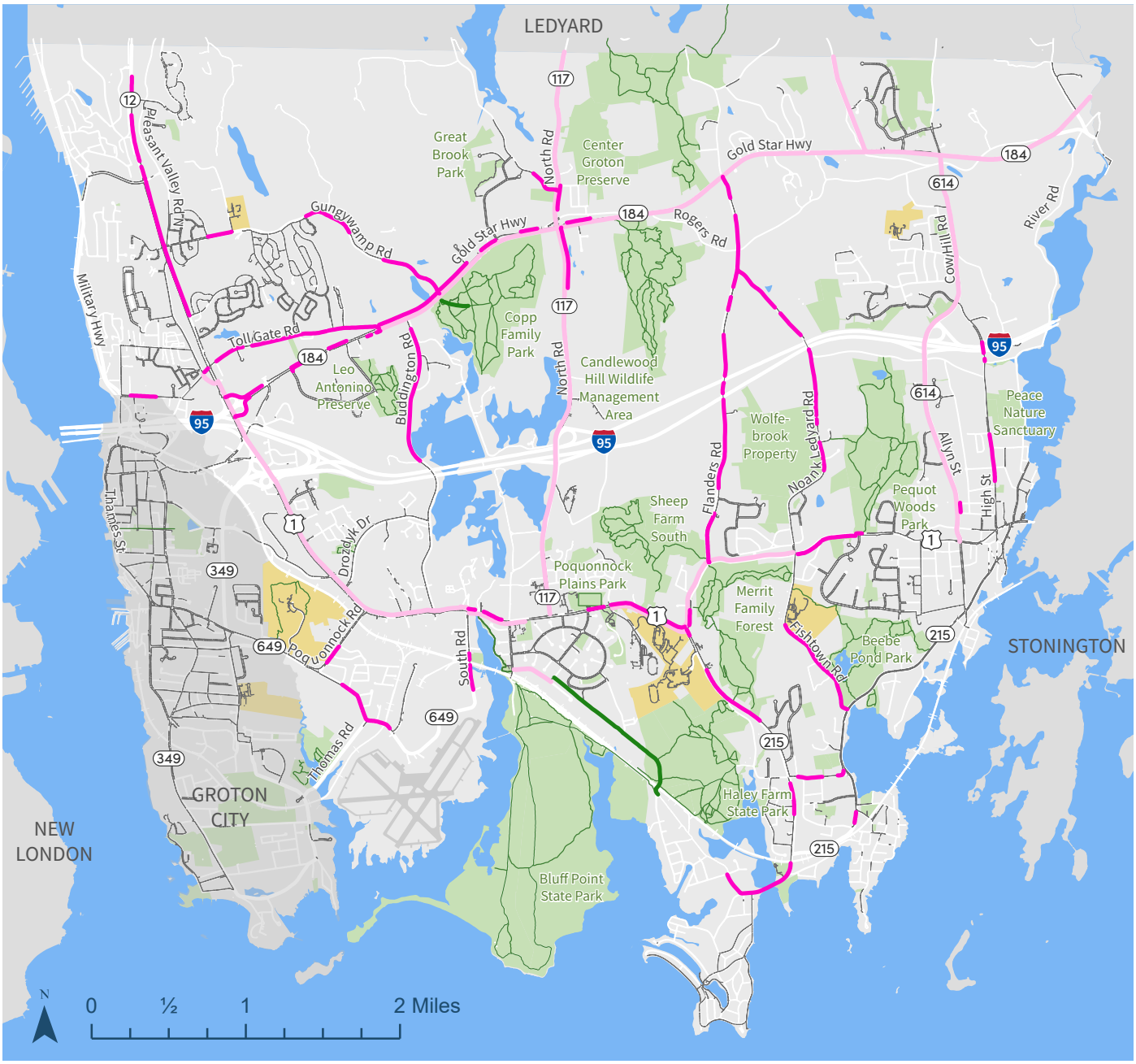
4.1 PEDESTRIAN FACILITY RECOMMENDATIONS

The recommended sidewalk network (**Map 4-1**) identifies areas that should be prioritized for the development of sidewalks based upon user demand, roadway conditions, and the presence of existing sidewalks. The plan also identifies recommended sidepaths (as also shown on **Map 4-2**). Like sidewalks, sidepaths are also intended to accommodate pedestrians and are part of the pedestrian network. In many instances, sidepaths are the only pedestrian facility type recommended along a corridor. Where there is demand for pedestrian travel on both sides of a roadway (such as along segments of Route 1), a sidepath is recommended on one side of the roadway and a sidewalk is recommended on the opposite side.

Sidewalks in these areas should be constructed in accordance with this plan under any of the following conditions:

1. Targeted expansion of the sidewalk network and completion of gaps in the network or improvement of existing sidewalks as a standalone project.
2. Improvements to sidewalk infrastructure accompanying roadway improvements such as resurfacing, widening, curb and drainage enhancements, safety improvements, etc.
3. Improvements associated with development activity including the installation of sidewalks within the right-of-way by a private developer of an adjacent site. In these conditions, where a sidepath is shown on **Map 4-1** and has not been constructed, a private developer should either construct a sidepath to the standards specified by **Section 5.10** or construct a sidewalk meeting the standards of **Section 6.3** to provide pedestrian connectivity until construction of the recommended sidepath along the corridor by the Town or State.

MAP 4-1 RECOMMENDED SIDEWALK NETWORK



Key

- Recommended Sidewalk
- Recommended Sidepath
- Existing Sidewalk
- Shared Use Path
- Trail
- Public Open Space
- Schools

4.2 BICYCLE FACILITY RECOMMENDATIONS

4.2.1 FACILITY TYPES

As shown in **Map 4-2**, a range of bicycle facility types are recommended for use within the Town. These include the on- and off-street facilities identified below. These facility types have been identified as the most appropriate facilities for use in Groton based upon local conditions such as traffic characteristics, right-of-way width, topography, land use, and existing facilities.

Shared Roadways allow bicyclists and motor vehicles to use the same roadway space without any separate lane designations. Shared roadways are typically delineated by "sharrow" pavement markings and accompanying signage.

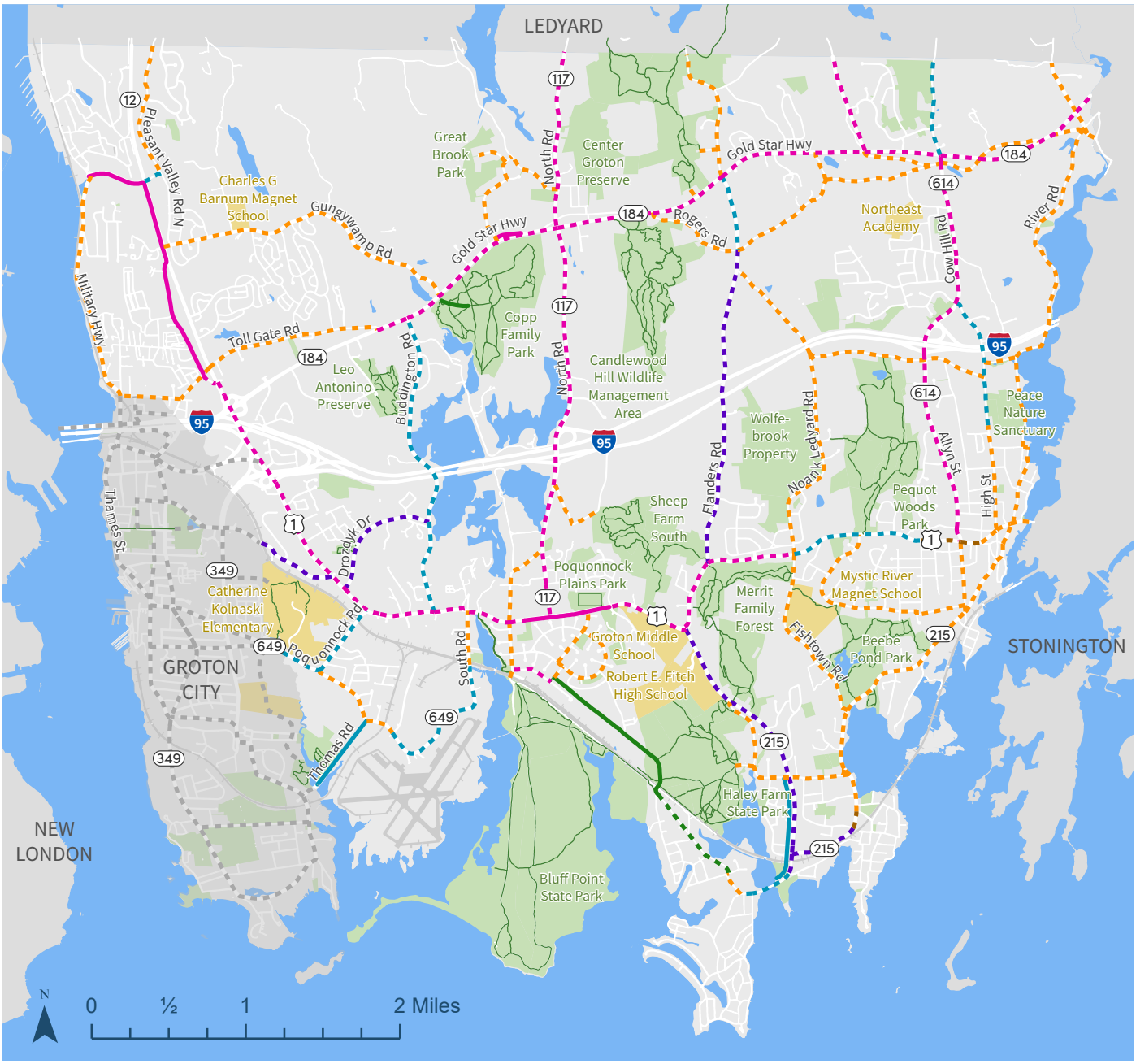
Bike Lanes designate an exclusive space on the roadway for bicycle travel, which is signified by pavement markings and signage. Bike lanes are typically located between a motor vehicle travel lane and the curb, road edge, or parking lane. *Image Source: Google Street View*

Buffered Bike Lanes are conventional striped bike lanes with a painted or textured pavement buffer space that is used to separate the bike lane from the adjacent motor vehicle lane and/or parking lane.

Sidepaths provide a separated facility for the shared use of bicyclists and pedestrians. Like sidewalks, these facilities are physically separated from motor vehicles by a curb, open space, or barrier. These facilities are adjacent to the roadway and are typically located within the right-of-way. *Image Source: Google Street View*

A **Shared Use Path** is a facility that is shared by bicyclists and pedestrians. These facilities are recreational in nature and often travel through open space areas and along natural features such as riverfronts. While similar in design and function to a sidepath, shared use paths, are not typically located adjacent to a roadway. *Image Source: Auntie Beak's Place*

MAP 4-2 RECOMMENDED BICYCLE FACILITY NETWORK



Recommended Facilities

- Sidepath
- Buffered Bike Lane
- Bike Lane
- Paired Facility: Bike Lane and Shared Roadway
- Shared Roadway
- Shared Use Path

Existing Facilities

- Sidepath
- Bike Lane
- Shared Use Path
- Trail

- Public Open Space
- Schools

4.3 IMPLEMENTATION RECOMMENDATIONS

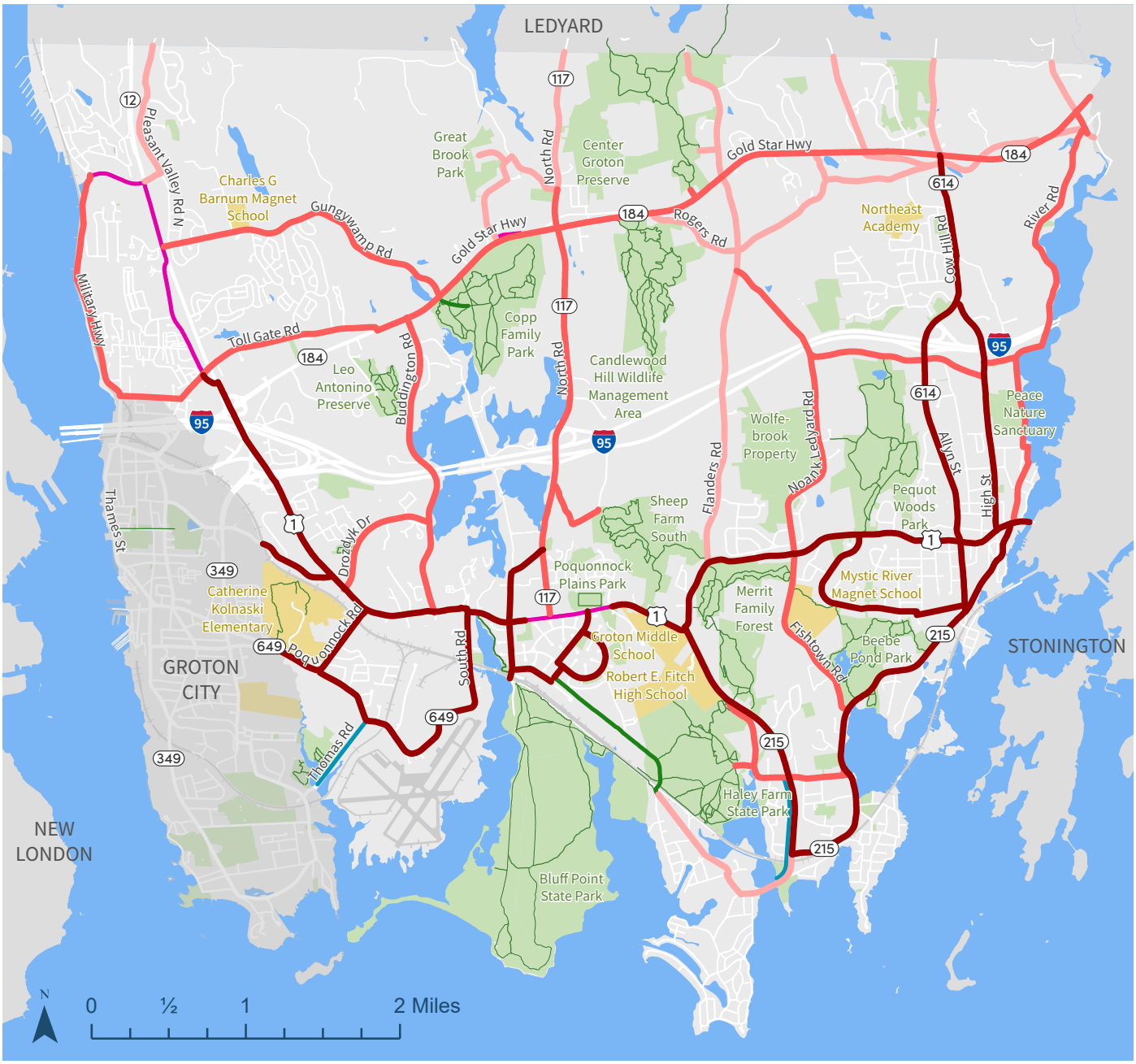
4.3.1 BICYCLE AND PEDESTRIAN FACILITIES DEMAND BY CORRIDOR

The Bicycle and Pedestrian Facilities Demand map (**Map 4-3**) on the following page identifies corridors that are expected to have the greatest demand for bicycle and pedestrian trips based upon the origins and destinations analysis presented in **Section 3.4**. The corridors either have or connect land uses that are most likely to attract or generate trips such as high residential densities, schools, parks, town facilities, commercial areas, and places of employment.

The highest demand corridors in Groton include but are not limited to Routes 1, 649, 215, 614 (Allyn Street and Cow Hill Road), and local roads such as High Street. Medium demand corridors include but are not limited to Routes 184, 117, and local roads such as Buddington Road. Low demand corridors have bicycle and pedestrian trip demand, but not to the same degree as medium or high demand corridors. Low demand corridors include many of the north/south roadways approaching Ledyard and other corridors such as Flanders Road.

Map 4-3 only identifies the demand level for corridors identified for bicycle and pedestrian *enhancements*.

MAP 4-3 BICYCLE AND PEDESTRIAN FACILITIES DEMAND BY CORRIDOR



Key

Demand

- High
- Medium
- Low

Existing Facilities

- Trail
- Path
- Sidepath
- Bike Lane

4.3.2 BICYCLE FACILITIES AND PATHS: EASE OF IMPLEMENTATION BY CORRIDOR

The ease of implementation map (**Map 4-4**) on the following page identifies the ease or difficulty of implementing the recommended bicycle and pedestrian facility along specific corridors based upon topographic, utility, and right-of-way constraints, and cost of construction.

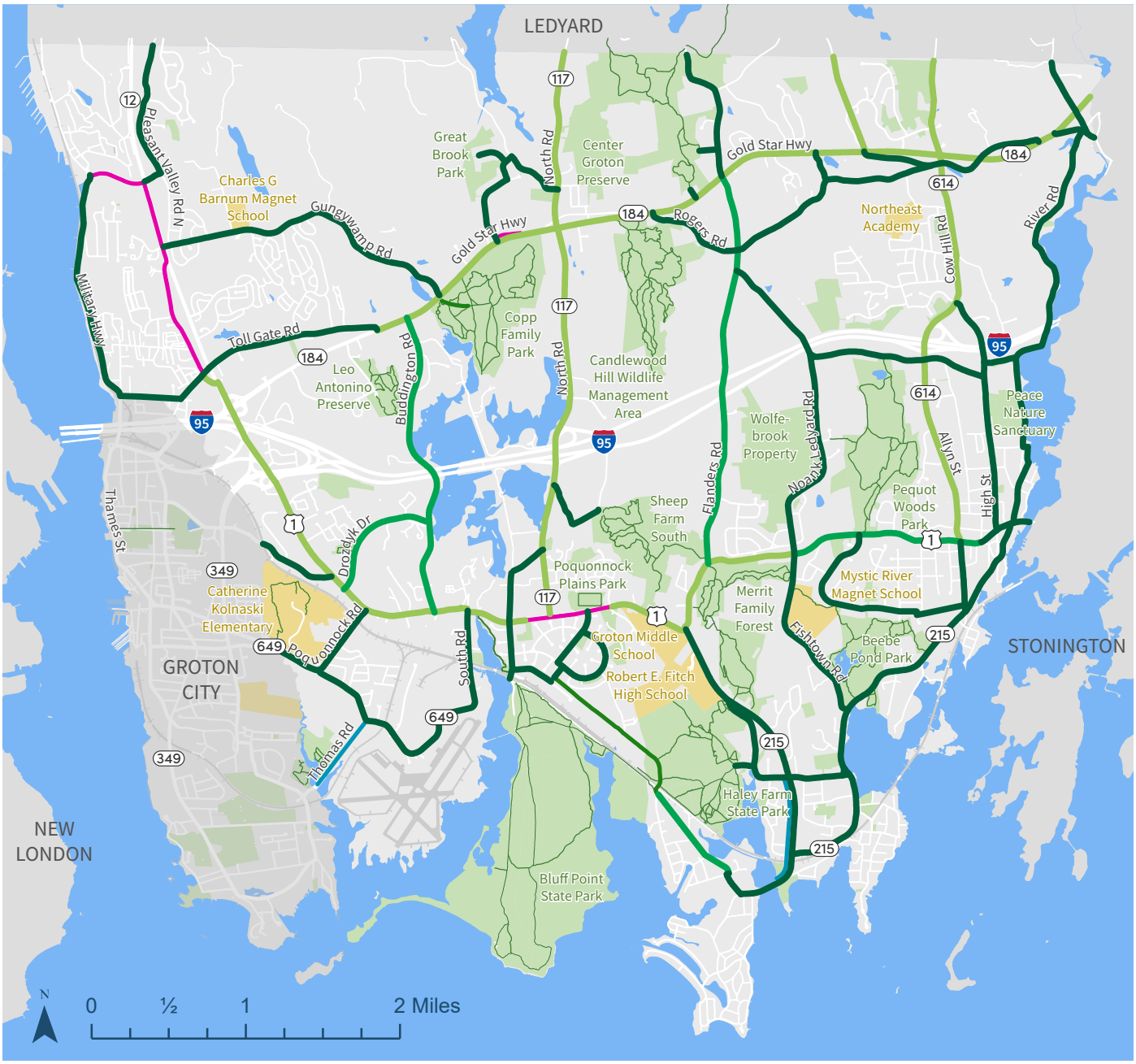
Corridors with a high ease of implementation are those for which the recommended bicycle facility enhancement primarily involves pavement marking and signage improvements within the existing roadway. This includes but is not limited to roadways such as Military Highway, Noank Ledyard Road, and River Road.

Corridors with a medium ease of implementation primarily require pavement markings and signage but may require limited areas of roadway widening to accommodate an on-road bicycle facility. These roadways include but are not limited to Buddington Road, Flanders Road, and a segment of Route 1.

Corridors with a low ease of implementation are those that require construction of a new facility such as a sidepath that may also require easements or property acquisition, bridge or culvert expansions or modifications, significant regrading and/or retaining wall construction, roadway narrowing, driveway modifications, traffic signal improvements, and utility relocation. These roadways include but are not limited to Routes 1, 184, 117, and local roadways such as Colonel Ledyard Highway.

Map 4-4 only identifies the ease of implementation level for corridors identified for bicycle and pedestrian *enhancements*; it excludes recommended sidewalk infrastructure, which has a low ease of implementation.

MAP 4-4 BICYCLE FACILITY AND PATHS EASE OF IMPLEMENTATION BY CORRIDOR



Key

Ease of Implementation*

- High
- Medium
- Low

Existing Facilities

- Trail
- Path
- Sidepath
- Bike Lane

*See prior page for an explanation of these terms.

4.3.3 BICYCLE NETWORK IMPLEMENTATION

The phasing plan map (**Map 4-5**) on the following page provides a recommended phasing for the implementation of bicycle and pedestrian facilities including sidepaths, shared use paths and on-road bicycle facilities (see **Section 4.3.4** for the sidewalk phasing plan). The phasing plan was developed based upon two factors: the trip demand for the corridor (see **Section 4.3.1**) and the ease of implementation of the recommended facility (see **Section 4.3.2**).

The phasing plan is structured around the following approach, with some exceptions based upon the need for strategic implementation:

- High and medium demand corridors that have a high ease of implementation of the recommended facility are identified as Phase 1 projects.
- High and medium demand corridors with a medium to low ease of implementation are identified as Phase 2 projects.
- Medium and low demand corridors with a medium to low ease of implementation are identified as Phase 3 projects.
- Low demand corridors with a low ease of implementation are identified as Phase 4 projects.

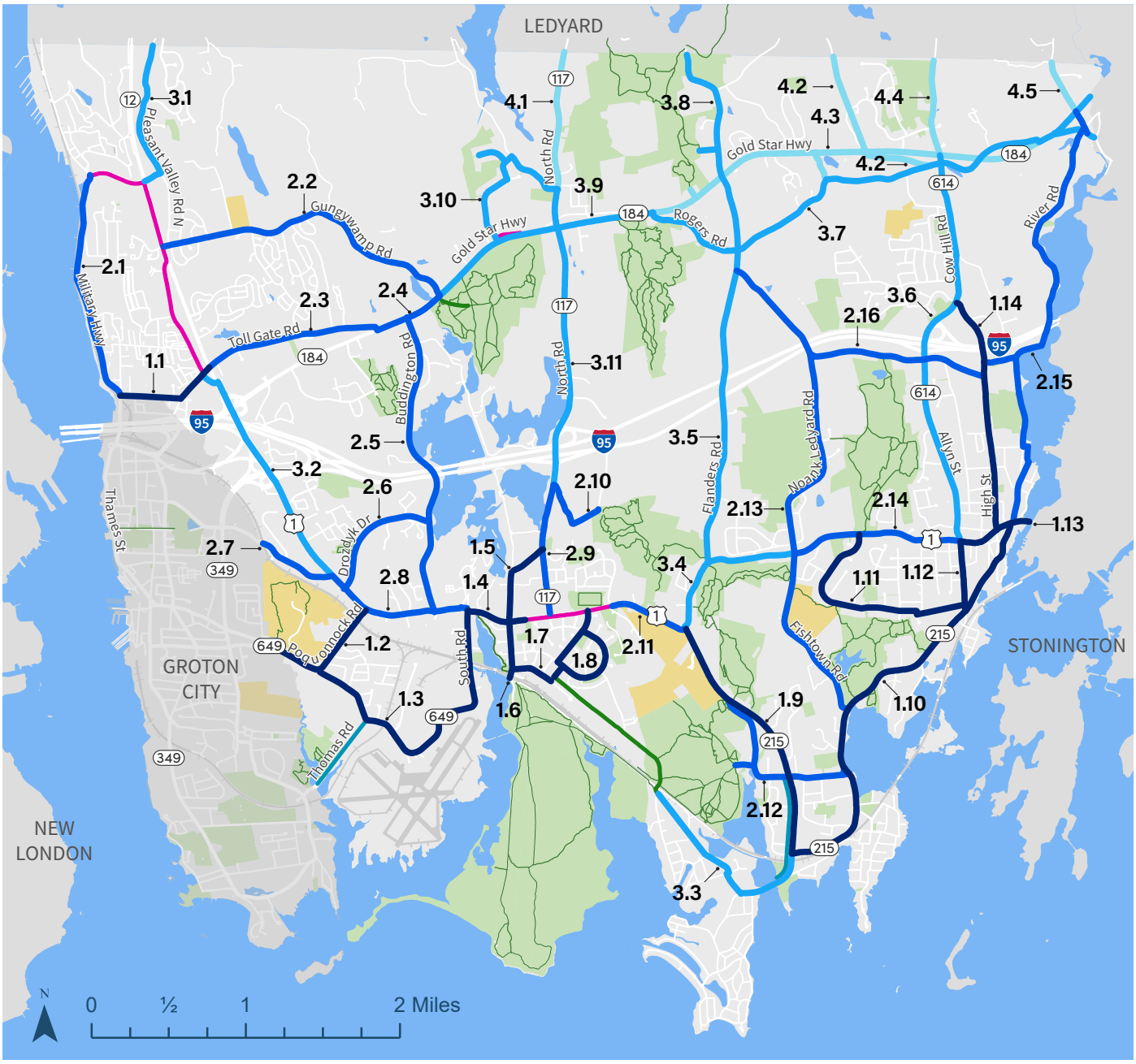
Phase 1 corridors are recommended for near-term implementation and include but are not limited to roadways such as Route 649, Route 215, and local roads such as High Street.

Phase 2 corridors are recommended for near- to medium-term implementation and include but are not limited to roadways such as Route 1, Buddington Road, Noank Ledyard Road, and River Road.

Phase 3 corridors are recommended for medium term implementation and include but are not limited to roadways such as Routes 1, 117, 184, 614 (Allyn Street and Cow Hill Road), and local roads such as Flanders Road.

Phase 4 corridors are recommended for long-term implementation and include but are not limited to Route 184, and roadways approaching Ledyard such as the northern end of Route 117, Lambtown Road, Colonel Ledyard Highway, and Shewville Road.

MAP 4-5 BICYCLE FACILITY AND PATH PHASING PLAN



Phase

- 1
- 2
- 3
- 4

Existing Facilities

- Trail
- Shared Use Path
- Sidepath
- Bike Lane

***Example**

3.5 ← Segment number

↑ Phase

*The labels in this map identify the phase and subsequent segment number of each recommendation. The segment number (following the decimal point) does not represent a level of sub-phasing, but rather is provided to easily cross reference the summary tables provided in **Appendix 2 Bicycle Facility Implementation Plan Summary Tables.**

In total, this plan recommends 61.2 roadway centerline miles of on-road bicycle facilities and paths with a total cost of $29.4 million as indicated in **Table 4-1** below. See **Appendix 2 Bicycle Facility Implementation Plan Summary Tables** for an itemized list per corridor segment.

Table 4-1 Bicycle Facility and Path Cost by Phase

Phase	Length (miles)	Cost	Cost per Mile
1	14.9	$1,947,000	$130,672
2	21.4	$8,041,000	$376,572
3	19.1	$13,805,000	$723,911
4	5.8	$5,617,000	891,276
	61.2	**$29,410,000**	**480,556**

These estimates were generated from aggregated cost estimate data based upon the following two approaches:

1. Detailed cost estimates were generated for each of the Concept Plan corridors which include Route 1, Route 117, and the South Elm Street/Noank Road segment of Route 215. These estimates include but are not limited to linear foot and per unit cost estimates for items such as sidepath construction, pavement markings, roadway widening, utility impacts, retaining wall construction, driveway modifications, and traffic signal enhancements. All estimates include a twenty percent contingency.
2. Planning level cost estimates were generated for all other corridors based upon a typical linear foot cost for the facility type with allowances for infrastructure modifications that may be necessary to accommodate the facility items such as but not limited to roadway widening, traffic signal improvements, drainage impacts, and utility impacts. The estimate includes a twenty-percent contingency on top of the linear foot cost estimates.

These cost estimates do not include potential cost associated with property acquisition if required.

4.3.4 PEDESTRIAN NETWORK IMPLEMENTATION

This plan recommends the implementation of sidewalks in three phases based upon the following factors:

- **Phase 1:** Sidewalks serving high demand areas as indicated by the demand analysis (see **Section 4.3.1**). These sidewalks would also fill gaps in existing sidewalk networks or provide a sidewalk where none exists on either side of the roadway.
- **Phase 2:** Sidewalks serving medium demand areas.
- **Phase 3:** Sidewalks in lower demand areas or where a sidewalk already exists on the other side of the road in higher demand areas.

In total, this plan recommends 15.5 miles of sidewalks with a total cost of $12.5 million as indicated in **Table 4-2** below.

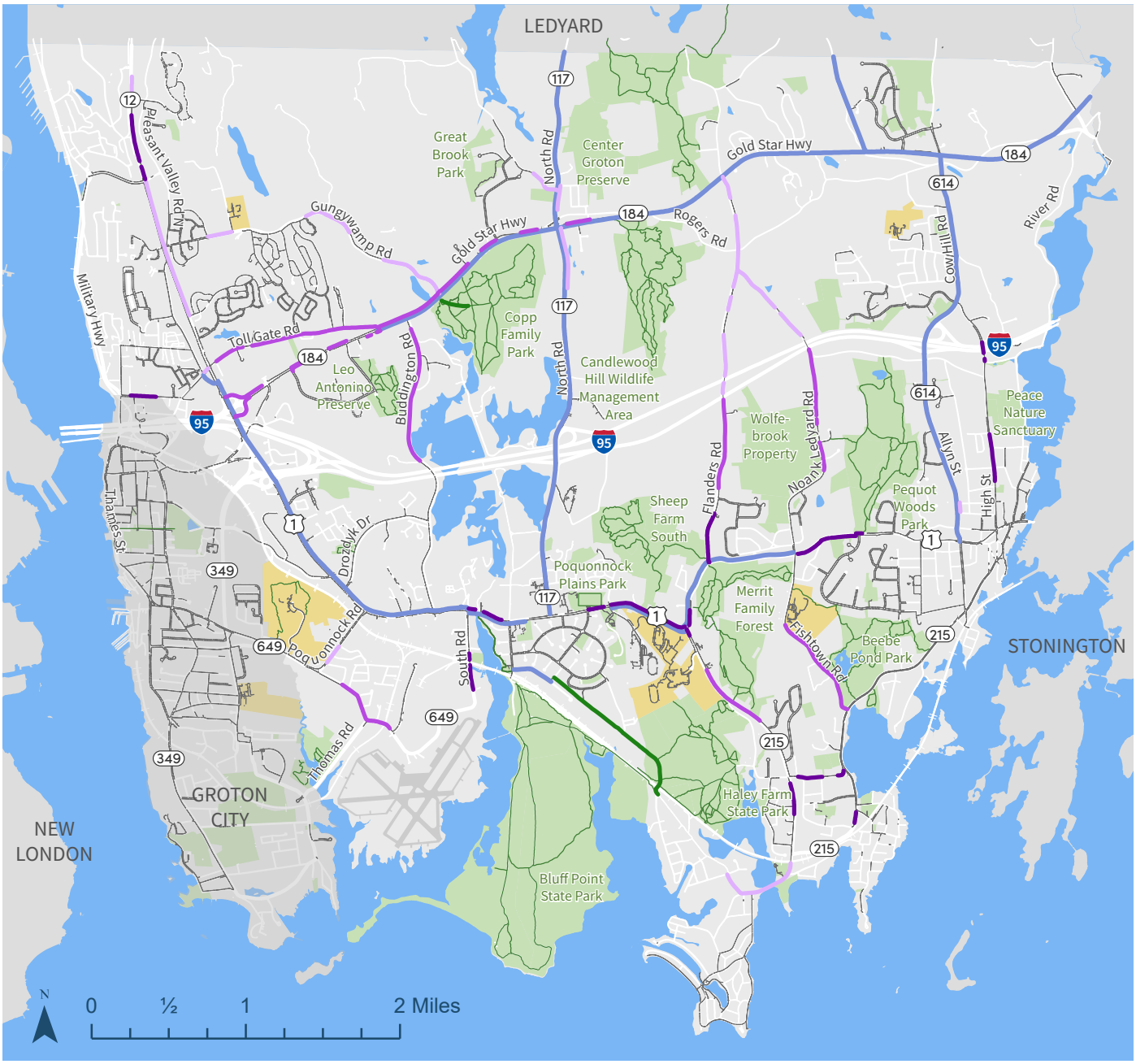
Table 4-2 Sidewalk Cost by Phase

Phase	Length (miles)	Cost
1	3.4	$ 3,126,000
2	6.9	$ 5,449,000
3	5.2	$ 3,928,000
	15.5	**$ 12,503,000**

Planning level cost estimates were generated based upon a typical cost of $150 per linear foot of five-foot wide concrete sidewalks with allowances for infrastructure modifications that may be necessary to accommodate the sidewalk such as but not limited to traffic signal improvements, crosswalk markings, drainage impacts, and utility impacts. The estimate includes a twenty-percent contingency on top of the linear foot cost estimates. *These cost estimates do not include potential cost associated with property acquisition if required.*

Sidewalk Construction on Route 1, Groton, Image Source: Google Earth

MAP 4-6 SIDEWALK PHASING PLAN



Key

Sidewalk Phase

- 1
- 2
- 3

- Existing Sidewalk
- Proposed Sidepath

See **Appendix 3 Sidewalk Facility Implementation Plan Summary Tables**, for segment information.

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5 BICYCLE FACILITIES TOOLBOX

5.1 USE OF TOOLBOX

There are a range of bicycle facilities that are appropriate for different contexts and types of users. This toolbox identifies the context for which specific facilities are most appropriate and the types of users that those facilities are most likely to serve.

This toolbox is not intended to be a detailed design manual to supersede the need for the application of sound principles by knowledgeable transportation professionals, nor is it intended to eliminate the flexibility needed to encourage independent designs tailored to specific conditions. Engineering judgment based upon knowledge of bicycle facility planning, operations, and design is needed to select appropriate bicycle accommodations.

This toolbox provides three levels of design guidance:

- Where design values are clearly and authoritatively established as requirements either through legislation such as the American with Disabilities Act (ADA) or through standards such as the MUTCD, design standards are provided using words such as “required”, “must”, and “shall”.
- Where there is a significant body of research to support design guidance on a particular issue or topic (such as from FHWA and AASHTO guidance documents), specific design values and recommendations are provided as guidance, using words like “should”.
- Where reliable research is not available to suggest definitive guidance, or where the guidance provided within this toolbox deviates from other guidance documents (such as NACTO), the term “recommended” or “acceptable” is used. This guidance is based upon the consensus and expert opinion of the consultants and reviewers who contributed to this toolbox.

There will be instances where it is appropriate for designs to vary from the guidance presented in this toolbox. In some cases, application of the guidance in this toolbox will be limited by constraints placed on the design by unique site conditions, fiscal constraints, or right-of-way constraints.

5.2 MAINTENANCE CONSIDERATIONS

The maintenance of bicycle facilities should be considered when planning and designing facilities. Facilities should be selected and designed with consideration of the ability of the Town to maintain those facilities which may include snow and ice removal, sweeping, pavement marking renewal, and other activities.

5.3 FOUNDATIONAL GUIDES, GUIDELINES AND MANUALS

Multiple guides and manuals were referenced in the creation of this toolbox. The principal resource referenced in this toolbox is the AASHTO Guide for the Development of Bicycle Facilities (referred to as the AASHTO Guide in this document). The guide was released in 2024 and provides more information specific to bicycle facility planning and design than is provided in this toolbox. This toolbox is, however, consistent with the guidance provided in the AASHTO Guide although the material may be presented differently.

Of these resources, only the Manual on Uniform Traffic Control Devices, PROWAG, and the ATBCB guidelines provide compulsory standards that must be adhered to. The other resources identified below are advisory; they reference best practices and preferable or desirable standards.

The field of bicycle facility planning and design is emerging and evolving, which leaves room for the application of standards that are specific to local conditions and based upon professional planning, design, and engineering judgement. The guides and manuals referenced include:

5.3.1 REQUIRED STANDARDS

FHWA Manual on Uniform Traffic Control Devices (MUTCD), 11th Edition

The MUTCD provides specific standards on bicycle signage and pavement markings. This recently updated manual now provides expanded guidance for bicycle facilities.

US Access Board Public Right-of-Way Accessibility Guidelines (PROWAG)

The purpose of these guidelines is to ensure that pedestrian facilities located in the public right-of-way are readily accessible to and usable by pedestrians with disabilities. While oriented towards pedestrian facilities and wheelchair users, the design of bicycle facilities should ensure compliance with these accessibility standards.

Architectural and Transportation Barriers Compliance Board (ATBCB) Shared Use Path Accessibility Guidelines

These guidelines provide accessibility standards for shared use paths specific to facility width, grade, surface materials and other design factors.

5.4 ADVISORY GUIDELINES

AASHTO Guide for the Development of Bicycle Facilities, 5th Edition, 2024

The 2024 AASHTO Guide provides information relevant to the design, operation, and maintenance of shared lanes, bicycle lanes, shared use paths and intersection treatments. The guide lacks reference to the selection of appropriate bicycle facilities. An update of the guide was in draft form at the time of this writing. References to the "AASHTO Guide" in this document are in reference to this guide.

FHWA Bikeway Selection Guide, 2019

The FHWA guide provides a recommended process for, and information on, the selection of appropriate bicycle facilities for roadway contexts. The guide provides recommendations for the selection of various bicycle facilities including shared lanes, bike lanes, buffered bike lanes, separated bike lanes, and sidepaths in urban, suburban, and rural contexts. The guide also recommends appropriate facilities based upon a range of conditions including traffic volume and speed.

NACTO Urban Bikeway Design Guide, Second Edition, 2012

The NACTO guide provides state of the practice information regarding the planning and design of bicycle facilities including bike lanes, buffered bike lanes, cycle tracks (separated bike lanes), intersection treatments, pavement markings, and signage. The guide is tailored to urban contexts and references practices and standards used and adopted by cities throughout the country. The NACTO guide is advisory only and presents many facility design concepts and treatments that are experimental.

