



Navigating the Minuteman Commuter Bikeway

July 2014

Prepared for the Towns of Arlington, Bedford, and Lexington, MA





Contents

1. Project Overview	4
Executive Summary	4
Context	4
Public Process	6
2. Existing Conditions	7
Usage	7
Level of Service for the Minuteman Bikeway	9
Level of Service for the Minuteman Bikeway	10
Wayfinding and Signage	10
Physical Conditions and Trail Design	12
Bikeway Amenities	13
Connections to Town Centers, Commercial Corridors, and Neighborhoods	14
3. Wayfinding and Signage Recommendations	15
4. Intersection Improvement Recommendations	20
Intersection Treatments	20
Roadway and Sidewalk Conditions Approaching the Bikeway	30
Pavement Markings	30
Access Control	31
5. Trailhead and Wayside Recommendations	32
Trailheads and Waysides	32
Amenity Design	34
Site Furniture General Guidelines	34
Level 1 Waysides	34
Level 2 Waysides	37
Level 3 Waysides and Trailheads	39
6. Partnership Recommendations	41
Town Coordination	41
7. Community Outreach Recommendations	43



8. Policing and Public Safety Recommendations	44
9. Maintenance Recommendations	45
Existing Maintenance Practices.....	45
Pavement Damage/Deterioration	46
Root Invasion.....	47
Signage & Pavement Marking	47
10. Future Improvement Recommendations	48
Widening.....	48
Context Sensitive Materials	49
Surfaces/ Paving Materials	49
Landscaping, Low Impact Development and Grading	50
11. Next Steps	52
Management and Maintenance of Trail.....	52
Appendix A: Public Outreach.....	54
Survey Responses (in order asked)	54
WikiMap	58
Appendix B: Community Input.....	60
Appendix C: Cost Estimates.....	66
Appendix D: Amenity Intensity Maps	67



1. Project Overview

Executive Summary

Navigating the Minuteman Commuter Bikeway is a plan that recommends infrastructure improvements, programs and policies to ensure the Minuteman Commuter Bikeway retains its attractiveness as a commuter bikeway and continues to accommodate new users in the future. The primary purpose of this plan is to develop a logical and cohesive navigational system along the Bikeway to better connect users to the trail and its surroundings. The plan also recommends a palette of trail amenities that will serve the needs of Bikeway users while preserving the historical and natural characteristics of the trail. Additionally, the plan identifies strategies to improve safety and comfort where the trail intersects with roadways along the length of the Bikeway.

Context

The Minuteman Commuter Bikeway was completed in 1993 by the Commonwealth of Massachusetts on an inactive railroad right-of-way, and extended to the Alewife MBTA station in Cambridge in 1999. The existing Minuteman Commuter Bikeway is a 10-mile multi-use trail system, which extends from Alewife Station in Cambridge to Bedford Depot in Bedford, travelling through the towns of Arlington and Lexington. Each Town/City has independent operating and maintenance responsibilities for its respective portion of the Bikeway.

The trail travels through a diverse landscape composed of rural, suburban, and urban settings. Plans to extend the Minuteman Commuter Bikeway beyond Bedford Depot along the Reformatory Branch Trail are currently in development. The Bikeway also provides connections to regional trail networks including the Bedford Narrow Gauge Rail Trail, the Fitchburg Cutoff Bike Path, the Somerville Community Path, and the Alewife Greenway Bike Path. And, as recommended in the *Commonwealth Connections* plan, begun in 1999 by the Massachusetts Department of Environmental Management, new greenway connections to the Minuteman are under various levels of planning (Minuteman Extension), design (Somerville Green Line Extension), and construction (Cambridge-Belmont-Somerville Linear Park). As these additional connections are completed, the Minuteman Commuter Bikeway likely will see tremendous growth in use, further strengthening its role as an essential component of the region's transportation and recreational network.

The Minuteman Commuter Bikeway is one of the most popular shared-use paths in the Commonwealth and is recognized as a National Trail Landmark by the Rails-to-Trails Conservancy. Although the path is called a "Bikeway," it is used by walkers, runners, and skaters in addition to bicyclists. The section of the trail in Arlington hosts similar numbers of walkers as bicyclists, in part due to its population density which is higher than Bedford and Lexington. References and promotion of the Bikeway should use inclusive language that addresses its use by pedestrians, as well as other non-motorized modes, such as inline skating, while still retaining its identity as a commuter bikeway. In addition to utilitarian, recreational and fitness uses, the trail supports local



tourism and commerce by virtue of its location running through the commercial center of each Town. This alignment allows trail users to walk or bike to shopping, parks, historic sites, senior activity centers, libraries, farmers' markets, schools, businesses, and workplaces. The Minuteman Commuter Bikeway itself is a regional destination attracting users from throughout the larger region. Adjacent communities are currently developing navigational systems which direct their residents and visitors to the trail.

The Towns of Arlington, Bedford, and Lexington collaborated to secure funding from the Department of Conservation and Recreation Recreational Trails Grants Program to create a unified navigational plan. Representatives from each Town's bicycle advisory committee participated in a stakeholder group to guide the plan and provide input during its development.

The purpose of the plan is to develop a uniform strategy for strengthening the Minuteman Commuter Bikeway's identity through upgrading and adding elements such as signs, pavement markings and amenities. The trail should include additional inviting and convenient waysides and trailheads with amenities and information throughout the trail corridor. An integrated wayside and interpretative system will create an additional layer of interest along the trail for users to learn about the historical, natural, and cultural context of the Bikeway and adjacent areas.

The navigational system should be designed with an understanding of the wide range of users, including bicyclists with varying levels of ability, pedestrians, and other users who have different needs and behavioral characteristics. Lastly, the navigational system must be designed with a maintenance strategy to ensure individual elements can be easily updated, repaired or replaced as needed. This plan outlines recommendations for a cohesive and comprehensive navigational system which will strengthen the identity of the Minuteman Commuter Bikeway and improve connections to local neighborhoods and the emerging regional trail system.

This plan outlines principles and recommendations for improvements across eight categories:

- Wayfinding and signage
- Trailheads and waysides
- Intersections
- Partnerships
- Community Outreach
- Policing and Public Safety
- Maintenance
- Future Improvements

Although these principles and recommendations are separated into distinct categories, each recommended improvement builds on the others to support an improved Bikeway as a whole.



Public Process

To gather necessary background information for this project, stakeholders and the public were engaged using a variety of methods. Input from a diverse set of constituencies was gathered and incorporated into all stages of developing the proposed improvements presented in this plan. The process is generally described below, with additional detailed information located in the appendix.

Outreach efforts included:

- **Project Kick-off Meeting:** Representatives from the Towns of Arlington, Bedford, and Lexington attended a project kick-off meeting to define goals for the project, confirm the scope of work, and identify areas of concern that should be focused on during the project.
- **Stakeholder Ride:** Stakeholders participated in a group ride on the Bikeway to identify and discuss future opportunities and issues.
- **Online Questionnaire:** An online questionnaire was distributed to gather input from the public regarding navigational issues, difficult intersections, and desired amenities.
- **Online Mapping Tool:** An online mapping tool was developed and distributed to gather input from the public regarding the connections to the Bikeway, problem areas, etc.
- **Trailside Public Open House:** A public open house was conducted adjacent to the Bikeway at the Lexington Depot to present the results of the public input, principles, and recommendations and to gather additional comments.

A summary of the various public involvement efforts are included in **Appendices A and B**. Results of these efforts is included in the following section and was used to develop the recommendations included in this report.



2. Existing Conditions

During the summer of 2012, field work was conducted and public outreach was initiated to identify the current condition of the Minuteman Commuter Bikeway and its relationship to the larger corridor.

14 community members volunteered to collect data on existing conditions and features along the Minuteman Commuter Bikeway from the Cambridge City Line to the Bedford Depot. Hands-on training was conducted for performing inventory using GPS-enabled smart phone cameras. After completion of the training, volunteers selected sections of trail and over the next two weeks performed a photographic inventory of all signage, pavement condition, site furniture, intersections, and any notable features along the trail. Volunteers uploaded approximately 1,300 geo-tagged photos which were used to create “heat maps” of amenities. These maps can be found in **Appendix D**. (Note: The accuracy and completeness of the inventory is limited by the volunteer nature of the effort.)

Additionally, an online crowdsourcing map (WikiMap) and online survey were created to collect information on Bikeway users’ activities, behaviors, and preferences. On the map, users were able to chart their routes to and from the Bikeway specifying the frequency, mode, and general nature of their trips. Users identified points along the Bikeway for potential infrastructure improvements and were able to upload photographs of specific locations. For the online survey, participation was solicited through email, newspaper articles, and by distributing announcements with a QR code linked to the survey. Nearly 1,000 responses were recorded for the 15-question survey.

Below is a summary of current conditions; details are presented in the following chapters.

Usage

Based on results of the online questionnaire, the online mapping tool, discussions with stakeholders, and on-site observations, the Bikeway sees a wide range of users with a variety of trip purposes.

Users include:

- Bicyclists of various skill levels including children, novices, and experienced cyclists, using standard bicycles, tandems, recumbents, bicycle trailers and “trail-a-bikes.”
- Pedestrians including children, the elderly, disabled persons in wheelchairs or electric scooters, people pushing strollers, dog walkers and others.
- Runners and joggers.
- In-line skaters, push scooters, skateboards, etc.

Common trip purposes include transportation to and from work and school, and natural, cultural and historic sites; running errands; shopping; visiting friends; attending events; and gaining access to entertainment venues. Intermodal trips are enabled by the trail’s access to the Alewife MBTA station and many MBTA bus routes/ stops.

A complete breakdown of the various user types and trip purposes reported in the Minuteman Online Survey is included in **Appendix A: Public Outreach.**

Bikeway Users



Level of Service for the Minuteman Bikeway

MAPC conducts annual counts along the Minuteman Bikeway.¹ Between May 7th and May 14th, 2013, 12-hour counts were conducted over a weekend and week day along the Bikeway at Swan Plan in Arlington and at the Lexington Depot. Weekday peak hour counts were also conducted in Arlington/Cambridge near the Alewife MBTA station.

- The Arlington/Cambridge location had the highest total hourly count of users with a total of 630 people including 374 pedestrians from 8 – 9 AM on a Tuesday.
- The highest hourly count in Lexington occurred on a Sunday afternoon with 409 bikes and 101 pedestrians, in addition to 24 joggers, 5 inline skaters and 16 baby carriages.
- The peak hour in Arlington occurred on a Tuesday from 6 – 7 PM with 202 bikes, 57 pedestrians, 34 joggers, 10 inline skaters and 5 baby carriages.
- Bicycles volumes peaked during traditional commute times while walking numbers were more consistent across different times of the day.
- On average, pedestrians represented a higher percentage of users in Arlington at 50 to 60 percent of all users, than in Lexington where pedestrians accounted for approximately 30 percent of users.

The degree of comfort and congestion for people using shared use paths can be estimated using the Federal Highway Administration's Shared Use Path Level of Service (LOS) Calculator. Developed through research, observation and user surveys of existing paths, the calculator considers the path design and volume of different types of users.²

LOS for the Minuteman Bikeway varies by day of the week, time of day and segment of the bikeway. On peak hours during both weekdays and weekend days, LOS was a C or below, with the exception of the peak hour on Tuesday in Lexington, which was a low-scoring LOS B.

¹ The database can be found here: http://www.ctps.org/apps/bike_ped4/bike_ped_query.html

² The calculator and user guide are available online here:
<http://www.fhwa.dot.gov/publications/research/safety/pedbike/05138/>

Level of Service for the Minuteman Bikeway ³			
	Arlington Swan Place	Lexington Lexington Depot / East of Hancock St / Meriam St / Station Way	Arlington/Cambridge North of Route 2 / Alewife Station
Peak Hour Weekday	C (3.31)	B (3.52)	F (1.49)
Peak Hour Weekend	C (3.30)	D (2.58)	Not available

Wayfinding and Signage

Wayfinding and signage along the Bikeway is an important amenity to users, providing location and directional information as well as interpretive information. Over time, different organizations and government agencies have installed wayfinding and interpretive signage of various design styles. Signage locations are not predictable and the signs are not always maintained, resulting in limited legibility in some cases. 44 information signs and kiosks were inventoried along the Bikeway. The following table illustrates some examples of the variety of existing signage on the Bikeway.

³ The Minuteman Bikeway ranges in width from 10 to 12 feet. The LOS calculations shown here are conservative estimates assuming a 12-foot width. Actual LOS may be lower in areas where the Bikeway is less than 12 feet wide.

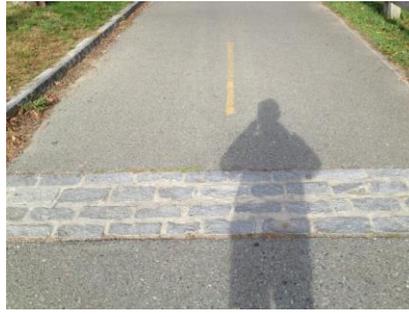
Existing Signage on the Bikeway



Physical Conditions and Trail Design

The Bikeway surface is asphalt pavement that ranges widely in condition. Field observations and public comments indicate that many areas exhibit root breakthroughs which create hazardous conditions for bicyclists and inline skaters, especially during periods of low light. Gates, bollards, rumble strips, fallen leaves, and restricted sight distance create additional hazards for bicyclists.

Physical Hazards on the Bikeway



Bikeway Amenities

The Bikeway offers amenities for commuters and recreational users, including bathrooms, benches, drinking fountains, and trash receptacles. The results of the inventory indicate that amenities are not evenly distributed and sometimes challenging for users to locate. Amenities must be immediately adjacent to the Bikeway to be included in the inventory.

Amenities on the Bikeway

- 2 restrooms*
- 37 benches
- 5 tables
- 17 bicycle racks
- 8 drinking fountains
- 19 trash receptacles
- 2 dog bag dispensers
- 10 lamp posts

*Note: Volunteer inventory did not identify the restroom located at the Lexington Visitor’s Center, potentially indicating that signage is needed to create awareness of this facility location. Although additional restrooms are located near the Bikeway, such as inside Trader Joes, agreements with the business owners would be needed to include those locations on wayfinding signs and maps.

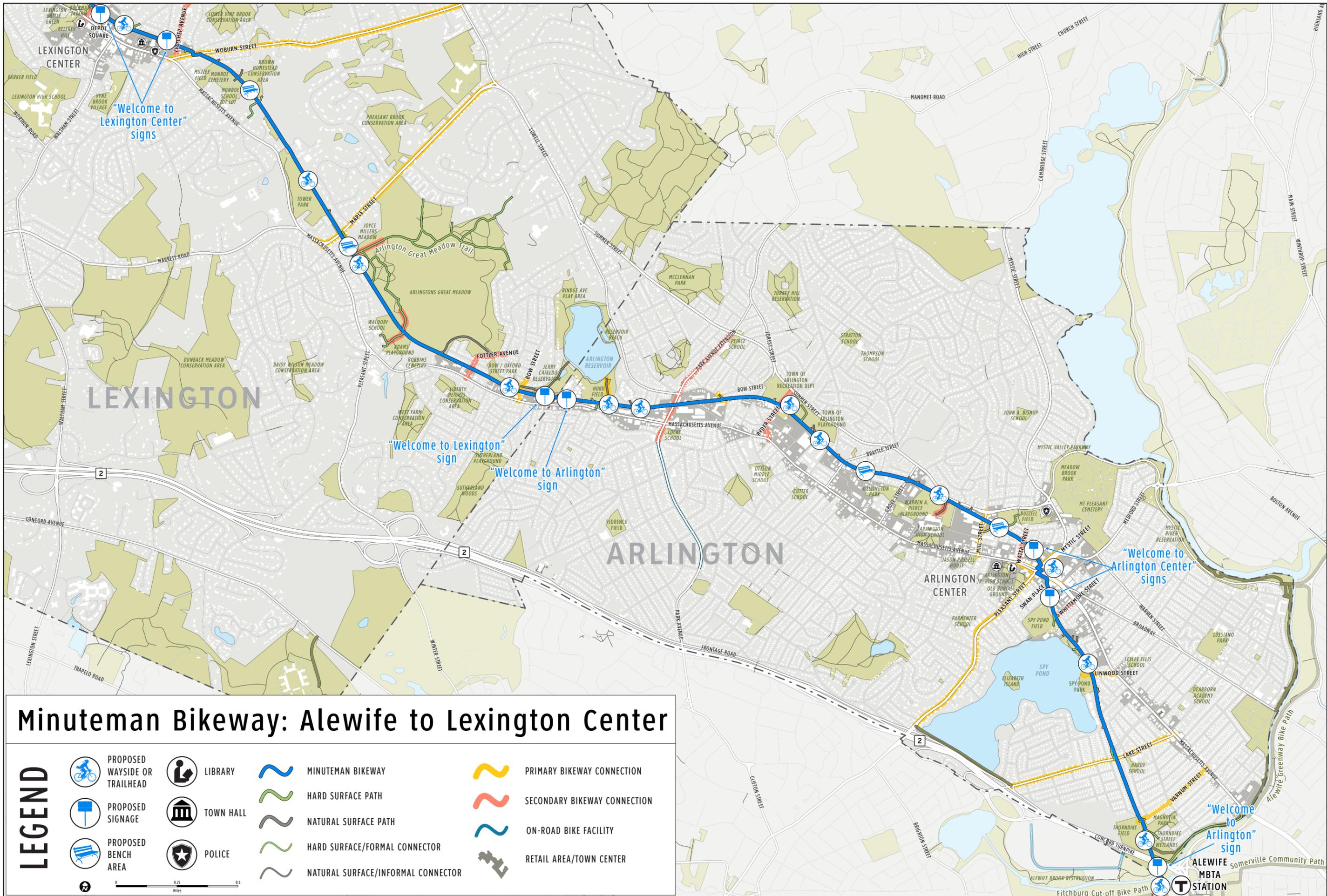


Connections to Town Centers, Commercial Corridors, and Neighborhoods

A total of 174 connections to the Bikeway (both formal and informal) were identified in Arlington, Bedford, and Lexington. Connections varied from footpaths to formal trailheads and provide additional opportunities to connect Bikeway users to local neighborhoods.

18 primary connections to town centers and commercial corridors have been identified along the Bikeway, presenting opportunities to draw traffic to retail areas in these towns. 24 secondary connections were also identified. Secondary connections are other points of access to the Bikeway, often connecting to side streets or small parks. These connections are illustrated in Appendix D. Recommended improvements to these connections are described in the following sections.



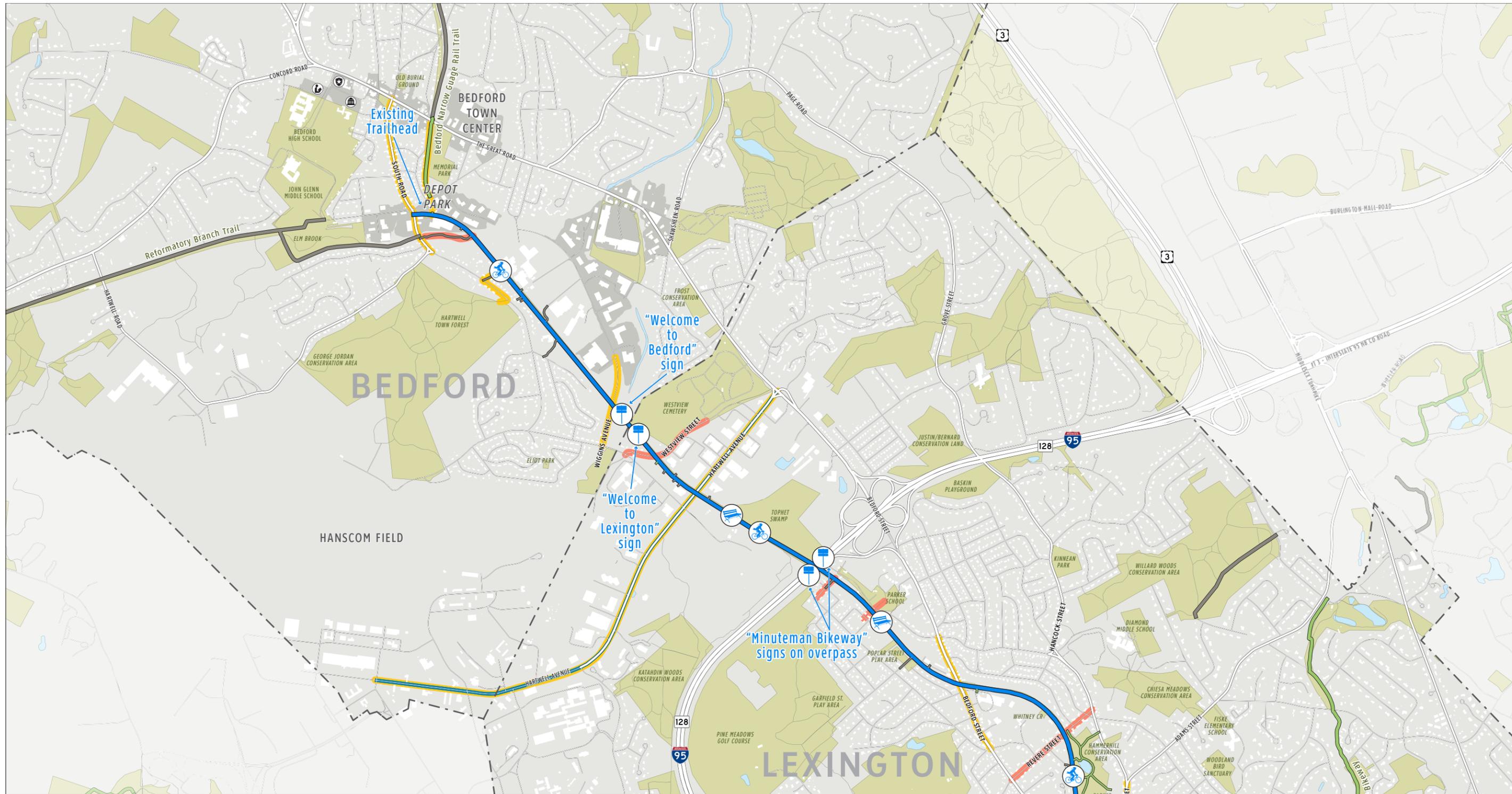


Minuteman Bikeway: Alewife to Lexington Center

LEGEND

	PROPOSED WAYSIDE OR TRAILHEAD		LIBRARY		MINUTEMAN BIKEWAY		PRIMARY BIKEWAY CONNECTION
	PROPOSED SIGNAGE		TOWN HALL		HARD SURFACE PATH		SECONDARY BIKEWAY CONNECTION
	PROPOSED BENCH AREA		POLICE		NATURAL SURFACE PATH		ON-ROAD BIKE FACILITY
					HARD SURFACE/FORMAL CONNECTOR		RETAIL AREA/TOWN CENTER
					NATURAL SURFACE/INFORMAL CONNECTOR		

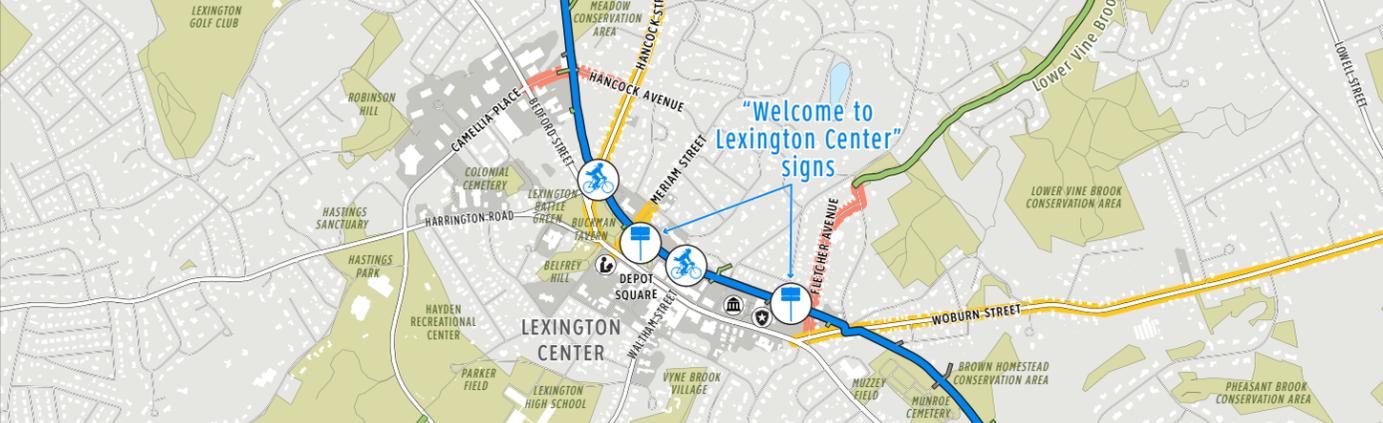
Scale: 0 to 0.5 Miles



Minuteman Bikeway: Lexington Center to Bedford

LEGEND

	PROPOSED WAYSIDE OR TRAILHEAD		LIBRARY		MINUTEMAN BIKEWAY		PRIMARY BIKEWAY CONNECTION
	PROPOSED SIGNAGE		TOWN HALL		HARD SURFACE PATH		SECONDARY BIKEWAY CONNECTION
	PROPOSED BENCH AREA		POLICE		NATURAL SURFACE PATH		ON-ROAD BIKE FACILITY
	0 0.25 0.5 Miles		HARD SURFACE/FORMAL CONNECTOR		NATURAL SURFACE/INFORMAL CONNECTOR		RETAIL AREA/TOWN CENTER



3. Wayfinding and Signage Recommendations

Existing Condition	Principle	Recommendation and Benefits
A wide variety of signs and mile markers exist along the Bikeway.	Establish consistency in signage along the Bikeway	Providing consistency through signage will create a unified feel to the entire Bikeway and help people readily identify the information they may need.
Many amenities exist in the Town Centers near the Bikeway, but are often unknown to Bikeway users.	Direct Bikeway users to Town Centers	Providing Wayfinding to Town Centers will attract Bikeway users to businesses, strengthening the economic impact of the Bikeway.
The existing granite mile markers along the Bikeway do not provide adequate distance information to Bikeway users, and in some case the information they provide is incorrect.	Improve location signage including at intersections and Bikeway connections.	Providing legible signage and location information and signage will improve the Bikeway experience and improve emergency response.
There is a lack of consistency in branding along the Bikeway.	Provide consistent Minuteman branding along the Bikeway	Use of the Minuteman Commuter Bikeway logo on signage along and approaching the Bikeway will strengthen the identity of the Bikeway.
A desire to limit the amount of signing on the Bikeway has been identified by the public.	Avoid over-signing the Bikeway	Providing signs only where most effective will provide the necessary Wayfinding without detracting from the natural setting of the trail.

