2. Project Alternatives

2.1. Introduction

This chapter describes the broad range of alternatives that was considered to address the purpose and need for the project and includes a description of how the alternatives were developed and screened. This chapter includes descriptions of the alternatives, a summary of the alternatives not advanced for further study, a summary of the alternatives that were advanced, and the reasons for selection of the Preferred Alternative.

CTDOT's design strategy for the Walk Bridge Project focused upon meeting the project purpose and need: providing a resilient bridge structure to enhance the safety and reliability of rail service, offering operational flexibility and ease of maintenance, and providing for increased capacity and efficiencies of rail transportation, while maintaining or improving navigational capacity. An important overall design objective was therefore predicated upon providing ***system resiliency*** and ***operational redundancy***, as mandated by FTA in its funding appropriation.[1]

2.2. Alternatives Development and Screening

CTDOT identified a range of alternatives and grouped them into four general categories:

1. **No Build (No Action) Alternative**: continuing the existing operations and maintenance of the historic swing (movable) bridge;
2. **Rehabilitation Alternative**: rehabilitating the existing bridge to extend its useful life by 100 years, a timeframe comparable to the useful life of a new bridge;
3. **Replacement Alternative – Movable Bridge**: constructing a new movable bridge, of either the bascule type or vertical lift type, on the same general alignment, and demolishing the existing bridge;
4. **Replacement Alternative – Fixed Bridge**: constructing a new fixed (non-movable) bridge on the same or a different general alignment and demolishing the existing bridge.

The parameters considered in the development and evaluation of alternatives and design options included:

- Horizontal and vertical navigation clearances
- Track spacing for center tracks
- Span length
- Counterweight locations
- Pier locations
- Mechanical systems
- Electrical systems
- Bridge aesthetics, including historic considerations
- Environmental considerations
- Resiliency
- Redundancy
- Constructability
- Rail, marine, and local impacts during construction
- Cost, including initial costs and life cycle costs

More than 70 different design variations within the four groups of alternatives were initially investigated to identify representative options that consider these parameters and meet the project purpose and need. CTDOT identified and developed concepts to replace the existing Walk Bridge with dual, double-track movable spans in accordance with the design objectives for resiliency and redundancy. For a bascule

[1] Notice of Funding Availability for Resilience Projects in Response to Hurricane Sandy, 78 FR 78486.

movable bridge, design options included deck girder, through girder and through truss bascule bridges of both the trunnion and rolling lift genre.[2] For a vertical lift movable bridge, design options included deck girder, through girder, or through truss vertical lift bridges with span-drive or tower-drive lift span operating systems.[3]

CTDOT held multiple meetings with public agencies and project stakeholders, including the USACE, USCG, the City of Norwalk, Metro-North, property owners, and waterway users to ascertain concerns and requirements for the replacement bridge design and to obtain public and agency input. CTDOT also held a public scoping meeting on February 24, 2015, an agency scoping meeting on March 5, 2015, and a public information meeting on May 11, 2016. With input from these meetings, CTDOT concluded that the evaluation of alternatives would focus on replacement of the bridge and would include consideration of a bascule movable bridge type, a through truss vertical lift movable bridge type, as well as a fixed bridge (non-movable) type with three design options of varied vertical clearances over the Norwalk River: a low-level, a mid-level, and a high-level bridge.

2.3. Alternatives Not Advanced for Further Evaluation

Of the four alternative groups which were evaluated, three groups were dismissed from further evaluation for a number of reasons: they would not meet the project purpose and need; they would be inferior to other alternatives in meeting project purpose and need; they would result in higher initial or long-term costs; or they would have a higher potential for adverse environmental impact. The alternatives not advanced for further evaluation consist of the following, and the reasons for not advancing these alternatives and design options are summarized in Table 2-1:

- **Rehabilitation Alternative.**
- **Replacement Alternative –Fixed Bridge**, all options.
- **No Build Alternative** (although this alternative is carried forward as a baseline condition for comparison purposes).

Table 2-1—Alternatives Not Advanced

Alternative/Option	Reasons for Not Advancing
Rehabilitation Alternative	Would not meet purpose and need with regard to structural age and deterioration, reliability, resiliency, safety standards, redundancy, operational flexibility, maintenance, rail capacity and efficiency, dependability and capacity for marine traffic, and sustainability.
Replacement Alternative – Fixed Bridge: Low-Level Option	Would not meet purpose and need with regard to dependability and capacity for marine traffic.
Replacement Alternative – Fixed Bridge: Mid-Level Option	Would not meet purpose and need with regard to dependability and capacity for marine traffic.
Replacement Alternative – Fixed Bridge: High-Level Option	High environmental impacts. High costs.
No Build Alternative	Would not meet purpose and need with regard to structural age and deterioration, reliability, resiliency, safety standards, redundancy, operational flexibility, maintenance, rail capacity and efficiency, dependability and capacity for marine traffic, and sustainability, but advanced to describe future no-action transportation conditions for comparison.

[2] See Chapter 11, Acronyms and Glossary of Terms, for descriptions.
[3] See Chapter 11, Acronyms and Glossary of Terms, for descriptions.

The following is a brief overview of these alternatives along with more detail about the reasons for not advancing them further. An overview of the No Build Alternative and the reasons for dismissal are included in Section 2.4.1. Additional information on the impacts of the No Build Alternative is presented in Chapter 3.

2.3.1. Rehabilitation Alternative

The Rehabilitation Alternative would require rehabilitation or replacement of the existing Walk Bridge elements that would extend the bridge's design life by an additional 100 years, which is comparable to a new bridge's design life.

The Rehabilitation Alternative would include measures to increase the structural and seismic capacity of the existing bridge, portions of the existing retaining walls, and high tower structures. To remedy corrosion, section loss and insufficient load ratings of the bridge superstructure, all elements exhibiting minor section loss would be strengthened, and all elements exhibiting major section loss would be replaced. Existing rivets would be replaced with high-strength bolts. All structural steel would be cleaned and coated. To address fatigue concerns, stringers and floorbeams would be replaced. All tension diagonals and truss chords would be replaced, as would gusset plates and connections. Other structural elements would be strengthened or replaced as required for increased live load capacity and seismic resistance. A combination of micropile and drilled shafts would be required to improve the stability and load carrying capacity of the existing foundations.

Although some swing span machinery has been replaced, the amount of current and predicted deterioration and wear is an issue that can only be eliminated by replacement of all operation machinery. Additionally, a complete replacement of the obsolete electrical service would be necessary to improve its electrical rating.

Repairs or partial replacements have been accomplished over the past 10 years on fender systems as well as on some track, signal and communication systems. However, in order to extend their functionality in the long term, full replacement of the fenders and track, signal, and communication systems is warranted.

Construction of a temporary, two-track bridge placed on an alignment immediately north of the existing bridge would be needed to allow for access to strengthen the existing masonry piers and to perform repairs on the existing structural, mechanical and electrical systems. Once this temporary bridge, or "runaround," becomes functional, train operations would shift from the existing bridge to the runaround bridge. This enables many rehabilitation measures to be completed while still accommodating rail service on the runaround. However, since the temporary runaround structure would not include a movable span and would also have a fixed bottom of structure elevation above Mean High Water, marine traffic would be limited to only those vessels that would fit under the runaround track structure. Replacement of the drive system and associated components also would require a complete channel outage.

The initial program cost of the Rehabilitation Alternative is estimated to range between $425 and $475 million.

The Rehabilitation Alternative was not advanced because it would not meet the project needs as detailed in Table 2-2.

Table 2-2—Project Needs Evaluation of the Rehabilitation Alternative

Project Needs[a]	Rehabilitation Alternative
Structure age and deterioration	Many structural elements require replacement. Extended construction schedule would be required for rehabilitation. Full track closures would be required for some improvements. Unknown potential problems in installation and fit-up with rehabilitating an old structure could extend schedule and costs beyond what is forecast. This need would not be fully met.
Decreasing reliability	Initial improvement in reliability due to replacement of key components, but systems would revert to current conditions resulting in unreliability. This need would not be met.
Lack of resiliency	Key mechanical and electrical systems would remain vulnerable to coastal storm events and temperature extremes. Provision of an emergency generator could improve reliability in some circumstances. This need would not be fully met.
Safety standards	The bridge does not meet current design standards which reflect improved safety aspects. This need would not be met.
Lack of redundancy	Overall system redundancy would not be enhanced. This need would not be met.
Limited operational flexibility	The operational limitations of the existing bridge would not be improved. This need would not be met.
Difficulty of maintenance	Certain maintenance would require a full bridge closure, presenting logistical problems for train and marine traffic. This need would not be met.
Reduced rail capacity and efficiency	Long term reliability would not be improved thereby resulting in potentially reduced capacity on the NHL. This need would not be met.
Reduced dependability and capacity for marine traffic	Long term reliability would not be improved thereby resulting in continued dependability and capacity issues for marine traffic. This need would not be met.
Lack of sustainability	Although bridge rehabilitation would improve conditions in the near-term, rehabilitation would not result in a sustainable bridge in the long term. This need would not be met.