5.5 FACILITY PLANNING PROCESS

This toolbox is intended for use in the selection, planning, and design of bicycle facilities. This process begins with the collection of supporting data such as traffic volume, traffic speed, geometric data, and land use. Based upon this available data, an appropriate facility type is identified with a preference for facilities that are within the "recommended" or "exceeds recommendations" ranges for ***both*** traffic volume ***and*** speed conditions. If these conditions cannot be met, alternatives include selecting an "acceptable" or "provisional" facility or providing improvements that modify the existing conditions to fall within "recommended" or "acceptable" ranges.

Once an appropriate facility has been identified, an analysis of geometric and land use conditions should be conducted to assess the spatial feasibility of providing the facility on the existing roadway or within the existing right-of-way. If the facility cannot be accommodated on the roadway or within the right-of-way, the feasibility of modifying the roadway via a road diet, narrowing of traffic lanes, removal of parking lanes, or widening should be explored. Expansion of the right-of-way may also be necessary to accommodate the bicycle facility.

If roadway modifications or right-of-way widening is not feasible, other solutions should be considered, or an alternative corridor should be identified. Town officials should meet and coordinate with the Complete Streets Advisory Committee in the selection of alternatives including the selection of facility in the "acceptable" range or the selection of an alternative corridor.

The planning process should proceed to the design process once an appropriate bicycle facility has been identified as feasible for the corridor. This process may be iterative; the design process may reveal additional information or identify constraints that require a reconsideration of the appropriate facility type for a corridor. The design process may also result in a determination that the provision of bicycle facilities on a corridor is not feasible due to right-of-way constraints, construction costs, or physical constraints that would result in adverse impacts that are not outweighed by the benefit expected to be provided through provision of the bicycle facility.

Figure 5-1 below provides an overview of the facility planning process. The process may differ.

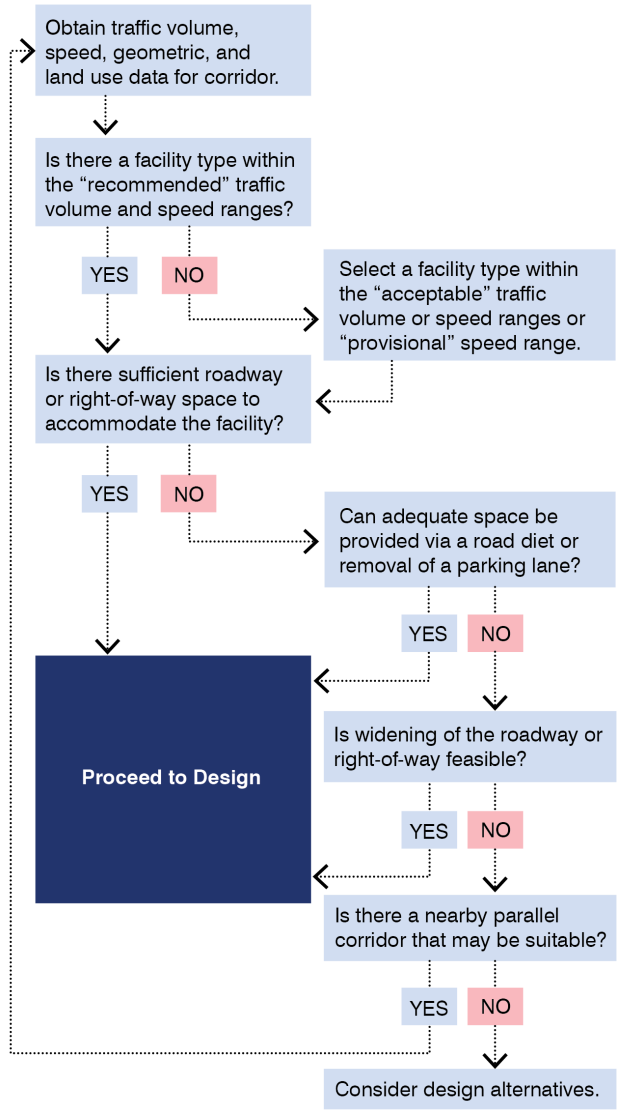


Figure 5-1 Facility Planning Process

5.6 BICYCLE FACILITY SELECTION

Several factors should be considered when selecting the appropriate bicycle facility for a roadway corridor. The primary factors are motor vehicle traffic speed and volume, but other factors such as right-of-way width, adjacent land uses, utility infrastructure, traffic operations, and construction costs should be considered.

The facility selected for a corridor should be selected based upon suitability for both traffic volume and speed conditions with the intent of providing facilities that are safe and comfortable for the widest range of users. **Where there is a difference between the facility recommended based upon the speed conditions versus traffic volume conditions, the facility that provides greater separation should be selected for use**. Such facility types typically include "recommended" facilities or facilities that "exceeds recommendation" for the conditions. Should those facility types not be feasible to implement, a facility type within the acceptable range may be considered for use. The use of facilities that fall into the acceptable range for both speed and traffic volume conditions is discouraged, but not prohibited. Such facilities should be carefully considered for use to ensure that they are appropriate for the conditions.

For the purposes of this plan, facilities are classified as follows:

Facilities Exceeding Recommendations: These facilities should be considered for use based upon local conditions such a high number of expected riders or proximity to a school but may exceed the measures necessary based upon traffic volume and speed conditions. The application of these facilities is typically associated with higher cost of implementation, higher maintenance cost, and additional space requirements than would otherwise be required by a recommended facility type.

Recommended Facilities: These facilities are the recommended facility type given conditions specific to that corridor. While this is the facility type that should be targeted for implementation, facilities that provide a higher measure of separation should also be considered.

Acceptable Facilities: These facilities are acceptable for application where physical conditions such as utility poles, traffic control equipment, on-street parking demand, retaining walls, trees, landscaping, or other similar factors place significant spatial or cost of construction constraints on the provision of recommended facility types. Acceptable facilities are generally reserved for use where the cost of construction due to physical conditions, and/or property constraints make the installation of recommended facilities infeasible.

Provisional Allowances: Facilities may be allowed providing improvements associated with the installation of the bicycle facility are expected to bring traffic speed conditions within an acceptable range.

Table 5-1 on the following page is based on CTDOT's Appendix A Bicycle Facility Selection Matrix, which was adopted by CTDOT as part of the Complete Streets Controlling Design Criteria and Justification Process implemented in 2023. These standards have been adopted by CTDOT for use on State and local roadways. While local municipalities may approve more stringent standards, they are discouraged from adopting standards that would allow facilities on higher volume or higher speed roadways than are recommended through this matrix.

The facility types identified in the matrix and recommended in this plan include shared roadways, bike lanes, buffered bike lanes, and sidepaths. Shared use paths are also recommended for use as part of the Town's bicycle network, but those facilities are not subject to traffic speed and volume consideration in their planning and are therefore not identified in the selection matrix. For more information on the facility types, see **Section 5.6** through **Section 5.11.**

Low-cost facilities, particularly those provided within the limits of an existing roadway, are typically more feasible to implement but may be less attractive to users and perceived as high stress depending on the roadway conditions.

Typically, there is an inverse correlation between the stress level and the cost of a facility with low stress facilities being more expensive to build and high stress facilities costing less to construct. See **Section 5.6** on the following page for a comparison of facilities.

Facilities should be selected based upon those that will provide bicyclists with a suitable accommodation and are feasible to implement given considerations such as, but not limited to, available right-of-way, geometric constraints, construction cost, and maintenance factors. Flexibility should be allowed in the selection of facilities and selections should be made on a case-by-case basis. Refer to the FHWA Bikeway Selection Guide for additional guidance.

Table 5-1 Bike Facility Selection Summary Matrix

Traffic Volume (ADT)	**0 – 5,000**	**5,000 –10,000**	**10,000 –18,000**	**18,000 – 20,000**	**20,000 – 25,000**
Shared Roadway	Recommended	Acceptable			
Bike Lane	Recommended		Acceptable		
Buffered Bike Lane	Exceeds Recommendation	Recommended			Acceptable
Sidepath	Exceeds Recommendation		Recommended		
85th Percentile Traffic Speed (mph)	**30 or less**	**31-35**	**36-40**	**41-45**	**46+**
Shared Roadway	Recommended	Acceptable	Provisional*		
Bike Lane	Recommended		Acceptable	Provisional*	
Buffered Bike Lane	Exceeds Recommendation	Recommended		Acceptable	
Sidepath	Exceeds Recommendation	Recommended			

**Provisional allowances are contingent upon speed reduction measures being implemented in association with the development of bicycle facilities that bring the 85th percent traffic speed within acceptable or recommended ranges.*

5.7 SHARED ROADWAY

Shared roadways allow bicyclists and motor vehicles to use the same roadway space without separate lane designations. While every roadway (except for limited access highways) is shared by multiple users including bicyclists, the reference to "shared roadway" in this toolbox is to facilities that provide pavement markings and signage supporting bicycle use.

Motorists have a greater awareness of bicyclists on shared roadways when compared to roadways that lack bicycle pavement marking or signage. Shared roadways should be used where the provision of dedicated bike lanes or other dedicated bicycle facilities are not feasible due to geometric or right-of-way constraints or are not required due to the traffic conditions.

One of the limitations of shared roadways is that they are susceptible to bicycle and vehicular conflicts because of the lack of designated space and/or separation between bicyclists and motorists. As such, the application of shared roadways should be sensitive to conditions such as lane and roadway width, on-street parking, and traffic volume and speed.

On a shared roadway, bicyclists can position themselves where they feel safest and most comfortable. While bicyclists often prefer the right edge of the shared lane, they may also opt to ride in the middle of the shared lane to discourage passing vehicles from attempting to pass within the lane.

Shared roadways can be a valuable tool in developing a bicycle network and providing strategic connections between corridors with dedicated bicycle facilities. Shared roadway pavement markings and accompanying signage provide cyclists with wayfinding assistance and promote awareness of the presence of bicyclists in the roadway environment.

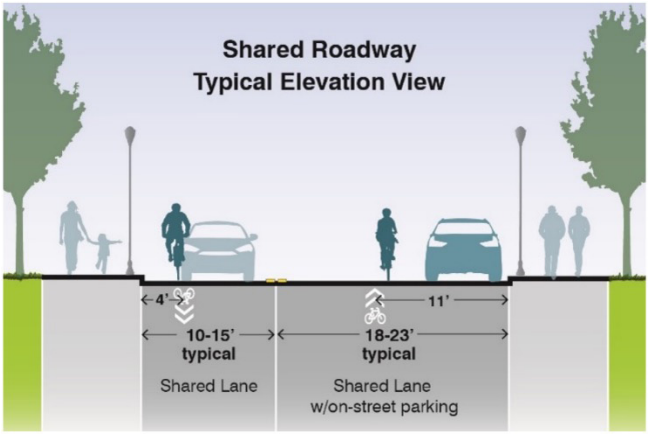


Figure 5-2 Typical Shared Roadway Elevation View

5.7.1 APPLICATION GUIDANCE

Shared roadways are suitable for corridors with low to moderate traffic volume and speeds. **Table 5-2** below provides the recommended and acceptable traffic volume and speed ranges for the application of shared roadways. Note: The MUTCD states that the shared lane marking (sharrow) should not be placed on roadways that have a speed limit above 35 mph.

Table 5-2 Shared Roadway Application Guidance

Traffic Volume	Recommended	5,000 ADT or less
	Acceptable	5,000 – 10,000 ADT
85th Percentile Speeds	Recommended	30 mph or less
	Acceptable	31 – 35 mph

5.7.2 DESIGN GUIDANCE

5.7.2.1 LANE WIDTH

- Shared lanes are generally suitable for roadways 20 feet or more in width that lack a yellow centerline pavement marking.
- Where a yellow centerline pavement marking is present, wide (13-15 foot) shared lanes are preferred over narrower lanes as they afford greater separation between motorists and bicyclists and require less encroachment of motor vehicles into adjacent traffic lanes when passing bicyclists. Bike lanes are recommended instead of shared lanes where traffic lanes are continuously wider than 15 feet.
- Where a yellow centerline pavement marking is present, narrow (less than 13 feet) shared lanes should only be used in lower traffic volume and speed conditions. Lower volume roadways afford greater gaps in traffic to allow for encroachment of motor vehicles into adjacent traffic lanes when passing bicyclists. Lower speed conditions are preferred for narrow shared lanes.

Table 5-3 below provides recommended shared lane width as a function of traffic speed and volume for roadways with no on-street parking.

Table 5-3 Recommended Shared Roadway Width (no on-street parking)

Recommended Shared Lane Width (inclusive of shoulder)	**Maximum 85th Percentile Speed**	**Maximum ADT**
10-12 feet	30 mph	5,000
13-15 feet	35 mph	10,000
No centerline: 20+ feet (edge of pavement to edge of pavement, bi-directional traffic)	35 mph	6,000

Table 5-4 below provides recommended shared lane width as a function of traffic speed and volume for roadways with on-street parking.

Table 5-4 Recommended Shared Roadway Width (on-street parking)

Recommended Shared Lane Width (inclusive of on-street parking lane)	**Maximum 85th Percentile Speed**	**Maximum ADT**
18-20 feet (edge of pavement to centerline)	30 mph	5,000
21-23 feet (edge of pavement to centerline)	35 mph	10,000
No centerline, parking one side: 24+ feet (edge of pavement to edge of pavement, bi-directional traffic**)**	35 mph	6,000
No centerline, parking both sides: 28+ feet (edge of pavement to edge of pavement, bi-directional traffic)	35 mph	6,000

5.7.2.2 PAVEMENT MARKINGS

- Shared lane markings (sharrows) shall be provided.
- Sharrows shall be 3'-4" wide by 9'-4" long.
- The centerline of the sharrow shall be placed at least 12 feet from the face of the curb or edge of pavement where on-street parking is present, and 4 feet from the face of the curb or edge of pavement where no on-street parking is present.
- Sharrows should be located and spaced at intervals no greater than 250 feet. Closer spacing should be considered in areas of high bicyclist use, a history of bicycle involved crashes, limited sight distance, or through intersections or roundabouts. The first sharrow downstream from an intersection should be placed no more than 50 feet from the intersection.
- Edge (shoulder) lines are not recommended for use on shared roadways. In situations where edge lines are present or required, the sharrow marking shall be placed on the traffic side of the edge line. The edge of the sharrow marking shall be spaced a minimum of six inches away from the edge line.
- It is preferable that yellow centerline markings are not applied to, or are removed from, local shared roadways with less than 6,000 ADT unless required due to roadway curvature, the presence of three or more traffic lanes, or other unique conditions. The absence of a centerline pavement marking provides additional separation between motorists and bicyclists due to the tendency of vehicles to operate closer to the center of the roadway in the absence of a center line pavement marking.

Figure 5-3 Shared Lane "Sharrow" Marking

5.7.2.3 SIGNAGE

- The MUTCD W11-1 Bicycle Warning sign should be placed at the beginning of a shared roadway and as conditions require. An "IN LANE" subplate may be used. "SHARE THE ROAD" subplates shall not be used.
- The MUTCD R5-1b "WRONG WAY" and R9-3cP "RIDE WITH TRAFFIC" plaque should be considered for use in areas prone to wrong-way riding.
- The MUTCD R9-20 "Bicycles Allowed Use of Full Lane" sign may be used. If used, the sharrow marking should be placed in the center of the travel lane. The sign may be used on roadways where no bicycle lanes or adjacent shoulders usable by bicycles are present and where travel lanes are too narrow for bicycles and motor vehicles to operate side-by-side.

Figure 5-4 MUTCD R4-11

Figure 5-5 Bicycle Warning Sign, MUTCD W11-1

5.7.3 LIMITATIONS

Shared roadways are low-cost facilities that have minimal impact on roadway operations. Shared roadways do not provide exclusive operating space for bicyclists and may not be as attractive to bicyclists as facilities that provide exclusive operating space.

5.8 BIKE LANE

Bike lanes provide a dedicated space on the roadway for bicycle travel, which is signified by pavement markings and signage. Bike lanes are typically located between a motor vehicle travel lane and the curb, road edge, or parking lane. Bike lanes are used for one-way travel in the same direction as the adjacent traffic lane. Bike lanes are generally reserved for use by bicyclists except for emergency use by public safety vehicles or disabled vehicles, temporary use by service/ delivery vehicles, and maintenance activities.

Connecticut General Statutes Section 14-251 regulates the use of public highways and prohibits parking on public highways that would constitute a traffic hazard or obstruct the free movement of traffic.

Bike lanes provide separation between bicyclists and traffic and require minimal roadway space, which allows for their inclusion via traffic lane width reductions, removal of traffic lanes, and/or removal of on-street parking lanes.

Bike lanes may be provided in isolated segments as climbing lanes. Climbing lanes are placed on the uphill direction of a steep roadway grade to provide bicyclists space to ride without slowing down vehicular traffic.

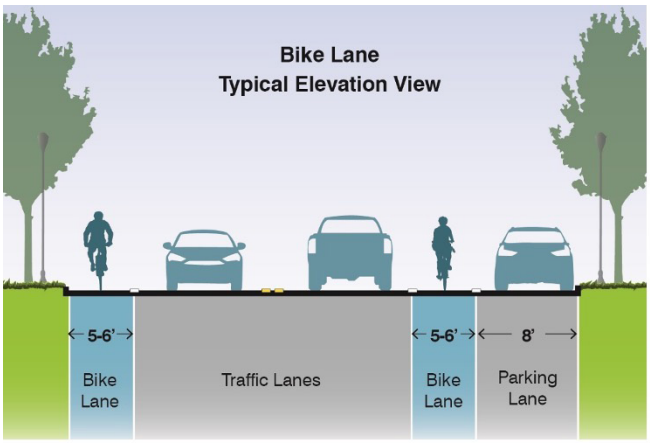


Figure 5-6 Typical Bike Lane Elevation View

5.8.1 APPLICATION GUIDANCE

Table 5-5 below provides guidance on the application of bike lanes based upon traffic speed and volume conditions.

Table 5-5 Bike Lane Application Guidance

Traffic Volume	Recommended	10,000 ADT or less
	Acceptable	10,000 – 18 ,000 ADT
85th Percentile Speeds	Recommended	35 mph or less
	Acceptable	36 – 40 mph

5.8.2 DESIGN GUIDANCE

5.8.2.1 BIKE LANE WIDTH

- Bike lanes should be between 4 and 6 feet wide. Selection of a bike lane width is based upon edge of roadway conditions, traffic volume, and traffic speed. While AASHTO recommends a minimum of 4- to 5-foot-wide bike lanes, a 6-foot-wide bike lane is preferred for use in higher traffic volume and speed conditions where space allows.
- The maximum bike lane width is 6 feet to discourage its use as a parking lane. Buffered bike lanes should be used where the bicycle operating space is greater than 6 feet.
- A consideration in selecting an appropriate bike lane width is the presence and location of roadway features such as catch basins, utility covers, and longitudinal pavement joints. Bicyclists should be provided with sufficient operating space within the bike lane to avoid potentially hazardous surface features.
- When placed between a parking lane and traffic lane, the combined width of the parking lane and bike lane should be no less than 13 feet to minimize door zone conflicts. In areas of high parking turnover such as areas with metered or time-limited spaces, the parking lane width should be increased to 9 feet, or a 2-foot-wide door zone buffer should be used with a 7-foot-wide parking lane to provide additional separation between bicyclists and open car doors.

Table 5-6 below provides guidance on determining appropriate bike lane width in response to adjacent traffic lane width, traffic speed, and traffic volume.

Table 5-6 Bike Lane Width Selection

Bike Lane Width	Adjacent Traffic Lane Width	Maximum 85th Percentile Speed	Maximum ADT
4 feet*	10 feet	30 mph	7,500
	11 feet	30 mph	10,000
5 feet	10 feet	30 mph	10,000
	11+ feet	35 mph	12,500
6 feet	10 feet	35 mph	12,500
	11+ feet	40 mph	15,000
Notes	*Only for use at edge of roadway where no curb is present, no drainage structures are located in bike lane, and the area adjacent to the roadway is flush with edge of pavement.		

5.8.2.2 PAVEMENT MARKINGS

- A solid white lane marking (4 or 6 inches wide) shall be used to separate the bike lane from the motor vehicle travel lane.
- Bike lane lines should be dotted at turning lanes, bus stops, and at approaches to intersections. A 6-inch-wide dotted bike lane line (2-foot line, 6-foot gap) should be used. Bike lanes may also be dotted at bus stops or bus pullouts and across unsignalized intersecting streets and major driveways. Bike lane lines should remain solid (not dotted) at unsignalized driveways and alleys.
- Bike lane symbols shall be used to define the bike lane. Symbol pavement markings should be placed no more than 50 feet after an intersection and spaced at intervals no greater than 250 feet in urban areas and 1,000 feet in rural areas or suburban areas with little roadside activity.
- Green pavement color may be used to enhance the visibility of a bike lane in locations with high traffic volumes, large numbers of turning movements, or where bike lanes cross traffic lanes.

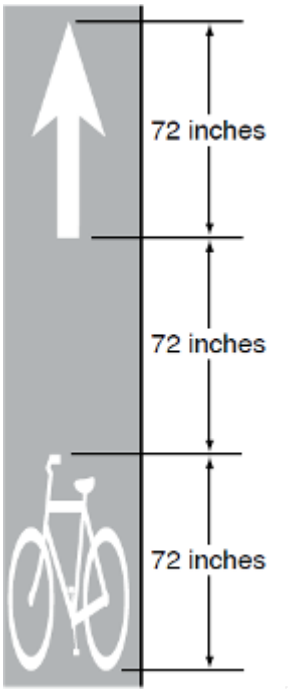


Figure 5-7 Bike Lane Marking

5.8.2.3 SIGNAGE

- Bike lane signage (MUTCD R3-17) is not required but may be used at the beginning of a bike lane or immediately following a signalized intersection.
- The "RIDE WITH TRAFFIC" plaque (MUTCD R9-3cP) should be considered for use in areas prone to wrong-way riding.
- The use of "Bike Lane Ahead" and "Bike Lane Ends" signage is not necessary.
- A "No Parking Bike Lane" (MUTCD R7-9 or R7-9a) sign may be used in areas with frequent and consistent parking in the bike lane.

Figure 5-8 Bike Lane Sign (MUTCD R3-17)

5.8.3 LIMITATIONS

While bike lanes provide separation between traffic and bicyclists, they do not physically protect bicyclists who remain exposed to traffic and open car doors where on-street parking is present.

Proper intersection treatments are required to avoid conflicts with right-turning vehicles and to assist bicyclists with left-turn movements.

Figure 5-9 Ride With Traffic Plaque (MUTCD R9-3cP)

5.9 BUFFERED BIKE LANE

Buffered bike lanes are located on the roadway and include a flush painted, colored, or textured buffer space that is used to separate the bike lane from the adjacent traffic or parking lane. Buffered bike lanes provide an improved level of comfort for the bicyclist above that provided by a standard bike lane by providing more space between bicyclists and motorists and more space for bicyclists to pass one another without encroaching into a traffic lane. Buffered bike lanes should be used where traffic volume and/or speed require additional separation between bicyclists and motor vehicles to improve bicyclist safety and comfort. Buffered bike lanes are typically paired one-way facilities that operate in the same direction of traffic.

One of the challenges of incorporating buffered bike lanes is the additional roadway space needed to accommodate the buffer space. Buffered bike lanes, while providing additional separation between bicyclists and motor vehicles, do not provide the same extent of physical separation as separated bike lanes. Buffered bike lanes may require additional maintenance when compared to standard bike lanes because of the need to maintain the buffer striping or surface treatment.

5.9.1 APPLICATION GUIDANCE

Table 5-7 to the right provides guidance on the application of buffered bike lanes based upon traffic speed and volume conditions.

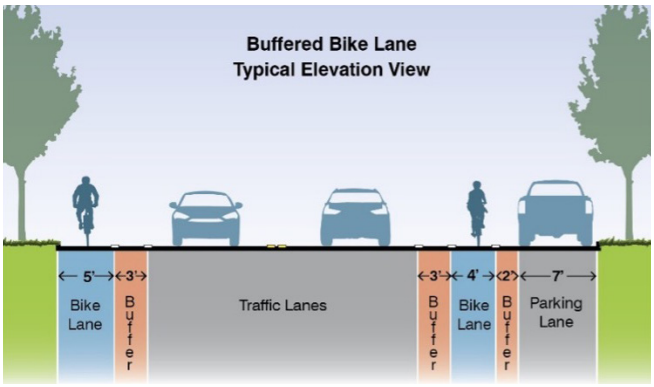


Figure 5-10 Typical Buffered Bike Lane Elevation View

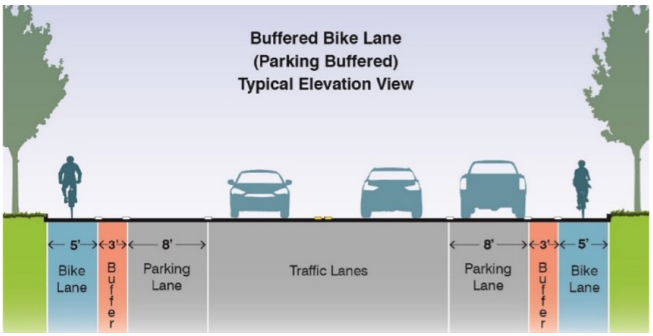


Figure 5-11 Typical Parking Buffered Bike Lane

Table 5-7 Buffered Bike Lane Application Guidance

Traffic Volume	Exceeds Recommendation	Less than 5,000 ADT
	Recommended	5,000 - 20,000 ADT
	Acceptable	20,000 - 25,000 ADT
85th Percentile Speeds	Exceeds Recommendation	30 mph or less
	Recommended	31 - 40 mph
	Acceptable	41 - 45 mph

5.9.2 DESIGN GUIDANCE

5.9.2.1 BIKE LANE WIDTH

- Bike lanes may be a minimum of 4 feet wide if buffered on both sides.
- Bike lanes shall be a minimum of 5 feet wide if buffered only on one side.

5.9.2.2 BUFFER WIDTH AND APPLICATION

Buffers, whether traffic side or parking side should be no less than 2 feet in width. Appropriate traffic side buffer width should be determined based upon adjacent traffic lane width, traffic speed, and traffic volume as per **Table 5-8** below.

- Where a parking lane buffer is provided on the left (driver) side of a parking lane, the combined width of the parking lane and parking lane buffer shall be no less than 9 feet to minimize door zone conflicts.
- Where a buffered bicycle lane is located on the right (passenger) side of a parking lane, the minimum buffer width between the parking lane and bike lane shall be 3 feet to minimize door zone conflicts.
- Bike lanes located between traffic and parking lanes should include parking lane side buffers when located adjacent to parking lanes in areas of high parking turnover such as metered spaces, time-limited spaces, and retail areas.
- Rumble strips may be used within a traffic side buffer and should be placed at the traffic side edge of the buffer when used.

Table 5-8 Traffic Side Buffer Width Selection Guidance

Traffic Side Buffer Width Minimum	Adjacent Traffic Lane Width	Maximum 85th Percentile Speed	Maximum ADT
2 feet	10 feet	40 mph	15,000
	11 feet	42.5 mph	20,000
3 feet	10 feet	42.5 mph	20,000
	11+ feet	45 mph	25,000

5.9.2.3 PAVEMENT MARKINGS

- Bicycle symbols shall be provided in the bike lane as per Bike Lane design guidance.
- The buffer area should be marked with two solid longitudinal white lines with interior diagonal cross hatching for buffers less than 4 feet wide and chevron cross hatch markings for buffers exceeding 4 feet in width.
- The diagonal cross hatch or chevron cross hatch should be an 8-inch, 45-degree, white marking spaced 20 to 30 feet apart.

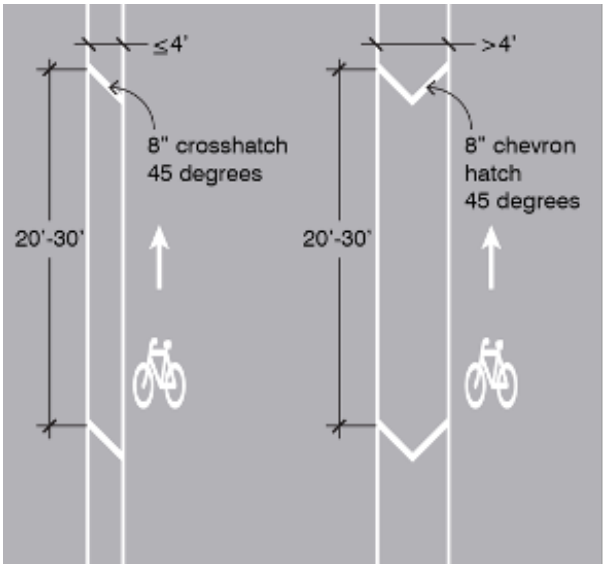


Figure 5-12 Bike Buffer Pavement Marking

5.9.2.4 SIGNAGE

Signage should be provided in accordance with design guidance for Bike Lanes (see Section 3.3).

5.9.3 LIMITATIONS

Buffered bike lanes may not provide physical protection from traffic. Proper intersection treatments are required to avoid conflicts with right-turning vehicles and to assist bicyclists with left-turn movements.

5.10 SIDEPATH

Sidepaths facilities for the exclusive use of bicycles and pedestrians. Sidepaths are physically separated from motor vehicles by open space, a curb or a barrier and run adjacent to the roadway. They differ from separated bike lanes in that both bicyclists and pedestrians use them. Sidepaths often connect recreational paths and are commonly found along the edge of parks and water features.

Sidepaths provide significant flexibility in accommodating bicyclists because the facility can be used by both pedestrians and bicyclists in lieu of a sidewalk and on-street bicycle lanes. A sidepath may be used along a corridor where a two-way separated bike lane may be desirable, but where physical or right-of-way constraints do not allow for the provision of a sidewalk and separated bike lane.

Sidepaths can create conflicts when they are located alongside a roadway with multiple driveways or frequent intersections. Turning motor vehicles may not expect crossing bicycle traffic in an area typically occupied by pedestrians when turning into or from a driveway or cross street.

5.10.1 APPLICATION GUIDANCE

Sidepaths are most suitable for corridors with high traffic volume and moderate to high traffic speeds.

5.10.2 DESIGN GUIDANCE

5.10.2.1 WIDTH

Sidepaths are typically 10 to 12 feet wide but may be as narrow as 8 feet under certain conditions. The recommended sidepath width is established by the projected peak hour bike and pedestrian traffic. See **Table 5-10** at right.

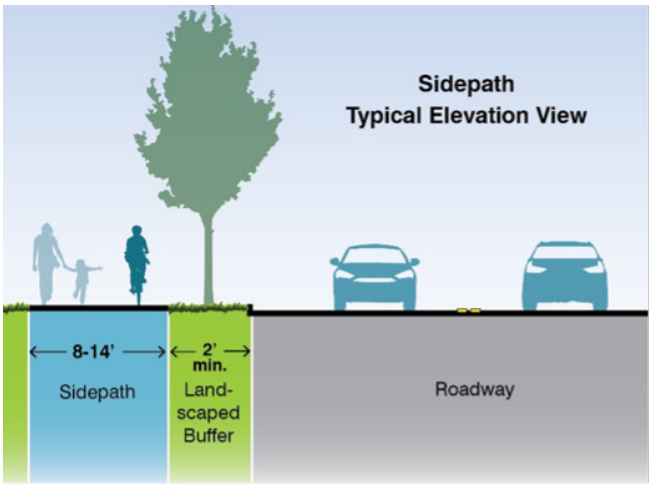


Figure 5-13 Sidepath Typical Elevation View

Table 5-9 Sidepath Application Guidance

Traffic Volume	Exceeds Recommendation	Less than 10,000 ADT
	Recommended	10,000 ADT or more
85th Percentile Speeds	Exceeds Recommendation	30 mph or less
	Recommended	31 mph or more

Table 5-10 Sidepath Width

Users per Peak Hour	Minimum Width	Recommended Width
<300	8 feet*	10 feet
300-500	11 feet	12 feet
>500	See Section 6.4.2 of AASHTO Guide	

* Sidepaths may have a minimum width of 8 feet where the following conditions prevail:

- Pedestrian use of the facility is expected to be occasional only.
- For a short distance due to a physical constraint such as an environmental feature, bridge abutment, utility structure fence and such.
- Horizontal and vertical alignments provide frequent, well-designed passing and resting opportunities.
- The path will not be regularly subjected to maintenance vehicle loading conditions that would cause pavement damage.

5.10.2.2 GRADE

- Sidepaths may be at roadway grade or at sidewalk grade.
- The horizontal alignment and grade of sidepaths is primarily established by the adjacent roadway.

5.10.2.3 BUFFER

- Sidepaths should be separated from the roadway by grade separation with use of a curb and/or by a landscaped buffer strip.
- The minimum recommended distance (buffer width) between the roadway (as measured from edge of pavement or face of curb) and sidepath is 5 feet to allow sufficient space for landscaping, utility structures, signage, and snow storage. The buffer may be reduced to a minimum of 2 feet, but only where conditions do not permit the use of a larger buffer.
- Adequate separation from motor vehicle traffic in an adjacent traffic lane is a primary consideration. Where a buffer width of 5 feet or more cannot be provided, consideration should be given to the adjacent roadway conditions including the presence of a marked shoulder, the width of a marked shoulder if present, and the width of the adjacent traffic lane if no shoulder is present. The primary consideration is the location of traffic relative to the sidepath, ensuring that there is a minimum of 5 feet of separation between the edge of moving vehicles and the sidepath.
- Where a curb or a buffer strip providing the minimum buffer width cannot be provided, physical barriers such as a traffic delineator posts, rigid bollards, or a concrete barrier with a railing or fence should be provided. Required roadway clearance from fixed objects should be considered in the design and implementation of barrier systems. Barrier systems less than 42 inches in height should be separated from the edge of the sidepath by a minimum distance of 2 feet to avoid bicyclist collisions with the barrier, which presents a potential fall hazard for bicyclists.

5.10.2.4 DRIVEWAY AND ROADWAY CROSSINGS

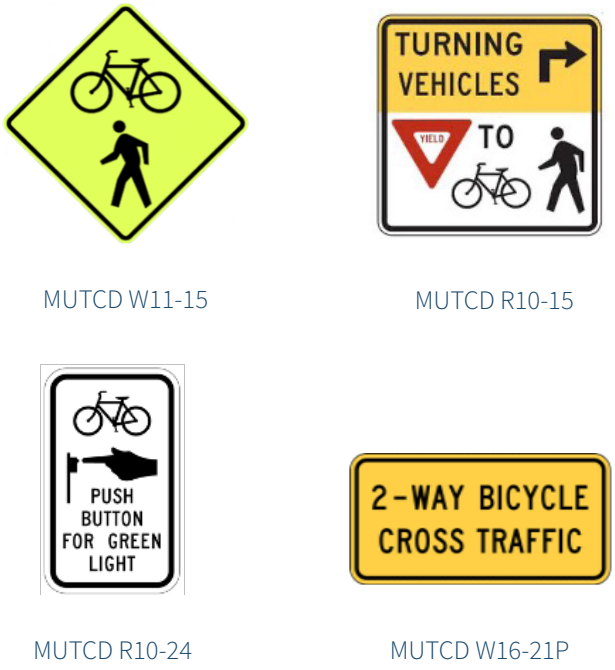
- Sidepaths should maintain grade across unsignalized driveway crossings.
- Crosswalk markings should be applied to all roadway crossings, signalized driveways, and driveways of major traffic generators.
- Concrete ramps and tactile warning strips should be used at the approach of all roadway crossings.

5.10.2.5 PAVEMENT MARKINGS

- A single yellow 4” wide centerline may be applied on curves or in high bicycle traffic areas. The line may be solid or dotted.
- Standard white pedestrian continental style crosswalk markings should be applied where required. The crosswalk should match or exceed the width of the approaching sidepath.

5.10.2.6 SIGNAGE

- An 18" W11-15 bike/pedestrian sign may be used at the entrance of sidepaths following an intersection to notify users of the expected shared use of the path.
- Signalized intersections with concurrent bike crossings should include the MUTCD R10-15 sign to warn both motorists of crossing bicycle traffic.
- The MUTCD R10-24 sign should be used at signalized intersections that require bicyclists to use a pedestrian actuated signal.
- The MUTCD W16-21P Two-Way Bicycle Cross Traffic Warning Plaque should be installed below the stop sign of intersecting streets.



MUTCD W11-15 | MUTCD R10-15

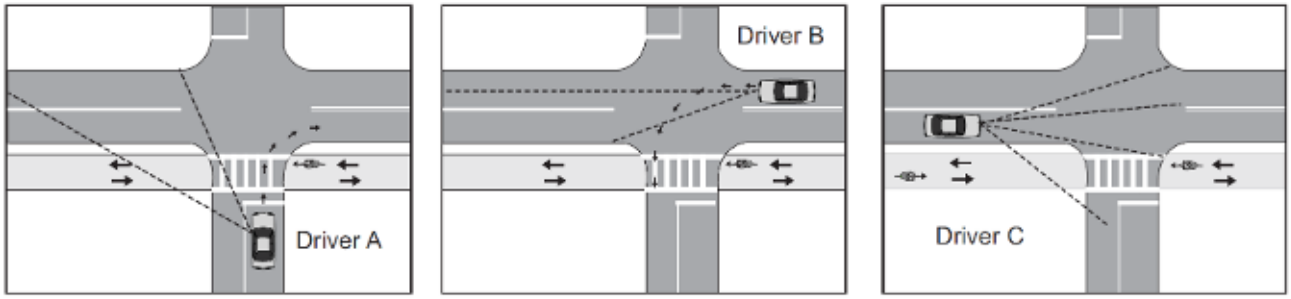
MUTCD R10-24 | MUTCD W16-21P

Figure 5-15 Signs for Use with Sidepaths

5.10.3 LIMITATIONS

Sidepaths are not ideal facilities for areas of high pedestrian volume and high potential bicycle use due to potential conflicts between the user groups. Like separated bike lanes, sidepaths require proper driveway and intersection treatments to reduce conflicts and protect users.

Sidepaths expose bicyclists to the crossing and turning movements of motor vehicles at driveways and unsignalized intersections. The planning and design of these facilities should account for, and take measures necessary, to reduce conflicts between bicyclists and motor vehicles (see **Figure 5-14** below).



Right turning Driver A is looking for traffic on the left. A contraflow bicyclist is not in the driver's main field of vision.

Left turning Driver B is looking for traffic ahead. A contraflow bicyclist is not in the driver's main field of vision.

Right turning Driver C is looking for left turning traffic on the main road and traffic on the minor road. A bicyclist riding with traffic is not in the driver's main field of vision.

Figure 5-14 Potential Sidepath Conflicts at Road Crossings.
Source: AASHTO Guide to Bicycle Facilities, 4th Edition

5.11 SHARED USE PATH

Shared use paths, similar to sidepaths, provide a separated facility for the exclusive use of bicycles and pedestrians. Shared use paths differ from separated bike lanes in that they are used by a range of users including bicyclists, pedestrians, and skaters. Shared use paths are typically recreational in nature but can also be effective facilities for transportation.

Shared use paths are typically physically separated from the roadway by a significant distance and have few roadway crossings. The paths often travel through open space areas and along natural features such as rivers and waterbodies.