Additional signs should be installed to provide important safety information including intersection warnings, wayfinding, trail and user restrictions and other right of way information. Comments from the public indicate a desire to limit the amount of overall signage on the Bikeway to preserve its natural character.

The following section illustrates recommended signs with usage guidance and conceptual renderings.



Wayfinding Signs

Destination Signs on Bikeway

Destination signs are recommended for placement on the Bikeway at primary connections to direct users to destinations near the Bikeway. Signage should include directional arrows, destination names, symbols for any amenities at the destination, and distances. Signage at town lines may include the identity of the town. All signs on the Bikeway should have reflective surfaces for visibility.

Recommended locations

Primary connections to the Bikeway.



Mile Markers

The existing granite mile markers are difficult to interpret and in some cases not accurate. These markers should either be relocated and updated for legibility and accuracy or replaced with context sensitive mile markers. The markers, which were installed with the development of the bikeway, reference railroad history but are not historic themselves.

In addition to mile markers, signage with location information or street sign names at intersections and trail connections will help orient Bikeway users. Signs indicating cross streets and trail connections, even if they do not intersect the trail may also be useful for emergency responders who are familiar with local streets and provide context for Bikeway users. Town identities can be incorporated into the signs if desired.

Comments from the public indicate a desire to limit the number of signs on the Bikeway. If mile markers are incorporated, they should be installed on wayfinding or other signage where feasible to reduce the number of sign posts along the Bikeway.

Recommended locations

Mile markers should be placed at ½ mile intervals.

Signs Approaching Bikeway

Wayfinding signs are recommended to direct users to the Bikeway near primary connections and trailheads. These signs should include directional arrows, the Minuteman logo and name, and distance to the Bikeway. The three towns should work together to create uniform signs that complement existing street signs.

Recommended locations

Wayfinding signs should be placed on streets and roadways that are desirable pedestrian and bicycle routes leading to Bikeway entrances. Signs identifying the Bikeway should be included at all crossing locations.



Example Wayfinding Sign Directing
Directing Users to the Bikeway

Etiquette Signs

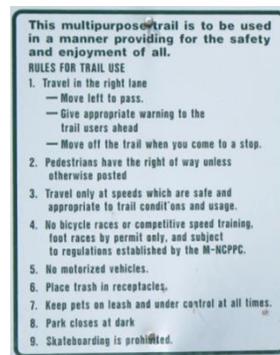
Etiquette signs remind trail users of courtesy on the road, especially in areas on conflicts. Detailed etiquette signs should include all areas of trail use etiquette such as “Keep right, dispose of dog bags in dog bag containers, Keep headphone volumes low in order to hear approaching cyclists,” etc. It is recommended to provide only the most important information at regular intervals such as shown on the sign to the right—simple signs should emphasize that all users should be cognizant of the presence of two-way traffic on the Bikeway and that users are responsible for keeping right and being courteous towards other users. Large amounts of information should be limited to trailhead locations because users are unlikely to stop to read the signs.

Recommended locations

Detailed etiquette signs should be included on information kiosks at trailheads. Passing etiquette signs should be included on the bike trail approaching areas of low visibility or areas known for potential conflicts.



Example Etiquette Sign For Use on Bikeway



Example Etiquette Sign For Use at Trailheads

Maps

Bikeway maps should be displayed at all trailheads, major access points, and waysides. Maps should include locations of amenities, including bathrooms, road names, and mileage. “You Are Here” labels should also be placed on the map to orient the user.

Recommended locations

On the trail at Thorndike Field, Arlington Reservoir Connection, Fletcher Avenue, and at recommended trailhead and wayside locations identified in Chapter 5: Trailhead and Wayside Recommendations.

Mobile Technology

Town agencies should consider incorporating mobile wayfinding to improve navigation. Suggestions for developing navigational tools include holding a contest to create a mobile app for the trail which may include historic content, maps, and local amenities / events and encouraging current mapmakers to issue a mobile version (including PocketRides, Mass Bike). A Minuteman Commuter Bikeway map is currently available on the mobile application “Maplets.” The mobile applications should be advertised through emails, newsletters, and websites.

GIS inventory data compiled for this project could be used as a starting point to create a mobile application.

4. Intersection Improvement Recommendations

Design of each intersection using best practices is key to ensuring trail users are able to use the space as safely and comfortably as possible. In general, intersections should be improved utilizing the trail/roadway crossing details in the *American Association of State Highway Transportation Officials Guide for the Development of Bicycle Facilities, 4th Edition (AASHTO Bike Guide)*. Improvements such as curb ramps, crosswalk markings, street and Bikeway signage, and accessible pedestrian crossing signals are the types of features needed at many of the proposed intersections to address site specific issues.

Existing Condition	Principle	Recommendation and Benefits
Many intersections along the Bikeway have been identified by the public as dangerous and difficult to cross.	Improve safety for all users	Improving the intersections will increase the safety of the Bikeway and provide a better Bikeway experience.
Inconsistency in intersection signing and pavement marking can decrease awareness and lead to safety issues.	Provide predictable context-sensitive intersection treatments along the Bikeway	Providing consistency to each intersection will increase awareness and improve safety.
Uncertainty in responsibility between motorists and Bikeway users presents safety concerns.	Provide clear directions for all users	Clearly signing and marking intersections improves expectations and communicates responsibility for all users.
Currently, Bikeway users are required to stop at every intersection, leading to many Bikeway users ignoring the stop signs.	Provide the least intersection control that is effective	Providing stop signs only where necessary will help increase compliance and improve safety.
Intersections are popular and convenient places for Bikeway users to wait for groups to catch up or to meet others, causing congestion.	Create gateway treatments at intersections	Creating attractive places for people to wait off the trail will improve traffic flow and enhance the Bikeway entrances.

Intersection Treatments

Routine use of stop signs intersections along the Bikeway may contribute to poor compliance. Bicyclists tend to operate as though intersections are controlled by yield signs. The following is a list of potential intersection treatments and criteria for determination of suitability. Control type for each intersection along the Bikeway should be determined on an individual basis by each Town after a detailed engineering analysis of speeds, sight distance, etc.



Yield Control for Bikeway Users

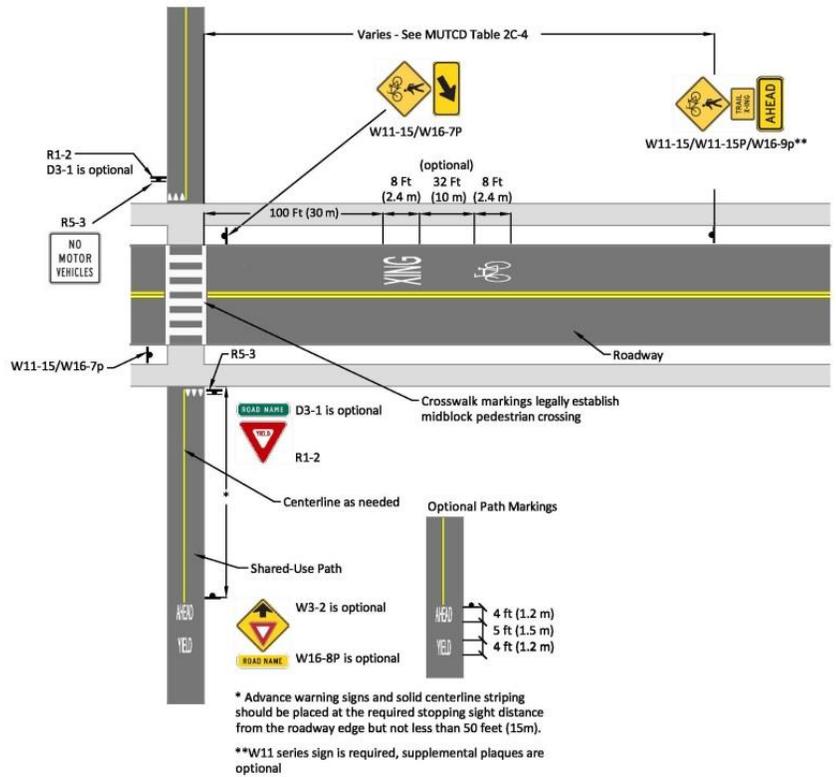
Bikeway users reduce speed and prepare to stop, but may continue if no traffic is present.

Criteria for Suitability:

- Roadway Volumes > Bikeway Volumes
- Lower Speed Roadways
- Adequate Sight Distance Between Roadway and Bikeway

Potential Candidates:

Revere St, Fottler Ave, Fletcher Ave, Wiggins Ave



Source: AASHTO Guide for the Development of Bicycle Facilities

Stop Control on Bikeway

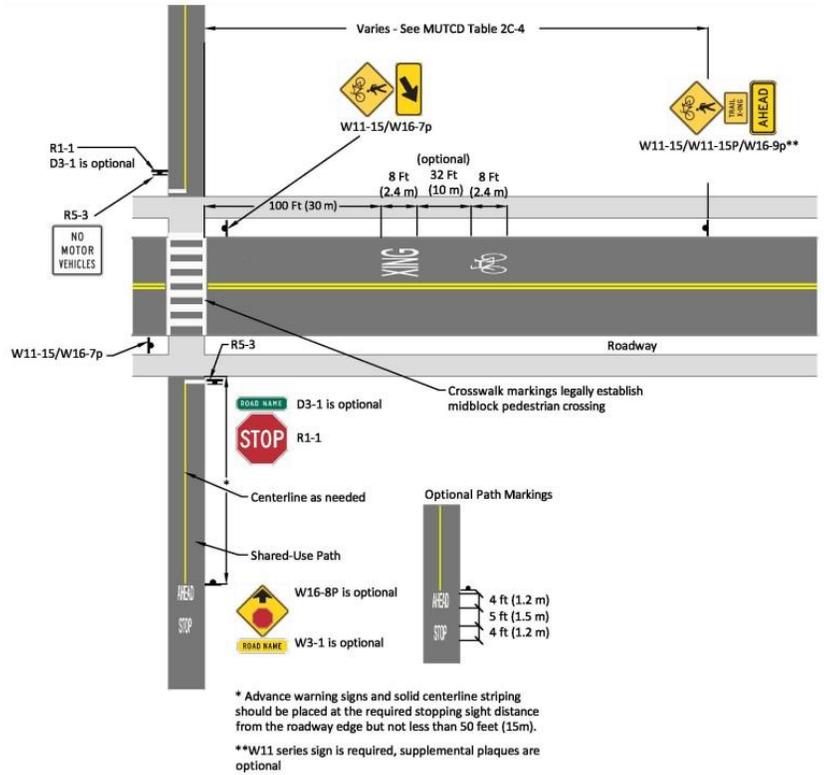
Bikeway users stop at intersection and continue when no traffic is present or traffic has stopped for them.

Criteria for Suitability:

- Roadway Volumes > Bikeway Volumes
- Higher Speed Roadways
- Limited Sight Distance Between Roadway and Bikeway

Potential Candidates:

Bow St, Westview St



Source: AASHTO Guide for the Development of Bicycle Facilities

Yield Control on Roadways

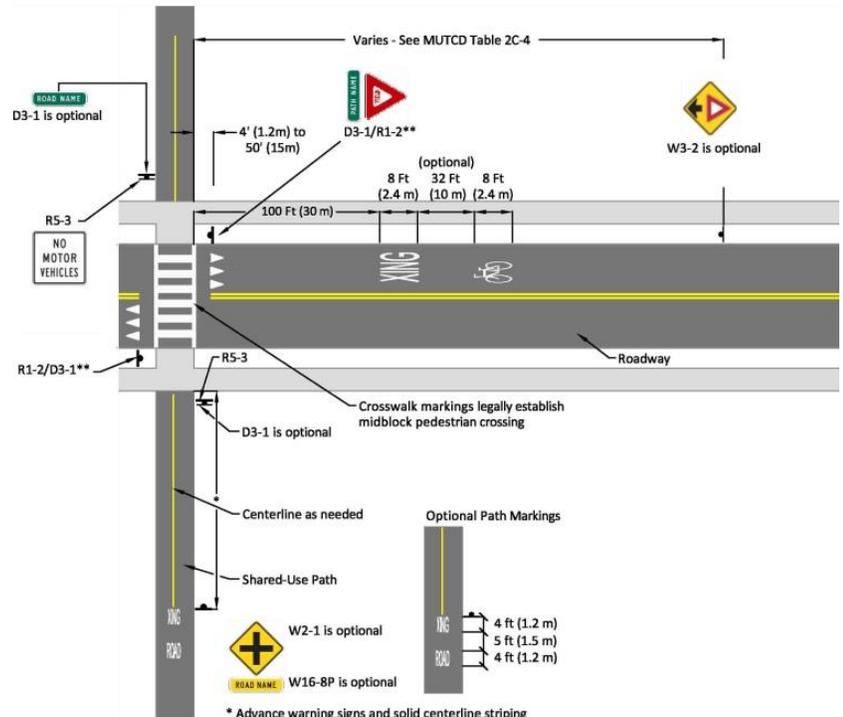
Motorists reduce speed and prepare to stop, but may continue if no Bikeway traffic is present.

Criteria for Suitability:

- Bikeway Volumes > Roadway Volumes
- Lower Speed Roadways
- Adequate Sight Distance Between Roadway and Bikeway

Potential Candidates:

Whittemore St, Pond Ln, Linwood St



* Advance warning signs and solid centerline striping should be placed at the required stopping sight distance from the roadway edge but not less than 50 feet (15m).

** D3-1 sign is optional, R1-2 sign is required. At multi-lane road crossings, the R1-5 series (Yield Here To/Stop Here For Pedestrians signs and markings, placed in advance of the crosswalk to reduce multiple-threat crashes) may be a more appropriate solution.

Source: AASHTO Guide for the Development of Bicycle Facilities

Stop Control on Roadways

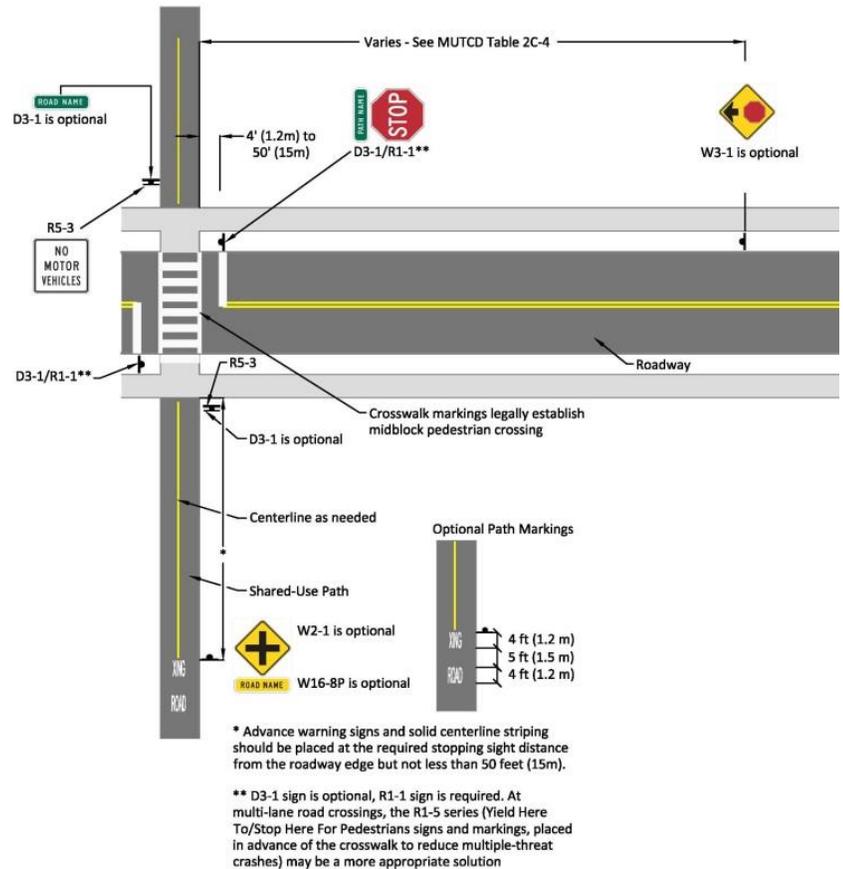
Motorists stop at Bikeway crossing and continue if no Bikeway traffic is present.

Criteria for Suitability:

- Bikeway Volumes > Roadway Volumes
- Lower Speed Roadways
- Private/Commercial Driveways

Potential Candidates:

Seasons 4 Driveway, Lexington Town Center Parking Lot Driveway



Source: AASHTO Guide for the Development of Bicycle Facilities

Accessible Crossings

Pedestrian activated signals with push buttons should be located between 5 and 6 feet from the curb to meet MUTCD requirements and should accommodate hand-cycles, bicycle trailers, recumbents and other similar cycles. Consider bicycle detectors to eliminate the need for a push button to allow cyclists to cross the street without dismounting or encroaching into the street. Audible features should also be considered at crossings to accommodate persons with vision impairments.

Criteria for Suitability:

- Signalized intersections

Potential Candidates:

All signalized intersections



Traffic Signal/Beacon on Roadways

Motorists stop or yield for Bikeway users after signal is activated by push-button or detection on the Bikeway. For intersections not meeting MUTCD signal warrants, flashing beacons such as a High-Intensity Activated Crosswalk Beacon (HAWK) or a Rectangular Rapid-Flashing Beacon (RRFB) should be considered.

Criteria for Suitability:

- Limited Sight Distance Between Roadway and Bikeway
- Higher Speed, Higher Volume Roadways
- Known Safety Concerns
- High Volume Bikeway Crossing
- Meets MUTCD Signal Warrant (Signal)

Existing Intersections:

Hartwell Ave, Bedford St, Mill St

Potential Candidates:

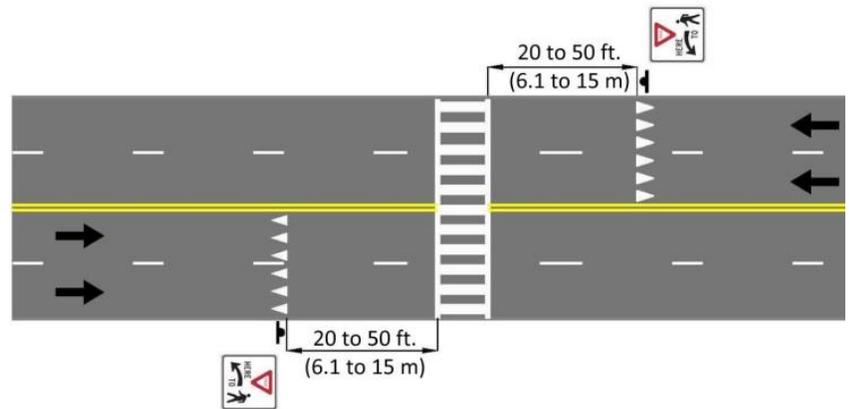
All midblock crossings of high speed, high volume streets that are difficult to cross.



Example Rectangular Rapid Flashing Beacon

Advance Yield Lines

Provide direction to motorists to yield in advance of Bikeway crossing to increase visibility between motorists and Bikeway users. These lines have been shown to reduce “multiple threat” crashes where one stopped vehicle blocks visibility of path users for a vehicle traveling in the adjacent lane. “Yield to Pedestrians” signs (MUTCD Sign R1-5) should be added to provide additional guidance on the yielding location.



Source: AASHTO Guide for the Development of Bicycle Facilities

Criteria for Suitability:

- Intersections with multi-lane streets

Potential Candidate:

Mill St

Improved Intersection Lighting

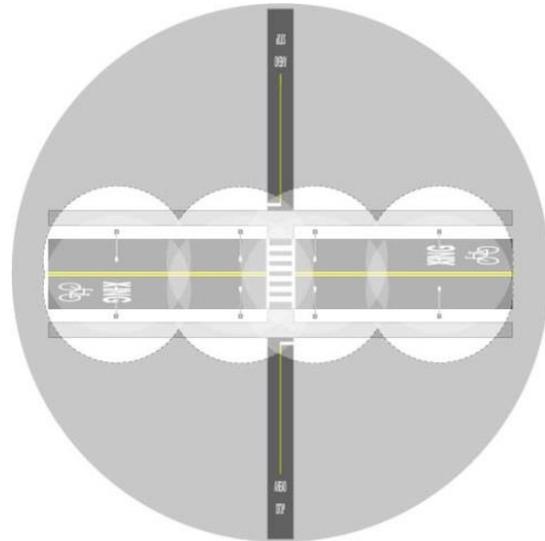
Improves the visibility of Bikeway users at crossings, increasing safety. This is especially important because nearly half of survey respondents reported using the Bikeway at night (see **Appendix A: Public Outreach**).

Criteria for Suitability:

- Primary connections to the Bikeway
- Intersections with low visibility

Potential Candidates:

All intersections of the Bikeway and all primary connections



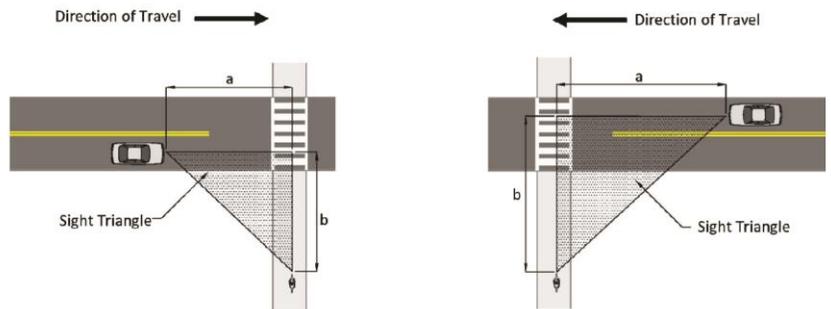
Source: AASHTO Guide for the Development of Bicycle Facilities

Sight Distance

Intersection sight distance, also referred to as a sight triangle, is a fundamental component in selecting the appropriate intersection control along the Bikeway. Bikeway and roadway users should have adequate sight lines to provide an unobstructed view of the entire intersection and a sufficient amount of the intersecting facility to anticipate and avoid a potential collision with crossing traffic, regardless of the intersection control.

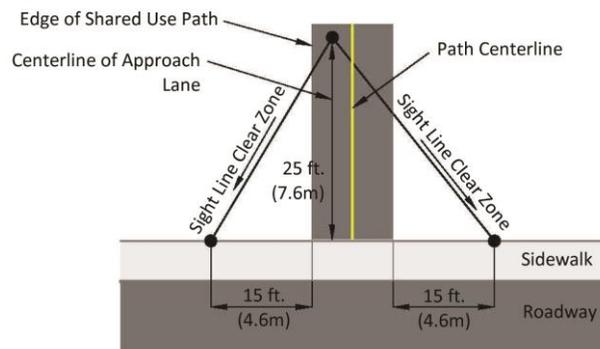
Approaches to yield-controlled intersections should provide the recommended approach sight triangle, or else a more restrictive control should be considered.

Regular maintenance of vegetation to maintain sight distance is also a key consideration for visibility on the Bikeway. See **Section 9: Maintenance** for details.



Yield Sight Distance Triangles Between Motorists and Bikeway Users

Source: AASHTO Guide for the Development of Bicycle Facilities



Minimum Path-Walkway Sight Distance Triangles (Recommended at every sidewalk and pathway intersection)

Source: AASHTO Guide for the Development of Bicycle Facilities

Trail Crossing Signs at Roadways

Alerts motorists of trail crossing, giving them adequate time to prepare to yield to Bikeway users. Trail crossing signs should be supplemented with a Minuteman Commuter Bikeway sign to identify the Bikeway.

Recommended locations

On roadways at all midblock trail intersections



Roadway and Sidewalk Conditions Approaching the Bikeway

Roadways and sidewalks leading to the Bikeway should accommodate bicyclists and pedestrians and should be regularly maintained. Where feasible, Town agencies should include bicycle facilities on streets that serve as connections to the Bikeway. Safe and convenient access to the Bikeway will likely reduce the demand for additional parking and better incorporate the Bikeway into the larger transportation system.

Pavement Markings

Pavement markings support safe use of the Bikeway by providing visual cues and guidance to users.

- **Edge Striping:** Edge striping helps users easily identify the edges of the trail which can be obscured by dirt, fallen leaves, and other debris. This is especially important in areas where a drop-off at the edge exists, as observed in some areas along the Bikeway. Where lighting is not provided, or only provided during certain hours, reflective edge lines may be beneficial. Edge lines may also be considered at approaches to intersections to alert path users of changing conditions, but only if they are not provided throughout the Bikeway.
- **Center Lane Marking:** Center lane markings remind users to walk or cycle on the right side of the road. During periods of low traffic, it is important to remind users that the Bikeway is a two-way trail. Center lines should typically be dashed, except in areas with low visibility, high volumes, narrow bridges, or other areas where passing is discouraged. In these areas, centerlines should be solid to indicate a “no-passing zone.”
- **Curve Warning:** Pavement curve warnings, such as “CURVE AHEAD” are typically more visible than wayside signage when not obscured by leaves or other debris. Curve warnings provide important information to bicyclists to help avoid collisions or falls. They should be considered at locations such as Woburn Street where sharp curves exist.
- **Intersection Warning:** Pavement markings to indicate upcoming stops help prepare cyclists for intersections where they are required to stop. In areas of limited sight distance or where there is a history of crashes, advance intersection warning pavement markings should be considered.



Access Control

Gates and bollards along the Bikeway consist of various designs (see below) to prevent motor vehicles from driving onto the trail. While often installed with the intent of protecting trail users, bicyclists are more likely to sustain injuries from colliding with a gate or bollard than from colliding with an automobile driving onto the path. Existing bollards and gates should be removed and future gateways should be designed without these features. Split entry points that separate entering and exiting traffic with a landscaped island create an aesthetic gateway treatment, effective at deterring motor vehicle traffic from entering the Bikeway. Waiting areas should also be incorporated at access points to reduce congregating on the Bikeway. For entrance points with a history of vehicles entering the Bikeway, a “No Entry” sign may be installed and evaluated for effectiveness. If signs and split intersection treatments are not enough of a deterrent, gates (not bollards) may be used provided these gates do not encroach on the Bikeway when in the open position.

Gateways should incorporate landscaping, pavement treatment, or signage to serve as a visual cue that the Bikeway is approaching an intersection. Any treatment must be designed so as not to limit visibility.

