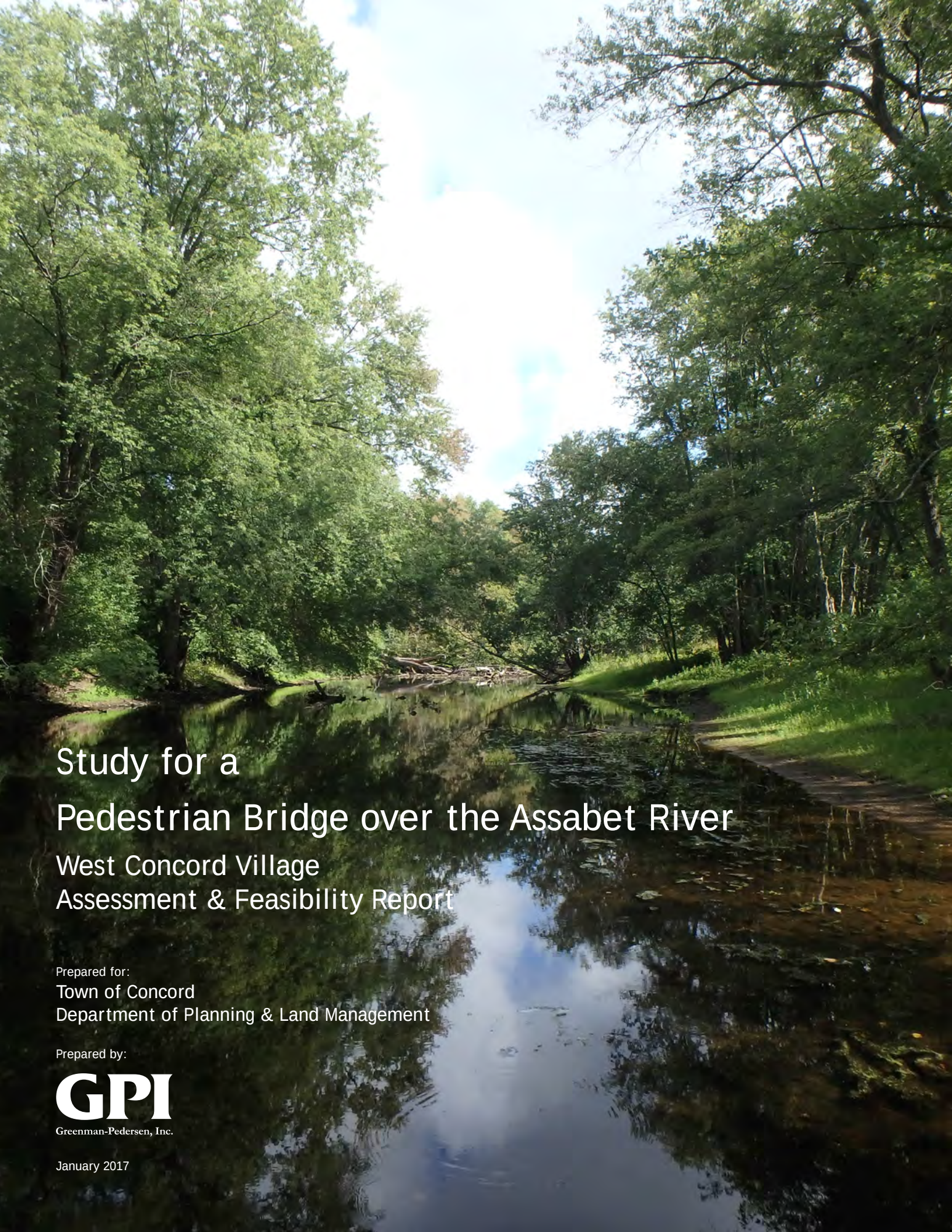

Study for a Pedestrian Bridge over the Assabet River

West Concord Village Assessment & Feasibility Report

Prepared for:
Town of Concord
Department of Planning & Land Management

Prepared by:

GPI
Greenman-Pedersen, Inc.

January 2017

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Photo of the Assabet River

Executive Summary

Vision

Pedestrian connectivity is the hallmark of a well-conceived and viable community. Although situated within walking distance of West Concord Center, the Baker Avenue Business Park lacks direct access to the MBTA Commuter Station as well as the neighborhoods and services of the downtown area. The goal of this project is to provide a safe and functional pedestrian connection that directly links the Village and this important business hub.

Design Process

The 2010 Master Plan recommended the incorporation of a pedestrian crossing linking the Commuter Station to the Business Park. In August of 2016, the Town of Concord selected GPI to develop an assessment and feasibility study for a pedestrian crossing of the Assabet River. A site walk with Town staff was conducted, and the attached report was developed.

The Plan

Four crossings along a 1,000-foot section of the Assabet River were analyzed to determine potential river impacts, alignment issues, and pedestrian travel times. The report assesses three main structural types (truss, beam, and trestle) and compares them based on performance characteristics, constructability, and costs that range from $2M to $3.6M. The study results conclude that a trestle type bridge offers the least expensive option but the greatest number of supports within the river floodway, the truss style bridge would provide the fewest supports within the river floodway at a mid-range cost, and the beam structure provides an equally low number of supports but at the highest cost.