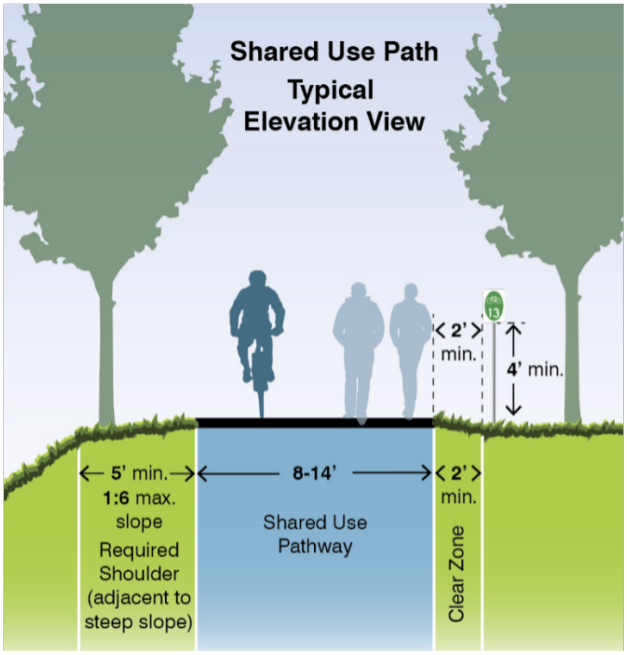


Figure 5-16 Shared Use Path Typical Elevation View

5.11.1 DESIGN GUIDANCE

5.11.1.1 WIDTH

Shared use paths are typically 10 to 12 feet wide but may be as narrow as 8 feet under certain conditions. **Table 5-11** provides guidance on the recommended shared use path width based upon projected peak hour bike and pedestrian traffic.

Paths wider than 12 feet are recommended where one or more of the following conditions prevail:

- Where it is desired to allow bicyclists and pedestrians to travel side-by-side throughout a corridor and still accommodate passing from the other direction.
- Where it is desired to allow bicyclists to operate at speeds of 20 to 30 mph to minimize conflicts with other users.
- The path is a regionally significant bicycle travel corridor.
- Where pedestrians, skaters, adult tricyclists, children or other users that need more operating width, are likely to exceed 30% of the path traffic.
- Where the shared use path is used by larger maintenance vehicles.
- On steep grades to provide additional passing area and shy distances to faster downhill bicyclists.

Table 5-11 Recommended Shared Use Path Width

Users per Peak Hour	Minimum Width	Recommended Width
<300	8 feet*	10 feet
300-500	11 feet	12 feet
>500	See Section 6.4.2 of AASHTO Guide	

* Shared use paths may have a minimum width of 8 feet where the following conditions prevail:

- Pedestrian use of the facility is expected to be occasional only.
- For a short distance due to a physical constraint such as an environmental feature, bridge abutment, utility structure fence and such.
- Horizontal and vertical alignments provide frequent, well-designed passing and resting opportunities.
- The path will not be regularly subjected to maintenance vehicle loading conditions that would cause pavement damage.

5.11.1.2 DESIGN SPEED

Design speed is used to determine geometric features of the shared use path. Once a design speed is selected, all relevant path features should relate to the design speed. In most situations, shared uses paths should be designed to accommodate the fastest typical user. When selecting an appropriate design speed for a path, or path segment, planners and designers should consider factors such as the environmental conditions, expected users, terrain, and path surface.

- Environmental Conditions: Urban, suburban, or rural; proximity to structures; frequency of crossings. Locations with more congestion and potential conflicts may, and in some conditions should, be designed for lower speeds.
- Expected Users: Recreational or commuting; less confident vs highly confident. Recreational paths that attract highly confident recreational users will require higher design speeds than paths that attract less confident users or commuters.
- Terrain: A path in hilly terrain should be designed for a higher speed.
- Path Surface: A lower design speed may be used on unpaved paths as bicycle speeds are slower on these facilities.
- The range of bicycle travel speed on shared use paths is typically between 12 mph and 30 mph.
- For most paths in flat areas (grades less than 2%), a design speed of 18 mph is sufficient except on inclines where higher speeds can occur.
- In areas with hilly terrain and sustained steeper grades (6% or greater) the design speed should be selected based on anticipated travel speed of bicyclists traveling downhill. In all but the most extreme cases, 30 mph is the maximum design speed that should be used.

Design speed should be lowered at the approach to crossing or conflict points to allow the path user to better perceive the crossing situation and potential conflicts. Geometric features such as horizontal curvature may be used to reduce travel speeds approaching such conditions.

5.11.1.3 HORIZONTAL CURVES

The appropriate horizontal curve of a path is a function of design speed, which is selected in response to factors described in Section 7.2.2. **Table 5-12** below provides the recommended minimum horizontal radii based upon a range of design speeds. The AASHTO Guide should be consulted to calculate values for a precise speed not listed at right and for additional information regarding factors related to design speed.

Other factors affect design speed and horizontal alignment such as cross slope and pavement materials. The other primary factor in designing the horizontal alignment of paths is the grade of the path (which is also a factor in selecting design speed).

Table 5-12 Design of Horizontal Curves Based Upon Design Speed

Design Speed (mph)	Minimum Width Minimum Curve Radius (ft)
8	12
10	18
12	27
14	36
16	47
18	60
20	74
25	115
30	166

5.11.1.4 VERTICAL CURVES

Vertical curves are established by stopping sight distance for which the primary factor is design speed. Section 6.6.4.2 of the AASHTO Guide should be consulted in determining appropriate vertical curves.

5.11.1.5 GRADE

Path grades should not exceed 5%. Where a shared use path runs along a roadway with a grade that exceeds 5%, the path grade may exceed 5% but must be less than or equal to the roadway grade. Grades steeper than 5% are undesirable because of accessibility concerns; the ascents are difficult for many path users, and the descents cause some users to exceed the speeds at which they are competent or comfortable. If 5% or lesser grades cannot be achieved, the following options should be considered to mitigate excessive grades:

- Use higher design speeds for horizontal and vertical alignments, stopping sight distance, and other geometric features
- When steep grades occur over a long distance, provide additional 4 to 6 feet of width to permit slower bicyclists to dismount and walk uphill and provide more maneuvering space for faster downhill bicyclists.
- Exceed minimum shy distances.
- Provide recovery areas or protective railings at points where running off the path is a possibility.
- Provide resting intervals with flatter grades to permit users to stop periodically and rest.

5.11.1.6 CROSS SLOPE AND SUPERELEVATION

Cross slopes should be designed to accommodate users with mobility impairments. The following standards should be applied:

- Cross slopes of 1% to 1.5% are recommended for shared use paths.
- Cross slopes should not exceed 2%. If cross slopes exceeding 2% are needed, they should be sloped to the inside of horizontal curves regardless of the drainage condition.
- Cross slopes should follow the existing terrain.
- Superelevation is not required for horizontal curves.
- A center crown with not more than 1% cross slope in either direction may be used.

5.11.1.7 SHOULDER & BARRIER REQUIREMENTS

A minimum 5-foot-wide shoulder is recommended along the path in areas adjacent to bodies of water or downward slopes of 1:3 or greater (vertical to horizontal). The maximum slope of the shoulder should be 1:6. A fence, railing, or dense shrubbery should be provided if conditions adjacent to the path are determined to pose significant risk or under the following conditions if a 5-foot-wide shoulder cannot be provided:

- Slopes of 1:3 (vertical to horizontal) or steeper with a drop of 6 feet or greater.
- Slopes of 1:3 or steeper adjacent to a parallel body of water or other substantial obstacles.
- Slopes of 1:2 or steeper with a drop of 4 feet or greater.
- Slopes of 1:1 or steeper with a drop of 1 foot or greater.

5.11.1.8 FENCE OR RAILING

See Section 10.11 Fences and Railings.

5.11.1.9 VERTICAL CLEARANCE

- The recommended vertical clearance is 10 feet.
- The minimum vertical clearance is 8 feet.

5.11.1.10 PATH SURFACE

- Asphalt or concrete path surfaces are preferred.
- Crushed stone surfaces may be appropriate on rural paths where the intended use of the path is primarily recreational. An example of a primarily recreational facility is a facility that does not directly connect residential areas to employment centers or schools. Crushed stone surfaces must comply with accessibility standards.
- A crushed stone shoulder may be provided along the edge of the path to accommodate users that prefer an unpaved surface. When provided for this purpose, the minimum recommended width is 3 feet. This area does not contribute to the required minimum width of the path.

5.11.1.11 PAVEMENT MARKINGS

Center lines are optional on all shared use paths. The use of a center line strip should be considered under the following conditions:

- For a path with high user volume.
- On curves with restricted sight distance or design speeds less than 14 mph.
- On unlit paths where nighttime riding is permitted.
- When approaching intersections.
- When approaching obstructions within the center of the path (such as a bollard).

Center lines should be applied in accordance with the following:

- A 4-inch solid yellow line may be used to separate the two directions of travel where passing is not permitted.
- A 4-inch dotted yellow line (3-foot segment/9-foot gap) may be used where passing is permitted.

Edge line markings may be used on paths under the following situations:

- Where nighttime use routinely occurs
- At approaches to intersection to alert path users of changing conditions
- To separate pedestrians from bicyclists where the path design includes a separate area for pedestrian travel.
- When the shared use path changes significantly over a relatively short distance.
- On approaches to constraints on the outside edge of the shared use path such as entrances to tunnels or bridge abutments.
- To establish a shy distance from an obstruction that might not be noticeable such as a short segment of curbing.

5.11.1.12 SIGNAGE

- Signs should be located a minimum of 2 feet from the edge of path.
- Signs should be a minimum of 4 feet above surface of path (to avoid bicyclists' hands and handlebars from colliding with sign).

5.11.1.13 ACCESS CONTROL

Path access points should be designed to prevent undesirable motor vehicle access while allowing for safe and comfortable bicyclists and pedestrian use and service and emergency vehicle access. Multiple measures can be used to manage access. These include:

- Bollards: Bollards should only be used in areas where there is the likelihood or history of motor vehicle intrusion.
  - Bollards should be placed a minimum of 30 feet from intersections to allow path users to cross the intersection before negotiating the barrier posts.
  - Bollards should be a minimum width of 4 inches, 40 to 48 inches tall, and should be marked on all sides with retroreflective material.
  - The minimum unobstructed path width on either side of the bollard should be 4 feet.
  - If more than one bollard is needed to control access, three bollards should be used. Two bollards should not be used as this application would place the bollards in the center of the bicyclist path of travel.
  - Bollards should be designed to be knock-down, removable, or hinged to permit entrance by emergency and service vehicles.
  - A solid yellow center line stripe should be provided around and on the approach to a central bollard.
- Median Islands: Median islands should be used in areas where there is low likelihood or little history of motor vehicle intrusion.
  - The path surface on either side of the median should be no less than 5 feet.
  - Low level perennial (not woody) plants may be used within the landscaped bed.
  - The median should be no wider than 4 feet and the surrounding curb should be no greater than 4 inches tall to allow emergency and service vehicles to mount or straddle the bed.
- Signs: “No Motor Vehicles” signage (MUTCD R5-3) should be used to reinforce regulatory access rules.

Median island path access, Source: Weston & Sampson

5.12 INTERSECTION TREATMENT

Bicycle facilities require specialized intersection treatments to improve the safety and operation of bicyclists traveling through intersections. These treatments vary based upon the approaching bicycle facility and the characteristics of the intersection.

Intersection Treatment

5.12.1 INTERSECTION TREATMENT SELECTION

Intersection treatments are specific to the conditions of each intersection. The selection of appropriate treatments is conditional upon the approaching or intersecting bicycle facility. Additional considerations include the number and configuration of traffic lanes, intersection traffic control, and the presence of sidewalks and pedestrian crossings. **Table 5-13** below provides guidance on which intersection treatments are typically used with the bicycle facilities identified in this manual. Application may vary based upon actual intersection conditions.

Table 5-13 Recommended Intersection Treatment Selection

	Combined Lanes	Bike Pockets	Bike Boxes	Two-Stage Turn Boxes	Intersection Crossing Markings	Mid-Block Crossings
Shared Roadway	●	●	●		●	
Bike Lane	●	●	●	●	●	
Buffered Bike Lane	●	●	●	●	●	
Separated Bike Lane				●	●	
Sidepath				●		
Shared Use Path						●

Combined Lanes feature the shared use of intersection queuing lanes by bicyclists and motor vehicles. Combined lanes are delineated by sharrow markings.

Image source: NACTO

Bike Pockets are striped bicycle lanes between thru-traffic and/or turning lanes at intersections.

Bike Boxes are used at signalized intersections to provide a dedicated space, between stopped traffic and the intersection, for bicyclists while they wait for a green light or to make a left turn.

Image credit: Google Earth

Two-Stage Turn Boxes are intersection design treatments that help facilitate left turns of bicyclists. The turn box is located on the far side of the intersection to the right of auto and bicycle traffic. They offer bicyclists a safer alternative to making left turns at signalized intersections by splitting the turning movement into two separate through movements.

Image credit: City of Cambridge, MA

Intersection Crossing Markings are pavement markings applied within an intersection or across a roadway to guide bicyclists through the intersection and increase driver awareness.

Mid-Block Crossing treatments are primarily used with shared use paths as path routes often diverge from, but cross, road networks. They use treatments that are similar to mid-block pedestrian crosswalks.

Image source: NACTO

5.12.2 COMBINED LANES

Combined lanes (referred to as mixing zones in the MUTCD) are used to reduce bicycle conflicts with right-turning motor vehicle traffic. Combined lanes provide markings that guide a bicyclist through an intersection along the left side of a right-turn lane or a thru-right traffic lane. This allows thru-bicyclists to travel with slower moving right-turning traffic. Cyclists making a right turn may ride at the right side of the combined lane. The combined lane creates a mixing zone between the two modes. Combined lanes are recommended at intersections lacking sufficient space to accommodate a bike pocket.

Combined lanes can be used as a continuation of a shared roadway, striped bike lanes, or buffered bike lanes. Connecticut statute allows thru-bicyclists to position themselves in the far-left edge of a right turn lane, whether a sharrow marking is present or not. The addition of a sharrow, however, assists bicyclists in positioning themselves properly and alerts motorists to their potential presence.

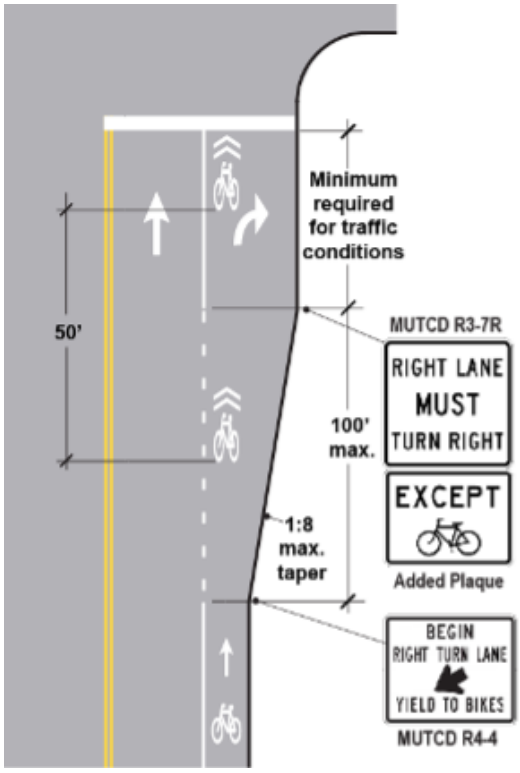


Figure 5-17 Combined lane markings and signage

Combined lane markings, Image Source: NACTO

5.12.2.1 USE WITH

- Shared Roadways
- Bike Lanes
- Buffered Bike Lanes

5.12.2.2 DESIGN GUIDANCE

- Sharrow pavement markings shall be used to indicate bicyclist position within the combined lane. Sharrows should be placed a maximum of 50 feet apart. If the lane is a turning lane, a turn arrow shall be provided.
- The width of the combined lane should be 10 to 14 feet.
- A dotted white stripe should be used to mark the transition to an exclusive right-turn combined lane and should extend for a maximum of 200 feet.
- Where a taper is provided for a dedicated right turn lane, the taper angle should be no more than 1:8 (1 foot perpendicular to the roadway per 8 feet parallel to the roadway).
- "Begin Right Turn Lane Yield to Bikes" (MUTCD R4-4) sign should be used at the beginning of the turn lane and the "Right Lane Must Turn Right" (MUTCD R3-7R) sign with "Except Bikes" Plaque should be provided at the end of the transition area.
- Where a general-purpose turn lane is controlled by a traffic control signal, through bicycle movements shall not be accommodated in the turn lane unless the turning movement is always permitted to proceed simultaneously with the adjacent through movement.

5.12.3 BIKE POCKETS

Bike pockets are design treatments used to reduce bicycle conflicts with right-turning motor vehicle traffic. Bike pockets are placed between right-turn lanes and through travel lanes to clearly distinguish the path for bicyclists traveling straight through the intersection. Bike pockets should be incorporated into intersections in favor of discontinuing bicycle facilities prior to an intersection and resuming bicycle facilities following an intersection.

Bike pocket, Hartford, CT

5.12.3.1 USE WITH

- Shared Roadways
- Bike Lanes
- Buffered Bike Lanes

5.12.3.2 DESIGN GUIDANCE

- The bike pocket should have a minimum width of 5 feet; the preferred width is that of the approaching bike lane.
- At least one bike lane symbol pavement markings should be used to identify the bike pocket and should be located a maximum of 50 feet apart. Bike lane symbols are not required within dotted segments of the bike pocket if green paint is used.
- A dotted white stripe should be provided on both sides of the bike pocket extending for a maximum distance of 200 feet.
- Where a taper is provided for a dedicated right turn lane, the taper angle should be no more than 1:8 (1 foot perpendicular to the roadway per 8 feet parallel to the roadway).
- Green pavement marking is recommended within the bike pocket in areas of high right turn volume.
- "Begin Right Turn Lane Yield to Bikes" (MUTCD R4-4) sign should be used at the beginning of the turn lane.

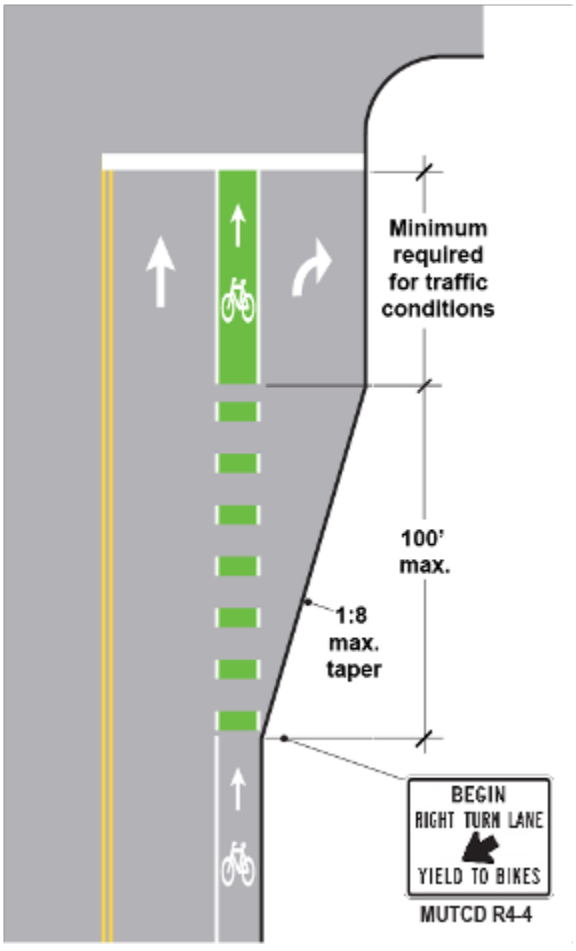


Figure 5-18 Bike Pocket

5.12.4 BIKE BOXES

Bike boxes are used at intersections to provide a dedicated space for bicyclists to queue for through movement or turns. Bike boxes enhance the visibility of bicyclists by positioning bicyclists at the front of motor vehicle lanes to get ahead of queuing vehicles during the red signal phase.

Although bike boxes are used to enhance visibility, conflicts can arise between bicyclists and motor vehicles, particularly when a traffic light is about to turn green for the corresponding approach. Additionally, bike boxes are not helpful to a bicyclist approaching an intersection during a green signal phase for the desired approach.

5.12.4.1 USE WITH

- Shared Roadways
- Bike Lanes
- Buffered Bike Lanes

5.12.4.2 DESIGN GUIDANCE

- Bike boxes should not be placed across more than two lanes of traffic due to the amount of lateral movement required of bicyclists to navigate the box and the risk of maneuvering while the traffic signal turns green.
- Turns on red shall be prohibited from the lane in front of which bike box is placed and a “No Turn on Red” (R10-11a) sign shall be provided.
- A “Stop Here on Red” (R10-6a) sign should be posted at the motor vehicle stop line to reinforce observance of the proper stop line and should be accompanied by an “Except Bicycles” (R3-7bP) sign.
- The distance from the upstream edge of the bike box that is nearest to the stop line for motor vehicles to the downstream edge of the bicycle box that is nearest the crosswalk or intersection shall be at least 10 feet.

Bike Box, Hartford, CT, Image Source: Google Earth

- At least one bicycle symbol marking shall be used in the bike box. One symbol per traffic lane is recommended. An arrow should not be used with the bike symbol.
- Where an existing stop line for motor vehicles is relocated upstream to install a new bike box, the yellow change and red clearance intervals shall be recalculated and if necessary, reprogrammed to accommodate the length of the bike box.
- Where a bike box crosses more than one traffic approach lane, Countdown pedestrian signals for the crosswalk or pedestrian crossing movement that crosses the approach shall be provided. The countdown pedestrian signal shall display the pedestrian change interval countdown without the need for actuation.
- Green-colored pavement may be used in a bike box. If used, green-colored pavement shall cover the full limits of the bike box. Green-colored pavement may also be used in the approaching bike lane.
- The approaching bike lane shall be a minimum length of 50 feet.
- A bike box should not be contiguous with a crosswalk. A stop line on the downstream end of the bicycle box should be used to mark the location where bicycles are required to stop. The stop bar should be a minimum of 1 foot wide (longitudinally) and spaced a minimum of 1 foot from a crosswalk if present.

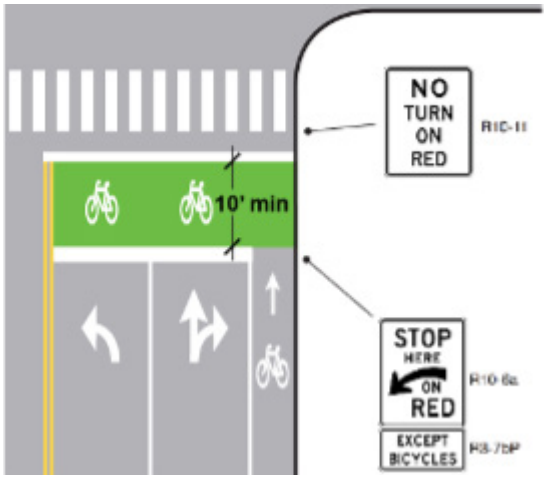


Figure 5-19 Bike Box

5.12.5 TWO-STAGE TURN BOX

Two-stage turn boxes (turn boxes) are intersection design treatments that facilitate left turns for bicyclists when approaching an intersection during a green phase for that approach. This type of bicycle maneuver is permitted by Connecticut state law. The maneuver eliminates the need for the bicyclist to merge into a left lane to make a left turn.

To facilitate left turns, the turn box is typically placed on the far side of the intersection to the right of a traffic or bicycle lane. Once the bicyclist arrives at the left turn box, they make a second through movement to complete their left turn once the intersection is clear. Use of the turn box at signalized intersections may result in delays for bicyclists because bicyclists need to wait for the green phase of the approach behind the turn box.

Situations in which a turn box might be necessary to facilitate turns include, but are not limited to, those in which:

- A separated bicycle facility is provided where upstream access to a lane used to facilitate turns by motor vehicle traffic is physically inaccessible to bicycles
- Left turns are prohibited from the left-most lane, or right turns are prohibited from the right-most lane, at an intersection
- Locations where physical or operational conditions make it impracticable or unsafe for a bicyclist to merge and make the appropriate turn as would any other vehicle

5.12.5.1 USE WITH

- Bike Lanes
- Buffered Bike Lanes
- Separated Bike Lanes

5.12.5.2 DESIGN GUIDANCE

- Two-stage bicycle turn boxes shall be located:
  - Outside of the path of through and turning traffic.
  - Adjacent to the direct path of bicyclist travel.
  - Downstream of an adjacent crosswalk or stop line.
  - In an area between the through bicycle movement and the parallel pedestrian crossing movement if no crosswalk is established,
  - On the innermost side of the bicycle facility provided that the two-stage turn box is located in a portion of the intersection where parallel or motor vehicle traffic does not travel, such as projections of islands or parking lanes, or
  - In an area between the through bicycle movement and a pedestrian facility for T-intersections.
- A turn box shall consist of at least one bicycle symbol pavement marking and at least one pavement marking arrow.
- A turn arrow in the appropriate direction shall be used if a turn box is used with a one-way bicycle lane, and a through arrow in the appropriate direction shall be used if a turn box is used with a two-way bikeway.
- A turn box shall be bounded on all sides by a solid white line. Green colored pavement may be used within the box and if used shall encompass all of the box.
- For turn boxes that facilitate turns from a one-way bikeway, the bicycle symbol shall precede the pavement marking turn arrow in the direction of bicycle travel.
- Passive detection of bicycles in the two-stage bicycle turn box shall be provided if the signal phase that permits bicycles to enter the intersection during the second stage of their turn is actuated.

- Where the path of vehicles lawfully turning on red would pass through a two-stage bicycle turn box, a full-time no-turn-on-red prohibition shall be provided for the crossroad approach and the accompanying R10-11, R10-11a, and/or R10-11b signage shall be provided in accordance with Section 2B.60 of the 11th edition of the MUTCD.
- A left turn box may be used in combination with a bike box. This application provides bicyclists with the greatest range of options for the conditions present.
- Turn boxes should be a minimum of 6.5 feet x 6.5 feet. Engineering judgment should be used to develop the size of the turn box.

5.12.5.3 SIGNAGE

- Where bicycles are required to use a turn box, the Bicycles All Turns from Bike Lane (R9-23) or Bicycle Left Turn from Bike Lane (R9-23a) advance regulatory sign shall be mounted in advance of the intersection, and at least one Bicycle Turn Must Use Turn Box (R9-23b or R9-23c) sign shall be used at the intersection.
- Where used, the Bicycle Turn Must Use Turn Box (R9-23b) sign shall be mounted at the near side of the intersection.
- Where used, the Bicycle Turn Must Use Turn Box location (R9-23c) sign shall be mounted at the far side of the intersection.

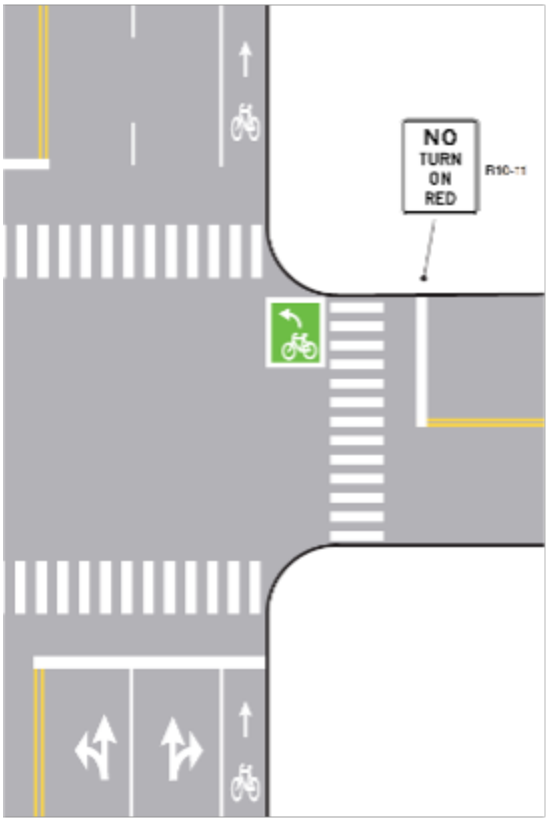


Figure 5-20 Two Stage Turn Box

Left Turn Box, Image Source: City of Cambridge, MA.

5.12.6 INTERSECTION CROSSING MARKINGS

Intersection crossing markings are pavement markings that may be applied within an intersection or across a roadway to guide bicyclists through the intersection and increase awareness of drivers. Marking types include dotted stripes and dashed green markings. Intersection markings are optional.

5.12.6.1 USE WITH

- Bike Lanes
- Buffered Bike Lanes
- Separated Bike Lanes

5.12.6.2 GREEN MARKINGS

- For use with Separated Bike Lanes.
- Green pavement marking should be bordered by dotted edge lines.
- White, dotted edge lines should be used.
- Edge lines should be spaced consistently. Spacing should not exceed 2.5 times that of line length.
- The width of the dotted green marking, inclusive of edges stripes, should match that of the approaching bike lane or bike lane ramp.
- When adjacent to a crosswalk, dotted green markings should be aligned with crosswalk markings.

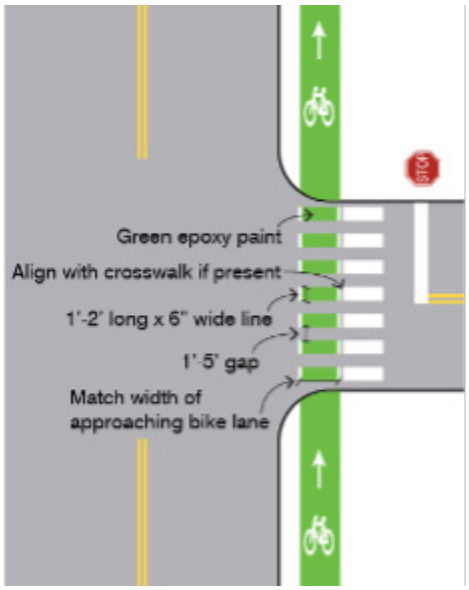


Figure 5-21 Green markings

5.12.6.3 DOTTED LINES

- For use with Bike Lanes or Buffered Bike Lanes.
- The distance between the center of the two dotted lines should match the width of the approaching bike lane.
- Lines should be 2 feet long and spaced 2.5 feet apart.
- The bicycle symbol and arrow marking may be used within the dotted lines.

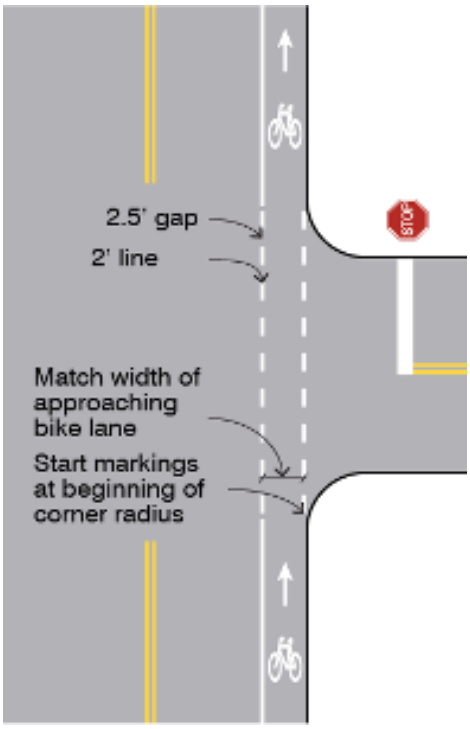


Figure 5-22 Dotted lines

5.12.7 MID-BLOCK CROSSINGS

Mid-block crossing treatments are primarily used with shared use paths where they cross roadways away from intersections. Design and application of these facilities is similar to mid-block pedestrian crosswalks. Treatment for mid-block crossings include marked crosswalks, crosswalks with median refuge islands, signalized crosswalks, and grade separated crossings. Recommended crossing treatments for different roadway conditions are identified in **Table 5-14**. Because conditions are unique at all crossings, engineering judgement should be used in selecting appropriate crossing treatments.

5.12.7.1 GEOMETRIC DESIGN CONSIDERATIONS

- The intersection should be conspicuous to both road and path users.
- Adequate sightlines should be maintained.
- Crossings and approaches should be on relatively flat grades.
- Crossings should be as near 90 degrees as possible, but no less than 60 degrees.
- Crossings should be located outside of the functional area of adjacent intersections.

5.12.7.2 SIGHT TRIANGLE

Sight distance between crossing bicyclists and roadway traffic is a critical factor in the safety of the crossing. Required sight distance is a function of path design speed and roadway traffic speed. Other factors such as roadway width and grade also impact sight distance. Section 5.5.4.1.3 of the AASHTO Guide for the Development of Bicycle Facilities, 5th Edition should be consulted to determine required site distances.

5.12.7.3 TRAFFIC CONTROL OF CROSSINGS

The selection of appropriate traffic control is primarily based upon roadway and path volumes and sight lines and should consider the likely or desired behavior of path users relative to the surrounding conditions. Generally, the least traffic control that is effective should be selected to improve the likelihood of conformance with the traffic control measure.

- Paths should be stop controlled at unsignalized roadway crossings unless otherwise meeting the conditions as specified below:
- Yield control of paths may be used for road crossings with two or fewer lanes, with an ADT below 5,000, 85th percentile speeds of 30 mph or less, and where yield sight triangles meet the requirements of the AASHTO Guide.
- Paths may be uncontrolled where the following conditions are met: local road or driveway crossings with two or fewer lanes, ADT below 1,000, 85th percentile speeds of 30 mph or less, yield sight triangles meet the requirements of the AASHTO Guide.

5.12.7.4 SELECTION OF MID-BLOCK CROSSING TREATMENTS

Table 5-14 provides guidance on the selection of mid-block crossing treatments. This guidance is extrapolated from FHWA's 2018 Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations and CTDOT's Pedestrian Safety Countermeasure Guidance at Marked Uncontrolled Crosswalks and is based upon traffic volume, lane configuration, and posted speed limit. Engineering judgement should be used in the selection of appropriate crossing facilities and other significant factors such as sight and stopping distance and expected bicycle and pedestrian crossing volumes should be considered.

5.12.7.5 CROSSWALK

Marked crosswalks with crossing signage are suitable for low-speed two-lane crossings.

- Crosswalk markings should be a minimum of 8 feet wide and should match or exceed the width of the approaching path.
- Longitudinal bars (continental style) crosswalk markings are recommended. Bar width should be 16 inches and spaced 24 inches apart.
- Tactile warning pads should be provided in advance of the crosswalk.
- An 18-inch stop or yield sign should be used and installed in advance of the roadway or crossing sidewalk if present. Stop bars or yield triangles should be provided on the path adjacent to the stop or yield sign.
- MUTCD W11-15/W16-7P should be used at the crossing on both sides of the roadway and sign faces should be provided on both sides of the sign assembly. The recommended location is within 10 feet in advance of the crosswalk.
- Where sight lines between approaching motor vehicles and the crosswalk are limited, crosswalk warning signage (MUTCD W11-15/ W16-9P) should be placed a minimum of 100 feet in advance of the crosswalk (see MUTCD for additional guidance).
- A sight line clear zone should be provided in accordance with Section 5.5.4.1.3 of the AASHTO Guide.
- Crossings should be a minimum of 60 degrees (30 degrees off perpendicular of the roadway). Perpendicular (90 degree) crossings are recommended.

Mid-Block Crossing, Image Source: AASHTO

5.12.7.6 CROSSWALK WITH RECTANGULAR RAPID FLASHING BEACON

Rectangular rapid flashing beacons (RRFBs) enhance the conspicuity of crosswalks and are used with a pedestrian and/or bicycle crossing warning sign to improve safety at uncontrolled, marked crosswalks. The device includes two rectangular shaped yellow indications, each with an LED-array-based light source, that flash with high frequency when activated. RRFB's should be used at the crossing on both sides of the roadway. The recommended location is within 10 feet in advance of the crosswalk.

Figure 5-23 RRFB Sign Assembly

Table 5-14 Recommended Mid-Block Crossing Treatments

		Speed (mpg)	Crosswalk	Crosswalk w/ RRFB	Crosswalk w/ HAWK Beacon	Raised Crosswalk	Crosswalk w/ Median Refuge Island	Crosswalk w/ Median Refuge Island & RRFB	Crosswalk w/ Median Refuge Island & PHB	Roadway Stop Control	Signalized Crosswalk	Grade Separated Crossing
ADT < 9,000	2 lanes	≤ 30	●			○	○			○		
		35	●	○	○		○			○	○	
		≥ 40		●	●		○			○	●	
	3 lanes	≤ 30	●	○	○	○	○				○	
		35	●	○	○		○	○	○		○	
		≥ 40			●		○	●	●		●	
	4+ lanes	≤ 30			○		●	○	○		○	
		35		●	○		●	○	○		○	
		≥ 40			●		○		●		●	
ADT 9,000-15,000	2 lanes	≤ 30	●				○			○		
		35	●	○	○		○			○	○	
		≥ 40		●	●		○			○	●	
	3 lanes	≤ 30		○	○		○	○	○		○	
		35		●	●		○	●	●		●	
		≥40			●		○	●	●		●	○
	4+ lanes	≤ 30			○		●	○	○		○	
		35			●		●	●	●		●	
		≥ 40			●		●		●		●	○
ADT >15,000	2 lanes	≤ 30	●	○	○		●		○	○	○	
		35		○	○		○		○	○	○	
		≥ 40			●		○		●	○	●	
	3 lanes	≤ 30		○	○		○	○	○		○	
		35			●		○	●	●		●	○
		≥ 40			●		○		●		●	○
	4+ lanes	≤ 30		●	●		●	●	●		●	
		35			●		●		●		●	○
		≥ 40			●		●		●		●	○

○ Potential Candidate for Use ● Recommended Treatment

5.12.8 CROSSWALK WITH PEDESTRIAN HYBRID BEACON

The pedestrian hybrid beacon (PHB) is a traffic control device designed to help pedestrians safely cross higher-speed roadways at midblock crossings and uncontrolled intersections. The beacon head consists of two red lenses above a single yellow lens. The lenses remain "dark" until a pedestrian desiring to cross the street pushes the call button to activate the beacon, which then initiates a yellow to red lighting sequence consisting of flashing and steady lights that directs motorists to slow and come to a stop. This provides the right-of-way to the pedestrian to safely cross the roadway before the signal goes dark again.

PHBs are typically used where it is difficult for pedestrians to cross a roadway, such as when gaps in traffic are not sufficient or speed limits exceed 35 miles per hour. They are highly effective at locations with three or more lanes or traffic volumes above 9,000 annual average daily traffic. Installation of a PHB must also include a marked crosswalk and pedestrian countdown signal.

5.12.8.1 RAISED CROSSWALK

A raised crosswalk may be used for crossings of roadways with up to three lanes and posted speeds of 30 mph or less. See FHWA's 2018 ***Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations.***

Crosswalk with median refuge island and a Pedestrian Hybrid Beacon in Cheshire, CT, Image source: Google Maps

5.12.8.2 CROSSWALK WITH MEDIAN REFUGE ISLAND

Median refuge islands are most useful on higher speed and multi-lane corridors. They allow bicyclists to break the crossing movement into two movements and provide a protected place to wait while crossing. Median refuge islands also provide space for crosswalk warning signage and can have a traffic calming effect.