Existing Bollards and Gates Along the Bikeway



5. Trailhead and Wayside Recommendations

Existing Condition	Principle	Recommendation and Benefits
The public has shown a strong desire to have additional amenities along the Bikeway.	Provide convenient amenities along the Bikeway.	Providing frequent places to rest and opportunities to obtain water and use a restroom will improve the Bikeway experience, especially for recreational users.
Very few developed waysides and trailheads exist along the Bikeway.	Provide waysides and trailheads at key places along the Bikeway.	Including waysides and trailheads regularly along the Bikeway will provide resting places and additional access points for visitors driving to the Bikeway.
There is a strong desire for clarification and communication of rules and responsibilities for Bikeway users.	Provide information about Bikeway rules and responsibilities to reduce conflict among users.	Providing educational information will help reduce conflicts between Bikeway users.
Existing trailheads and entrances to Town Centers lack character and prominence.	Enhance the Bikeway through gateway treatments.	Enhancing the Bikeway through gateway treatments will provide a sense of arrival upon entering Town Centers and at trailheads.

Trailheads and Waysides

At focal areas along the trail, waysides should be created to provide occasional areas for users to pull off and enjoy the areas of interest around the trail, or simply to have a place to rest. Trailhead gateways should serve to identify key access points and landmarks with informational kiosks and aesthetically pleasing nodes of interest by incorporating art or landscape elements.

Waysides should range in the intensity of amenities offered. For the purposes of this plan, three levels of accommodation are recommended. At the low end, **Level 1 waysides** include amenities that serve as a spot to rest and find information. **Level 2 waysides** include additional amenities such as drinking fountains and bicycle racks. **Level 3 waysides** include tables with seating, restrooms, additional lighting, and other amenities. **Trailheads** should include the suggested amenities for Level 3 waysides with the addition of vehicular parking. These are described in more detail in the following section. The types of trailheads and waysides should be distributed relatively evenly to create predictable locations for the amenities desired by users. Suggested locations for trailheads and waysides are also included in the following table.



Wayside Level	Purpose	Suggested Amenities	Proposed Locations*	Sample Waysides
1	These minimalistic waysides should be located regularly along the Bikeway to offer frequent opportunities to rest and obtain location information.	<ul style="list-style-type: none"> • Information kiosk • Bench • Interpretive signs** • Lighting 	<ul style="list-style-type: none"> • Between the Bedford Town line and Bedford Street in Lexington • Between Woburn Street and Joyce Miller’s Meadow in Lexington • Between Brattle Street and Pleasant Street in Arlington 	
2	Enhanced waysides should be located in proximity to popular walking and hiking areas and near town centers.	<ul style="list-style-type: none"> • Information kiosk • Interpretive panel • Bench • Lighting • Trash/recycling receptacle • Bicycle rack 	<ul style="list-style-type: none"> • Joyce Miller’s Meadow/ Arlington’s Great Meadow • Town of Arlington Playground • Arlington Reservoir Area Playground • Parker Meadow Cons. Area • Tophet Swamp Cons. Area • Warren A. Pierce Playground • Spy Pond Park • Tower Park • Bow/Oxford Street Park 	
3	High quality trailheads and waysides should be located at primary parking locations and in each community to provide additional opportunities to obtain water and use a restroom.	<ul style="list-style-type: none"> • Information kiosk • Interpretive panel • Bench • Lighting • Trash/recycling receptable • Bicycle rack • Bicycle repair station • Tables with seating • Drinking fountain • Restroom • Dog bag dispenser • Public art and civic design • Motor vehicle parking (where feasible) 	<ul style="list-style-type: none"> • Lexington Depot and/or Lexington Visitor Center • Hurd Field Parking Lot • Mystic Street, Arlington • Spy Pond Park • Arlington Recreation Department 	

*Site of proposed new location. Other locations refer to existing locations.

** Interpretive signs should be located at sites of historic elements or trail features, not limited to waysides

Amenity Design

Site Furniture General Guidelines

Site furniture is recommended along the trail corridor, particularly at trailheads, waysides and other areas of interest for Bikeway users. All furnishings should be made of durable materials. Stone (granite) or metal rather than wood furnishings are recommended because wood can splinter or burn. Where possible, recycled materials should be used. Metal furniture, if used, should be painted a solid, standard color (such as black) for ease of maintenance and to resist vandalism. In general, when placing site furniture along the Bikeway, benches, tables, trash and recycling receptacles, bike racks and other furnishings should be placed at least 3 feet away from the trail.

Level 1 Waysides

Level 1 Waysides are intended to provide basic amenities for Bikeway users and be located frequently along the Bikeway. They provide resting areas and offer a great opportunity to provide interpretive and informational signs. Level 1 Waysides should also include the following:

Benches

A total of 37 benches were inventoried along the length of the Bikeway. Benches ranged widely in style and accessibility. Distribution is generally pretty good near the Town centers, but is lacking outside of those areas. Benches should be distributed frequently along the Bikeway to provide resting places. Additional benches are recommended at the following locations:

- Between the Bedford Town line and Bedford Street in Lexington
- Between Woburn Street and Joyce Miller's Meadow in Lexington
- Between Brattle Street and Pleasant Street in Arlington

Benches should accommodate all users. The bench seat should be between 16 and 18 inches above the ground, with handrails at the end between 6 and 12 inches above the seat. The depth of the seat should range between 18 to 20 inches with a width varying between 24 to 30 inches allotted per person. There should be a clear level space where a person using a wheelchair can rest adjacent to seated

Existing Amenities

- 2 restrooms
- 37 benches
- 44 information signs and kiosks
- 5 tables
- 17 bicycle racks
- 8 drinking fountains
- 19 trash receptacles
- 2 dog bag dispensers
- 10 lamp posts

Please refer to **Appendix D: Heat Maps** for inventoried locations of existing amenities along the Bikeway.



people. This area must be at least 30 by 48 inches and should be located adjacent to the benches. Benches should be positioned on an accessible surface with an accessible walk to the seating area.

Interpretive Panels / Information Kiosks

Interpretive panels and information kiosks should be located intermittently along the Bikeway to enhance the user experience, provide a reason to stop, and embrace the areas rich history.

Recommended content includes:

- Geologic/natural history
- Colonial history
- Railroad history
- Recent history

Interpretive signage provides users with objective information about trails, such as trail symbols, length, direction, rules, surface type and accessibility. Signs may also include an area map and timeline of events related to the trail to provide additional context.

Signage design should be chosen based on long-term maintenance needs, and have a design theme consistent with other Bikeway amenities and signs. When choosing materials and design, graffiti removal and vandalism control should be a key consideration. Like directional signs, informational signage must meet the most current ADA guidelines including a 42-inch minimum space between other protruding objects.

Potential locations for additional interpretation kiosks include historic sites such as:

- Lexington Battle Green
- Lexington Depot
- Arlington Heights Station

Information kiosks with maps should be located at major entry points to the trail.



Figure 1: Conceptual Interpretive Sign



Figure 2: Conceptual Information Kiosk

Lighting

Lighting elements of the trail serve a decorative function, accenting landscaping concepts, landmarks, artwork, etc., as well as providing for functional illumination and security of the trailheads during the evening and dusk hours. Through the use of appropriate lighting concepts, the trail can be a focal point that is integrated into the existing neighborhoods and streetscapes, providing an interesting transition for users from the surrounding streetscape onto the trail. By maximizing the use of energy efficient and self-sufficient lighting systems, lighting elements become an integral part of the landscape concept, adding to the users overall trail experience.

The design and material of lighting should be consistent with the design of other site amenities, and be scaled for pedestrian use. Lighting levels should comply with local ordinances and should have cut-offs to shield lighting from adjacent properties. LED and solar-powered lighting is a good option that is ultimately less expensive to operate. As with other site amenities, lighting should be tamper resistant and made to withstand vandalism.

Recommended locations for lighting include:

- Waysides
- Near town centers where high foot traffic is anticipated
- Intersections

To preserve the natural setting of the Bikeway, lighting should not be incorporated along the entire length of the path.

Level 2 Waysides

Level 2 Waysides are intended to provide additional amenities for Bikeway users, located less frequently along the Bikeway. Recommended locations are near natural areas, playgrounds, and parks where users may wish to park their bicycles and enjoy a hike in a natural area, play on playground equipment, or just relax. In addition to the amenities described in Level 1 Waysides, Level 2 Waysides should also include the following:

Bike Racks

17 bike racks were inventoried along the Bikeway, generally located near the Town centers. Bike racks should be located at trailheads, recreation areas, parking areas, commercial areas, and as close as possible to destinations without interfering with traffic flow (this includes the space needed for a locked bicycle). Recommended locations for additional bike racks include:

- Joyce Miller's Meadow/Arlington's Great Meadow
- Town of Arlington Playground
- Arlington Reservoir Area Playground
- Parker Meadow Conservation Area
- Tophet Swamp Conservation Area
- Warren A. Pierce Playground
- Spy Pond Park
- Tower Park
- Bow/Oxford Street Park



Figure 3: Conceptual Minuteman Branded Bicycle Rack

Stationary u-shaped and post racks are the most common, easy to use, and affordable option. These devices allow cyclists to lock both the wheels and the frame as well as move bicycles into and out of the racks with minimal effort and damage. The location of a rack should be well lit and visible to prevent theft, and be protected from the elements with a roof if possible.

Trash and Recycling Receptacles

19 trash and/or recycling receptacles were inventoried along the Bikeway. These were primarily located near Town centers and also at Revere Street and Bow Street in Lexington. Trash and recycling receptacles should be located throughout trail corridor to reduce littering. Recommended locations for additional trash and recycling receptacles include:

- Existing and future trail heads
- Existing and future picnic table locations
- Existing and future bench locations
- Existing and future dog bag dispensers

Receptacles should be of similar character as other site furniture, and be ADA accessible. Receptacles require a 30 to 48 inch clear space with an opening height of 15 to 36 inches. Lids must be hinged, tamper resistant, and any removable tops should be lockable. In areas with sufficient sunlight, solar compacting receptacles could be considered to reduce maintenance.

Water Fountains

Eight water fountains were inventoried along the Bikeway, primarily on the Lexington segment of the Bikeway. Water fountains should be located along existing water main lines. Assuming existing water facilities are in place, recommended locations for additional drinking fountains include:

- Waysides in Arlington, near Tower Park or the Great Meadow
- Level 3 waysides with heavy use

Each fountain should have an ADA-compliant design and ideally include a fountain for pets, since many users indicated using the Bikeway for dog-walking. If possible, new water fountains should employ a downward spout designed to fill water bottles in addition to an upward spout to allow users to drink directly from the fountain.

Level 3 Waysides and Trailheads

Level 3 Waysides and Trailheads are intended to provide the highest level of amenities for Bikeway users, limited to a few locations along the Bikeway. Typical locations are near Town centers and parking lots where higher volumes of walkers can be expected as well as people beginning and ending a trip. Additionally, locations that provide high levels of visibility will be a deterrent from vandalism.

Recommended locations for Level 3 Waysides and Trailheads include:

- Lexington Depot and/or Lexington Visitor Center
- Hurd Field Parking Lot
- Mystic Street, Arlington
- Spy Pond Park
- Arlington Recreation Department

In addition to those described in Level 2 Waysides, amenities for Level 3 Waysides and Trailheads should also include the following:

Restrooms

One public restroom was inventoried near the trail, located at the Bedford Depot. An additional restroom is located adjacent to the Bikeway at the Lexington Visitor's Center but was not inventoried by volunteers, demonstrating the need for signage. Although additional restrooms are located near the Bikeway, such as Trader Joe's, agreements with the business owners are needed to include those locations on wayfinding signs and maps. Additional restrooms are recommended at major waysides. Wayfinding signs should be provided to direct Bikeway users to nearby restrooms located off the trail in areas where restrooms are not provided adjacent to the Bikeway.

Tables

Five tables were inventoried along the Bikeway, in Arlington Center, Bow/Oxford Street Park, and Lexington Center. Additional tables are recommended between Lexington Center and the Bedford Depot. Tables should be provided at waysides and general picnicking areas along the Bikeway. Tables should be made of durable materials, such as vinyl coated, expanded metal which require minimal maintenance, and should be secured to a paved, accessible surface so they are universally accessible. The height of the bench should be about 18 to 20 inches high with the table top at 30 inches high. The paved surface below the table should not have a slope greater than 2 percent in any direction and have an accessible path to the Bikeway. Trash and recycling receptacles should be located at all waysides with tables.

Dog Bag Dispensers

Two dog bag dispensers were inventoried near the Bikeway, both near the trail connection to Colonial Village in Arlington. Dog bag dispensers should be located throughout the trail corridor near popular access points for walking. Dispensers should be accompanied by trash receptacles to reduce the likelihood of full bags being left trailside due to lack of places to deposit them.

Bicycle Repair Station

Bicycle repair stations include air pumps and tools to perform basic maintenance on their bikes in the event of a flat tire or other damage. These repair stations add a level of comfort to trail users and are installed on many bike paths around the country.

Public Art & Civic Design

Throughout the Bikeway, public art and civic design elements are recommended for integration into the trail infrastructure and landscape. Trailheads, waysides, and similar locations provide significant opportunities to create a cohesive theme for the Minuteman Commuter Bikeway and the surrounding neighborhoods. Where possible, it is recommended that the art integration be coordinated with local community centers, schools, and citizen groups to encourage a greater “sense of ownership” of these features. Citizen involvement (particularly youth involvement) into the public art and civic design process increases citizen awareness of the Bikeway, encourages citizen investment into the maintenance and upkeep of the Bikeway, and illustrates local talent within the community. Public art should be placed at least 3 feet away from the trail. Maple Street Underpass may be a good candidate for public art.

Motor Vehicle Parking

Because many Bikeway users travel by motor vehicle to parking locations near the Bikeway, sufficient space should be available to accommodate these users. Parking locations should be identified on maps with signage provided on adjacent streets and the Bikeway directing motorists to and from the parking lots.

Existing parking locations that should be considered to include on maps and signage are:

- Alewife MBTA Station
- Arlington Center
- Arlington Recreation Department
- Bedford Depot
- Hurd Field
- Lexington Center
- Lexington Department of Public Works
- Mystic Street, Arlington
- Spy Pond Park

6. Partnership Recommendations

Existing Condition	Principle	Recommendation and Benefits
The Bikeway is maintained and operated independently by individual municipalities.	Increase collaboration between towns.	Increasing collaboration between the Towns will improve operations and reduce inefficiencies.
Conflicts between bicyclists and pedestrians on the Bikeway are common.	Reduce conflicts between users through education.	Providing education and outreach to Bikeway users will help reduce conflicts and increase compliance with the Bikeway rules.

Town Coordination

Although most trail improvements can be made independently by each Town, several improvements would benefit from coordination between communities. Collaboration is recommended to improve operations and increase efficiencies. It is recommended that coordination between the Towns occur on the following items:

- Graphic standards for signage
- Placement of Bikeway signs on multi-jurisdictional streets leading to the Bikeway
- Outreach and communication
- Maintenance and clean up

Joint Powers Committee

A Joint Powers Committee, such as that created to manage the North Idaho Centennial Trail (NICTF), could bring the neighboring communities together to make decisions that affect each Town and provide efficiencies in future maintenance and improvements. The intent would be to set standards and manage the Bikeway in a uniform way, from day-to-day maintenance to capital improvement projects. The Joint Powers Committee could adopt a trail maintenance plan approximately every five years. Each agency would be obligated through a Joint Powers agreement to contribute money into a capital improvements account (for example, the NICTF currently requires \$7,500 each, per year). Funds in the account could be used for planned and unplanned projects. These funds can also be used to fund or match funds for grant projects to improve the Bikeway. The committee should be comprised of one official from each municipality, meeting quarterly to semiannually. Additional consideration for the structure, funding and support of this committee will be necessary to determine feasibility. However the Town's bicycle advisory committees should continue to meet jointly on an annual basis, as well as maintaining open lines of communication, to ensure collaboration among the three towns regarding the Bikeway

Other examples of trail systems with collaborative management include the Ohio & Erie Canalway (managed by the Ohio & Erie Canalway Coalition) and the Swamp Rabbit Trail in North Carolina (managed by the Greenville County Recreation District).

Additional information on maintenance agreements along with sample Memorandums of Understanding can be found on the Rail-to-Trails Conservancy website at:



Event Permitting

Requirements for event permits are different in each Town and securing a permit for event use requires contacting each Town individually. A collaborative effort between the Towns would improve the process and potentially reduce unsanctioned events. A website that includes the permit requirements, contact information, and an application would streamline the process for potential user groups.

Community Support

The communities along the Bikeway should continue to be called upon to support the trail through encouraging proper trail usage, organizing community clean-ups on the trail, and participating in local government activities related to the trail. The business community can support the trail by providing bicycle parking, maps of the trail, and discounts to customers arriving by bicycle.

Procurement of Amenities

To maintain consistency in the Minuteman Commuter Bikeway's identity, it is recommended that amenities throughout the length of the trail be of a uniform look. Procurement of many future amenities should be completed at one time to reduce costs and create uniformity. These include:

- Benches
- Signage
- Lighting
- Trash receptacles

Habitat and Natural Resource Protection

One of the valued characteristics of the Minuteman Commuter Bikeway is the natural setting that it provides, even while travelling through urbanized areas. Any construction must consider impacts on local habitat and natural resources to maintain the natural setting of the trail.

Rules and Regulations

Rules and regulations should be consistent on the Bikeway sections of all towns. Hours of operation should be consistent throughout the Bikeway. And, to better facilitate bicycle commuting, the Bikeway should remain open during evening hours.

7. Community Outreach Recommendations

Existing Condition	Principle	Recommendation and Benefits
Conflicts between bicyclists and pedestrians on the Bikeway are common.	Reduce conflicts between users through education.	Providing education and outreach to Bikeway users will help reduce conflicts and increase compliance with the Bikeway rules.

Education and outreach efforts should be increased to improve courtesy between users and reduce conflicts on the Bikeway. Education and outreach should be targeted toward both motorists and Bikeway users to clarify responsibilities at Bikeway crossings and encourage courtesy between users.

Education and outreach can take several forms. The following list includes effective methods of conveying information about proper trail use. This list serves as a starting point and is not exhaustive.

- **Press Releases:** Communicate key messages to motorists and Bikeway users throughout the year, especially in the spring and before events when Bikeway use is expected to increase.
- **Social Media:** Communicate key messages to Bikeway users through Facebook, websites, email distribution, Twitter, etc.
- **Club Member Outreach:** Target bicycling and running clubs to exhibit safe and courteous behavior, setting a good example for other users.
- **Safe Routes to School:** Leverage the existing program to educate students on safe and courteous Bikeway behavior.



8. Policing and Public Safety Recommendations

Existing Condition	Principle	Recommendation and Benefits
Municipal police respond to reports and conduct periodic patrols, .	Engage Bikeway users to serve as ambassadors to improve safety.	Working with volunteer ambassadors will help improve safety and user etiquette on the trail.

Within each Town’s jurisdiction, individual Town police forces will be responsible for public safety and security. Bicycle mounted patrols will be most effective along the Bikeway, but some towns do not have the person power or equipment to participate in patrol of the Bikeway.

User security can be augmented by citizen volunteers or through cooperative arrangements with other Town programs. Formation of a Bicycle Ambassadors program would provide additional “eyes” on the trail and have the ability to report incidents and assist troubled Bikeway users. Bikeway Ambassadors: are volunteers who demonstrate appropriate Bikeway behavior, communicate key messages to other users, and provide assistance when needed. The key to effective trail policing will be coordination and proper training of ambassadors (including CPR); among the government police forces as well as with civic groups.



9. Maintenance Recommendations

Existing Condition	Principle	Recommendation and Benefits
Some areas of the trail show significant damage from root invasion and other pavement condition problems.	Use best practices to repair the Bikeway from root damage.	Timely repair of pavement, especially from root damage will reduce safety hazards on the trail.
Some signage on the trail is damaged or vandalized.	Work collaboratively to maintain signage on the Bikeway.	Maintained signage presents valuable information and creates a positive aesthetic environment for all users.

Existing Maintenance Practices

Each town has established practices to maintain the trail throughout the year. The Commonwealth of Massachusetts has established maintenance standards for multi-use trail maintenance (http://www.massdot.state.ma.us/Portals/8/docs/designGuide/CH_11_a.pdf) which are used by some agencies as a guide for their operations. Regular maintenance is important for Bikeway safety and comfort. Specifically:

- The Bikeway should be cleared of debris that creates obstacles for cyclists. This is a concern especially after storm events when significant amounts of leaf litter and broken branches can fall onto the trail.
- Vegetation should be pruned or mowed to maintain sightlines.
- Snow and ice should be plowed to allow cyclists to use the trail safely.
- Broken pavement, especially from root invasion, should be repaired to maintain a smooth riding surface and reduce hazardous obstacles for cyclists, runners, and pedestrians.

The following table outlines current maintenance practices and funding sources.



ARLINGTON		
Maintenance activity	Activity Details	Funding Source
Snow plowing	Snowplow	DPW
Leaf litter sweeping	Volunteer spring clean-up event. DPW picks up debris bags following the event	Arlington Bikeway Advisory Committee & DPW
Shoulder mowing	Unknown	Unknown

BEDFORD		
Maintenance activity	Activity Details	Funding Source
Snow plowing	Snowplow	DPW
Leaf litter sweeping	Performed a couple times in the fall	DPW
Shoulder mowing	As Needed	DPW

LEXINGTON		
Maintenance activity	Activity Details	Funding Source
Snow plowing	Private contractor snowplow	Private donations obtained from Lexington Bikeway Advisory Committee
Leaf litter sweeping	Weekly sweeping from May-November and as needed after storm events Volunteer Spring and Fall Cleanup events	DPW Lexington Bikeway Advisory Committee
Shoulder mowing	Every 4-6 weeks Pruning 2 times a year or as needed with volunteers	DPW Volunteers

Pavement Damage/Deterioration

The Bikeway pavement should be kept in satisfactory condition to maintain safety for Bikeway users and reduce long-term costs associated with complete reconstruction. Obstructions should be removed to accommodate cyclists and skaters as well as users with disabilities.

Currently, some Bikeway users report trail conditions via a Yahoo Group to other trail users to alert users to exercise caution on unplowed or unswept sections. While each town should strive to keep the trail clear, social media can be used to communicate conditions of the trail after storm events. The Towns can use a mobile app such as *SeeClickFix* (<http://seeclickfix.com/>) to allow Bikeway users to report hazardous condition to the Towns.



Root Invasion

A common complaint heard from Bikeway users is the pavement damage due to tree root invasion. Pavement damage from tree roots is hazardous to Bikeway users and creates accessibility issues. A three-fold approach should be used to mitigate root damage hazards, beginning with the least effort and increasing effort as needed.

1. **Spot Improvement:** Grind pavement or overlay/patch isolated locations to remove hazards.
2. **Root Removal:** Remove roots from beneath trail surface and repair pavement surface.
3. **Tree Removal:** Completely remove the tree and root system and repair the pavement and adjacent surface.

Root barriers have shown varying degrees of success in different applications. To be effective, the root barrier must extend deep enough to reduce the likelihood of roots growing beneath the barrier and returning to the surface. If used, root barriers should extend to a depth of two feet below the ground surface.

Town agencies should discuss best practices and challenges for root removal to improve maintenance techniques. If root removal cannot be addressed immediately, Town agencies should continue to mark pavement damage from roots with spray paint to increase visibility to cyclists.

Signage & Pavement Marking

Signage and pavement markings on and approaching the Bikeway should be inspected annually. Worn or missing signs and pavement markings should be replaced as soon as possible, especially at intersections.



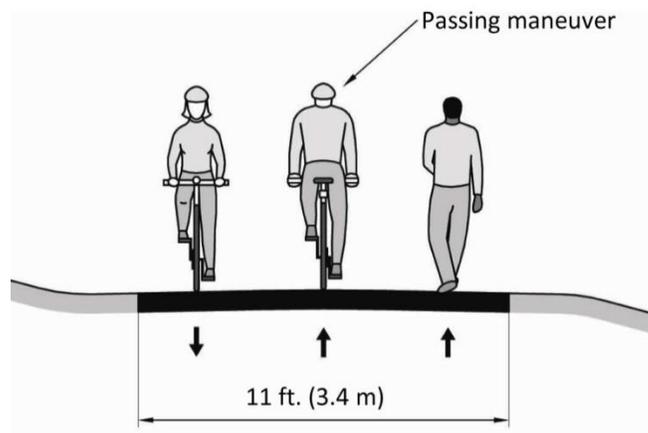
10. Future Improvement Recommendations

Existing Condition	Principle	Recommendation and Benefits
The existing trail is relatively narrow in many places for the high volumes of users it sees today.	Manage and accommodate increased growth and use of the Bikeway.	Widening the Bikeway where feasible and providing waysides for users to get off the trail will improve safety and comfort along the Bikeway.
There is a desire to create a long-lasting trail system while reducing environmental impacts.	Incorporate sustainability and low-impact designs.	Future improvements should be constructed to reduce maintenance. Environmentally sensitive construction materials should be used on the Bikeway.

In addition to wayfinding, amenities, and intersection improvements, there are several areas of improvement that may be addressed in the future to improve the Bikeway experience. As plans to extend the Minuteman Commuter Bikeway solidify, uniformity and consistency with these recommendations should continue on future extensions to maintain the Bikeway identity.

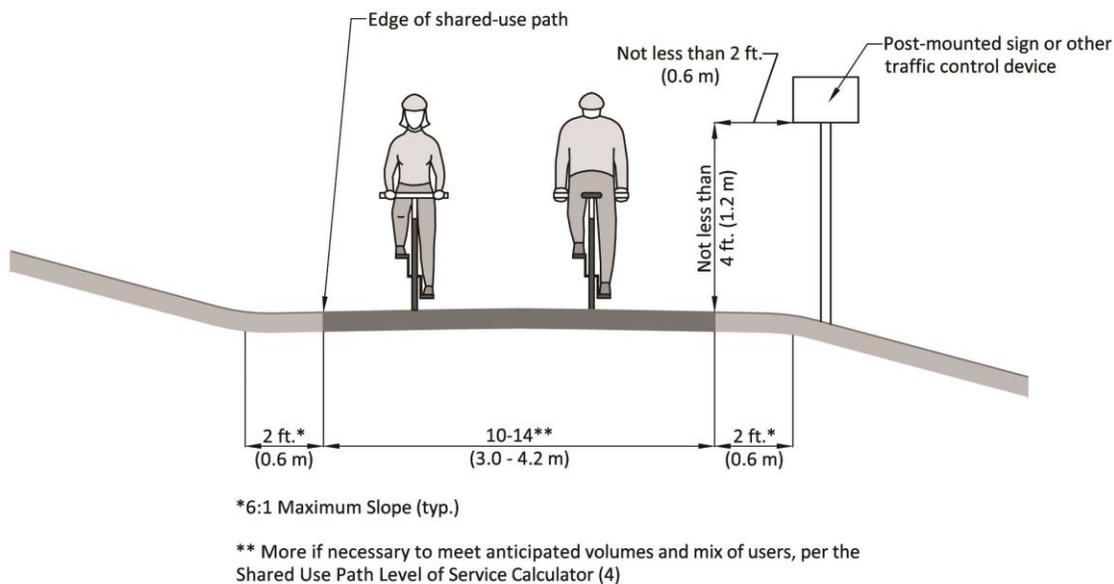
Widening

The existing Bikeway is between 10 and 12 feet wide and is heavily used. AASHTO identifies 11 foot trails as acceptable for cyclists to pass one another in areas of bi-directional bicycle travel, however, this does not accommodate passing when bicycles are riding side by side.