0 100 250 600 1000

Figure 1: STUDY AREA

Study for a Pedestrian Bridge
over the Assabet River
West Concord, MA

GPI Greenman-Pedersen, Inc.

1.0 INTRODUCTION

Greenman-Pedersen, Inc. (GPI) was retained by the Town of Concord to prepare a feasibility study for a pedestrian bridge over the Assabet River. This study was funded through a mitigation fund provided for redevelopment of Baker Avenue.

1.1 BACKGROUND

The center of West Concord Village is found along Commonwealth Avenue between Kenny Dunn Square and the intersection at Main Street. From this location, most neighborhoods and businesses are set within a comfortable quarter-mile to half-mile walking distance. Developed as a traditional village center, the compact nature of the downtown offers various shops and services that meet the daily needs of residents and workers alike ï sans auto. As such, walkability is a key characteristic of the village, and is considered an important aspect of West Concord.

The Baker Avenue Business Park is located just to the east of the village center along Baker Avenue and Baker Avenue Extension. The office and industrial developments found here have emerged as some of the largest employers within West Concord Village, and although much of the park is situated within a half-mile of the downtown and train station, it is isolated by the Assabet River. This lack of a direct connection creates access and safety issues that are contrary to the village purpose, function, and success.

The lack of bicycle and pedestrian facilities between the Business Park, the train station, and the village center have been recognized for a number of years. Most recently, the 2010 Master Plan included a recommendation to incorporate a pedestrian crossing over the Assabet River to establish a connection from the MBTA station to the Business Park.

1.2 STUDY AREA

Figure 1 highlights the study area in relation to the MBTA West Concord Station, the Baker Avenue Business Park, and the West Concord Village Center. The study area is located along approximately 1,000-feet of the Assabet River.

1.3 PROJECT PURPOSE & NEED

This study provides analysis and recommendations for advancing a proposed Assabet River crossing, between the MBTA West Concord Station and the Baker Avenue Business Park. The goal of this crossing is to improve pedestrian access, and to address on-going safety concerns.

According to the CTPS, there are an estimated 1,500 employees working in the Baker Avenue Business Park, and over 4,300 primary jobs within a one-mile radius of West Concord Station.[1] The lack of safe and efficient bicycle and pedestrian connections between the Baker Avenue Business Park and the station is believed to dissuade transit based commuting and associated interaction between this significant employment center and West Concord Village. Conversely, some number of commuters are not deterred by the current configurations, but rather illegally cross over the Assabet River via the railroad bridge, resulting in a highly dangerous situation. The only other available option is to use Main Street, which lacks proper bicycle and pedestrian zones, and adds an additional 1/4ï mile travel distance.

The perceived benefits of a direct pedestrian bridge crossing are enhanced incentive for commuter rail use, and increased visitations to the downtown business district.

[1] Technical Memorandum RE: Analysis of Potential Last-Mile Shuttle in West Concord; Andrew Reker, CTPS; September 19, 2016; page 4.

2.0 PROJECT CONTEXT

The following built and natural features are found within or immediately adjacent to the project study area:

2.1 MBTA WEST CONCORD STATION

West Concord Station is located in West Concord Village on the MBTA Fitchburg Commuter Rail Line. The station is situated just north of the intersection of Commonwealth Avenue and Main Street, and consists of low-level access platforms and a single at-grade pedestrian crossing. Approximately 190 commuter parking spaces are provided along the northerly side of the station.

The railroad corridor at the station is approximately 100-feet in width, narrowing at the Assabet River to a width of approximately 65-feet.

2.2 WETLAND RESOURCE AREAS

The Assabet River flows in a northerly direction under Main Street and the MBTA Fitchburg Commuter Rail Line, and passes just east of West Concord Station. The river lies just to the east of West Concord Village, and effectively creates a natural barrier between the downtown and the Baker Avenue Business Park. Nashoba Brook flows into the Assabet River at the northern project limits.

All work within the study area is protected by the Wetlands Protection Act (M.G.L. 131 §40) and implementing regulations (310 CMR 10.00), and the Concord Wetlands Bylaw. For this project, wetland resource areas include Bank, Bordering Vegetated Wetlands, Land under Water Bodies and Waterways, the 100-year floodplain (Land Subject to Flooding), and the 200-foot Riverfront Area of Nashoba Brook and the Assabet River. Close coordination with the Concord Natural Resources Commission (NRC) will be required to insure that all proposed improvements comply with the Wetlands Protection Act and Concord Wetlands Bylaw for work which will remove, fill, dredge or alter any wetland resource area.

The Assabet River was designated a Wild and Scenic River in 1999 with ecological, archaeological, historic, scenic, recreational, and literary resources identified with ñoutstandingly remarkable valuesò. The Wild and Scenic Rivers Act prohibits any department or agency of the United States from assisting in the construction of any water resources project that would have a ñdirect and adverseò effect on the values for which the river was established and it precludes federal assistance to projects below/above a designated river that have been determined to ñinvade the area or unreasonably diminish the scenic, recreational, and fish and wildlife values presentéò as of the date of designationò.