Note: a. Project Needs are the existing bridge deficiencies as defined in the project purpose and need.

2.3.2. Replacement Alternative – Fixed Bridge

Three fixed span bridge replacement options were developed and not advanced for further evaluation. The evaluation of the alternative options relative to project purpose and need is detailed in Table 2-3. The low-level bridge option would reduce the capacity for marine traffic passing beneath the bridge and therefore would not meet this part of the project purpose and need. The high-level bridge option would meet all aspects of the purpose and need, but it would result in a high level of environmental impact because the bridge and approaches would be on a much higher vertical alignment and would be more than three times as expensive as the other fixed bridge options. Similar to the low-level bridge option, the mid-level bridge option would reduce the capacity for marine traffic crossing under the bridge, albeit to a lesser extent than the low-level bridge. Therefore the mid-level bridge option would not meet this part of the project purpose and need.

Table 2-3—Project Needs Evaluation of the Fixed Bridge Options

Project Needs[a]	Fixed Bridge Low-Level Option	Fixed Bridge Mid-Level Option	Fixed Bridge High-Level Option
Structure age and deterioration	As a replacement bridge, this need would be met.	As a replacement bridge, this need would be met.	As a replacement bridge, this need would be met.
Decreasing reliability	As a fixed bridge, the reliability of a movable bridge would not be an issue and therefore this need would be met.	As a fixed bridge, the reliability of a movable bridge would not be an issue and therefore this need would be met.	As a fixed bridge, the reliability of a movable bridge would not be an issue and therefore this need would be met.
Lack of resiliency	As a fixed bridge, the susceptibility of movable bridge mechanical and electrical systems would not be an issue. Clearance above the 500 year flood elevation would be provided. This need would be met.	As a fixed bridge, the susceptibility of movable bridge mechanical and electrical systems would not be an issue. Clearance above the 500 year flood elevation would be provided. This need would be met.	As a fixed bridge, the susceptibility of movable bridge mechanical and electrical systems would not be an issue. Clearance above the 500 year flood elevation would be provided. This need would be met.
Safety standards	As a replacement bridge designed and built to current standards, this need would be met.	As a replacement bridge designed and built to current standards, this need would be met.	As a replacement bridge designed and built to current standards, this need would be met.
Lack of redundancy	As a fixed bridge, structural redundancy can be designed into the structure and mechanical and electrical systems redundancy is not an issue. This need would be met.	As a fixed bridge, structural redundancy can be designed into the structure and mechanical and electrical systems redundancy is not an issue. This need would be met.	As a fixed bridge, structural redundancy can be designed into the structure and mechanical and electrical systems redundancy is not an issue. This need would be met.
Limited operational flexibility	As a replacement bridge designed and built to current standards, this need would be met.	As a replacement bridge designed and built to current standards, this need would be met.	As a replacement bridge designed and built to current standards, this need would be met.
Difficulty of maintenance	As a replacement bridge, designed and built to current standards, this need would be met.	As a replacement bridge, designed and built to current standards, this need would be met.	As a replacement bridge, designed and built to current standards, this need would be met.
Reduced rail capacity and efficiency	As a replacement bridge designed and built to current standards, reliability and other factors affecting rail capacity and efficiency are not issues. Therefore, this need would be met.	As a replacement bridge designed and built to current standards, reliability and other factors affecting rail capacity and efficiency are not issues. Therefore, this need would be met.	As a replacement bridge designed and built to current standards, reliability and other factors affecting rail capacity and efficiency are not issues. Therefore, this need would be met.
Reduced dependability and capacity for marine traffic	As a fixed bridge, the vertical clearance cannot be increased by opening the bridge. The vertical clearance is increased by 4 feet over the existing vertical clearance when closed but some boats will no longer be able to pass upstream of the Walk Bridge. This need would not be met.	As a fixed bridge, the vertical clearance cannot be increased by opening the bridge. The vertical clearance is increased by 18 feet over the existing vertical clearance when closed but some boats will no longer be able to pass upstream of the Walk Bridge. This need would not be met.	The vertical clearance would be the same as that provided under the upstream I-95 bridge. This need would be met.
Lack of sustainability	As a replacement bridge designed and built to current standards, this need would be met.	As a replacement bridge designed and built to current standards, this need would be met.	As a replacement bridge designed and built to current standards, this need would be met.

Note: a. Project Needs are the existing bridge deficiencies as defined in the project purpose and need.

Fixed Span – Low-Level Option

The low-level option would be a fixed bridge located on the existing horizontal and vertical alignments. For this option, the Norwalk River would be crossed by four deck plate girder spans, providing approximately 20 feet of vertical clearance above Mean High Water, four feet more than the existing bridge. There would be four bridge piers located in the river with spans of approximately 100 feet and a horizontal navigational clearance of approximately 70 feet. The total bridge length would be 865 feet. It would extend approximately 270 feet to the west of the existing bridge's west abutment, and approximately 30 feet to the east of the existing bridge's east abutment.

In addition, retaining walls approximately 100 feet long would be required at the west end of the low-level bridge option (not including cross over track, high tower, and OCS work).

CTDOT estimated the construction and program cost of the low-level option to range between $290 and $340 million. Life cycle costs, equalized to present worth of 100 year life, were estimated to range between $5.6 and $6.1 million per year.

Fixed Span – Mid-Level Option

The mid-level option would be a fixed bridge with a top of track profile approximately 7 feet higher than the existing bridge. For this option, the Norwalk River would be crossed by two deck plate girder spans to the west and two deck plate girder spans to the east of a 170-foot through plate girder navigation span. This bridge option would provide 34 feet of vertical clearance over Mean High Water, an increase of 18 feet over existing conditions. This span arrangement would place three piers in the river with a horizontal navigation clearance of approximately140 feet. The through plate girder, while minimizing structure depth, would change the horizontal railroad track alignment, because it would require more space between Tracks 1 and 2 than currently exists (approximately 25 feet as compared to the existing 12.5 feet). Similar to the low-level bridge option, the total bridge length of the mid-level option would be 865 feet. It would extend approximately 270 feet to the west of the existing bridge's west abutment, and approximately 30 feet to the east of the existing bridges east abutment.

Rail work would be required to accommodate the grade raise and change in horizontal alignment. Similar to the low-level option, this option would require retaining walls. Retaining wall lengths of 120 feet to the west and 1,000 feet to the east would be required. The rail work required to accommodate the grade raise would impact approximately 1,400 linear feet along the tracks (not including cross over track, high tower and OCS work).

CTDOT estimated the construction and program cost of the mid-level option to range between $320 and $370 million. Life cycle costs, equalized to present worth of 100 year life, were estimated to range between $4.3 and $4.8 million per year.

Fixed Span – High-Level Option

The high-level option would be a fixed bridge with a top of track profile approximately 35 feet higher than the existing bridge. The horizontal alignment would be similar to that of the mid-level bridge option. For this option, the navigational channel of the Norwalk River would be crossed by a 170-foot through plate girder span resulting in a 140 foot horizontal navigational clearance. This bridge option would provide 60 feet of vertical clearance, matching the vertical clearance of the upstream I-95 bridge. The through plate girder, while minimizing structure depth, would require more space between Tracks 1 and 2 than currently exists. The total bridge length is estimated to be 4,300 feet bridge and an additional 1,600 feet of rail work would be required to accommodate the large increase in grade. This additional rail work would extend approximately from the South Norwalk Station on the west to 600 feet beyond Osborne Avenue on the east. Approximately 1,000 feet of the Danbury Branch will require reconstruction in order to accommodate the re-connection to the main line tracks

CTDOT estimated the construction and program cost of the high-level option to be in excess of $1 billion. Life cycle costs, equalized to present worth of 100 year life, were estimated to range between $3.8 and $4.3 million per year.