Source: AASHTO Guide for the Development of Bicycle Facilities

Areas of highest use should be widened to 14-16 feet, where feasible, to accommodate passing cyclists during periods of heavy two-way traffic. Significant financial investment is needed for widening, especially in physically constrained areas. Based on the Federal Highway Administration’s Shared Use Path Level of Service (LOS) Model, the current LOS on the Minuteman Commuter Bikeway is a C. This score will likely decrease as usage increases, necessitating widening to improve the comfort of all users. This greatly improves the level of service on pathways with high user volumes.



Source: AASHTO Guide for the Development of Bicycle Facilities

Many trails employ stone dust pathways or shoulders adjacent to paved pathways to accommodate walkers and runners in high traffic areas. Using stone dust can be a cost effective way to shift some of the Bikeway's traffic to one or both of the shoulders, however, this is not a direct substitute for widening the paved section of the roadway as stone dust pathways are not recommended to accommodate passing cyclists.

Context Sensitive Materials

As improvements are made to the Bikeway, environmentally and historically sensitive materials should be considered to reduce environmental impacts and strengthen the image of the Bikeway as an environmentally friendly and historical amenity.

Surfaces/ Paving Materials

A variety of surface material options are appropriate for various segments of the Bikeway and amenity areas.

- **Pavement:** Standard asphalt is recommended for the primary trail and circulation routes along the alignment. An asphalt surface with an aggregate base is suggested depending on local geotechnical conditions. Along segments where the existing asphalt surface is planned to be rehabilitated or resurfaced, milled materials should be reused or recycled within the project to minimize waste to the greatest extent possible.
- **Pavers:** Within gateways, waysides and connecting trails, a variety of concrete, granite, or brick pavers may be utilized in different patterns to create unique areas of interest. However, similar use of surface material is recommended for consistency and user familiarity when using the trail. Accessible routes, preferably concrete, should be maintained through all locations utilizing pavers.

- **Permeable Surfaces:** Similar to locations acceptable to the use of pavers, permeable material surfaces allow water to penetrate through the surface directly to the subsoil by using specialized paving materials such as paving blocks, pervious concrete or asphalt, turf block, decomposed granite, crushed rock, gravel, or soil pavement. Most materials are available in a variety of colors, shapes, and forms and may be arranged in various patterns or stamped to create a unique aesthetic appearance. However, where trail segments, wayside or trailhead areas are frequently flooded, the use of permeable surfaces is not recommended, due to the increased chances of clogging of the porous spaces.

Landscaping, Low Impact Development and Grading

Landscaping and low impact development treatments should be provided along the trail alignment to provide visual interest and to treat the water quality and erosive impacts of stormwater runoff.

- **Landscaping:** Planting areas should be complementary to the general park-like setting of the Bikeway and should vary in function, form, and scale to frame positive views, as well as guide circulation, screen negative views, and provide shade and relief from the sun. In general low bushes and limbed-up trees are recommended to improve visibility along the Bikeway and improve surveillance visibility. The landscaping character should embrace the gateways and waysides in particular. Landscaping should be considered at the recommended waysides and trailheads described in this report.
- **Low Impact Development:** Low impact development (LID) is the treatment of stormwater through the use of biofiltration techniques such as bioswales, raingardens, permeable surfaces, and tree box filters to improve water quality and reduce stormwater runoff and pressures on existing storm water infrastructure systems. Low-impact development areas are recommended along the trail at the trailhead, wayside, and Town center areas, where feasible.

Low Impact Stormwater Solutions

Bioswales

Bioswales are vegetated drainage channels that convey, infiltrate, and treat stormwater runoff water through the use of vegetation and natural biological processes. These systems can be designed into areas that receive run-off from paved areas where runoff may be laden with oil and other waste washed from roadways or as overflow conveyance systems for other bioretention facilities.



Figure 4: Bioswale with information signage

Rain Gardens

Rain gardens are shallow depressions that infiltrate and treat stormwater through the use of deep-rooted native plants and grasses. These systems are located near a runoff source with

drainage areas up to 5 acres in size. These features provide an aesthetically interesting garden area while treating stormwater, compatible with a park setting or educational interpretative area.



Figure 5: Rain garden at crossing

Tree Box Filters

Tree box filters consist of a container filled with an engineered soil mixture, under-drain system, and a tree or various plantings located along a roadway or impervious surface area. These systems typically replace or provide pre-treatment upstream of traditional stormwater drain inlets and treat stormwater runoff through infiltration, and natural biological processes by the plant materials present in the tree boxes.



Figure 6: Tree box filter |
Massachusetts Stormwater Handbook

Permeable Surfaces

As noted in the surfaces and paving materials section, permeable surfaces would be used to provide additional areas for water infiltration into the underlying soil, reducing stormwater runoff.



Figure 7: Permeable pavers

11. Next Steps

The Towns should review this plan with local stakeholder groups and government agencies to prioritize next steps and determine responsibilities for implementation. Stakeholder groups may include but are not limited to, the following:

- Arlington Bicycle Advisory Committee
- Bedford Friends of the Minuteman Commuter Bikeway
- Friends of Lexington Bikeways
- Economic development departments
- Tourism organizations
- Public Safety departments
- Town center committees

Management and Maintenance of Trail

Trail maintenance and management will involve a variety of activities through a variety of jurisdictions. As described earlier, collaboration between jurisdictions is recommended to improve efficiencies and reduce costs.

Implementation

- Managing phased addition of wayfinding and trail amenities
- Coordinating design and installation of waysides, trailheads, and/or interpretive signs

Ongoing Maintenance

- Coordinating with Town agencies to provide maintenance and surveillance support, and ensuring on-going coordination and information exchange among town agencies, neighborhood groups.
- Developing promotional materials.
- Managing trail operations and addressing any user conflicts that may arise.
- Regular clearing of vegetation and overgrowth.
- Repairing damaged sections of the trail treadway.
- Trail sweeping and emptying trash receptacles.
- Regular inspection and cleaning of catch basins, culverts and other drainage facilities.
- Maintaining and replacing signs and pavement markings.
- Graffiti removal, if necessary.
- Tree root damage maintenance and prevention

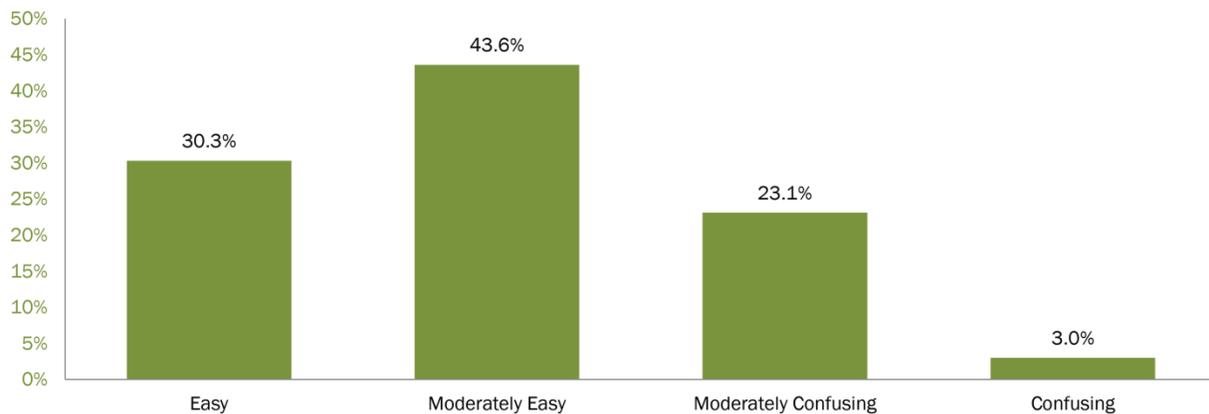


Appendix A: Public Outreach

The Minuteman Commuter Bikeway public online survey, conducted in September 2012, was prepared by Toole Design Group on behalf of the Town of Lexington for the Navigating the Minuteman Commuter Bikeway Project. The purpose of this questionnaire was to collect feedback from Bikeway users to identify desired improvements to trail signage, intersection crossings, and trailside amenities within the Towns of Arlington, Bedford, and Lexington. Posters were placed along the Bikeway with a link to the survey and a Quick Response code for use with mobile devices. Nearly 1,000 responses were recorded for the 15-question survey.

Survey Responses (in order asked)

1. How easy or difficult is it to navigate along the Bikeway?

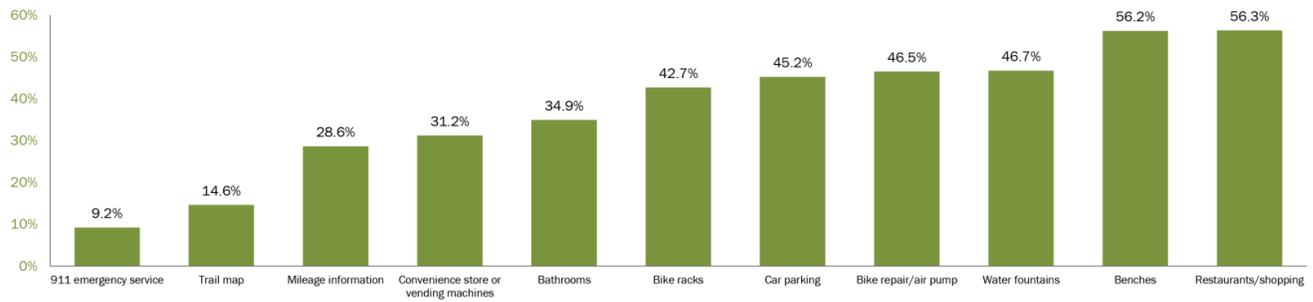


2. What aspects of Bikeway signage would be most important to improve?

- | | |
|-----------------------------------------------------|-----------------------------------------|
| 1. Mile Markers / Distances | 5. "You Are Here" Maps |
| 2. Context Signs (Amenities / Historic Sites, etc.) | 6. Entrance / Exit Signs |
| 3. Cross Street Signs | 7. Signs for Arlington Center |
| 4. Rules of the Road / Trail Etiquette | 8. "Stay to the right" Signs |
| | 9. Distance to Town Centers |
| | 10. Bathroom / Water Fountain Locations |

3. Which of the following amenities do you know where to locate along or near the Bikeway?

(Mark all that apply.)



4.

Are there additional amenities or destinations you would appreciate navigational information to?

Directions to:

1. Other Trails / Paths
2. Parks / Playgrounds / Athletic fields
3. Restaurants / Cafes / Food stores
4. Shopping centers
5. Bike Shops / Bike Friendly Businesses
6. Historic Sites
7. Tourist Point of Interest
8. Town Centers
9. Public Transportation
10. Schools

Amenities:

1. Bathrooms
2. Water Fountains
3. Mileage Markers
4. Trail Maps
5. Bike Repair Stands
6. Street Signs
7. Trash Cans
8. Benches
9. Lights
10. Bike Parking

5. What amenities would you recommend to improve your Bikeway experience?

- | | |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ol style="list-style-type: none"> 1. Repave Bumps 2. Water Fountains 3. Bathrooms or Directions to Bathrooms 4. "Rules of the Road" Signs 5. Lighting | <ol style="list-style-type: none"> 6. Intersection Improvements (Gates, stop signs, safer crossings) 7. Snow and Debris Removal 8. Bike Repair Stations 9. Signs to Nearby Amenities and Trails 10. Benches |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

6a. What three Bikeway intersections are the most difficult to cross?

- | | |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| <ol style="list-style-type: none"> 1. Arlington Center/Mass Ave 2. Lake Street 3. Hancock Street in Lexington 4. Woburn Street 5. Bedford Depot | <ol style="list-style-type: none"> 6. Alewife 7. Pleasant Street 8. Lexington Center 9. Hartwell Avenue |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|

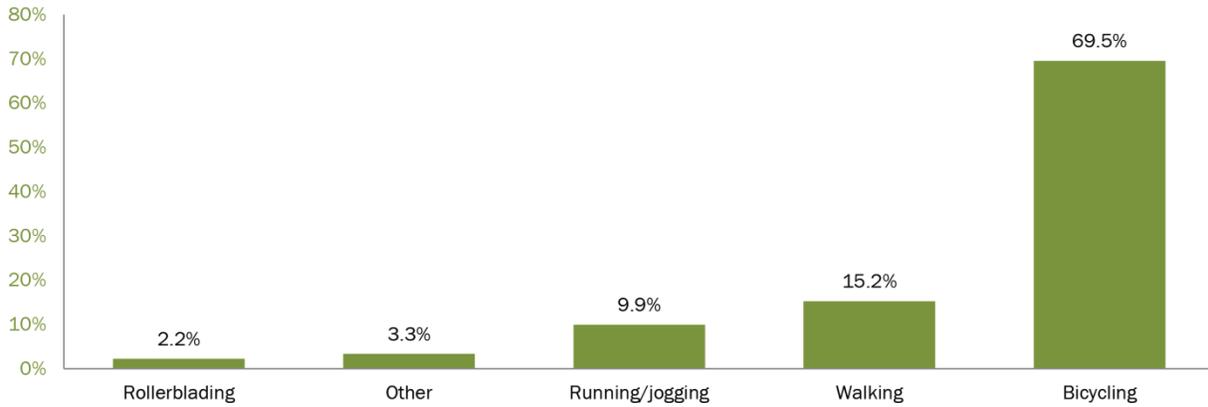
6b. What makes these intersections challenging?

- | | |
|--------------------------------------------------------------------------|----------------------------------------------------------------|
| <ol style="list-style-type: none"> 1. Traffic / Congested | <ol style="list-style-type: none"> 6. Confusing |
|--------------------------------------------------------------------------|----------------------------------------------------------------|

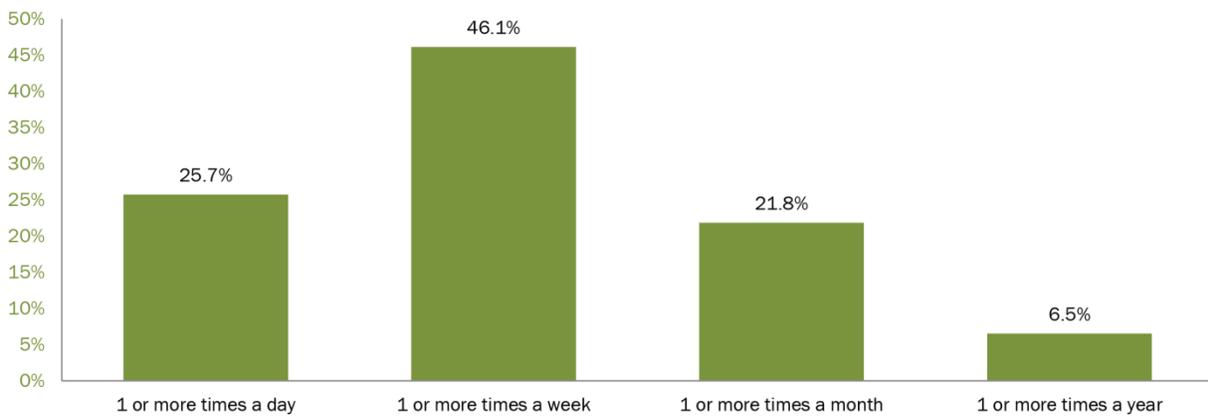


- 2. Car Drivers
- 3. Gap in Pathway
- 4. Visibility (e.g. landscape, lack of lighting, etc.)
- 5. Lack of Enforcement / Signs / Speed Bumps
- 7. Tricky / Twisty / Bad Angled Pathway
 - Unsafe Pathway
 - Scary / Dangerous
- 8. Technical Problems (e.g. walk traffic lights)

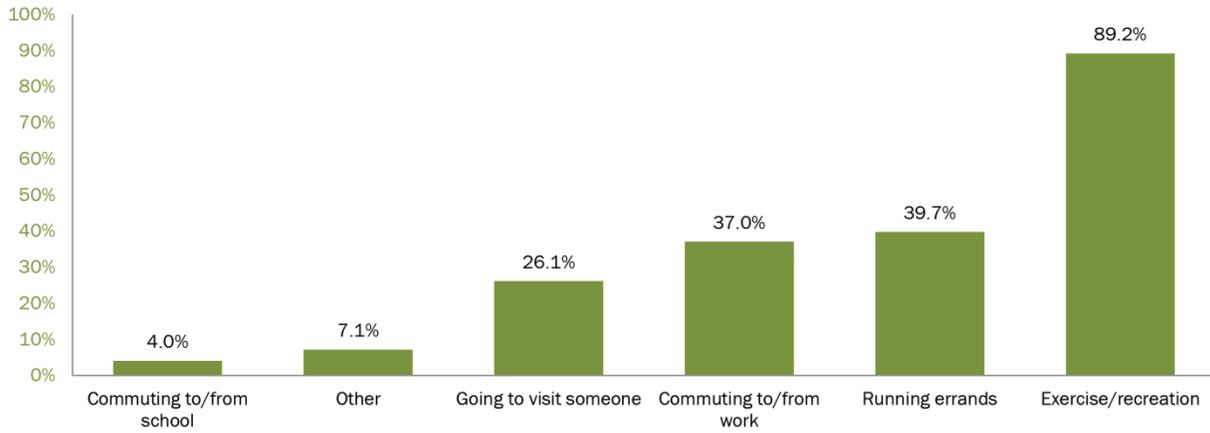
7. How do you most frequently travel on the Bikeway?



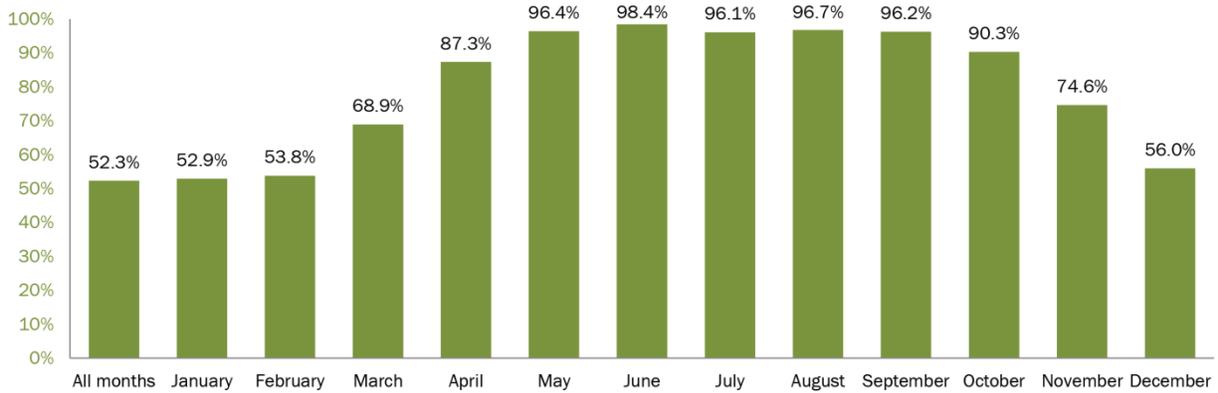
8. How frequently do you use the Bikeway?



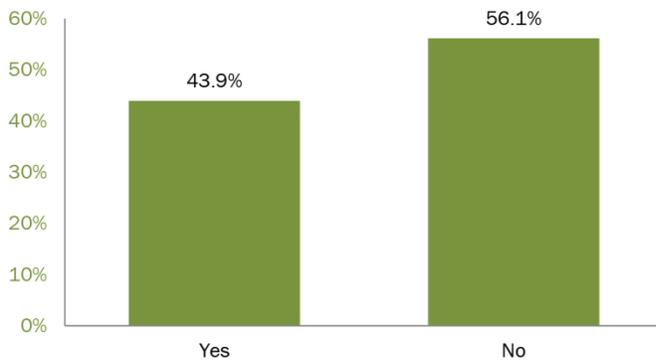
9. How do you use the Bikeway? (Check all that apply.)



10. During which months do you use the Bikeway?

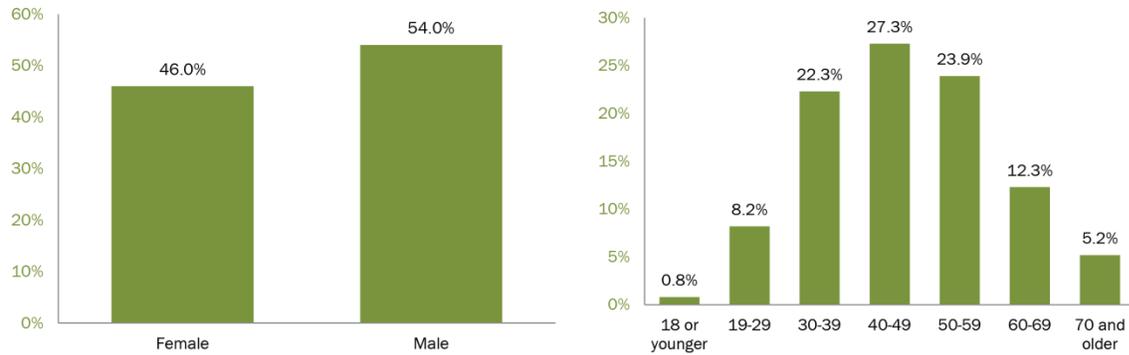


11. Do you use the Bikeway at night?



2.

Survey Respondents' Gender and Age

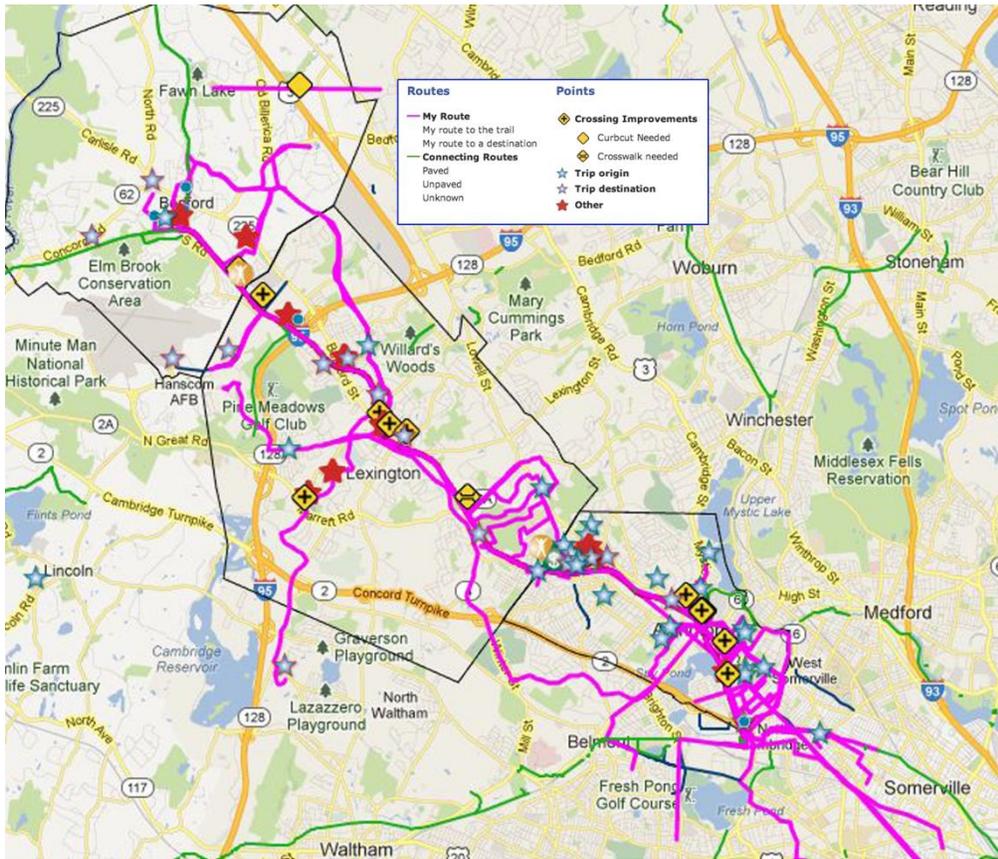


WikiMap

The public outreach included an online mapping tool used to gather public comment on connections to and from the Bikeway and nearby destinations.

From their home computers, participants used the map to:

- Draw their routes to and from the Bikeway and indicate how frequently the routes were used.
- Identify specific points of interest of personal importance.
- Leave comments or “like” points of interest identified by other users.
- Upload photos on their routes or on specific points of interest.
- Submit their observations, needs, and wants, and provide feedback on the Bikeway both as a whole and about specific locations or elements.



A total of 34 community members used the WikiMap to provide additional information. Generally, information provided was routes traveled on the Bikeway (pink lines) preferences to and from the Bikeway (green lines) and troublesome intersections (yellow intersection signs).



Appendix B: Community Input

The following table lists comments received from public and stakeholder meetings, the open house, and additional communication with the public and stakeholders.