The River Stewardship Council (RSC) was established to coordinate conservation of the river. They function as an advisory committee to the National Park Service (NPS) on federal permits affecting the riversô outstanding resources. Any work would need to be reviewed by the RSC. Since they are not a permitting agency, they review projects through the Army Corps of Engineers permit applications to determine if any project within a quarter mile of the designated river has a direct and adverse impact. Unless the National Park Service has determined in writing to the Town of Concord that the

proposed work will not adversely affect the Wild and Scenic River designation or study status, a permit from the Army Corps of Engineers would be required. Depending on bridge type selected, either a Pre-Construction Notification (PCN) or Individual Permit (IP) would need to be filed with the Army Corps of Engineers. If a pile-supported structure is selected, a PCN would be required. Otherwise, an IP will be required. If an IP is required, a 401 Water Quality Certification would also need to be submitted.

With regard to 401 Water Quality Certification (WQC), if only a PCN is required, the project would still require the filing of this permit if the resource areas impacts exceed 5,000 square feet. Otherwise, the Order of Conditions will serve as the WQC.

As much of the project also lies within the 100-year flood plain, any loss of flood plain storage (i.e. filling, or structures) will require a 5:1 replication per vertical foot of impact and approval from the Concord Zoning Board of Appeals in addition to the NRC.

2.3 BAKER AVENUE BUSINESS PARK

Located along Baker Avenue and Baker Avenue Extension, the Baker Avenue Business Park includes a large number of office and industrial employers that include the following:

- Technology: Avention, Kayak Software, Accrueve, GSG, EveryNetwork, and Apriori
- Healthcare: Emerson Hospital Home Care, Lexington Eye Care Associates, Harvard Vanguard Medical Associates
- Food Products: Welch Food Products

According to the Boston Region Metropolitan Planning Organization, an estimated 1,500 people currently (2016) work at this location.[2] Additional medical company tenants and the construction of a new 118-room extended stay hotel are expected to increase the volume of traffic into and out of the business center.

Welch Food products is located on a 65-acre site that adjoins the Assabet River. This piece of land, which includes the eastern bank of the river, is owned by 300 Baker Owner LLC. A Conservation Restriction covers 34 acres of woodland within the project area. The Restriction allows for the construction of a bridge and trails, with locations approved by the Grantor.

2.4 CONCORD PARK ASSISTED LIVING CENTER

Concord Park is an assisted living center located adjacent to the MBTA station at 68 Commonwealth Avenue. The center provides service-enriched independent living, assisted living and Alzheimer's care options for seniors in New England. Concord Park is operated by Senior Living Residences (SLR), who

[2] Technical Memorandum RE: Analysis of Potential Last-Mile Shuttle in West Concord; Andrew Reker, CTPS; September 19, 2016; page 4.

in turn partners with other organizations, such as the Boston University Alzheimer's Disease Center, to provide holistic focused, research-based care for seniors, with expertise in Alzheimer's disease. SLR operates approximately 14 such facilities throughout Massachusetts.

Concord Park is located on 9.07 acres of land with frontage on the Assabet River and Nashoba Brook. There is an existing network of pedestrian paths on the property currently along the river, some of which are private. This piece of land, which includes the western bank of the Assabet river, is owned by the VOA Concord Assisted Living Inc, who has granted a Conservation Restriction over 5.81 acres to the Town of Concord. The Restriction allows for the construction of a bridge and trails, with locations approved by the Grantor.

2.5 MAIN STREET

Main Street is a two-lane roadway running approximately west-to-east between West Concord Village and the center of Concord. Main Street provides the shortest passable route between the MBTA West Concord Station and the Baker Avenue Business Park. Significant portions of Main Street have existing sidewalk on both sides, although the sidewalk width varies, particularly where Main Street crosses the Assabet River. There are currently no bicycle accommodations along this route.

2.6 BRUCE FREEMAN RAIL TRAIL

The Bruce Freeman Rail Trail (BFRT) is a planned 25-mile non-motorized path along the route of the old New Haven Railroad ï Framingham & Lowell Line. Approximately 3.5-miles of the trail falls within Concord, stretching from the border of Sudbury near White Pond, north through the West Concord Village to just south of Route 2 at the Acton Town border. Under design for well over two decades, the majority of the Concord section of the BFRT is planned for a 2017 construction start.

The BFRT provides north-to-south access, and passes directly through Junction Park and the West Concord Station. The trail is expected to provide recreational and commuter access from surrounding neighborhoods to the village center.

3.0 PROJECT COMPONENTS

Three important components of the bridge design include path alignment, length of river crossing, and the responding bridge type.

3.1 PATH ALIGNMENT OPTIONS

Path alignment is an integral component of any bridge crossing, as it is important to identify the most obvious desire lines and to create the shortest corresponding route. When designing the pathway, it is also advisable to avoid sharp corners and turns. As shown in Figure 2, four river crossing locations were analyzed based on existing and/or potential connection points as follows:

- Option #1 ï Adds a sidewalk just north of the existing MBTA parking. Crossing location is considered to be the shortest path to the southern half of the business park.
- Option #2 ï Ties into the assisted living center public path where it first reaches the river edge. Crossing location explores balancing access to both the southern and northern half of the business park.
- Option #3 ï Ties into the assisted living center public path at an existing path intersection. Crossing location explores a middle location to provide equal service to both the southern and northern half of the business park.
- Option #4 ï Integrates into the existing assisted living center public path and could connect to the Bruce Freeman Rail Trail along a future path. Crossing explores providing the shortest route to the northern half of the business park.