2.4. Alternatives Retained for Further Evaluation

In addition to the **No Build Alternative**, CTDOT retained and advanced a **Build Alternative** for further evaluation in this EA/EIE: the **Replacement Alternative – Movable Bridge**. Two types of bridges were considered for the Build Alternative, both replacement movable bridges: a rolling lift bascule bridge was advanced; and, a through truss vertical lift bridge was advanced. A variation of the vertical lift bridge type with a longer span also was advanced. Respectively, the three options advanced are called Option 4S, Option 8A, and Option 11C, and they are described in Section 2.4.2. These options emanated from the considerations and screening of more than 70 options (refer to Section 2.2) and are representative of the bascule and vertical lift bridge types as a balance of user needs, engineering, environmental, cost, and constructability needs and constraints. As design progresses on a bridge type, design refinements such as modifying final span lengths and other dimensional attributes are possible.

2.4.1. No Build Alternative

The No Build Alternative would retain the existing bridge and provide for normal maintenance activities during the life of the bridge. There would not be any major rehabilitation or replacement of structural elements, foundation elements, mechanical components, or electrical systems. The existing high towers would be retained and undergo normal maintenance by the owner. This alternative is carried forward for evaluation to describe the transportation conditions if no actions other than normal maintenance were conducted, and for comparison to the Build Alternative. However, the No Build Alternative would not meet the purpose and needs, as detailed in Table 2-4.

Table 2-4—Project Needs Evaluation of the No Build Alternative

Project Needs[a]	No Build Alternative
Structure age and deterioration	Normal maintenance would not prolong the structure's useful life. This need would not be met.
Decreasing reliability	Bridge failures would likely increase and worsen. This need would not be met.
Lack of resiliency	Key mechanical and electrical systems would continue to be vulnerable to storm surges and other weather events. This need would not be met.
Safety standards	Current design standards for safety, which are currently not met, would remain unmet. This need would not be met.
Lack of redundancy	Single structure causes closure of all tracks if bridge fails and for some maintenance activities. This need would not be met.
Limited operational flexibility	This need would not be met.
Difficulty of maintenance	Full closure of all tracks would be required for some maintenance activities. This need would not be met.
Reduced rail capacity and efficiency	The unreliable nature of the bridge would reduce capacity on the NHL. This need would not be met.
Reduced dependability and capacity for marine traffic	Bridge failures would obstruct marine traffic. This need would not be met.
Lack of sustainability	Increased maintenance would be required and the bridge could eventually fail to operate, causing stoppages of rail and marine traffic. This need would not be met.

Note: a. Project Needs are the existing bridge deficiencies as defined in the project purpose and need.

Figure 2-1 presents a rendering of the existing Walk Bridge. Figure 2-2 presents an elevation of the existing Walk Bridge.

Figure 2-1—Rendering of the Existing Swing Span

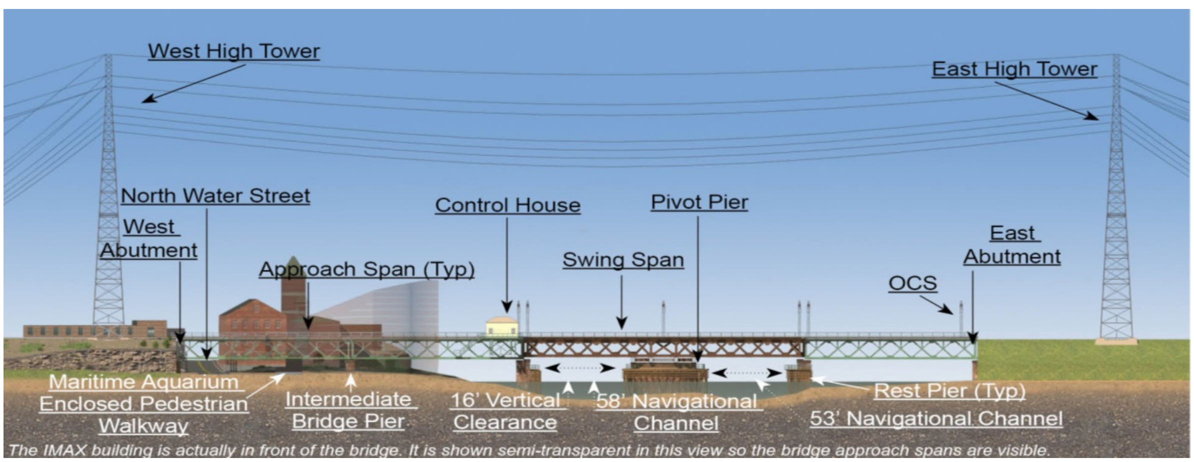

Figure 2-2—Existing Swing Span – Elevation View

2.4.2. Build Alternative: Replacement Alternative – Movable Bridge

Bascule Bridge Option (Option 4S)

A bascule bridge (Figure 2-3, Figure 2-4, and Figure 2-5) would provide two side-by-side single-leaf rolling lift bascule spans across the Norwalk River, each with separate mechanical and electrical equipment and controls so that each span can work independently of the other, or in unison with the other. Option 4S was chosen for analysis in this document as representative of a bascule movable bridge that meets project purpose and need and balances user needs, engineering, constructability, environmental impacts, and costs. It would provide a vertical clearance of approximately 27 feet above mean high water when the movable span is in the closed position, and a vertical clearance of at least 60 feet, when the movable span is in the opened position, as shown on the elevation view of the bascule bridge, Figure 2-5. When closed, the vertical clearance of Option 4S is increased by approximately 11 feet over the existing vertical clearance of 16 feet due to the configuration of the structure. However, the top of rail elevations on the new bridge would be approximately the same as the top of rail elevations on the existing bridge. A horizontal clearance of at least 120 feet would be provided for navigation, and the alignment of the navigation channel under the new bridge with the alignment of the navigation channel under the Stroffolino Bridge would be improved.

Figure 2-3—Rendering of Bascule Bridge in the Closed Position (Option 4S)

The rolling bascule spans would be comprised of 170 foot movable truss spans with overhead counterweights. As the span moves, the structure would be supported by curved segmental girders that are connected to the bascule span and the counterweight. As the span rotates during movements, it would also translate, or roll, horizontally, with the movements guided by the curved segmental girder. The overhead counterweights would be configured to permit the counterweights to pass to the outside of the adjacent fixed approach spans. The drive machinery, electrical components, and controls for operating the span would be located above track level, improving the resiliency of the systems by offering protection from high water events.

The new movable spans would each carry two tracks: Tracks 1 and 3 on the northern span and Tracks 2 and 4 on the southern span. The tracks would be on a non-parallel alignment with adequate spacing between the two center tracks (Tracks 1 and 2) to accommodate structural and mechanical clearances. With this non-parallel alignment, the total width of the two bridge structures would vary from approximately 50 feet at the western abutment to 95 feet at the eastern abutment. The movable spans would be flanked by four spans on the western side and two spans on the eastern side. These approach spans would be fixed spans and would not move. Including the approach spans, the total length of Walk Bridge would be approximately 650 feet from bridge abutment to bridge abutment.

Figure 2-4—Rendering of Bascule Bridge in the Open Position (Option 4S)

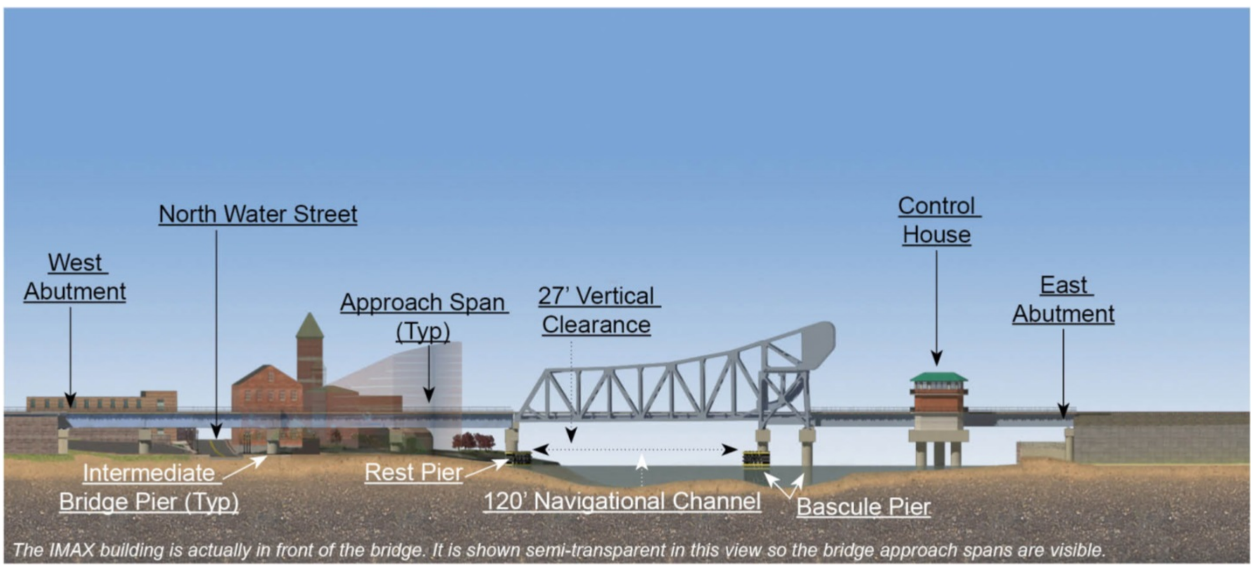

Figure 2-5—Elevation View of the Bascule Bridge (Option 4S), Span Closed

The bridge would be supported by new abutments at each end and by six intermediate bridge piers, including the bascule pier and the bascule rest pier. The foundations for the bascule piers, rest pier, and intermediate pier supporting the control house would all be located in the Norwalk River and would be comprised of drilled shafts installed into bedrock with a cap beam connecting the drilled shafts. The western bridge abutment would be located approximately 100 feet further west than the existing abutment to avoid construction conflicts with the existing abutment, high tower foundations, and retaining walls. Although not the intent of the abutment relocation, this action would result in a more open environment on the west side of North Water Street under the bridge. A new control house would be located on the southern end of the intermediate pier.