COMMENT	RESPONSE
Awesome presentation of ideas.	No response needed
Don't know what trail marker this means (near Bedford Narrow Gauge Rail)	Town agencies should use a consistent graphic style for signage and a standard design for new site furniture.
Lexington welcome signs should be coordinated with Lexington Tourism Signage Program (near bottom right corner)	Town agencies should use a consistent graphic style for signage and a standard design for new site furniture.
I only have one comment. I did not see any use of current mobile technology like a QR code or app or link. Many people travel the bike path with smart phones and simply providing them with a link - may be to a map of local businesses or QR with this info, would be a good way to stay current.	Town agencies should improve mobile wayfinding. Suggestions include: Holding a contest to create a mobile app for the trail which may include historic content, maps, and local amenities / events; Encourage current mapmakers to issue a mobile version (including PocketRides, Mass Bike);
Every road have trail signage	Key routes to the Bikeway should have signage.
Incorporation wayfinding into buildings, i.e. depot	Wayfinding from each town is the responsibility of the town. Towns should use the Minuteman logo for consistency where possible.
Consistency!	Town agencies should use a consistent graphic style for signage and a standard design for new site furniture.
Using the mile markers that exist on the Bikeway may be a problem. The roman numerals going west to east are incorrect, showing an 11 mile trail because the first marker says "1" instead of "0". There are no ½ mile markers on the Bikeway now, should be, and should include the name of the town the user is in.	Mile markers are not recommended due to the number of intersections along the Bikeway.
Encourage adjacent business to have signs describing their amenities? (water, food, restroom); (near #2 Direct Bikeway Users...)	Water and restrooms should be provided on the trail. Signage and maps on the Bikeway should identify town centers or areas with retail and amenities.
Like simplicity of signage. Please formally present to Lexington Tourism Committee for recommendations/support (near Mile Markers)	Town agencies should use a consistent graphic style for signage.
New mileage markers should look like smaller version of trail head signs (near title border)	Town agencies should use a consistent graphic style for signage.
Lexington Depot: "railroad station" type sign on Depot Building "Lexington Center" (near comment above)	Town agencies should use a consistent graphic style for signage.
Do <u>not</u> deface existing granite mile markers w/ modern signage. They are BEAUTIFUL. Would you put a sign on Stonehenge (near comment above)	Mile markers are not recommended due to the number of intersections along the Bikeway.
Put up colored flag along the pathway to represent the town (near "Minuteman Bikeway 0.5" title)	Town agencies should use a consistent graphic style for signage.
Perhaps an "add-on" option where there already (too) many signs (near Maguire Rd photo)	Fingerboard signs can combine information.
How about putting up street name signs where bike paths cross streets? Besides being a convenience issue, this is also a safety issue. Someone who dials 911 needs to be able to describe their location. So please put street name signs at every street crossing on the Minuteman and the other bike paths in town.	All intersecting streets should have a street sign, including those that do not intersect with the path (e.g. an overpasses and underpasses).
Use full name: "Minuteman Commuter Bikeway"	Full name will be used.



COMMENT	RESPONSE
Great to have more signage! Would be more of they are w/ a good height for biker (near above comment)	A strategic signage plan is needed to convey important information without creating signage clutter. Signs should be placed at a minimum of 4 feet from the ground, per MUTCD guidance.
Gates are hazardous; replace with splitter islands; at least paint bright colors	Gates and bollards should be removed from all entrances to reduce hazards to cyclists.
Planned Improvements to Lexington Visitors Center would benefit by incorporating suggested Bikeway needs (near Revere Street)	Lexington Visitors Center is recommended as a potential wayside.
Remediate headlight glare from Summer St? (near Warren Pierce Playground)	Noted.
Arlington is putting a visitor info booth in Arlington Center (by Uncle Sam Statue); (near Water Street)	Each town should consider including wayfinding to the Bikeway on town maps.
Bench design should be consistent with existing benches	While there are several bench designs in existence on the trail, future benches should have a uniform design.
Signage for bathroom (near Depot Square)	Maps and signs should identify restrooms along the trail.
Better access to town center and bike lanes along Mass Ave in commercial area	Addressed in wayfinding recommendations.
Where are ideas about how to better utilize the Lexington Depot and the Lexington Visitors' Center as trailhead/wayside/information center for Bikeway? What is the analogue in Arlington and Lexington to the Bedford Depot?	Recommendations for waysides at these locations and others are included in the report.
Need to beef up recommendations about trailheads and parking. Parking is badly needed.	Recommendations for additional parking areas are included in the report.
Historic kiosk example?	Interpretive panel examples shown in the Trailheads and Waysides section.
Visitor Center plan	A wayside may be located at the Visitor Center.
Signs for bathrooms	Maps and signs should identify restrooms along the trail.
Kiosks: add "natural history" to the types of information.	Interpretive panels will include Colonial history, Railroad Era history, Recent history, and Natural History and Features.
Consistency—reflective paint	Signage should be made with reflective paint for visibility in low light conditions.
Signage	Signage should be consistent and strategically placed to provide important information to users without creating visual clutter.
Rest places and water would be great. Please avoid marketing/advertising and keep the Bikeway green (near #1 title)	Signage should be consistent and strategically placed to provide important information to users without creating visual clutter.
List amenities in Google Maps. Develop App! (near head title)	Town agencies should improve mobile wayfinding. Suggestions include: Holding a contest to create a mobile app for the trail which may include historic content, maps, and local amenities / events; encourage current mapmakers to issue a mobile version (including PocketRides, Mass Bike).
Concerned about over signage (near "Recommended Informational Kiosk Content")	Signage should be consistent and strategically placed to provide important information to users without creating visual clutter.
Creating more rest stops is a great idea. PLEASE, granite benches only (near photo in right bottom corner)	Town agencies should consider granite benches if budgets allow. If not, metal benches are preferred to wooden benches.
Separate trash bins & recycling bins (near above comment)	Town agencies should work together to encourage recycling on the trail, through separated bins or co-mingled operations.
Mileage markers distance believe points; distance to level 3 waypoints & other amenities	Wayfinding
(Happen to notice the logo here blocks bike through rack. Conceptual only?) (near bike rack graphics)	The bicycle racks shown are intended to support bicycles parallel to the rack rather than through the rack.
Trash cans w/ lids (and recycling) (near trash/recycling photos)	Town agencies should work together to encourage recycling on the trail, through separated bins or co-mingled operations.



COMMENT	RESPONSE
More clearly marked/visible restrooms or porta potties please! Might be more important than water for many users (ex families & children). You can carry your own water, but you can't really carry your own potty (near Level 3 Waysides)	Maps and signs should identify restrooms along the trail.
Great amenities all. Much needed (near above comment)	No response needed.
Drinking fountain away from edge of trail & convenient to fill water bottles (near drinking fountain photo)	Drinking fountains should be located off the path on waysides and should include a spout to easily fill water bottles.
Lights at intersections for night crossings (near above comment)	Intersection lighting recommendations are included in the report.
Too modern for historic town (near Information kiosk conceptual mockup photo)	Kiosk design should include the Minuteman Logo and reflect the historic nature of the trail.
Lexington visitor's center lacks any welcome sign on the "back" door facing the Bikeway. Also, no wayfinding to toilet facility within! (near above comment)	Wayfinding and gateway signs on streets leading to the trail should be clearly visible. Maps and signs should identify restrooms along the trail.
Arlington Center intersection needs help. ?change lights so that traffic stops in all directions so users in both directions can stay on the trail be pressing the diamond button only once (also minimize disruption to motorists); (near above comment)	The intersection at Arlington Center is currently being redesigned.
Coordinate content w/ tourism Committee. Providing too much info keeps users from coming into Town (near Recent History box)	Maps should include town centers and key destinations adjacent to the Bikeway.
Massive traffic @ Lake St.	This comment has been noted.
Arlington Center needs complete overhaul-trail confusing traffic - I avoid it!	The intersection at Arlington Center is currently being redesigned.
Much improved. but time Mass Ave street lights for one continuous crossing	The intersection at Arlington Center is currently being redesigned.
Maybe some graphics could illustrate "No parking on one-way" and way signs for cellphone use (near What aspects of Bikeway signage would be most important to improve?)	Trail etiquette should include language about minimizing volume on cell phones and headphones to increase awareness of passing Bikeway users.
Repair the bumps - avoid serious injuries (near above comment)	Town agencies should conduct spot improvements to remove hazards.
Again - bumps are a red danger (near above comment)	Town agencies should conduct spot improvements to remove hazards.
Taxi stand (near "Amenities" by map)	Maps should include existing taxi stands in town centers or transit hubs near the Bikeway.
Stop signs for autos at all intersection except where there are lights & Woburn St. (near Revere Street)	Intersection control will be based on engineering analyses considering motor vehicle speeds and volumes, Bikeway volumes, available sight distance and other factors.
Chirpers for light would be good (near Westview Street)	Accessible pedestrian signals are recommended.
Make Water Street 2 way Bikeway with crossing at intersection of Mass Ave (Jon Joe Michelle)	Noted. This route is a popular alternative.
Make route to Water Street on Mass Ave official	Noted. This route is a popular alternative.
Soft shoulder	Stone dust shoulders are recommended for consideration along the trail.
Mill St. - new treatment	Noted.
Pavement markings on the Bikeway (near "Principles" title)	Centerlines and side striping are recommended, along with regular maintenance.
Clearer roles of the Bikeway for bikers and walkers (near above comment)	Detailed trail etiquette signs should be located at information kiosks at trailheads and passing etiquette signs should be located in high volume areas or areas with low visibility.
For walkers, rules of guidance about walking 3 or more abreast (near above comment)	Detailed trail etiquette signs should be located at information kiosks at trailheads.
Excellent (near "Provide the Least Intersection Control that is Effective")	No response needed



COMMENT	RESPONSE
As a biker or walker on the Bikeway. I do not see differences between these (?) streets. Therefore, control is inconsistent to me (near "Yield Control for Bikeway Users" graphic)	Different levels of control based on the volume of the street can help improve compliance and safety at intersections.
Fabulous Trail!: Some concerns about lack of stop lights at certain crossings Lexington-Bedford section of trail;	Intersection control will be based on engineering analyses considering motor vehicle speeds and volumes, Bikeway volumes, available sight distance and other factors.
Really like 'yields' where appropriate! Seconded! Third! (near above comment)	Yield signs should be employed at low volume intersections rather than full stop signs.
Woburn St - Fletcher really needs to be repaved (near "welcome to Lexington Center " signs)	Noted.
Thanks for fixing (most of) the bumps on the path (near Ryder Street)	Positive comment.
Root Barrier - best practice	DCR and Town agencies should discuss best practices and challenges to improve maintenance techniques.
Closing time?	Hours should be consistent throughout the Bikeway.
Make time consistent	Hours should be consistent throughout the Bikeway.
The root barriers have been put down in Lexington, should acknowledge that.	DCR and Town agencies should discuss best practices and challenges to improve maintenance techniques.
What is meant by "green" material?	Environmentally friendly materials are outlined in the "Future Improvements" section of the report.
What about rain gardens at the chronically flooded spots in Lexington (that is, at Seasons 4 and at Hancock Street).	Analysis to properly locate rain gardens in areas to minimize flooding?
Spell out how "powers group" would work in terms of budget. The reasons the towns don't work together is because they have separate budgets, equipment, etc. The three bike committees work together, but they don't have any power or money. They did develop Bikeway guidelines.	Town agencies should coordinate regular maintenance and dedicate regular funding for this activity as part of regular town activities.
Drainage problems striping of surface (near "Signage & Pavement Marking)	Drainage improvements and striping are recommended.
Annual repainting of centerline needed (it is now faded to non-existent). Also paint fog lines (side stripes); (near above comment)	Centerlines and side striping are recommended, along with regular maintenance.
The three towns should each establish revolving funds to receive & spend private donations and public funding for Bikeway repair/maintenance/improvements (near "Policy" box)	Town agencies should coordinate regular maintenance and dedicate regular funding for this activity as part of regular town activities.
- can Toole be more specific on what types of 'education' will increase compliance of 'rules of the trail'? We already have signs and maps and web sites w/ the information but people don't read them, or choose to ignore	Detailed signage should be located at trailheads and volunteer ambassadors can help spread messages. Signage targeting passing behavior should be placed approaching areas of low visibility.
- improving/maintaining (pruning vegetation) sight-lines as much as possible at intersections is important	DCR and Town agencies should coordinate regular maintenance on the Bikeway.
+ icons/arrows on the pavement indicating proper direction for peds	All trail users should keep right; trail use signs placed on heavily used areas of the trail are recommended to remind users.
+ suggest that young children go on right side of lane, away from center line	Detailed signage should be located at trailheads and volunteer ambassadors can help spread messages. Signage targeting passing behavior should be placed approaching areas of low visibility.
+ ticketing the 'cowboys' who speed/pass on the center line	Trail ambassadors will maintain a presence on the Bikeway to discourage violations.
+ cameras to monitor/record violations	Trail ambassadors will maintain a presence on the Bikeway to discourage violations.
- the ad hoc access path behind Gold Gym, Arlington needs to be 'fixed'. Very dangerous	Noted.

COMMENT	RESPONSE
- ensure abutting parking lot snow is not dumped onto MM (e.g., near Arlington Center)	Town agencies should coordinate regular maintenance on the Bikeway, which includes snow removal.
- DPW inspect rail tree repairs to ensure the contractor has not left bumps	Town agencies should coordinate regular maintenance on the Bikeway.
- the tree root cracks are dangerous; can maintenance paint them orange?	Town agencies should conduct spot improvements to remove hazards.
Spray paint root damage	Town agencies should conduct spot improvements to remove hazards.
Trail maintenance via community clean-up	Town agencies should coordinate to encourage community clean up days.
Spray paint roots	Town agencies should conduct spot improvements to remove hazards.
Brush clearance	Town agencies should coordinate regular maintenance on the Bikeway.
M.O.U best consistent practices	Town agencies should discuss best practices and challenges to improve maintenance techniques.
Country skiing?	The trail must be plowed to accommodate winter commuter cyclists, as commuting is a primary use of the trail. Trailheads may include seasonal information about nearby cross country skiing locations.
Woburn St RFB?	Report includes criteria for locations of rapid flashing beacons.
Volunteer trail ambassador	Volunteer Bikeway ambassadors will help communicate key messages to users and provide assistance where needed.
Police on bikes	Bicycle mounted patrols will be most effective along the Bikeway. However, some agencies do not have the person power or equipment to participate in patrol of the Bikeway. User security can be augmented by citizen volunteers or through cooperative arrangements with other city programs.
Re grinding of root heaves on Bikeway: acknowledge in report that Arlington has recently accomplished this. Lexington's root heaves are awful and getting worse, perhaps Lexington should borrow the equipment Arlington used. (This is in the spirit of more cooperation between towns when it comes to Bikeway maintenance.)	Town agencies should discuss best practices and challenges to improve maintenance techniques.
The root barriers have been put down in Lexington, should acknowledge that.	Town agencies should discuss best practices and challenges to improve maintenance techniques.
This stretch of Bikeway is defined as part of Approved Battle Green Masterplan area and amenities should be consistent with plan (near Meriam Street)	The Battle Green Master Plan calls for landscaping to screen the Minuteman Commuter Bikeway. The Battle Green should be listed on Minuteman Commuter Bikeway maps and historic markers may reference the Battle Green.
Please work w/ Bedford & Billerica on extending completing reformatory branch & narrow gauge/Yankee doodle Bikeway; need parking in Billerica at start of narrow gauge	The Reformatory Branch is outside the scope of this project. Connecting Bikeways and pathways are encouraged to improve access to the trail.
It's really bumpy here (wiggins-128); Barbwire closures for re-paving with preserving access to trail; for many a bumpy trail is better than no trail (near "welcome to Lexington" sign under Westview Street)	Town agencies should coordinate regular maintenance on the Bikeway and maintain access whenever possible.
Particularly liked the engineering of the crossing of roadways/Bikeway;	Context-appropriate intersection controls will help compliance with stop signs.
- the new intersection controls based on context (volume, speed, sight-lines, etc.) - great idea	Context-appropriate intersection controls will help compliance with stop signs.
- widening where feasible - good idea	Widening the bike lane will help accommodate future growth.
+ solid yellow (not dashed) to convey the two lanes	A single dashed yellow line is recommended, except in no-passing areas (per agreement among towns).
- removing the 'dangerous' gates/posts will be welcomed	Positive comment.
Add RF Beacon!	Report includes criteria for locations of rapid flashing beacons.



COMMENT	RESPONSE
Add trail sign	Signage should be consistent and strategically placed to provide important information to users without creating visual clutter.
At Revere St: is yield/stop also on the roadway? Or just on Bikeway?	Draft recommendations are for control only on the Bikeway. An engineering analysis should be conducted.
"Stop" control should also be shown at Depot intersection. This is a very dangerous intersection and is probably what is meant on poster by "Lexington Center." That should be corrected.	The map has been updated to include a stop control at this intersection.
Remove rumble strips! They are a danger to skaters.	Rumble strips are important for accessibility.
In suggestions about widening path: if it's too expensive to widen, then add stone-dust walking paths on either side (the area is already worn down from runners on both sides, just widen it slightly and add a soft surface).	Because cycling constitutes the highest percentage of users, it is recommended to increase the paved area rather than adding stone dust paths.
The map between Bedford and Lexington shows one of the "secondary" connections as the rough trail behind the dump! That is not an access point worth showing. Don't think the survey data for the wikimap was valid if that was one of the secondary points identified. Meriam St is a major access point, as is the roadway to the parking lot behind the Lexington Depot.	The map has been updated to remove this connection and add Meriam St as a primary connection.
What about bollards, what is company's recommendation about blocking intersection entrances with gates or poles? More explicit advice about what is best for intersection safety and modern intersection design (drawings show old fashioned standard right angle intersections – shouldn't intersections be curved like at Westview?)	Bollards and gates should be removed to reduce obstacles for cyclists. Recommended intersection improvements are based on current AASHTO safety standards.



Appendix C: Cost Estimates

Estimated costs to install recommended amenities and other trail improvements are summarized in the following table. The estimated costs are planning level estimates that are subject to change. Construction cost estimates were developed for the recommendations by identifying pay items and assuming low to moderate quantities. Unit costs are based on 2013 dollars and were assigned based on historical cost data from MassDOT, other state departments of transportation and other sources. The costs are intended to be general and used for planning purposes. Construction costs will vary based on the ultimate project scope (i.e. potential combination of projects, or use of Town forces) and economic conditions at the time of construction. Design, survey, and other pre-construction activities would add to the level of required funding shown below.

Costing Alternatives:

Trail widening: Asphalt (\$75-100/lf)

Trail installation: Stone Dust (\$15-25/lf)

Wayfinding: Post & Sign Set (\$150-250/each)

Wayfinding: Interpretation Sign (\$750-1500/each)

Information Kiosk (\$1,200-2,000/each)

Trail Wayside Installation (\$5-15,000/each)

Site Furniture: Benches (\$750-1500/each)

Site Furniture: Tables (\$800-2000/each)

Site Furniture: Bike Racks (\$200-500/each)

Site Furniture: Trash/Recycle Receptacles (\$200-500/each)

Site Furniture: Solar Compacting Trash/Recycle Receptacles (\$5,000-7,000/each)

Site Furniture: Dog Bag Dispensers (\$100-200/each)

Site Furniture: Drinking fountain (\$1,000-5,000/each)

Site Furniture: Light post (\$5,000-10,000/each)

Appendix D: Amenity Intensity Maps



Minuteman Bikeway Trail Inventory Amenity Intensity Map

1/4 mile radius

**Bike
Racks**

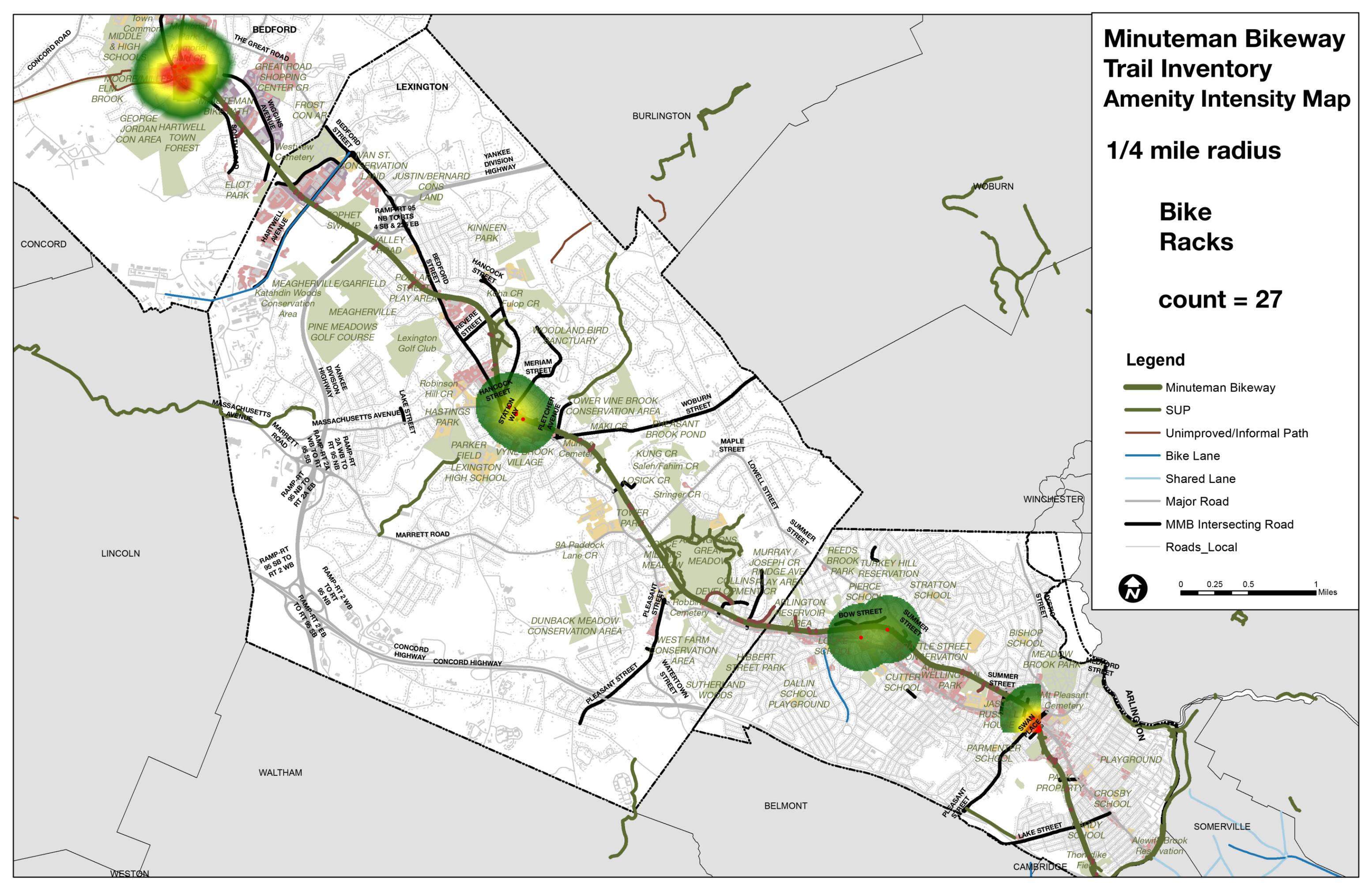
count = 27

Legend

- Minuteman Bikeway
- SUP
- Unimproved/Informal Path
- Bike Lane
- Shared Lane
- Major Road
- MMB Intersecting Road
- Roads_Local



0 0.25 0.5 1 Miles



Minuteman Bikeway Trail Inventory Amenity Intensity Map

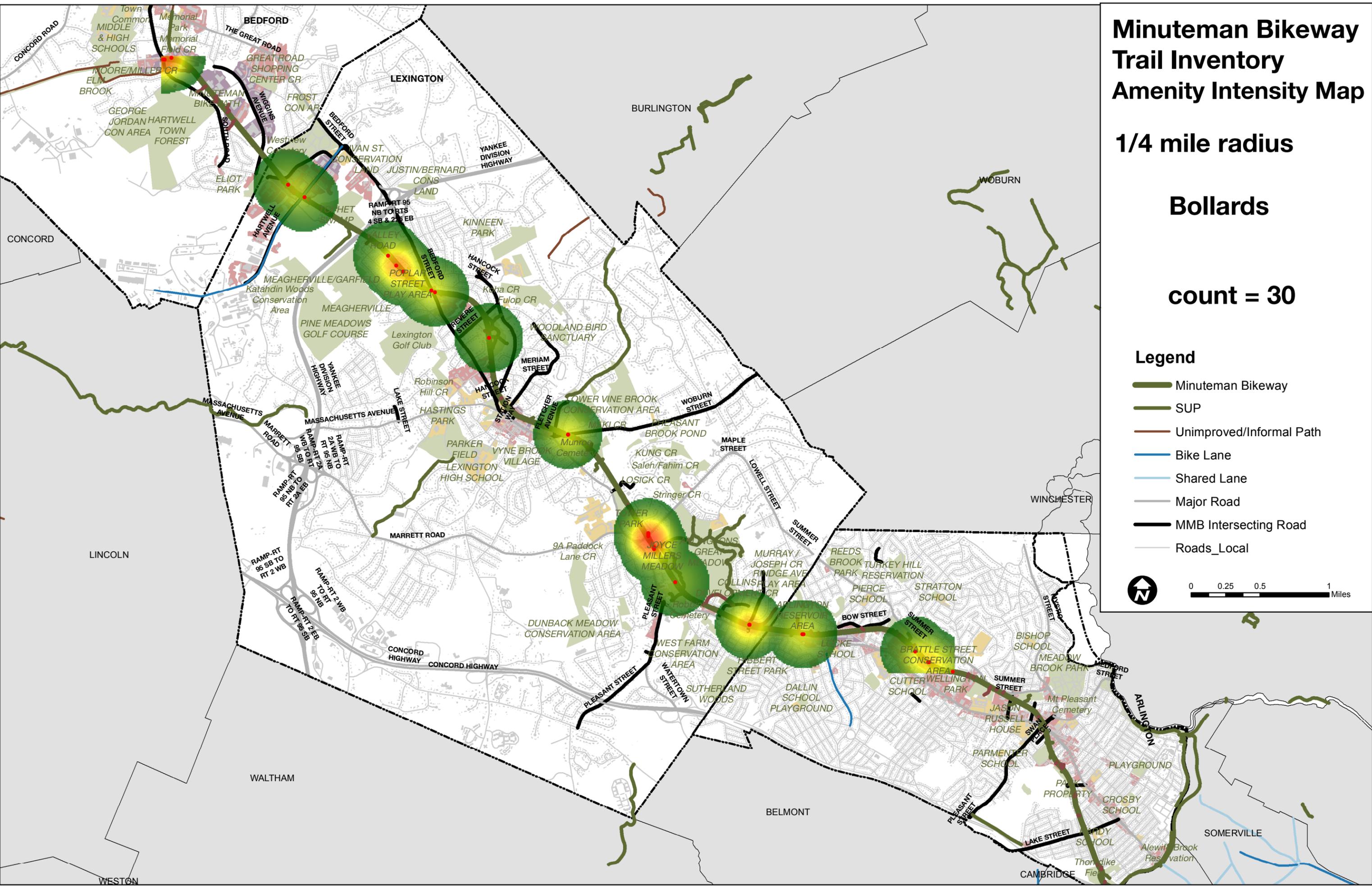
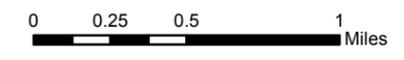
1/4 mile radius

Bollards

count = 30

Legend

-  Minuteman Bikeway
-  SUP
-  Unimproved/Informal Path
-  Bike Lane
-  Shared Lane
-  Major Road
-  MMB Intersecting Road
-  Roads_Local