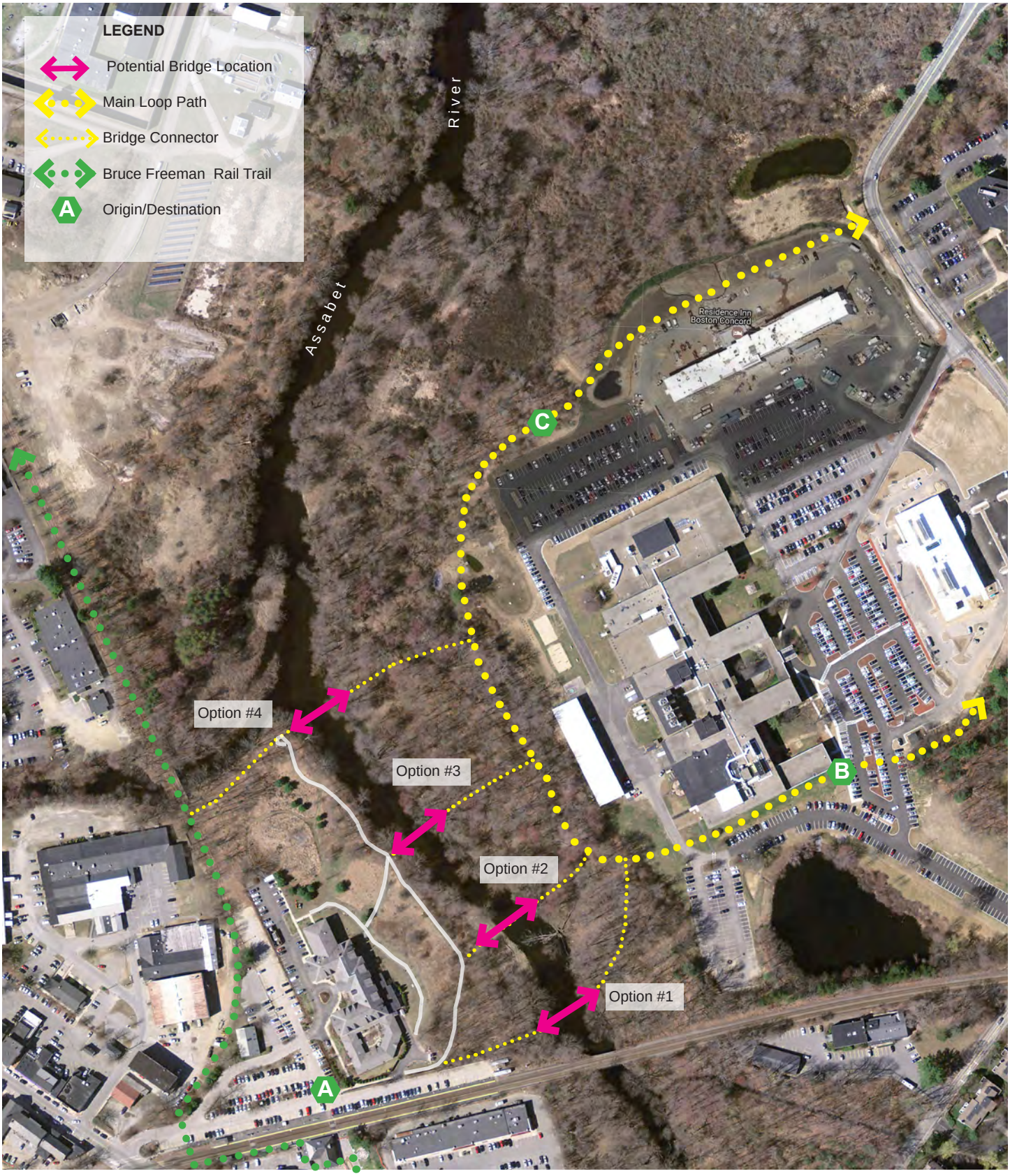
For the purposes of this study, it was assumed that a circulation loop at the Baker Avenue Business Park would be an integral component of the bridge installation. Such a loop would provide access to all areas of the business park, as well as serve as a recreational trail unto itself. This loop trail recognizes that commuters may work at any one of the eleven buildings within the business park, and that non-commuters may make use of the path system to access the village center.

Each routing option was measured based on an origin at the MBTA station (location ôAõ), and a destination at either the south side (location ôBõ) or north side (location ôCõ) of the Welch Food Products plant. The following table summarizes these distances in both feet and minutes.

	Distance (FT)		Distance (Mins.)*	
Crossing Location	A → B	A → C	A → B	A → C
Option #1	1,441	2,086	5.46	7.90
Option #2	1,468	1,985	5.56	7.52
Option #3	1,996	2,017	7.56	7.64
Option #4	2,587	2,086	9.80	7.90

*Based on a walking rate of 3 mph.

Table 1. Walking Distances



0 50 125 300 500

GPI Greenman-Pedersen, Inc.