- Refuge islands should be a minimum of 6 feet in width (measured across the roadway), 8 feet is the preferred minimum width.
- Refuge island should be a minimum of 6 feet long on either side of the crosswalk opening (measured along roadway).
- Crosswalk openings should match or exceed the width of the approaching path.
- Refuge islands may be landscaped, low level landscaping (less than 3 feet in height) is recommended to protect sight lines.
- MUTCD R1-6 or R1-6a signs should be placed at both ends of the median at two-lane crossings.
- MUTCD W11-15 should be placed at both ends of the median at multilane (3 or more) crossings.

5.12.8.3 CROSSWALK WITH MEDIAN REFUGE ISLAND AND RRFB OR PHB

Crosswalks may be enhanced with median refuge islands and RRFBs or PHBs. The combination of these facilities and devices improves the conspicuity of crossing bicyclists and pedestrians and is beneficial on multilane corridors and in higher traffic speed and volume conditions.

5.12.8.4 ROADWAY STOP CONTROL

Crosswalks may be stop controlled if the traffic conditions warrant stop control. Stop control is not recommended on multi-lane roadways (3 or more lanes).

- Stop bars should be provided and placed approximately 10 feet in advance of the crosswalk.

5.12.8.5 SIGNALIZED CROSSWALKS

Crosswalks may be signalized if the traffic conditions warrant a traffic signal. This treatment is most appropriate on multi-lane corridors and higher traffic speed and volume corridors.

- Stop bars should be provided and placed approximately 10 feet in advance of the crosswalk.
- Pedestrian signal heads and signal actuators should be used on path approaches.
- Pedestrian signal heads may be accompanied by bicycle signal heads.

5.12.8.6 GRADE SEPARATED CROSSINGS

Grade separated crossings should be considered where grade differences between the path and roadway present a challenge to providing ADA compliant path grades and/or where the path grade lends itself to a crossing below or above the roadway. Grade separated crossings may also be appropriate for high volume paths that cross multilane, high speed, and/or high-volume roadways.

  - Grade separated crossing should meet accessibility standards including, but not limited to the following:
  - Grades should not exceed 8.3% (1 inch rise per foot of run).
  - Grades exceeding 5% should not exceed more than 30 inches rise per run.
  - Landings should be a minimum of 5 feet in length and should not exceed a slope of 2% (1 inch of rise per four feet of run).

- Elevated grade crossings should include railings a minimum of 48 inches high.
- Tunnel crossings should provide a minimum vertical clearance of 8 feet.

5.13 SPECIAL DESIGN CONSIDERATIONS

There are multiple conditions that require the use of special techniques to accommodate bicyclists. Likewise, there are special treatments that may be used in appropriate conditions to improve the comfort and safety of bicyclists.

5.13.1 CONTRA-FLOW BIKE FACILITIES

Section 14-286b of the Connecticut General Statutes allows bicyclists to operate in contra-flow facilities. Contra-flow facilities are facilities that allow for bicycle travel that is opposite of vehicular travel adjacent to the bicycle facility. Examples include:

- A bike lane opposing traffic on a one-way roadway
- A two-way buffered bike lane or separated bike lane located on one side of a roadway

5.13.1.1 DESIGN GUIDANCE

- One-way contra-flow bike lanes should be located on the left side of the roadway (relative to the direction of roadway traffic) such that bicyclists using the lane have the traffic lane located to their left.
- A bicycle lane or shared roadway markings should be provided for bicyclists traveling in the same direction as traffic to discourage wrong-way riding in the contra-flow bike lane.
- Contra-flow bike lanes located at the edge of the roadway shall use double yellow center line pavement markings, a painted or raised median island, or some form of physical separation where the speed limit is 30 mph or less.
- For speed limits 35 mph or greater, a buffer, a painted or raised median island, or some form of physical separation shall be used to separate a contra-flow bicycle lane from the adjacent travel lane.
- Lane extension markings should be used where contra-flow bicycle movements cross intersections.
- Contra-flow bike lanes should not be located between a traffic lane and an on-street parallel parking lane.
- Where intersection traffic controls are provided (such as STOP signs or traffic signals), appropriate devices shall be provided and oriented toward bicyclists in the contra-flow lane.
- At signalized locations, appropriate bicycle signalization shall be provided and oriented toward bicyclists in the contra-flow lane, including a method for bicyclists to actuate the green phase for the contra-flow movement.

5.13.2 ON-STREET PARKING

Bike lanes should be properly separated from parking lanes to avoid door zone conflicts or conflicts with maneuvering vehicles. On-street parking may also be used, under the proper conditions, as a barrier between traffic and bicyclists.

5.13.2.1 PARALLEL PARKING

While curbside parking lanes typically vary from 7 to 9 feet wide, the functional operation of on-street parking requires space outside of the parking lane for drivers and passengers to exit and enter vehicles. The typical distance of the driver side of a parked vehicle from the edge of roadway where a curb is present is up to 7 feet (0.5 feet spacing from curb plus 6.5-foot vehicle width for a large SUV or full-size truck). A typical passenger vehicle door fully opens to approximately 3.5 feet, this places the typical driver side fully opened door of a large vehicle at approximately 10.5 feet from the edge of curb.

Where bike lanes are located between a parking and traffic lane, the outside edge of the bike lane should be located a minimum of 13 feet from the face of curb to provide adequate space for bicyclists to avoid door zone conflicts without entering the traffic lane. The separation provided between a bike lane and an on-street parking lane should be increased or reinforced by a painted buffer in areas of high parking turnover such as metered or time limited parking spaces or parking spaces in retail districts.

When a bike lane is placed on the right (curb) side of a parking lane, a passenger side door zone should be provided to avoid door zone conflicts as bicyclists are physically constrained to the bike lane by a curb or road edge. In this case, the minimum distance between the parking lane and face of curb or edge of roadway should be 8 feet.

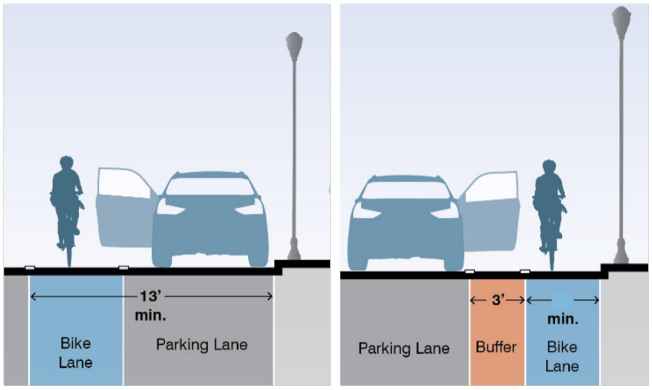


Figure 5-24 Bike Lanes and Parallel On-Street Parking

5.13.2.2 ANGLED ON-STREET PARKING

Bike lanes should also be adequately separated from angled on-street parking where present. The minimum recommended distance between the face of curb, edge of pavement, or wheel stop and the bike lane is specified in **Table 5-15** below. This distance provides the minimum separation needed to provide bicyclists and drivers with space and time to identify and react to each other and to avoid collisions.

Back-in angled on-street parking has potential safety benefits in reducing collisions between bicyclists and motor vehicles and should be considered over pull-in angled parking in areas with bike lanes and high-volume bicycle traffic or high parking turnover such as areas with metered or time-limited parking spaces. Bicyclist safety in areas of pull-in angled parking can be improved by providing adequate separation between the bike lane and parked vehicles as specified in **Table 5-15** below.

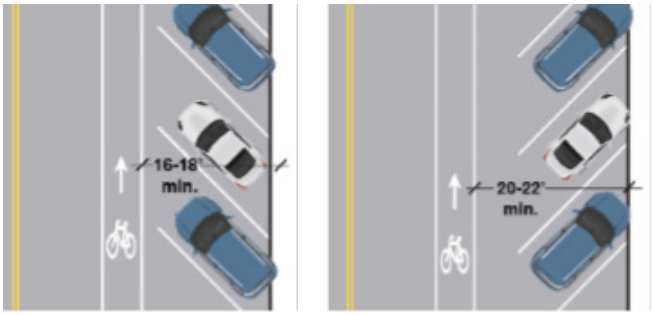


Figure 5-25 Bike Lane Offset from Back-In (left) and Pull-In (right) Angled Parking

Table 5-15 Bike Lanes and Angled On-Street Parking

Parking Angle	Minimum Bike Lane Offset Pull-In Angled Parking*	Minimum Bike Lane Offset Back-In Angled Parking*
45 degrees	20 feet	18 feet
60 degrees	22 feet	20 feet

*As measured from face of curb, edge of pavement, or wheel stop to nearest lane stripe of bike lane.

5.13.3 FENCES AND RAILINGS

The AASHTO Guide specifies a minimum safety rail height of 42 inches. A minimum 4-foot (48 inch) high bicycle railing is, however, recommended to better protect cyclists from falls. (NCHRP Determination of Appropriate Railing Heights for Bicyclists, 2004).

Railings are recommended for use in the following conditions:

- Immediately adjacent to the edge of a highway bridge.
- Between a shared use path (or sidepath) and a travel lane on a bridge or highway where a bicyclist may fall into the path of oncoming traffic. If the edge of the travel lane is greater than 5 feet from the edge of the shared use path, a railing is not required.
- On a bikeway bridge with a drop-off of 2 feet or greater.
- On a shared use path (or sidepath) adjacent to a hazard where the bicyclist could be severely injured if they were to fall. Typical hazards would include cliffs, water bodies or rocks.

Long narrow corridors constrained by fences on both sides should be avoided as this creates access issues and prevents path users from leaving the path in the event of an emergency.

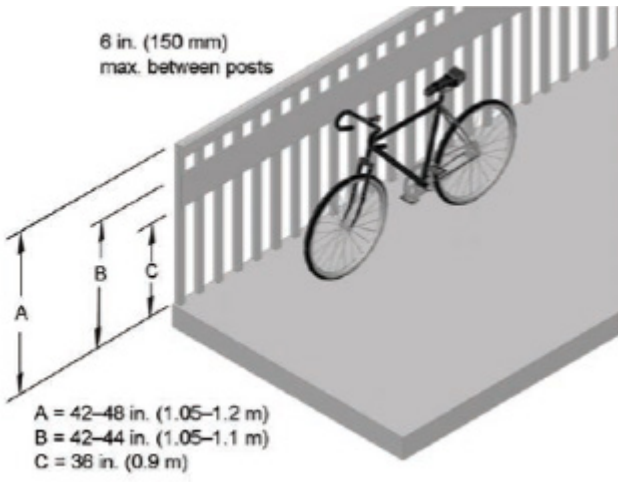


Figure 5-26 Bridge Railing, Image Source: AASHTO Guide for the Development of Bicycle Facilities, 4th Edition

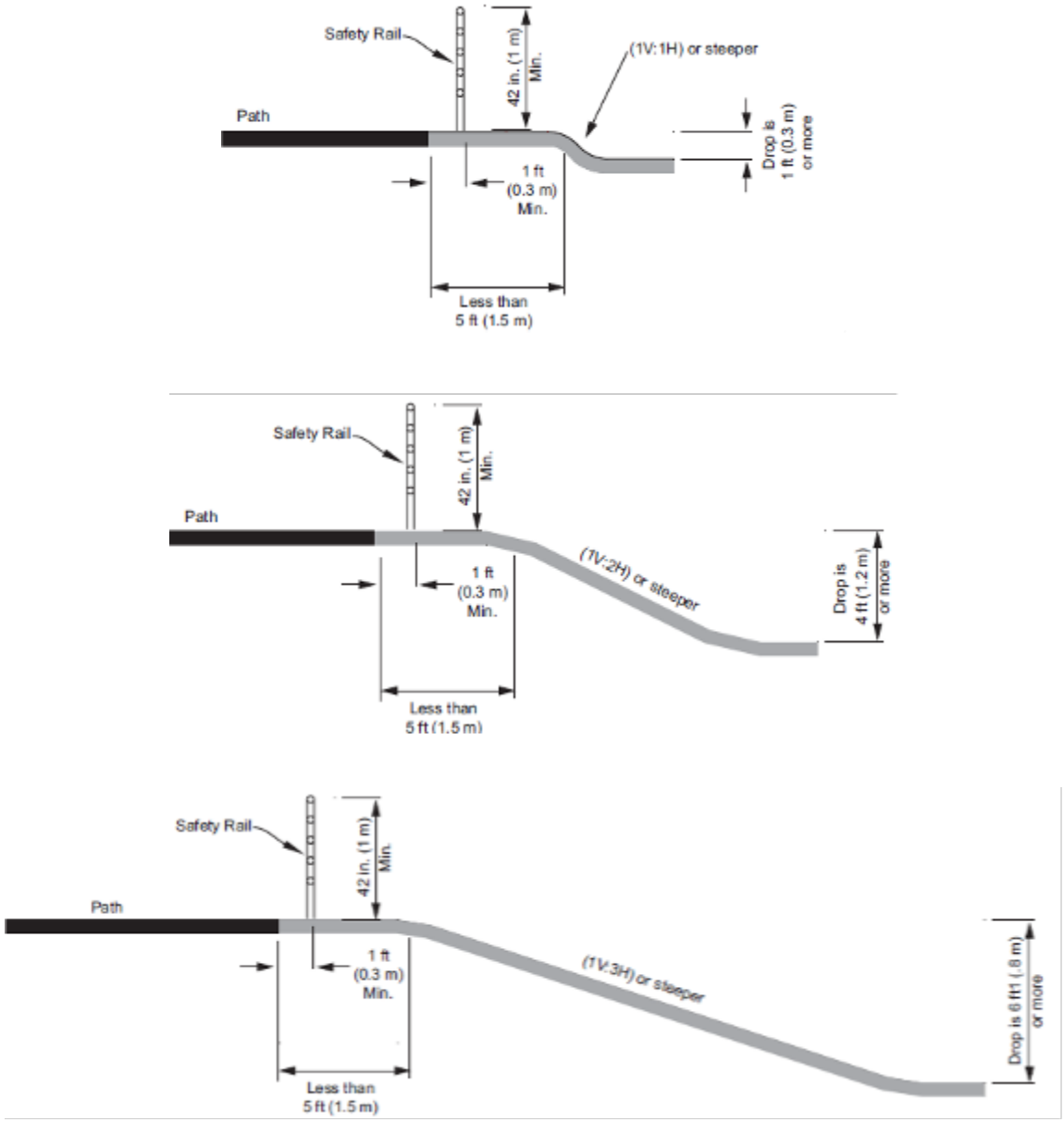


Figure 5-27 Safety Rail Adjacent to Slopes, Image Source: AASHTO Guide for the Development of Bicycle Facilities, 4th Edition

5.13.4 TRAFFIC BARRIERS

Multiple types of physical barriers can be deployed to provide physical separation from a bike lane or path and traffic. The selection of a barrier system should be based on factors such as the presence of on-street parking, buffer width, cost, durability, aesthetics, traffic speeds, emergency vehicle and service access needs, drainage, and maintenance considerations. Intermittent (spaced) barriers may be preferred in some conditions over continuous barriers due to the potential drainage impacts of a continuous barrier. A combination of separation treatments may be used to improve the effectiveness of the barrier system.

Typical barriers include the following:

Curbs and raised medians: An asphalt, concrete, or granite curb, typically 6 inches in height, may be used to separate bike lanes or paths from traffic in combination with a buffer area. For bicycle facilities at road grade, a raised median a minimum of 2 feet in width may be used to provide separation. The median should be approximately 6 inches in height with an integrated asphalt, concrete, or granite curb. The median may be planted or hardscaped.

Landscaped raised median, Image Source: Planetizen

Traffic delineator posts: Traffic delineator posts have low installation cost and have high visibility. However, these devices are not durable and require periodic replacement. Delineators are typically placed within a buffer area and may be located in the center or to one side or the other as site conditions dictate (such as street sweeper width or vehicle door opening). Typical post spacing is 10 feet to 40 feet.

Traffic delineator posts, Image Source: Developtech.com

Concrete barriers: Concrete barriers provide the highest level of crash protection among these separation types. However, this barrier type may not be suitable for aesthetic purposes and gaps in the barrier system should be provided to allow for emergency vehicle and maintenance vehicle access. Concrete barriers are typically located within a buffer space between a roadway and bicycle facility. Bicycle lanes or paths should be located a minimum of 2 feet from a concrete barrier (assuming the barrier is less than 42 inches in height) to avoid fall hazards associated with collisions. If a 2-foot separation cannot be provided, a steel railing should be installed on top of the concrete barrier to provide a total barrier height of 42 inches.

Decorated concrete barrier with steel railing, Image Source: Curbed New York

Planters: Planters may be used within a buffer area to provide physical separation between traffic and a bicycle facility. While more aesthetically pleasing than other barrier types, planters require regular maintenance and therefore may be suitable only for locations where aesthetics are a priority. Planters should be spaced consistently at a distance of up to 40 feet apart.

Planters in buffer, Image Source: Minneapolis Street Design Guide

Low linear barriers: These systems are relatively inexpensive, can provide near continuous separation, and are a good solution when minimal buffer width is available.

Low linear barrier, Image Source: Greater-Greater Washington

Guard rail systems: Guard rail (or guide rail) systems may be used to provide separation from traffic. Square beam steel rail, W-beam steel rail, or a timber rail system may be used. These systems are typically 30 inches tall. Bicycle lanes or paths should be located a minimum of 2 feet from a guard rail system to avoid fall hazards associated with collisions. Breaks in the system should be provided to allow for emergency and maintenance vehicle access.

Timber guard rail, Image Source: Google Earth

Parking lanes: Parking lanes may be used to provide separation between traffic and a bicycle facility. Parking lanes are typically used in combination with other barrier measures such as a curb, raised median, traffic delineator posts, or bollards to prevent parking vehicles from encroaching upon the bicycle facility. Barrier types that obstruct the opening of car doors or create tripping hazards should be avoided. A minimum buffer width of 3 feet is required between the bicycle facility and parking lane to allow for the opening of doors and other maneuvers.

Parking buffered bike lane with traffic delineator posts, Image Source: League of American Bicyclists

5.13.5 BICYCLE PARKING

Bicycle parking is an integral component of the bicycle transportation network. Bicycle parking should be located in close proximity to the locations which they are intended to serve. If that location is a building, bicycle parking should be located as close to entrances as feasible. In retail areas with multiple buildings or storefronts, bicycle parking should be located in multiple areas in favor of a single centralized location. In addition to incorporating the installation of bike racks alongside bicycle facility enhancement projects, the Town should consider amending its zoning regulations to require that bike racks be provided by any development project similar to how off-street parking is required for automobiles.

While bicycle parking can take many forms such as bike lockers and indoor storage facilities, bicycle racks are most typical of a municipal system. Racks may be located outside or in a sheltered location. Racks should be located so they are highly visible and in frequented areas to discourage theft or vandalism of parked bicycles. Racks should be easily accessed from bicycle facilities, sidewalks, or other pedestrian areas, but should be installed so as not to obstruct pedestrian or bicycle traffic.

There are multiple styles and designs of bicycle racks that are available and commonly used. Bicycle racks should be selected so that they:

- Support the bicycle upright by its frame in two places.
- Prevent the wheel of the bicycle from tipping over.
- Enable the frame and one or both wheels to be secured.
- Support bicycles that lack a horizontal top tube (step through bicycles).
- Allow front-in parking: a U-lock should be able to lock the front wheel and the down tube of an upright bicycle.
- Allow back-in parking: a U-lock should be able to lock the rear wheel and seat tube of the bicycle.

Comb, toast, schoolyard, and other wheel bending racks that provide no support for the bicycle frame should not be used. The rack element should resist being cut or detached using common hand tools such as bolt cutters, pipe cutters, wrenches, and pry bars.

Bicycle racks should be located in areas that are free from obstructions. The minimum storage depth to allow for parking of a bicycle is 6 feet (as measured along the length of the parked bicycle). Individual bicycle rack elements may serve two bicycles, but those elements should be spaced at least 30 inches apart. Additionally, a minimum clear area of 2 feet should be provided between the side of a rack and a fixed element such as a wall to ensure user access. If racks are located in parallel rows (such as the spaces to the left and right in a parking lot) bicycle racks should be spaced so that an aisle of no less than 4 feet is provided between the tires of parked bicycles.

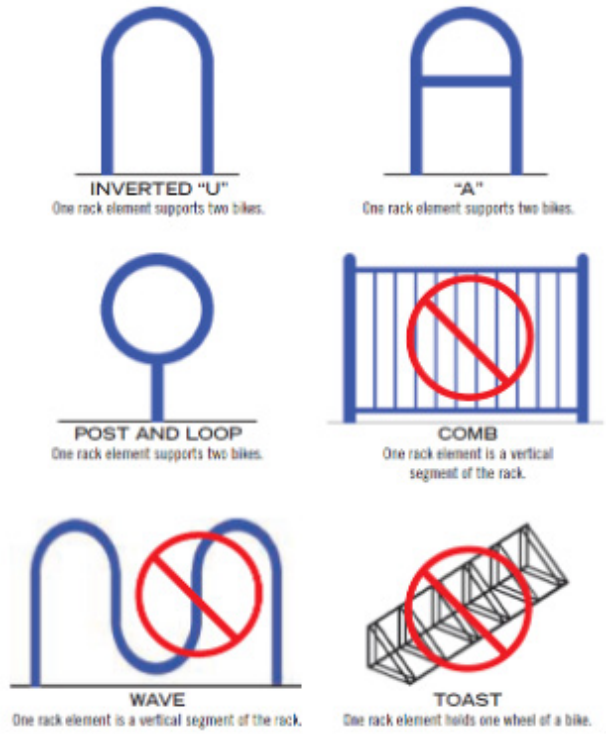


Figure 5-28 Bicycle Rack Types, Source: APBP

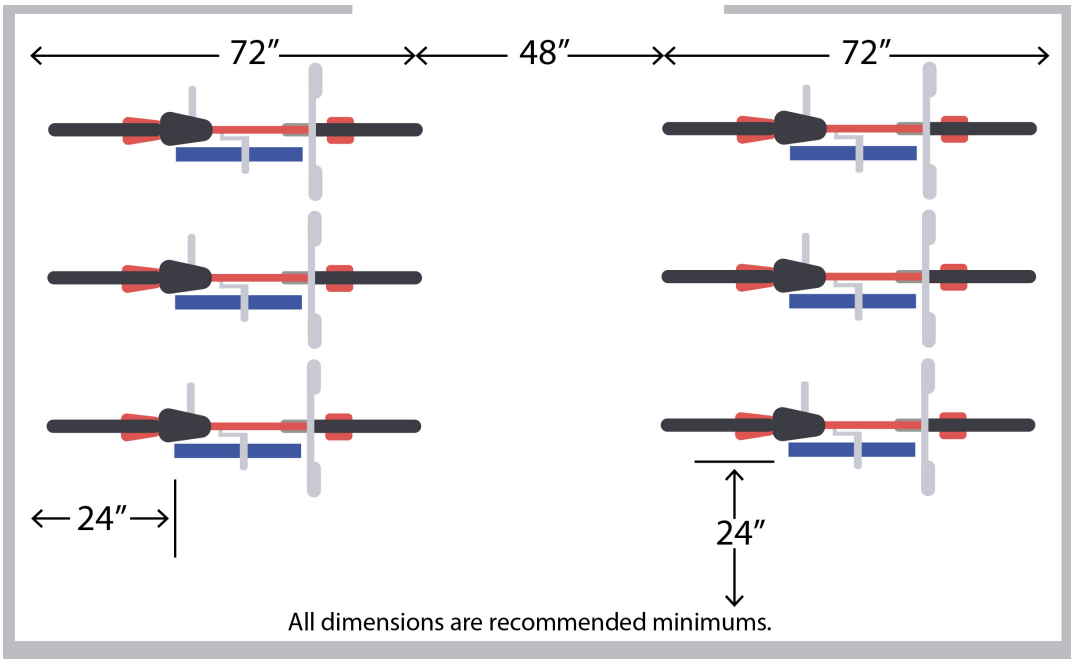


Figure 5-29 Bicycle Rack Spacing, Source: APBP

5.13.6 BICYCLE SERVICE STATION

Bicycle service stations provide tools necessary to perform basic bike repairs and maintenance. They typically include tools that are securely attached to the station and hangars that allow for hanging the bike for repairs. Stations may also be equipped with an air pump. They should be located where available to the public in well-lit spaces that provide adequate room for bicycle service and pedestrian movement around the station. Locations such as outside libraries, community centers and parks are ideal.

Bicycle Service Station, Image Source: Dero Fixit

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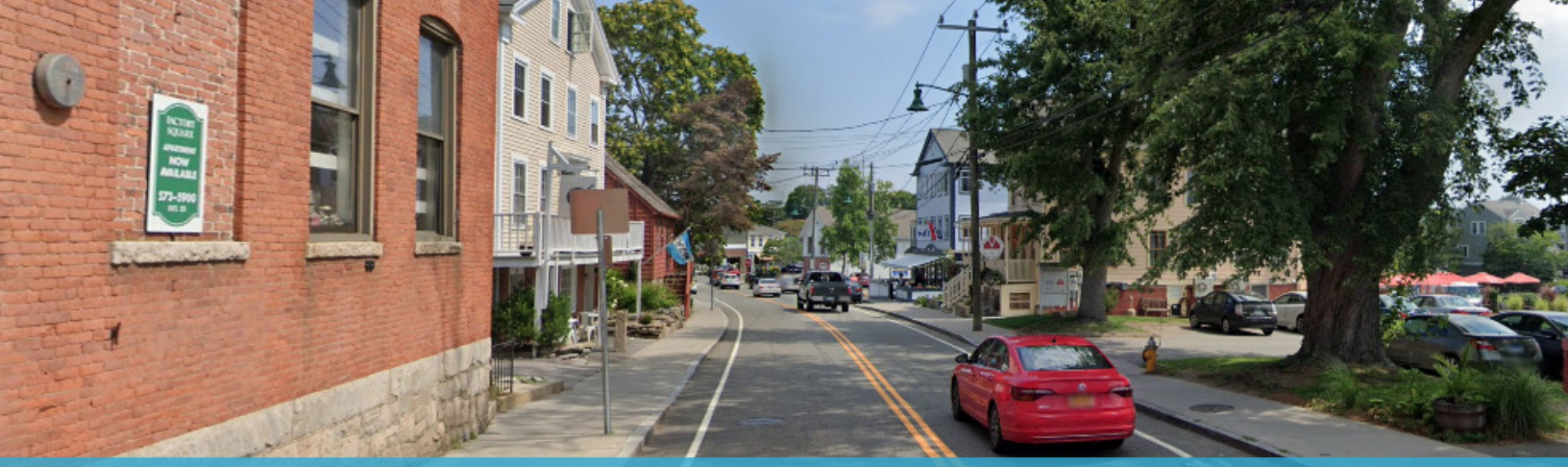

6 PEDESTRIAN FACILITIES TOOLBOX

6.1 USE OF TOOLBOX

This toolbox provides guidance on the use and design of the most common pedestrian facilities and features. This toolbox is intended to provide a convenient reference and guide for the planning and design of such facilities but is not intended to replace the foundational guidelines and standards on which it is based including the:

FHWA Manual on Uniform Traffic Control Devices (MUTCD), 11th Edition:
The MUTCD provides specific standards on pedestrian signage, signals, and pavement markings.

US Access Board Public Right-of-Way Accessibility Guidelines (PROWAG):
These guidelines ensure that pedestrian facilities located in the public right-of-way are readily accessible to and usable by pedestrians with disabilities.

Connecticut Department of Transportation Highway Design Manual, October 2024:
The manual provides design guidelines for all State roadways including pedestrian facility design.

6.2 PEDESTRIAN FACILITY TYPES AND FEATURES

Sections 6.3 through **Section 6.9** of this toolbox provide detailed guidance for facility types and features for use in Groton.

Pedestrian Actuated Signals and Signal Heads

Sidewalks

Crosswalk Signage

Curb Ramps

Pedestrian Refuge Island

Marked Crosswalks

Curb Extension

6.3 SIDEWALKS

Sidewalks are the core of the pedestrian network and often the most capital-intensive infrastructure component of the network. Sidewalks are typically constructed or concrete but may also be constructed of asphalt. A minimum of five feet wide (this width allows two adults to walk comfortably side by side) is recommended for use in most conditions and a minimum width of 6 feet is recommended in areas of high pedestrian activity.

Sidewalk

"Sidewalks used for pedestrian access to schools, parks, shopping areas, and transit stops and placed along all streets in commercial areas should be provided along both sides of the street. In residential areas, sidewalks are desirable on both sides of the street but need to be provided on at least one side of all local streets."

– American Association of State and Highway Transportation Officials (AASHTO)

"Sidewalks and walkways separate pedestrians from the roadway and provide places for children to walk, run, skate, ride their bikes, and play. Sidewalks have been found to be associated with significant reductions in pedestrian collisions with motor vehicles. Such facilities improve mobility for pedestrians and should be provided for all types of pedestrian travel: to or from home, work, parks, schools, shopping areas, transit stops, etc. Walkways should be part of every new and renovated facility and every effort should be made to retrofit streets that currently do not have sidewalks or walkways."

-Institute for Transportation Engineers - Traffic Safety Toolbox

Benefits

- Minimizes pedestrian exposure to vehicles by providing walking space off of the roadway.
- Encourages walking trips

Design Guidance

- Minimum sidewalk width of 5 feet is necessary for two adults to comfortably walk side-by-side.
- Sidewalks are most effective when separated from the curb by a buffer space, which provides space for street trees, signs, utilities, & snow storage.
- Maximum 2% cross-slope
- The sidewalk zone should be kept clear of obstructions, providing a minimum clear width of 32 inches at spot locations and 36 inches for the length of the walk.
- A protected zone of 27 inches to 80 inches in height must be kept clear of vegetation, signage, and other structures.

6.4 CURB RAMPS

Curb ramps are required by the American Disabilities Act at intersections and marked crosswalks. Any roadway that undergoes reconstruction is required, by federal law, to include these facilities. Curb ramps are integral to the pedestrian network and are a critical link between crosswalks and sidewalks. According to the Connecticut Highway Design Manual, when determining the need for a curb ramp, the designer should consider the following:

1. If at least one curb will be disturbed by construction at an existing intersection, then curb ramps shall be constructed at all crosswalks which extend from a paved sidewalk in that intersection.
2. For all projects, curb ramps will be constructed at all crosswalks which provide pedestrian access in that intersection and will be provided on all corners. At T-intersections, the designer must ensure that curb ramps are located on the side opposite the minor intersecting road.
3. Opposing ramps must always be provided on adjacent legs of an intersection even if outside project limits.
4. Curb ramps shall be positioned so as not to cause a safety hazard for blind pedestrians.

Curb Ramp

5. Curb ramps shall be located or protected to prevent their obstruction by parked vehicles.
6. Curb ramps at marked crossings shall be wholly contained within the markings, excluding any flared sides.
7. The function of the curb ramp must not be compromised by other highway features (e.g., guide rail, catch basins, utility poles, signs).
8. Curb ramps are required at all curbed intersections with sidewalks or along all accessible routes.
9. The location of the curb ramp must be consistent with the operation of pedestrian-actuated traffic signals, if present. In addition, a pedestrian push-button must be located so it can be reached by wheelchair-bound individuals.

Benefits

- Provides accessibility for people with mobility aids.
- Improves the mobility of people with carriages, strollers, carts, and children on bicycles.
- Encourages pedestrians to cross roadway at a fixed point.
- Provides tactile detection of the edge of roadway for the visually impaired.

Design Guidance

- Install ramp perpendicular to curbline
- 1:12 (8.3%) maximum running slope
- 1:48 (2%) maximum cross slope
- 36-inch minimum width
- Provide level landing at top
- Provide a minimum landing of 3 feet long if toe room available
- Provide a minimum landing of 4 feet long if constrained
- Toe of ramp should be located within crosswalk marking if present
- The connection to the roadway pavement should be flush (no lip)
- Provide a tactile warning strip at the bottom of the curb ramp extending a minimum of 2 feet in the direction of travel and cover the full width of the curb ramp, excluding any flared sides

6.5 MARKED CROSSWALKS

Marked crosswalks are a critical component of the pedestrian network. They visually direct pedestrians to the safest crossing of the roadway and alert drivers to expect their presence. The "piano key" style crosswalk, which consists of multiple white bars aligned perpendicular to the walking path, is currently in use in Groton and should be used for crosswalk locations identified in this plan.

Marked Crosswalk

Benefits

- Encourages pedestrians to cross the street at regular locations.
- Improves awareness of pedestrians, alerts drivers to the presence of pedestrian traffic.

Design Guidance

- Crosswalks should be a minimum 6 feet wide to 10 feet wide or width of sidewalk if greater.
- Curb ramps, if present, should be aligned with crosswalk.
- Crosswalks are most effective when crossing the roadway at a right angle.
- Crosswalks should be accompanied by signage or signalization where conditions warrant.

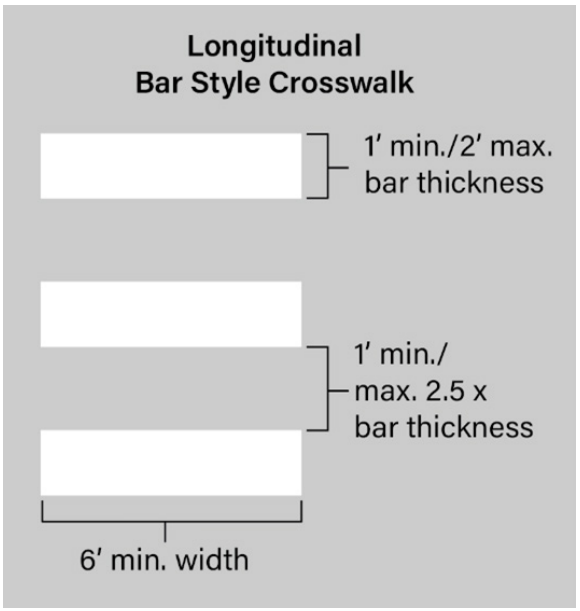

Figure 6-1 Crosswalk Dimensions

"Crosswalk markings provide guidance for pedestrians crossing the roadway by defining and delineating the most appropriate crossing path. Crosswalk markings also alert road users to a pedestrian crossing point not controlled by traffic signals or stop signs. At non-intersection locations, these markings legally establish the crosswalk."

–Institute for Transportation Engineers - Traffic Safety Toolbox

"In general, crosswalk markings at unsignalized intersections appear to have several positive effects and no observed negative effects. Specifically, drivers appear to be aware that pedestrians are in a marked crosswalk and drive slightly slower. Crosswalks also have the positive benefit of channeling pedestrians to the intersection. Also, there appears to be no evidence to support the contention that pedestrians feel protected in marked crosswalks and act more carelessly. In conclusion, it appears that marking pedestrian crosswalks at relatively narrow, low-speed, unsignalized intersections is a desirable practice."

-Federal Highway Administration -RD-00-103

6.6 PEDESTRIAN ACTUATED SIGNALS AND SIGNAL HEADS

Pedestrian actuated signals are activated by push buttons that pedestrians use to prompt a pedestrian crossing signal or a green light. Pedestrian signal heads are required for use in conjunction with vehicular traffic control signals under any of the following conditions:

- If a traffic control signal is justified by an engineering study and meets warrant requirements. -or-
- If an exclusive signal phase is provided or made available for pedestrian movements in one or more directions, with all conflicting vehicular movements being stopped; at an established school crossing at any signalized location; or where engineering judgment determines that multi-phase signal indications would tend to confuse or cause conflicts with pedestrians using a crosswalk guided only by vehicular signal indications.

Pedestrian actuated signal head

Pedestrian actuated signal

Pedestrian signal heads should be used under any of the following conditions:

- If it is necessary to assist pedestrians in deciding when to begin crossing the roadway in the chosen direction or if engineering judgment determines that pedestrian signal heads are justified to minimize vehicle-pedestrian conflicts
- If pedestrians are permitted to cross a portion of a street, such as to or from a median of sufficient width for pedestrians to wait, during a particular interval but are not permitted to cross the remainder of the street during any part of the same interval
- If no vehicular signal indications are visible to pedestrians, or if the vehicular signal indications that are visible to pedestrians starting a crossing provide insufficient guidance for them to decide when to begin crossing the roadway in the chosen direction, such as on one-way streets, at T-intersections, or at multi-phase signal operations.

Benefits

- Enables pedestrians to activate a crossing phase, whether exclusive or concurrent.
- Provides a visual queue for crossing and warning when the crossing phase is nearing an end.

Design Guidance

- Keep pedestrian waiting time to 30 seconds or less.
- Set crossing time to pedestrian crossing speed of 3 ft/second versus standard 4 ft/second.
- Walk interval should be at least 7 seconds in length
- Provide signed instructions of light operation for pedestrians
- Actuators should be located at least 1.5 feet and no more than 6 feet from the edge of roadway and within 5 feet of the outside edge of a curb ramp or marked crosswalk.

In general, shorter cycle lengths and longer WALK intervals provide better service to pedestrians and encourage greater signal compliance. For optimal pedestrian service, fixed time signal operation usually works the best. Pedestrian push buttons may be installed at locations where pedestrians are expected at intermittent intervals. Quick response to the button or feedback to the pedestrian should be programmed into the system. When used, push buttons should be well-signed and should be fully accessible to pedestrians in wheelchairs. They should be conveniently placed in the area where pedestrians wait to cross. -Institute for Transportation Engineers

- Traffic Safety Toolbox

6.7 CROSSWALK SIGNAGE

Crosswalk signage should be used at all crosswalks where traffic is not controlled by a traffic light or stop sign. This signage may also be used to supplement crosswalks at locations where sightlines are an issue or where drivers fail to yield to pedestrians despite stop signs or traffic lights. The most common application of this sign would be a mid-block crosswalk. When located within a school zone, the school crossing sign should be used in lieu of the pedestrian crossing sign.