The bascule pier would consist of two adjacent, open piers that support the rolling bascule span structural elements. Drilled shafts with cap beams would make up the bascule pier foundations. The open nature of the substructure would promote hydraulic flow through the limits of the bridge.

A new fender system would be constructed approximately 10 feet from the new bascule and rest piers to protect them, providing at least 120 feet of horizontal clearance in the navigation channel. The fenders would be supported by concrete, steel or composite material piles. Navigational lighting in accordance with USCG standards would be installed.

In addition to replacement of Walk Bridge, the project would include other improvement elements as shown on Figure 2-6. The railroad corridor approaching the bridge from the west would be on retained fill. The existing retaining walls would be replaced with new retaining walls along both sides of the corridor for a distance of approximately 350 feet. These two new retaining walls would be constructed within the railroad right-of-way in the same general location as the existing retaining walls. The work would not extend to the Danbury Branch interlocking but would end approximately 100 feet east of this interlocking, which is approximately 250 feet east of the existing Washington Street Bridge.

East of Walk Bridge, the project would continue on the existing railroad corridor location with construction of new retaining walls within the existing right-of-way on both the northern and southern sides of the corridor. The project would extend east to a point approximately 300 feet east of the Fort Point Street Bridge. The railroad bridge over Fort Point Street would be replaced, including replacement of the existing superstructure and bridge abutments. This is necessary to accommodate the diverging track alignments for the two non-parallel Walk Bridges. The Fort Point Street Bridge abutments may be constructed in the same general location as the existing bridge abutments, or may be pulled back to accommodate a wider Fort Point Street below. CTDOT would continue to work with the City of Norwalk as design progresses to determine the abutment locations and span length of this bridge.

Track, catenary, and signal work would be performed in addition to the work to replace Walk Bridge. Track work would include replacing about one-half mile of tracks and ballast within the existing railroad right-of-way from approximately the Washington Street Bridge to approximately 300 feet east of the Fort Point Street Bridge. Overhead catenary and supports would be replaced within the limits of the project, generally from the Washington Street Bridge to a point approximately 300 feet east of the Fort Point Street Bridge. All approach track, catenary and signal work for the project would be within the existing state right-of-way.

The existing Walk Bridge and fender system would be dismantled and removed. This would include removal of the foundations and fender supports in the river to a depth to be determined in consultation with USACE and USCG. The existing western bridge abutment would be removed in its entirety, while the eastern abutment would be retained and partially lowered so that the remaining portions of the abutment can be used as a retaining wall to support an extension of the bike/pedestrian trail north of the bridge to areas south of the bridge.

The probable construction cost of the Bascule Bridge (Option 4S) is estimated to range between $330 and $365 million in year 2020 dollars, which is the anticipated mid-point of construction. Life cycle costs, equalized to present worth of 100 year life, are estimated to range between $3.4 and $3.9 million per year.

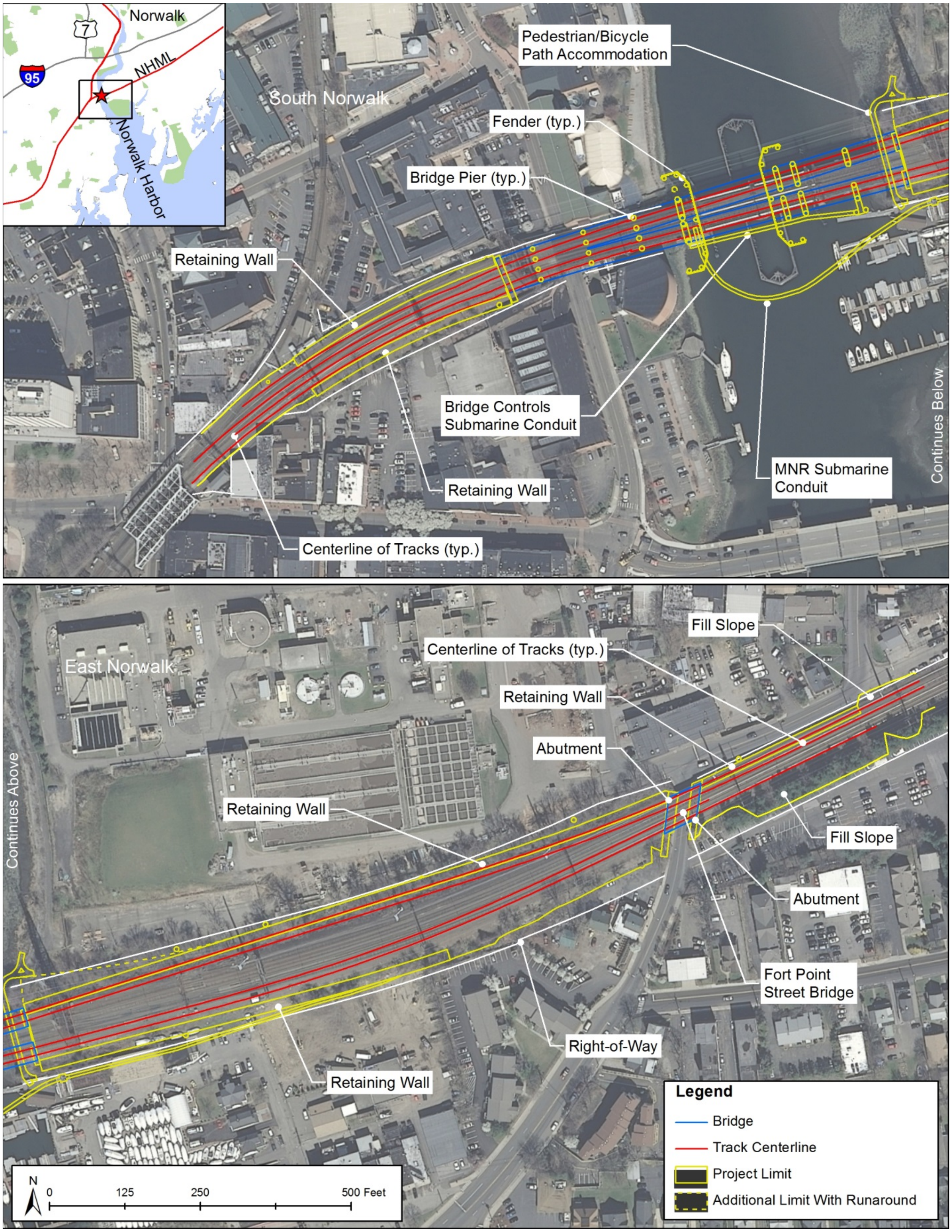

Figure 2-6—Illustration of the Project Limits with the Bascule Bridge (Option 4S)

Vertical Lift Bridge Option (Option 8A - Short Span)

A vertical lift bridge (Figure 2-7, Figure 2-8 and Figure 2-9) would provide two side-by-side vertical lift spans across the Norwalk River, each with separate mechanical and electrical equipment and controls so that each span can work independently of the other, or in unison with the other. Option 8A was chosen for analysis in this document as representative of a short span vertical lift movable bridge that meets project purpose and need and balances user needs, engineering, constructability, environmental impacts, and costs. A span-drive vertical lift bridge with a 170-foot open-deck through-truss lift span would provide a minimum of 120 feet of horizontal navigational clearance and 60 feet of vertical clearance when the span is fully raised. There would be two separate lift spans, one through-truss span for Tracks 1 and 3 and one through-truss span for Tracks 2 and 4, providing system redundancy. The tracks would be on a parallel alignment across the Norwalk River, resulting in the two movable spans being parallel with one another. Track spacing between Tracks 1 and 2 would be 25 feet to allow for structural and mechanical system clearance between the adjacent lift spans. The alignment of Tracks 1 and 3 would remain close to the current alignment, while the alignment of Tracks 2 and 4 would be shifted to the south to accommodate the increase in center track spacing. The total width of the bridge would be approximately 70 feet. As shown on Figure 2-9, the lift span would provide approximately 27 feet of vertical clearance above Mean High Water in the closed position, which would be approximately 11 feet more than the vertical clearance of the existing swing span. To achieve 60 feet of vertical clearance at mean high water, the lift span would be raised 35 feet above the profile of the existing bridge. The bridge tower heights would be determined during final design and would range between approximately 100 and 150 feet above the top of the support piers (the taller tower heights are shown).