Figure 2: CROSSING OPTIONS

Study for a Pedestrian Bridge
over the Assabet River
West Concord, MA

3.2 RIVER CROSSING LOCATIONS

The following provides a brief description of each river crossing location.

3.2.1 Location Option #1

This crossing starts out parallel to the MBTA West Concord Station platform and then turns northeast across the river just downstream of the MBTA rail bridge over the Assabet River. The river crossing in this location would consist of an embankment retaining wall to define the bridge approach. Due to the steep railroad side slope, approximately 20 foot grade difference, and desire for safe offset distance from the railroad, the wall would probably be 50 to 75 feet long prior to transition to a bridge structure. The wide river channel, high elevation, and skewed alignment will likely extend the length of the river crossing. The east embankment is tree covered and approximately 5 feet higher than the west floodplain area, but still 10 feet lower than the railroad embankment.

Figure 3. Crossing Location #1

3.2.2 Location Option #2

This crossing is about 300 feet north of the railroad bridge and the embankment is relatively flat and clear due to the path network that leads to this location. The west embankment is approximately 5 feet higher than the east embankment, and both sides of the river have defined bank as well as floodway areas. The river crossing would be generally perpendicular to the Assabet River.

Figure 4. Crossing Location #2

Figure 5. Crossing Location #3

3.2.3 Location Option #3

This crossing is about 600 feet north of the railroad bridge at an intersection within the existing path network. The river and embankment features at this location are similar to Option 2.

Figure 6. Crossing Location #4

3.2.4 Location Option #4

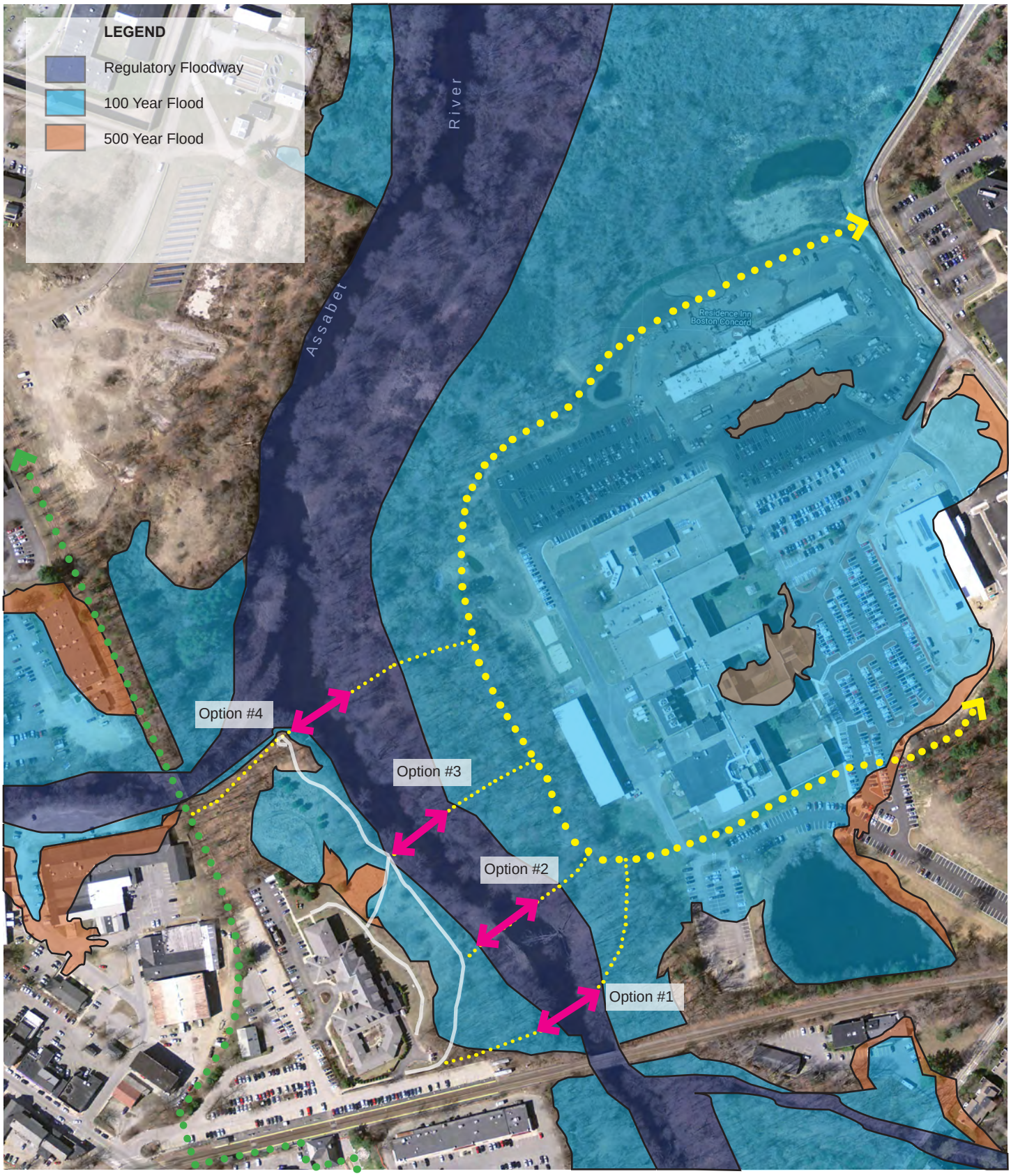
This crossing is located near the confluence of Nashoba Brook with the Assabet River at the northern limits of the study area. The embankment elevations are similar to Option 2 and Option 3, however the river is less defined in this area due to the flows from Nashoba Brook. The total width of floodway and river at this location is the greatest of all the options.