The Manual for Uniform Traffic Control Devices (MUTCD) provides the following guidance:

- *If used in advance of a pedestrian crossing, the W11-2 signs should be supplemented with plaques with the legend AHEAD or XX FEET to inform road users that they are approaching a point where crossing activity might occur.*
- *The W11-2 and W11-9 signs and their related supplemental plaques may have a fluorescent yellow-green background with a black legend and border.*
- *When a fluorescent yellow-green background is used, a systematic approach featuring one background color within a zone or area should be used. The mixing of standard yellow and fluorescent yellow-green backgrounds within a selected site area should be avoided. Crossing signs should be used only at locations where the crossing activity is unexpected or at locations not readily apparent.*

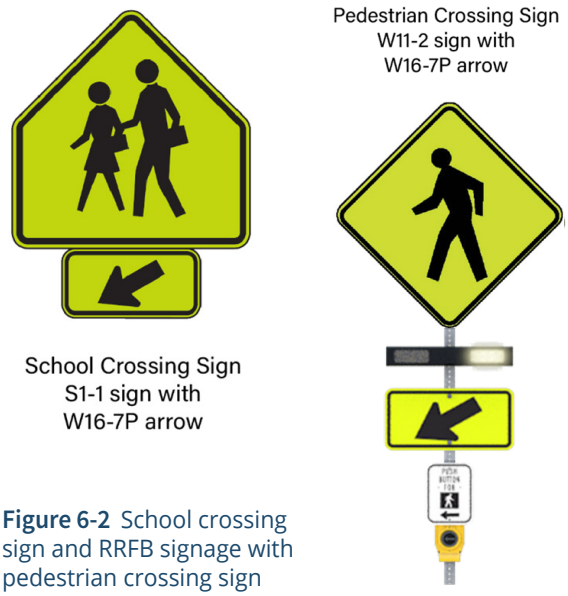

Figure 6-2 School crossing sign and RRFB signage with pedestrian crossing sign

Benefits

- Increases driver awareness
- Assists pedestrians in locating crosswalks

Design Guidance

- Typically used at mid-block crossing locations
- Signage must not interfere with sidewalk or curb ramp function
- School crossing sign should be used when crosswalk is located within a school zone or has a high number of students in route to school
- RRFBs should supplement signs where there are high traffic volumes, high pedestrian activity, limited sight-lines, or other unique conditions

In conditions where there are high traffic volumes, high pedestrian activity, limited sight-lines, or other unique conditions, a Rectangular Rapid Flashing Beacon (RRFB) should be considered for use. RRFBs enhance the conspicuity of crosswalks and are used with a pedestrian and/or bicycle crossing warning sign to improve safety at uncontrolled, marked crosswalks. The device includes two rectangular shaped yellow indications, each with an LED-array-based light source, that flash with high frequency when activated. RRFB's should be used at the crossing on both sides of the roadway. The recommended location is within 10 feet in advance of the crosswalk.

6.8 PEDESTRIAN REFUGE ISLANDS

Refuge islands are a highly effective tool for assisting pedestrians in crossing wide roadways, heavily trafficked roads, or at midblock locations. These islands provide the pedestrian a protected place to stop if they are unable to cross the road in one attempt. In addition to assisting pedestrians in crossing, these devices provide a location for the placement of pedestrian crossing signs and can slow traffic. (Also see Section 5.12.8.2)

Crossing islands, also known as center islands, refuge islands, or median slow points, are raised islands placed in the center of the street at intersection or midblock locations that help to protect pedestrians from motor vehicles. Crossing islands allow pedestrians to be concerned with only one direction of the street and wait for an adequate gap in traffic before crossing the second half of the street. Where midblock or intersection crosswalks are to be installed at uncontrolled locations (i.e., where no traffic signals or stop signs exist), crossing islands should be strongly considered as a supplement to the crosswalk. If there is sufficient width, crossing islands and curb extensions can be used together to create a highly improved pedestrian crossing.

-Institute of Transportation Engineers - Traffic Safety Toolbox

Pedestrian Refuge Island

Benefits

- Reduces vehicle speeds
- Decreases pedestrian crossing distance
- Increases visibility of crossing

Design Guidance

- For use at intersections or mid-block
- Appropriate signage is required including MUTCD W11-15 and R1-6 or R1-6a (mid-block locations) signs.
- Mid-block locations may require supplemental RRFB sign assembly or pedestrian hybrid beacon.
- Adequate lighting required
- Minimum width of 6 feet

6.9 CURB EXTENSIONS

Curb extensions are used to shorten the crossing distance for pedestrians. These devices have the added benefit of improving visibility of and for pedestrians when crossing and can slow traffic. These devices take many forms and are often referred to as bumpouts or bulbouts.

Curb extensions, also known as bulbouts or neckdowns, involve extending the sidewalk or curb line into the street, reducing the effective width. Curb extensions significantly improve pedestrian crossings by reducing pedestrian crossing distance, improving the ability of pedestrians and motorist to see each other, and reducing the time that pedestrians are in the street. Curb extensions that are placed at an intersection essentially prevent motorists from parking in a crosswalk or blocking a curb ramp. Motor vehicles parked at corners present a serious threat to pedestrian safety because they block sight lines, hide pedestrians, and other vehicles and make turning particularly difficult for emergency vehicles and trucks. Motorists are encouraged to travel more slowly at intersections or midblock locations with curb extensions, because the restricted street width sends them a visual cue. Turning speeds at intersections are reduced with curb extensions (curb radii should be as tight as practicable). Curb extensions are appropriate only where there is an on-street parking lane (curb extensions must not extend into travel lanes, bicycle lanes, or shoulders).

-Institute for Transportation Engineers - Traffic Safety Toolbox

Curb Extension

Benefits

- Shortens crossing distance for pedestrians
- Provides additional space for curb ramps
- Improves pedestrian visibility by extending past parked vehicles
- Improves driver's visibility of pedestrians
- Slows turning vehicles
- Prevents parking at corner

Design Guidance

- For use where wide curb lanes, shoulders, or on-street parking result in wide pavement widths.
- Curb extension should not extend beyond 6 feet of existing curb line and should not obstruct a bike or travel lane.
- Adequate vehicle turning radii must be maintained when used at intersections.

6.10 BUS STOPS

Bus stops are an important component of both a transit network and a pedestrian network. Groton is served by the Southeast Area Transit District and three of its routes. Those routes have multiple stops in Groton but those stops often lack amenities such as paved waiting areas, benches, or shelters. Bus stops should be provided with a paved ADA compliant off-street waiting and disembarking area. Stops with high rider usage should be provided with amenities such as benches or shelters.

Benefits

- Provides safe, ADA compliant, off-street waiting area
- Provides a place to rest when benches are installed
- Provides shelter from rain and wind when shelters are installed

Design Guidance

- Locate stops away from potential driveway conflicts.
- "Far-side" stops downstream of an intersection are preferred over "near-side" stops in advance of an intersection.
- A minimum "landing pad" area of 5 feet wide by 8 feet deep should be provided at the curb for boarding and disembarking.
- The amount of sidewalk space around a bus stop should meet the intended demand and ridership levels.
- Adequate lighting should be installed around bus stops and shelters to ensure personal safety and security.

Figure 6-3 Landing Pad, Image Source: BCDCOG Transit and Bus Stop Design Guidelines

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Appendix

GROTON
PARKS & RECREATION

Appendix 1
Grant Programs

Bike Ped Planning and Infrastructure Grant Programs in Connecticut							
Program	**Funding Source**	**Application To**	**Typical Application Frequency**	**Last or Upcoming Deadline**	**Funding Value**	**Eligible Bike/Ped Activities**	**Notes**
Transportation Alternatives (TA) Set-Aside Program	Federal	COG	4-5 years	March 2024	$300k-$4m per project	Wide range of bike/ped projects	
Local Transportation Capital Improvement Program (LOTCIP)	State	COG	2 years	2/21/24	$300k-$4m per project	Sidewalks and multi-use trails	Municipality pays 100% of project design costs (considered local share). 100% LOTCIP State-funded construction phase
Local Capital Improvement Program (LoCIP)	State	CTOPM	Annual			Bikeways and greenways, public park improvements	Projects must be identified in the municipality's capital improvement program
Community Connectivity Grant Program	State	CTDOT	2 years	7/21/23	$100k-$800k per project	Wide range of bike/ped projects	Multi-use trails are eligible, recreational trails are ineligible
Recreational Trails Program	Federal	CTDEEP	Annual	3/11/24	Up to $1m per project	New trail construction, maintenance and restoration of existing trails, and acquisition of land or easements	Grants can pay up to 80% of total project costs, a 20% match is required
Congestion Mitigation & Air Quality (CMAQ)	Federal	COG	3-4 years	4/7/21	$200k-$4m per project	Wide range of bike/ped projects	Up to 5 applications from SECCOG were eligible for funding in the last round
Urban Act Grants Program	State	CTDECD	Annual	8/18/23		Wide range of bike/ped projects and recreation projects	
Federal Discretionary Grants (BIL/IIJA)	Federal	USDOT	Multiple Application Dates	1/13/25 (RAISE), 5/16/24, 8/29/24 (SS4A)		Wide range of bike/ped projects, safety projects	Includes SS4A, RAISE, BRIC, BIP, RCP, CFI, and MPDG programs

Bike Ped Planning and Infrastructure Grant Programs in Connecticut							
Program	**Funding Source**	**Application To**	**Typical Application Frequency**	**Last or Upcoming Deadline**	**Funding Value**	**Eligible Bike/Ped Activities**	**Notes**
Defense Community Infrastructure Program (DCIP)	Federal	DOD OLDCC		2024 pending	$800k-$14m awarded	Any complete and useable transportation project that meets program criteria	Project must directly support a military installation or community
CT Communities Challenge Grant	State	CTDECD	Annual, Future Rounds?	8/10/23	$1.2-$4.5m awarded	Mobility improvements that increase connectivity to transit and promotes economic activity, including pedestrian, ADA, and bicycle improvements.	50% of the funds go to competitive projects in distressed municipalities.
Small Cities CDBG	Federal	CTDOH	Annual			Public Facilities and Improvements	Groton is eligible
Community Investment Fund 2030	State	CTDECD	Twice-Annual	6/21/24	$250k-$22.5m awarded	Wide range of transportation and infrastructure projects	Groton is eligible. Projects should align with Governor's Economic Action Plan.
AARP Community Challenge Grant Program	AARP	AARP	Annual	3/6/24	$500-$50k	Temporary or permanent physical improvements	
Active Transportation Infrastructure Investment Program (ATIIP)	Federal	FHWA		7/17/24	Min. $100,000 (planning & design), $15 million (construction)	Planning and Design grants and Construction grants for active transportation networks and active transportation spines	Covers 80% of project costs

Appendix 2

Bicycle Facility Implementation Plan Summary Tables

Bicycle Facilities Summary Table (Table 1 of 3)

Segment	Road Name	Start Segment	End Segment	Segment Length (Miles)
1.1	Grove Ave	Military Hwy	Walker Hill Rd	0.39
1.1	Walker Hill Rd	Grove Ave	Rt 12	0.27
1.2	Poquonnock Rd	Rt 1 (Long Hill Rd)	Rt 649 (High Rock Rd)	0.49
1.3	Rt 649 (South Rd)	Train overpass at Groton Little League	Leonard Dr	1.02
1.3	Rt 649 (Poquonnock Rd)	Rt 649 (High Rock Rd)	Old Farm Rd	0.43
1.3	Rt 649 (South Rd)	Rt 1 (Poquonnock Rd)	Train overpass at Groton Little League	0.35
1.3	Rt 649 (Tower Rd/High Rock Rd)	Leonard Dr	Poquonnock Rd	0.67
1.4	Rt 1 (Poquonnock Rd/ Fort Hill Rd)	South Rd	Depot Rd	0.27
1.5	North Rd	Rt 1 (Fort Hill Rd)	Rt 117 (Newtown Rd)	0.55
1.6	Depot Rd	Rt 1 (Fort Hill Rd)	Bluff Point	0.37
1.7	Industrial Dr	Depot Rd	G&S Trolley Trailhead	0.26
1.8	Central Ave	Midway Oval	Rt 1 (Fort Hill Rd)	0.40
1.8	Knoxville Ct	G&S Trolley Trailhead	Midway Oval	0.09
1.8	Midway Oval	Central Ave	Central Ave	0.66
1.9	Rt 215 (Groton Long Point Rd)	Rt 1 (Fort Hill Rd)	Elm St South	1.71
1.10	Rt 215 (Elm St)	Prospect Hill Rd	Mosher Ave	0.11
1.10	Rt 215 (S Elm St)	Rt 215 (Groton Long Point Rd)	Prospect Hill Rd	0.45
1.10	Rt 215 (Elm St)	Mosher Ave	Fishtown Rd	0.69
1.10	Rt 215 (Noank Rd/Water St)	Fishtown Rd	Rt 1 (W Main St)	1.69
1.11	Irving St	West Mystic Ave	Judson Ave	0.32
1.11	Judson Ave	Irving St	Rt 1 (New London Rd)	1.16
1.12	W Mystic Ave	Rt 1 (New London Rd)	Rt 215 (Noank Rd)	0.45
1.13	Rt 1 (New London Rd)	Allyn St	Elm St	0.13
1.13	Rt 1 (W Main St)	Elm St	Stonington Town Line	0.35
1.14	High St/ Cow Hill Rd	Peace Nature Sanctuary	Rt 614 (Mystic St)	0.85
1.14	High St	Rt 1 (W Main St)	Peace Nature Sanctuary	0.68
2.1	Military Hwy	Crystal Lake Rd	Grove Ave	1.51
2.2	Gungywamp Rd	Rt 12	Rt 184 (Gold Star Hwy)	2.05
2.3	Toll Gate Rd	Rt 12	Rt 184 (Gold Star Hwy)	1.15
2.4	Rt 184 (Gold Star Hwy)	Toll Gate Rd	Gungywamp Rd	0.47
2.5	Buddington Rd	Rt 1 (Poquonnock Rd)	Rt 184 (Gold Star Hwy)	2.03
2.6	Drozdyk Dr	Rt 1 (Long Hill Rd)	Buddington Rd	0.85
2.7	Meridian St. Extension	Rt 1	City of Groton Line	0.52
2.8	Rt 1 (Long Hill Rd/ Poquonnock Rd)	Meridian St Extension	South Rd	0.98
2.9	Rt 117 (Newtown Rd)	Rt 1 (Fort Hill Rd)	N (Rd)	0.42
2.9	Rt 117 (N Rd)	North Rd	Hazelnut Hill Rd	0.43
2.10	Hazelnut Hill Rd	Rt 117 (N Rd)	Sheep Farm Park	0.48

Bicycle Facilities Summary Table (Table 1 of 3 continued)

Segment	Road Name	Start Segment	End Segment	Segment Length (Miles)
2.11	Rt 1 (Poquonnock Rd/ Fort Hill Rd)	Ring Drive	Groton Long Point Rd	0.52
2.12	Brook St	Rt 215 (Groton Long Point Rd)	Rt 215 (Groton Long Point Rd)	0.76
2.12	Brook St	Rt 215 (Groton Long Point Rd)	Rt 215 (Elm St)	0.39
2.12	Haley Farm Ln	Brook St	Haley Farm Trailhead	0.12
2.13	Fishtown Rd	Rt 1 (New London Rd)	Rt 215 (Noank Rd)	1.18
2.13	Noank Ledyard Rd	Rt 1 (New London Rd)	Flanders Rd	2.14
2.14	Rt 1 (New London Rd)	Ocean View Ave	Allyn St	0.26
2.14	Rt 1 (New London Rd)	Noank Ledyard Rd	Ocean View Ave	0.87
2.15	Bindloss Rd	Cow Hill Rd	River Rd	0.21
2.15	Pearl St	Rt 1 (W Main St)	Starr St	0.51
2.15	River Rd	Starr St	Old Mystic Center Rd	2.33
2.15	Starr St	Pearl St	River Rd	0.03
2.15	Shewville Rd	Old Mystic Center Rd	Rt 184 (Gold Star Hwy)	0.16
2.16	Sandy Hollow Rd	Noank Ledyard Rd	High St	1.17
3.1	Crystal Lake Rd	Rt 12	Pleasant Valley Rd N	0.12
3.1	Pleasant Valley Rd N	Crystal Lake Rd	Ledyard Town Line	0.88
3.2	Rt 1 (Long Hill Rd/ Poquonnock Rd)	Rt 349 Interchange	Meridian St Extension	0.70
3.2	Rt 12/Rt 1 (Long Hill Rd)	Pleasant Valley Rd S	Rt 349 Interchange	0.72
3.3	Groton Long Point Rd	Marsh Rd	Mumford Cove Rd	0.35
3.3	Groton Long Point Rd	Rt 215 (S Elm St)	Marsh Rd	0.13
3.3	0 Haley Crescent ROW	0 Haley Crescent	G&S Trolley Trail	0.69
3.3	Mumford Cove Rd	Groton Long Point Rd	0 Haley Crescent	0.18
3.4	Rt 1 (New London Rd)	Groton Long Point Rd	Noank Ledyard Rd	1.02
3.5	Flanders Rd	Rogers Rd	Rt 184 (Gold Star Hwy)	0.50
3.5	Flanders Rd	Rt 1 (New London Rd)	Rogers Rd	2.07
3.6	Rt 614 (Allyn St)	Rt 1 (New London Rd)	Library St	0.09
3.6	Rt 614 (Allyn St/Mystic St)	Library St	Ledgeland Dr	1.57
3.6	Rt 614 (Cow Hill Rd)	Ledgeland Dr	R 184 (Gold Star Hwy)	0.97
3.7	Godfrey Rd	Cold Spring Rd	Packer Rd	0.70
3.7	Packer Rd	Godfrey Rd	Welles Rd	0.36
3.7	Welles Rd	Rt 184 (Gold Star Hwy)	Rt 184 (Gold Star Hwy)	0.41
3.7	Yetter Rd	Flanders Rd	Cold Spring Rd	0.76
3.7	Rogers Rd	Rt 184 (Gold Star Hwy)	Flanders Rd	0.65
3.7	Rt 27 (Old Mystic Center Rd)	Rt 184 (Gold Star Hwy)	Stonington Town Line	0.28
3.7	Rt 184 (Gold Star Hwy)	Welles Road	Stonington Town Line	0.45
3.8	Lambtown Rd	Rt 184 (Gold Star Hwy)	Ledyard Town Line	0.90
3.8	Larchmont Ter	Lambtown Rd	End	0.12
3.9	Rt 184 (Gold Star Hwy)	Rt 117 (N Rd)	Rogers Rd	0.62
3.9	Rt 184 (Gold Star Hwy)	Gungywamp Rd	Rt 117 (N Rd)	0.92

Bicycle Facilities Summary Table (Table 1 of 3 continued)				
Segment	**Road Name**	**Start Segment**	**End Segment**	**Segment Length (Miles)**
3.10	Charlton Ln	Mountain Laurel Rd	End	0.20
3.10	Gales Ferry Rd	Rt 117 (N Rd)	Mountain Laurel Rd	0.39
3.10	Great Brook Rd	Rt 184 (Gold Star Hwy)	Mountain Laurel Rd	0.50
3.10	Mountain Laurel Rd	Great Brook Rd	Gales Ferry Rd	0.18
3.11	Rt 117 (N Rd)	Hazelnut Hill Rd	Gales Ferry Rd	1.92
4.1	Rt 117 (N Rd)	Gales Ferry Rd	Ledyard Town Line	0.90
4.2	Packer Rd	Rt 184 (Gold Star Hwy)	Godfrey Rd	0.46
4.2	Colonel Ledyard Hwy	Rt 184 (Gold Star Hwy)	Ledyard Town Line	0.64
4.3	Cold Spring Rd	Rt 184 (Gold Star Hwy)	Godfrey Rd	0.19
4.3	Rt 184 (Gold Star Hwy)	Rogers Rd	Colonel Ledyard Hwy	1.49
4.3	Rt 184 (Gold Star Hwy)	Colonel Ledyard Hwy	Welles Road	1.16
4.4	Pumpkin Hill Rd	Rt 184 (Gold Star Hwy)	Ledyard Town Line	0.62
4.5	Shewville Rd	Ledyard Town Line	Rt 184 (Gold Star Hwy)	0.36

Bicycle Facilities Summary Table (Table 2 of 3)

Segment	Road Name	Functional Classification	ADT (*estimated)	85th Percentile Speeds or Posted Limit* (mph)
1.1	Grove Ave	Local	3,100*	30*
1.1	Walker Hill Rd	Local	4,600*	30*
1.2	Poquonnock Rd	Major Collector	8,700	43
1.3	Rt 649 (South Rd)	Minor Arterial	2,100	41
1.3	Rt 649 (Poquonnock Rd)	Minor Arterial	7,300	41
1.3	Rt 649 (South Rd)	Minor Arterial	3,700	28
1.3	Rt 649 (Tower Rd/High Rock Rd)	Minor Arterial	3,600-4,400	32-35
1.4	Rt 1 (Poquonnock Rd/ Fort Hill Rd)	Minor Arterial	12,300-19,700	39-44
1.5	North Rd	Local	1,200-1,700*	30*
1.6	Depot Rd	Local	1,700*	30*
1.7	Industrial Dr	Local	2,400*	30*
1.8	Central Ave	Local	1,400*	30*
1.8	Knoxville Ct	Local	4,500*	30*
1.8	Midway Oval	Local	4,500*	30*
1.9	Rt 215 (Groton Long Point Rd)	Major Collector	2,300-7,000	41-58
1.10	Rt 215 (Elm St)	Major Collector	1,400	35
1.10	Rt 215 (S Elm St)	Major Collector	1,400	50
1.10	Rt 215 (Elm St)	Major Collector	4,900	39
1.10	Rt 215 (Noank Rd/Water St)	Major Collector	2,500-5,000	22-35
1.11	Irving St	Local	NA	30*
1.11	Judson Ave	Local	NA	30*
1.12	W Mystic Ave	Local	2,600*	30*
1.13	Rt 1 (New London Rd)	Minor Arterial	5,000-6,300	35-38
1.13	Rt 1 (W Main St)	Minor Arterial	6,300-7,500	22-36
1.14	High St/ Cow Hill Rd	Local	2,300-2,500*	40*
1.14	High St	Local	2,500*	40*
2.1	Military Hwy	Major Collector	3,400	44
2.2	Gungywamp Rd	Major Collector	4,400	30*
2.3	Toll Gate Rd	Local	4,400*	35*
2.4	Rt 184 (Gold Star Hwy)	Minor Arterial	13,600-14,300	41-50
2.5	Buddington Rd	Major Collector	5,000	41
2.6	Drozdyk Dr	Major Collector	5,100	27
2.7	Meridian St. Extension		3,900	41
2.8	Rt 1 (Long Hill Rd/ Poquonnock Rd)	Minor Arterial	12,300-19,700	39-44
2.9	Rt 117 (Newtown Rd)	Minor Arterial	12,600-13,000	41-47
2.9	Rt 117 (N Rd)	Minor Arterial	6,400-13,900	46-52
2.10	Hazelnut Hill Rd	Local	700*	30*

Bicycle Facilities Summary Table (Table 2 of 3 continued)				
Segment	**Road Name**	**Functional Classification**	**ADT (*estimated)**	**85th Percentile Speeds or Posted Limit* (mph)**
2.11	Rt 1 (Poquonnock Rd/ Fort Hill Rd)	Minor Arterial	10,900-14,500	40-55
2.12	Brook St	Local	700*	30*
2.12	Brook St	Local	2,800*	30*
2.12	Haley Farm Ln	Local	NA	N/A
2.13	Fishtown Rd	Local	1,500*	30*
2.13	Noank Ledyard Rd	Local	2,300-2,500	35*
2.14	Rt 1 (New London Rd)	Minor Arterial	5,000-6,300	35-38
2.14	Rt 1 (New London Rd)	Minor Arterial	5,000	38
2.15	Bindloss Rd	Local	1,100*	30*
2.15	Pearl St	Local	600-2,200*	30*
2.15	River Rd	Local	1,100*	30*
2.15	Starr St	Local	600*	30*
2.15	Shewville Rd	Major Collector	2,200	37
2.16	Sandy Hollow Rd	Local	2,500*	30-35*
3.1	Crystal Lake Rd	Local	1,600*	30*
3.1	Pleasant Valley Rd N	Local	1,600*	30*
3.2	Rt 1 (Long Hill Rd/ Poquonnock Rd)	Minor Arterial	12,300-19,700	39-44
3.2	Rt 12/Rt 1 (Long Hill Rd)	Principal Arterial	21,600-26,000	40-48
3.3	Groton Long Point Rd	Local	1,900-3,300*	30*
3.3	Groton Long Point Rd	Local	3,300*	30*
3.3	0 Haley Crescent ROW	-	-	-
3.3	Mumford Cove Rd	Local	1,500*	30*
3.4	Rt 1 (New London Rd)	Minor Arterial	5,200-6400	41-47
3.5	Flanders Rd	Major Collector	2,200	38
3.5	Flanders Rd	Major Collector	2,200	38
3.6	Rt 614 (Allyn St)	Minor Arterial	6,700	27
3.6	Rt 614 (Allyn St/Mystic St)	Minor Arterial/ Major Collector	7,500-10,500	51-59
3.6	Rt 614 (Cow Hill Rd)	Major Collector	6,000-6,900	38-54
3.7	Godfrey Rd	Local	400*	30*
3.7	Packer Rd	Local	800*	30*
3.7	Welles Rd	Local	700*	35*
3.7	Yetter Rd	Local	500*	30*
3.7	Rogers Rd	Local	1,100	37
3.7	Rt 27 (Old Mystic Center Rd)	Minor Arterial	3,800-5,600	29-41
3.7	Rt 184 (Gold Star Hwy)	Minor Arterial	8,700-9,300	56-64
3.8	Lambtown Rd	Local	4,500*	30*
3.8	Larchmont Ter	Local	200*	
3.9	Rt 184 (Gold Star Hwy)	Minor Arterial	10,300	44
3.9	Rt 184 (Gold Star Hwy)	Minor Arterial	13,600-14,300	41-50

Bicycle Facilities Summary Table (Table 2 of 3 continued)				
Segment	**Road Name**	**Functional Classification**	**ADT (*estimated)**	**85th Percentile Speeds or Posted Limit* (mph)**
3.10	Charlton Ln	Local	300*	
3.10	Gales Ferry Rd	Local	2,400*	30*
3.10	Great Brook Rd	Local	1,100*	30*
3.10	Mountain Laurel Rd	Local	1,300*	
3.11	Rt 117 (N Rd)	Minor Arterial	6,400-13,900	46-52
4.1	Rt 117 (N Rd)	Minor Arterial	9,200-9,600	46-50
4.2	Packer Rd	Local	800*	30*
4.2	Colonel Ledyard Hwy	Major Collector	3,200	56
4.3	Cold Spring Rd	Local	500*	30*
4.3	Rt 184 (Gold Star Hwy)	Minor Arterial	8,800-8,900	53-55
4.3	Rt 184 (Gold Star Hwy)	Minor Arterial	8,700-9,300	56-64
4.4	Pumpkin Hill Rd	Local	3,400	42
4.5	Shewville Rd	Major Collector	2,200	37

*Dashed segments indicate areas where data is estimated using posted speed limits + 5 mph and/or ADT data from UConn's Connecticut AADT Visualization Tool

Bicycle Facilities Summary Table (Table 3 of 3)

Segment	Road Name	Recommended Facility	Demand	Ease of Implementation	Phase
1.1	Grove Ave	Shared Roadway	Medium	High	1
1.1	Walker Hill Rd	Shared Roadway	Medium	High	1
1.2	Poquonnock Rd	Bike Lanes	High	High	1
1.3	Rt 649 (South Rd)	Bike Lanes	High	High	1
1.3	Rt 649 (Poquonnock Rd)	Bike Lanes	High	High	1
1.3	Rt 649 (South Rd)	Shared Roadway	High	High	1
1.3	Rt 649 (Tower Rd/High Rock Rd)	Shared Roadway	High	High	1
1.4	Rt 1 (Poquonnock Rd/ Fort Hill Rd)	Sidepath (south side of roadway)	High	Low	1
1.5	North Rd	Shared Roadway	High	High	1
1.6	Depot Rd	Shared Roadway	High	High	1
1.7	Industrial Dr	Sidepath	High	Low	1
1.8	Central Ave	Shared Roadway	High	High	1
1.8	Knoxville Ct	Shared Roadway	High	High	1
1.8	Midway Oval	Shared Roadway	High	High	1
1.9	Rt 215 (Groton Long Point Rd)	Buffered Bike Lanes	High	Medium	1
1.10	Rt 215 (Elm St)	Bike Lane (northbound) Shared Roadway (southbound)	High	High	1
1.10	Rt 215 (S Elm St)	Buffered Bike Lanes	High	Medium	1
1.10	Rt 215 (Elm St)	Shared Roadway	High	High	1
1.10	Rt 215 (Noank Rd/Water St)	Shared Roadway	High	High	1
1.11	Irving St	Shared Roadway	High	High	1
1.11	Judson Ave	Shared Roadway	High	High	1
1.12	W Mystic Ave	Shared Roadway	High	High	1
1.13	Rt 1 (New London Rd)	Bike Lane (westbound) Shared Roadway (eastbound)	High	High	1
1.13	Rt 1 (W Main St)	Shared Roadway*	High	High	1
1.14	High St/ Cow Hill Rd	Bike Lanes	High	High	1
1.14	High St	Shared Roadway*	High	High	1
2.1	Military Hwy	Shared Roadway*	Medium	High	2
2.2	Gungywamp Rd	Shared Roadway	Medium	High	2
2.3	Toll Gate Rd	Shared Roadway	Medium	High	2
2.4	Rt 184 (Gold Star Hwy)	Sidepath (south side of roadway)	Medium	Low	2
2.5	Buddington Rd	Bike Lanes	Medium	Medium	2
2.6	Drozdyk Dr	Buffered Bike Lanes	Medium	Medium	2
2.7	Meridian St. Extension	Buffered Bike Lanes	High	Medium	2
2.8	Rt 1 (Long Hill Rd/ Poquonnock Rd)	Sidepath (north side of roadway)	High	Low	2
2.9	Rt 117 (Newtown Rd)	Sidepath (west side of roadway)	Medium	Low	2
2.9	Rt 117 (N Rd)	Sidepath (west side of roadway)	Medium	Low	2
2.10	Hazelnut Hill Rd	Shared Roadway	Medium	High	2

Bicycle Facilities Summary Table (Table 3 of 3 continued)

Segment	Road Name	Recommended Facility	Demand	Ease of Implementation	Phase
2.11	Rt 1 (Poquonnock Rd/ Fort Hill Rd)	Sidepath (south side of roadway)	High	Low	2
2.12	Brook St	Shared Roadway	Medium	High	2
2.12	Brook St	Shared Roadway	Medium	High	2
2.12	Haley Farm Ln	Shared Roadway	Medium	High	2
2.13	Fishtown Rd	Shared Roadway	Medium	High	2
2.13	Noank Ledyard Rd	Shared Roadway	Medium	High	2
2.14	Rt 1 (New London Rd)	Bike Lane (westbound) Shared Roadway (eastbound)	High	Medium	2
2.14	Rt 1 (New London Rd)	Bike Lanes	High	High	2
2.15	Bindloss Rd	Shared Roadway	Medium	High	2
2.15	Pearl St	Shared Roadway	Medium	High	2
2.15	River Rd	Shared Roadway	Medium	High	2
2.15	Starr St	Shared Roadway	Medium	High	2
2.15	Shewville Rd	Shared Roadway	Medium	High	2
2.16	Sandy Hollow Rd	Shared Roadway	Medium	High	2
3.1	Crystal Lake Rd	Bike Lanes	Low	High	3
3.1	Pleasant Valley Rd N	Shared Roadway	Low	High	3
3.2	Rt 1 (Long Hill Rd/ Poquonnock Rd)	Sidepath (north side of roadway)	High	Low	3
3.2	Rt 12/Rt 1 (Long Hill Rd)	Sidepath (north side of roadway)	High	Low	3
3.3	Groton Long Point Rd	Bike Lanes	Low	High	3
3.3	Groton Long Point Rd	Buffered Bike Lanes	Low	Medium	3
3.3	0 Haley Crescent ROW	Shared Use Path	Low	Medium	3
3.3	Mumford Cove Rd	Shared Roadway	Low	High	3
3.4	Rt 1 (New London Rd)	Sidepath (north side of roadway)	High	Low	3
3.5	Flanders Rd	Bike Lanes	Low	Medium	3
3.5	Flanders Rd	Buffered Bike Lanes	Low	Medium	3
3.6	Rt 614 (Allyn St)	Sidepath (west side of roadway)	High	Low	3
3.6	Rt 614 (Allyn St/Mystic St)	Sidepath (west side of roadway)	High	Low	3
3.6	Rt 614 (Cow Hill Rd)	Sidepath (west side of roadway)	High	Low	3
3.7	Godfrey Rd	Shared Roadway	Low	High	3
3.7	Packer Rd	Shared Roadway	Low	High	3
3.7	Welles Rd	Shared Roadway	Low	High	3
3.7	Yetter Rd	Shared Roadway	Low	High	3
3.7	Rogers Rd	Shared Roadway*	Low	High	3
3.7	Rt 27 (Old Mystic Center Rd)	Shared Roadway*	Low	High	3
3.7	Rt 184 (Gold Star Hwy)	Sidepath (south side of roadway)	Low	Low	3
3.8	Lambtown Rd	Shared Roadway	Low	High	3
3.8	Larchmont Ter	Shared Roadway	Low	High	3
3.9	Rt 184 (Gold Star Hwy)	Sidepath (south side of roadway)	Medium	Low	3
3.9	Rt 184 (Gold Star Hwy)	Sidepath (south side of roadway)	Medium	Low	3

Bicycle Facilities Summary Table (Table 3 of 3 continued)					
Segment	**Road Name**	**Recommended Facility**	**Demand**	**Ease of Implementation**	**Phase**
3.10	Charlton Ln	Shared Roadway	Low	High	3
3.10	Gales Ferry Rd	Shared Roadway	Low	High	3
3.10	Great Brook Rd	Shared Roadway	Low	High	3
3.10	Mountain Laurel Rd	Shared Roadway	Low	High	3
3.11	Rt 117 (N Rd)	Sidepath (west side of roadway)	Medium	Low	3
4.1	Rt 117 (N Rd)	Sidepath (west side of roadway)	Low	Low	4
4.2	Packer Rd	Shared Roadway	Low	High	4
4.2	Colonel Ledyard Hwy	Sidepath (east side of roadway)	Low	Low	4
4.3	Cold Spring Rd	Shared Roadway	Medium	High	4
4.3	Rt 184 (Gold Star Hwy)	Sidepath (south side of roadway)	Medium	Low	4
4.3	Rt 184 (Gold Star Hwy)	Sidepath (south side of roadway)	Medium	Low	4
4.4	Pumpkin Hill Rd	Bike Lanes*	Low	High	4
4.5	Shewville Rd	Shared Roadway*	Low	High	4

*Traffic calming measures are recommended for implementation prior to or along with installation of roadway improvements on these corridors due to existing traffic speeds.

Appendix 3

Sidewalk Facility Implementation Plan Summary Tables

Phase 1 Sidewalk Improvements

Road	Approximate Extends*	Length of proposed sidewalk (miles)
Brook St	Groton Long Point to Elm St	0.22
Flanders Rd	Rt 1 to Ensign Dr	0.33
Grove Ave	Marquardt Ln to Fieldside Dr	0.16
High St	Godfrey St to Mystic Mobile Home Park	0.39
Rt 1	South Rd to Judson Ave	1.34
Rt 12	Crystal Lake Rd to Ledyard Town Line	0.39
Rt 215 (Elm St)	Prospect Hill Rd to Mosher Ave	0.07
Rt 215 (Groton Long Point Rd)	Rt 1 to Fishers View Dr	0.25
South Rd	Groton Little League to Karen Ave	0.20
		3.35

Phase 2 Sidewalk Improvements

Road	Approximate Extends*	Length of proposed sidewalk (miles)
Buddington Rd	Roberts Rd to Rt 184	0.90
Fishtown Rd	Rt 215 to Mystic River Magnet School	0.71
Flanders Rd	Ensign Dr to I-95 overpass	0.58
Noank Ledyard Rd	Daniel Brown Dr to I-95 overpass	0.65
Rt 184	Rt 12 to Atrium Storage	2.08
Rt 215 (Groton Long Point Rd)	Fitch High School to Windrose Dr	0.49
Rt 649	Leonard Dr to Johl Dr	0.46
Toll Gate Rd	Rt 12 to Rt 184	1.03
		6.90

*Approximated extents indicate areas between which proposed sidewalk segments are recommended for each phase. They do not indicate a continuous segment of proposed sidewalk. Refer to the map for individual segments.

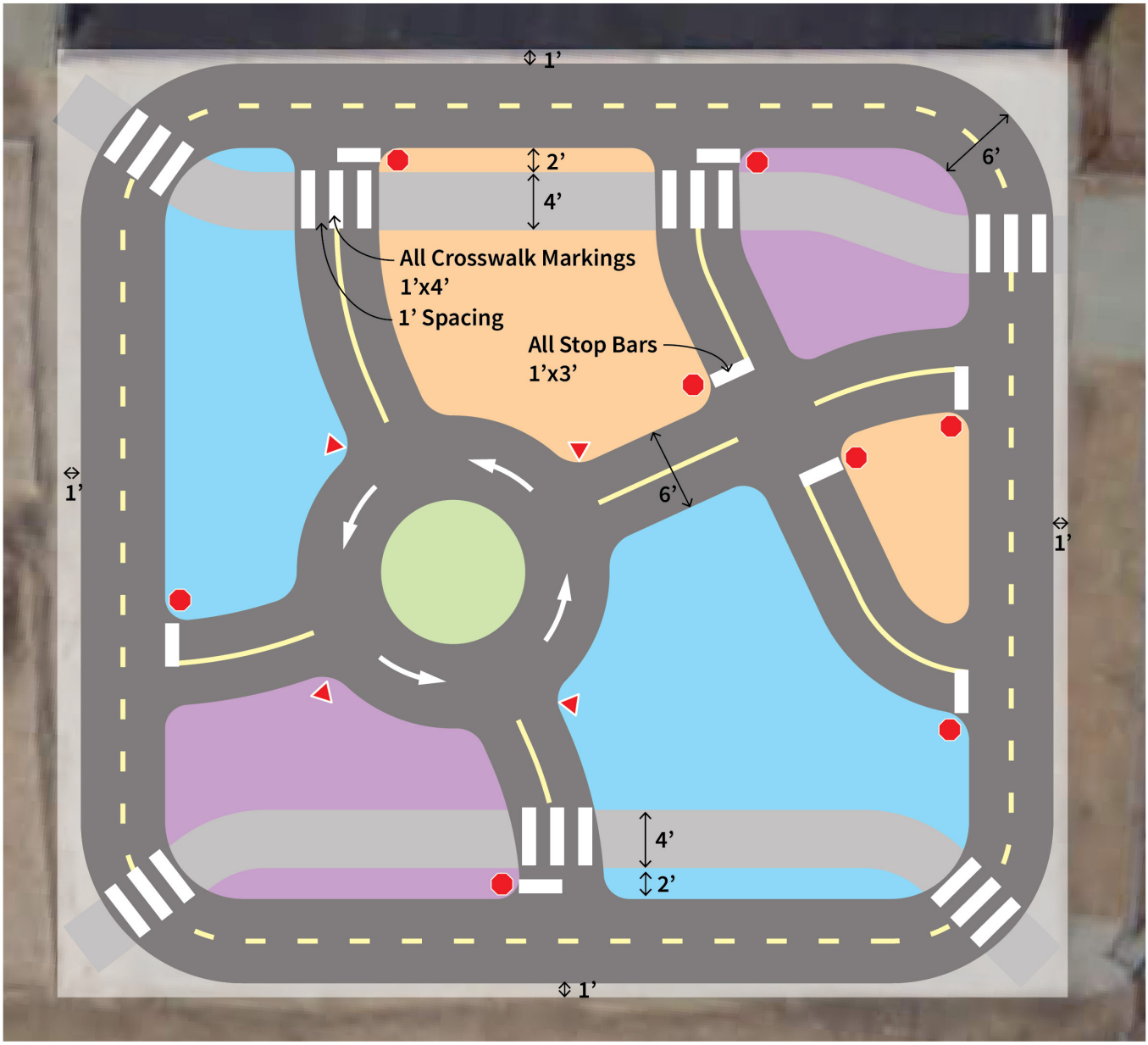
Phase 3 Sidewalk Improvements		
Road	**Approximate Extends***	**Length of proposed sidewalk (miles)**
Flanders Rd	Rt 184 to I-95 Overpass	1.04
Gales Ferry Rd	Rt 117 to Mountain Laurel Rd	0.23
Groton Long Point Rd	S Elm St to Mumford Cove Rd	0.42
Gungywamp Rd	Rt 12 to Rt 184	0.94
Mumford Cove Rd	Groton Long Point Rd to Haley Crescent	0.15
Noank Ledyard Rd	Flanders Rd to I-95 Overpass	0.55
Poquonnock Rd	Ginger Dr to Johl Dr	0.13
Rt 117	Rt 184 to Thames Valley Winsupply	0.56
Rt 12	Ohio Ave to Ledyard Town Line	0.14
Rt 12	Crystal Lake Rd to Hickory Dr	0.90
Rt 614 (Allyn St)	Burrows St to Edgecomb St	0.06
Walker Hill Rd	Rt 12 to Pleasant Valley Rd S	0.03
		5.15

*Approximated extents indicate areas between which proposed sidewalk segments are recommended for each phase. They do not indicate a continuous segment of proposed sidewalk. Refer to the map for individual segments.