Figure 2-7—Rendering of the Short Span Vertical Lift Bridge in the Closed Position (Option 8A)

The movable spans would be flanked by four spans on the western side and two spans on the eastern side. These approach spans would be fixed spans and would not move. Including the approach spans, the total length of Walk Bridge would be approximately 690 feet from bridge abutment to bridge abutment.

Figure 2-8—Rendering of the Short Span Vertical Lift Bridge in the Open Position (Option 8A)

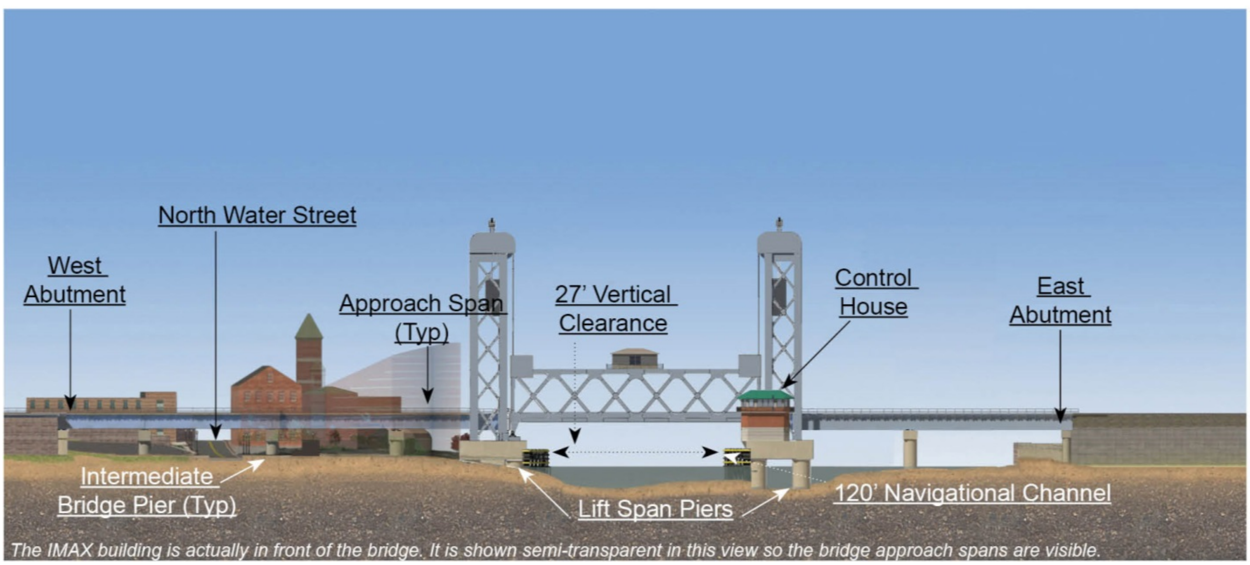

Figure 2-9—Elevation View of the Short Span Vertical Lift Bridge (Option 8A), Span Closed

The bridge would be supported by new abutments at each end and by six intermediate bridge piers, including the vertical lift bridge piers. The foundations for the vertical lift span piers and one intermediate pier would all be located in the Norwalk River and would be comprised of drilled shafts installed into bedrock, with a cap beam connecting the drilled shafts. The western bridge abutment would be located approximately 100 feet further west than the existing abutment to avoid construction conflicts with the existing abutment, high tower foundations, and retaining walls. Although not the intent of the abutment relocation, this action would result in a more open environment on the west side of North Water Street under the bridge. A new control house would be located on the southern end of the east vertical lift span pier.

A new fender system would be constructed approximately 10 feet from the new vertical lift span piers to protect them, providing at least 120 feet of horizontal clearance in the navigation channel. The fenders would be supported by concrete, steel or composite material piles. Navigational lighting in accordance with USCG standards would be installed.

In addition to replacement of Walk Bridge, the project would include other improvement elements as shown on Figure 2-10. Like the bascule movable bridge, the railroad corridor approaching the bridge from the west would be on retained fill. The existing retaining walls would be replaced with new retaining walls along both sides of the corridor for a distance of approximately 350 feet. These two new retaining walls would be constructed within the railroad right-of-way in the same general location as the existing retaining walls. The work would not extend to the Danbury Branch interlocking but would end approximately 100 feet east of this interlocking, which is approximately 250 feet east of the existing Washington Street Bridge.

East of Walk Bridge, the project would continue on the existing railroad corridor location with construction of a new retaining wall within the existing right-of-way on the southern side of the corridor. A retaining wall would not be necessary on the north side of the corridor in the area from the Walk Bridge to Fort Point Street. The project would extend east to a point approximately 300 feet east of the Fort Point Street Bridge. The railroad bridge over Fort Point Street would be replaced. The Fort Point Street Bridge abutments may be constructed in the same general location as the existing bridge abutments, or may be pulled back to accommodate a wider Fort Point Street below. CTDOT will continue to work with the City of Norwalk as design progresses to determine the abutment locations and span length of this bridge.

Track, catenary, and signal work would be performed in addition to the work to replace Walk Bridge. Track work would include replacing about one-half-mile of tracks and ballast within the existing railroad right-of-way from approximately the Washington Street Bridge to approximately 300 feet east of the Fort Point Street Bridge. Overhead catenary and supports would be replaced within the limits of the project, generally from the Washington Street Bridge to a point approximately 300 feet east of the Fort Point Street Bridge. All approach track, catenary and signal work for the project would be within the existing state right-of-way.

The existing Walk Bridge and fender system would be dismantled and removed. This would include removal of the foundations and fender supports in the river to a depth to be determined in consultation with USACE and USCG. The existing western bridge abutment would be removed in its entirety, while the eastern abutment would be retained and partially lowered so that the remaining portions of the abutment can be used as a retaining wall to support an extension of the bike/pedestrian trail north of the bridge to areas south of the bridge.

The probable construction cost of the short span Vertical Lift Bridge (Option 8A) is estimated to range between $380 and $415 million in year 2020 dollars, which is the anticipated mid-point of construction. Life cycle costs, equalized to present worth of 100 year life, were estimated to range between $3.4 and $3.9 million per year.