3.3 RIVER CROSSING IMPACTS

Minimizing bridge length is an important consideration of the design, and river width varies based on the selected location. Within the study area, the river width was measured for each crossing option and is summarized in Table 2.

Crossing Location	Distance (FT) Bank to Bank	Distance (FT) Floodway	Distance (FT) Floodplain
Option #1	120	150	650
Option #2	75	220	450
Option #3	110	190	400
Option #4	120	280	550

Table 2. River Width



0 50 125 300 500

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Figure 7: FLOOD ZONES

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over the Assabet River
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The distances listed in Table 2 and shown in Figure 7 represent the observable shore line and the approximate width of the floodway as represented on the associated FEMA Flood Insurance Rate Map.[3] Floodways are characterized as areas subject to inundation by floodwaters having hazardous velocities. Encroachment into the floodway has the potential to further aggravate flood damage by increasing velocities. However, it should be recognized that the capacity of the floodway is currently regulated by the existing railroad crossing, which throttles the river between two earthen embankments.

The bridge must not only clear the existing water way, but it must also account for periodic flat water flooding within the river corridor. As shown in Figure 8, the available FEMA Flood Insurance Study for the study location indicates the following elevations (NAVD 88):

- 10 Year Flood Elevation ï EL. 122.50
- 100 Year Flood Elevation ï EL. 123.80

Following MassDOT requirements, this project would be classified similar to a rural local road, and therefore would need to provide 2-feet of clearance above the 10-year flood elevation. Therefore, the bottom of the structure would need to be set no lower than EL. 124.50.

Limited available topographic information indicates that much of the study area, as well as the business park west of Baker Avenue Extension lies below EL. 122, well within the 100-year flood plain. As such, it will not be feasible to entirely construct the bridge and path out of the flood waters ï see Figure 7. Therefore, the project will need to minimize filling within the 100-year flood plain, as any such filling will need to be compensated on a vertical foot basis in a location within the same waterway.

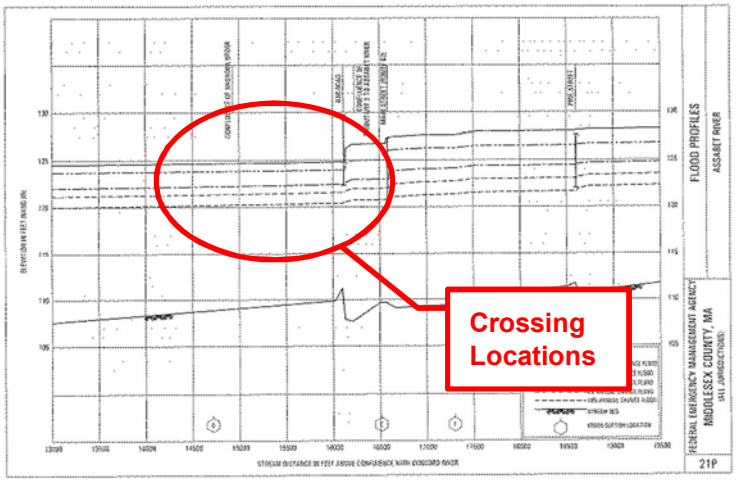


Figure 8. Assabet River Flood Profiles[4]

[3] Flood Insurance Rate Map, Middlesex County, MA; Panel 359 of 656; Map Number 250170C0359F; FEMA; Revised July 7, 2014.

[4] Flood Insurance Study, Volume 3 of 8; FEMA; Revised July 7, 2014.

3.4 BRIDGE OPTIONS

Based on the various site dynamics and constraints, the following bridge options were reviewed:

Trestle bridge ï this type of bridge is composed of a number of short spans supported by A-frame structures (i.e. trestles) or bents. Trestle bridges are useful in spanning long distances with minimal filling, as well as constructing structures in hard to reach or sensitive locations.

Figure 9. Example of a Trestle Bridge

Truss bridge ï this bridge type is composed of a structure of connected elements forming triangular units. Truss bridges are one of the oldest types of modern bridges, and are economical to construct because they use materials efficiently. Multiple spans can be assembled.

Figure 10. Example of a Truss Bridge

Beam bridge ï these are the simplest structural forms for bridge spans supported by an abutment or pier at each end. Beam bridges rarely span more than 250 feet, with beam depth proportional to the length. Longer spans are accomplished by a series of beam bridges joined together.

Figure 11. Example of a Beam Bridge

3.5 EVALUATION OF OPTIONS

A number of attributes were evaluated for each bridge type, including span length, depth of structure, the number of required supports, potential geometry, costs, and constructability. As with most bridge locations, site conditions and constraints dictate.