The bicycle and pedestrian network recommended in this plan proposes the replacement of 6.2 miles of sidewalk for sidepath. This enhancement will allow various roadways, such as Route 1, to more comfortably accommodate both bicyclists and pedestrians.

Replacement of Sidewalk with Sidepath		
Road	**Proposed Sidepath Length (mi)**	**Sidewalk Replacement Length (mi)**
Colonel Ledyard Hwy	0.64	0.31
Industrial Dr	0.26	0.00
Pleasant Valley Rd S	0.10	0.00
Rt 1	4.37	3.74
Rt 184	5.11	0.59
Rt 117	3.67	0.31
Rt 614 (Allyn St/ Cow Hill Rd)	2.64	1.27
	16.80	**6.22**

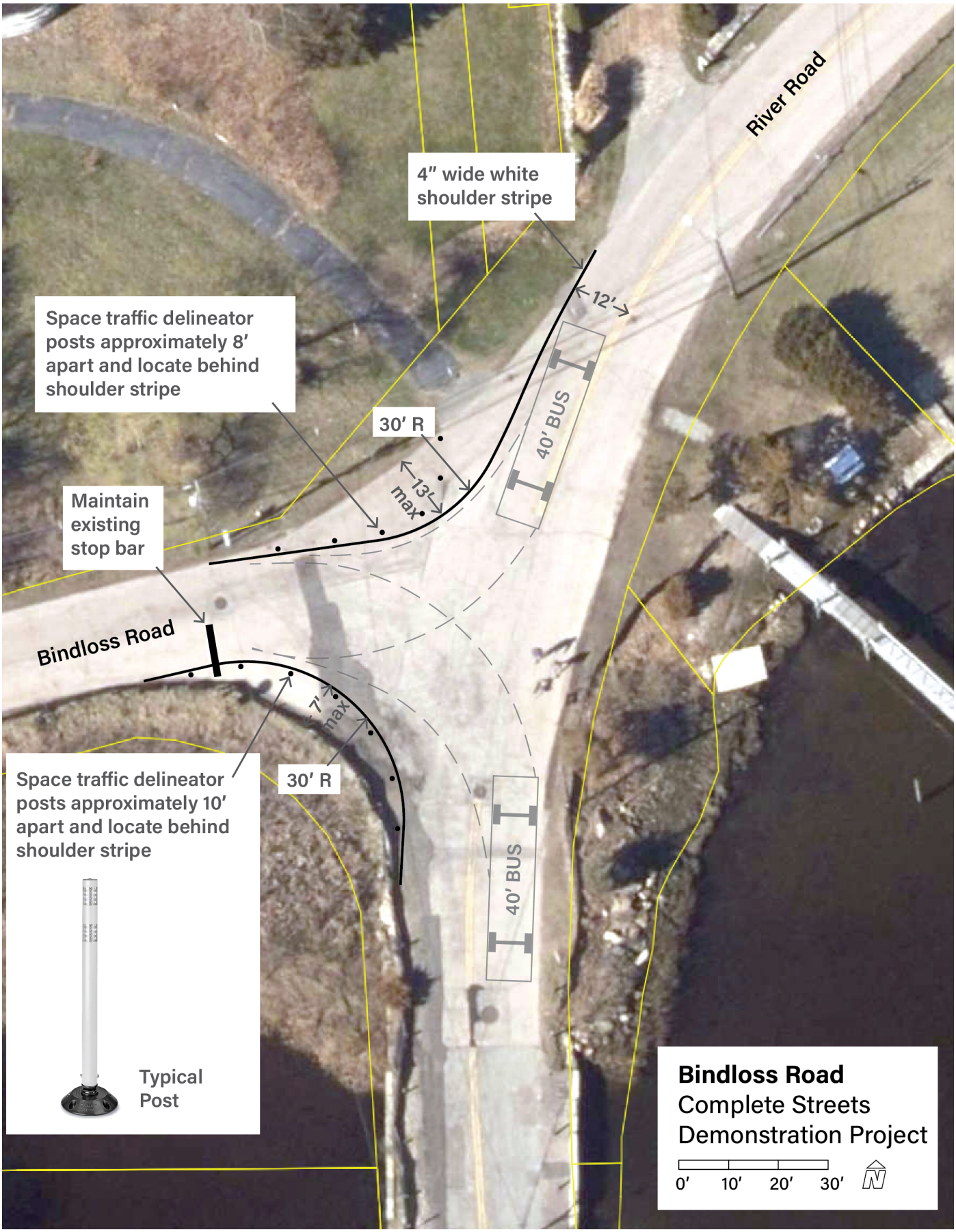
Appendix 4
Demonstration Projects

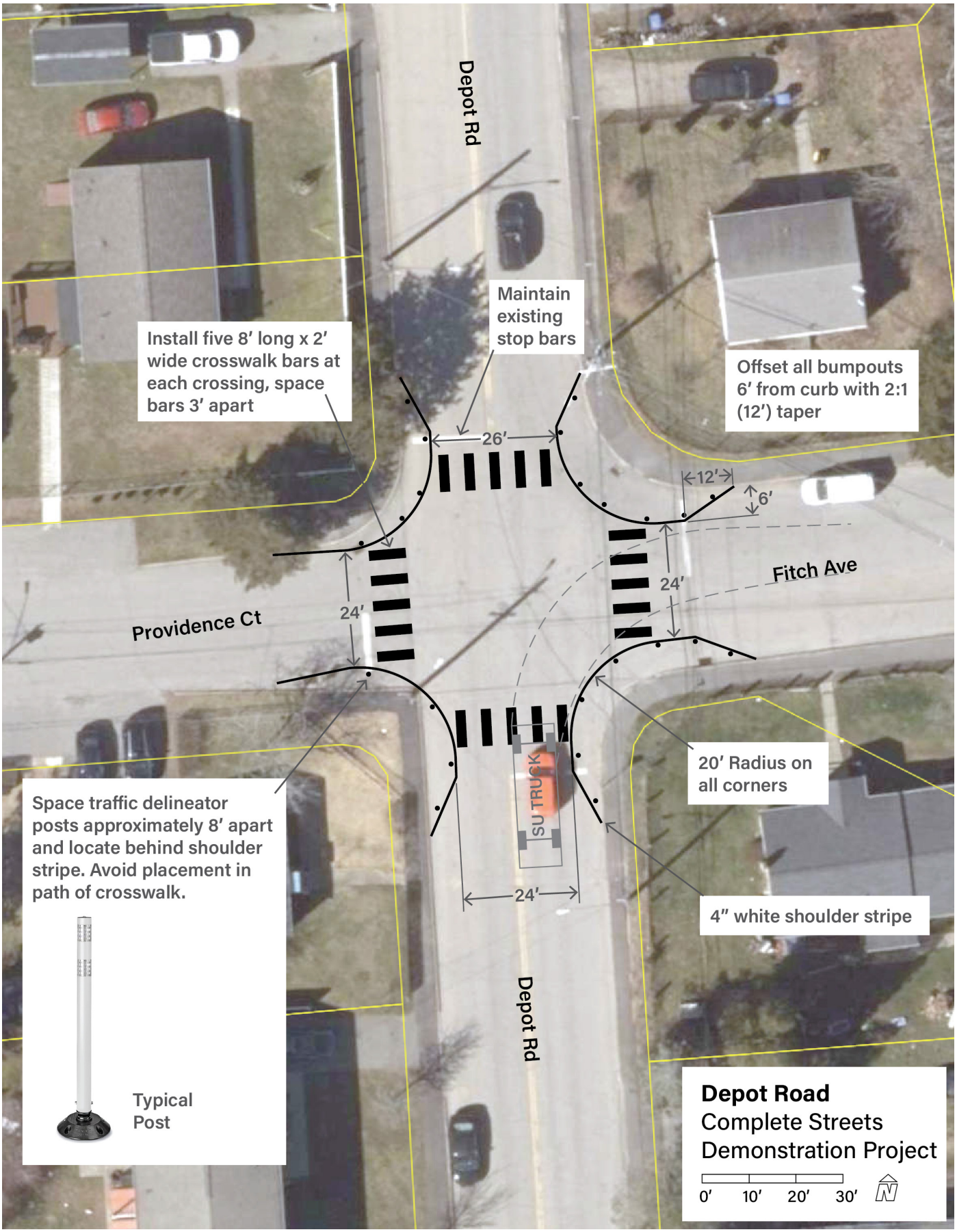


Completion of Traffic Garden

Claude Chester School
Traffic Garden
Demonstration Project

0’ 4’ 8’ 12’


River Road
4" wide white shoulder stripe
12'
Space traffic delineator posts approximately 8' apart and locate behind shoulder stripe
30' R
13' max
40' BUS
Maintain existing stop bar
Bindloss Road
7' max
30' R
Space traffic delineator posts approximately 10' apart and locate behind shoulder stripe
40' BUS
Typical Post
Bindloss Road
Complete Streets
Demonstration Project
0'
10'
20'
30'
N


Depot Rd
Maintain existing stop bars
Install five 8′ long x 2′ wide crosswalk bars at each crossing, space bars 3′ apart
Offset all bumpouts 6′ from curb with 2:1 (12′) taper
26′
12′
6′
24′
Fitch Ave
Providence Ct
24′
SU TRUCK
20′ Radius on all corners
Space traffic delineator posts approximately 8′ apart and locate behind shoulder stripe. Avoid placement in path of crosswalk.
24′
4″ white shoulder stripe
Typical Post
Depot Rd
Depot Road
Complete Streets
Demonstration Project
0′ 10′ 20′ 30′
N

Appendix 5
Community Workshop Summary

Community Workshop Summary
9/18/24

Overview

FHI Studio conducted a workshop at 6:00 pm on September 18th, 2024, at Thrive55 (Senior Center) in Groton. The workshop was promoted on the Town website, via a press release, lawn signs, and through social media. Approximately twenty members of the public attended the workshop. Live access to the workshop was also provided by the Town via Zoom and a recording of the workshop was provided on the Town's community access channel.

The workshop consisted of a presentation by the FHI Studio team regarding the complete streets and trails plan. The presentation was followed by break-out sessions. Attendees were divided into two groups of approximately ten people. Each group was tasked with an assignment to discuss the following:

- What type of bicycle and pedestrian improvements are a priority for you and why?
- What locations or roads in town should be a priority for improving bicycle and pedestrian facilities?
- What are your thoughts on the recommended bicycle and pedestrian network?
- Are there roads or areas that need more improvements than are recommended?

The break-out sessions lasted over one hour. Discussion was documented on flip charts and a map of the Town. Each break-out group reported their findings to all groups at the end of each session.

Workshop Agenda

1. Introduction of Team and Plan
2. Existing Conditions
3. Online Survey
4. Recommended Facility Types
5. Recommended Bicycle and Pedestrian Network
6. Breakout Sessions
7. Review of Demonstration Projects
8. Conclusion

Attendees at Community Workshop

Breakout Session 1

During this session, which lasted 15 minutes, participants were asked to engage in a discussion responding to the following question:

What type of bicycle and pedestrian improvements are a priority for you and why?

The discussion was documented on flip charts. The key themes that emerged from the two group discussions are summarized below.

- Better maintenance of the shoulders for both bicyclists and pedestrians
- Beter maintenance of sidewalks
- Completion of the sidewalk network, including crosswalks
- Sharrows play a role but may not be the most effective facility because drivers don't always understand this type of facility.
- More designated bike facilities are needed so that bicyclists have their own space.
- Provide more warning on bike lanes for what is coming ahead (if there is a change in facility type)
- Driver education is needed for different types of bicycle facilities and the expectations/rules of each facility
- Major commuter routes should provide at least bike lanes, specifically the east/west commuter routes
- Provide resources online for bike routes and facilities in town as the town develops the network
- Look to see where shared use paths are feasible through town owned parcels and open space. More people will use these for recreation and transportation
- More places to gather in downtown Groton would make it more of a destination for bicyclists and pedestrians. More like Mystic.
- Incentivize new developments or require new developments to provide sidewalks as a part of their projects
- Sidewalks – sidewalk maintenance and cleanup of debris and vegetation that is encroaching into the sidewalk
- Improve signage placement to avoid placement in sidewalks
- Provide sidewalks on both sides of roads
- Provide bike lanes
- Reconfigure intersections to provide better pedestrian amenities
- Provide continuous bicyclist and pedestrian facilities
- Provide dedicated bicycle facilities
- Provide ADA improvements and wheelchair accessibility
- Need to address long crossing distances at intersections

Breakout Session at Community Workshop

Breakout Session 2

During this session, which lasted 15 minutes, participants were asked to engage in a discussion responding to the following question:

What locations or roads in town should be a priority for improving bicycle and pedestrian facilities?

The discussion was documented on flip charts and on maps. The key themes that emerged from the two group discussions are summarized below.

- Rt 1 is a high priority area
- Big Y to "Hamburger Hill" (Long Hill Road area) is a priority for both bicyclists and pedestrians
- Near Charles Barnum School
- Toll Gate Road and its intersection with Route 12 is a very important area
- Provide sidewalks on both sides of Route 12
- The side path along Route 12 should connect to the Gold Star Bridge. Note that there is a new development near the end of this side path
- Fort Hill area along Route 1 (east of Ring Dr) is very hilly and not an ideal route for cyclists. Still an important connection, however. See if there are any alternatives here or look to keep bicyclists separated from traffic here.
- Improve Poquonnock Park boardwalk. There are issues surrounding drainage
- Need for better facilities along Route 1, sidewalk abruptly ends along Route 1
- Crosswalks are needed along Route 1 west of South Rd
- Provide bicycle facilities along Buddington Rd
- Provide bicycle facilities along Route 117 to Gold Star Hwy
- Look just south of Route 1 for potential off-road connections, near the rail line. A rail trail would be favorable here

Breakout Session at Community Workshop

Breakout Session 3

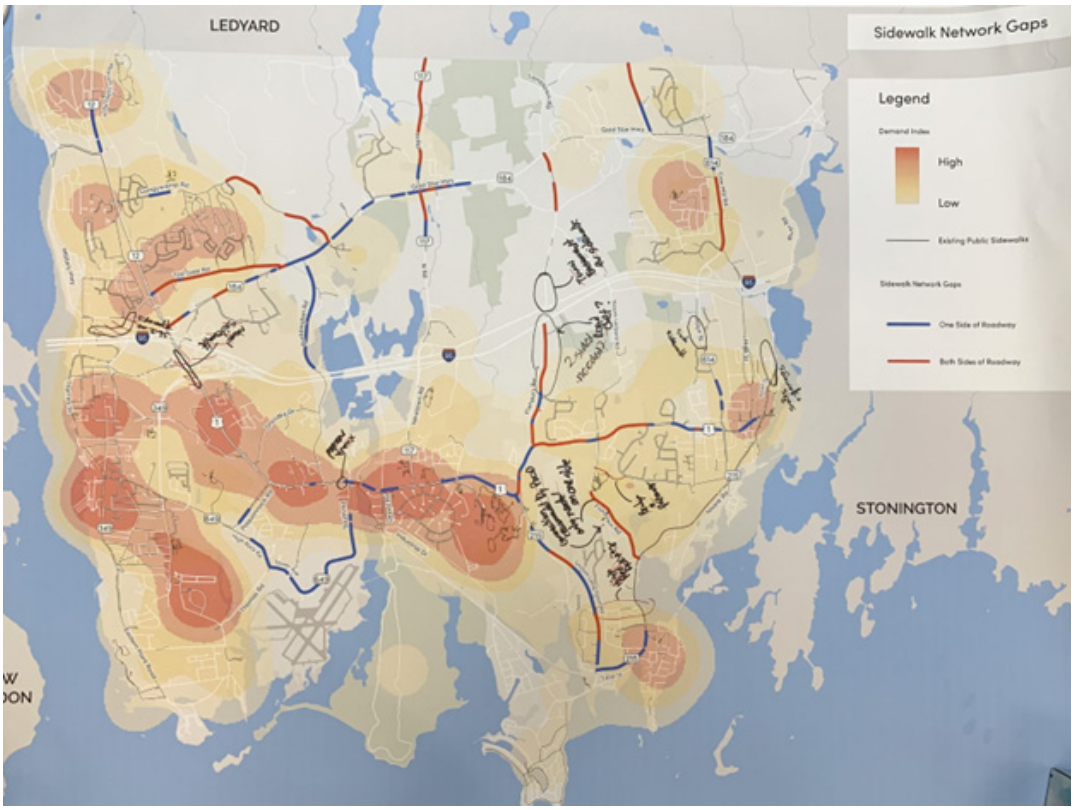
During this session, which lasted 25 minutes, participants were asked to engage in a discussion responding to the following questions:

- ***What are your thoughts on the recommended bicycle and pedestrian network?***
- ***Are there roads or areas that need more improvements than are recommended?***

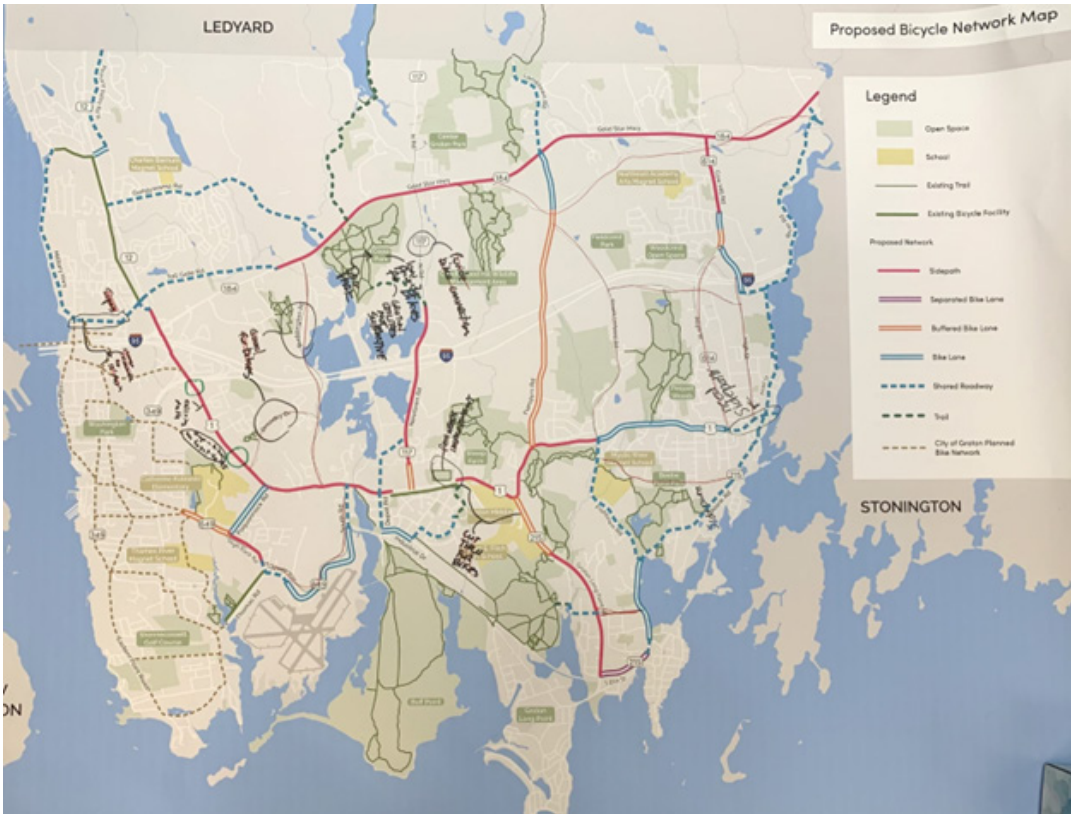
The discussion was documented on flip charts and on maps. The key themes that emerged from the two group discussions are summarized below. Following this session, each group reported back their findings to the other group.

- Route 1 is the highest priority in the network, specifically between the side path along Route 12 and the side path near the community center. This is a priority gap to close in the existing network
- Haley Farm area is a priority
- Rt 184 is a priority area
- Rt 184 is viewed as mostly a commuter route while Route 1 and Route 215 are commuter routes with recreational importance as well
- Fort Hill area is important but challenging due to topography
- A sidepath is needed along Groton Long Point Rd
- Provide a separated bike path on Route 649 near the airport. Look into upcoming project on 649
- More demand for pedestrian facilities on Newtown Road than Flanders Rd
- Extend proposed facility along Route 117 north to GOSA property near Center Groton Park
- Provide facility along Sandy Hollow Rd
- Cow Hill Road connection may be tough due to narrowness of roadway
- Look into newly acquired open space property near the Tree Trails. There are some existing trails that connect into this property
- Culvert replacement will be happening on Elm St. There may be roadway widening as a part of this project and the potential for a bike lane to go in (only a short segment)
- Copp Park has a lot of dog walkers and shouldn't be used as a primary route for bicyclists
- Wayfinding signage is needed for bike routes
- The Town should provide route maps for bicyclists and pedestrians at Town Hall
- Need for a sidewalk to 1-95, Gold Star Bridge
- Look into road diet on Flanders Road and provide sidewalk
- High pedestrian activity on Brook St, provide connection there
- Close sidewalk gaps on Allyn Street and High Street
- Provide sidewalks and signs on Grove Ave

Breakout Session at Community Workshop



Example of marked-up pedestrian network map from break-out session



Example of marked-up bicycle network map from break-out session

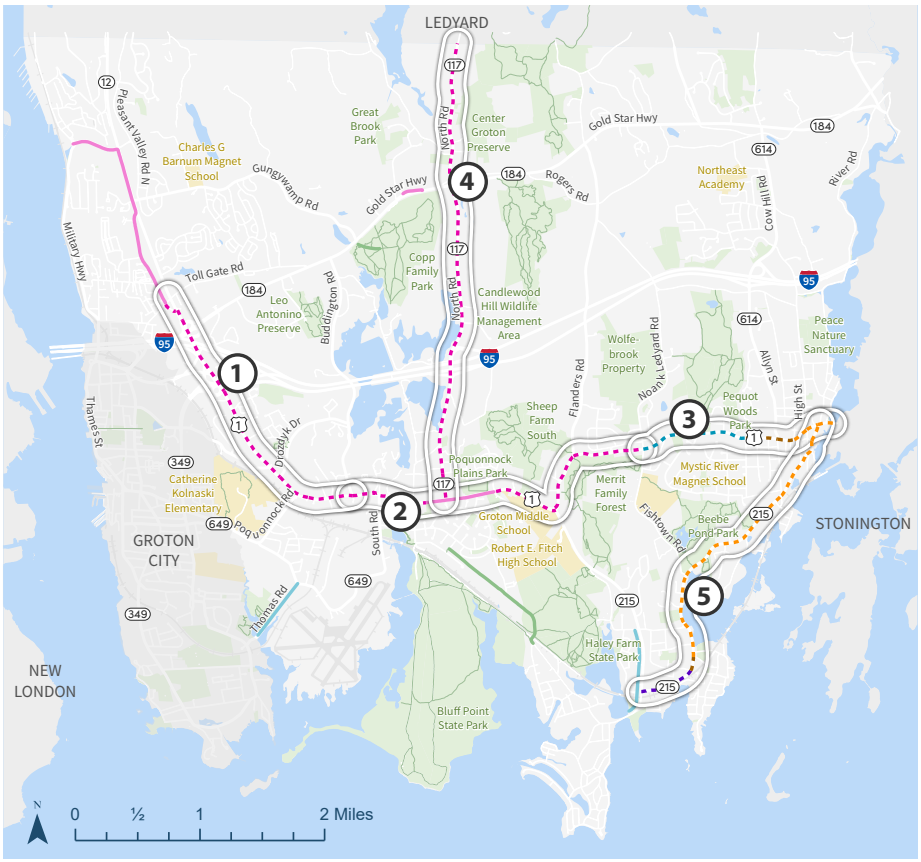
Appendix 6
Concept Plans

Concept Plans

Five sets concept plans for bicycle and pedestrian improvements were developed for three corridors in Groton: Route 1 (presented in three segments), Route 117, and Route 215. These corridors were selected by the Town and the Complete Streets Committee based upon their usage by bicyclists and/or pedestrians or the potential demand for usage based upon the strategic links they provide.

The purpose of these plans is to identify specific improvements that would be required and constraints that need to be addressed to provide the preferred facilities identified in accordance with the guidance established by this plan. The details provided by these plans also allows for a cost estimate that may be used for capital budgeting purposes or for the pursuit of grant financing. As such, these plans are suitable for use in a grant application and demonstrate the feasibility of the recommended concepts. These plans are for planning purposes only but may be used to guide and orient a design and engineering team thereby advancing the design process should these corridors be advanced to design and engineering.

The implementation of these recommended measures will be subject to future design that will further identify the need for grading that may require retaining wall construction, utility relocation, right-of-way constraints that may require easements or property acquisition, and regulatory constraints such as wetland permitting, permitting associated with Class 1 reservoirs, encroachment permits, and coordination with the Connecticut Department of Transportation. Given these potential constraints and requirements, these recommendations may be modified through the design phase and some recommendations may be determined to be infeasible.



Concept Plan Corridors

Findings

Based upon the concept plan developments, all recommended improvements appear feasible, with varying levels of constraints and cost based upon the corridor, segment within the corridor, and type of improvement proposed. Findings per corridor are as follows:

Route 12/ Route 1 (Toll Gate Road to Buddington Road): Improvements to this corridor have a high estimated cost of construction driven primarily by sidepath construction and required traffic signal improvements. The primary constraints include conflicts with and impacts to driveways and right-of-way constraints that are likely to require easements or sliver takings. These constraints are most present east of Colver Avenue.

Route 1 (Buddington Road to Noank Ledyard Road): Improvements to this corridor also have a high estimated cost of construction. The factors contributing to this differ from the west side of the corridor to the east. West of North Road this is driven primarily by sidepath construction and required traffic signal improvements, but also by driveway impacts and the need for access management. The primary constraints include conflicts with and impacts to driveways and right-of-way constraints that are likely to require easements or sliver takings. East of Ring Drive, costs and constraints are caused primarily by steep roadside grades and dense vegetation.

Route 1 (Noank Ledyard Road to Stonington Town Line): This corridor is the most feasible to implement from a cost and constraints perspective. Bicycle facilities along this corridor are exclusively on-road. The greatest share of the cost associated with improvements is due to necessary roadway widening to accommodate bike lanes and sidewalk construction. Right-of-way constraints are minimal through this corridor.

Route 117: Recommended improvements for this corridor have high feasibility but also have high construction costs. Bicycle and pedestrian facilities are entirely off-road along the corridor in the form of a sidepath and sidewalks. Driveway conflicts are minimal and there are few traffic signal improvements required. Right-of-way constraints are minimal.

Route 215: Recommended improvements for this corridor have high feasibility and relatively low construction costs. This is due to all bicycle facilities being located on-road with a minimal amount of roadway widening needed to accommodate those facilities. Additionally, the recommended sidewalks along this corridor are minimal in length and there are few right-of-way constraints.

Cost Estimates

Planning level construction cost estimates were developed for each of the corridors. These estimates are based upon typical per unit costs (linear foot or per item). A twenty-percent contingency is provided on top of the unit costs to account for unknown factors. These estimates are intended for planning and budgeting purposes only, actual construction cost may vary significantly. These costs do not factor in the potential impacts of inflation, nor do they include potential costs associated with property acquisition if required. The total estimated cost of improvements, as shown in the table below, is approximately $15 million. These costs are included in the bicycle facility and path cost estimates in Section 4.3.3 and the sidewalk cost estimates in Section 4.3.4. An itemized summary for each corridor is provided following this table.

Cost Estimates Summary Table

Corridor	Cost Estimate
Route 12/Route 1 (Toll Gate Road to Buddington Road)	$3,828,696
Route 1 (Buddington Road to Noank Ledyard Road)	$3,518,904
Route 1 (Noank Ledyard Road to Stonington Town Line)	$1,482,624
Route 117 (Route 1 to Ledyard Town Line)	$4,565,952
Route 215 (Groton Long Point Road to Route 1, West Main Street)	$240,840
Total	**$13,637,016**

Route 12/ Route 1 (Toll Gate Road to Buddington Road)

Improvement	Units	Unit Cost	Cost
Sidepath (lf)	11,615	$150	$1,742,250
Driveway Closure (ea)	1	$20,000	$20,000
Driveway Narrowing (ea)	6	$10,000	$60,000
Marked Crosswalk (lf)	1,333	$10	$13,330
New Ped Signal (per intersection)	13	$100,000	$1,300,000
New RRFB (per location)	4	$10,000	$40,000
Utility Pole Relocation (ea)	3	$5,000	$15,000
Subtotal			$3,190,580
Contingency (20%)			$638,116
Lump Sum Total			**$3,828,696**

Route 1 (Buddington Road to Noank Ledyard Road)

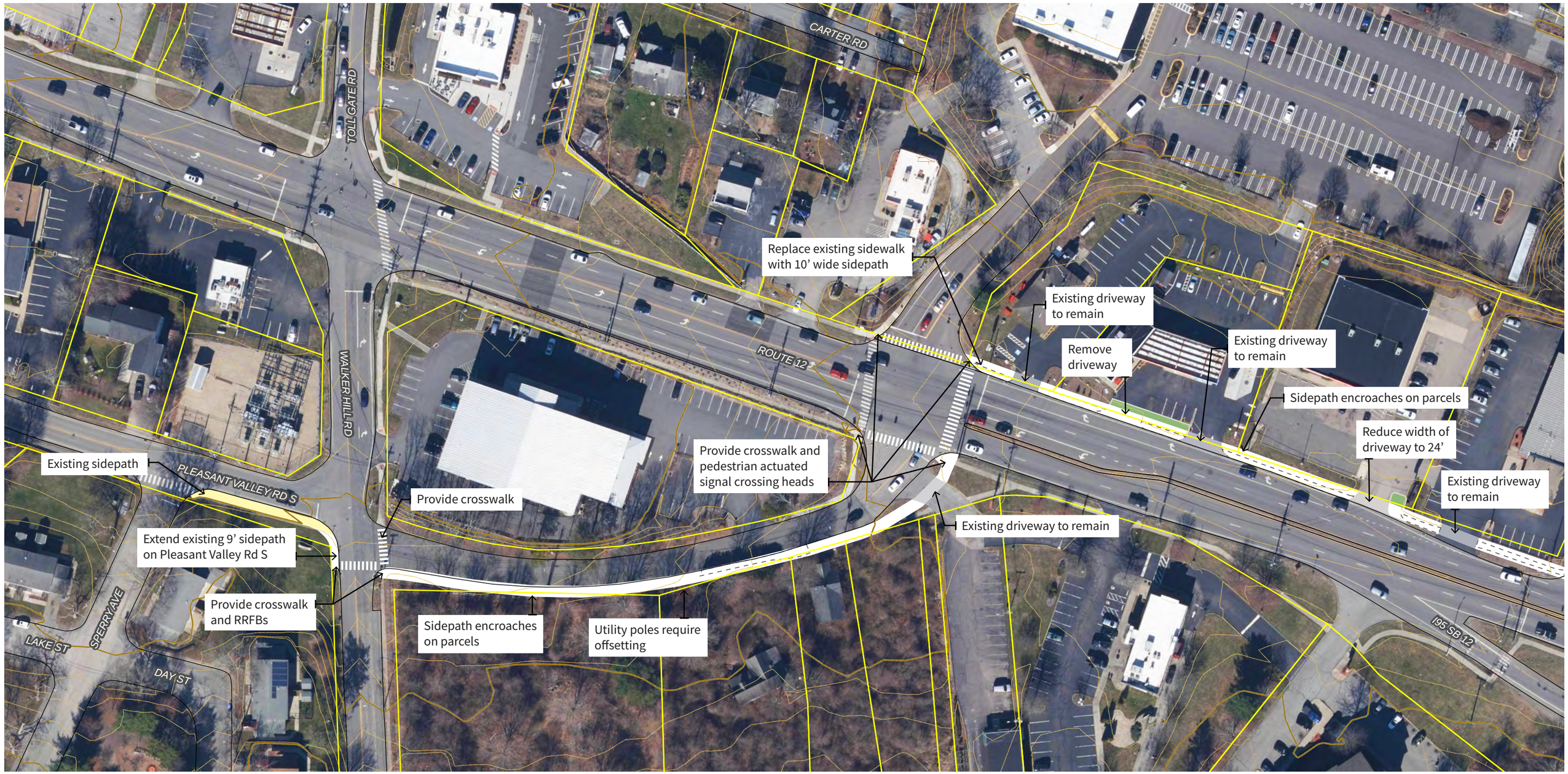
Improvement	Units	Unit Cost	Cost
Sidepath (lf)	12,601	$150	$1,890,150
Sidewalk (lf)	4,570	$100	$457,000
Driveway Narrowing (ea)	3	$10,000	$30,000
Marked Crosswalk (lf)	527	$10	$5,270
New Ped Signal (per intersection)	5	$100,000	$500,000
Groton Long Point Rd Intersection Improvements	1	$10,000	$10,000
Curb Extensions (ea)	8	$5,000	$40,000
Subtotal			$2,932,420
Contingency (20%)			$586,484
Lump Sum Total			**$3,518,904**

Route 1 (Noank Ledyard Road to Stonington Town Line)

Improvement	Units	Unit Cost	Cost
Bike Lane (lf)	4,450	$15	$66,750
Shared Roadway (lf)	2,194	$5	$10,970
Bike Lane/Shared Roadway (lf)	2,000	$10	$20,000
Roadway Widening (lf)	3,464	$200	$692,800
Sidewalk (lf)	2,400	$100	$240,000
Extend Fishtown Brook bridge/culvert	1	$200,000	$200,000
Curb Extensions	1	$5,000	$5,000
Subtotal			$1,235,520
Contingency (20%)			$247,104
Lump Sum Total			**$1,482,624**

Route 117			
Improvement	**Units**	**Unit Cost**	**Cost**
Sidepath (lf)	19,400	$150	$2,910,000
Sidewalk (lf)	2,750	$100	$275,000
Driveway Narrowing (ea)	2	$10,000	$20,000
Marked Crosswalk (lf)	246	$10	$2,460
New Ped Signal (per intersection)	2	$100,000	$200,000
Curb and Guardrail Relocation (lf)	650	$50	$32,500
Utility Pole Relocation (ea)	5	$5,000	$25,000
Retaining Wall (lf)	1,700	$200	$340,000
Subtotal			$3,804,960
Contingency (20%)			$760,992
Lump Sum Total			**$4,565,952**

Route 215			
Improvement	**Units**	**Unit Cost**	**Cost**
Bike Lane/Shared Roadway (lf)	600	$10	$6,000
Buffered Bike Lane (lf)	2,470	$10	$24,700
Shared Roadway (lf)	12,500	$5	$62,500
Roadway Widening (lf)	200	$200	$40,000
Sidewalk (lf)	375	$100	$37,500
Retaining Wall Reconstruction (lf)	150	$200	$30,000
Subtotal			$200,700
Contingency (20%)			$40,140
Lump Sum Total			**$240,840**



Route 12/ Route 1 (Toll Gate Rd to Buddington Rd): Sheet 1 of 9

GROTON PARKS & RECREATION

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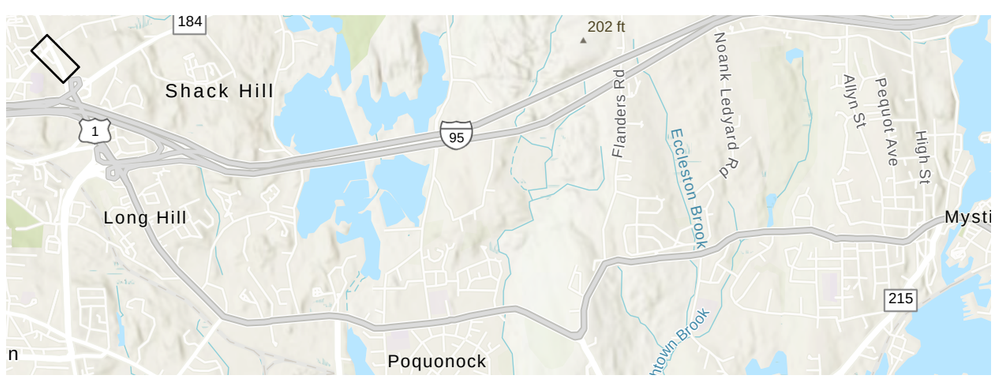

Replace existing sidewalk with 10' wide sidepath

Provide pedestrian signal crossing heads

Install RRFBs

Shift curb 3 feet into the shoulder to provide 8' wide sidepath with a 2' buffer below bridge.

Provide pedestrian actuated signal crossing heads

Existing driveway to remain

Provide 8' wide sidepath below bridges.

Reduce median to 10' wide and shift northbound traffic lanes 2' to accommodate 8' wide sidepath below bridges.