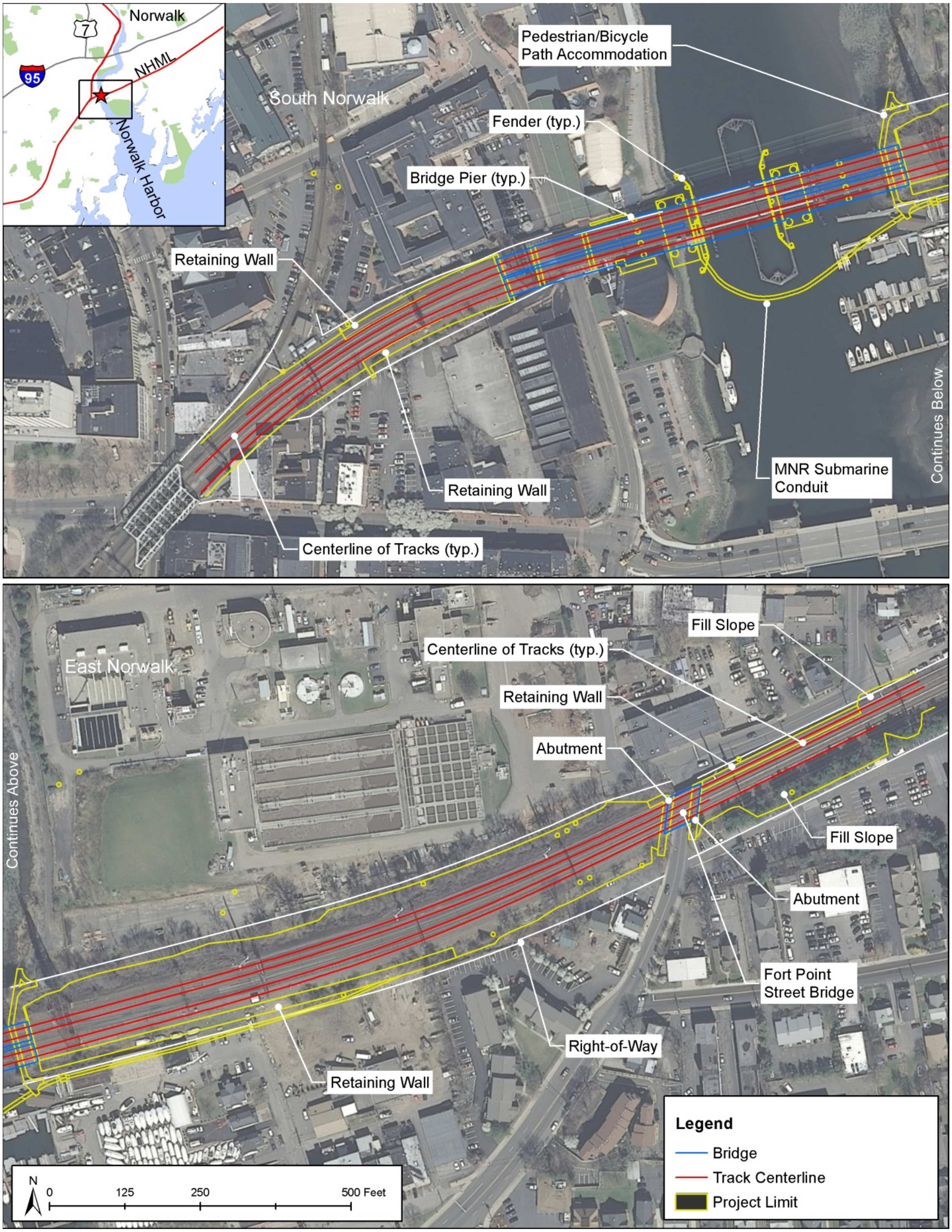

Figure 2-10—Illustration of the Project Limits with the Short Span Vertical Lift Bridge (Option 8A)

Vertical Lift Bridge Option (Option 11C - Long Span)

Like the short span vertical lift bridge, a long span vertical lift bridge (Figure 2-11, Figure 2-12, and Figure 2-13) would provide two side-by-side vertical lift spans across the Norwalk River, each with separate mechanical and electrical equipment and controls so that each span can work independently of the other, or in unison with the other. Option 11C was chosen for analysis in this document as representative of a long span vertical lift movable bridge that meets project purpose and need and balances user needs, engineering, constructability, environmental impacts, and costs. A vertical lift bridge with a 240-foot open-deck through-truss lift span would provide a minimum of 200 feet of horizontal navigational clearance and 60 feet of vertical clearance when the span is fully raised. There would be two separate lift spans, one through-truss for Tracks 1 and 3 and one through-truss for Tracks 2 and 4, providing system redundancy. The tracks would be on a parallel alignment across the Norwalk River, resulting in the two movable spans being parallel with one another. Track spacing between Tracks 1 and 2 would be 25 feet to allow for structural and mechanical clearance between the lift spans. The alignment of Tracks 1 and 3 would remain close to the current alignment, while the alignment of Tracks 2 and 4 would be shifted to the south to accommodate the increase in center track spacing. The total width of the bridge would be approximately 70 feet. As shown on Figure 2-13, the lift span would provide approximately 27 feet of vertical clearance in the closed position, which would be approximately 11 feet more than the vertical clearance of the existing swing span. To achieve 60 feet of vertical clearance at mean high water, the lift span would be raised 35 feet above the profile of the existing bridge. Like the short span vertical lift bridge, Option 11C's bridge tower heights will be determined during final design and would range between approximately 100 and 150 feet above the top of the support piers (the taller tower heights are shown).

Figure 2-11—Rendering of the Long Span Vertical Lift Bridge in the Closed Position (Option 11C)

The movable spans would be flanked by four spans on the western side and one span on the eastern side. These approach spans would be fixed spans and would not move. Including the approach spans, the total length of the Walk Bridge would be approximately 690 feet from bridge abutment to bridge abutment.

Figure 2-12—Rendering of the Long Span Vertical Lift Bridge in the Open Position (Option 11C)

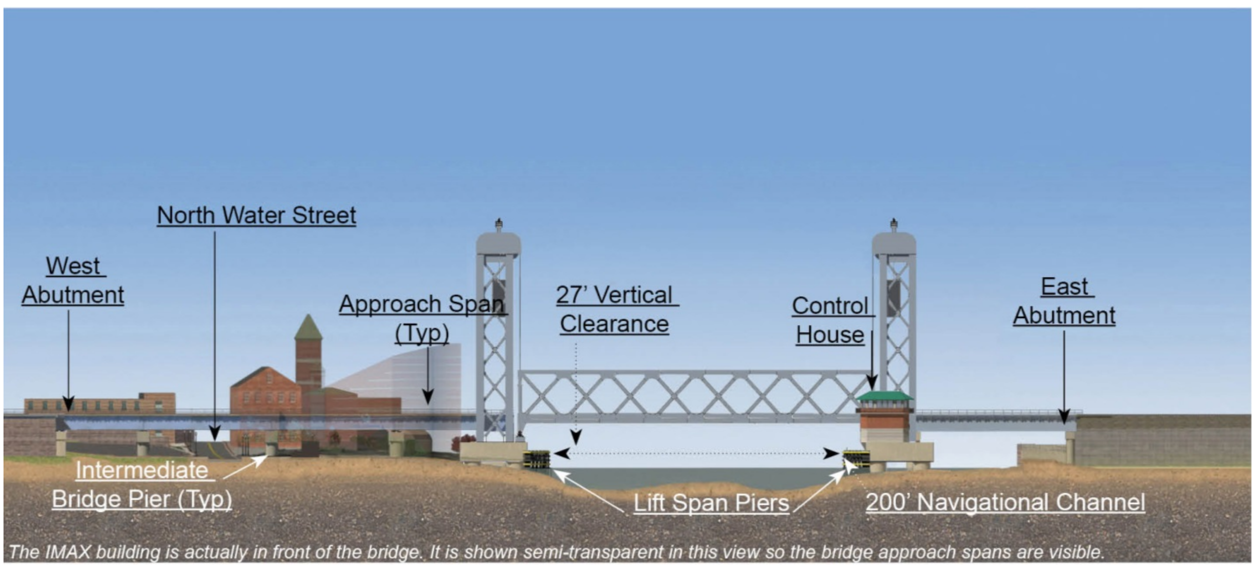

Figure 2-13—Elevation View of the Long Span Vertical Lift Bridge (Option 11C)

The bridge would be supported by new abutments at each end and by five intermediate bridge piers, including the vertical lift bridge piers. The eastern lift pier would be located further east than the eastern lift pier for the short-span vertical lift bridge (Option 8A), thus increasing the span length and the horizontal clearance between the vertical lift bridge piers. Both piers supporting the vertical lift span towers would be placed outside of the limits of the existing swing span, with no new foundation construction occurring in either the west or east navigation channels, as currently defined by the existing swing span. The foundations for the vertical lift span piers would be located in the Norwalk River and would be comprised of drilled shafts installed into bedrock, with a cap beam connecting the drilled shafts. The western bridge abutment would be located approximately 100 feet further west than the existing abutment to avoid construction conflicts with the existing abutment, high tower foundations, and retaining walls. Although not the intent of the abutment relocation, this action would result in a more open environment on the west side of North Water Street under the bridge. A new control house would be located on the southern end of the east vertical lift span pier.

A new fender system would be constructed approximately 10 feet from the new vertical lift span piers to protect them, providing at least 200 feet of horizontal clearance in the navigation channel. The fenders would be supported by concrete, steel, or composite piles. Navigational lighting in accordance with USCG standards would be installed.

The differences between the short span (Option 8A) and long span (Option 11C) options lie in the pier placement and span length between the east and west bridge abutments of the Walk Bridge, as just described. Beyond these abutments, the improvements to the corridor approaching the Walk Bridge would be the same for the short span or long span options of the vertical lift bridge, as shown on Figure 2-14. The railroad corridor approaching the bridge from the west would be on retained fill. The existing retaining walls would be replaced with new retaining walls along both sides of the corridor for a distance of approximately 350 feet. These two new retaining walls would be constructed within the railroad right-of-way in the same general location as the existing retaining walls. The work would not extend to the Danbury Branch interlocking but would end approximately 100 feet east of this interlocking, which is approximately 250 feet east of the existing Washington Street Bridge.