The following provides a brief evaluation of each attribute:

- **Span Length** ï Each bridge type has been reviewed for the achievable distance between two supports. Based on an approximate river width of 75ô120ô a truss type bridge is the structure most readily capable of spanning the river without requiring an intermediate support. Beam bridges can also span the river without an intermediate support, however the beam depth will need to increase to accommodate the span. Greater span lengths allow for uninterrupted flow of the river and debris.

- **Multiple Spans** ï Multiple spans can be created using intermediate supports. This can be useful wherever the span distance is in exceedance of the achievable span length. Given that the river floodway is between 150ôto 280ôin width, there is a clear need to incorporate multiple spans in order to minimize the number of spans within the river, floodway and floodplain.

- **Depth of Structure** ï The relationship of the structure depth to the bridge length can impact the height of the walking surface depending on the structure type selected. A typical depth to span ratio for girder bridges is 1/30. Also, for every vertical foot added, an additional 22-feet of horizontal run is required on either side of the bridge to provide an accessible 4.5% transition back to grade. As such, Thru-structure configurations such as truss structures, versus Over-structure configurations such as beam and trestle, are useful in minimizing these potential impacts.

- **Piers** ï Piers are the intermediate supports required for multiple span bridges. In the case of the beam or truss style bridge, these would likely be cast-in-place concrete but may also consist of circular steel piles with a cross beam cap. Trestle style structure typically relies on timber or steel piles for support. The project should seek a balance between minimizing the number of piers relative to costs and impacts.

- **Foundations** ï Located below the ground surface, these are the underlying supports to the piers. Traditional trestle design relies on driven steel or timber piles. Beam and Truss style bridges are often constructed using driven steel piles or cast in place concrete drilled shafts.

- **Geometry** ï Based on the use of short spans, the trestle style structure provides greater horizontal flexibility compared to the truss or beam style bridge. This can be useful if a curvilinear structure is desired.

- **Cost** ï Costs must account for environmental impact and constructability.

- **Environmental Impact** ï Structures built within the natural environment create impact through supports in the river, restriction of river flow, collection of debris, damage to vegetation, etc. Additional impacts are felt by aquatic and land lifeforms that now must traverse a manmade obstruction. Larger span structures have less impact than shorter spans.

- **Right of Way**ï the Assabet River crossing will impact private owners on both sides of the river. Easements and agreements can be obtained to allow for use of the properties.

- **Constructability –** based on its remote and vegetated location, the ability to lift a structure into place must be a prime consideration, as well as temporary impact to abutters and the environment.

These attributes are summarized in Table 3 below:

	Bridge Type		
Attribute	**Trestle**	**Truss**	**Beam**
Span Length	15'	120'	60'
Multiple Spans	Yes	Yes	Yes
Depth of Structure	Lowest	Lowest	Highest
Piers	Numerous, slender piles	Only at ends	Only at ends
Foundations	Exposed piles	Concrete piers or exposed large pile	Concrete piers or exposed large pile
Geometry	Flexible	Rigid	Semi-flexible
Cost	Lowest	Middle	Highest
Environmental Impact	Most	Least	Moderate
Right of Way	Some	Some	Some
Constructability	Highest	Lowest	Middle

Table 3. Bridge Type Attributes

Figure 12. Example of a footbridge in floodway/floodplain

4.0 FINDINGS

4.1 LOCATION OF CROSSING

Based on an analysis of four potential locations, location options #1 and #2 are roughly equal in providing the most efficient location to place the bridge based on walking distance to anticipated destinations. Recognizing the potential for pedestrian and bicycle generators in all areas of the business park, these options provide the best performance based on the need to circumnavigate the Welch's Food Products plant. Location option #4 would provide the most efficient connection for hotel guests to access the West Concord Village.

4.2 STRUCTURE LENGTH

Available data indicates that location option #2 provides the shortest bank-to-bank crossing within the study area at 75 feet. Further review of the data suggests that multiple spans will be required to clear the 220 foot regulated floodway at this location. Although the bank-to-bank crossing on option #1 is 120 feet, the floodway distance is less than option #2 at 150-feet.