Minuteman Bikeway Trail Inventory Amenity Intensity Map

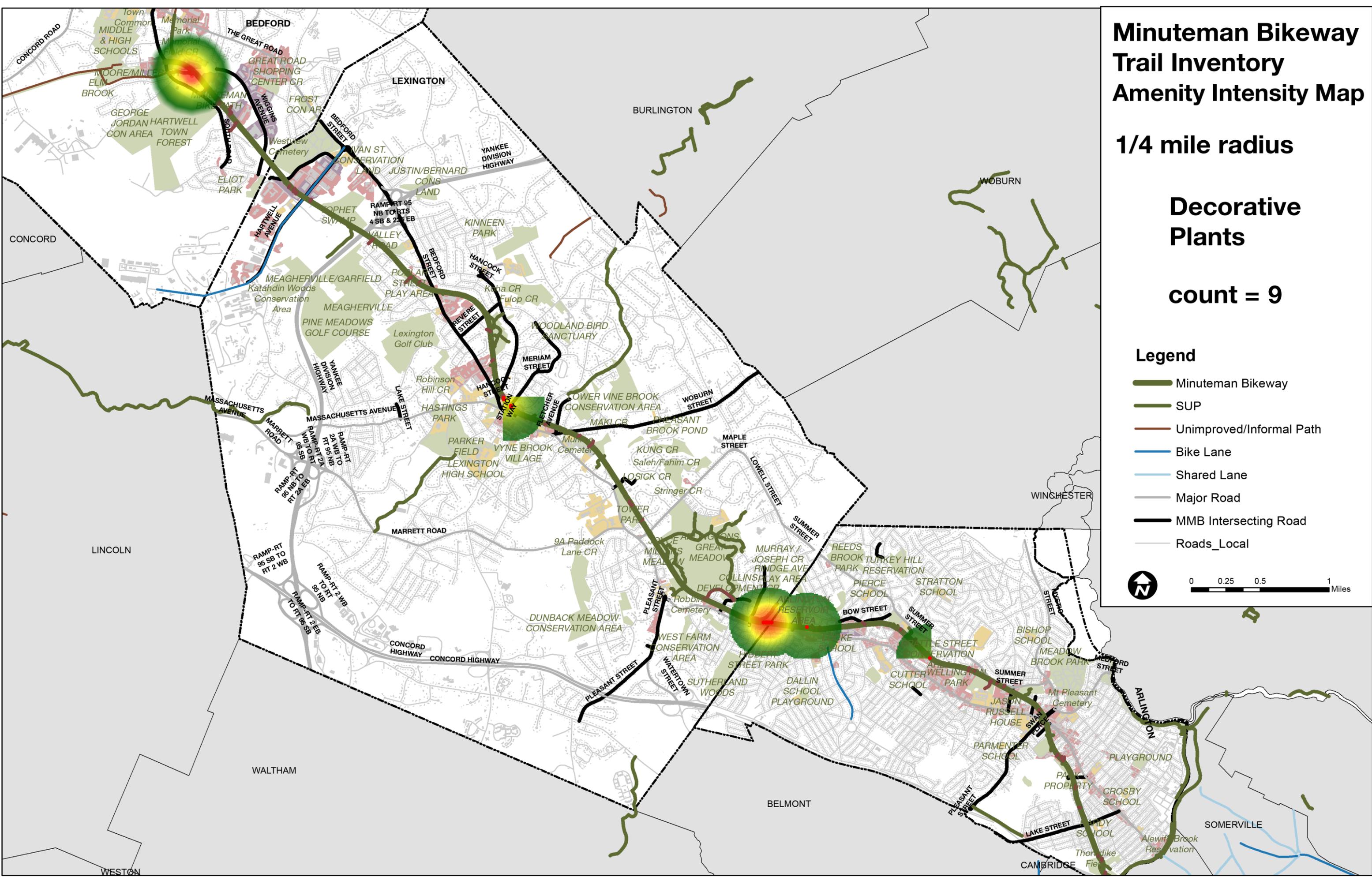
1/4 mile radius

Decorative
Plants

count = 9

Legend

- Minuteman Bikeway
- SUP
- Unimproved/Informal Path
- Bike Lane
- Shared Lane
- Major Road
- MMB Intersecting Road
- Roads_Local



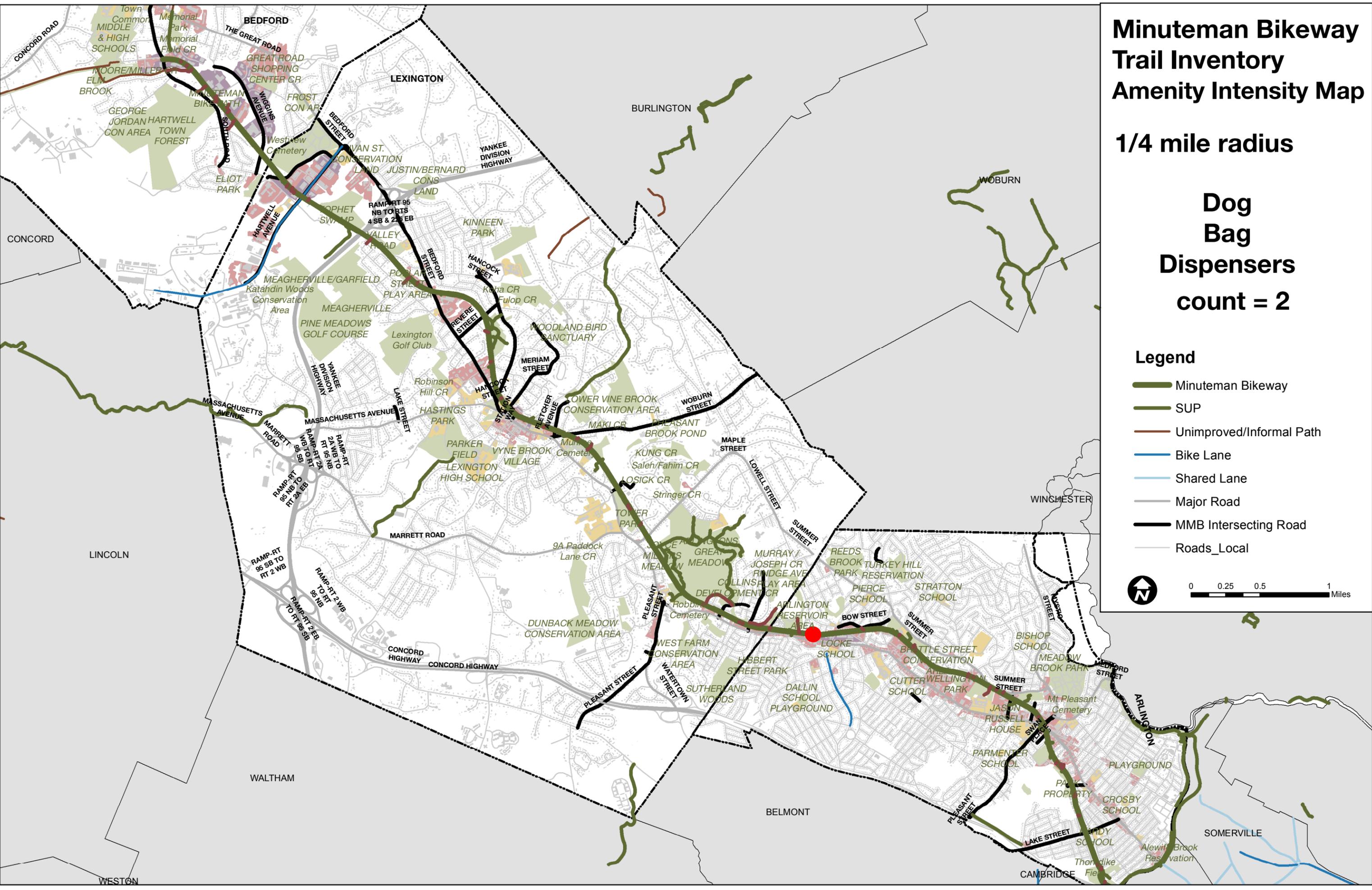
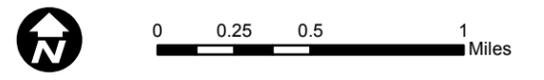
Minuteman Bikeway Trail Inventory Amenity Intensity Map

1/4 mile radius

**Dog
Bag
Dispensers
count = 2**

Legend

- Minuteman Bikeway
- SUP
- Unimproved/Informal Path
- Bike Lane
- Shared Lane
- Major Road
- MMB Intersecting Road
- Roads_Local



Minuteman Bikeway Trail Inventory

Amenity Intensity Map

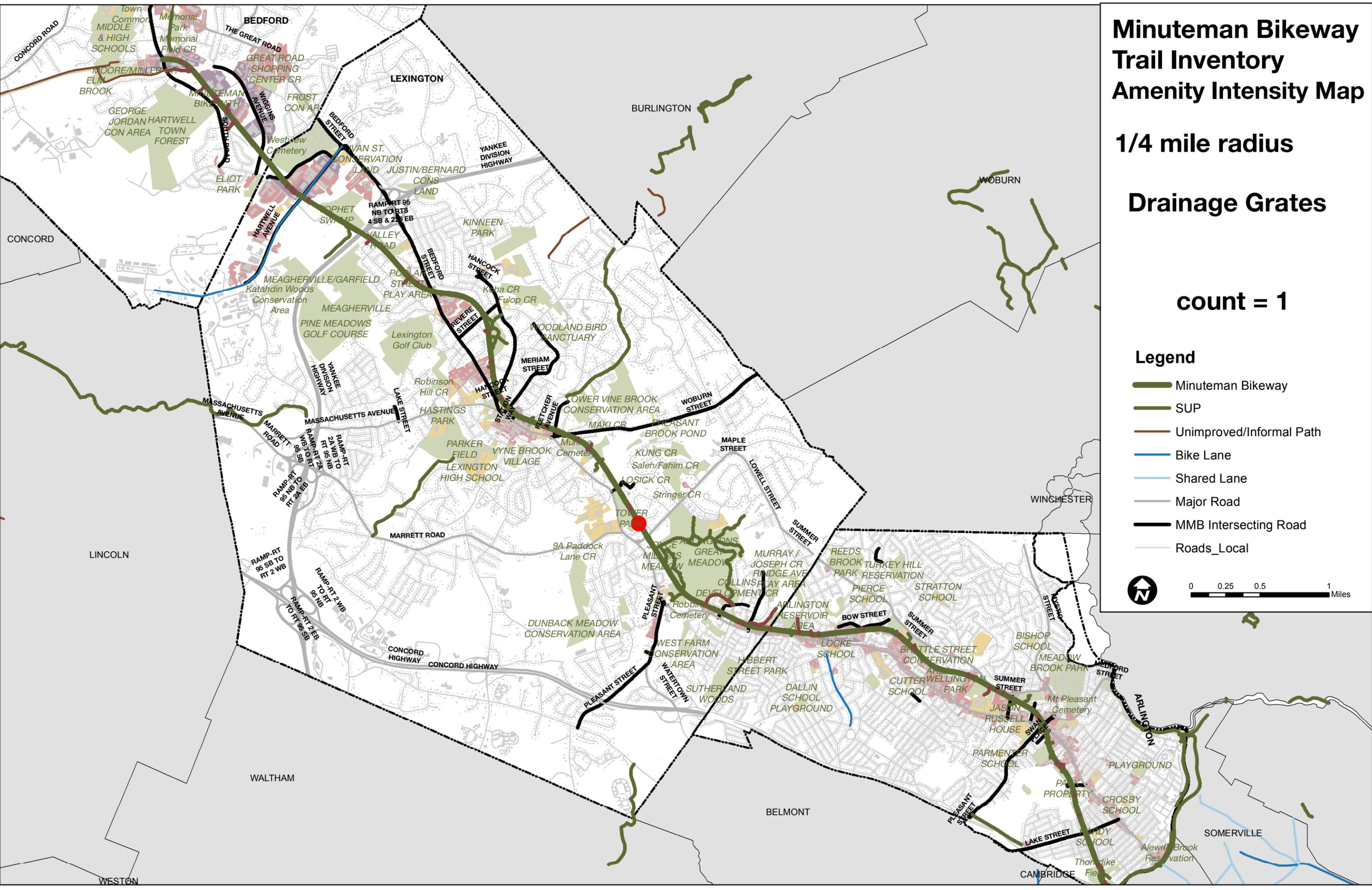
1/4 mile radius

Drainage Grates

count = 1

Legend

-  Minuteman Bikeway
-  SUP
-  Unimproved/Informal Path
-  Bike Lane
-  Shared Lane
-  Major Road
-  MMB Intersecting Road
-  Roads_Local



Minuteman Bikeway Trail Inventory Amenity Intensity Map

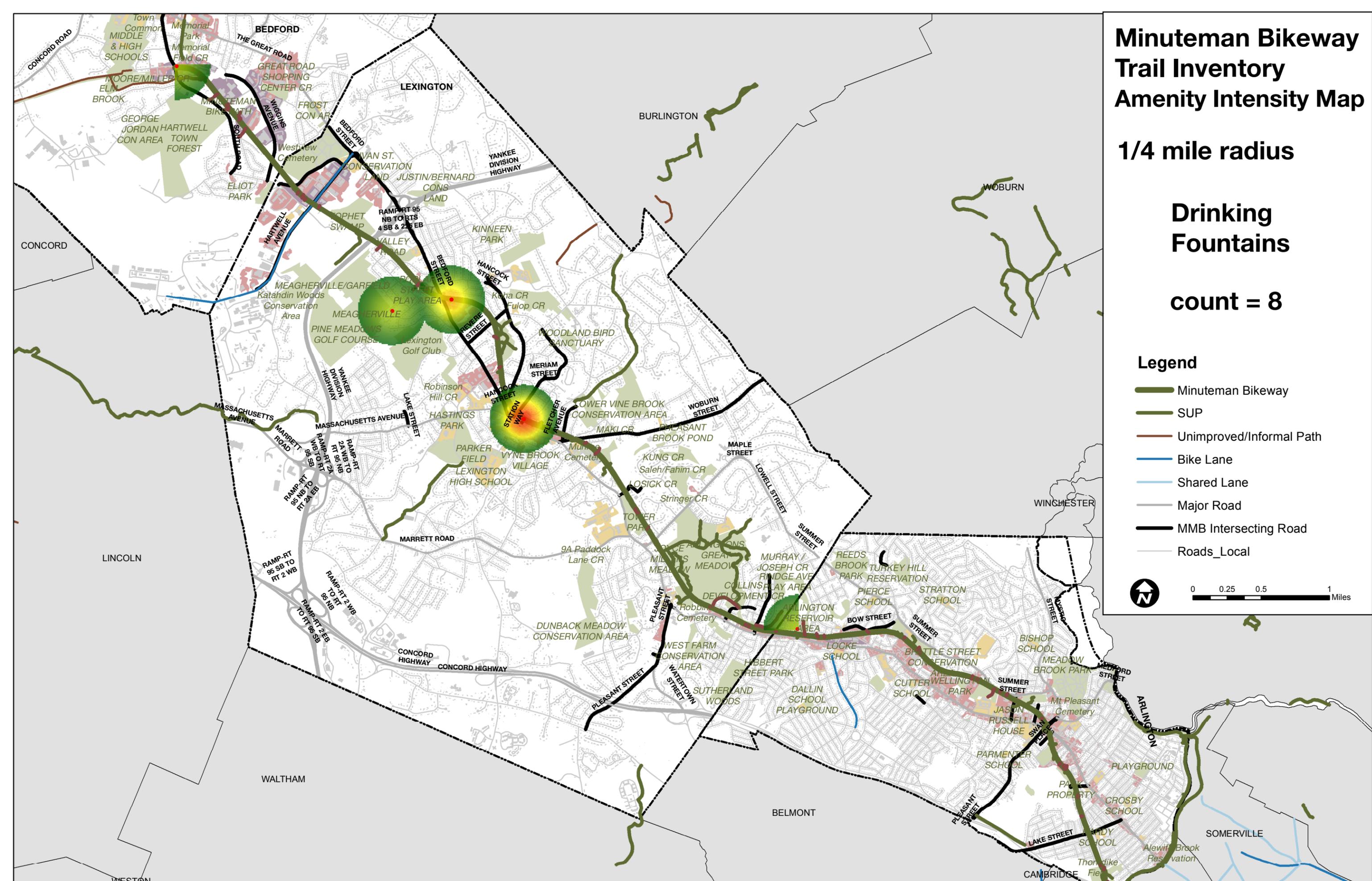
1/4 mile radius

Drinking
Fountains

count = 8

Legend

- Minuteman Bikeway
- SUP
- Unimproved/Informal Path
- Bike Lane
- Shared Lane
- Major Road
- MMB Intersecting Road
- Roads_Local



Minuteman Bikeway Trail Inventory Amenity Intensity Map

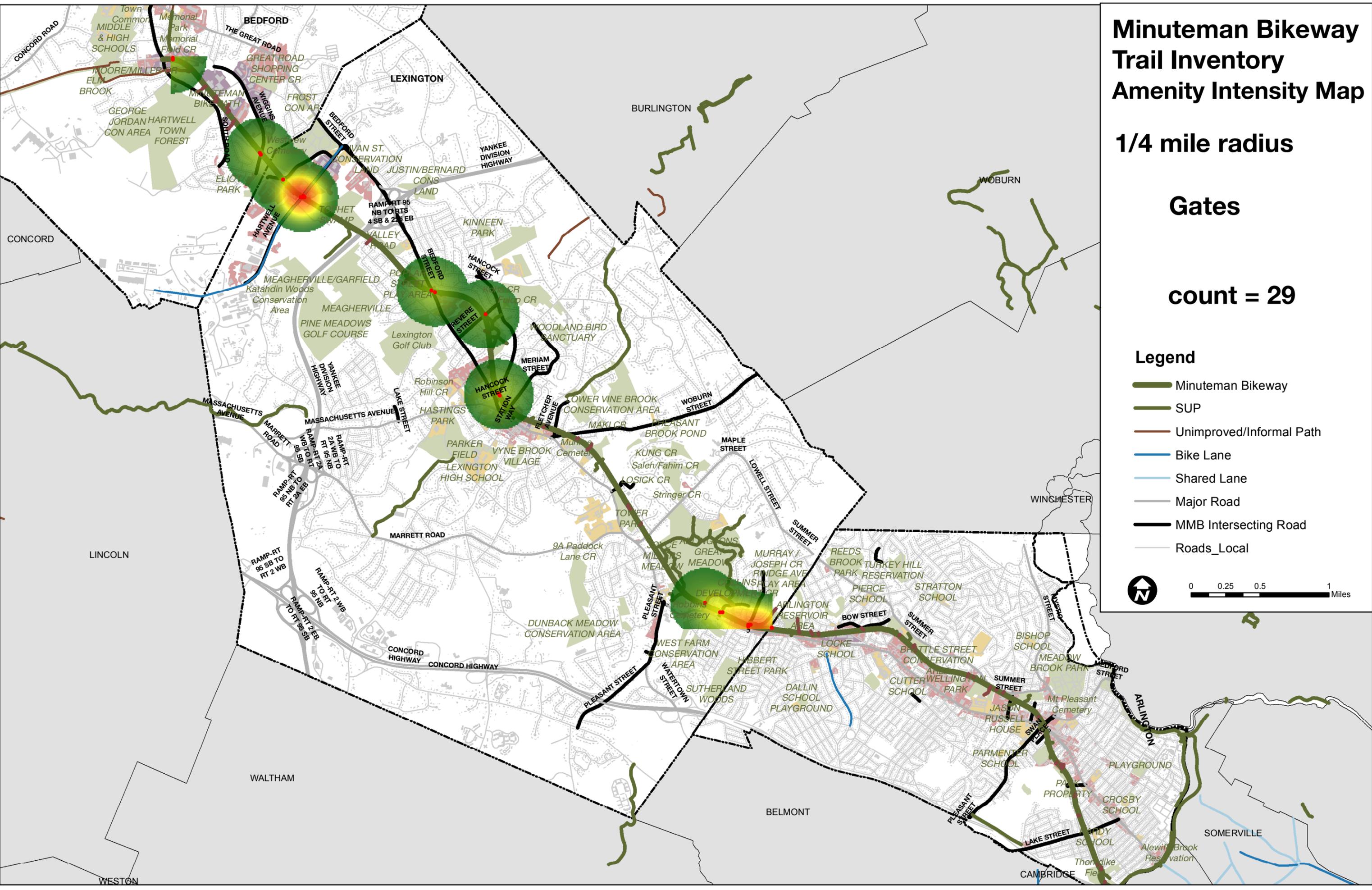
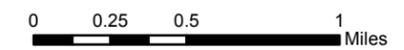
1/4 mile radius

Gates

count = 29

Legend

-  Minuteman Bikeway
-  SUP
-  Unimproved/Informal Path
-  Bike Lane
-  Shared Lane
-  Major Road
-  MMB Intersecting Road
-  Roads_Local



Minuteman Bikeway Trail Inventory Amenity Intensity Map

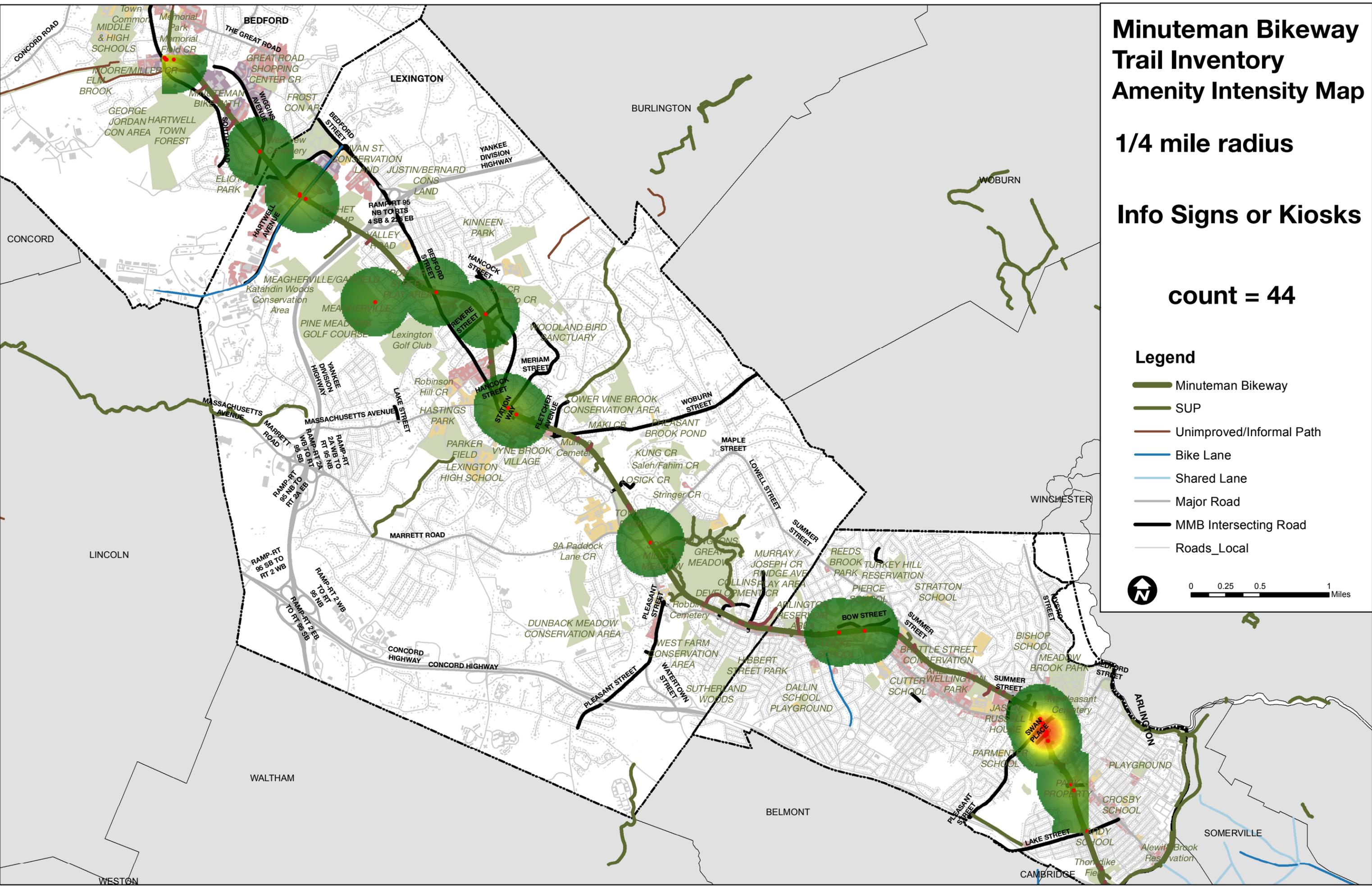
1/4 mile radius

Info Signs or Kiosks

count = 44

Legend

- Minuteman Bikeway
- SUP
- Unimproved/Informal Path
- Bike Lane
- Shared Lane
- Major Road
- MMB Intersecting Road
- Roads_Local