Realign existing guardrail

I95 SB 184

I95 NB X86 OFF

ROUTE 12

I95 SB 12

GOLD STAR HWY

I95 SB 86-184

LONG HILL RD

I95 NB 86-87

KINGS HWY

I95 NB X85 OFF

Route 12/ Route 1 (Toll Gate Rd to Buddington Rd): Sheet 2 of 9

GROTON PARKS & RECREATION

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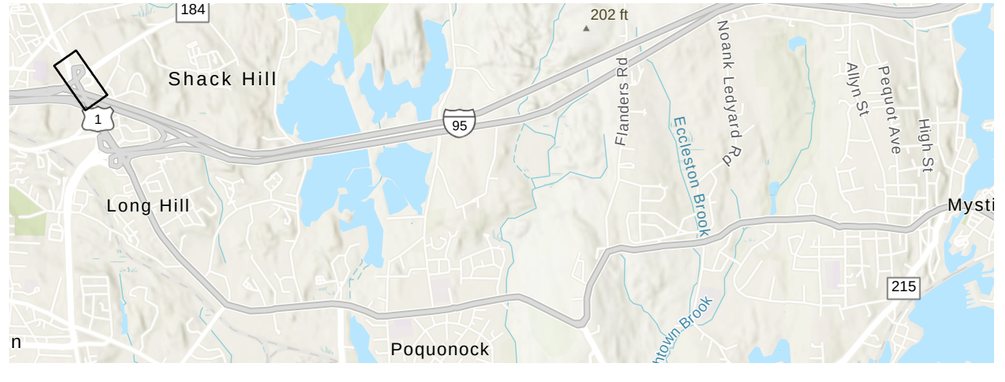

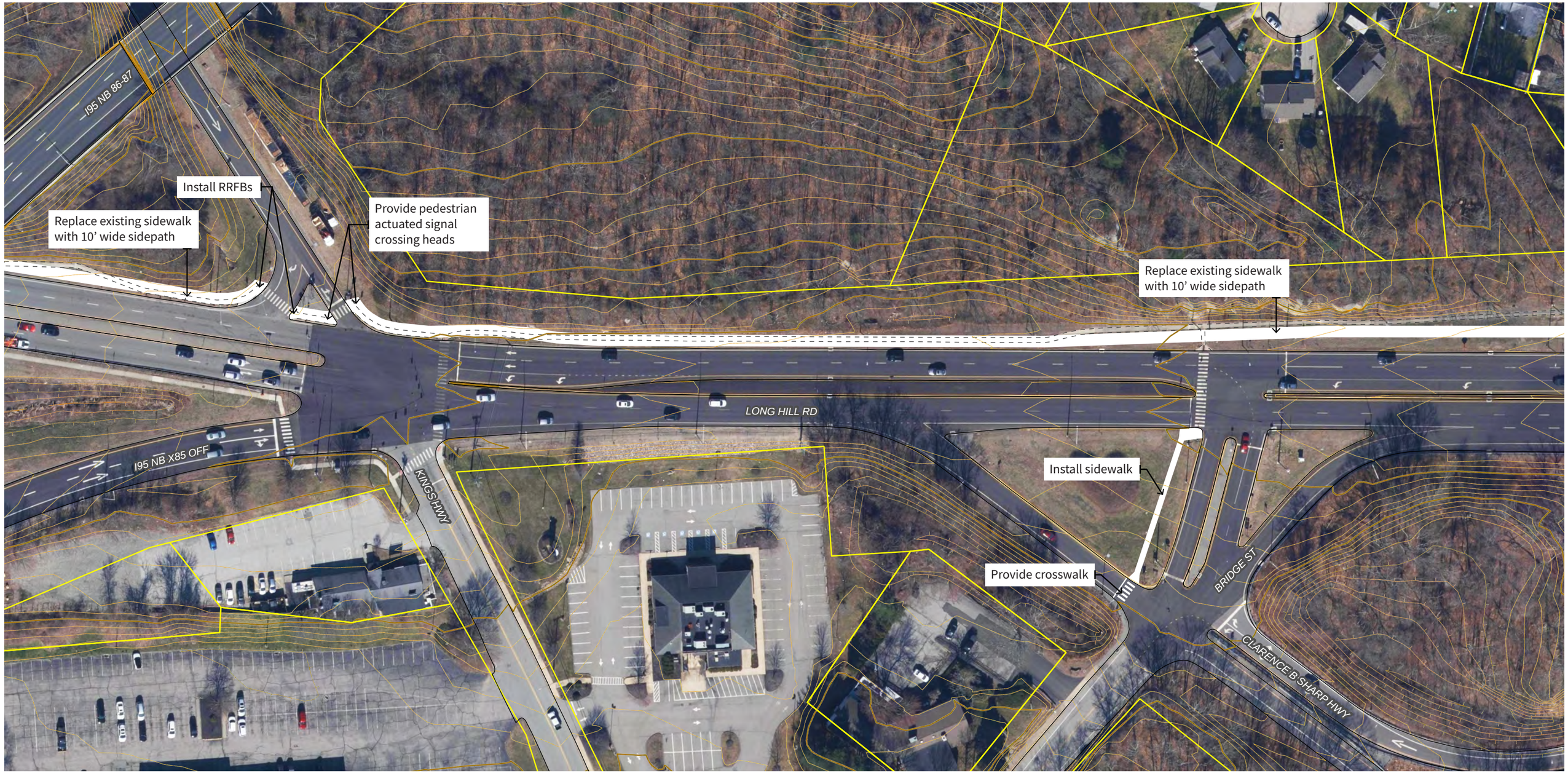

Route 1 (Toll Gate Rd to Buddington Rd): Sheet 3 of 9

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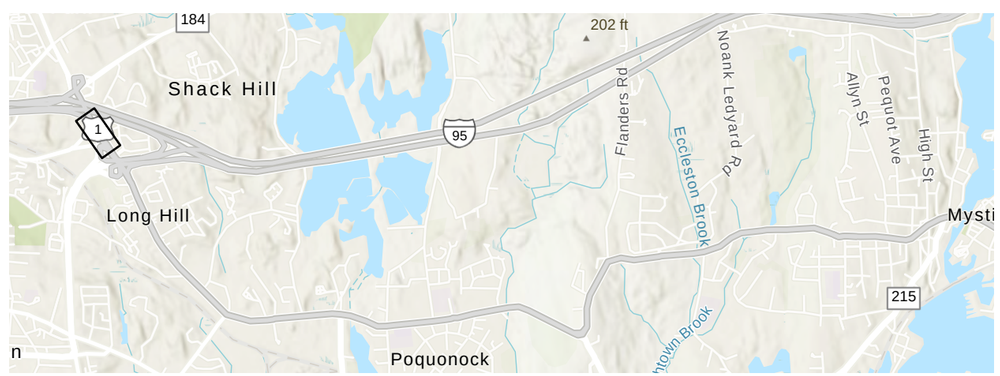

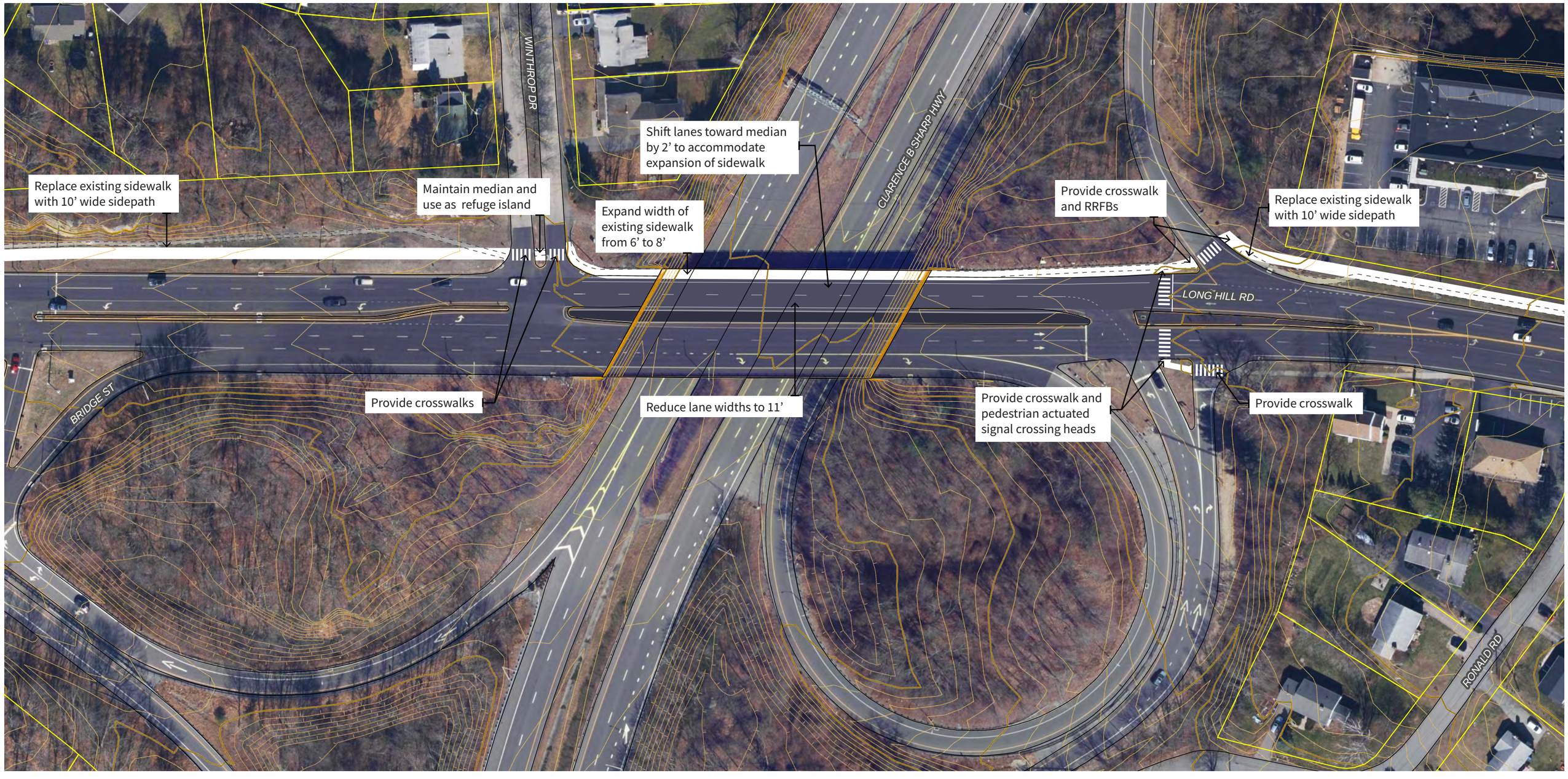

Route 12/ Route 1 (Toll Gate Rd to Buddington Rd): Sheet 4 of 9

GROTON PARKS & RECREATION

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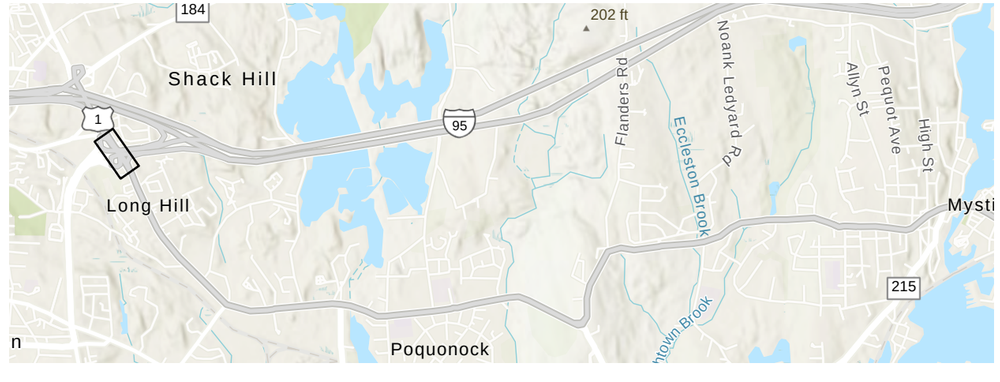

Replace existing sidewalk with 10’ wide sidepath

Existing driveways to remain

Provide crosswalk and pedestrian actuated signal crossing heads

Sidepath encroaches on parcels

Reduce driveway widths to 24’

Sidepath encroaches on parcels

Provide crosswalk and pedestrian actuated signal crossing heads

Existing driveways to remain

Provide crosswalk and pedestrian actuated signal crossing heads

COLVER AVE

BROOKSHAVEN RD

LONG HILL RD

MAXSON RD

RONALD RD

Route 12/ Route 1 (Toll Gate Rd to Buddington Rd): Sheet 5 of 9

GROTON PARKS & RECREATION

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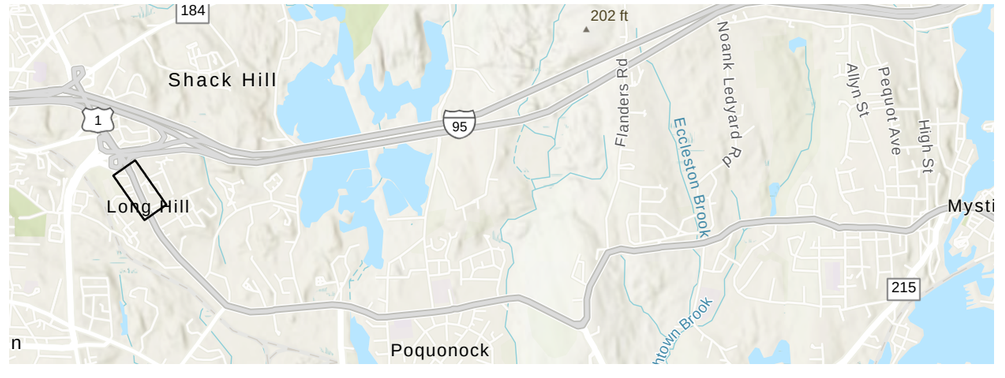

Route 12/ Route 1 (Toll Gate Rd to Buddington Rd): Sheet 6 of 9

GROTON PARKS & RECREATION

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Route 12/ Route 1 (Toll Gate Rd to Buddington Rd): Sheet 7 of 9

GROTON PARKS & RECREATION

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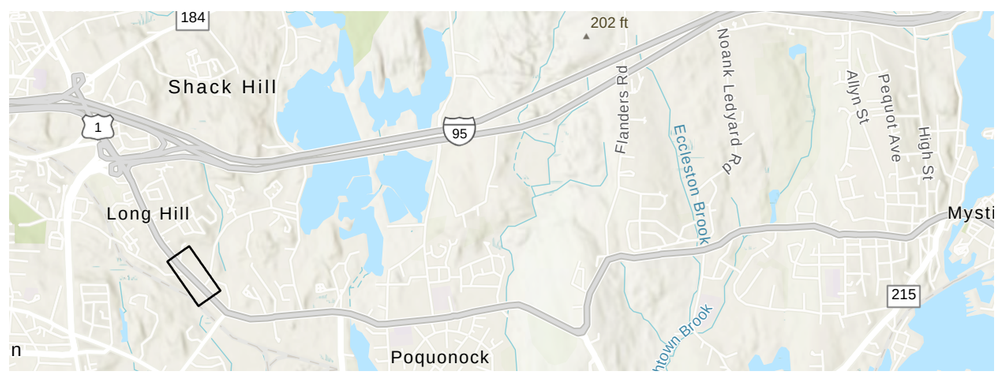

Replace existing sidewalk with 10’ wide sidepath

Square existing driveway to Rt 1

Existing driveway to remain

Provide crosswalk and pedestrian actuated signal crossing heads

Existing driveway to remain

Existing 10' sidepath

Provide crosswalk and pedestrian actuated signal crossing heads

Provide sidepath and reduce access along frontage

Provide crosswalk and pedestrian actuated signal crossing heads

Provide crosswalk and pedestrian actuated signal crossing heads

PLAZA CT

LONG HILL RD

POQUONNOCK RD

Route 12/ Route 1 (Toll Gate Rd to Buddington Rd): Sheet 8 of 9

GROTON PARKS & RECREATION

FHI studio IMEG

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Route 12/ Route 1 (Toll Gate Rd to Buddington Rd): Sheet 9 of 9

GROTON PARKS & RECREATION

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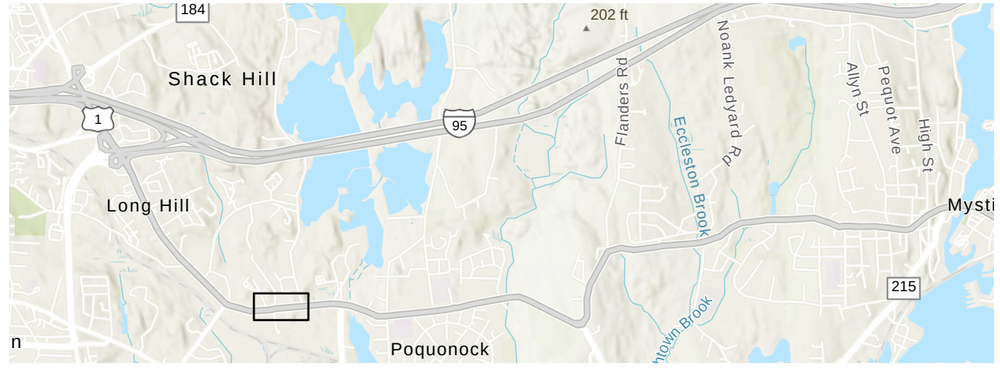

Route 1 (Buddington Rd to Noank Ledyard Rd): Sheet 1 of 8

GROTON PARKS & RECREATION

FHI studio IMEG

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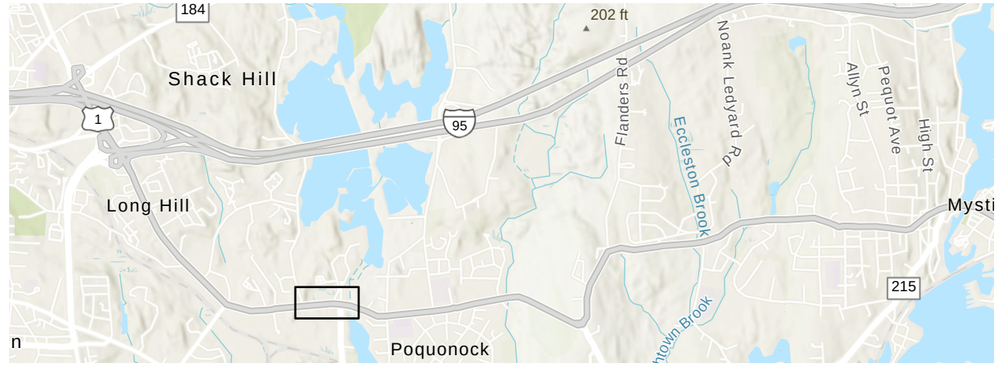


Replace existing sidewalk with 10’ wide sidepath

Provide crosswalk

Install new 5’ wide sidewalk

Existing driveways to remain

Existing driveways to remain

Existing driveways to remain

Existing driveways to remain

Sidewalk encroaches on parcels

Existing driveways to remain

Reduce driveway width to 24’

Existing driveway to remain

Reduce driveway widths to 24’

Existing driveway to remain

Install bumpouts and provide curb ramps and sidewalk

Connect proposed sidepath to existing 10’ sidepath

FORT HILL RD

NORTH RD

DEPOT RD

RALEIGH CT

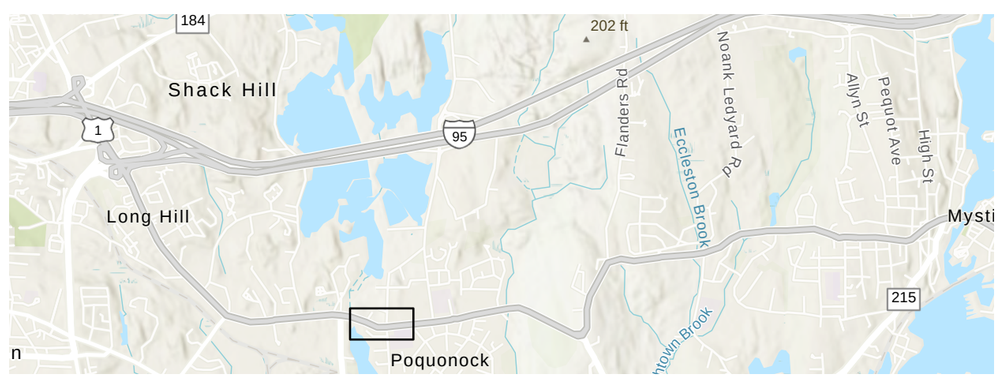
Route 1 (Buddington Rd to Noank Ledyard Rd): Sheet 2 of 8

GROTON PARKS & RECREATION

FHI studio now IMEG

N

0 25 50 100 150 200 Feet



Route 1 (Buddington Rd to Noank Ledyard Rd): Sheet 3 of 8

GROTON PARKS & RECREATION

FHI studio now IMEG

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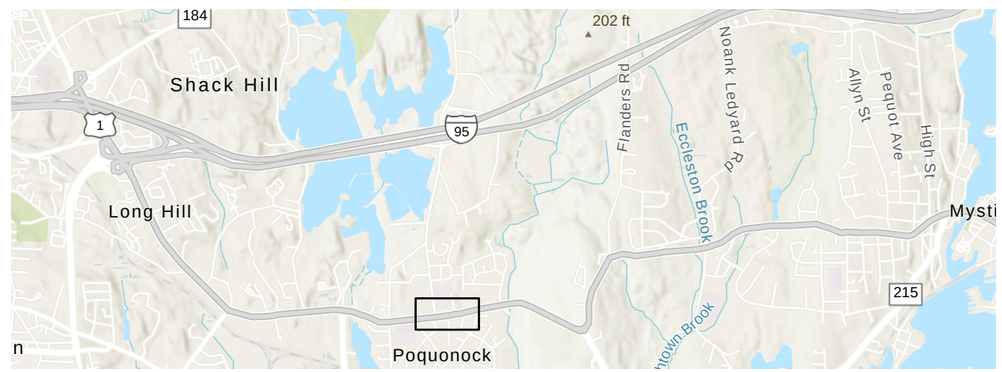

Route 1 (Buddington Rd to Noank Ledyard Rd): Sheet 4 of 8

GROTON PARKS & RECREATION

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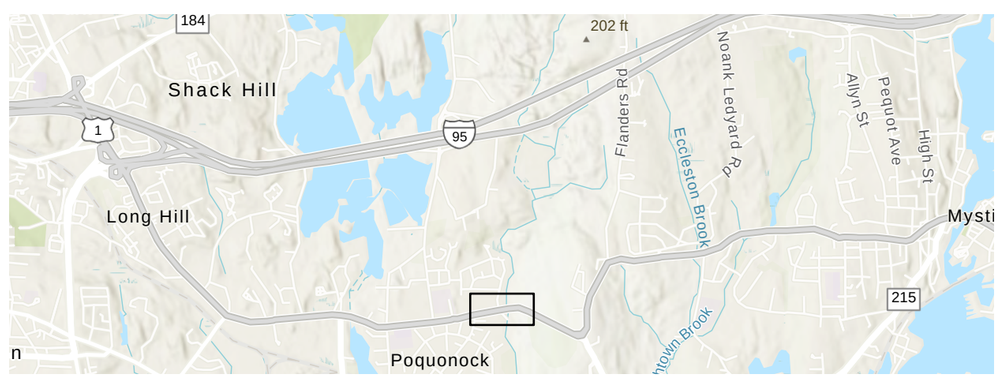

Route 1 (Buddington Rd to Noank Ledyard Rd): Sheet 5 of 8

GROTON PARKS & RECREATION

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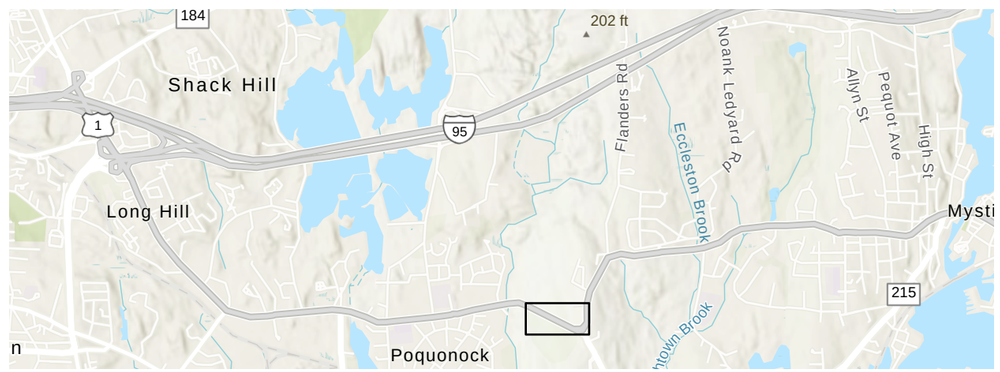

Route 1 (Buddington Rd to Noank Ledyard Rd): Sheet 6 of 8

GROTON PARKS & RECREATION

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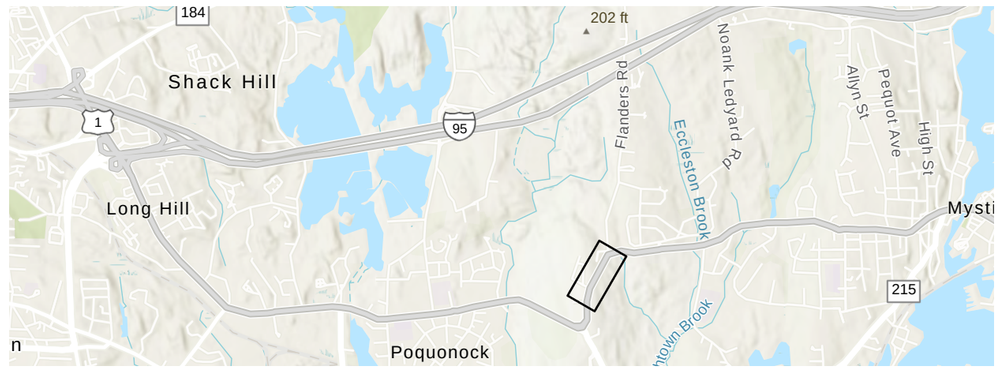
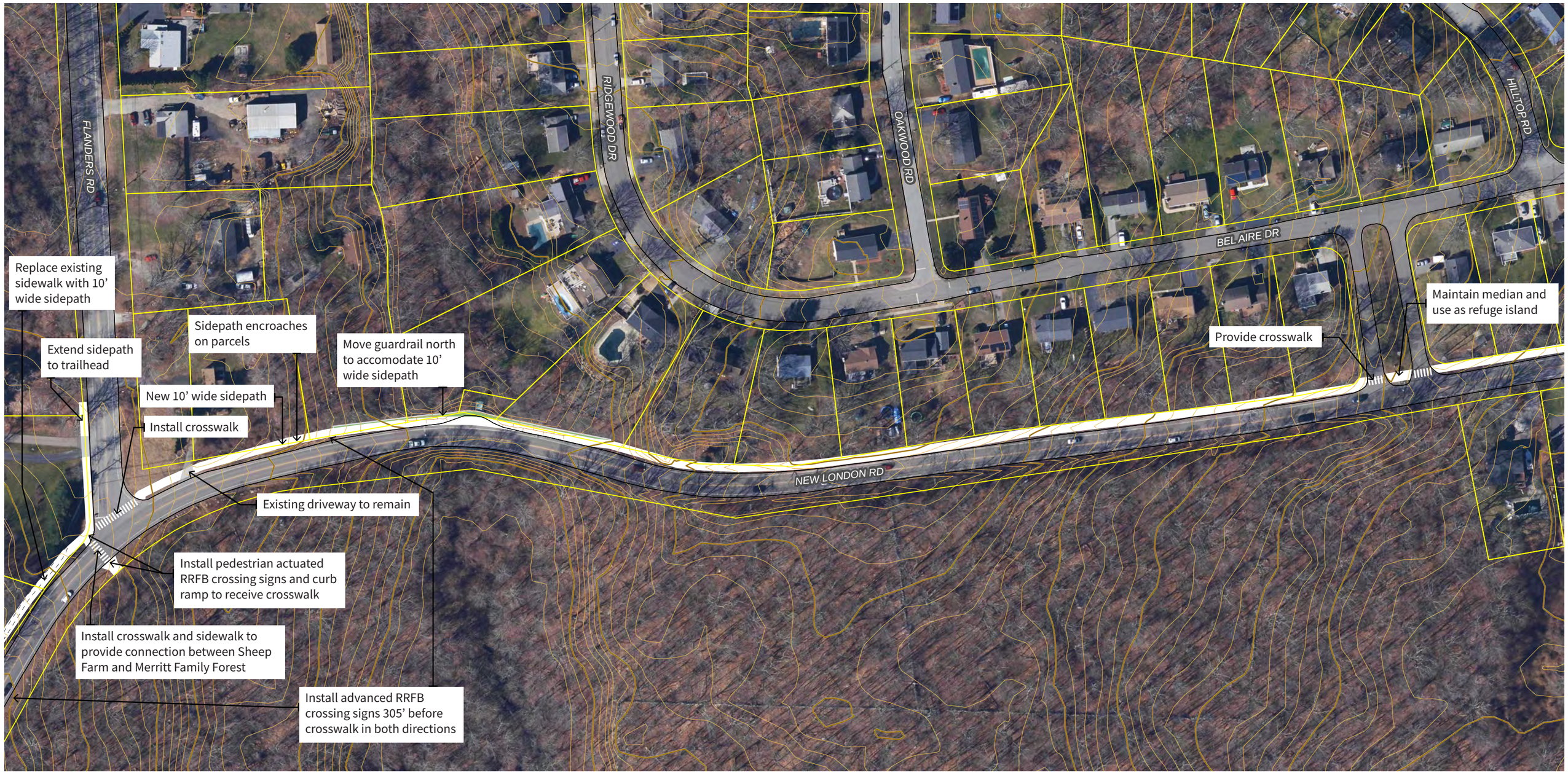




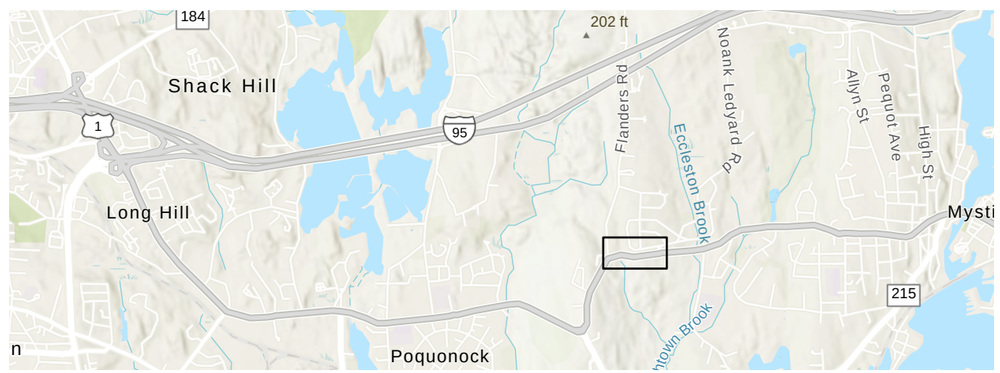
Route 1 (Buddington Rd to Noank Ledyard Rd): Sheet 7 of 8

GROTON PARKS & RECREATION

FHI studio now IMEG

N

0 25 50 100 150 200 Feet



HILLTOP RD
BEL AIRE DR
RIDGEWOOD DR
DANIEL BROWN DR
NOANK LEDYARD RD
NEW LONDON RD
FISHTOWN RD

Provide crosswalk
Maintain median and use as refuge island
Existing driveway to remain
Sidepath encroaches on parcels
Realign existing driveway
Existing driveways to remain
Provide crosswalk and pedestrian actuated signal crossing heads
Install bumpout and provide crosswalk and pedestrian actuated signal crossing heads
Install bumpout and provide bike ramp to sidewalk
Begin 5’ wide bike lanes
Install bike lane signage
Provide crosswalk and pedestrian actuated signal crossing heads
Proposed 10’ wide sidepath ends
Replace existing sidewalk with 10’ wide sidepath
New 10’ wide sidepath
Sidepath encroaches on parcels

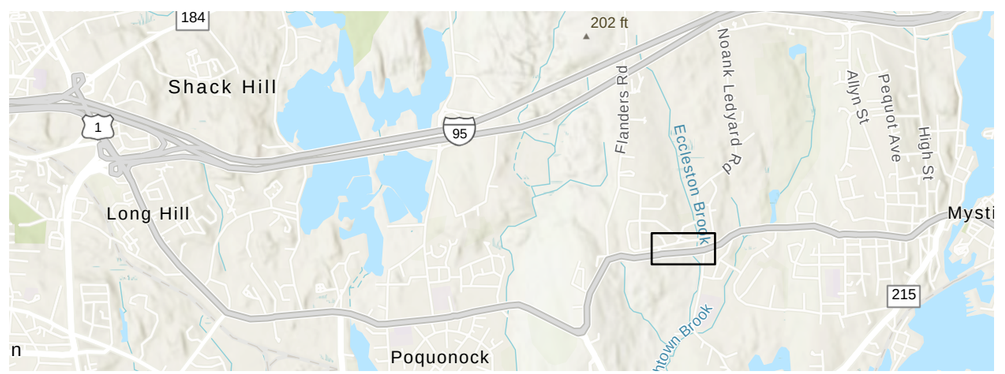
Route 1 (Buddington Rd to Noank Ledyard Rd): Sheet 8 of 8

GROTON PARKS & RECREATION

FHI studio now IMEG

N

0 25 50 100 150 200 Feet



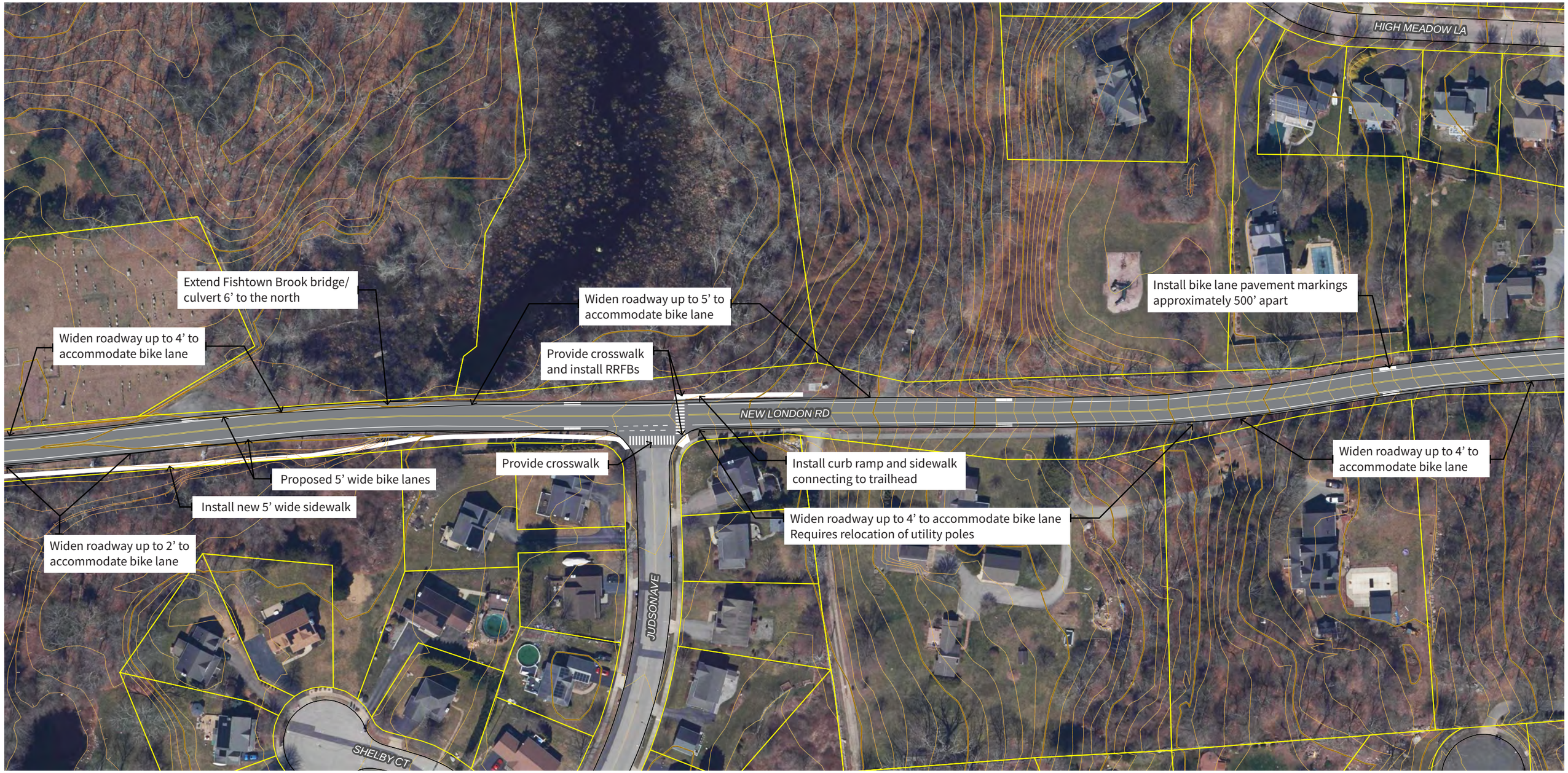
Route 1 (Noank Ledyard Rd to Stonington): Sheet 1 of 6

GROTON PARKS & RECREATION

FHI studio now IMEG

N

0 25 50 100 150 200 Feet



Route 1 (Noank Ledyard Rd to Stonington): Sheet 2 of 6

GROTON PARKS & RECREATION

FHI studio now IMEG

N

0 25 50 100 150 200 Feet

Proposed 5’ wide bike lanes

Provide crosswalk

Install bike lane pavement markings approximately 500’ apart

Provide crosswalk

Widen roadway up to 5’ to accommodate bike lane

Add pedestrian actuated signal crossing heads to existing traffic signal

Install bike lane signage

Continue proposed 5’ wide bike lane on north side of roadway

Transition to shared roadway eastbound of Ocean View Ave. Provide 12’ wide shared lane.

Widen roadway up to 5’ to accommodate bike lane.

Widen roadway up to 6’ to accommodate bike lane. Requires relocation of utlity poles.