East of Walk Bridge, the project would continue on the existing railroad corridor location with construction of a new retaining wall within the existing right-of-way on the southern side of the corridor. A retaining wall would not be necessary on the north side of the corridor in the area from the Walk Bridge to Fort Point Street. The project would extend east to a point approximately 300 feet east of the Fort Point Street Bridge. The railroad bridge over Fort Point Street would be replaced. The Fort Point Street Bridge abutments may be constructed in the same general location as the existing bridge abutments, or may be pulled back to accommodate a wider Fort Point Street below. CTDOT will continue to work with the City of Norwalk as design progresses to determine the abutment locations and span length of this bridge.

Track, catenary, and signal work would be performed in addition to the work to replace Walk Bridge. Track work would include replacing about one-half-mile of tracks and ballast within the existing railroad right-of-way from approximately the Washington Street Bridge to approximately 300 feet east of the Fort Point Street Bridge. Overhead catenary and supports would be replaced within the limits of the project, generally from the Washington Street Bridge to a point approximately 300 feet east of the Fort Point Street Bridge. All approach track, catenary and signal work for the project would be accomplished within the existing state right-of-way.

The existing Walk Bridge and fender system would be dismantled and removed. This would include removal of the foundations and fender supports in the river to a depth to be determined in consultation with USACE and USCG. The existing western bridge abutment would be removed in its entirety, while the eastern abutment would be retained and partially lowered so that the remaining portions of the abutment can be used as a retaining wall to support an extension of the bike/pedestrian trail north of the bridge to areas south of the bridge.

The probable construction cost of the long span Vertical Lift Bridge (Option 11C) is estimated to range between $425 and $460 million in year 2020 dollars, which is the anticipated mid-point of construction. Life cycle costs, equalized to present worth of 100 year life, were estimated to range between $3.7 and $4.2 million per year.

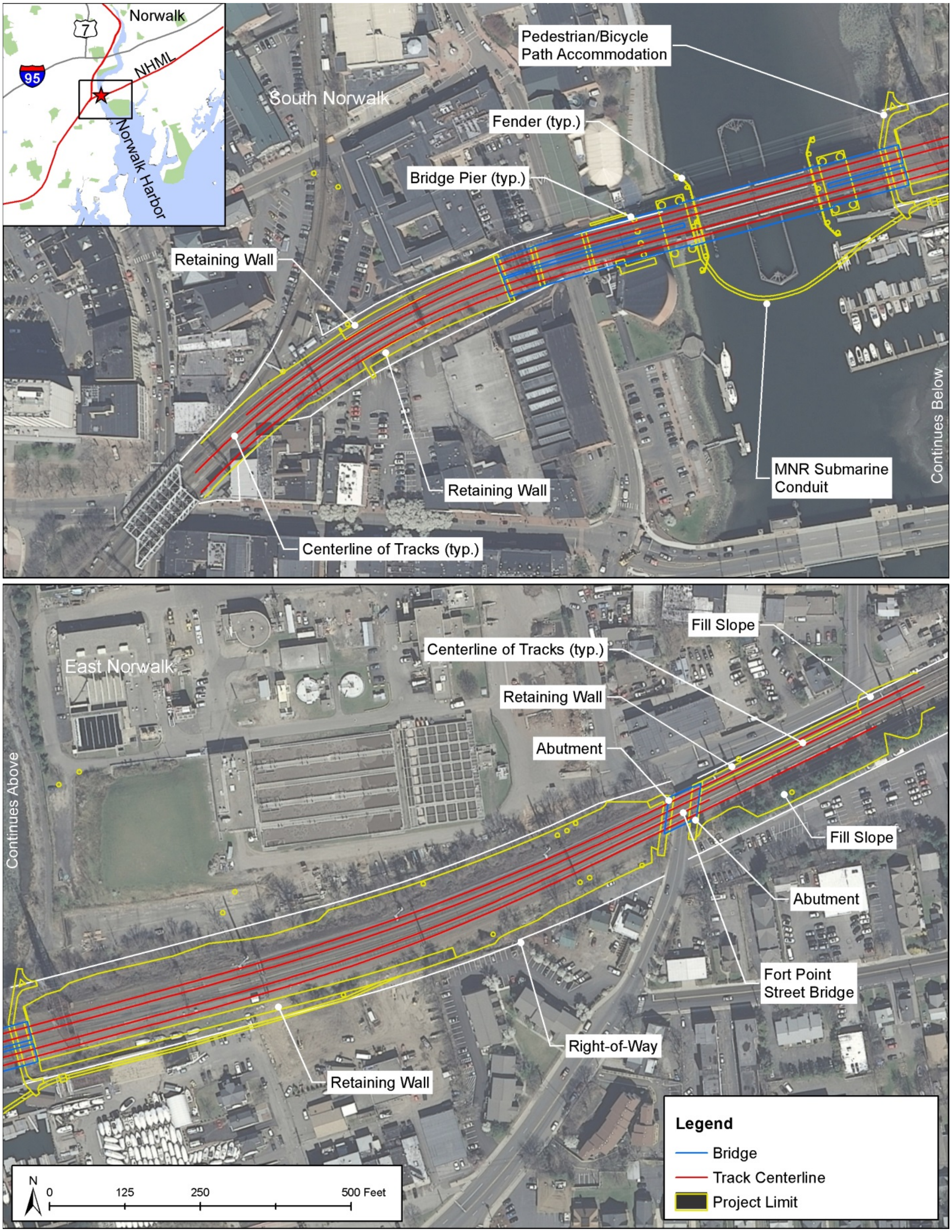

Figure 2-14—Illustration of the Project Limits with the Long Span Vertical Lift Bridge (Option 11C)

Removal of High Towers

The three options for replacing the Walk Bridge all require the removal of the two existing high towers which carry Eversource Energy high voltage power and Metro-North Railroad communications over the Norwalk River. These towers do not meet current structural design standards and will conflict with the replacement bridge and associated track alignments. Several options for replacement of the utility functions that exist on the high towers are under consideration from engineering, cost, environmental, and historical perspectives. Metro-North communication functions will potentially be carried on the new bridge on either side of the movable span, transitioning to a placement beneath the Norwalk River at the navigation channel, as shown on Figure 2-6, Figure 2-10, and Figure 2-14. Engineering studies are being undertaken, and coordination is underway with Metro-North Railroad, Eversource, the State Historic Preservation Office (CT Department of Economic and Community Development), historic stakeholders, and the City of Norwalk to determine the best option for replacing the utility functions that exist on these high towers, including a new alignment. The Eversource power relocation will undergo a separate environmental evaluation and permitting process, including potential CT Siting Council review, among other reviews, where there will be opportunities for public review and comment. Eversource Energy will be responsible for relocating its lines and the associated environmental evaluations and permits. CTDOT will be responsible for removing the existing high towers as part of the Walk Bridge Replacement Project.

Dredging for a Wider Navigation Channel

Because the existing bridge's support piers will be removed, including the swing span's pivot pier and rest piers, and protective fenders, the new bridge will provide for a wider navigational opening. Therefore, portions of the river under the bridge that are not currently maintained as part of the federal navigation channel, will be dredged to match the federal channel depth of ten feet and tie into the existing 125 foot navigation channel that exists upstream of the bridge. Channel dredging will be conducted using a hydraulic clamshell bucket during the approved in-water work months, typically November through January where containment is not required. The approximate amounts of dredged material are estimated at 4,100 cubic yards (cy) for the Bascule Bridge option and the short span Vertical Lift Bridge option, and 4,900 cy for the long span Vertical Lift Bridge option. Additional information on channel dredging is provided in Section 5.3.6.

A discussion of the existing aquatic resources and habitats affected, the potential impacts, and potential mitigation is provided in Section 3.14. Section 5.3.18 includes a discussion of the actions CTDOT will take during final design for testing and disposal of dredged sediments.

State and federal permits from CTDEEP OLISP, USCG, and ACOE will be required for dredging activities in the federal navigation channel, as described in Chapter 7.

2.5. Preferred Alternative

CTDOT considered the project purpose and need, engineering, constructability, potential impacts to rail and navigation traffic, estimated costs, and potential environmental impacts of the alternatives and options. With public input, CTDOT has determined that the **Build Alternative,** specifically the **Replacement Alternative – Movable Bridge, Long Span Vertical Lift Bridge (Option 11C),** is the preferred alternative. The Build Alternative is the only alternative that satisfies the project purpose and need. Each of the three design options for the Build Alternative would have similar environmental impacts. However, construction requirements and the associated impact to rail and navigation traffic, as well as the costs of the three design options, would be different.