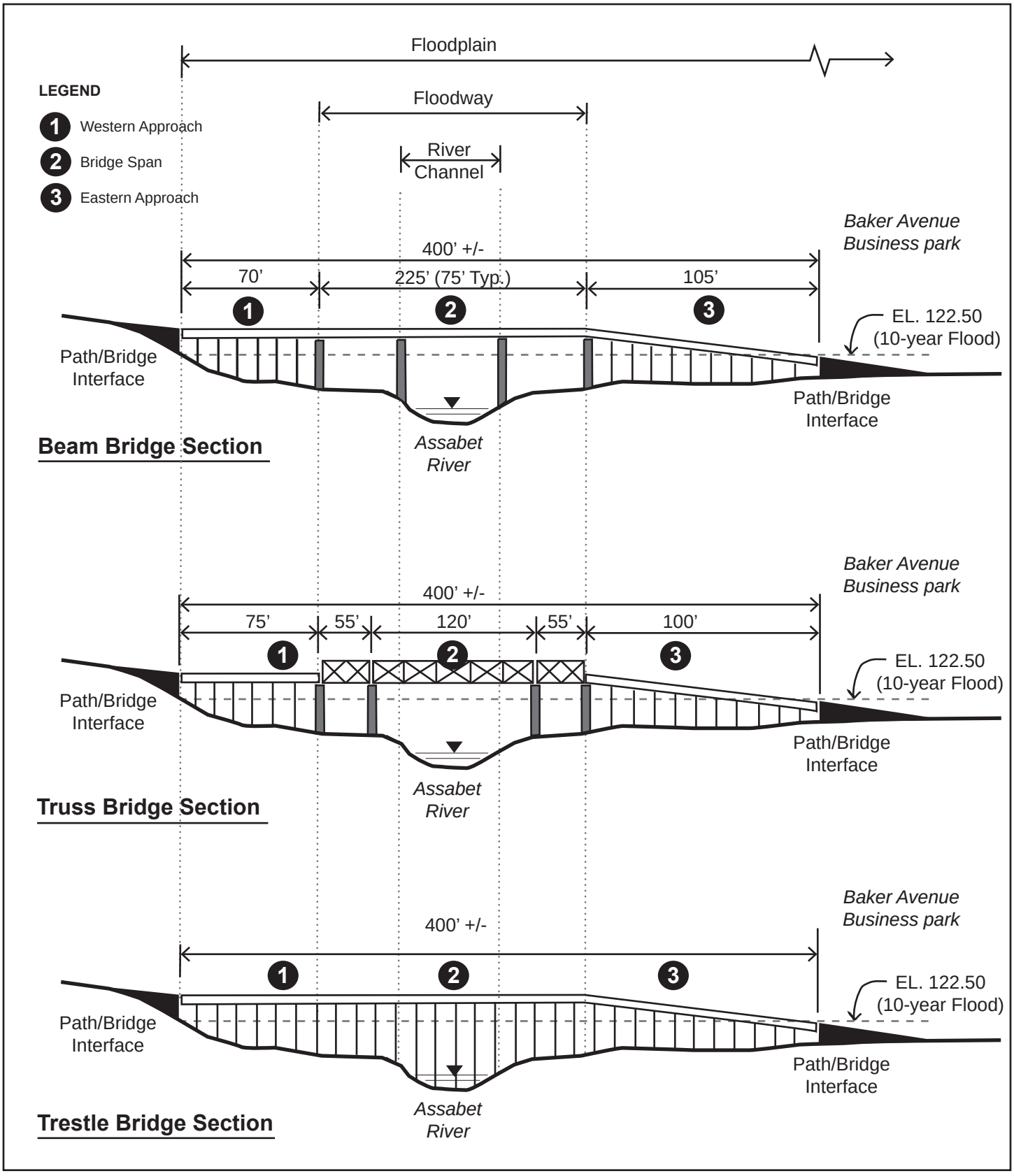
Additional structure will likely be the preferred means of crossing the floodplain area outside of the floodway, as the area is protected under the MA Wetlands Protection Act. The resulting total structure length is 400 feet for location option #2, 475 feet for location option #1 and #3, and 600 feet for location option #4.

4.3 BRIDGE HEIGHT

Based on the FEMA Flood Insurance Study, the bottom of the bridge should be set no lower than EL. 124.50. Assuming a depth of structure of approximately 3', the top deck of the bridge over the river will be approximately EL. 127.50.

4.4 BRIDGE CONFIGURATION

In general, the preferred bridge will span the river floodway with as few piers or supports as possible to minimize impacts to water flows and to avoid a buildup of floating debris. The structures over the remaining sections of the floodplain do not need to be as long in span, but should avoid fill impacts and should allow light penetration below the deck. Refer to Figure 12 for schematic sections that demonstrates solutions where the primary river is crossed with a beam, truss, or trestle bridge. The approaches are comprised of trestle type spans, however they could also be beam and truss spans.



Not to Scale

GPI Greenman-Pedersen, Inc.

Figure 13: Schematic Sections

Study for a Pedestrian Bridge
over the Assabet River
West Concord, MA

5.0 COSTS & FUNDING

5.1 DESIGN & PERMITTING

The design and permitting costs for each type and location of crossing is not significantly different. Crossing Option 1 could be more expensive due to the proximity to the railroad and coordination issues, as well as the need for a retaining wall adjacent to the tracks due to the steep side slope. Crossing Options 2, 3, and 4 would require more design efforts for the path network and coordination with the Concord Park Assisted Living facility. The structure design for all 4 crossing locations is similar regardless of the structure type.

The permitting efforts would also be similar between the 4 crossing locations since they all impact the same resources and would require similar levels of permit filings and agency coordination meetings.

5.2 CONSTRUCTION

Our construction cost evaluation is based on high level estimates from similar structures using comparable square footage calculations. The construction cost estimates shown in Table 4, are based on a 14-foot wide bridge that would allow for shared bicycle and pedestrian accommodation. An approximate 25% cost reduction would be realized if an 8-foot wide, pedestrian-only bridge were constructed instead of the 14-foot wide shared used bridge.

The costs are for the structure crossing only and do not include path costs, right of way acquisition, or any special project features such as signage, benches, and lighting.

	$ Costs (in millions)			
	Option 1	Option 2	Option 3	Option 4
Beam	3.4	2.6	3.0	3.6
Truss	3.3	2.5	2.9	3.6
Trestle	2.7	2.0	2.3	2.9

Table 4. Construction Cost Summary Matrix

END OF DOCUMENT