Realign sidewalk with new edge of roadway

Install shared roadway signage

Space sharrow markings approximately 250’ apart

HIGH MEADOW LA

ICE HOUSE LA

NEW LONDON RD

HEATH ST

LIBRARY ST

CAPSTAN AVE

STRIBLLA

OCEAN VIEW AVE

0 25 50 100 150 200 US Feet

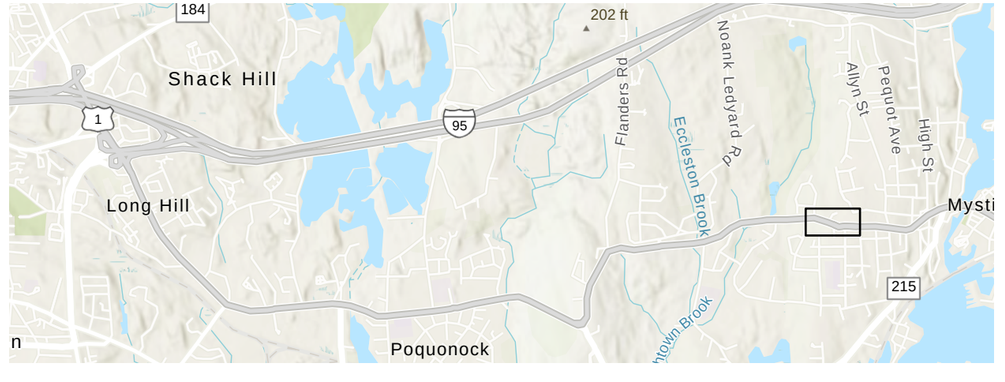
Route 1 (Noank Ledyard Rd to Stonington): Sheet 3 of 6

GROTON PARKS & RECREATION

FHI studio IMEG

N

0 25 50 100 150 200 Feet



Install bike lane pavement markings approximately 500’ apart

Widen roadway up to 4’ to accommodate bike lane

Provide 5’ wide bike lane on north side of roadway

Install bumpout and provide curb ramps

Install bike lane signage

Space sharrow markings approximately 250’ apart

Widen roadway by up to 5’

Proposed shared roadway on south side of roadway

Install shared roadway signage

Provide 12’ wide shared lane in eastbound direction

LIBRARY ST

ALLYN ST

NEW LONDON RD

BAY VIEW AVE

PROSPECT ST (MYSTIC) ST

WEST MYSTIC AVE

RATHBUN PL

ORCHARD LA

MISTY VIEW AVE

SCOTT LA

WILBUR ST

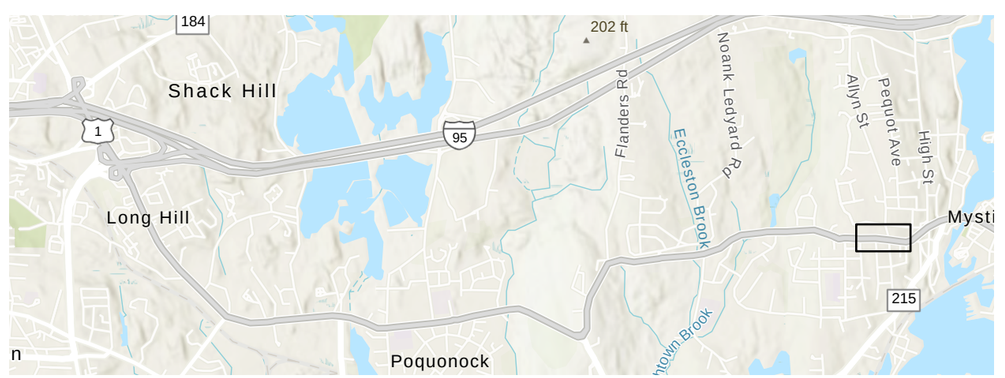
Route 1 (Noank Ledyard Rd to Stonington): Sheet 4 of 6

GROTON PARKS & RECREATION

FHI studio now IMEG

N

0 25 50 100 150 200 Feet



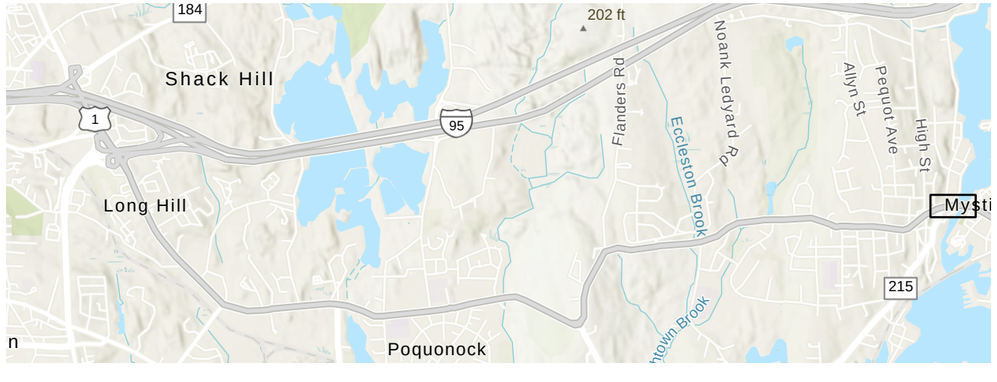
Route 1 (Noank Ledyard Rd to Stonington): Sheet 5 of 6

GROTON PARKS & RECREATION

FHI studio now IMEG

N

0 25 50 100 150 200 Feet



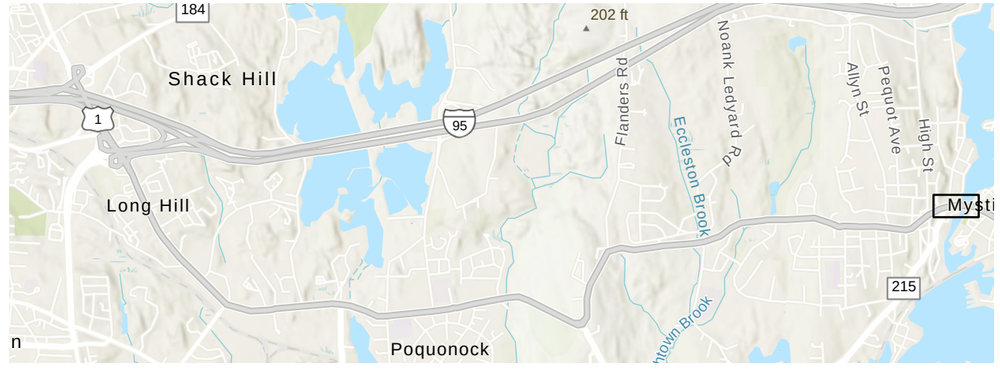
Route 1 (Noank Ledyard Rd to Stonington): Sheet 6 of 6

GROTON PARKS & RECREATION

FHI studio now IMEG

N

0 25 50 100 150 200 Feet



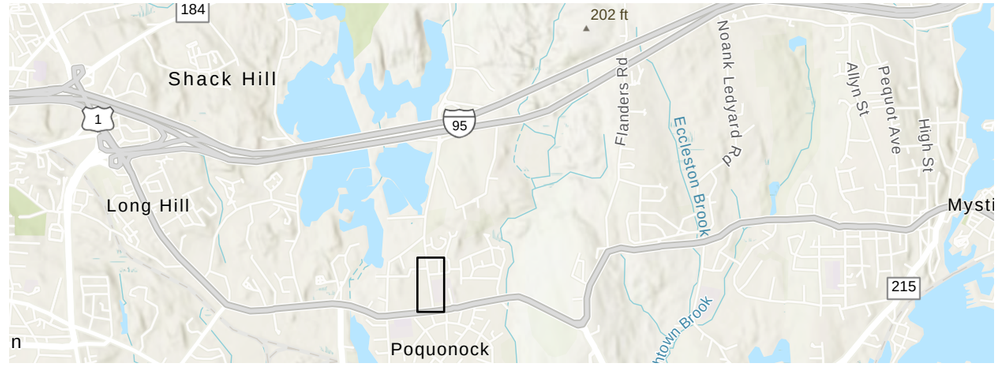
Route 117: Sheet 1 of 13

GROTON PARKS & RECREATION

FHI studio now IMEG

N

0 25 50 100 150 200 Feet



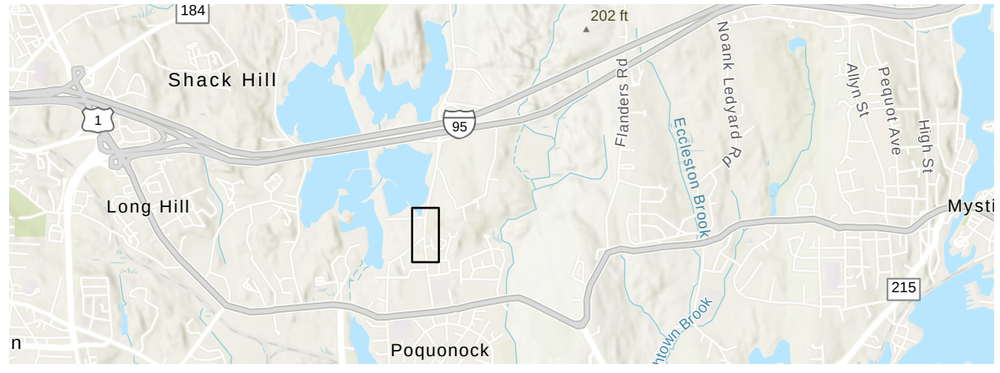
Route 117: Sheet 2 of 13

GROTON PARKS & RECREATION

FHI studio IMEG

N

0 25 50 100 150 200 Feet



Install new 10’ wide sidepath west of utility poles

NORTH RD

Realign and install fence along guardrail

Proposed curb relocation

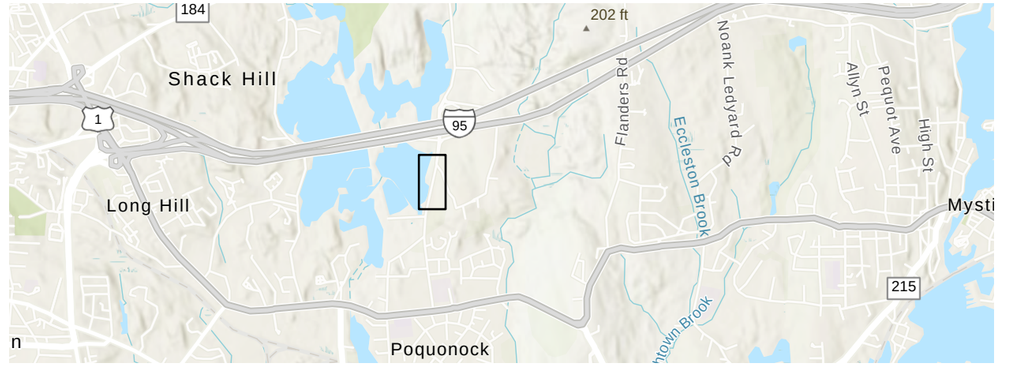
HAZELNUT HILL RD

Route 117: Sheet 3 of 13

GROTON PARKS & RECREATION

FHI studio now IMEG

0 25 50 100 150 200 Feet



Realign guardrail and install fence between guardrail and pathway

Install new 10’ wide sidepath

Install fence between guardrail and pathway

Provide crosswalk and pedestrian actuated signal crossing heads

I95 NB X88 OFF

Continue sidepath under overpass

Continue sidepath under overpass

Existing driveway to remain

Sidepath encroaches on parcel

NORTH RD

I95 NB 88 RAMPS

I95 SB 87 RAMPS

I95 SB X88 ON

Existing driveway to remain

Reduce lane width to approximately 20’ to accommodate sidepath

Proposed curb relocation

I95 NB X88 ON

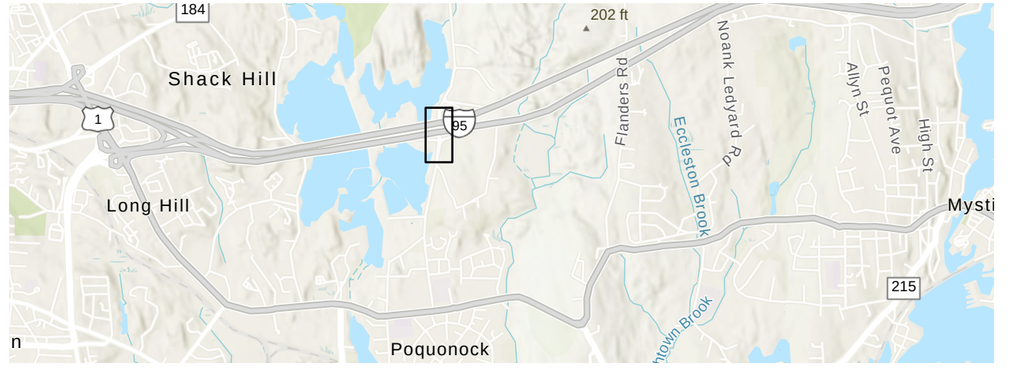
Route 117: Sheet 4 of 13

GROTON PARKS & RECREATION

FHI studio IMEG

N

0 25 50 100 150 200 Feet



Install new 10’ wide sidepath

Sidepath encroaches on parcel

Retaining wall and fence required at culvert

Requires relocation of utility poles

Steep grades, may require retaining wall

I95 SB X88 ON

I95 SB X88 OFF

NORTH RD

POHEGANUT DR

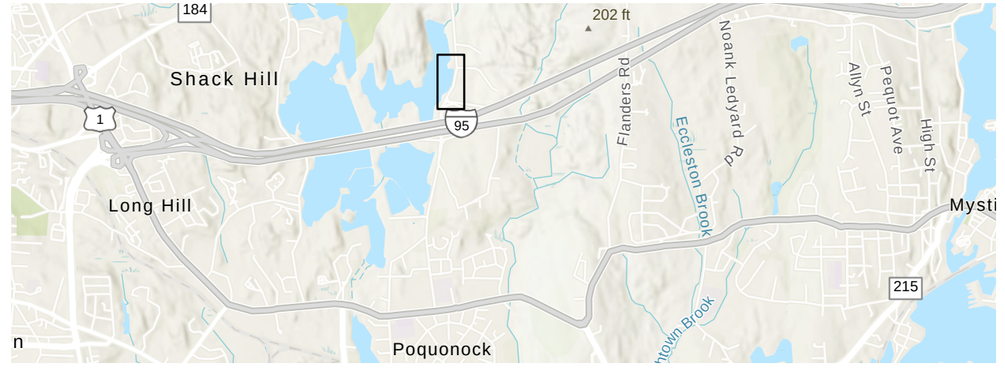
Route 117: Sheet 5 of 13

GROTON PARKS & RECREATION

FHI studio IMEG

N

0 25 50 100 150 200 Feet

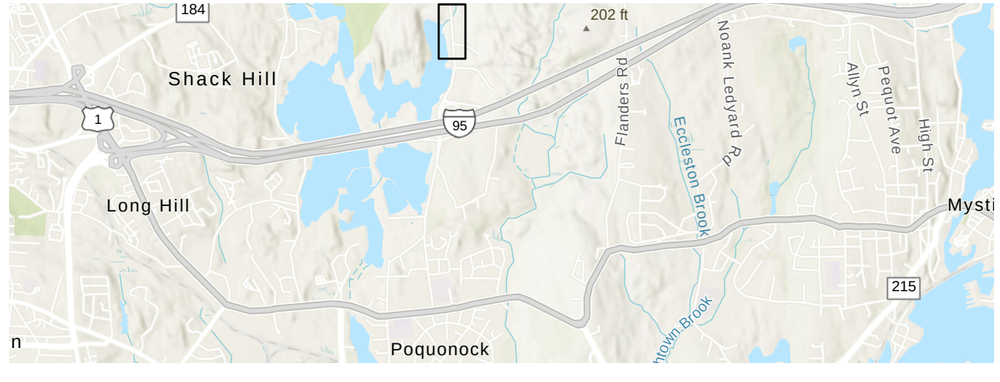


Route 117: Sheet 6 of 13

GROTON PARKS & RECREATION

FHI studio IMEG

0 25 50 100 150 200 Feet

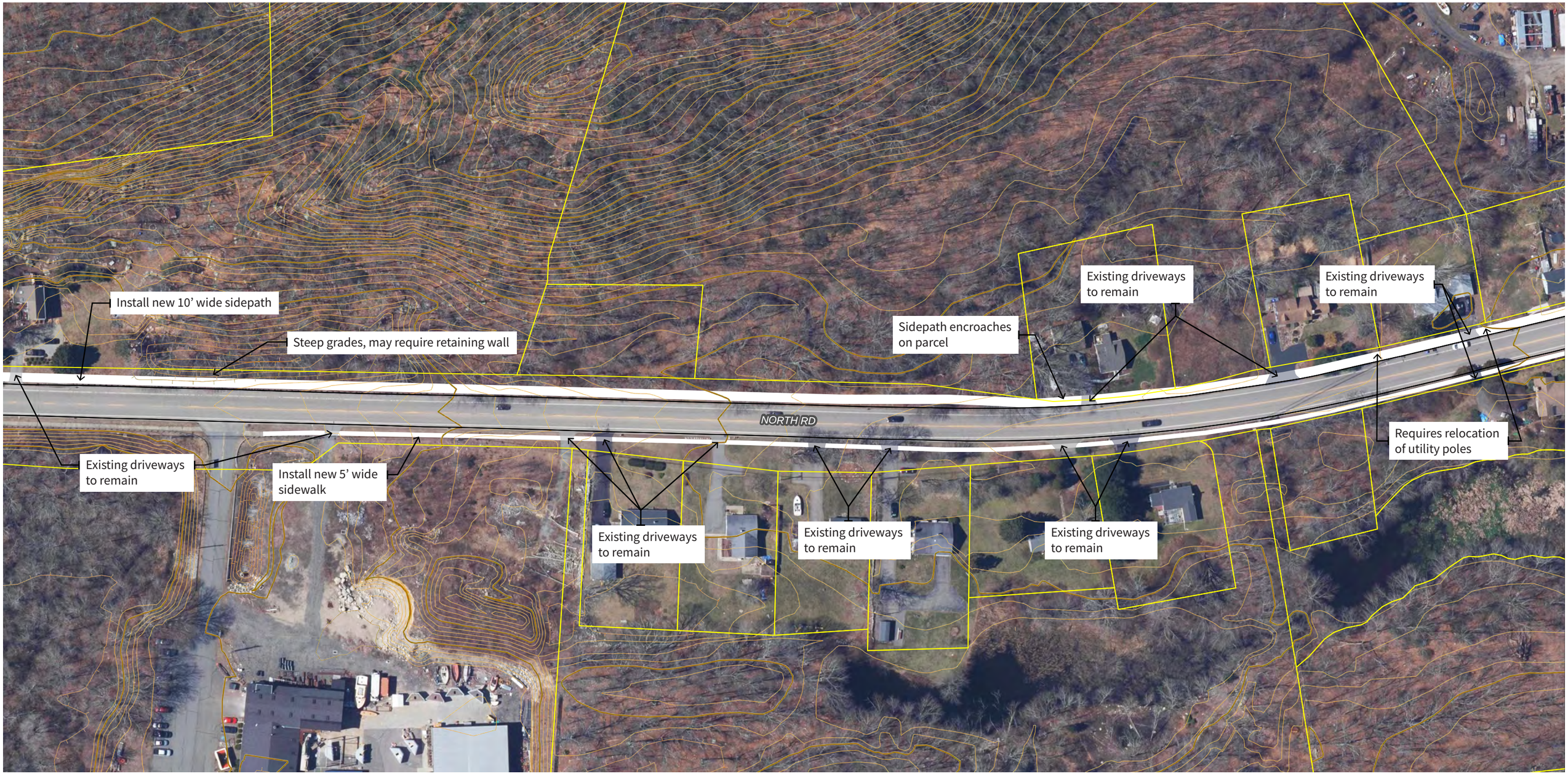


Route 117: Sheet 7 of 13

GROTON PARKS & RECREATION

FHI studio now IMEG

0 25 50 100 150 200 Feet

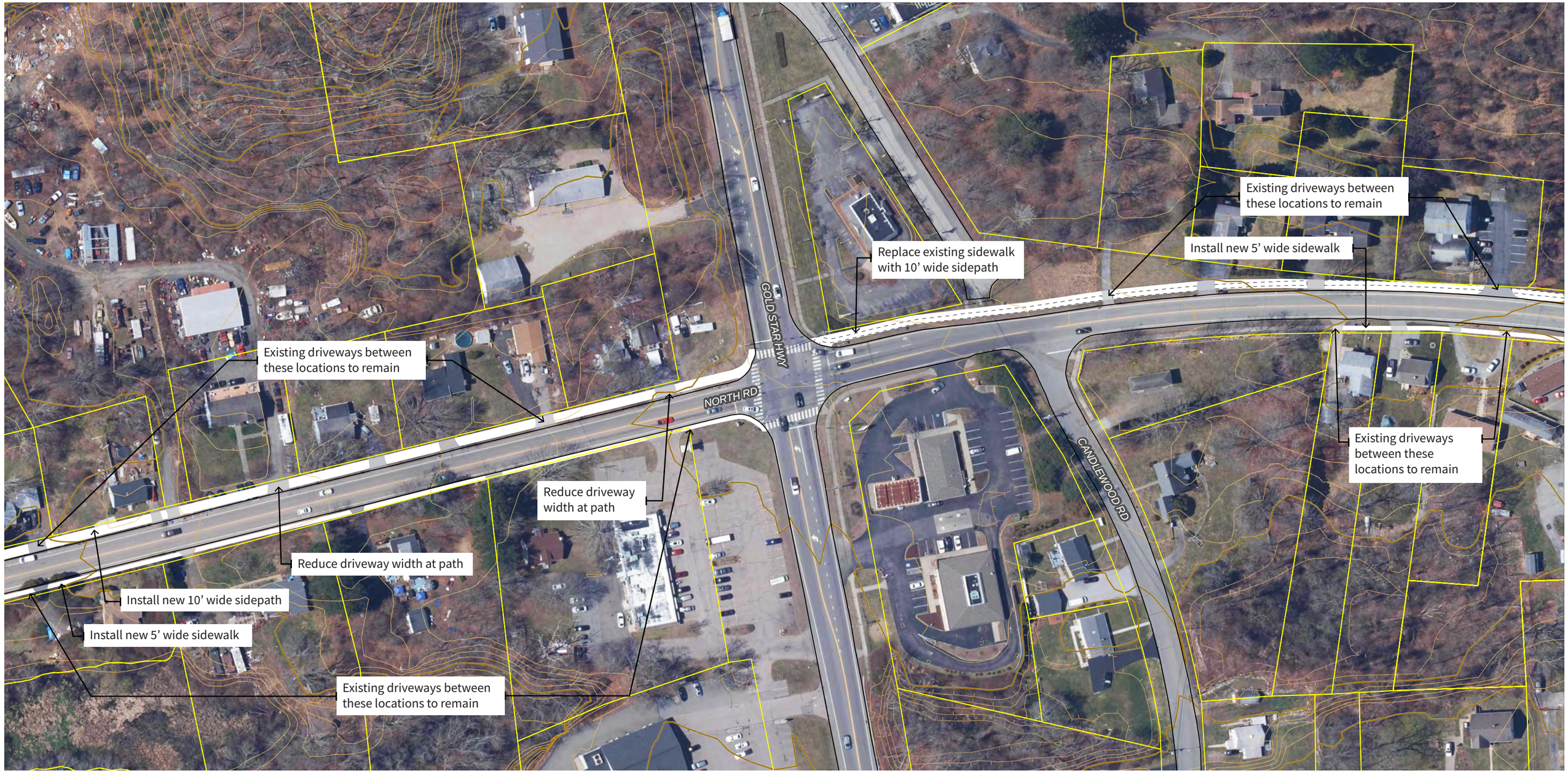


Route 117: Sheet 8 of 13

GROTON PARKS & RECREATION

FHI studio now IMEG

0 25 50 100 150 200 Feet



Route 117: Sheet 9 of 13

GROTON PARKS & RECREATION

FHI studio IMEG

0 25 50 100 150 200 Feet

Existing driveway to remain

Replace existing sidewalk with 10’ wide sidepath

Provide crosswalk

Existing driveways to remain

Existing driveways to remain

Install new 5’ wide sidewalk

Existing driveways between these locations to remain

Install RRFBs and provide curb ramp

GALES FERRY RD

NORTH RD

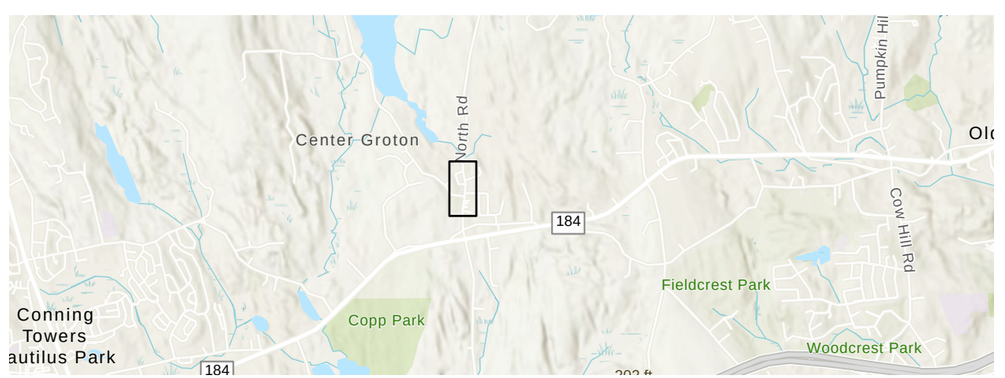
ALPHA AVE

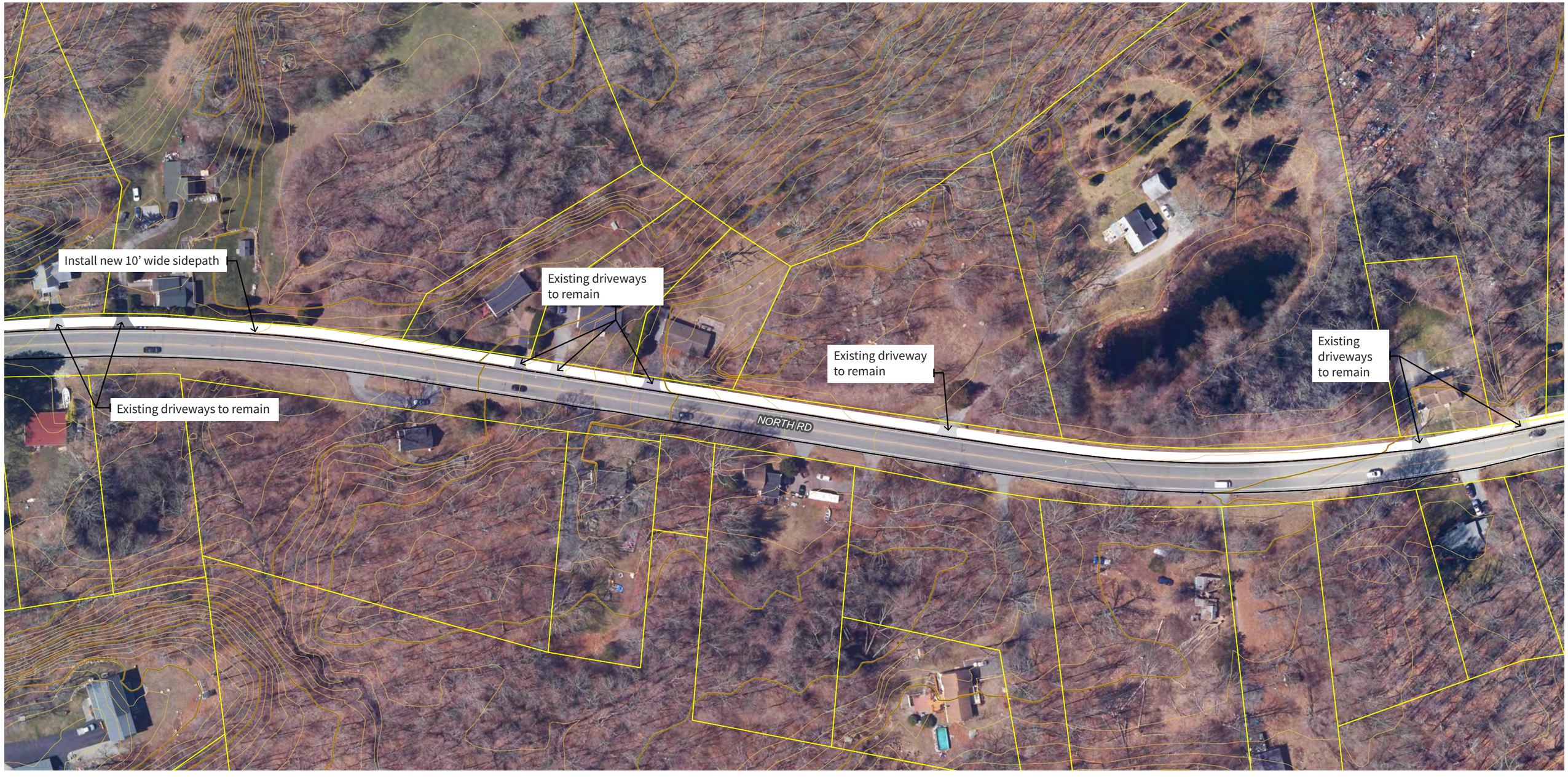
Route 117: Sheet 10 of 13

GROTON PARKS & RECREATION

FHI studio now IMEG

0 25 50 100 150 200 Feet





Route 117: Sheet 11 of 13

GROTON PARKS & RECREATION

FHI studio IMEG

N

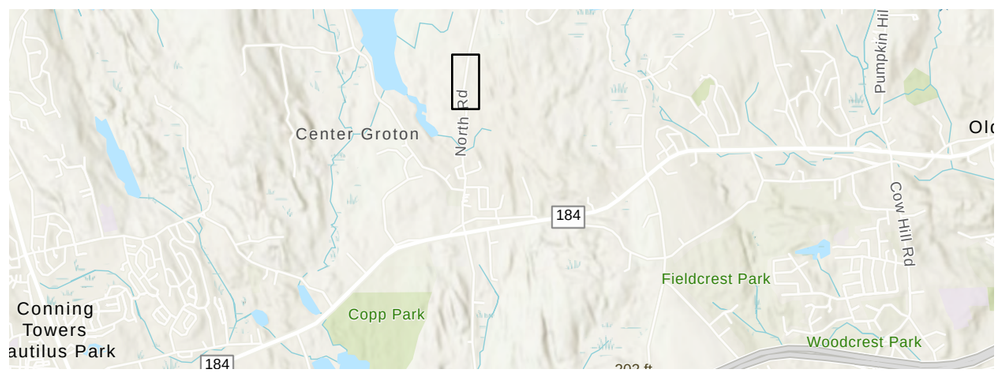
0 25 50 100 150 200 Feet

Route 117: Sheet 12 of 13

GROTON PARKS & RECREATION

FHI studio now IMEG

0 25 50 100 150 200 Feet



Route 117: Sheet 13 of 13

GROTON PARKS & RECREATION

FHI studio now IMEG

0 25 50 100 150 200 Feet

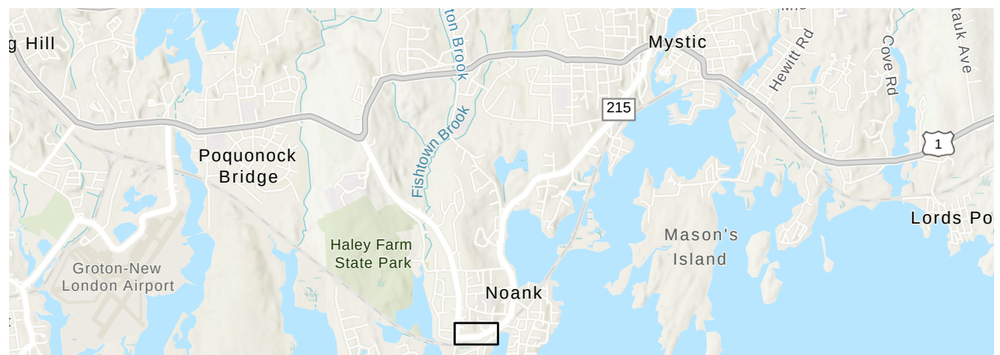
Route 215: Sheet 1 of 10

GROTON PARKS & RECREATION

FHI studio now IMEG

N

0 25 50 100 150 200 Feet



Route 215: Sheet 2 of 10

GROTON PARKS & RECREATION

FHI studio IMEG

0 25 50 100 150 200 Feet

Route 215: Sheet 3 of 10

GROTON PARKS & RECREATION

FHI studio now IMEG

N

0 25 50 100 150 200 Feet

Route 215: Sheet 4 of 10

GROTON PARKS & RECREATION

FHI studio now IMEG

N

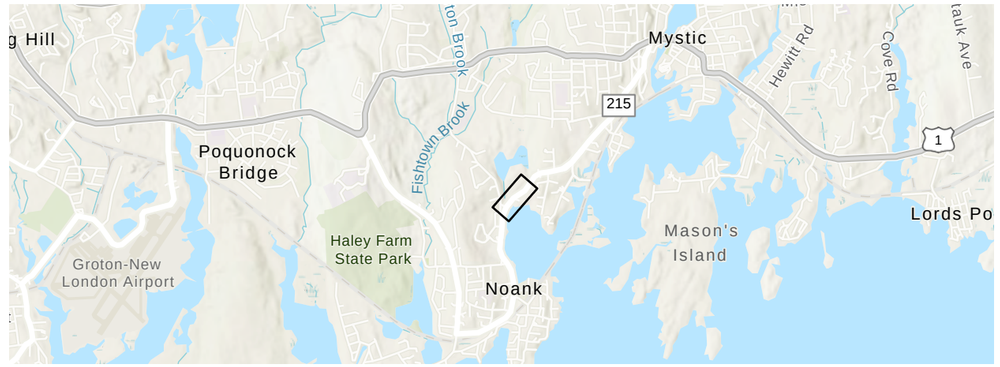
0 25 50 100 150 200 Feet

Route 215: Sheet 5 of 10

GROTON PARKS & RECREATION

FHI studio IMEG

0 25 50 100 150 200 Feet



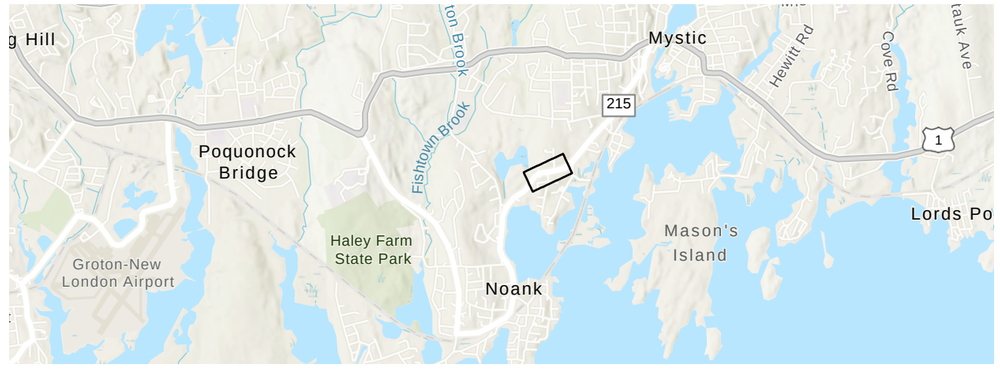
Route 215: Sheet 6 of 10

GROTON PARKS & RECREATION

FHI studio now IMEG

N

0 25 50 100 150 200 Feet

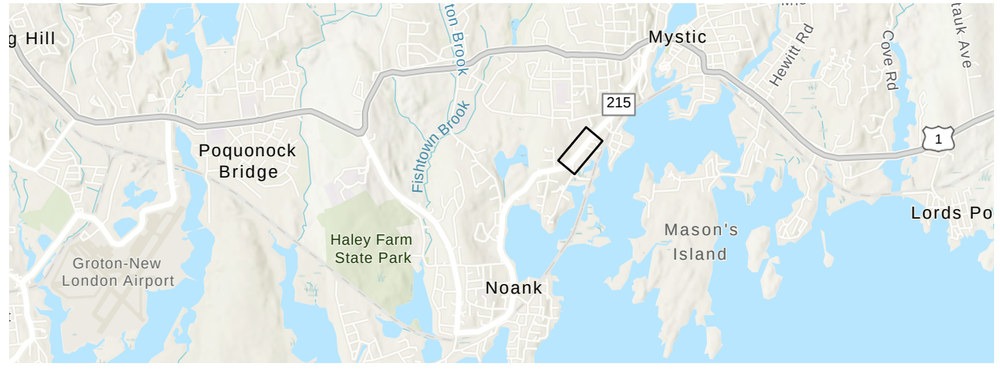


Route 215: Sheet 7 of 10

GROTON PARKS & RECREATION

FHI studio now IMEG

0 25 50 100 150 200 Feet



Space sharrow markings approximately 250’ apart

Install shared roadway signage

Install sidewalk and curb ramp

Provide crosswalk

Provide crosswalk and curb ramps

Install shared roadway signage

IRVING ST

WEST MYSTIC AVE

NOANK RD

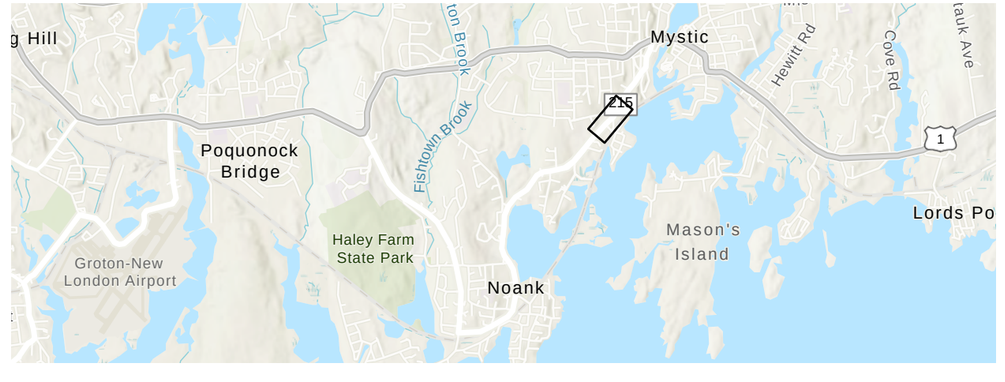
SCHOOL ST (MYSTIC) ST

Route 215: Sheet 8 of 10

GROTON PARKS & RECREATION

FHI studio now IMEG

0 25 50 100 150 200 Feet



Space sharrow markings approximately 250’ apart

Provide crosswalk

Existing sidewalk

Provide crosswalk and curb ramps and install RRFBs

Install shared roadway signage

Provide crosswalk

Provide crosswalk

Install shared roadway signage

NOANK RD

BUTTONWOOD LA

ASHBY ST

LATHAM ST (MYSTIC) ST

HIGH ST (MYSTIC) ST

FORT RACHEL PL

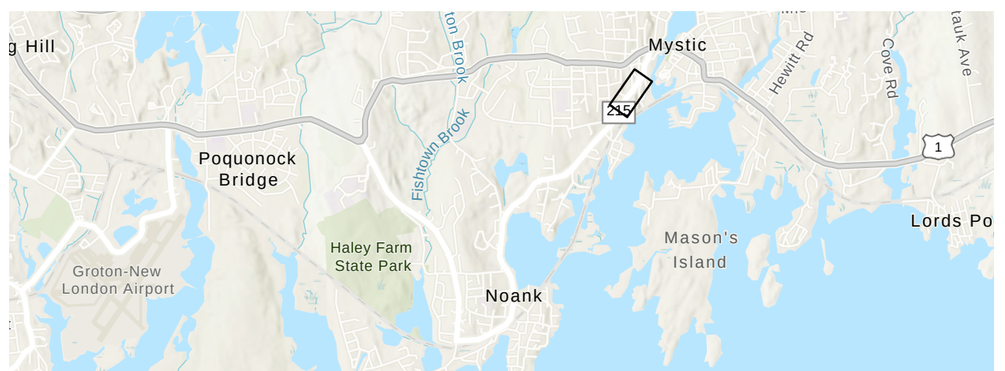
WATER ST

Route 215: Sheet 9 of 10

GROTON PARKS & RECREATION

FHI studio now IMEG

0 25 50 100 150 200 Feet



Route 215: Sheet 10 of 10

GROTON PARKS & RECREATION

FHI studio now IMEG

0 25 50 100 150 200 Feet