Minuteman Bikeway Trail Inventory Amenity Intensity Map

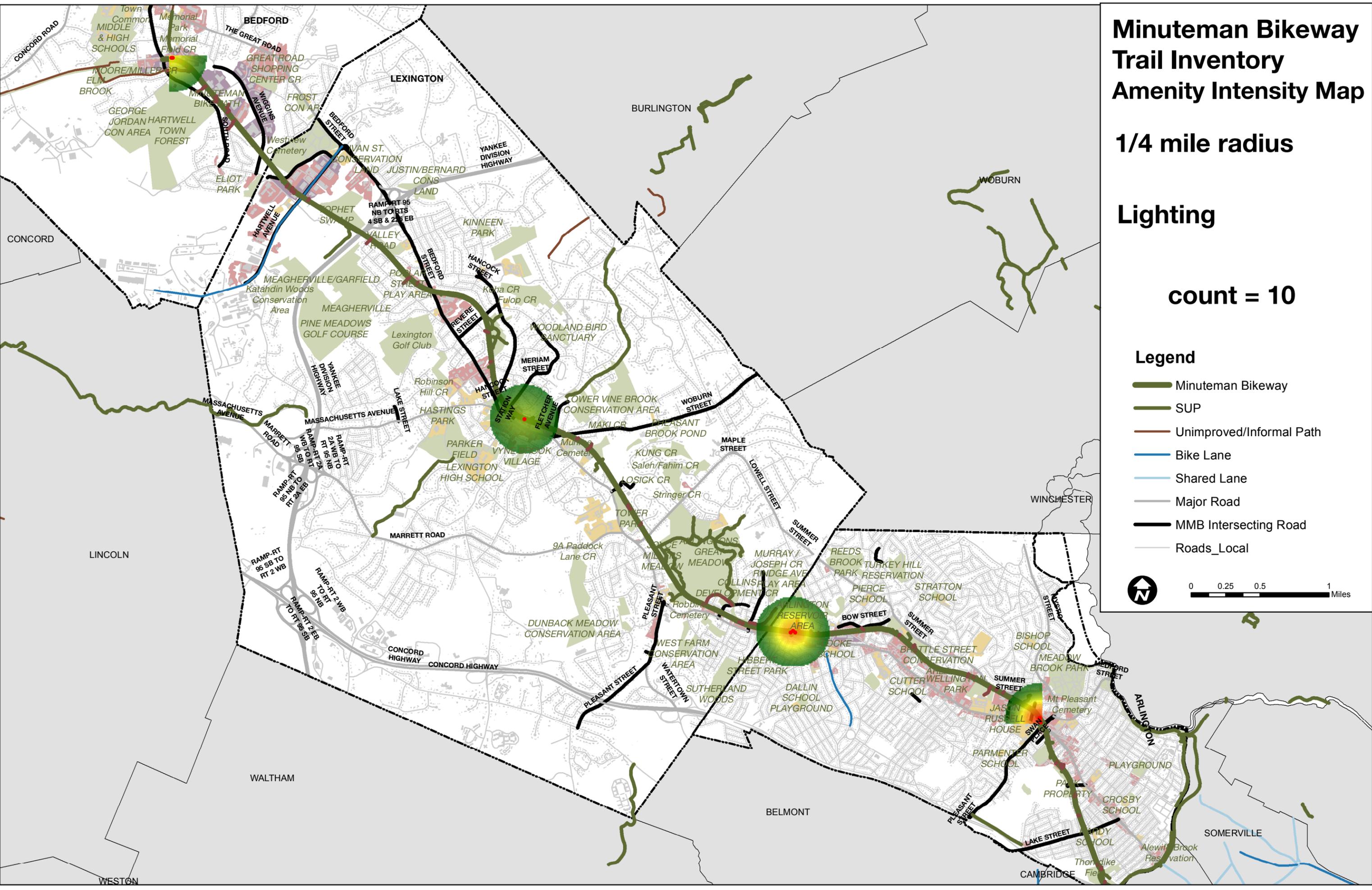
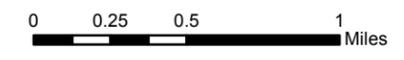
1/4 mile radius

Lighting

count = 10

Legend

-  Minuteman Bikeway
-  SUP
-  Unimproved/Informal Path
-  Bike Lane
-  Shared Lane
-  Major Road
-  MMB Intersecting Road
-  Roads_Local



Minuteman Bikeway Trail Inventory Amenity Intensity Map

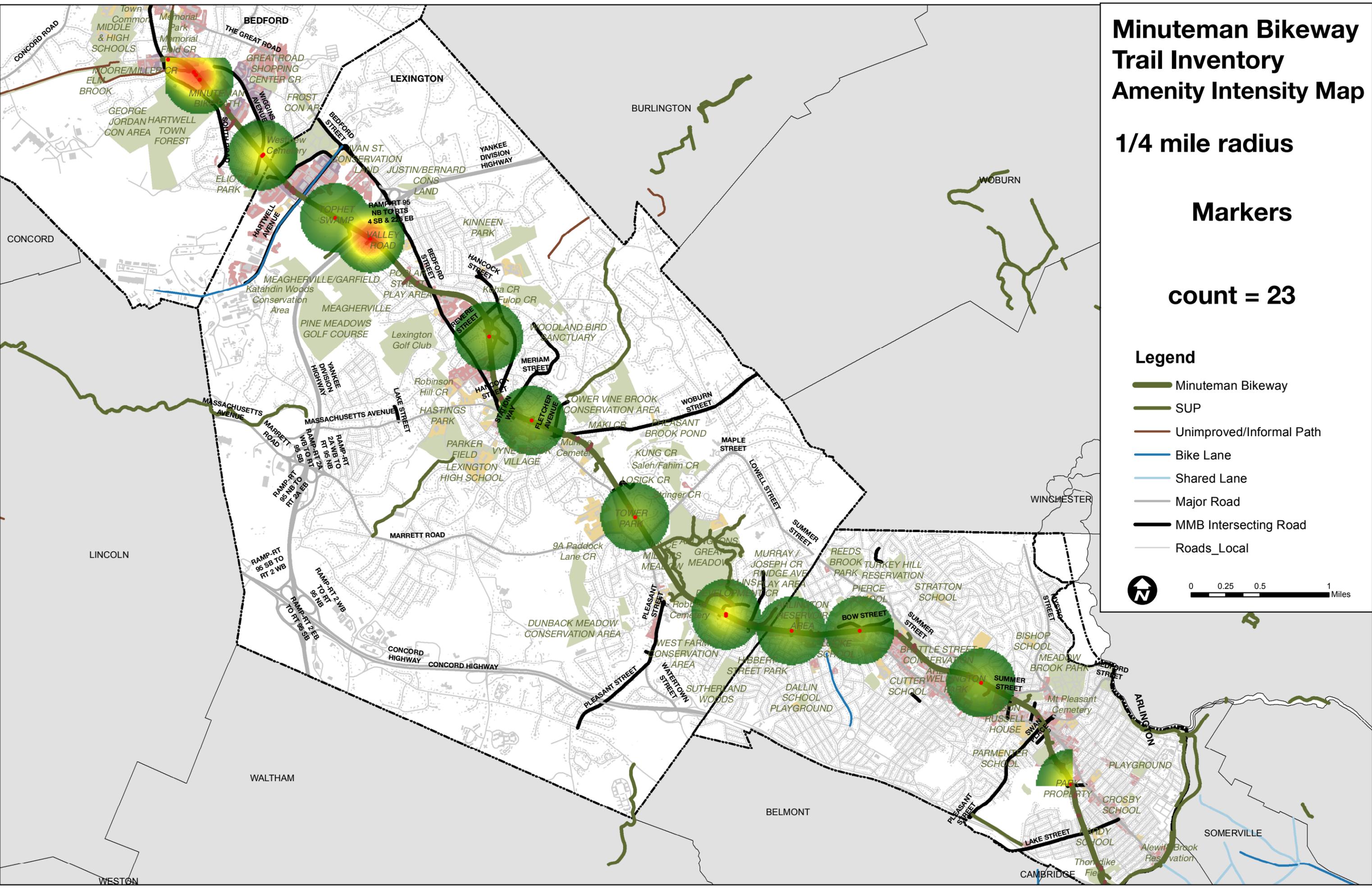
1/4 mile radius

Markers

count = 23

Legend

- Minuteman Bikeway
- SUP
- Unimproved/Informal Path
- Bike Lane
- Shared Lane
- Major Road
- MMB Intersecting Road
- Roads_Local



Minuteman Bikeway Trail Inventory Amenity Intensity Map

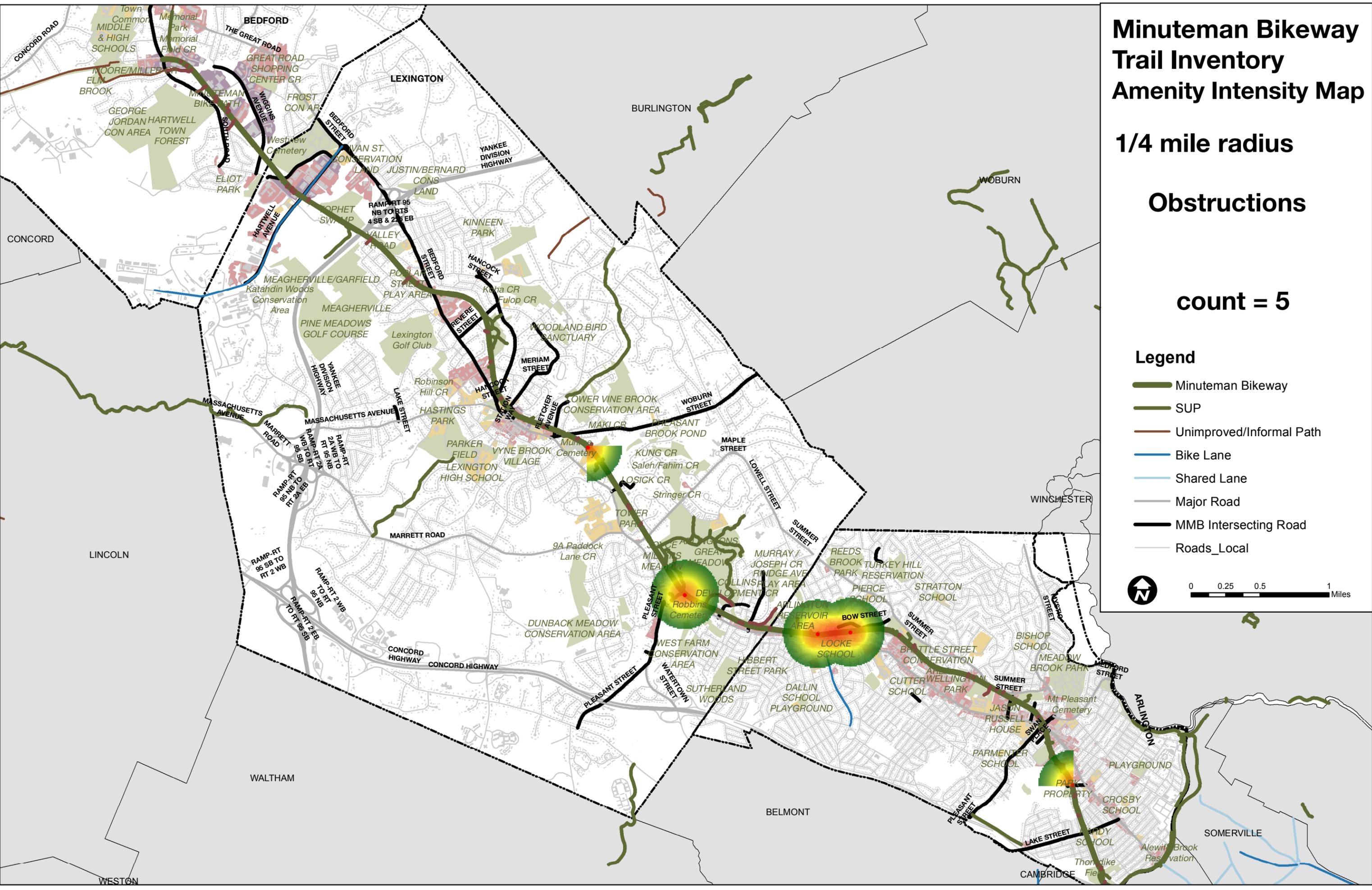
1/4 mile radius

Obstructions

count = 5

Legend

- Minuteman Bikeway
- SUP
- Unimproved/Informal Path
- Bike Lane
- Shared Lane
- Major Road
- MMB Intersecting Road
- Roads_Local



Minuteman Bikeway Trail Inventory Amenity Intensity Map

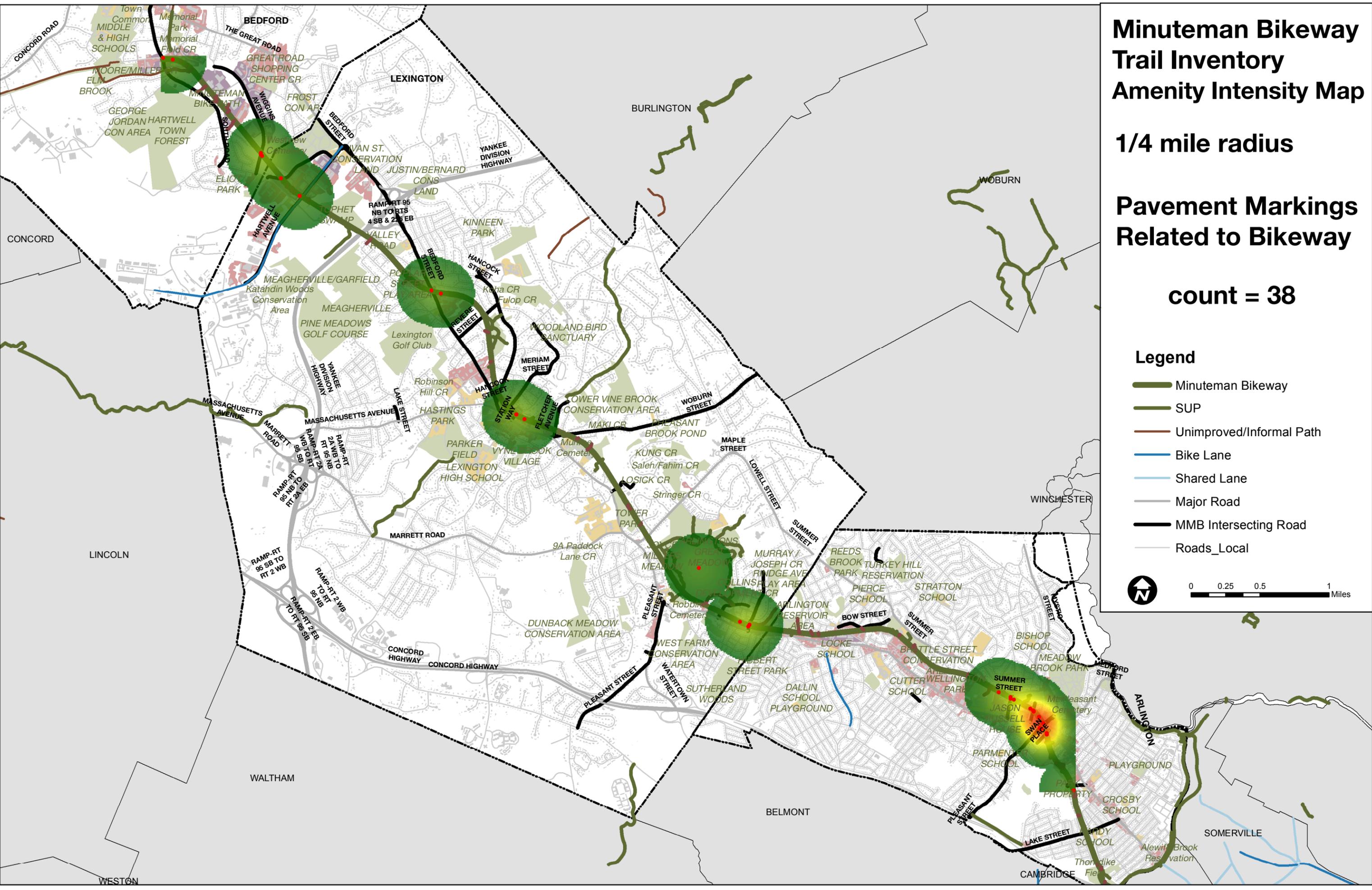
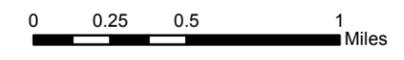
1/4 mile radius

Pavement Markings Related to Bikeway

count = 38

Legend

- Minuteman Bikeway
- SUP
- Unimproved/Informal Path
- Bike Lane
- Shared Lane
- Major Road
- MMB Intersecting Road
- Roads_Local



Minuteman Bikeway Trail Inventory Amenity Intensity Map

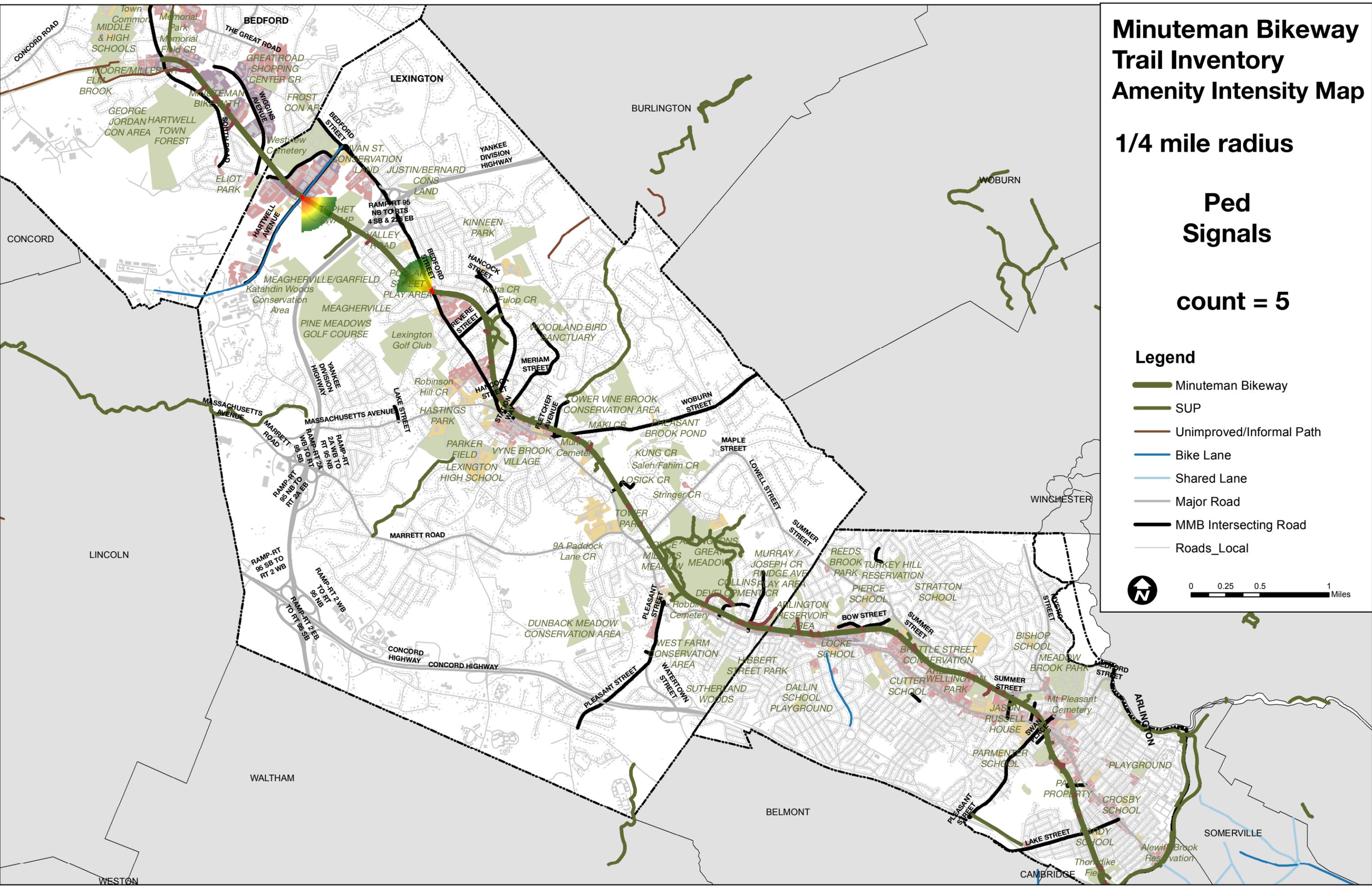
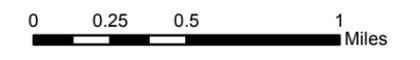
1/4 mile radius

**Ped
Signals**

count = 5

Legend

-  Minuteman Bikeway
-  SUP
-  Unimproved/Informal Path
-  Bike Lane
-  Shared Lane
-  Major Road
-  MMB Intersecting Road
-  Roads_Local



Minuteman Bikeway Trail Inventory Amenity Intensity Map

1/4 mile radius

**Picnic
Tables**

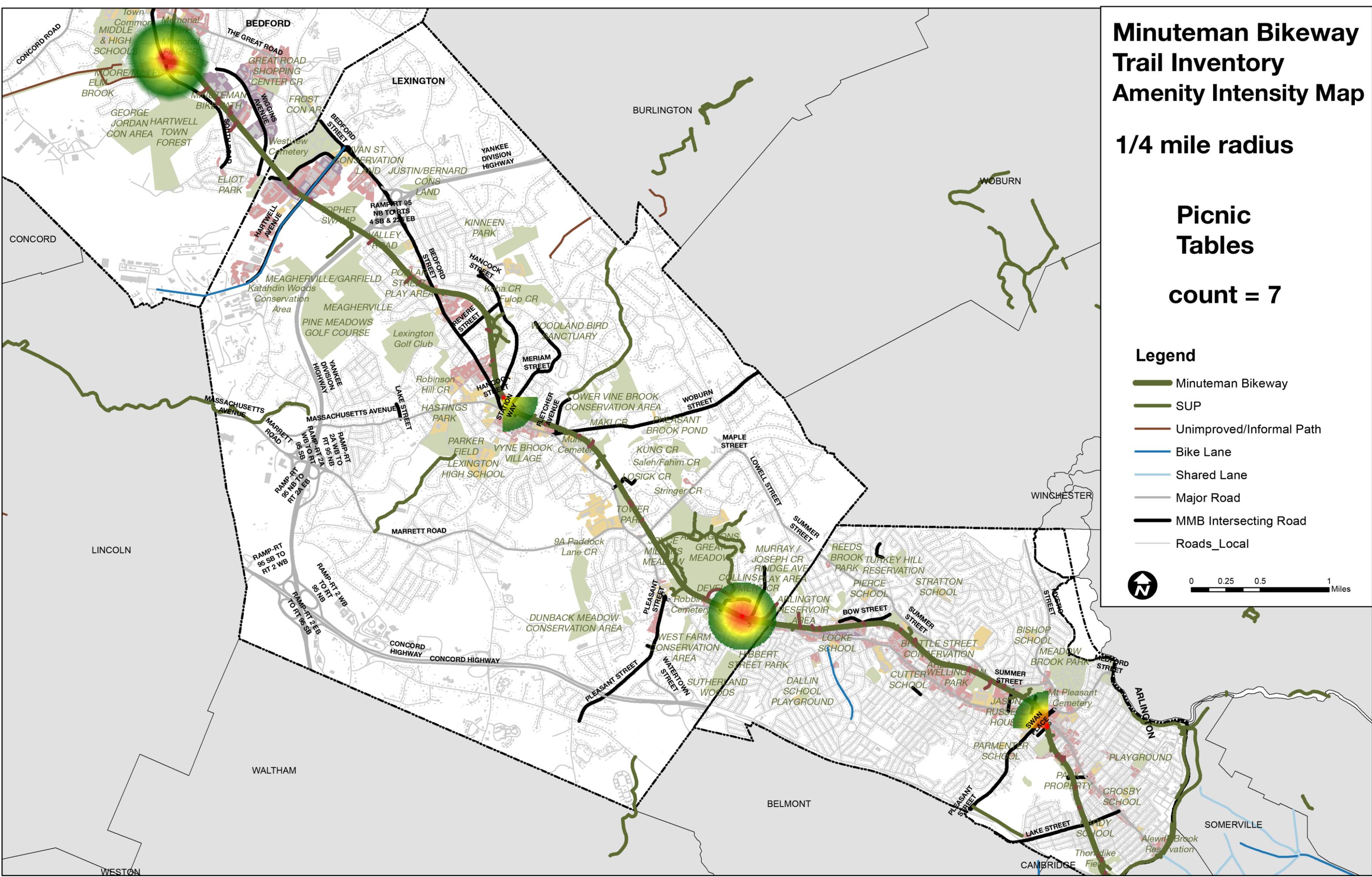
count = 7

Legend

- Minuteman Bikeway
- SUP
- Unimproved/Informal Path
- Bike Lane
- Shared Lane
- Major Road
- MMB Intersecting Road
- Roads_Local



0 0.25 0.5 1 Miles



Minuteman Bikeway Trail Inventory Amenity Intensity Map

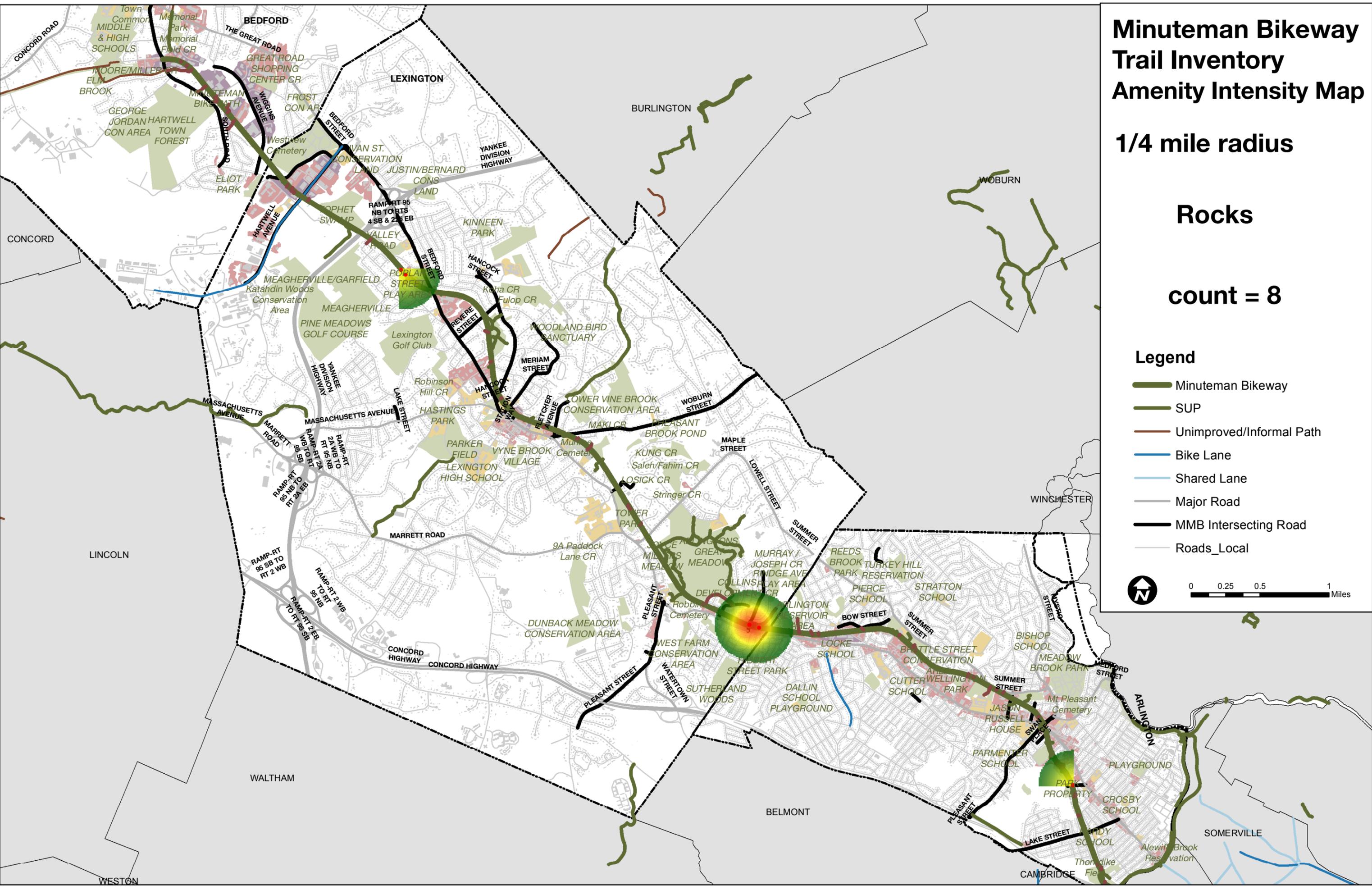
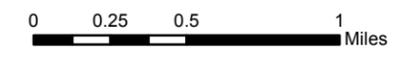
1/4 mile radius