The existing bridge, in whole or in part, is expected to remain in service throughout a significant portion of the construction duration. Maintaining the integrity of the existing bridge, in particular the foundations, is imperative to minimizing disruptions to rail and navigation traffic. Therefore, bridge replacement options requiring activities that limit proximity exposure of the existing bridge during construction are viewed favorably. For example, designs with foundations located in close proximity to the existing supports, specifically the pivot pier, exhibit more risk than other designs. Option 11C is the only alternative for which all foundations are located beyond the limits of the existing swing span.

Superstructure erection for all options will require a two-track outage. However, the amount of substructure work that can be completed without service disruptions (from a four-track operation to a two-track operation) would vary among the options. The design concept that allows for conducting the largest portion of substructure work in advance of an outage, along with the shortest period of superstructure construction, is expected to require the shortest overall construction duration. The shortest construction duration generally corresponds with the least disruptions to rail, maritime, and other users. Option 11C offers the greatest opportunity for maximum substructure construction prior to imposing a two-track outage, thereby minimizing the remaining duration of construction once the outage takes effect.

Designs that present fewer challenges during scheduled outages will have less risk of extending those outages and prolonging the disruptions to commuters and waterway users. The east movable span foundations for Option 4S and Option 8A would be located in the existing east navigation channel. Equipment access for float-in installation of the new lift spans is, therefore, obstructed by the existing pivot pier and limited to the west channel unless the pier is removed in advance of the span installation, indicating that additional temporary support is required for the tracks remaining in service. Option 4S also exhibits a highly asymmetric and unbalanced lift span configuration, further complicating a float-in installation. Symmetry and balance are favorable characteristics of Option 8A and Option 11C. Additionally, access to both channels would mitigate the pivot pier obstruction, presenting a potential advantage for Option 11C over Option 8A.

Work in the river is inherently riskier than work that is not in the water. For Option 11C, the elimination of the eastern intermediate approach span pier and the location of the east lift span tower foundation closer to shore, outside the navigation channel, and in shallower water (compared to Option 4S and Option 8A), introduce clear advantages regarding risks associated with in-water construction.

Option 11C exhibits navigation advantages over Option 4S and Option 8A by not blocking the east channel and thereby delaying immobilization of the swing span. Construction equipment can be operated on one side of the existing pivot pier while maintaining safe vessel transit through the bridge on the opposite side. Since the swing span would be operational until it is removed, over-height vessels could pass through the bridge, albeit on a restricted schedule that balances construction efficiency with the reasonable needs of safe, efficient navigation. Based on the configuration of the new movable spans and the associated track alignment, Option 11C does not require the use of a temporary runaround bridge during construction.

Option 8A introduces a vertical navigation restriction prior to completion of the lift span towers due to locking down the swing span for partial demolition or replacement with a non-movable temporary span. Option 4S requires removal of the existing bridge in the east channel to install the bascule pier foundations, thereby imposing a vertical restriction with temporary spans for drilled shaft installation, which is earlier in the construction sequence than Option 8A.

The environmental impacts of the three design options are comparable. All options would require that the historic Walk Bridge and high towers be demolished. Fort Point Street Bridge also would be replaced under all options. In general, all other environmental impacts would be similar. The bascule bridge option

(Option 4S) would require a wider bridge and project footprint on the east side of the Norwalk River than the two vertical lift bridge options. The footprint impacts of the options to natural resources would be comparable; however, the impacts of the bascule bridge to tidal wetlands, freshwater wetlands and subtidal habitat would be slightly higher than the vertical lift bridge options. When the impacts associated with a temporary runaround bridge are considered, some impacts would be further increased. In all cases, the long span vertical lift bridge option (Option 11C) would have the same or slightly less impact to natural resources than the short span vertical lift option (Option 8A).

The existing high towers present prominent vertical elements at the site and they contribute to the overall historic character of the project area. As previously noted, these latticed high towers must be removed. A potential advantage of the vertical lift bridge options (Option 8A and 11C) is that these options will reintroduce a prominent vertical element to the site and will offer flexibility, as the design advances, to retain this vertical element and continue to contribute to the character of the project area.

Figure 2-15 illustrates the estimated construction durations for each of the three design options. At approximately 40 months, Option 11C will require the shortest overall time from commencement of Walk Bridge construction to restoration of four-track service and full operation capability for marine traffic. This compares to 44 months for the short span vertical lift bridge (Option 8A) and to 47 months for the bascule bridge (Option 4S).

Figure 2-15 shows that more construction activities can be undertaken while the existing swing span is operational with Option 11C, thereby reducing the vertical navigation restrictions during construction by up to 14 months compared to the other two options. Two-track rail operation with Option 11C is four months shorter than Option 8A and seven months shorter than Option 4S, thus minimizing the duration of rail restrictions during construction. Construction of Option 11C will result in less disruption to rail service and navigational traffic during construction.

Temporary track outages, temporary channel restrictions or closures, and temporary street detours could potentially affect business operations in the area of construction. Selection of Option 11C minimizes this temporary disruption by minimizing the duration of construction activities, restrictions, or closures. As a result, this Option 11C corresponds with the least social and economic risks and impacts to the City of Norwalk and the larger region.

The estimated costs of Option 11C are higher than the other two design options. At an estimated construction cost between $365 million and $415 million, Option 11C would cost about 12 percent more than Option 8A ($325 million -$375 million) and about 10 percent more than Option 4S ($330 million - $380 million). Life cycle costs also would be highest for Option 11C at between $3.7 million and $4.2 million per year. This compares to annual life cycle costs ranging from $3.4 million to $3.9 million for Option 4S and $3.4 million to $3.9 million for Option 8A. CTDOT has determined that Option 11C's shorter construction duration and the reduced disruption to rail traffic along the NEC and navigation traffic on the Norwalk River, along with lower environmental impacts, outweighs the additional costs of Option 11C.

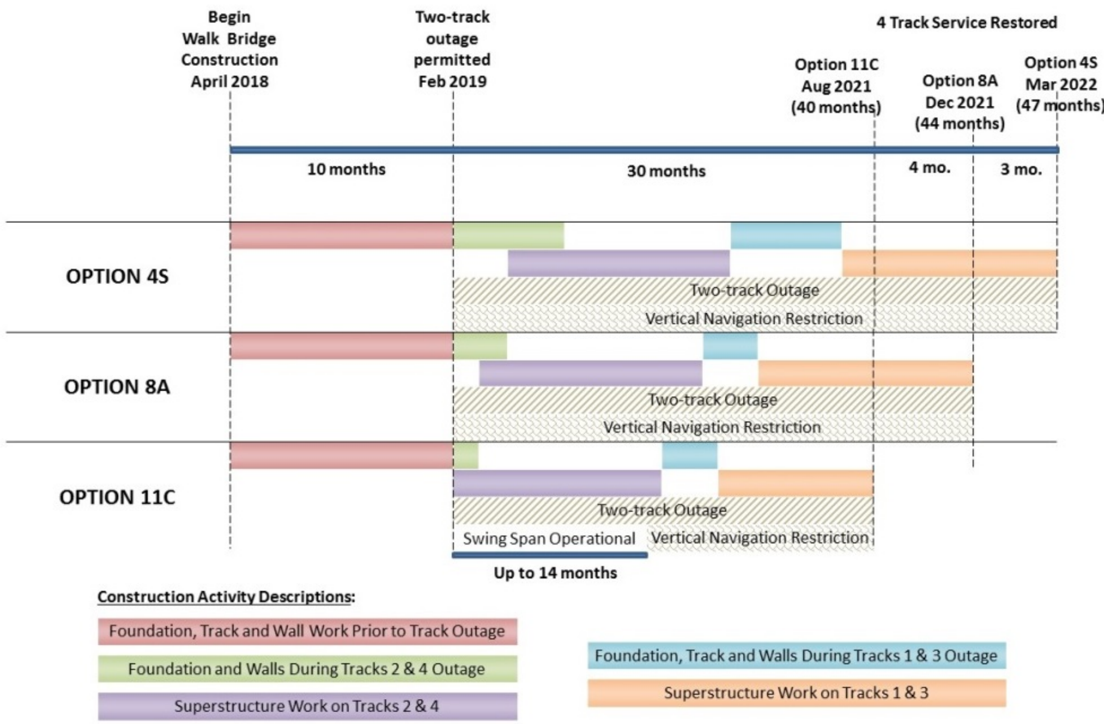

Figure 2-15 – Construction Schedule - Comparison of Bridge Options