Rocks

count = 8

Legend

- Minuteman Bikeway
- SUP
- Unimproved/Informal Path
- Bike Lane
- Shared Lane
- Major Road
- MMB Intersecting Road
- Roads_Local

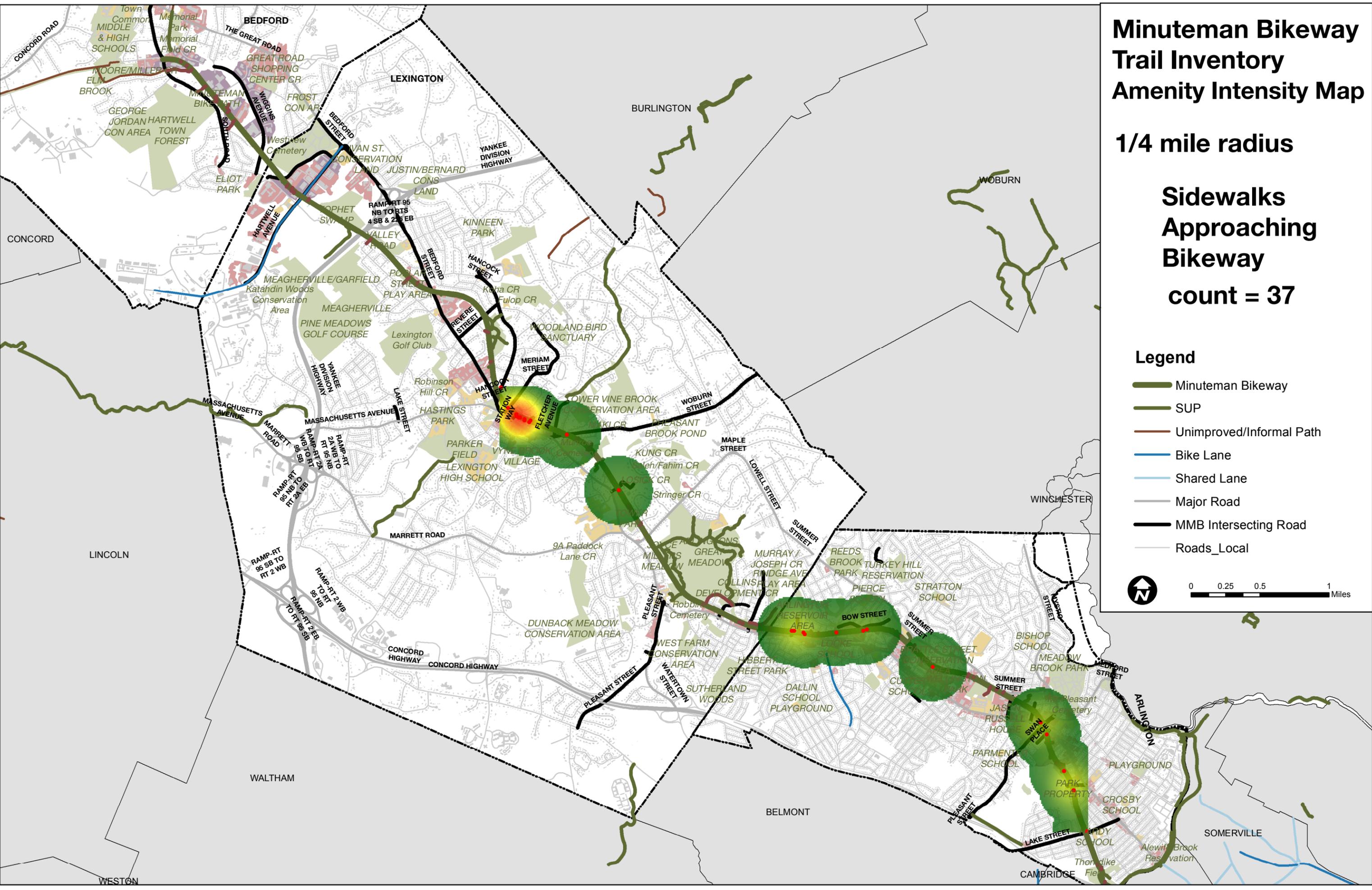


Minuteman Bikeway Trail Inventory Amenity Intensity Map

1/4 mile radius

**Sidewalks
Approaching
Bikeway
count = 37**

- Legend**
- Minuteman Bikeway
 - SUP
 - Unimproved/Informal Path
 - Bike Lane
 - Shared Lane
 - Major Road
 - MMB Intersecting Road
 - Roads_Local



Minuteman Bikeway Trail Inventory Amenity Intensity Map

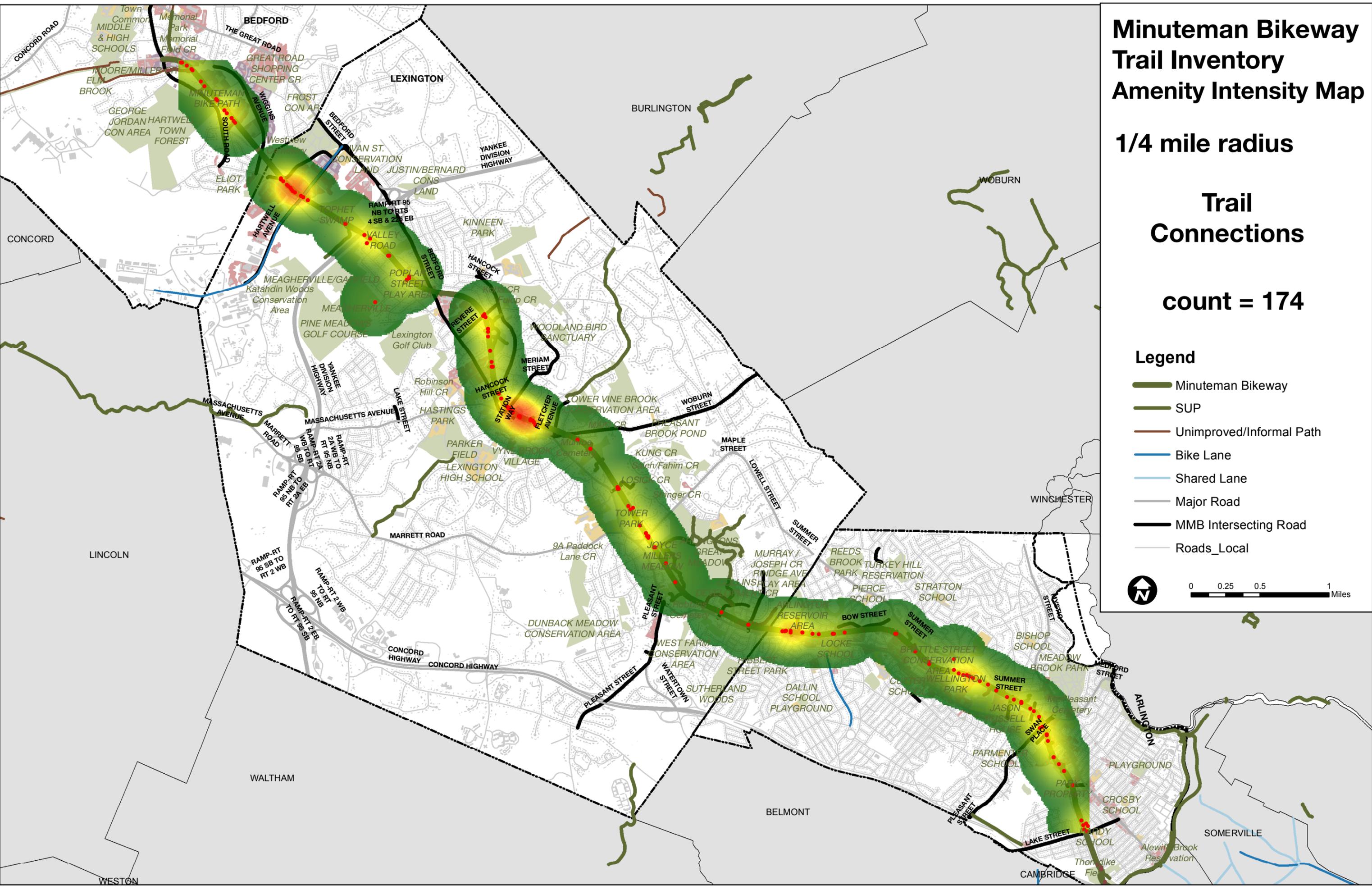
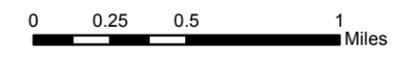
1/4 mile radius

Trail
Connections

count = 174

Legend

- Minuteman Bikeway
- SUP
- Unimproved/Informal Path
- Bike Lane
- Shared Lane
- Major Road
- MMB Intersecting Road
- Roads_Local



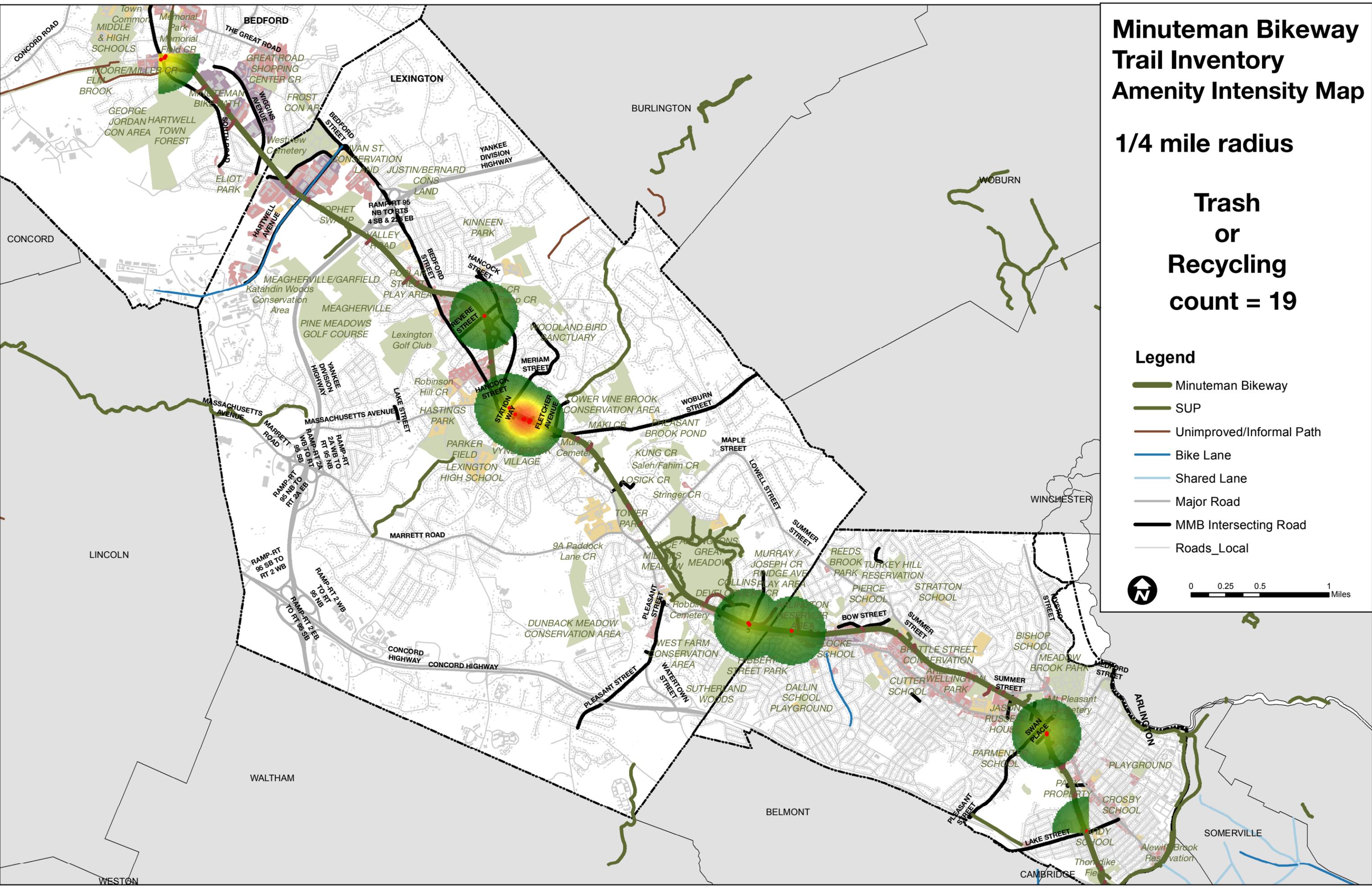
Minuteman Bikeway Trail Inventory Amenity Intensity Map

1/4 mile radius

**Trash
or
Recycling
count = 19**

Legend

-  Minuteman Bikeway
-  SUP
-  Unimproved/Informal Path
-  Bike Lane
-  Shared Lane
-  Major Road
-  MMB Intersecting Road
-  Roads_Local



Minuteman Bikeway Trail Inventory Amenity Intensity Map

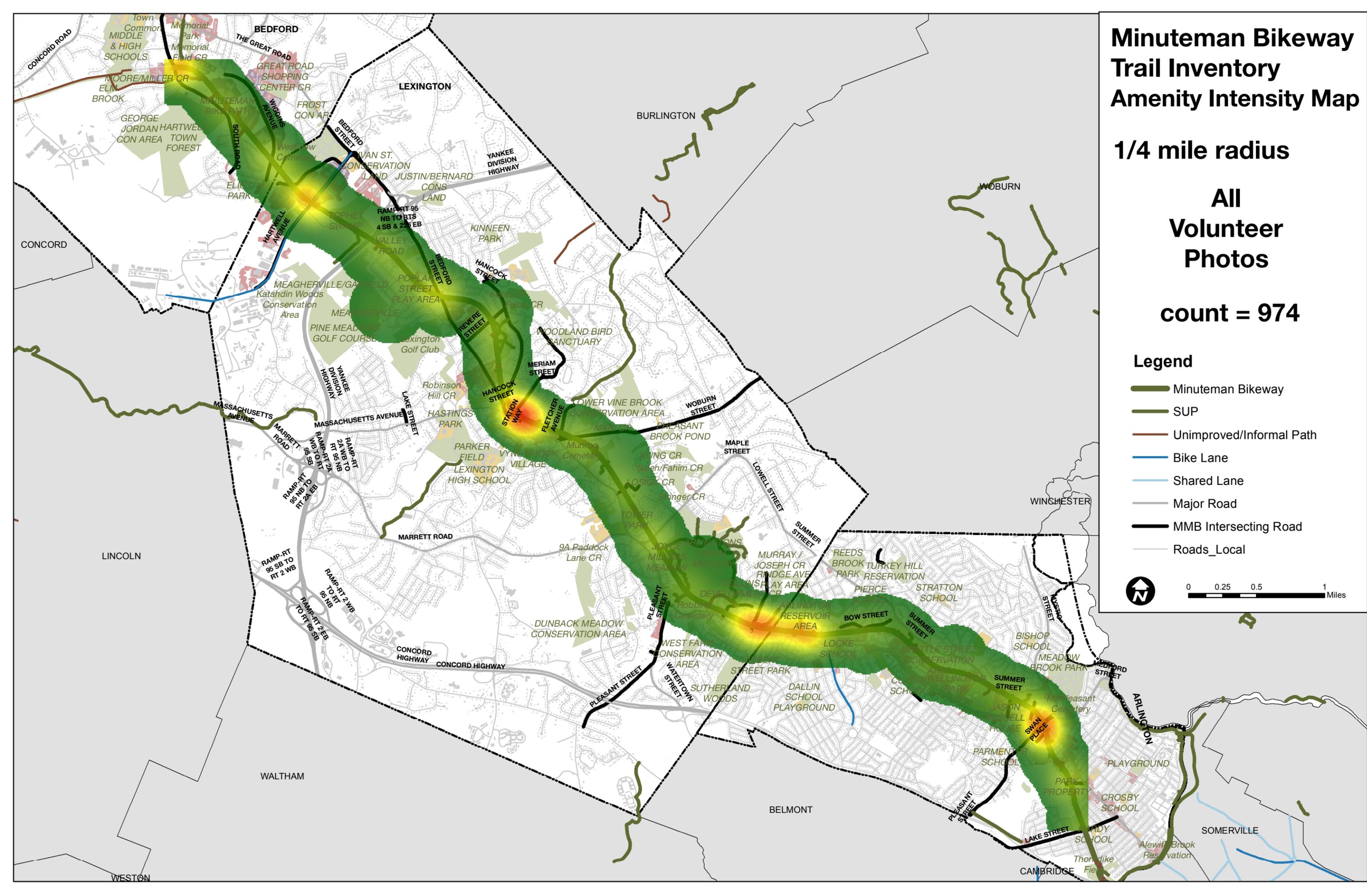
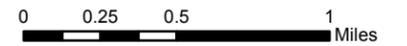
1/4 mile radius

All
Volunteer
Photos

count = 974

Legend

- Minuteman Bikeway
- SUP
- Unimproved/Informal Path
- Bike Lane
- Shared Lane
- Major Road
- MMB Intersecting Road
- Roads_Local



Minuteman Bikeway Trail Inventory Amenity Intensity Map

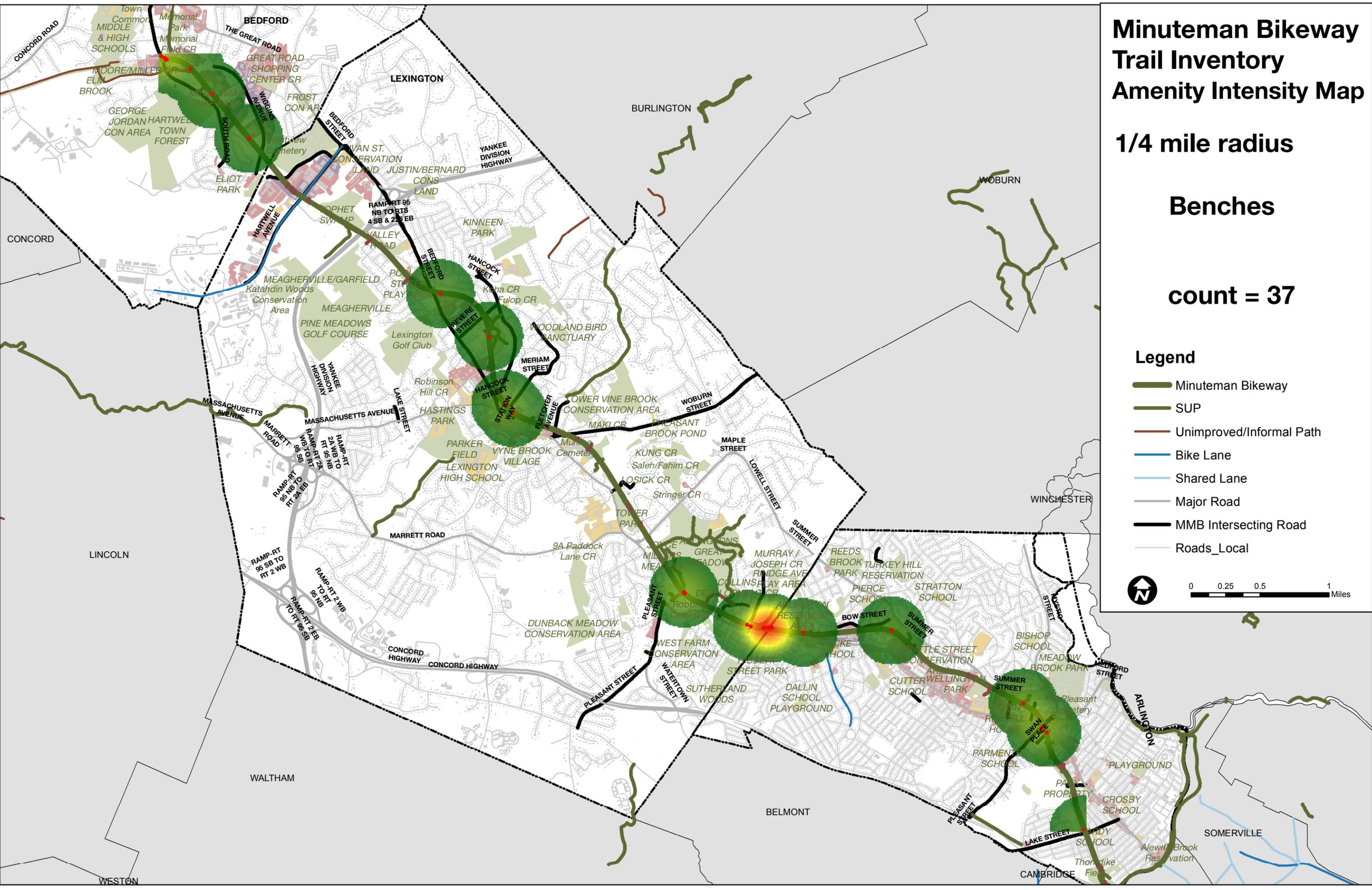
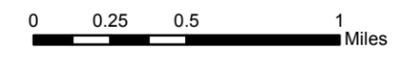
1/4 mile radius

Benches

count = 37

Legend

-  Minuteman Bikeway
-  SUP
-  Unimproved/Informal Path
-  Bike Lane
-  Shared Lane
-  Major Road
-  MMB Intersecting Road
-  Roads_Local



Minuteman Bikeway Trail Inventory Amenity Intensity Map

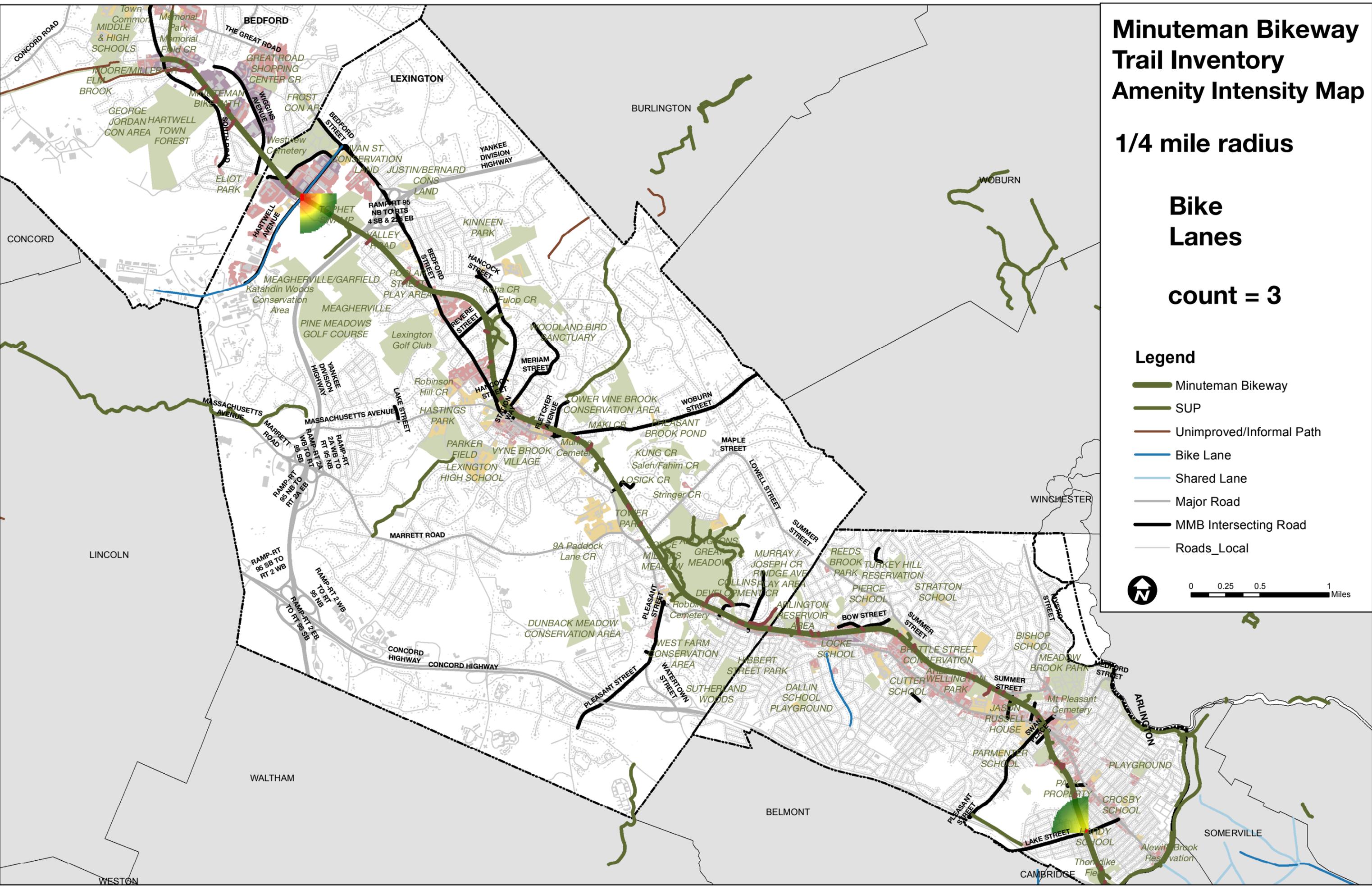
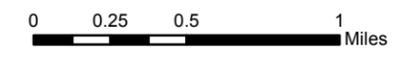
1/4 mile radius

**Bike
Lanes**

count = 3

Legend

- Minuteman Bikeway
- SUP
- Unimproved/Informal Path
- Bike Lane
- Shared Lane
- Major Road
- MMB Intersecting Road
- Roads_Local



Minuteman Bikeway Trail Inventory Amenity Intensity Map

1/4 mile radius

Manholes

count = 8

Legend

- Minuteman Bikeway
- SUP
- Unimproved/Informal Path
- Bike Lane
- Shared Lane
- Major Road
- MMB Intersecting Road
- Roads_Local

